RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

HEC-HMS PREPROCESSOR USER MANUAL AND HEC-HMS GUIDANCE DOCUMENT



Ver. 1.0; July 2016

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Disclaimer

The instructions in this manual should not be understood to be official instructions or training in Riverside County Flood Control and Water Conservation District (District) methods or the use of U.S. Army Corps of Engineers' HEC-HMS program. This document shall be used as a guide for preparing a HEC-HMS model that incorporates District methods outlined in the District's Hydrology Manual.

The District reserves the right to modify the preprocessor software without prior notification.

Introduction

In the past, the District has accepted synthetic unit hydrograph (SUH) models prepared with the U.S. Army Corps of Engineers' (Corps) HEC-1 program in conjuction with the LAPRE-1 Preprocessor. The HEC-1 software has been superceded by HEC-HMS and is no longer supported by the Corps. In an effort to allow the use of HEC-HMS for District projects, District staff has developed the HEC-HMS Preprocessor web-based program to assist the user in calculating input parameters for preparing a SUH model in HEC-HMS consistent with District methods. More specifically, the HEC-HMS Preprocessor incorporates the District's rainfall distribution patterns, areal adjustment factors, and loss rate methods to calculate the effective rainfall for the 1-, 3-, 6- and 24-hour storm durations. The Preprocessor has a calcualtor to determine lag time and also provides the S-graph ordinates to be input into HEC-HMS. The effective rainfall, lag time, and S-graph ordinates are copied and pasted into HEC-HMS.

This document provides guidance on how to use the District's HEC-HMS Preprocessor and how to model a watershed in HEC-HMS using the District's SUH method. Pages and Plates listed in this document refer to the District's Hydrology Manual. Links to the District's Hydrology Manual, District's HEC-HMS Preprocessor, and the Corps' HEC-HMS program are listed below.

District's Hydrology Manual

http://rcflood.org/downloads/Planning/Hydrology%20Manual%20-%20Complete.pdf

District's HEC-HMS Preprocessor Web-Based Program

http://www.rcflood.org/hechms/

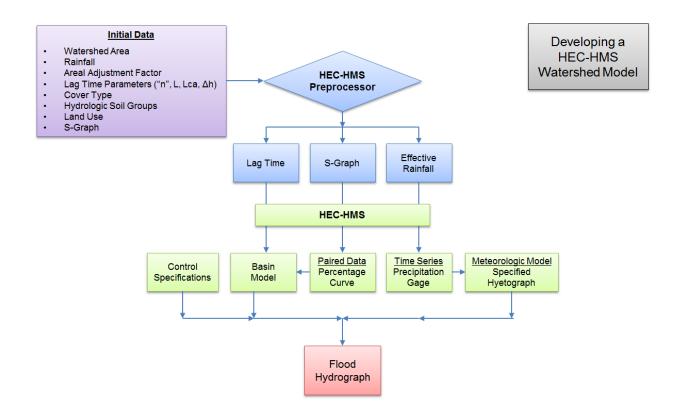
HEC-HMS (Hydrologic Engineering Center – Hydrologic Modeling System)

http://www.hec.usace.army.mil/software/hec-hms/downloads.aspx

Overview

In order to prepare input parameters for the HEC-HMS model, the following data must be processed in the District's HEC-HMS Preprocessor:

- Watershed area (sq. mi)
- Basin factor, "n" (Plate E-3)
- Point precipitation (in)
- Areal adjustment factor (%) (*Plate E-5.8*)
- Length of main watercourse, L (ft)
- Length along main watercourse measured upstream to a point opposite the centroid, Lca (ft)
- Difference in elevation from the concentration point and the upstream end of the watercourse, H (ft)
- Areas identified by cover type, soil group and land use



District's HEC-HMS Preprocessor

Precipitation

1-, 3-, 6-, 24-hour storm durations (From NOAA Atlas 2 Isohyetal Maps in District's Hydrology Manual or other sources of data applicable to the study, such as NOAA Atlas 14 Volume 6 or District rain gage analysis)

- Enter the "Point Precipitation" for the storm events being analyzed
- Enter the "Areal Adjustment Factor" (Plate E-5.8)
- If analyzing the 1-hour storm event, enter the "Slope of Rainfall Intensity-Duration Curve" (Plate D-4.6)

Watershed Area 5.2 sq mi			
1 Hour Storm	3 Hour Storm	6 Hour Storm	24 Hour Storm
Point Precipitation 1.61 in.	Point Precipitation 2.3 in.	Point Precipitation 3.1 in.	Point Precipitation 5.77 in.
Areal Adjustment Factor 97 %	Areal Adjustment Factor 98.5 %	Areal Adjustment Factor 99 %	Areal Adjustment Factor 99.5 %
Adjusted Point Precipitation	Adjusted Point Precipitation	Adjusted Point Precipitation	Adjusted Point Precipitation
Slope of Rainfall Intensity - 0.5			

Lag Time

A calculator has been provided to determine the Lag Time of a watershed and selecting the Unit Time period for the analysis. (*Page E-4*)

- Enter the "Basin Factor, n" (Plate E-3)
- Enter the "Length along main watercourse, L"
- Enter the "Length along main watercourse measured upstream to a point opposite the centroid, Lca"
- Enter the "Elevation Difference, H" between the concentration point and point at the upstream end of the watercourse
- Click the **RUN** button to calculate the **Lag Time** and 40% of that value (the unit time period for the analysis must be less than 40% of the lag time)

Lag Time Calculator		
Basin Factor - n	.025	
Length along longest watercourse - L	24321	ft
Length along longest watercourse measured upstream to a point opposite the centroid of the area - Lca	11285	ft
Elevation Difference	988	ft
Lag Time	0.516	hr
40% Lag Time	12.4	min
	Run	

Loss Rate

The "Average Adjusted Loss Rate" is based on the soil-cover complex and land use impervious percentage. The user can either use the built in calculator to determine the loss rate or enter it manually (*Page E-8*).

