



DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 5.6.0

TUTORIAL # 1 DEVELOPING A NEW HEC-1 MODEL



KVL Consultants, Inc.

DEVELOPING A NEW HEC-1 MODEL

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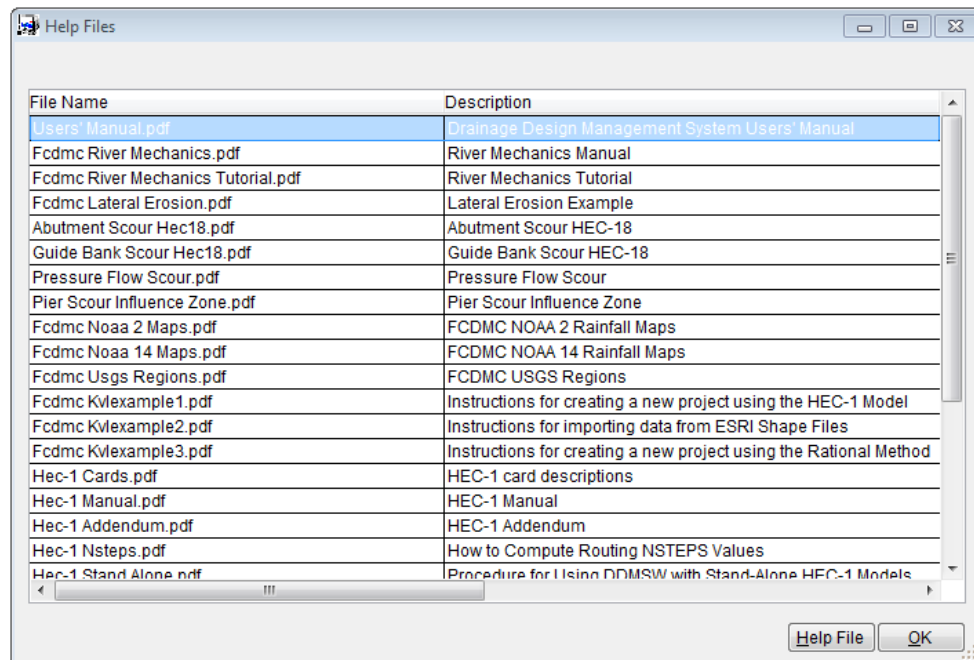
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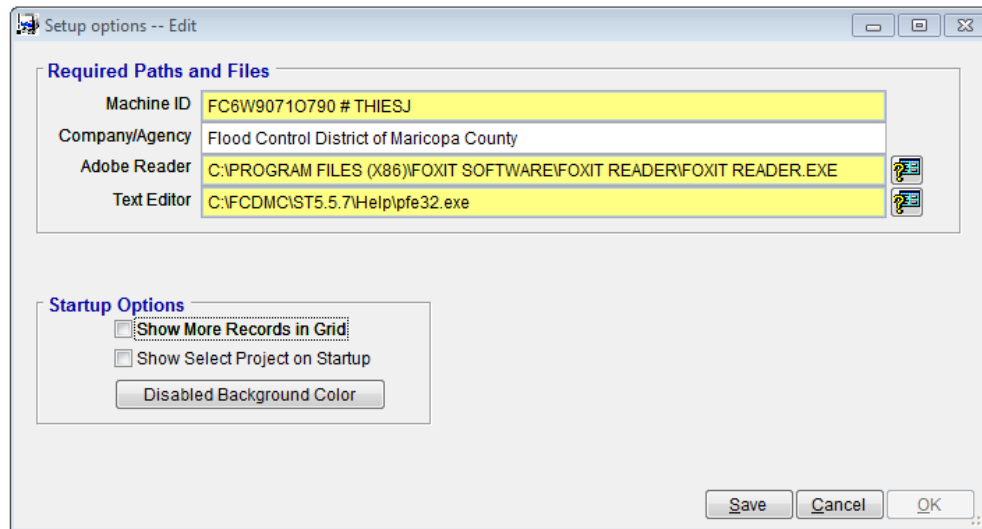
DEVELOPING A NEW HEC-1 MODEL

DATE UPDATED: APRIL 27, 2018

1.0 USING THE HELP FEATURE OF DDMSW

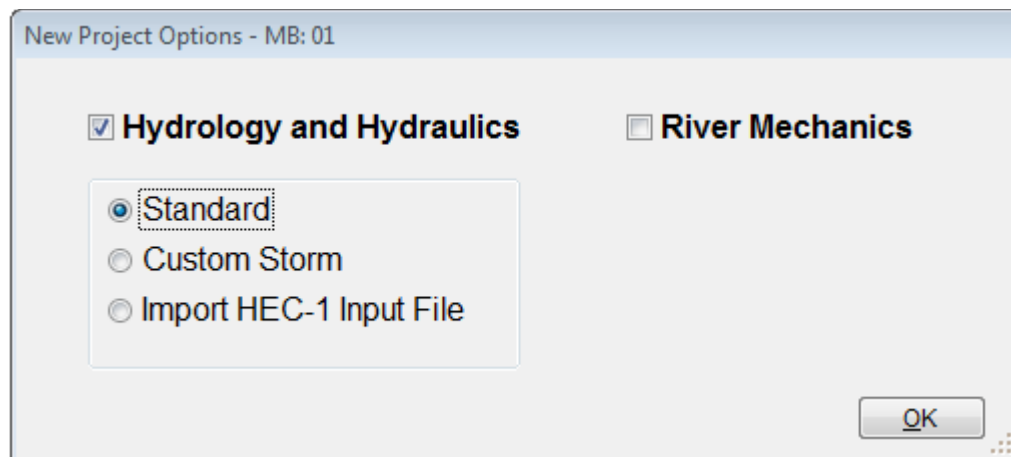
Launch the DDMSW program. Go to the **'Help'** menu and go to the **'Other Help Files'** submenu. For the remainder of this tutorial, this step process will be abbreviated through the use of the following convention i.e., **Help → Other Help Files**. You can read the DDMSW User's Manual by selecting the file titled, **'User's Manual'** and pressing the **'Help File'** button at the bottom of the form. This will launch Adobe Acrobat Reader (or Foxit Reader) and open the **DDMSW User's Manual** document. If your computer does not have Adobe Acrobat or Adobe Acrobat Reader installed, please contact your IT Department. After the Adobe Acrobat Reader or Foxit Reader program is installed, the DDMSW Program should point to the Acrobat or Foxit executable file, under **Tools → Options → Adobe Reader**. Additionally, there is a text editing program (e.g., Notepad, PFE Editor, or Textpad) identified under **Tools → Options → Text Editor**. It will be used to read text files used by DDMSW. The path and file names in the 'Adobe Reader' and 'Text Editor' fields shown on the figure below are not necessarily the same as the users' path. The paths and file names are the specific locations where the above programs are installed.





