



DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 6.8.0

TUTORIAL # 2 DEVELOPING A NEW HEC-1 MODEL USING GIS SHAPEFILES



KVL Consultants, Inc.

Table of Contents

1.	Introduction	1
2.	Add a New Project	2
3.	Project Paths	4
4.	Establish Major Basin Id's	5
5.	Digitize in GIS.....	6
	Nodes and Routing	7
	Sub Basins.....	8
	Time of Concentration, Tc.....	9
	Land Use	10
	Soils.....	10
	Rainfall.....	11
6.	Rainfall Data	12
7.	Review Land Use Defaults	15
8.	Review Soil Defaults	16
9.	Update Hydrology Data	17
	View Land Use Data	18
	View Soils Data.....	19
	View Sub Basin Data	20
10.	Routing Data	21
	Import Routing Data.....	21
	View Routing Data	22
11.	Storage Facility Data	23
12.	Diversion Data.....	24
13.	Hydrographs	25
	Hydrograph IDs.....	25
	Hydrograph Data.....	26
14.	Special Code	28
15.	HEC-1 Model Network.....	31
16.	Run HEC-1 Model.....	34
17.	Flow Summary	36
18.	Storage Summary	37

19. Graph Hydrographs	38
Export Hydrographs.....	41
20. Backup Project.....	42

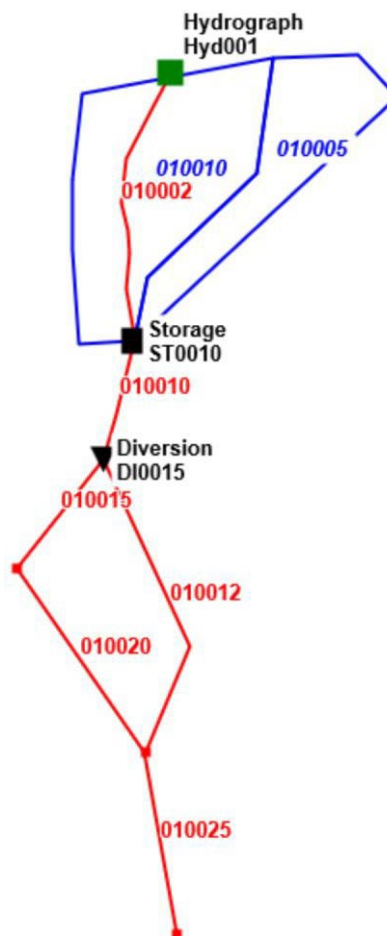
1. Introduction

The application for this example can be imported from the \\St\\BackupExamples folder. The application is “HEC1TUTORIAL.ZIP”.

The HEC-1 modeling will include:

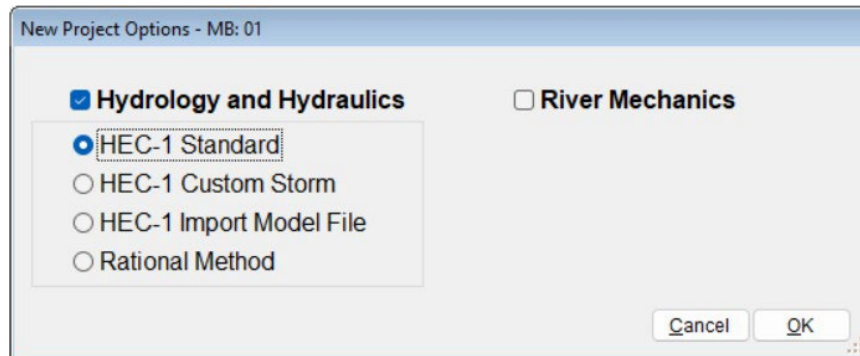
- Sub Basins (010005) for example.
- Routing (010002) for example.
- Hydrograph (Hyd001)
- Storage Facility (ST0010).
- Diversion (DI0015).
- Special Code (For 010025 Routing)
- Rainfall (the outline of all Sub Basins).
- Graph Hydrographs

A map of the model is shown below.

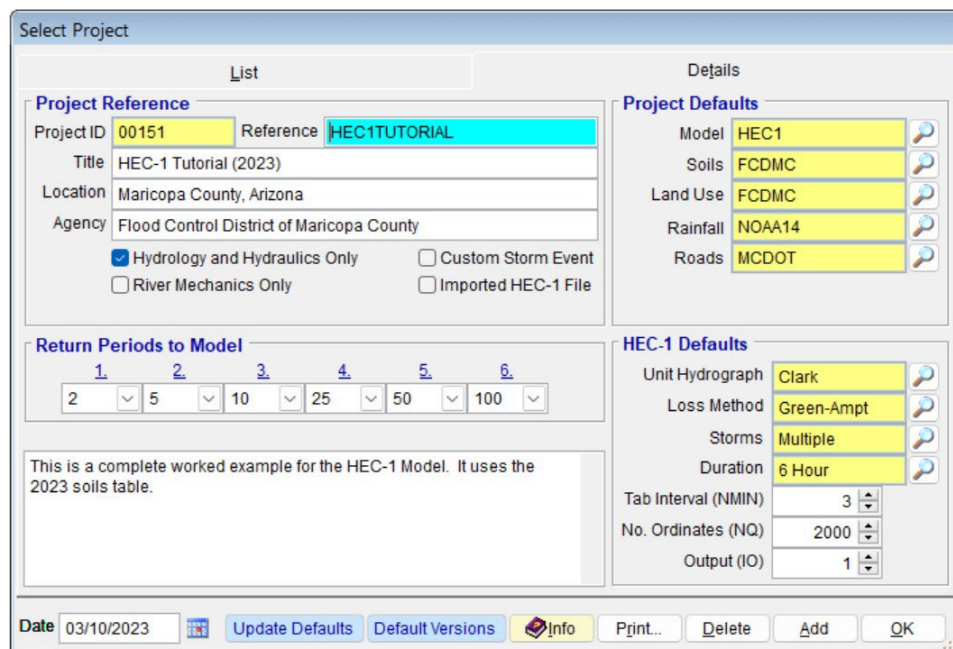


2. Add a New Project

1. Select “File/New Project”
2. Check “Hydrology and Hydraulics” and HEC-1 Standard”.



3. Click “OK”
4. Enter HEC1TUTORIAL as the Reference.
5. Enter HEC-1 Tutorial for the Title.
6. Enter Maricopa County, Arizona for the Location.
7. Change Tab Interval (NMIN) from 5 to 3.
8. Change Output (IO) to 1 (to get hydrographs).
9. On the “List” Tab, select “HEC1 Model” for the Group.
10. Click “OK”



When a new project is established, the latest versions from Agency data are established for the Project defaults. In this case the new 2023 Soil Defaults is used. If it is necessary to change the default version, then Click “*Default Versions*” to open the following form. Then click on the Hour-Glass adjacent to the required table and select the version. Please note if there is only one version available, the the Hour-Glass is disabled.

For this example leave the Soils version to 11/30/2023.

Default Versions

Reference
HEC1TUTORIAL

Rainfall

Area Reduction Factors
12/31/2016

Noaa14 Rainfall
12/31/2016

Land Use and Soils

Land Use
12/31/2016

Soils
11/30/2023

PSIF-DTHETA Relationship
12/31/2016

Kb Parameters
12/31/2016

Patterns

Area Patterns
12/31/2016

Two Hour Patterns
12/31/2016

Six Hour Patterns
12/31/2016

Twenty Four Hour Patterns
12/31/2016

Distributions

Time-Area
12/31/2016

Sgraph
12/31/2016

Hydraulics

Inlets
12/31/2016

Road Ids
12/31/2016

Manning's n
12/31/2016

Stepped Spillway

Alpha
12/31/2016

E Loss
12/31/2016

HJ Length
12/31/2016

River Mechanics

Sediment Yield
12/31/2016

Alpha
12/31/2016

Options
12/31/2016

Other Parameters

Other Defaults
12/31/2016

Select version buttons enabled when more than one version is available.