Note: If the user chooses to enter the Average Adjusted Loss Rate manually, the backup calculation for this value will need to be attached to the Preprocessor printout.

- To use the Average Adjusted Loss Rate calculator provided:
 - Select the AMC condition (I, II, or III) (Page C-3)
 - Select the **Soil-Cover Complex** for pervious areas (*Plate E-6.1*)
 - Select the Actual Impervious Cover Percentage for developed areas (*Plate E-6.3*)
 - Enter the **AREA** and click the **ADD** button to record the entry

ss Rate Data Effective Rainfall S-Graphs									
Average Adjusted Loss Rate Ca	alculator (Plate E	-2.1) OAvera	ige Adjusted Los	ss Rate (Manual E	Entry)				
			Add Loss F	Rate Values					
AMC Condition:									
Soil Group / Cover Type View Chart	RI Number	Perv. Area Infiltrn Rate (in/hr)	Land Use	Imp. Area Decimal %	Adj.Infiltrn Rate (in/hr)	Area (acres)			
- T							Add		
Soil Group / Cover Type	RI Number	Perv. Area Infiltrn Rate (in/hr)	Land Use	Imp. Area Decimal %	Adj.Infiltrn Rate (in/hr)	Area (acres)	Area/ Total Area	Ave. Adj. (in/hr	
Grass Good B	61	0.4590	50	50	0.252	100	0.571	0.144	X
Grass Good C	74	0.3150	40	40	0.202	50	0.286	0.058	X
Grass Good D	80	0.2440	20	20	0.2	25	0.143	0.029	X
					Total area =	175			
							Average Soil Loss =	0.231	1

OR Manual Entry

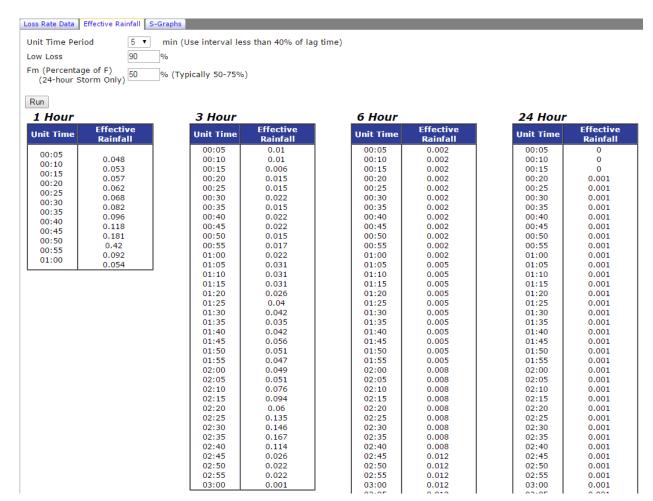
Loss Rate Data	Effective Rainfall S-Graphs			
Average	Adjusted Loss Rate Calculator (Plate E-2.1)	Average Adjusted Loss Rate (Manual Entry)	.230	in/hr

Effective Rainfall

The **Effective Rainfall** (rainfall converted to runoff after infiltration) per unit time is required since HEC-HMS does not support the District's loss rate methods (*low loss, 24-hour storm variable loss rate*). Therefore, rainfall in HEC-HMS is entered as effective rainfall with no loss method specified.

- Select the Unit Time Period (select a unit time period less than 40% of the calculated lag time)
- Enter the Low Loss Percentage (usually taken to be 80-90% of the rainfall for any unit time period where loss would otherwise exceed rainfall) (Page E-8)
- If analyzing the 24-hour storm event, enter **F**_m (minimum value on loss curve, typically 50-75% of the "Average Adjusted Loss Rate") (Page E-8)
- Click the RUN button. The program will calculate the effective rainfall (inches) per unit time.

Shown below is an example of the calculated Effective Rainfall for the 1-, 3-, 6- and 24-hour storm durations.



S-Graph

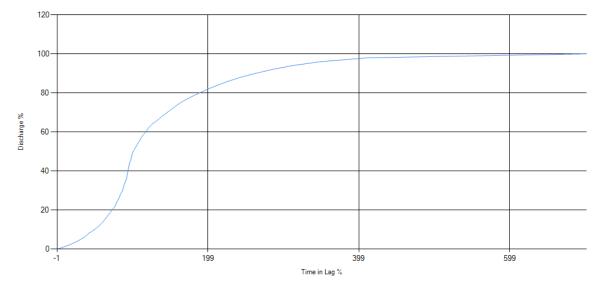
An **S-graph**, summation hydrograph, is a hydrograph of runoff that would result from the continuous generation of unit storm effective rainfall over the area. An S-graph represents the basic time-runoff relationship for watershed type in a form suitable for application of ungaged basins. Per the District's Hydrology Manual, four (4) S-graphs are used to represent the runoff characteristics of watersheds in western Riverside County (*Page E-3*).

- The **Mountain** curve is suitable for major watersheds in the Santa Ana, western San Jacinto and San Bernardino Mountains (*Plate E-4.3*)
- The Valley curve is suitable for valley floor and alluvial cone areas (*Plate E-4.1*)
- The **Foothill** curve is suitable for small watersheds with extreme slopes, or for confined valley areas surrounded by steep foothills (*Plate E-4.2*)
- The **Desert** curve is suitable for the southeastern San Bernardino and eastern San Jacinto mountains (*Plate E-4.4*)

Shown below are the S-graph ordinates for a 100% Foothill S-graph.