2.0 ESTABLISH A NEW PROJECT AND SET DEFAULTS

Select **File** ➔ **New Project**. On the **NEW PROJECT OPTIONS** form, select the **Hydrology and Hydraulics** checkbox, and the **Standard** radio button as shown. Click the **OK** button to close the dialog box.



On the **SELECT PROJECT** form, fill in the fields using the data shown on the screen capture provided below. Each project must have a unique **Reference** (without spaces) name, **Title**, a project **Location**, a **Project ID** (a number the software automatically gives the project), and an **Agency** name (this can be your firm's name if you are a consultant) are optional data. On the **Project Defaults** data group, select the appropriate **Model** ('*HEC1*' or '*Rational*', but select '*HEC1*' for this example), data sources for **Soils**, **Land Use**, **Roads**, and **Rainfall** data. Finally, on the **HEC-1 Defaults** data group, select the appropriate HEC-1 **Loss Method**, the **Unit Hydrograph** method, **Storms**, and **Duration**. Model parameters such as **Tab Interval (NMIN)**, **No of Ordinates (NQ)** and printing **Output (IO)** level are required.

As shown, there are three checkboxes in the **Project Reference** data group identified as **Hydrology and Hydraulics Only**, **Custom Storm Event**, and **Imported HEC-1 File**. Only the **Hydrology and Hydraulics Only** checkbox should be checked for this tutorial.

On the “Return Periods to Model” data group, six (6) default event settings are provided. They are: *2-year*, *5-year*, *10-year*, *25-year*, *50-year*, and *100-year* storm events from which the model will generate respective hydrographs and peak flows. For this tutorial, leave the default values as shown.

On the Comment box, add any appropriate comments that may include a brief description of the model, assumptions used, documentation of data sources, or other information that maybe helpful or crucial to understanding the model when the user revisits the model after a hiatus.

On the **Modification Data**, the user can now select the date when the model was developed, modified, or updated. This is to provide a timeline when the model was last accessed, used, or ran.

Select Project

List

Details

Project Reference

Project ID: 00085 Reference: KYLEXAMPLE1

Title: Example 1 HEC-1 Tutorial Project

Location: Maricopa County

Agency: KVL Consultants, Inc.

☒ Hydrology and Hydraulics Only ☐ Custom Storm Event ☐ Imported Hec-1 File

Project Defaults

Model: HEC1

Soils: FCDMC

Land Use: FCDMC

Rainfall: NOAA14

Roads: MCDOT

Return Periods to Model

1. 2. 3. 4. 5. 6.

2 5 10 25 50 100

This project is the tutorial example for establishing a new project using HEC-1.

HEC-1 Defaults

Unit Hydrograph: Clark

Loss Method: Green-Ampt

Storms: Multiple

Duration: 6 Hour

Tab Interval (NMIN): 5

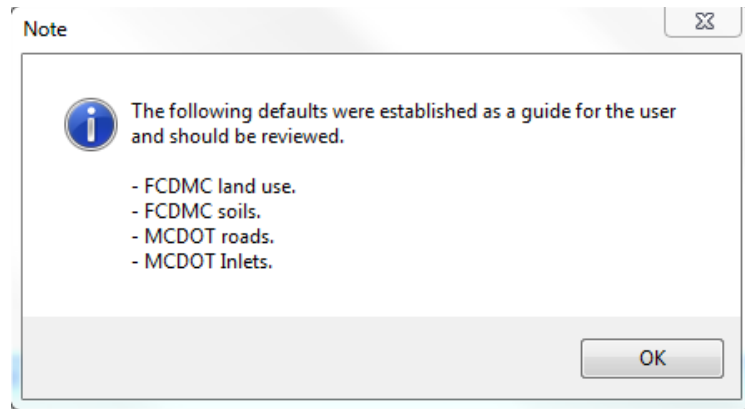
No. Ordinates (NQ): 2000

Output (IO): 5

Modification Date: 04/11/2018

Info Print... Delete Add OK

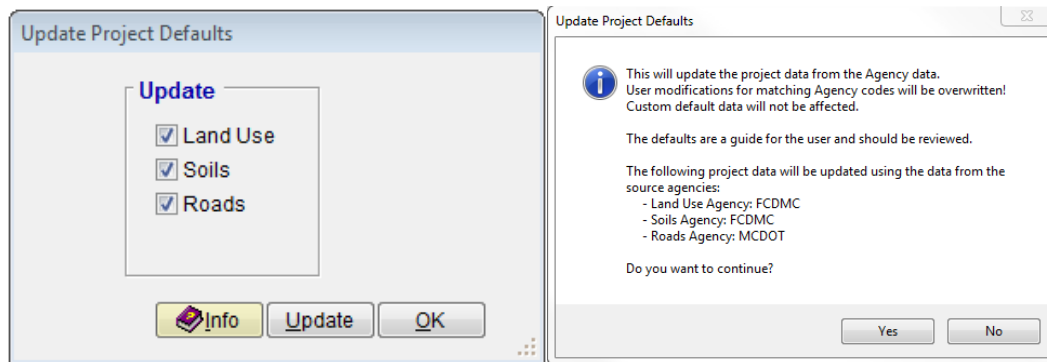
After entering the required data on the form, press the **‘Save’** button. Then, press **‘OK’** to exit the **SELECT PROJECT** form.



Then click '**OK**' to accept the data defaults (FCDMC land use, FCDMC soils, MCDOT roads, and MCDOT Inlets) from which the model to be developed will base its calculation for model parameters as well as in accessing standard design data for the model to use.

3.0 UPDATE PROJECT DEFAULTS

Select **File ➔ Update Project Defaults**. Check all the boxes and then press '**Save**'. Press the '**Update**' button to update the defaults data from the source agencies identified. Press '**OK**' to continue.



If users have already made a lot of changes in either the Land Use or Soils or both, and they want to preserve these changes, **DO NOT** click 'Yes'. That will overwrite all the changes already made.

4.0 SETTING THE MODEL RUNS PATH

When running models, the input and result files have similar file names for each project. Therefore to prevent one project overwriting the results of another project, it is necessary to establish a unique directory for each model runs.

Go to **File ➔ Project Paths** to establish the Model Runs Path. Press the ellipse

button (...) to the right of the '*Model Runs Path*' textbox and navigate to an appropriate directory. Select / choose this folder as the model runs path or press the '*Make New Folder*' button if the required folder does not exist. Rename the new folder, and press '*OK*' to close the '*Browse for folder*' form. Note that the file path defined in the '*Model Runs Path*' in the following figure is not necessarily the same as the user's path. The path depends on the location of the program installed.