Modification Date
03/10/2023

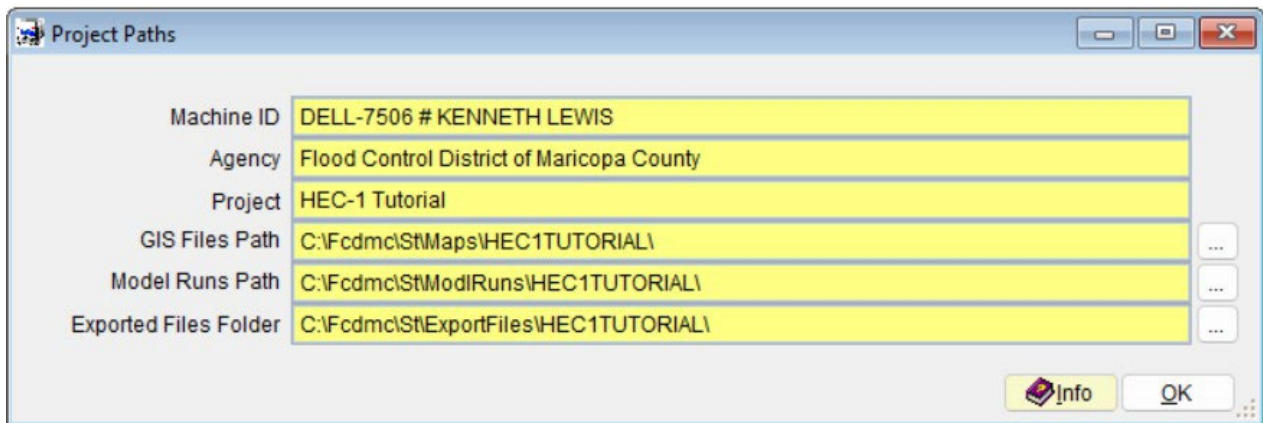
Info
OK

3. Project Paths

1. Select 'File' => 'Project Paths'.

For each project, it is necessary to establish folders for: GIS files (if using GIS), Model Runs and Exported Files. When saving a new project, the folders are automatically established using the Project Reference. For example, the Project Reference for this example is "HEC1TUTORIAL", and assuming the application is installed in "C:\FCDMC", then the established folders are shown below.

The folders can be changed by clicking the button ('...') to the right of the folder field and navigate to an appropriate folder.



The screenshot shows a dialog box titled "Project Paths". It contains several fields for project information:

Field	Value	Action
Machine ID	DELL-7506 # KENNETH LEWIS	
Agency	Flood Control District of Maricopa County	
Project	HEC-1 Tutorial	
GIS Files Path	C:\Fcdmc\StMaps\HEC1TUTORIAL\	...
Model Runs Path	C:\Fcdmc\StModIRuns\HEC1TUTORIAL\	...
Exported Files Folder	C:\Fcdmc\StExportFiles\HEC1TUTORIAL\	...

At the bottom right, there are buttons for "Info" and "OK".

2. Click "OK" to exit the form.

4. Establish Major Basin Id's

1. 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 we will only have one major basin in this project, there is no need for further modification at this time. The area will be updated when updating the Sub Basins.

The screenshot shows the 'Major Basins' window with the 'Details' tab selected. The 'Major Basin' section contains the following fields:

- Major Basin ID: 01
- Description: Major Basin 01
- Area (sq mi): [Empty]
- Rain ID: DEFAULT

The 'Modeling Options' section includes:

- Model This Major Basin: ☒
- Storms: Multiple
- Duration: 6 Hour
- Tab Interval: 3
- No. Ordinates: 2000
- Output: 1

The 'Return Period for Steps' section shows:

- Step RP: 100

The 'Reduction Factors' section displays a table with 9 rows and 2 columns (Area, RF). The 'Custom' checkbox is unchecked.

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

2. Click on the 'OK' button to close the form.

5. Digitize in GIS

All GIS files must be in ESRI Shape file format. For this example, all shapefiles are contained in C:\Fcdmc\St\Maps\HEC1TUTORIAL.

The necessary field structure can be found for the Sub Basins, Land Use, Soils, and Tc by going to Select Maps => *Update Hydrology* and Clicking “*Required Map Fields*”. Note that once the shapefiles have been selected, the Required Map Fields can be automatically established by Clicking “*Check Required Map Fields*”.

The necessary field structure can be found for the Routing by going to Select Maps => *Import Routing Data* and Clicking “*Required Map Fields*”. Note that once the shapefiles have been selected, the Required Map Fields can be automatically established by Clicking “*Check Required Map Fields*”.

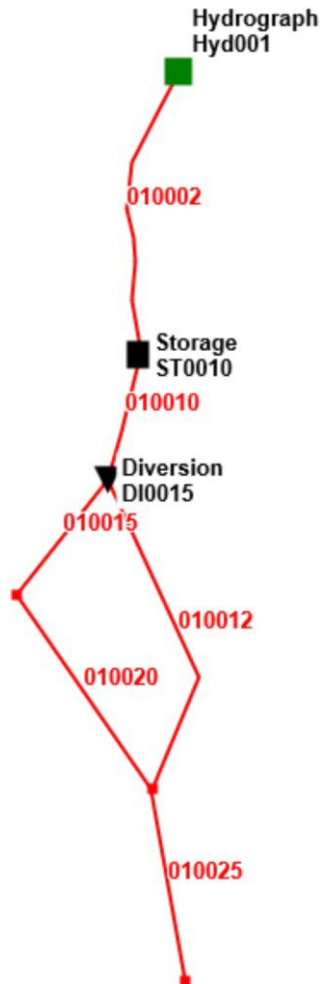
[illegible]

Required Map Fields			
Map	Field Name	Type	Description
Routing	BASINID	Character 2	Major Basin ID (All)
Routing	ID	Character 6	Routing ID (All)
Routing	ROUTETYPE	Character 20	Routing Type (Normal Depth, Kinematic Wave, Muskingum)
Routing	LENGTH	Numeric 8.1	Routing length in feet (All)
Routing	USGE	Numeric 8.2	Upstream ground elevation (All)
Routing	DSGE	Numeric 8.2	Downstream ground elevation (All)
Routing	MAN	Numeric 5.3	Manning's n for channel (All)
Routing	MANL	Numeric 5.3	Manning's n for left overbank (Normal Depth)
Routing	MANR	Numeric 5.3	Manning's n for right overbank (Normal Depth)
Routing	X1	Numeric 6.1	First horizontal station in feet (Normal Depth)
Routing	Y1	Numeric 8.2	First vertical elevation in feet (Normal Depth)
Routing	X2	Numeric 6.1	Second horizontal station in feet (Normal Depth)
Routing	Y2	Numeric 8.2	Second vertical elevation in feet (Normal Depth)
Routing	X3	Numeric 6.1	Third horizontal station in feet (Normal Depth)
Routing	Y3	Numeric 8.2	Third vertical elevation in feet (Normal Depth)
Routing	X4	Numeric 6.1	Fourth horizontal station in feet (Normal Depth)
Routing	Y4	Numeric 8.2	Fourth vertical elevation in feet (Normal Depth)
Routing	X5	Numeric 6.1	Fifth horizontal station in feet (Normal Depth)
Routing	Y5	Numeric 8.2	Fifth vertical elevation in feet (Normal Depth)
Routing	X6	Numeric 6.1	Sixth horizontal station in feet (Normal Depth)

Nodes and Routing

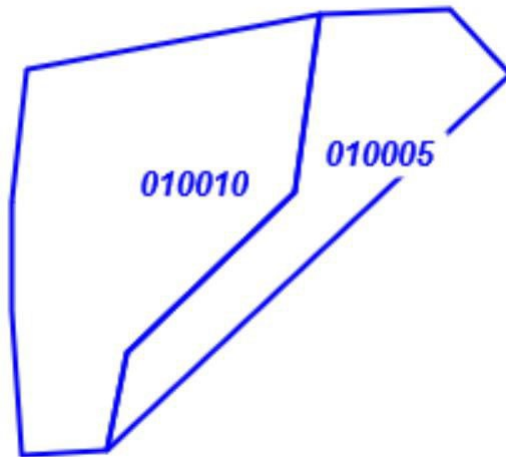
The Nodes include the Hydrograph, Storage, Diversion and points at the beginning and end of Route features. The Nodes are for cosmetic purposes only.

The Routing data is contained in the Route shapefile for importing into DDMSW.



GIS_LENGTH	GIS_AREA	ID	BASINID	ROUTETYPE	LENGTH	USGE	DSGE	MAN	MANL	MANR	X1	Y1	X2	Y2	X3	Y3	X4	Y4
198	0	010010	01	NORMAL DEPTH	198	998	997	0.035	0.045	0.045	100	100	120	99	140	95	190	94
443.76	0	010002	01	NORMAL DEPTH	444	1000	999	0.035	0.045	0.045	100	100	120	99	140	95	190	94
223.76	0	010015	01	NORMAL DEPTH	224	996	994	0.035	0.045	0.045	100	100	120	99	140	95	190	94
361.75	0	010020	01	NORMAL DEPTH	362	994	993	0.035	0.045	0.045	100	100	120	99	140	95	190	94
296.82	0	010025	01	NORMAL DEPTH	297	992	991	0.035	0.045	0.045	100	100	120	99	140	95	190	94
515.05	0	010012	01	NORMAL DEPTH	515	996	995	0.035	0.045	0.045	100	100	120	99	140	95	190	94

Sub Basins

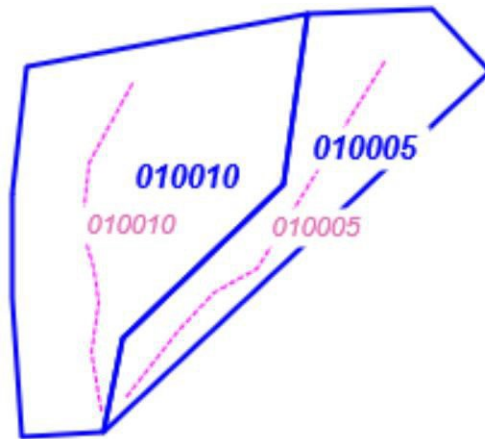


Enter the AREAID and BASINID. The AREASF is automatically calculated when updating the Hydrology from Maps.