Run S Graphs														
S-Graph 1		S-Graph 2			9	5-Graph 3			S-Graph 4			1	S-Graph Combi	ined
Туре:	Mountain	Туре:	Valley			Гуре:		thill	Туре:	Desert			Туре:	Combine
Weight %		Weight %				Neight %	100		Weight %				Weight %	
Time in Percen	t Discharge	Time in Percent				Time in Percent		Discharge	Time in Percent		harge	1	Time in Percent	
of Lag	(percent)	of Lag	(perc			of Lag		(percent)	of Lag	(pe	rcent)		of Lag	(perce
0		0		0		0		0	0		0		15	2
0		0		2		15 26		2	0		2 4		26	4
0		0		6		35		6	0		6		35	6
ō		Ő		8		41		8	ŏ		8			8
0		0		10		49		10	0		10		49	10
0		0		12		55		12	0		12		55 60	12 14
0		0		14		60 64		14	0		14		64	16
0		0		16 18		68		16 18	0		16 18			18
0		0		20		72		20	0		20		72	20
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0		0		24		78		24	0		24		78	24
0		0		26		81		26	0		26		81 83	26 28
0		0		28		83		28	0		28		86	30
0		0		30		86 87		30	0		30		87	32
0		0		32 34		87		32 34	0		32 34		89	34
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0		0		38		92		38	0		38		92	38
0		0		40		93		40	0		40		93 94	40 42
0		0		42		94		42	0		42		94 95	42 44
0		0		44		95		44	0		44		97	46
0		0		46 48		97 98		46 48	0		46 48		98	48
0		0		50		100		50	0		50		100	50
ŏ		ŏ		52		103		52	ŏ		52			52
0	54	0		54		106		54	0		54		106	54
0		0		56		109		56	0		56		109 112	56 58
0		0		58		112		58	0		58		117	58 60
0		0		60 62		117 120		60 62	0		60 62		120	62
0		0		64		120		64	0		64			64
0		0		66		132		66	0		66		132	66
0	68	0		68		138		68	0		68		138	68
0		0		70		145		70	0		70		145	70 72
0		0		72		152		72	0		72		152 159	72
0		0		74		159		74	0		74		167	76
0		0		76 78		167 177		76 78	0		76 78		177	78
0		ő		80		188		80	0		80		188	80
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0		0		84		212		84	0		84			84
0		0		86		226		86	0		86		226	86 88
0		0		88		242		88	0		88			88 90
0		0		90		262		90	0		90			90
0		0		92 94		284 311		92 94	0		92 94		311	94
0		o o		94		311 348		94	0		94		348	96
0		ő		98		410		98	o o		98			98
0		0		100		700		100	0		100		700	100

S-Graph Combined



Discharge (percent)

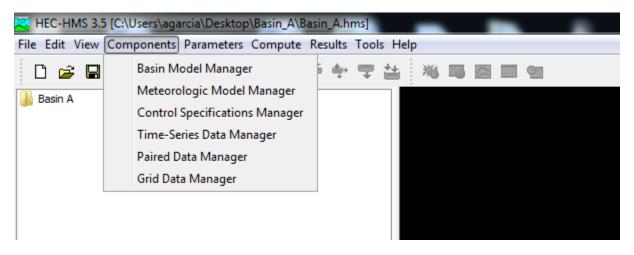
Preparing a HEC-HMS Model

Open **HEC-HMS** and create a new project.

🗮 Create a New Pro	ject	
Name: Description:	Basin A	
Location: Default Unit System:	C:\Users\agarcia\Desktop	
	or costand y	Create Cancel

Basin Model Manager

Navigate to the Components option on the menu bar and select "**Basin Model Manager**". The Basin Model Manager allows the user to create subbasins (watersheds) and other elements such as detention basins to the model. It can also be used to copy, rename or delete an existing basin model.



Create a new basin model and provide a name and description.

HEC-HMS 3.5 [C:\Users\agarcia\Desktop\Basin_A\Basin_A.hms File Edit View Components Parameters Compute Results To	s] ools H 🔀 Basin Model Manager
🗋 🖨 📾 💽 中 🤇 🎰 🖿 筆 中 🦷	
📙 Basin A	New
Í	Create A New Basin Model
	Name : Watershed A
	Description :
	Create Cancel

Select the **Subbasin Creation Tool** and click anywhere in the model space to create a subbasin within the model.

💐 HEC-HMS 3.5 [C:\Users\agarcia\Desktop\l	Basin_A\Basin_A.hms]
File Edit View Components Parameters C	Compute Results Tools Help
🗋 🗃 🖩 🎒 💽 🕂 🤹 ।	노 🖬 🌩 🚔 📅 🕷 📾 📾 📾
Basin A Sub Basin Models Watershed A	basin Creation Tool Basin Model [Watershed A]
	Create A New Subbasin Element
	Name : Basin 1
	Description :
	Create Cancel
Components Compute Results	
🕖 Basin Model	

Select the subbasin previously created in the Watershed Explorer pane under the Components tab to begin entering parameters for the model.

Enter the Area and change the Loss Method, Transform Method and Baseflow Method to match the figure below.

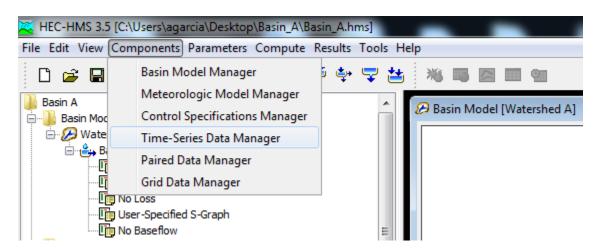
Components Comp	ute Results	
🚑 Subbasin Trans	form Options	Note: No loss method is specified since the
Basin Name: Element Name:	Watershed A Basin 1	rainfall will be entered as effective rainfall (rainfall available for runoff after infiltration).
Description:		
Downstream:	None	
*Area (MI2)	5.2	
Canopy Method:	None	▼
Surface Method:	None	•
Loss Method:	None	▼
Transform Method:	User-Specified S-Graph	▼
Baseflow Method:	None	▼

Enter the **Lag Time** calculated from the Preprocessor. An **S-graph** will be selectable once it is imported into the program. This will be discussed later in the manual.

Subbasin Transform Options					
Basin Name: Watershed A Element Name: Basin 1					
*S-Graph:	None 👻				
*Lag Time (HR)) 0.516				

Time-Series Data Manager

Navigate to the Components option on the menu bar and select "**Time-Series Data Manager**". The Time-Series Data Manager allows the user to input the precipitation data calculated in the Preprocessor.