5.0 ESTABLISH RAINFALL DATA FOR PROJECT

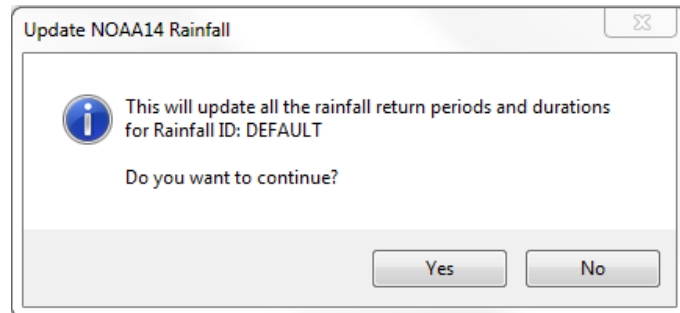
On the Rainfall Ids form (***Hydrology → Rainfall Ids***), select Manual as the *Data Source* (GIS files are used for for this tutorial). For Rainfall ID, enter "*Default*". In the Comment box, add appropriate data description of the rainfall data being used. Click "OK" to close the "Rainfall IDs" form.

ID	Source	Description
DEFAULT	MANUAL	Default Rainfall ID

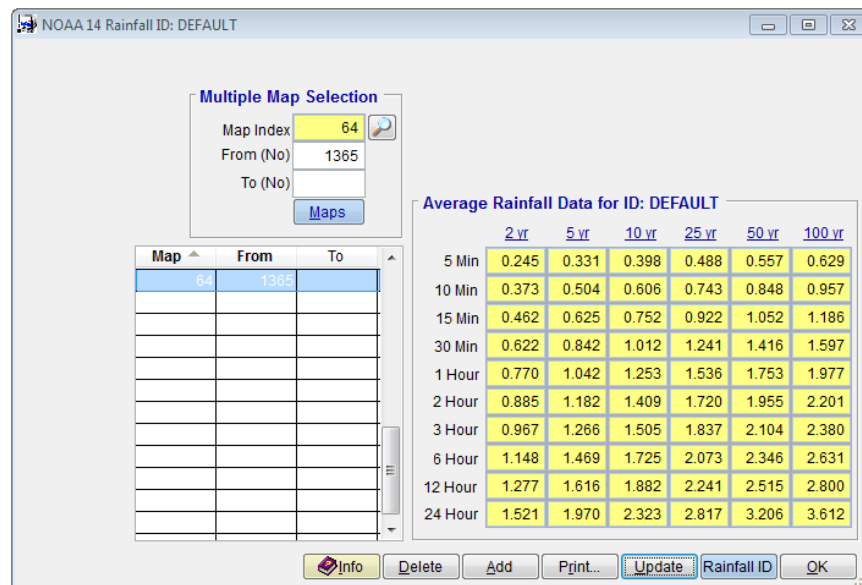
On the "NOAA 14 Rainfall ID" form (***Hydrology → Rainfall***), click the '*Maps*' button to locate the project by identifying the appropriate cell from which to develop the Rainfall data. For this tutorial, cell 64 (*Map 64*) will be used. Before

exiting the map, identify the sub cells where the project is located (let us use 1365).

Each map has a Township and Range address (T02NR04E for this example) to assist in locating the project. Street atlas maps (not included here) often show the Township and Range. Click the *Map Index* selector button and select 64. Then enter 1365 in the *From (No)* textbox. Do not enter any value on the *To (No)* textbox. Click the 'Save' and the 'Update' buttons to establish the project data for the rainfall.



Click 'Yes' to continue. When the 'Update' is complete, click 'OK' to exit.

The main application window titled "NOAA 14 Rainfall ID: DEFAULT". It features a "Multiple Map Selection" section with a "Map Index" dropdown set to 64, a "From (No)" text box with 1365, and an empty "To (No)" text box. Below these is a "Maps" button and a table with columns "Map", "From", and "To". The "Map" column has a value of 64, and the "From" column has a value of 1365. To the right is a table titled "Average Rainfall Data for ID: DEFAULT" with columns for return periods (2 yr, 5 yr, 10 yr, 25 yr, 50 yr, 100 yr) and rows for durations (5 Min, 10 Min, 15 Min, 30 Min, 1 Hour, 2 Hour, 3 Hour, 6 Hour, 12 Hour, 24 Hour). At the bottom are buttons for Info, Delete, Add, Print..., Update, Rainfall ID, and OK.

Map	From	To
64	1365	

	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
5 Min	0.245	0.331	0.398	0.488	0.557	0.629
10 Min	0.373	0.504	0.606	0.743	0.848	0.957
15 Min	0.462	0.625	0.752	0.922	1.052	1.186
30 Min	0.622	0.842	1.012	1.241	1.416	1.597
1 Hour	0.770	1.042	1.253	1.536	1.753	1.977
2 Hour	0.885	1.182	1.409	1.720	1.955	2.201
3 Hour	0.967	1.266	1.505	1.837	2.104	2.380
6 Hour	1.148	1.469	1.725	2.073	2.346	2.631
12 Hour	1.277	1.616	1.882	2.241	2.515	2.800
24 Hour	1.521	1.970	2.323	2.817	3.206	3.612

When the Rainfall data has been updated, observe the generated rainfall data for the six return intervals with varying rainfall time durations. Press 'OK' to close the "NOAA 14 Rainfall" form.

6.0 REVIEW SOIL DEFAULTS

Select **Hydrology** → **Soil Defaults** to view or modify Agency Soil Defaults

or add a 'Custom' data. For this tutorial, custom values are not required assuming that the existing Agency Soil Defaults are sufficient. Click on the 'OK' button to close the form.

Soil ID	Book	Map Unit	XKSAT	Rock Pct	Description
6451	645	1	0.410	0.00	Antho sandy loams
6452	645	2	0.410	0.00	Antho gravelly sandy loams
6453	645	3	0.580	0.00	Antho-Carrizo-Maripo complex
6454	645	4	0.580	0.00	Antho-Carrizo-Maripo complex low precipitation
6455	645	5	0.430	0.00	Anthony sandy loam
6456	645	6	0.620	0.00	Anthony-Arizo complex
6457	645	7	0.620	0.00	Anthony-Arizo complex low precipitation
6458	645	8	0.960	0.00	Arizo cobbly sandy loam
6459	645	9	0.270	0.00	Beeline-Cipriano complex 3 to 45 percent slopes
6531	653	1	0.230	0.00	Agualt and Ripley soils
6532	653	2	0.210	0.00	Agualt and Ripley soils saline-sodic
6533	653	3	0.530	0.00	Ajo-Gunsight-Pompeii complex 3 to 25 percent slopes
6534	653	4	0.400	40.00	Akela-Rock outcrop complex 15 to 65 percent slopes
6535	653	5	0.790	0.00	Carrizo-Dateland complex 0 to 3 percent slopes
6536	653	6	1.170	0.00	Carrizo-Momoli complex 0 to 3 percent slopes

7.0 REVIEW LAND USE DEFAULTS

Select **Hydrology => Land Use Defaults** to view or modify Agency land use defaults or add a 'Custom' data. For this tutorial, custom values are not required assuming that the existing Agency Land Use Defaults are sufficient. Click on the 'OK' button to close the form.