	AREAID	BASINID	AREASF
2	010010	01	993441
3	010005	01	529969

Time of Concentration, Tc

Digitize Time of Concentration. Make sure that the Time of Concentration lines are entirely contained within the sub basin.

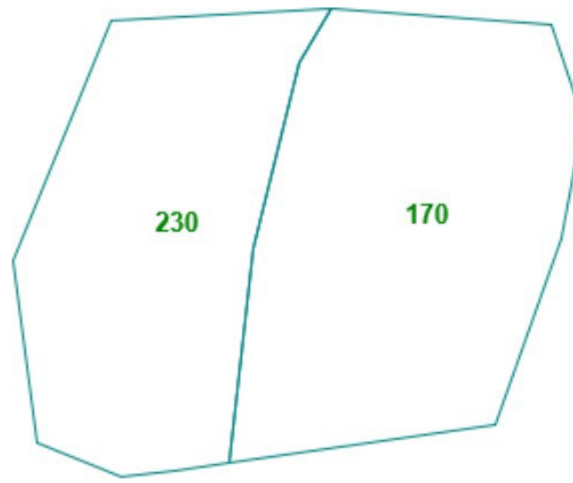


Enter the USGE, DSGE AREAID and BASINID. The LENGTH is automatically calculated when updating the Hydrology from Maps.

USGE	DSGE	LENGTH	AREAID	BASINID
1000	998	1212	010010	01
1000	998	1543	010005	01

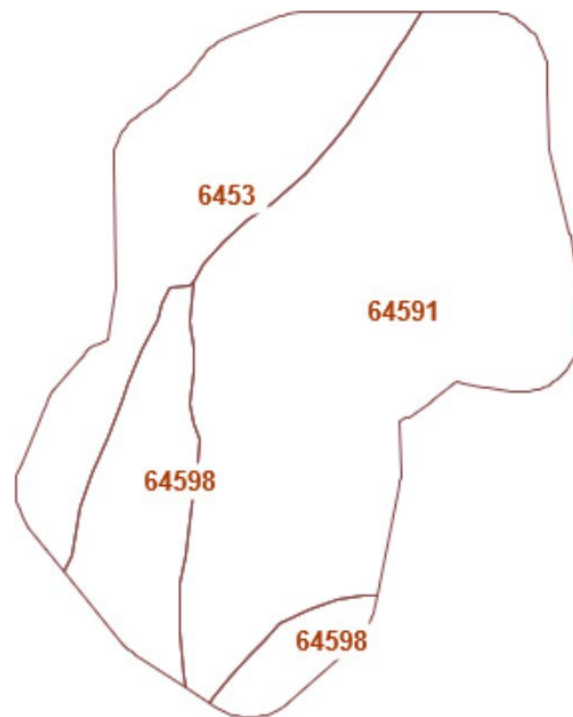
Land Use

Obtain Land Use Map or Digitize. Make sure Land Use codes are included in Land Use Defaults in DDMSW. Also make sure that the land use map extends beyond all sub basin polygons. The only necessary data is the Land Use Code.



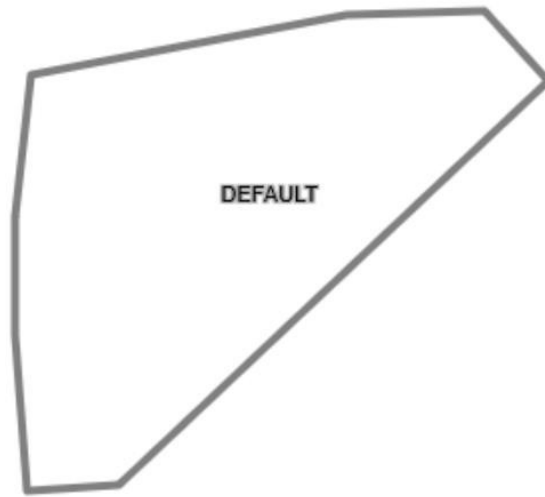
Soils

Obtain Soils map from FCDMC or establish from NRCS file or Digitize. Make sure Soil IDs are included in Soil Defaults in DDMSW. Also make sure that the soils map extends beyond all sub basin polygons. The only necessary data is the Soil ID.



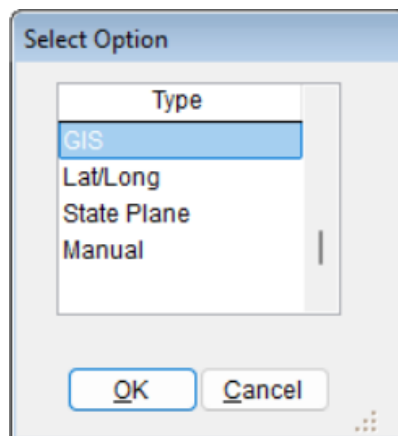
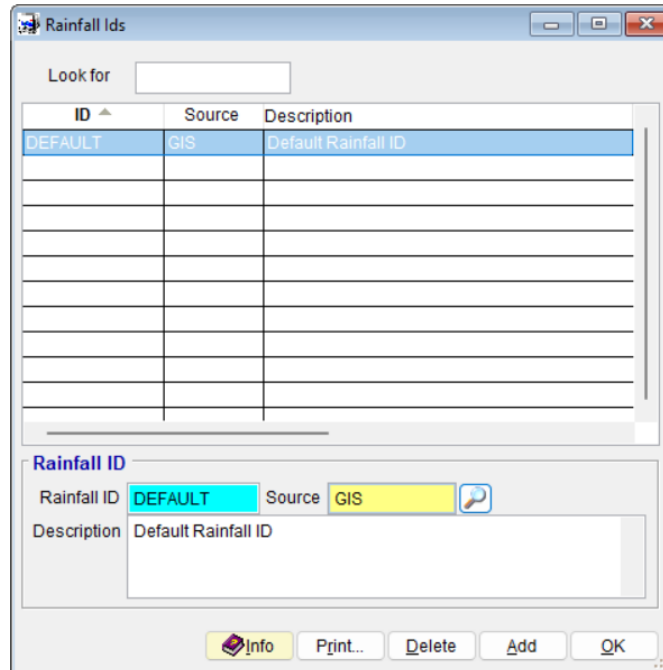
Rainfall

Digitize the Rainfall Map. This can be the outline of all the Sub Basins. The only necessary data is the RAINID and BASINID.