In the Data Type pull down menu, select "**Precipitation Gages**". Create a new precipitation gage and provide a name and description (e.g., 03h 100y, 03h 010y, 24h 100y).

🗮 Time-Series Data Manager	
Data Type: Precipitation Gages Current tim Precipitation Gages Discharge Gages Temperature Gages Solar Radiation Gages Windspeed Gages Air Pressure Gages Humidity Gages Description	Create A New Precipitation Gage
Add Window Delete Window	

Select the precipitation gage in the Watershed Explorer pane under the Components tab. Set the **Time Interval** to the **Unit Time** used in the Preprocessor and the **Units** field as incremental inches.

☐ Time-Series Data ☐			
Components Compu	Ite Results		
🔓 Time-Series Gage			
Name:	03h 100y		
Description:		æ	
Data Source:	Manual Entry 👻		
Units:	Incremental Inches		
Time Interval:	5 Minutes 👻		
Latitude Degrees:			
Latitude Minutes:			
Latitude Seconds:			
Longitude Degrees:			
Longitude Minutes:			
Longitude Seconds:			

Under the Time Window tab, specify the **Start Date**, **End Date** and an **End Time** corresponding to the duration of the storm event being analyzed (e.g., for a 3-hour storm, enter the end time to as 03:00; 6-hour storm, enter the end time as 06:00; 24-hour storm, enter the end time as 00:00 and end date to the succeeding day).

Components Compute Results		
Time-Series Gage Time Window Table Graph		
Name: 03h 100y		
*Start Date (ddMMMYYYY) 01Jan2016		
*Start Time (HH:mm) 00:00		
*End Date (ddMMMYYYY) 01Jan2016		
*End Time (HH:mm) 03:00		

Copy the Effective Rainfall column from the Preprocessor into the Table tab of the Precipitation Gage. The effective rainfall hyetograph can then be viewed in the Graph tab.

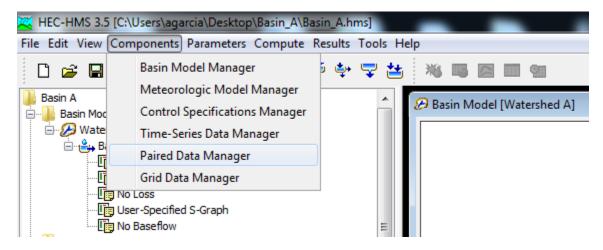
Unit Time Effective Rainfall 00:05 0.01 00:10 0.01 00:15 0.006 00:20 0.015 00:30 0.022 00:30 0.022 00:30 0.022 00:40 0.022 00:35 0.015 00:30 0.022 00:40 0.022 01:45 0.022 01:45 0.022 01:45 0.022 01:45 0.022 01:45 0.022 01:55 0.017 01:00 0.022 01:10 0.031 01:120 0.026 01:120 0.026 01:120 0.026 01:130 0.042 01:20 0.026 01:310 0.042 01:320 0.042 01:330 0.042 01:340 0.051 01:35 0.047 01:320 0.042 <	3 Hour		Components Compute Results	
Kainrali Time (ddwdwf/YYY, HH:mm) Predpitation (N) 00:05 0.01 0.01 0.01 0.01 00:10 0.01 0.01 0.01 0.01 00:20 0.015 0.006 0.01 0.01 00:20 0.015 0.010 0.01 0.01 00:35 0.015 0.022 0.015 0.015 00:40 0.022 0.015 0.015 0.015 00:45 0.022 0.13an2016, 00:30 0.022 00:55 0.017 013an2016, 00:45 0.0022 01:00 0.022 013an2016, 00:50 0.015 013an2016, 00:50 0.017 013an2016, 00:50 0.022 01:00 0.022 0.031 01an2016, 01:50 0.022 01:10 0.031 01an2016, 01:50 0.031 01an2016, 01:50 0.031 01:25 0.04 01an2016, 01:50 0.035 0.031 01an2016, 01:50 0.035 01:35 0.051 01an2016, 01:55 0.042	Unit Time		Time-Series Gage Time Window	Table Graph
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OD 115 OD 006 OD 1125 OD 000 00:20 0.015 0.016 0.01 00:25 0.015 0.016 0.015 00:30 0.022 0.015 0.018 0.015 00:35 0.015 0.018005, 00:30 0.022 00:40 0.022 0.018005, 00:35 0.015 013an205, 00:35 0.015 0.018005, 00:35 0.022 00:50 0.017 0.018005, 00:40 0.022 013an205, 00:50 0.017 0.018005, 00:40 0.022 013an205, 00:50 0.017 0.018005, 00:50 0.015 013an205, 00:50 0.017 0.018005, 00:50 0.022 013an205, 00:50 0.017 0.018005, 00:50 0.017 013an205, 00:50 0.017 0.018005, 00:50 0.017 013an205, 00:50 0.022 0.026 0.018 0.031 013an205, 00:50 0.021 0.026 0.031 0.042 013an205, 01:00 0.022 0.044 0.031 0.042			01Jan2016, 00:00	
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omponents	Compute	Resul



Paired Data Manager

Navigate to the Components option on the menu bar and select "**Paired Data Manager**". The Paired Data Manager is where placeholders are created for stage-storage curves, stage-discharge curves, storage-discharge curves, etc. The S-graph will be imported using this manager.



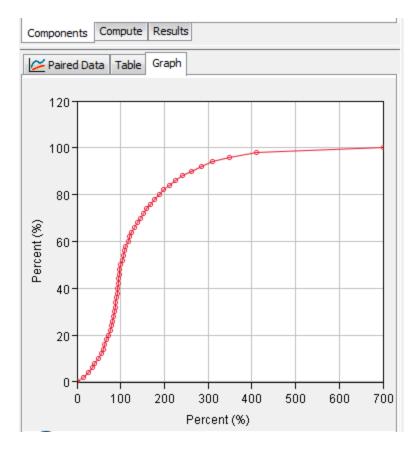
In the Data Type pull down menu, select "**Percentage Curves**". Create a new percentage curve and provide a name and description (e.g., Valley, Foothill, etc.).