Sort	Code	Group	IA	Rtmp	Cover	Dtheta	Kb	Description
	110	Residential	0.30	5	30.0	NORMAL	MIN	Rural Residential (<= 1/5 du pe
	120	Residential	0.30	5	30.0	NORMAL	MIN	Estate Residential (1/5 du per
	130	Residential	0.30	15	50.0	NORMAL	MIN	Large Lot Residential - Single F
	140	Residential	0.25	30	50.0	NORMAL	MIN	Medium Lot Residential - Single
	150	Residential	0.25	30	50.0	NORMAL	MIN	Small Lot Residential - Single F
	160	Residential	0.25	40	50.0	NORMAL	MIN	Very Small Lot Residential - Sin
	170	Residential	0.25	45	50.0	NORMAL	MIN	Medium Density Residential - In
	180	Residential	0.25	45	50.0	NORMAL	MIN	High Density Residential - Multi
	190	Residential	0.25	45	50.0	NORMAL	MIN	Very High Density Residential -
	200	Commercial	0.10	80	60.0	NORMAL	MIN	General Commercial (Commer
	210	Commercial	0.10	80	65.0	NORMAL	MIN	Specialty Commercial (<=50,00
	220	Commercial	0.10	80	65.0	NORMAL	MIN	Neighborhood Commercial (50
	230	Commercial	0.10	80	75.0	NORMAL	MIN	Community Commercial (100,0
	240	Commercial	0.10	80	65.0	NORMAL	MIN	Regional Commercial (500,000
	250	Commercial	0.10	80	70.0	NORMAL	MIN	Super-Regional Commercial (>
	300	Industrial	0.15	55	60.0	NORMAL	MIN	General Industrial (Industrial w

8.0 ESTABLISH MAJOR BASIN ID'S

Select **Hydrology** ➔ **Major Basins** to access the *Major Basins* data. The software automatically establishes at least one *Major Basin* (01) when creating a new project. Since there is only one major basin in this project, there is no need to change or modify the project data as provided. Once the sub basins are established, we will return here to update *Major Basin* 01. Click on the 'OK' button to close the form.

The screenshot shows the 'Major Basins' window with a 'List' tab and a 'Details' tab. The 'Details' tab is active, showing the following information:

- Major Basin ID:** 01
- Description:** Major Basin 01
- Area (sq mi):** 12.3900
- Rain ID:** DEFAULT
- Modeling Options:**
 - Model This Major Basin: ☒
 - Storms: Multiple
 - Duration: 6 Hour
 - Tab Interval: 5
 - No. Ordinates: 2000
 - Output: 5
- Return Period for Steps:** Step RP: 100
- Reduction Factors:**

	Area	RF
1.	0.0001	1.0000
2.	0.5	0.9940
3.	2.8	0.9750
4.	16.0	0.9220
5.		
6.		
7.		
8.		
9.		

At the bottom of the window are buttons: Info, ReSort, Print..., Delete, Add, Update, and OK.

9.0 ESTABLISH PRELIMINARY SUB BASIN DATA

Select **Hydrology** ➔ **Sub Basins** to access the sub basin data. Click on 'Add' to add the first record. On the form, enter the following:

Sub Basin	010105
Area	6.690 sq. miles
Length	5.060 miles
USGE	2760 ft (can enter Slope directly and not USGE and DSGE)
DSGE	2200 ft (can enter Slope directly and not USGE and DSGE)
Time-Area	URBAN

The image displays two screenshots of the 'Sub Basins - MB: 01' software window. The top screenshot shows the 'Sub Basin' section with Major Basin '01' and Sub Basin '010105'. The 'Sub Basin Parameters - Clark' section shows Area (6.690), Length (5.060), USGE (2760.0), DSGE (2200.0), Slope (empty), and Time-Area (URBAN). The 'Rainfall Losses - Green-Ampt' section shows IA (empty), DTHETA (empty), PSIF (empty), XKSAT (empty), RTIMP (empty), XKSAT (Bare Ground) (empty), and Avg Vegetation (empty). The 'Return Period Parameters' section shows Custom Tc (empty) and Tc (hrs) (empty). The bottom screenshot shows the same window with the 'Sub Basin Parameters - Clark' section updated: Slope (110.7) and Kb (0.017). The 'Rainfall Losses - Green-Ampt' section is updated: IA (0.30), DTHETA (0.13), PSIF (10.22), XKSAT (0.039), RTIMP (12), XKSAT (Bare Ground) (0.028), and Avg Vegetation (44.0). The 'Return Period Parameters' section is updated: Custom Tc (empty), Tc (hrs) (0.999, 0.827, 0.749, 0.684, 0.644, 0.611), Vel (ft/s) (7.43, 8.97, 9.91, 10.85, 11.52, 12.15), and R (hrs) (0.458, 0.371, 0.332, 0.301, 0.281, 0.265).

The data shown above is for *Sub Basin 010105*. Click 'Save' to save the data and then click 'Add' to add a second record.

Enter the following:

Sub Basin	010110
Area	5.700 sq. miles
Length	3.75 miles
USGE	2584 ft (can enter Slope directly and not USGE and DSGE)
DSGE	2195 ft (can enter Slope directly and not USGE and DSGE)
Time-Area	URBAN

The top screenshot shows the 'Sub Basins - MB: 01' window with the 'Details' tab selected. The 'Sub Basin' section shows Major Basin '01' and Sub Basin '010110'. The 'Sub Basin Parameters - Clark' section shows Area (sq mi) 5.700, Length (mi) 3.750, USGE (ft) 2584.0, DSGE (ft) 2195.0, Slope (ft/mi) [empty], Time-Area URBAN, and Kb [empty]. The 'Rainfall Losses - Green-Ampt' section has empty fields for IA (in), DTHETA, PSIF (in), XKSAT, RTIMP (%), XKSAT (Bare Ground), and Avg Vegetation (%). The 'Return Period Parameters' section has empty fields for Custom Tc, Tc (hrs), Vel (ft/s), and R (hrs) across 2, 5, 10, 25, 50, and 100 year return periods.

The bottom screenshot shows the same window with the following values entered:

- Sub Basin Parameters - Clark:** Slope (ft/mi) 103.7
- Rainfall Losses - Green-Ampt:** IA (in) 0.25, DTHETA 0.05, PSIF (in) 12.49, XKSAT 0.014, RTIMP (%) 30, XKSAT (Bare Ground) 0.010, Avg Vegetation (%) 50.0
- Return Period Parameters:**

	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
Tc (hrs)	0.754	0.675	0.630	0.585	0.556	0.531
Vel (ft/s)	7.29	8.15	8.73	9.40	9.89	10.36
R (hrs)	0.289	0.255	0.236	0.218	0.206	0.196

The data shown above is for *Sub Basin 010110*. Click 'Save' to save the data and then click 'OK' to close the form.