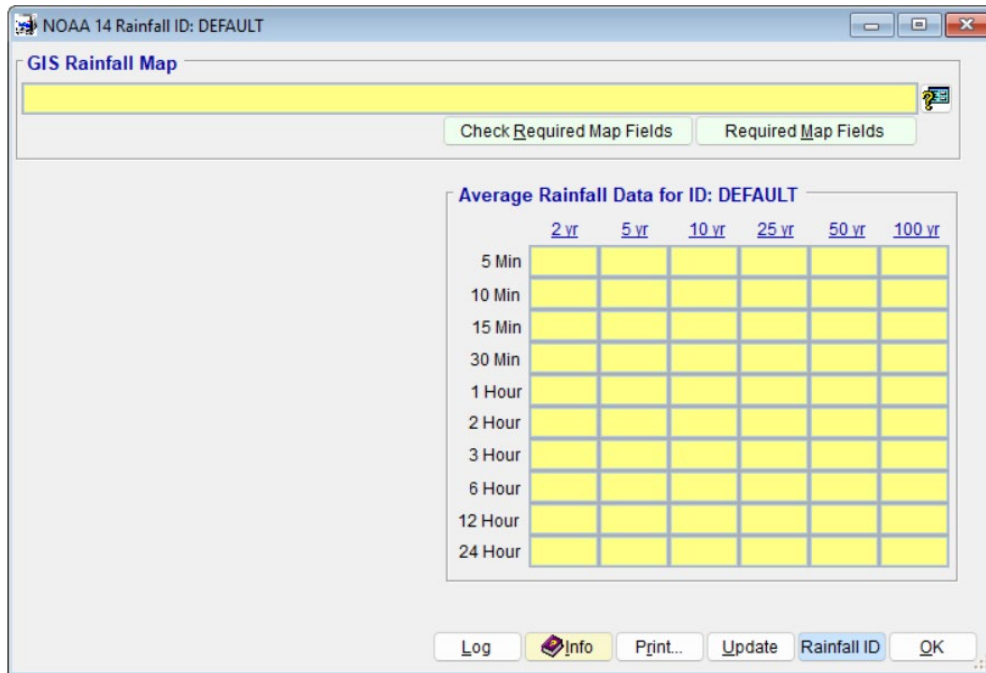


6. Rainfall Data

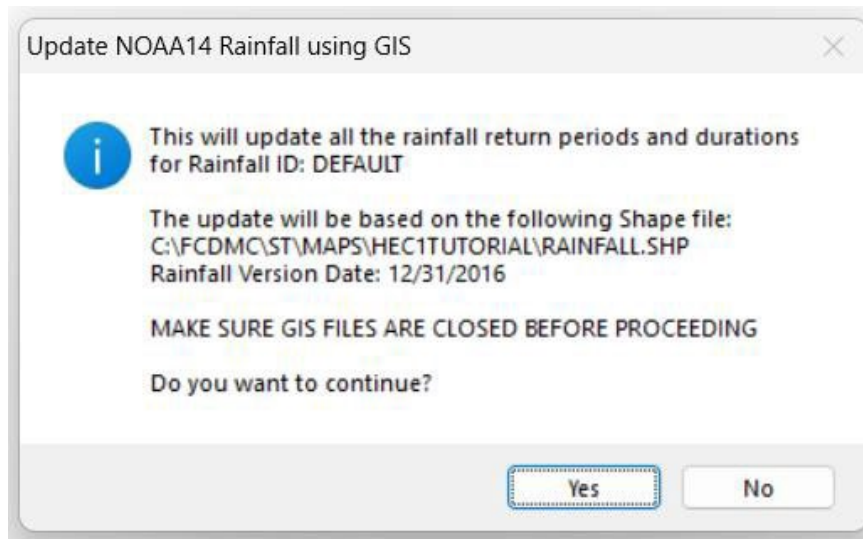
1. Select Hydrology => *Rainfall IDs*
2. Change “Source” to GIS



3. Click “OK” to continue.
4. Select Hydrology => *Rainfall*



5. Select the Rainfall shapefile.
6. Click “Save” to save the data.
7. Click “Update” to develop the Rainfall data.



8. Click “Yes” to continue.

NOAA 14 Rainfall ID: DEFAULT

GIS Rainfall Map

C:\FCDMC\STMAPS\HEC1TUTORIAL\RAINFALL.SHP

Check Required Map Fields Required Map Fields

Average Rainfall Data for ID: DEFAULT

	<u>2</u> yr	<u>5</u> yr	<u>10</u> yr	<u>25</u> yr	<u>50</u> yr	<u>100</u> yr
5 Min	0.264	0.357	0.427	0.521	0.593	0.666
10 Min	0.402	0.543	0.650	0.793	0.903	1.015
15 Min	0.499	0.673	0.806	0.983	1.119	1.258
30 Min	0.672	0.907	1.085	1.324	1.507	1.694
1 Hour	0.831	1.122	1.343	1.639	1.865	2.096
2 Hour	0.964	1.281	1.524	1.854	2.102	2.360
3 Hour	1.045	1.365	1.618	1.971	2.252	2.542
6 Hour	1.237	1.577	1.848	2.218	2.505	2.804
12 Hour	1.414	1.784	2.075	2.467	2.768	3.080
24 Hour	1.679	2.174	2.569	3.121	3.559	4.018

Log Info Print... Update Rainfall ID OK

7. Review Land Use Defaults

1. Select *Hydrology* => *Land Use Defaults* to view or modify land use defaults or add 'Custom' data. For this example, custom values are not required.

Land Use Defaults

Look for ☒ Custom

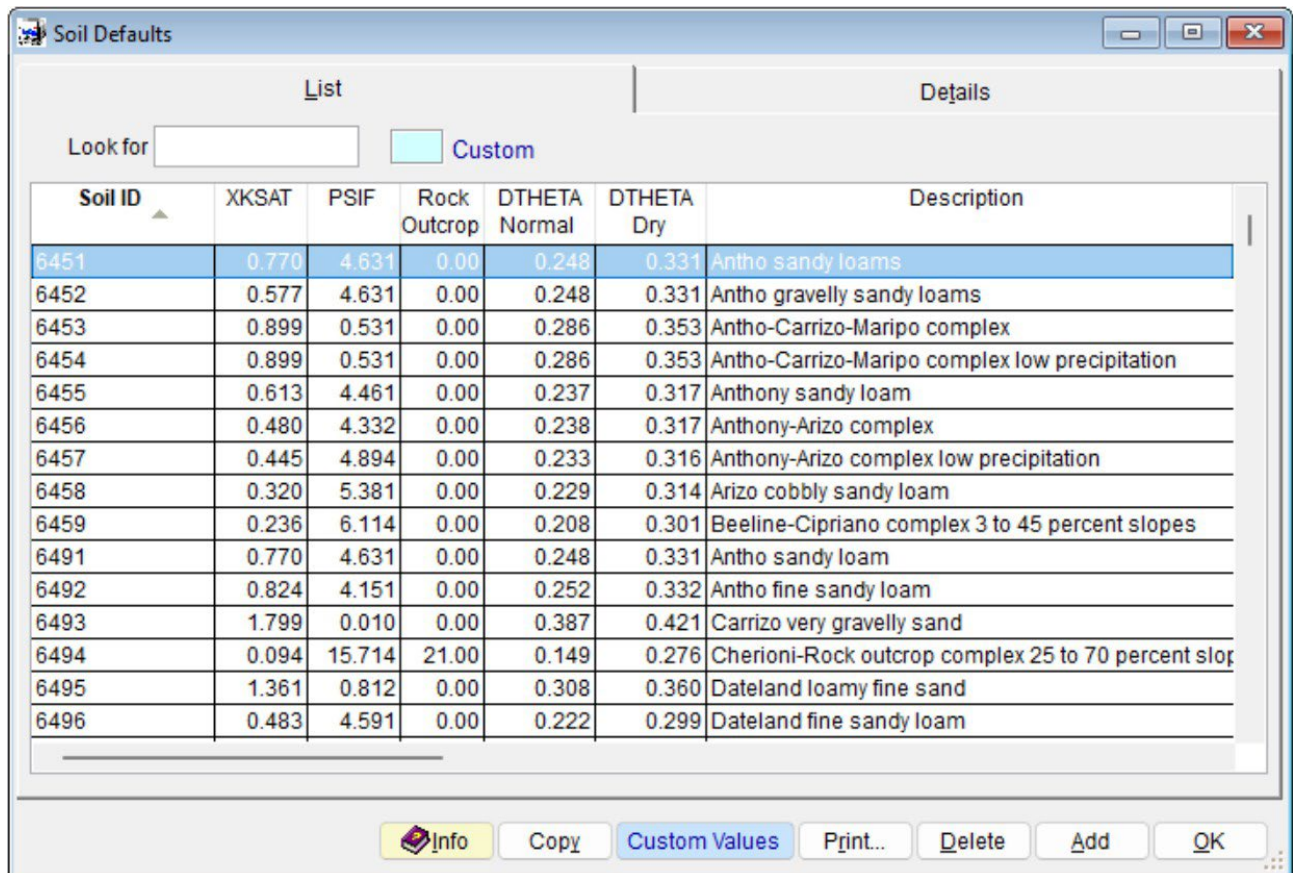
Sort	Code	Group	IA	Rtime	Cover	Dtheta	Kb	Description
10	110	Residential	0.30	5	30.0	NORMAL	MIN	Rural Residential (<= 1/5 du pe
20	120	Residential	0.30	5	30.0	NORMAL	MIN	Estate Residential (1/5 du per a
30	130	Residential	0.30	15	50.0	NORMAL	MIN	Large Lot Residential - Single F
40	140	Residential	0.25	20	50.0	NORMAL	MIN	Medium Lot Residential - Singl
50	150	Residential	0.25	30	50.0	NORMAL	MIN	Small Lot Residential - Single F
60	160	Residential	0.25	40	50.0	NORMAL	MIN	Very Small Lot Residential - Sir
70	170	Residential	0.25	45	50.0	NORMAL	MIN	Medium Density Residential - M
80	180	Residential	0.25	45	50.0	NORMAL	MIN	High Density Residential - Multi
90	190	Residential	0.25	45	50.0	NORMAL	MIN	Very High Density Residential -
100	200	Commercial	0.10	80	60.0	NORMAL	MIN	General Commercial (Commer
110	210	Commercial	0.10	80	65.0	NORMAL	MIN	Specialty Commercial (<=50,00
120	220	Commercial	0.10	80	65.0	NORMAL	MIN	Neighborhood Commercial (50
130	230	Commercial	0.10	80	75.0	NORMAL	MIN	Community Commercial (100,0
140	240	Commercial	0.10	80	65.0	NORMAL	MIN	Regional Commercial (500,000
150	250	Commercial	0.10	80	70.0	NORMAL	MIN	Super-Regional Commercial (>
160	300	Industrial	0.15	55	60.0	NORMAL	MIN	General Industrial (Industrial w

Info ReSort Copy Print... Delete Add OK

2. After *review*, Click 'OK' to close the form.

8. Review Soil Defaults

1. Select Hydrology => *Soil Defaults* to view or modify soil defaults or add 'Custom' data. For this example, custom values are not required.