Í	Z Paired Data Manager	22)
	Data Type: Percentage Curves Current paired data	•	
🔀 Cre	eate A New S-Graph Curve	-	23
	Name : Foothill S-Graph Description : 100% Foothill	Create Cance	

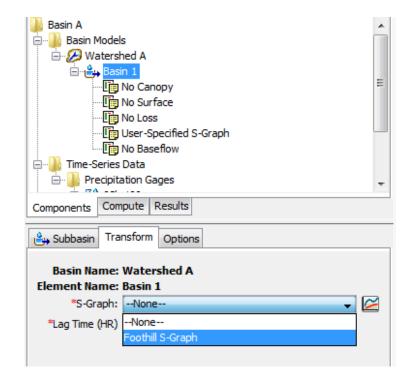
Select the S-graph in the Watershed Explorer under the Components tab. Set the **Data Source** to **Manual Entry** in the Paired Data tab. In the Table tab, copy and paste the S-graph ordinates from the **S-Graph Combined** table from the Preprocessor into HEC-HMS. The S-graph can then be viewed in the Graph tab.

Paired D	03h 100y 1 01Jan2016, 00:00 - 01Jan2016, 03:00 Nata sentage Curves Foothill S-Graph
Components	Compute Results
🗡 Paired Data	Table Graph
Name: I	Foothill S-Graph
Description:	100% Foothill
Data Source:	Manual Entry 🗸

S-Graph Com	nbined	1	
Туре:	Combined		
Weight %		🖶 🔒 Paired Data	
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of Lag	(percent)		
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15	2		
26	4	Components Compute Results	
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95	44	78	24 ⋿
97	46	81	26
98	48	83	28
100	50	86	30
103	52		
106	54	87	32
109	56	89	34
112	58	91	36



Now that the S-graph has been imported, the S-graph can be assigned to a subbasin. Select the Subbasin previously created in the Watershed Explorer pane under the Components tab. Navigate to the Transform tab and assign the **S-Graph** field to the S-graph imported in the previous step.



Meteorologic Model Manager

Navigate to the Components option on the menu bar and select "**Meteorologic Model Manager**". The Meteorologic Model Manager assigns the storm rainfall to the subbasins.

HEC-HMS 3.5 [C:\Users\agarcia\Desktop\Basin_A\Basin_A.hms] File Edit View Components Parameters Compute Results Tools Help Basin Model Manager i 🧄 🖵 📇 🗋 📂 P 漓 13 CH Meteorologic Model Manager 📗 Basin A ۸ Basin Model [Watershed A] 🖶 📗 Basin Mod Control Specifications Manager 🗄 🧭 Wate Time-Series Data Manager 🖻 🔒 Bi Paired Data Manager Ū Ū Grid Data Manager I No Loss User-Specified S-Graph 23 Meterologic Model Manager Current meterologic models New.... 23 🏹 Create A New Meteorologic Model Name : 03h 100y Description : ÷E Create Cancel

Create a new Meteorologic Model and provide a name and description.

Select the Meteorologic Model in the Watershed Explorer under the Components tab. Set the **Precipitation** option in the Meteorology Model tab to "**Specified Hyetograph**". In the Basins tab, set the option to include Subbasins to "**Yes**".

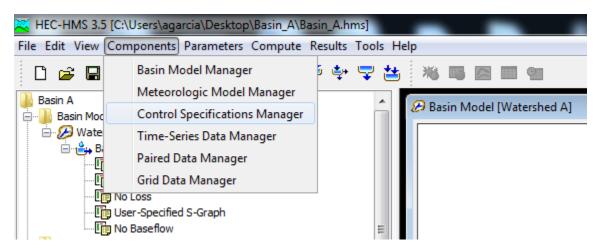
Meteorologic Models			
Meteorology Model Basins Options			
Met Name: 03h 100y Description: Precipitation: Specified Hyetograph Evapotranspiration:None Snowmelt:None Unit System: U.S. Customary			
Meteorologic Models Meteorologic Mode			
Meteorology Model Basins Options			
Met Name: 03h 100y			
Basin Model Include Subbasins			
Watershed A No 🗸			
Yes No			

Expand the Meteorologic Model heading in the Watershed Explorer pane under the Components tab to display the "**Specified Hyetograph**" heading. Click on this heading to display the option to assign a Precipitation Gage to a subbasin.

Meteorologic Models Other Specified Hyetograph Time-Series Data Other Specified Hyetograph Time-Series Data Other Specified Hyetograph Components Compute Results Compute Results				
Subbasins				
Met Name: 03h 100y				
Subbasin Name	Gage			
Basin 1	None			
	None			
	03h 100y			

Control Specifications Manager

Navigate to the Components option on the menu bar and select "**Control Specifications Manager**". The Control-Specifications Manager allows the user to create a Control Specification to control when simulations start and stop, and the time interval used in the simulation. Create a new Control Specification and provide a name and description.



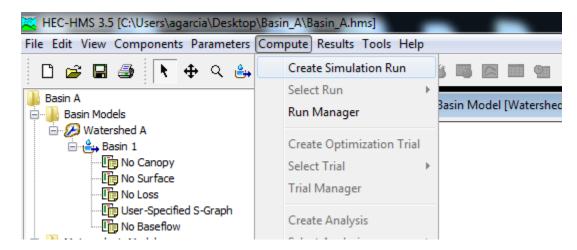
Control Specifications Manager	22
Current control specifications	
New	
Create A New Control Specifications	23
Name : 01	
Description :	Æ
Create	Cancel

Select the control specification in the Watershed Explorer pan under the Components tab. The **Start Date**, **Start Time**, **End Date** and **Time Interval** should be consistent with what was specified for the **Precipitation Gage**. However, the End Time should be longer than the storm duration being analyzed to ensure that the entire hydrograph will plot in the results.