10.0 ESTABLISH SOIL DATA

Select **Hydrology** → **Soils** to access the Soils data. Click on 'Add' to add the first record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Soil ID	64512 (Click on adjacent icon to select)
Area	1.73 sq. miles

Soils - MB: 01

List **Details**

Sub Basin

Major Basin ID: 01

Sub Basin ID: 010105

Soil ID: 64512

Area (sq mi): 1.7300

Area (%): 25.9

Soil Data

	Value	Default	Custom
XKSAT	0.010	0.010	<input type="checkbox"/>
Rock Outcrop (%)			<input type="checkbox"/>
Effective (%)	100		

Soil Description

Book Number: 645 Map Unit: 12

Description: Carefree cobbly clay loam 1 to 8 percent slopes

Info Copy Print... Delete Add MB OK

Pressing the 'Save' button will auto-populate the Soil Description, Soil Data and Area (%) values. Click 'Add' to add a second record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Soil ID	64522 (Click on adjacent icon to select)
Area	4.96 sq. miles

Soils - MB: 01

List **Details**

Sub Basin

Major Basin ID: 01

Sub Basin ID: 010105

Soil ID: 64522

Area (sq mi): 4.9600

Area (%): 74.1

Soil Data

	Value	Default	Custom
XKSAT	0.040	0.040	<input type="checkbox"/>
Rock Outcrop (%)			<input type="checkbox"/>
Effective (%)	100		

Soil Description

Book Number: 645 Map Unit: 22

Description: Contine clay loam

Info Copy Print... Delete Add MB OK

Click 'Save' to save the data and then click 'Add' to add a third record. Enter the following:

Sub Basin	010110 (Click on adjacent icon to select)
Soil ID	64512 (Click on adjacent icon to select)
Area	5.70 sq. miles

Click 'Save' to save the data.

After all Soils data has been entered and updated, click on the 'OK' button to close the form.

11.0 ESTABLISH LAND USE DATA

Select **Hydrology** → **Land Use** to access the Land Use data. Click on 'Add' to add the first record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Land Use Code	110 (Click on adjacent icon to select)
Area	2.00 sq. miles

Land Use - MB: 01

Land Use

Major Basin ID: 01 Area (sq mi): 2.0000
 Sub Basin ID: 010105 Area (%): 29.9
 Land Use Code: 110 Rural Residential (<= 1/5 du per acre)

Land Use Data

	Value	Default	Custom
Initial Loss (IA)	0.30	0.30	<input type="checkbox"/>
Percent Impervious (RTIMP)	5	5	<input type="checkbox"/>
Vegetation Cover	30.0	30.0	<input type="checkbox"/>
Moisture Deficit (DTHETA)	NORMAL	NORMAL	<input type="checkbox"/>
Resistance Coefficient (Kb)	MIN	MIN	<input type="checkbox"/>

Details

Info Copy Print... Delete Add MB OK

Click 'Save' to save the data.

Click 'Add' to add a second record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Land Use Code	130 (Click on adjacent icon to select)
Area	4.69 sq. miles

Land Use - MB: 01

Land Use

Major Basin ID: 01 Area (sq mi): 4.6900
 Sub Basin ID: 010105 Area (%): 70.1
 Land Use Code: 130 Large Lot Residential - Single Family (1 du per acre to 2 du)

Land Use Data

	Value	Default	Custom
Initial Loss (IA)	0.30	0.30	<input type="checkbox"/>
Percent Impervious (RTIMP)	15	15	<input type="checkbox"/>
Vegetation Cover	50.0	50.0	<input type="checkbox"/>
Moisture Deficit (DTHETA)	NORMAL	NORMAL	<input type="checkbox"/>
Resistance Coefficient (Kb)	MIN	MIN	<input type="checkbox"/>

Details

Info Copy Print... Delete Add MB OK

Click 'Save' to save the data.

Click 'Add' to add a second record. Enter the following:

Sub Basin	010110 (Click on adjacent icon to select)
Land Use Code	140 (Click on adjacent icon to select)
Area	5.700 sq. miles

The image displays two screenshots of the 'Land Use - MB: 01' software window. The top screenshot shows the 'Land Use' section with the following data: Major Basin ID 01, Sub Basin ID 010110, Land Use Code 140, Area (sq mi) 5.7000, and Area (%) 100.0. The 'Land Use Data' section shows values for Initial Loss (IA), Percent Impervious (RTIMP), Vegetation Cover, Moisture Deficit (DTHETA), and Resistance Coefficient (Kb). The bottom screenshot is identical but shows the 'Add' button highlighted in the bottom toolbar.

Land Use	
Major Basin ID	01
Sub Basin ID	010110
Land Use Code	140
Area (sq mi)	5.7000
Area (%)	100.0

Land Use Data	
Initial Loss (IA)	0.25
Percent Impervious (RTIMP)	30
Vegetation Cover	50.0
Moisture Deficit (DTHETA)	NORMAL
Resistance Coefficient (Kb)	MIN

Click 'Save' to save the data. After all Land Use data has been entered and updated, click on the 'OK' button to close the form.

12.0 UPDATE SUB BASIN DATA

Select **Hydrology** → **Sub Basins**. Click on the 'Details' tab to view all the data for a record. Click 'Update' to update the data.

Sub Basins - MB: 01

List

Sub Basin

Major Basin: 01

Sub Basin: 010105

Sort: 2

Sub Basin Parameters - Clark

Area (sq mi): 6.690

Length (mi): 5.060

USGE (ft): 2760.0

DSGE (ft): 2200.0

Slope (ft/mi): 110.7

Time-Area: URBAN

Kb: 0.017

Details

Rainfall Losses - Green-Ampt

	Value	Default	Custom
IA (in)	0.30	0.30	<input type="checkbox"/>
DTHETA	0.13	0.13	<input type="checkbox"/>
PSIF (in)	10.22	10.22	<input type="checkbox"/>
XKSAT	0.039	0.039	<input type="checkbox"/>
RTIMP (%)	12	12	<input type="checkbox"/>
XKSAT (Bare Ground)	0.028		<input type="button" value="Custom"/>
Avg Vegetation (%)	44.0		

Return Period Parameters

	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
Custom Tc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tc (hrs)	0.999	0.827	0.749	0.684	0.644	0.611
Vel (ft/s)	7.43	8.97	9.91	10.85	11.52	12.15
R (hrs)	0.458	0.371	0.332	0.301	0.281	0.265

Info ReSort Print... Delete Add MB Update OK

Update Sub Basin Data

i This will update Major Basin: 01 where Custom values are not checked:
The update will include:

- Major Basin Area and Reduction Factors
- Land Use parameters
- Soil parameters
- Sub Basin parameters by establishing appropriate averages of Land Use and Soils.

Tc values will be developed using the model MCUHP1.

Please Note!
It is necessary to update Sub Basins parameters whenever land use and/or soils data have changed to ensure the correct data for running the HEC-1 model.

Do you want to continue?

Yes No

Click 'Yes' to confirm the update. Following the update, there may be a Warning

message report. Address the issues and provide a comment if necessary. For this example, there is not a Warning message.