The screenshot shows the 'Soil Defaults' window with a 'List' tab selected. It features a search bar labeled 'Look for' and a 'Custom' button. Below is a table with columns: Soil ID, XKSAT, PSIF, Rock Outcrop, DTHETA Normal, DTHETA Dry, and Description. The table lists 16 soil types with their corresponding values. At the bottom, there are buttons for Info, Copy, Custom Values, Print..., Delete, Add, and OK.

Soil ID	XKSAT	PSIF	Rock Outcrop	DTHETA Normal	DTHETA Dry	Description
6451	0.770	4.631	0.00	0.248	0.331	Antho sandy loams
6452	0.577	4.631	0.00	0.248	0.331	Antho gravelly sandy loams
6453	0.899	0.531	0.00	0.286	0.353	Antho-Carrizo-Maripo complex
6454	0.899	0.531	0.00	0.286	0.353	Antho-Carrizo-Maripo complex low precipitation
6455	0.613	4.461	0.00	0.237	0.317	Anthony sandy loam
6456	0.480	4.332	0.00	0.238	0.317	Anthony-Arizo complex
6457	0.445	4.894	0.00	0.233	0.316	Anthony-Arizo complex low precipitation
6458	0.320	5.381	0.00	0.229	0.314	Arizo cobbly sandy loam
6459	0.236	6.114	0.00	0.208	0.301	Beeline-Cipriano complex 3 to 45 percent slopes
6491	0.770	4.631	0.00	0.248	0.331	Antho sandy loam
6492	0.824	4.151	0.00	0.252	0.332	Antho fine sandy loam
6493	1.799	0.010	0.00	0.387	0.421	Carrizo very gravelly sand
6494	0.094	15.714	21.00	0.149	0.276	Cherioni-Rock outcrop complex 25 to 70 percent slopes
6495	1.361	0.812	0.00	0.308	0.360	Dateland loamy fine sand
6496	0.483	4.591	0.00	0.222	0.299	Dateland fine sandy loam

2. After review, Click 'OK' to close the form.

9. Update Hydrology Data

For this example, Sub Basin, Land Use, Soils and Time of Concentration (Tc) data will be developed from the developed GIS files. **The data can also be entered manually.**

1. Select *Maps => Update Hydrology* to access the mapping update.
2. Check *Land Use, Soils and Tc* to access the *Name and Path of Maps*
3. Locate the *Sub Basin, Land Use, Soils and Tc* shape Files.
4. Click “Save”
5. Click ‘Update’ to update the data.

6. Click ‘Yes’ to continue.

View Land Use Data

7. Select *Hydrology* => *Land Use* to view or modify land use data.

The screenshot shows the 'Land Use - MB: 01' window with the 'List' tab selected. It features a search bar labeled 'Look for' and a table with the following data:

Sub Basin ID	Land Use Code	Area	Area %	IA	RTIMP	Vegetation Cover	DTHETA	Kb
010005	170	0.0161	84.7	0.25	45	50.0	NORMAL	0.033
010005	230	0.0029	15.3	0.10	80	75.0	NORMAL	0.033
010010	170	0.0059	16.6	0.25	45	50.0	NORMAL	0.031
010010	230	0.0297	83.4	0.10	80	75.0	NORMAL	0.031

At the bottom of the window are buttons for Info, Copy, Print..., Delete, Add, MB, and OK.

The screenshot shows the 'Land Use - MB: 01' window with the 'Details' tab selected. It displays the following information:

Land Use

- Major Basin ID: 01
- Sub Basin ID: 010005
- Land Use Code: 170
- Area (sq mi): 0.0161
- Area (%): 84.7
- Description: Medium Density Residential - Multi Family (5-10 du per acre)

Land Use Data

	Value	Default	Custom
Initial Loss (IA)	0.25	0.25	<input type="checkbox"/>
Percent Impervious (RTIMP)	45	45	<input type="checkbox"/>
Vegetation Cover	50.0	50.0	<input type="checkbox"/>
Resistance Coefficient (Kb)	MIN	MIN	<input type="checkbox"/>

There is a large text area for 'Comments' on the right side of the 'Land Use Data' section.

At the bottom of the window are buttons for Info, Copy, Print..., Delete, Add, MB, and OK.

8. After *review*, Click 'OK' to close the form.

View Soils Data

9. *Select Hydrology => Soils to view or modify Soils data.*

The screenshot shows the 'Combined Soils and Land Use - MB: 01' window. It has two tabs: 'List' and 'Details'. The 'List' tab is active, displaying a table with the following data:

Sub Basin ID	Area	Area %	Soil ID	Land Use ID	XKSAT	PSIF	DTHETA
010005	0.0161	84.7	64591	170	0.344	4.424	0.237
010005	0.0029	15.3	64591	230	0.344	4.424	0.237
010010	0.0059	16.6	64591	170	0.344	4.424	0.237
010010	0.0210	59.0	64591	230	0.344	4.424	0.237
010010	0.0087	24.4	64598	230	0.120	11.336	0.158

At the bottom of the window, there are buttons for 'Info', 'Copy', 'Print...', 'Delete', 'Add', 'MB', and 'OK'.

The screenshot shows the 'Combined Soils and Land Use - MB: 01' window with the 'Details' tab active. It displays the following information:

- Sub Basin:** Major Basin ID: 01, Sub Basin ID: 010005
- Intersected Area:** Area (sq mi): 0.0161, Area (%): 84.7
- Soil Data:** Soil ID: 64591. A table shows values for XKSAT (0.344), PSIF (4.424), Rock Outcrop (%) (0.00), and Effective (%) (100). The 'Momoli-Carrizo complex' is listed below.
- Land Use Data:** Land Use Code: 170. A table shows values for Moisture Deficit (NORMAL) and DTHETA (0.237). The description 'Medium Density Residential - Multi Family (5-10 du per acre)' is shown.
- Comments:** A text area for additional notes.

At the bottom of the window, there are buttons for 'Info', 'Copy', 'Print...', 'Delete', 'Add', 'MB', and 'OK'.

10. After *review*, Click 'OK' to close the form.

View Sub Basin Data

11. Select *Hydrology* => Sub Basins to view or modify Sub Basin data.

Sort	Sub Basin	Area	Length	Slope	Time-Area	Kb	IA	DTHETA	PSIF	XKSAT
10	010005	0.019	0.292	34.2	NATURAL	0.033	0.23	0.24	4.42	0.513
20	010010	0.036	0.230	43.5	NATURAL	0.031	0.12	0.22	5.57	0.449

Sub Basin

Major Basin: 01

Sub Basin: 010005

Sort: 10

Sub Basin Parameters - Clark

Area (sq mi): 0.019

Length (mi): 0.292

USGE (ft): 1000.0

DSGE (ft): 990.0

Slope (ft/mi): 34.2

Time-Area: NATURAL

Kb: 0.033

Rainfall Losses - Green-Ampt

	Value	Default	Custom
IA (in)	0.23	0.23	<input type="checkbox"/>
DTHETA	0.24	0.24	<input type="checkbox"/>
PSIF (in)	4.42	4.42	<input type="checkbox"/>
XKSAT	0.513	0.513	<input type="checkbox"/>
RTIMP (%)	50	50	<input type="checkbox"/>
XKSAT (Bare Ground)		0.344	<input type="button" value="Custom"/>
Avg Vegetation (%)		53.8	

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)	0.419	0.364	0.336	0.308	0.290	0.275
Vel (f/s)	1.02	1.17	1.27	1.38	1.47	1.55
R (hrs)	0.500	0.429	0.392	0.356	0.333	0.314