Components Compute Ra	es 16, 00:00 - 01Jan2016, 03:00 es	•
Control Specifications		
Name:	01	
Description:		E
*Start Date (ddMMMYYYY)	01Jan2016	
*Start Time (HH:mm)	00:00	
*End Date (ddMMMYYYY)	01Jan2016	
*End Time (HH:mm)	05:00	
Time Interval:	5 Minutes 🗸	

Simulating a HEC-HMS Model

Navigate to the Compute option on the menu bar and select "Create Simulation Run".



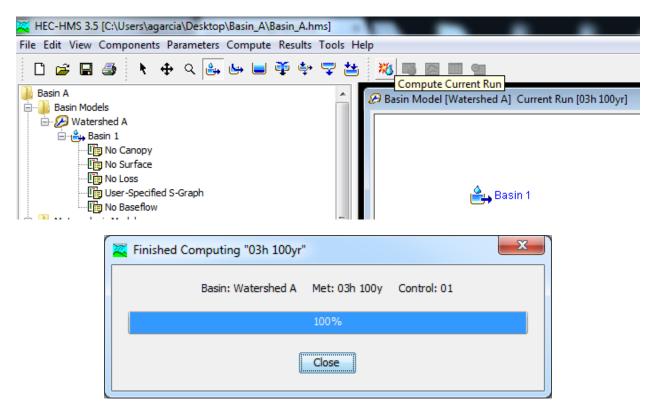
Assign a name to the simulation run in Step 1 (e.g., 03h 100yr), select the **basin model** in Step 2, select the **meteorologic model** in Step 3, and the **control specification** in Step 4.

Create a Simulation Run [Step	1 of 4]	×					
A simulation run must have a has been created.	🔀 Create a Simulation Ru	un [Step 2 of 4]					
	A simulation run includ	es a basin model. Selec	t one from the list below.				
Name 03h 100yr		Description					
	Watershed A	🔀 Create a Simulation	n Run [Step 3 of 4]				
To continue, enter a name ar		Selected basin model "Watershed A". A simulation run includes a meteorologic model. Select one from the list below.					
	•	Name	Description				
< Back	To continue, select a ba	03h 100y	📉 Create a Simulation Run [Step 4 of 4]				
	< Back		Selected basin model "Watershed A" and meteorologic model "03h 100y". A simulation run includes a control specifications. Select one from the list below.				
		To continue, select	Name Description				
		< Back	01				
			٠				
			Select a control specifications and click Finish.				
			< Back Finish Cancel				

Once a run has been created, the user may navigate back to the Compute option on the menu bar to select a run. Runs can be added or deleted in the Run Manager.

🔀 HEC-HMS 3.5 [C:\Users\agarcia\Desktop\B	Basin_A\Basin_A.hms]	
File Edit View Components Parameters	ompute Results Tools Help	
🗅 😅 🖬 🎒 🦎 🕂 🤮	Create Simulation Run	
Basin A	Select Run	✓ 03h 100yr
Basin A Basin Models	Run Manager	asın ivlodei [ivvatershed A] Current Run [03h 100yr]
⊡ 🤪 Watershed A ⊡ 🚔 Basin 1	Create Optimization Trial	
	Select Trial	
	Trial Manager	
User-Specified S-Graph	Create Analysis	Basin 1

Once a Run is selected, select the **Compute Current Run** to begin the simulation. A processing dialog box will appear showing the status of the simulation. Be sure to review the message log for any errors that may have been encountered.

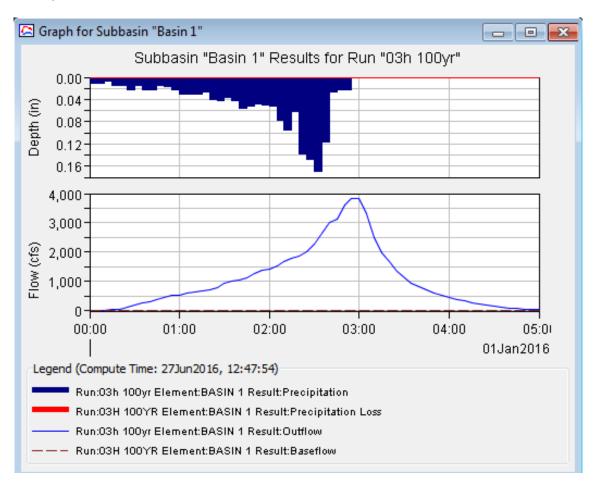


Viewing the HEC-HMS Results

View Global Summary Table

Global Summary Result	s for Run "03h 10)0yr"				
	Project: Basin	A Simulation	Run: 03h 100yr			
Start of Run: 01Jan2016, 00:00 Basin Model: Watershed A End of Run: 01Jan2016, 05:00 Meteorologic Model: 03h 100y Compute Time: 27Jun2016, 12:47:54 Control Specifications: 01 Show Elements: Initial Selection Volume Units: IN AC-FT Sorting: Hydrologic 						
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)		
	5.2	3848.2	01Jan2016, 02:55	1.59		

View Graph for Selected Element(s)



View Summary Table for Selected Element(s)

Summary Results for	r Subbasin "Basin	1"	- • ×
	· · · · · · · · · · · · · · · · · · ·	ect: Basin A h 100yr Subbasin: Basin 1	
End of Run: 0	01Jan2016, 00:00 01Jan2016, 05:00 27Jun2016, 12:47:	Meteorologic Model:	
	Volume Unit	s: 🔘 IN 💿 AC-FT	
Computed Results			
Total Precipitation : 4 Total Loss : 0	145.7 (AC-FT)).0 (AC-FT)	Date/Time of Peak Discharge : Total Direct Runoff : Total Baseflow : Discharge :	01Jan2016, 02:55 441.7 (AC-FT) 0.0 (AC-FT) 441.7 (AC-FT)