Click 'OK' to close the Sub Basins form.

13.0 ESTABLISH PRELIMINARY ROUTING DATA

Select **Hydrology** → **HEC-1** → **Routing** to access the Routing data. Click on 'Add' to add the first record. Enter the data as shown on the following for Route ID '010105'.

HEC-1 Routing Data - MB: 01

Look for

ID	Type
010105	Normal Depth
010110	Normal Depth

Route

Major Basin ID 01

Route ID 010105

Type NORMAL DEPTH

☐ Channel Loss

Normal Depth

		Station	Elevation
LOB N	0.035	1. 510.0	99.70
Chan N	0.038	2. 1510.0	94.10
ROB N	0.035	LB 1585.0	93.60
Length	4224.0	4. 1596.0	92.20
Slope	0.0012	5. 1600.0	92.20
Max Elev	99.70	RB 1612.0	93.60
		7. 1662.0	94.90
		8. 2262.0	99.70

NSTPS

Model	NSTPS	Custom
2 Year	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5 Year	<input checked="" type="checkbox"/>	<input type="checkbox"/>
10 Year	<input checked="" type="checkbox"/>	<input type="checkbox"/>
25 Year	<input checked="" type="checkbox"/>	<input type="checkbox"/>
50 Year	<input checked="" type="checkbox"/>	<input type="checkbox"/>
100 Year	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Custom	<input type="checkbox"/>	<input type="checkbox"/>

Update NSTPS from HEC-1

Info Copy Print... Delete Add MB OK

After data has been entered click 'Save' and the 'Add' to add another record. Enter the following data in the new record for Route ID '010110'.

HEC-1 Diversions - MB: 01

List Details

Diversion Facility

Major Basin ID 01

Diversion ID (KK) 010105

Retrieval ID (KK Card) RT0105

DT Card ID DT0105

Maximum Diversions

Volume (ac-ft)

Flow (cfs)

Diver 35% of flow for later retrieval

Inflow/Diversion Data

	Inflow (cfs)	Diversion (cfs)
1.	0.0	0.0
2.	100.0	35.0
3.	200.0	70.0
4.	500.0	175.0
5.	1000.0	350.0
6.	2000.0	700.0
7.	4000.0	1400.0
8.	10000.0	3500.0
9.	20000.0	7000.0
10.	50000.0	17500.0

% Diversion

35

Build

Info ReSort Copy Print... Delete Add Graph MB OK

Enter the Retrieval ID (KK Card) and the DT Card ID as RT0105 and DT0105, respectively. These values can be left blank and DDMSW will use the Diversion ID (KK card) for these values.

Enter 35 in the % Diversion and click “*Build*”. DDMSW will fill in the diversion data based on a 35% diversion of flow.

15.0 ESTABLISH STORAGE DATA

Select **Hydrology** ➔ **HEC-1** ➔ **Storage** to access the Storage data. Click on ‘Add’ to add the first record. Enter the data as shown on the following for Storage ID ‘ST0115’. The Peak Storage and Stage will be automatically entered from the model runs.

	Storage (ac-ft)	Elevation (ft)
1.	0.00	90.0
2.	100.00	92.00
3.	150.00	94.00
4.	200.00	96.00
5.	275.00	98.00
6.	350.00	100.00
7.		
8.		
9.		
10.		

	Storage (ac-ft)	Elevation (ft)
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		

16.0 ESTABLISH HYDROGRAPH DATA (QI CARD)

This example is going to use a hydrograph. Initially it is necessary to establish the Hydrograph IDs. Select **Hydrology** → **HEC-1** → **Hydrograph IDs** to access the Hydrograph IDs data. Click on 'Add' to add the first record. Enter the Hydrograph ID, the drainage area and the time interval for the hydrograph data

(NMIN).

HEC-1 Hydrograph Ids

List Details

Hydrograph ID

Hydrograph ID	HYD001
Area (sq mi)	3.76
Time Interval, N (min)	5

This is a test hydrograph for the tutorial project

Info Print... Delete Add OK

Now select **Hydrology** → **HEC-1** → **Hydrograph Data** to access the Hydrograph data. It is necessary to enter hydrograph data for each return period to be modeled. Although the data can be entered by hand, it is easier to import this data. Click “**Select ID**” to establish the ID and return period for the data.

HEC-1 Model Network - MB: 01

Look for ☒ Exclude

Sort	ID	Type	Retrieve ID	Combine	Area
10		ID			
20	010105	Basin			
30	010105	Divert	DT0105		
40	010105	Route			
50	010110	Basin			
60	010105	Retrieve	DT0105		
70	010105	Combine		3	
80	010110	Route			
90	HYD001	Hydrograph			
100	HYD001	Combine		2	
102	ST0115	Storage			

Model Network

MB

Sort

Type

Basin Divert ID

Combining Retrieve *

Route Storage KM Comment

Hydrograph Special Code

This is the HEC-1 tutorial program example.

Info ReSort Copy Print... Delete Add MB Create Draft OK

Click on 'Add' to add the first record and select ID from the Select Type List and enter the following: Comment: This is the HEC-1 tutorial program example.

Click 'Save' and then Click '*Basin*' and select 010105 from the list. Click 'Save' and then Click '*Divert*' and select 010105 from the list.

Click 'Save' and then Click '*Route*' and select 010105 from the list. Select Normal Depth as the Route Type. Click 'Save' and then Click '*Basin*' and select 010110 from the list.

Click 'Save' and then Click 'Retrieve' and select 010105 from the list. Click 'Save' and then Click 'Combine'. Modify the Combine No to 3. Click 'Save' and then Click 'Route' and select 010110 from the list.

Click 'Save' and then Click '*Hydrograph*' and select HYD001 from the list.

Click 'Save' and then Click 'Combine'. Combine No defaults to 2 and this is OK. Click 'Save' and then Click 'Storage' and select ST0105 from the list.

After all data has been entered click '*Create Draft*' and the following file is created.