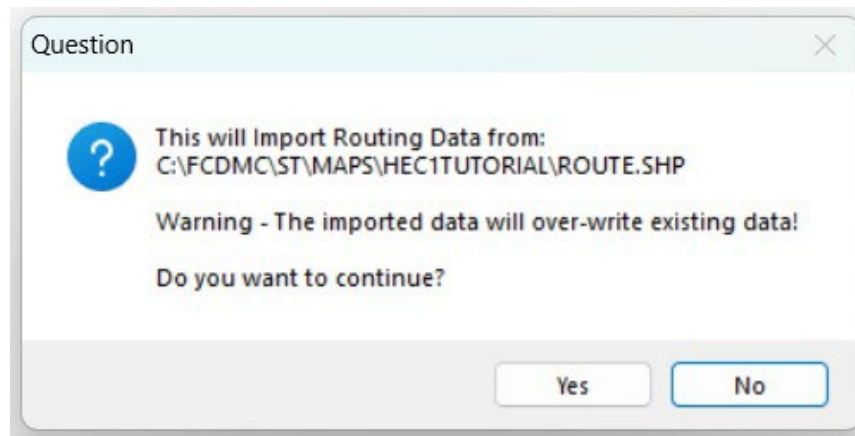
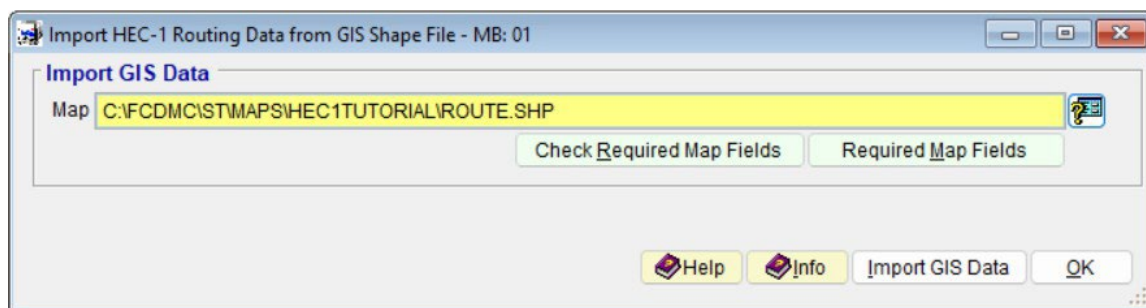
12. After review, Click 'OK' to close the form.

10. Routing Data

Import Routing Data

For this example, the routing data is contained in the Route shapefile. **The data can also be entered manually.**

1. Select *Maps* => Import Routing Data.
2. Click "*Required Map Fields*" to make sure the data structure is correct.
3. Locate the Map shapefile.
4. Click "*Import GIS Data*"



5. Click "Yes" to continue.

View Routing Data

1. Select *Hydrology => HEC-1=> Routing*.

HEC-1 Routing Data - MB: 01

Look for

ID	Type
010002	Normal Depth
010010	Normal Depth
010012	Normal Depth
010015	Normal Depth
010020	Normal Depth
010025	Normal Depth

Route

Major Basin ID: 01

Route ID: 010002

Type: NORMAL DEPTH

☐ Channel Loss

Normal Depth

		Station	Elevation
LOB N	0.045	1. 100.0	100.00
Chan N	0.035	2. 120.0	99.00
ROB N	0.045	LB 140.0	95.00
Length	444.0	4. 190.0	94.00
Slope	0.0023	5. 210.0	102.00
Max Elev		RB 250.0	101.00
		7. 270.0	100.00
		8. 300.0	102.00

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

2. Click "OK" to close the form.

11. Storage Facility Data

1. Select “Hydrology=>HEC-1=>Storage.
2. Click “Add” to add a record.
3. Enter ST0010 for the Storage Basin ID.
4. Select SQ Only for the Discharge Option.

HEC-1 Storage Facilities - MB: 01

List Details Storage/Elevation/Discharge

Storage Facility

MB ID 01

Storage ID ST0010

Discharge Options

SQ Only

Low-Level Outlet (SL) ☐

Spillway (SS) ☐

Top of Dam Overflow (ST) ☐

If the Discharge Options are changed, it is necessary to recreate the Draft HEC-1 Network to add or remove relevant data.

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

5. Click “Save”
6. Click the Tab “Storage/Discharge/Elevation” and enter the data shown below:

HEC-1 Storage Facilities - MB: 01

List Details Storage/Elevation/Discharge

Storage Facilities Rating Data

	Storage (ac-ft)	Elevation (ft)	Discharge (cfs)		Storage (ac-ft)	Elevation (ft)	Discharge (cfs)
1.	0.00	0.0	0	11.	3000.0	99.0	3000
2.	100.00	90.00	250	12.	5000.00	100.00	10000
3.	150.00	91.00	500	13.			
4.	200.00	92.00	750	14.			
5.	250.00	93.00	1000	15.			
6.	300.00	94.00	1250	16.			
7.	500.00	95.00	1500	17.			
8.	1000.00	96.00	1750	18.			
9.	2000.00	97.00	2000	19.			
10.	2500.00	98.00	2500	20.			

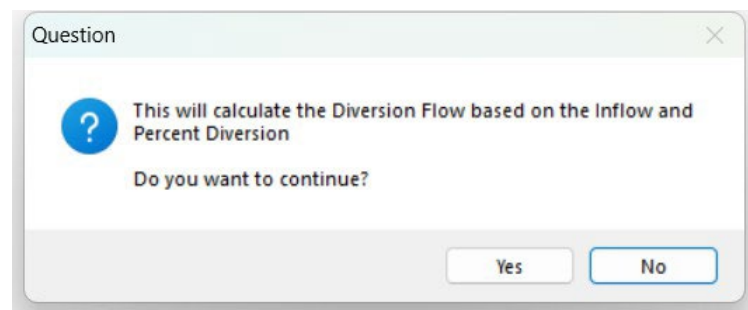
Storage ID ST0010 Use Surface Area ☐

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

7. Click “Save” to save the data and “OK” to exit.

12. Diversion Data

1. Select "Hydrology=>HEC-1=>Diversions."
2. Click "Add" to add a record.
3. Enter DI0015 for the Diversion ID.
4. Click "Save". This will establish the Retrieval and DT IDs.
5. Enter 250 for the Maximum Volume.
6. Enter 200 for the Maximum Flow.
7. Click "Save"
8. Enter the Inflow Data shown below (Diversion data will be calculated)
9. Enter 30 for the "Percent Diversion"
10. Click "Build Diversion"



11. Click "Yes"

The "HEC-1 Divisions - MB: 01" window is shown with the "Details" tab selected. It contains the following sections:

- Diversion Facility:**
 - Major Basin ID: 01
 - Diversion ID (KK): DI0015
 - Retrieval ID (KK Card): RT0015
 - DT Card ID: DT0015
- Maximum Diversions:**
 - Volume (ac-ft): 250.00
 - Flow (cfs): 200.0
- Inflow/Diversion Data:**

	Inflow (cfs)	Diversion (cfs)
1.	0.0	0.0
2.	50.0	15.0
3.	100.0	30.0
4.	200.0	60.0
5.	500.0	150.0
6.	1000.0	300.0
7.	2000.0	600.0
8.	4000.0	1200.0
9.	5000.0	1500.0
10.	10000.0	3000.0
- % Diversion:**
 - Input field: 30
 - Build button

At the bottom of the window is a toolbar with buttons: Info, ReSort, Copy, Print..., Delete, Add, Graph, MB, and OK.

12. Click "OK" to exit.

13. Hydrographs

For this model, hydrograph data from a previous HEC-1 model will be inserted at the beginning of the model. The data for the hydrographs for all return periods are available in folder C:\Fcdmc\ST\Modlrns\HEC1TUTORIAL. They are:

- Hyd001-2
- Hyd001-5
- Hyd001-10
- Hyd001-25
- Hyd001-50
- Hyd001-100

Hydrograph IDs

1. Select “Hydrology=>HEC-1=>Hydrograph IDs.
2. Click “Add” to add a record.
3. Enter HYD001 for the Hydrograph ID and enter the data shown below.