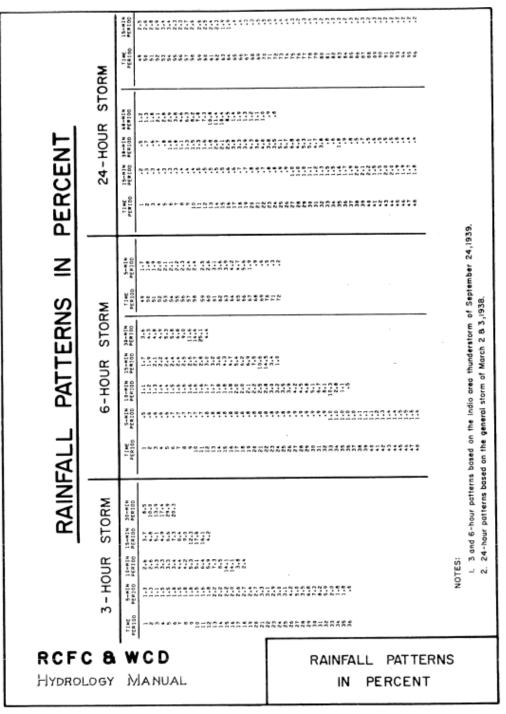
View Time-Series Table for Selected Element(s)

Ģ

	s	imulation F		t: Basin A 100yr	Subbasin:	: Basin 1		
Start		1Jan2016			sin Model:		Watersh	od A
End of		1Jan2016			teorologia		03h 100	
	ute Time: 2				ntrol Spec			,
Date	Time	Precip	Loss	Excess	Direc	Base	Total	
		(IN)	(IN)	(IN)	(CFS)	(CFS)	(CFS)	
01Jan2016	00:00				0.0	0.0	0.0	
01Jan2016	00:05	0.01	0.00	0.01	9.8	0.0	9.8	
01Jan2016	00:10	0.01	0.00	0.01	23.9	0.0	23.9	
01Jan2016	00:15	0.01	0.00	0.01	39.2	0.0	39.2	
01Jan2016	00:20	0.01	0.00	0.01	69.3	0.0	69.3	
01Jan2016	00:25	0.01	0.00	0.01	114.1	0.0	114.1	=
01Jan2016	00:30	0.02	0.00	0.02	212.5	0.0	212.5	
01Jan2016	00:35	0.01	0.00	0.01	274.8	0.0	274.8	
01Jan2016	00:40	0.02	0.00	0.02	308.8	0.0	308.8	
01Jan2016	00:45	0.02	0.00	0.02	392.6	0.0	392.6	
01Jan2016	00:50	0.01	0.00	0.01	459.4	0.0	459.4	
01Jan2016	00:55	0.02	0.00	0.02	530.3	0.0	530.3	
01Jan2016	01:00	0.02	0.00	0.02	551.9	0.0	551.9	
01Jan2016	01:05	0.03	0.00	0.03	613.2	0.0	613.2	
01Jan2016	01:10	0.03	0.00	0.03	659.1	0.0	659.1	
01Jan2016	01:15	0.03	0.00	0.03	671.7	0.0	671.7	
01Jan2016	01:20	0.03	0.00	0.03	714.4	0.0	714.4	
01Jan2016	01:25	0.04	0.00	0.04	809.0	0.0	809.0	
01Jan2016	01:30	0.04	0.00	0.04	929.8	0.0	929.8	
01Jan2016	01:35	0.04	0.00	0.04	1006.2	0.0	1006.2	
01Jan2016	01:40	0.04	0.00	0.04	1068.9	0.0	1068.9	
01Jan2016	01:45	0.06	0.00	0.06	1135.4	0.0	1135.4	
01Jan2016	01:50	0.05	0.00	0.05	1268.7	0.0	1268.7	-

Appendix A Rainfall Distributions

Tabulations of rainfall patterns published in the District's Hydrology Manual for the 3-, 6-, and 24-hour storms are for use with the Synthetic Unit Hydrograph method. As for the 1-hour storm, the District generally does not recommend the use of the Synthetic Unit Hydrograph method for smaller watersheds (less than 300 to 500 acres), however, when volume is a consideration, such as with a basin, rational tabling will not suffice. Consequently, the District has developed a method for generating the 1-hour rainfall distribution to assist with calculating the volume difference between the pre-project and post-project condition hydrology analysis.



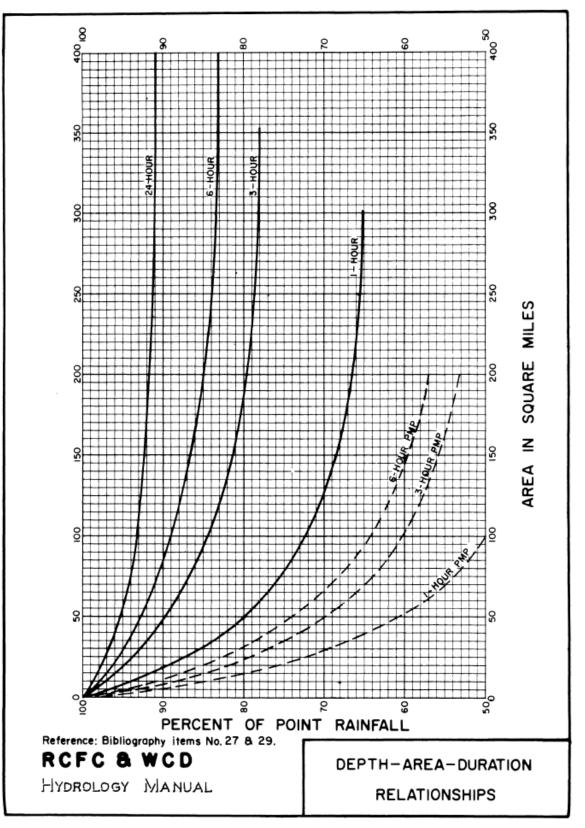


PLATE E-5.8

Appendix C Lag Time Equation

Lag for a drainage area is defined as the elapsed time in hours from the beginning of unit effective rainfall to the instant that the summation hydrograph for the concentration point of an area reaches 50 percent of ultimate discharge. Lag can be calculated from the physical characteristics of a drainage area by the empirical formula:

Lag (hours) =
$$24n \left[\frac{L * Lca}{S^{1/2}}\right]^{0.38}$$

where:

- n = the visually estimated mean of the n (Manning's formula) values of all collection streams and channels within the watershed.
- L = length of longest watercourse (miles)
- Lca = length along longest watercourse, measured upstream to a point opposite the centroid of the area (miles)
- S = overall slope of the longest watercourse between headwaters and the collection point (ft/mile)

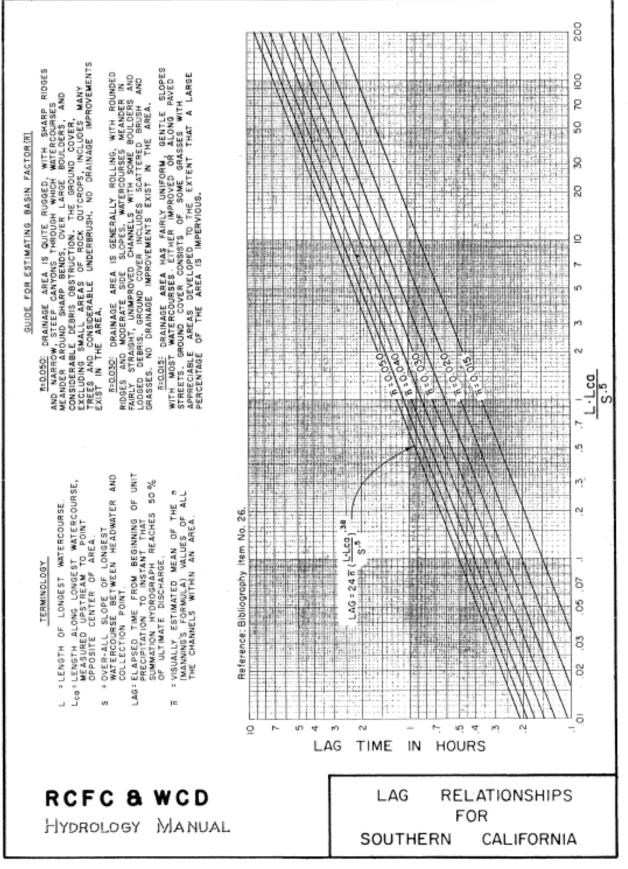


PLATE E-3

Appendix D Loss Rates

Loss rates for pervious areas can be estimated using Plates E-6.1 and E-6.2.

Loss rates for pervious areas can be adjusted to account for developed area using the relationship:

$$F = F_p (1.00 - 0.9A_i)$$

Where:

- F = Adjusted loss rate inches/hour
- F_p = Loss rate for pervious areas inches/hour (*Plate E-6.2*)
- A_i = Impervious area (actual) decimal percent (*Plate E6.3*)

Adjusted loss rates for watersheds within the District are generally between 0.10 to 0.40 inches/hour.

Constant Loss Rate

For short storm durations (1-, 3-, 6-hour) the adjusted loss rate may be taken as constant.

Variable Loss Rate

For longer storm durations (24-hour) the loss rate should normally be varied to decrease with time to yield a mean equal to the adjusted loss rate.

This can be expressed as a function of time:

$$F_{\rm T} = C(D - T)^{1.55} + F_{\rm m}$$

Where:

 F_T = Adjusted loss rate at time "T" – inches/hour

 $C = (F-F_m)/54$

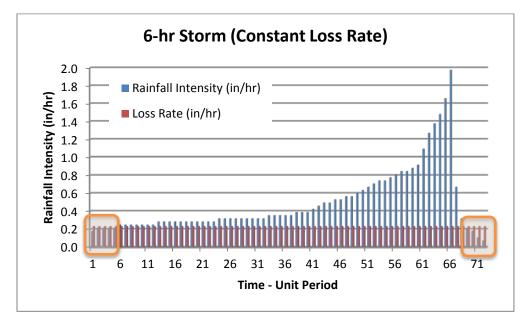
- F = Adjusted loss rate inches/hour (as previously defined)
- D = Storm duration hours = 24-hours
- T = Time from beginning of storm hours
- F_m = Minimum value on loss curve inches/hour (*typically 50-75% of F*)

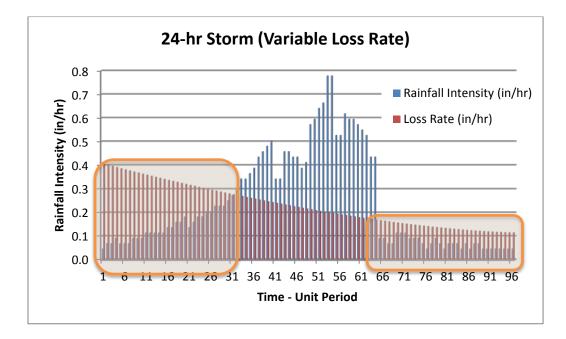
Low Loss

In the early and late stages of a design storm, the adjusted loss rate (constant or variable) will generally exceed the rainfall intensity on a unit time basis, indicating a zero runoff condition. This is considered unrealistic and therefore, to account for runoff occurring during such periods, a low loss rate is used.

The low loss rate is usually taken to be 80 to 90-percent of the rainfall for any unit time period where loss would otherwise exceed rainfall. This is equivalent to an effective rain of 10 to 20-percent of the storm rainfall for a particular time period.

Example:





Appendix E HEC-HMS vs CIVILDESIGN

CivilDesign, created by Joseph E. Bonadiman & Associates, has been used by the District for many years to generate flood hydrographs using the Synthetic Unit Hydrograph method. A sample project was used to compare the peak flow rates and volumes between CivilDesign and HEC-HMS. The results showed that peak flow rates and volumes were nearly identical between the two programs.