Programmer's File Editor

File Edit Options Template Execute Macro Window Help

\FCDMC\ST5.5.7\MODLRUNS\KVLEXAMPLE1\01.Dat

```

ID      KVL Consultants, Inc.
ID      KVLEXAMPLE1 - Example 1 HEC-1 Tutorial Project
ID      100 Year
ID      6 Hour Storm
ID      Unit Hydrograph: Clark
ID      Storm: Multiple
ID      04/11/2018
ID      This is the HEC-1 tutorial program example.
*DIAGRAM
IT      5              0      2000
IO      5
IN      15
*
JD      3.2      0.0001
PC      0.000      0.008      0.016      0.025      0.033      0.041      0.050      0.058      0.066      0.074
PC      0.087      0.099      0.118      0.138      0.216      0.377      0.834      0.911      0.931      0.950
PC      0.962      0.972      0.983      0.991      1.000
JD      3.18      0.5
PC      0.000      0.008      0.016      0.025      0.033      0.041      0.050      0.058      0.066      0.074
PC      0.087      0.099      0.118      0.138      0.216      0.377      0.834      0.911      0.931      0.950
PC      0.962      0.972      0.983      0.991      1.000
JD      3.14      2.8
PC      0.000      0.009      0.016      0.025      0.034      0.042      0.051      0.059      0.067      0.076
PC      0.087      0.100      0.120      0.163      0.252      0.451      0.694      0.837      0.900      0.938
PC      0.950      0.963      0.975      0.988      1.000
JD      3.05      10.0
PC      0.000      0.015      0.020      0.030      0.048      0.063      0.076      0.090      0.105      0.119
PC      0.135      0.152      0.175      0.222      0.304      0.472      0.670      0.796      0.868      0.912
PC      0.946      0.960      0.973      0.987      1.000
*
KK010105      BASIN
BA      1.0
LG      0.15      0.25      4.50      0.50      50
UC      1.0      1.0
UA      0      5      16      30      65      77      84      90      94      97
UA      100
*
KK010105      DIVERT
DTDT0105      0      100
DI      0      100      200      1000      10000
DQ      0      50      100      500      5000
*
KK010105      ROUTE
RS      5      FLOW

```

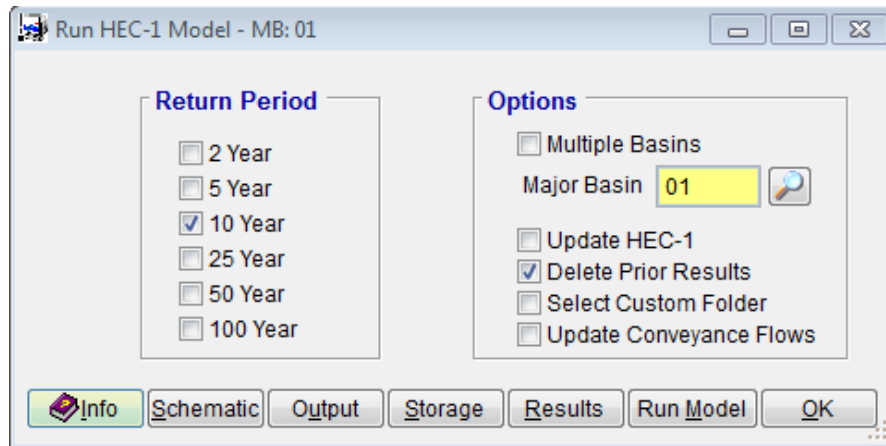
Ln1 Col1 92 |WR| Rec Off No Wrap DOS INS NUM

C:\FCDMC\ST\MODLRUNS\EXAMPLE1\KVLEXAMPLE4\01.Dat										
DQ	0	50	100	500	5000					
*										
KK010105 ROUTE										
RS	5	FLOW								
RC	0.016	0.016	0.016	1000	0.015					
RX	10	25	50	52	82	84	100	110		
RY	15.0	15.0	15.0	0.0	0.0	15.0	15.0	15.0		
*										
KK010110 BASIN										
BA	1.0									
LG	0.15	0.25	4.50	0.50	50					
UC	1.0	1.0								
UA	0	5	16	30	65	77	84	90	94	97
UA	100									
*										
KK010105RETRIEVE										
DRDT0105										
*										
KK010105 COMBINE										
HC	3									
*										
KK010110 ROUTE										
RS	5	FLOW								
RC	0.016	0.016	0.016	1000	0.015					
RX	10	25	50	52	82	84	100	110		
RY	15.0	15.0	15.0	0.0	0.0	15.0	15.0	15.0		
*										
KKHYD001 HYDRO										
IN	5									
BA	3.76									
QI	51	82	161	325	386	473	693	840	890	1002
QI	1069	1085	1120	1252	1401	1663	1721	1967	2185	2261
QI	2543	2718	2458	2162	1876	1645	1443	1249	1044	836
QI	705	587	477	391	336	297	267	240	219	201
QI	184	168	156	146	137	129	120	111	103	96
QI	89	84	79	74	70	65	61	56	53	49
QI	47	44	43	41	39	37	35	34	32	30
*										
IN	15									
*										
KKHYD001 COMBINE										
HC	2									
*										
KKST0115 STORAGE										
KO										
RS	1	STOR								
SU	0.0	10.0	100	1000	10000					

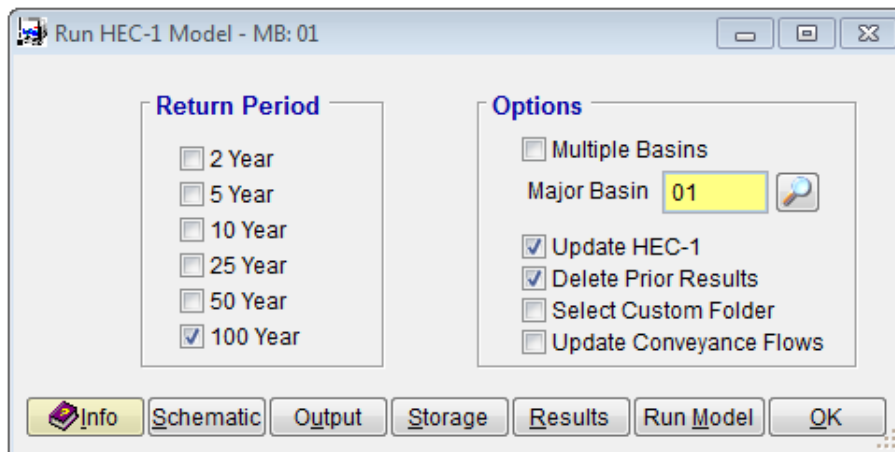
18.0 RUN DRAFT HEC-1 MODEL

Select **Hydrology** ➔ **HEC-1** ➔ **Model** to access the HEC-1 model.

Check the '10 Year' Return Period and the 'Delete Prior Results' option. Uncheck all other return periods and options.



Click 'Save'. Click 'Run Model' to run the Draft HEC-1 Model. If the model runs correctly, it means the HEC-1 Network is fine. If there are no errors, run the model for the 100-year Return Period. Check the Update HEC-1 checkbox. Press Save to save the selections made and then click Run Model button.



This previous model run has performed an update on the HEC-1 model based on the model framework that was built. The update has integrated real project data into the model. To close the **RUN HEC-1 MODEL** form, press **OK**.

19.0 UPDATE ROUTING STEP VALUES

Select **Hydrology → HEC-1 → Routing** to access the Routing data. Click on the 'Update from HEC-1' button to update the Steps. A note will pop up saying that the HEC-1 model will run three times and the 'Steps' field for all routing channels will be updated if the custom checkbox is not filled in. Select 'Yes'. The following will be the results for **Route ID 010105**. Press **'OK'** to close the **HEC-1 ROUTING**

DATA form.