HEC-1 Hydrograph Ids

List Details

Hydrograph ID

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

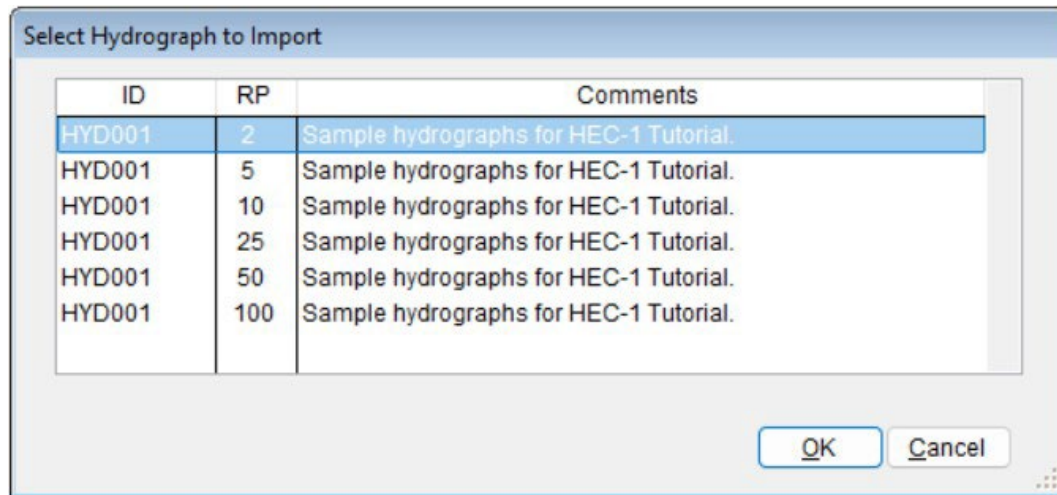
Sample hydrographs for HEC-1 Tutorial.

Info Print... Delete Add OK

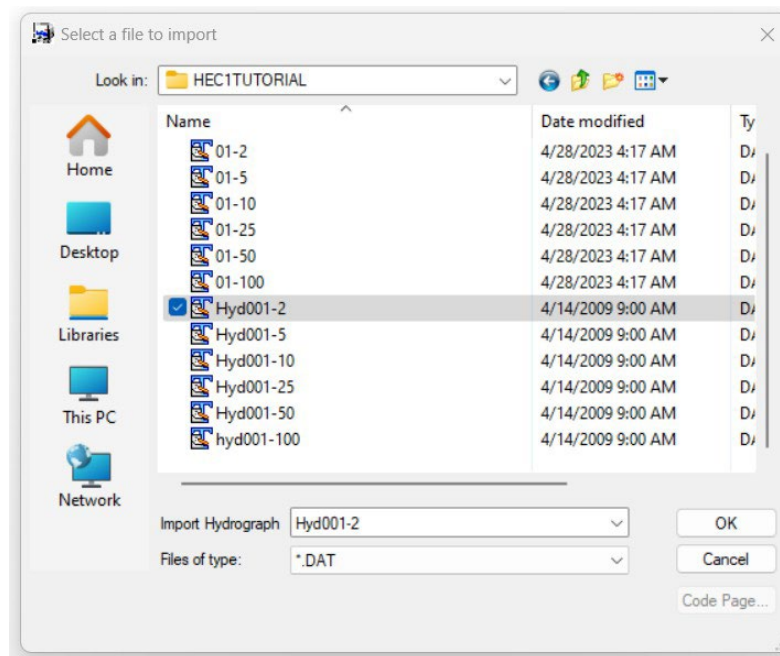
4. Click “Save”.
5. Click “OK”. To exit the form.

Hydrograph Data

1. Select “Hydrology=>HEC-1=>Hydrograph Data.
2. Click “Import Hydrograph” to add a hydrograph data.
3. Select the 2-Year return period.



4. Click “OK”.
5. Select DAT as the extension and Click “OK”.
6. Migrate to the C:\Fcdmc\ST\Modlrns\HEC1TUTORIAL folder and select Hyd001-2



7. Click “OK”.

14. Special Code

“Special Code” has been established in DDMSW to manage HEC-1 features that are available in the HEC-1 model but are not included in DDMSW.

For this example, the Straddle/Stagger Routing data will be used for Route ID 010025.

The **Straddle Stagger** method uses empirical representations of translation and attenuation processes to route water through a reach. Inflow is delayed a specified amount of time. The delayed flows are averaged over a specified amount of time to produce the final outflow.

1. Select *Hydrology => HEC-1 => Special Code*.
2. Click ‘Add’ to add the first record.
3. Enter the data shown below and Click “Save”.

HEC-1 Special Code - MB: 01

List

Major Basin ID 01
Sort 2
Special Code ID SPEC01

Details

F0	KK
F1	010025
F2	ROUTE
F3	
F4	
F5	
F6	
F7	
F8	
F9	
F10	

Comments

Sample Special Code for the HEC-1 Tutotial.

Info ReSort Print... Delete Add MB Filter OK

4. Click “Add”. To add a new record.
5. Enter KM for F0.
6. Enter the KM comment in the KM Card Data
7. Click “Save”.
8. Click “Build KM data”.

HEC-1 Special Code - MB: 01

List Details

Major Basin ID: 01
Sort: 4
Special Code ID: SPEC01

F0: KM
F1:
F2: THIS IS
F3: A SPECIA
F4: L CODE E
F5: XAMPLE F
F6: OR STRAD
F7: DLE STAG
F8: GER ROUT
F9: ING.
F10:

Comments

KM Card Data
This is a Special Code Example for Straddle Stagger routing.

Build KM Data

Info ReSort Print... Delete Add MB Filter OK

9. Click "Add". To add a new record.

10. Enter the data shown below.

HEC-1 Special Code - MB: 01

List Details

Major Basin ID: 01
Sort: 6
Special Code ID: SPEC01

F0: RT
F1: 1
F2:
F3:
F4:
F5:
F6:
F7:
F8:
F9:
F10:

Comments

Info ReSort Print... Delete Add MB Filter OK

15. HEC-1 Model Network

1. Select Hydrology => HEC-1 => Network to access the model network.
2. Click 'Add' to add the first record and select Hydrograph.
3. Click the button next to ID and select HYD001, then Click "Save".
4. Click 'Route' and select 010002.
5. Click 'Basin' and select 010010.
6. Click "Basin" and select 010005.
7. Click "Combine" and change Combine to 3. Then Click "Save".
8. Click 'Storage' and select ST0010.
9. Click 'Route' and select 010010.
10. Click 'Divert' and select DI0015.
11. Click 'Route' and select 010015.
12. Click 'Route' and select 010012.
13. Click 'Retrieve' and select DI0015.
14. Click 'Route' and select 010012.
15. Click 'Combine'.
16. Click 'Special Code' and select SPEC01.
17. Click 'Create Draft' to create the draft network model.

HEC-1 Model Network - MB: 01

Look for

☐ **Exclude**

Sort ▲	ID	Type	Retrieve ID	Combine	Area
10	HYD001	Hydrograph			
20	010002	Route			
30	010010	Basin			
40	010005	Basin			
50	010005	Combine		3	
60	ST0010	Storage			
70	010010	Route			
80	DI0015	Divert	DT0015		
90	010015	Route			
100	010020	Route			
110	DI0015	Retrieve	DT0015		
120	010012	Route			
130	010012	Combine		2	
140	SPEC01	Special Code			

Model Network

MB **01**

Sort **10**

Type **Hydrograph**

ID **HYD001**

KO Output **0** ☐ Tape 21

Basin

Divert

ID

Combining

Retrieve

*

Route

Storage

KM Comment

Hydrograph

Special Code

Info

ReSort

Copy

Print...