ID	Type
010105	Normal Depth
010110	Normal Depth

Look for: []

Route

Major Basin ID: 01

Route ID: 010105

Type: NORMAL DEPTH

☐ Channel Loss

Normal Depth

		Station	Elevation
LOB N	0.035	1.	510.0
Chan N	0.038	2.	1510.0
ROB N	0.035	LB	1585.0
Length	4224.0	4.	1596.0
Slope	0.0012	5.	1600.0
Max Elev	99.70	RB	1612.0
		7.	1662.0
		8.	2262.0

NSTPS

Model	NSTPS	Custom
2 Year	7	<input type="checkbox"/>
5 Year	7	<input type="checkbox"/>
10 Year	6	<input type="checkbox"/>
25 Year	6	<input type="checkbox"/>
50 Year	6	<input type="checkbox"/>
100 Year	5	<input type="checkbox"/>
Custom		<input type="checkbox"/>

☒ Update NSTPS from HEC-1

Info Copy Print... Delete Add MB OK

20.0 RUN FINAL HEC-1 MODEL FOR ALL RETURN PERIODS

Select **Hydrology** → **HEC-1** → **Model** to access the HEC-1 model. Check all Return Periods, and the *Update HEC-1* and *Delete Prior Results* checkbox options.

Return Period

☒ 2 Year

☒ 5 Year

☒ 10 Year

☒ 25 Year

☒ 50 Year

☒ 100 Year

Options

☐ Multiple Basins

Major Basin: 01

☒ Update HEC-1

☒ Delete Prior Results

☐ Select Custom Folder

☐ Update Conveyance Flows

Info Schematic Output Storage Results Run Model OK

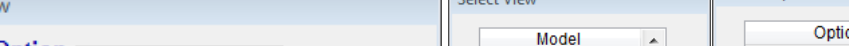
Click **'Run Model'** to run the updated HEC-1 model for all return periods. If the model runs correctly, it means the HEC-1 network and data are fine. The results can be viewed by clicking **'Results'**. A full output file can be viewed with the

HEC-1 Flow Summary - FLOWS - MB: 01

Look for _____

ID	Sort ^	Type	Area	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
DT0105	10	Hydrograph	6.69	1392	2500	3403	4587	5551	6548
DT0105	20	Diversión	6.69	484	875	1191	1605	1943	2292
010105	30	Hydrograph	6.69	898	1625	2212	2982	3608	4256
010105	40	Routed	6.69	781	1448	1954	2674	3260	3786
010110	50	Hydrograph	5.70	2364	3332	4094	5110	5938	6790
010105	60	Hydrograph	6.69	484	875	1191	1605	1943	2292
010105	70	Combined	12.39	2579	3891	5040	6778	8203	9644
010110	80	Routed	12.39	2508	3845	4992	6536	7887	9500
HYD001	90	Hydrograph	3.76	1941	2718	3883	5047	5824	7765
HYD001	100	Combined	16.15	2508	3845	4992	6536	7882	9500
ST0115	110	Routed	16.15	1684	2688	3669	5557	7035	8703

Info Export Print... View MB OK



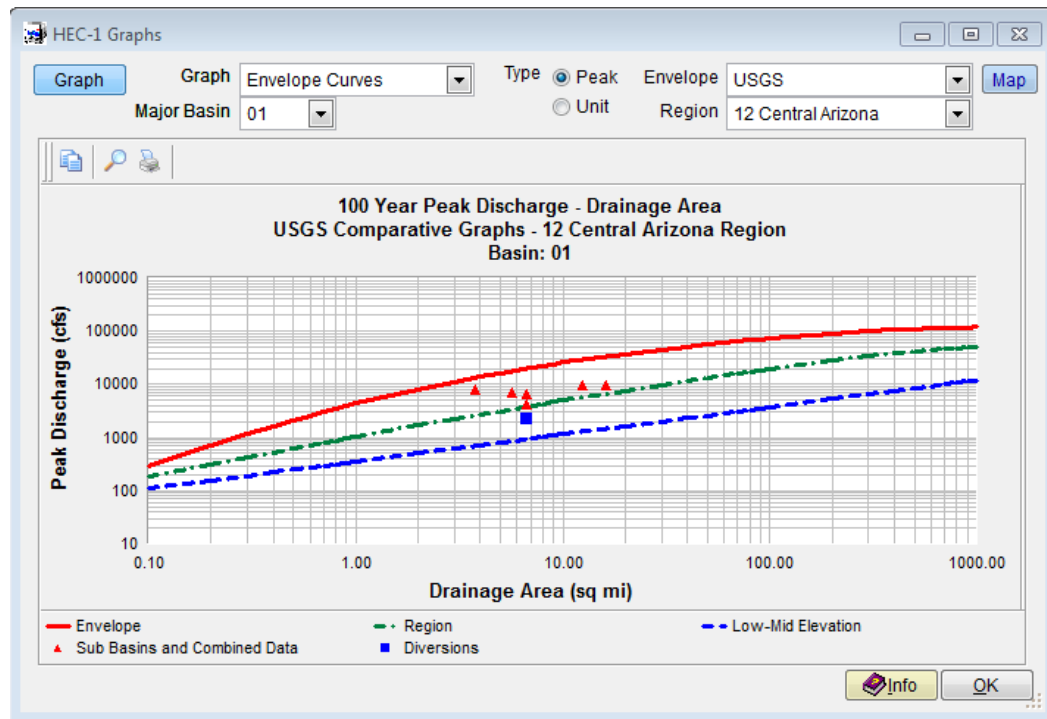
The first screenshot shows the 'View Option' dialog box. It has a title bar 'Model View' and a section 'View Option'. Under 'View', 'Flows' is selected. Under 'Option', 'All' is selected. There are magnifying glass icons next to the selection fields. At the bottom are 'Info' and 'OK' buttons.

The second screenshot shows the 'Select View' dialog box. It has a title bar 'Select View' and a list box containing: 'Flows', 'Volumes (IN)', 'Volumes (AF)', 'Attenuation/Velocity', and 'Time to Peak (Hrs)'. 'Flows' is selected. At the bottom are 'OK' and 'Cancel' buttons.

The third screenshot shows the 'Select Option' dialog box. It has a title bar 'Select Option' and a list box containing: 'All', 'Hydrograph', 'Routed', 'Combined', and 'Storage'. 'All' is selected. At the bottom are 'OK' and 'Cancel' buttons.

22.0 GRAPH HEC-1 RESULTS

Select **Hydrology** → **HEC-1** → **Graph Envelope Curves** to access the Graphing module. Enter the appropriate data for your location and click the **'Graph'** button as follows:



23.0 BACKUP PROJECT

Select **File** → **Project Management** to access the Project Management module. Select '**Backup Project**' as the **Action** and 'KVLEXAMPLE1A' as the project (use the adjacent icon to select). Click the '**Backup**' button to backup the project and select the directory where your backup file should go. Finally, click '**Yes**' after a directory has been chosen.