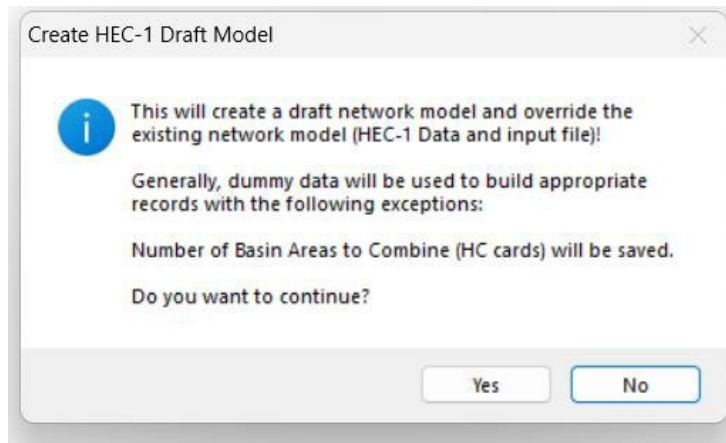
Delete

Add

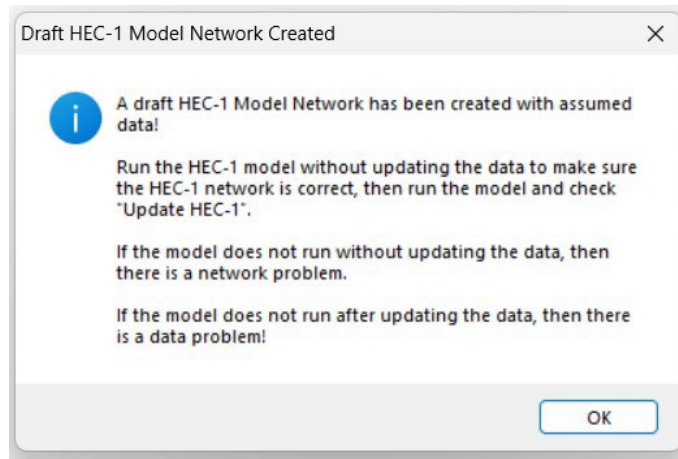
MB

Create Draft

OK



18. Click 'Yes' to continue.



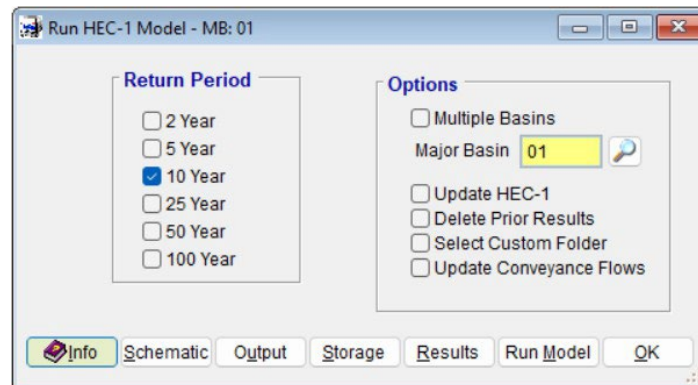
```

\Fcdm\SR\ModlRuns\HEC1TUTORIAL\01.Dat
ID Flood Control District of Maricopa County
ID HEC1TUTORIAL - HEC-1 Tutorial
ID 100 Year
ID 6 Hour Storm
ID Unit Hydrograph: Clark
ID Storm: Multiple
ID 05/03/2023
*DIAGRAM
IT 9 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
KKHYD001 HYDRO
IN 5
BA 3.76
QI 36 59 115 232 276 338 495 600 636 716
QI 764 775 800 895 1001 1188 1230 1405 1561 1615
QI 1817 1941 1756 1544 1340 1175 1031 892 746 597
QI 504 419 341 279 240 212 191 172 156 144
QI 131 120 111 104 98 92 86 80 74 68
QI 64 60 57 53 50 46 43 40 38 35
QI 34 32 31 29 28 27 25 24 23 22
*
IN 15
*
KK010002 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
*
*
KK010010 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
*
KK010005 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
*
KK010005 COMBINE
HC 3
*
KKST0010 STORAGE
KO
RS 1 STOR
SU 0.0 10.0 100 1000 10000
SQ 0.0 10.0 100 1000 50000
SE 85.0 90.0 95.0 100.0 105.0
*
KK010010 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
*
KKDI0015 DIVERT
DTDT0015 0 100
DI 0 100 200 1000 10000
DQ 0 50 100 500 5000
*
KK010015 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
*
KKDI0015RETRIEVE
DRDT0015
*
KK010012 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
*
KK010012 COMBINE
HC 2
*
KK010025 ROUTE
KM This is a Special Code Example for Straddle Stagger routing.
RT 1
ZZ

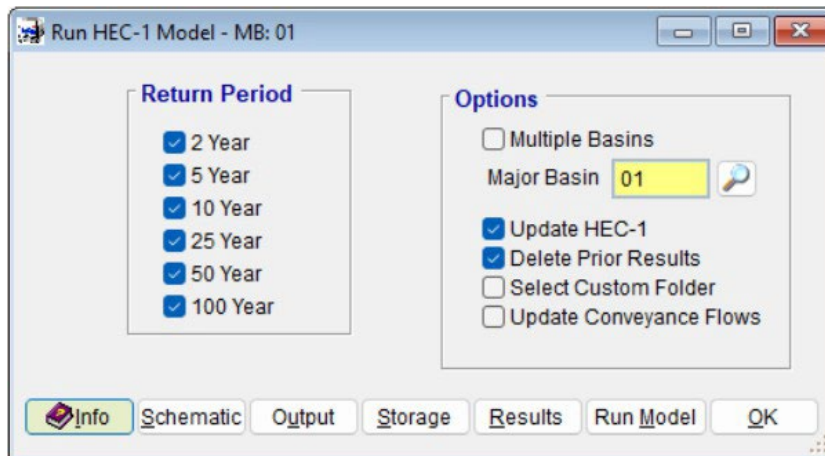
```

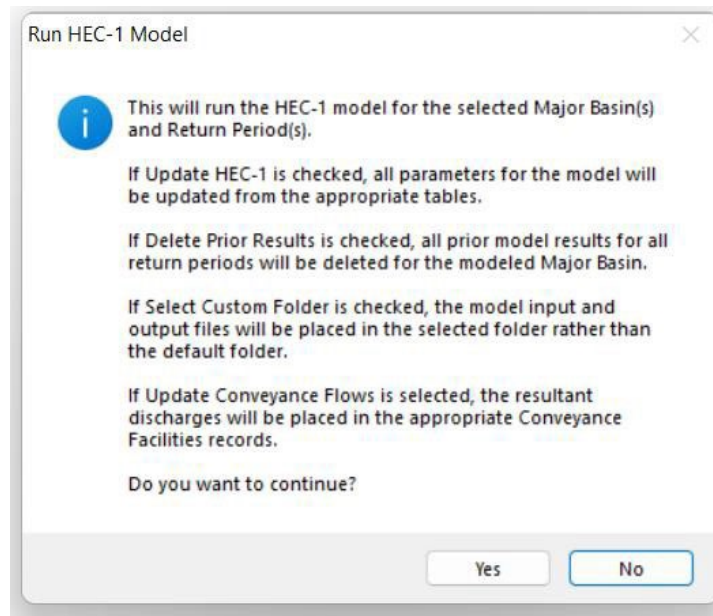
16. Run HEC-1 Model

1. Select *Hydrology => HEC-1 => Model* to access the HEC-1 model.
2. Check the '10 Year' Return Period and the 'Delete Prior Results' option. Uncheck all other return periods and options.

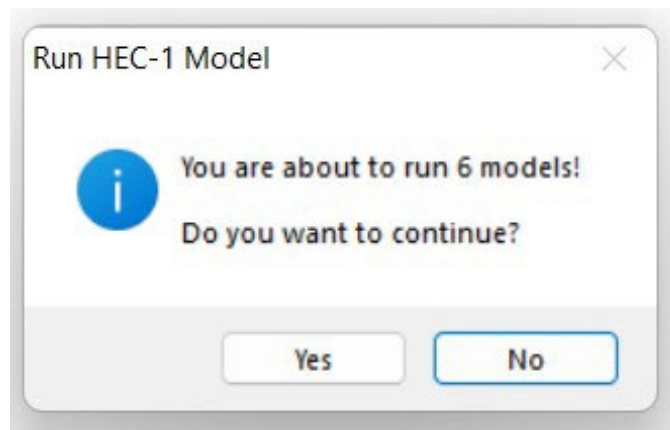


1. Click 'Save', then Click 'Run Model' to run the Draft HEC-1 Model. If the model runs correctly, it means the HEC-1 Network is fine.
2. If no errors, Check all the Return Periods, Update HEC-1 and Delete Prior Results.
3. Click "Save" and then Click "Run Model".





4. Click 'Yes' to continue.



5. Click 'Yes' to run the models.
6. Click "Results" to view the results.
1. Click "Yes" to continue.
2. Click "OK" to close the form.

17. Flow Summary

1. Select *Hydrology* => *HEC-1* => *Flow Summary*

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
HYD001	10	Hydrograph	3.76	1941	2718	3883	5047	5824	7765
010002	20	Routed	3.76	1913	2665	3769	4899	5653	7537
010010	30	Hydrograph	0.04	31	44	53	68	80	92
010005	40	Hydrograph	0.02	8	12	16	22	26	31
010005	50	Combined	3.82	1914	2667	3770	4901	5655	7539
ST0010	60	Routed	3.82	506	778	1181	1343	1423	1553
010010	70	Routed	3.82	506	778	1181	1343	1423	1553
DT0015	80	Diversion	3.82	152	200	200	200	200	200
DI0015	90	Hydrograph	3.82	354	578	981	1143	1223	1353
010015	100	Routed	3.82	354	578	981	1143	1223	1353
010020	110	Routed	3.82	354	578	981	1143	1223	1353
DI0015	120	Hydrograph	3.82	152	200	200	200	200	200
010012	130	Routed	3.82	152	200	200	200	200	200
010012	140	Combined	3.82	506	778	1181	1343	1423	1553
010025	150	Routed	3.82	506	778	1181	1343	1423	1553

Info Export Print... More Results MB OK

18. Storage Summary

1. Select *Hydrology* => *HEC-1* => *Storage Summary*

HEC-1 Storage Summary - MB: 01

ID

ST0010

Storage ID: ST0010

Option: SQ Only

Storms: Multiple

Peak Storage, Stage and Discharge

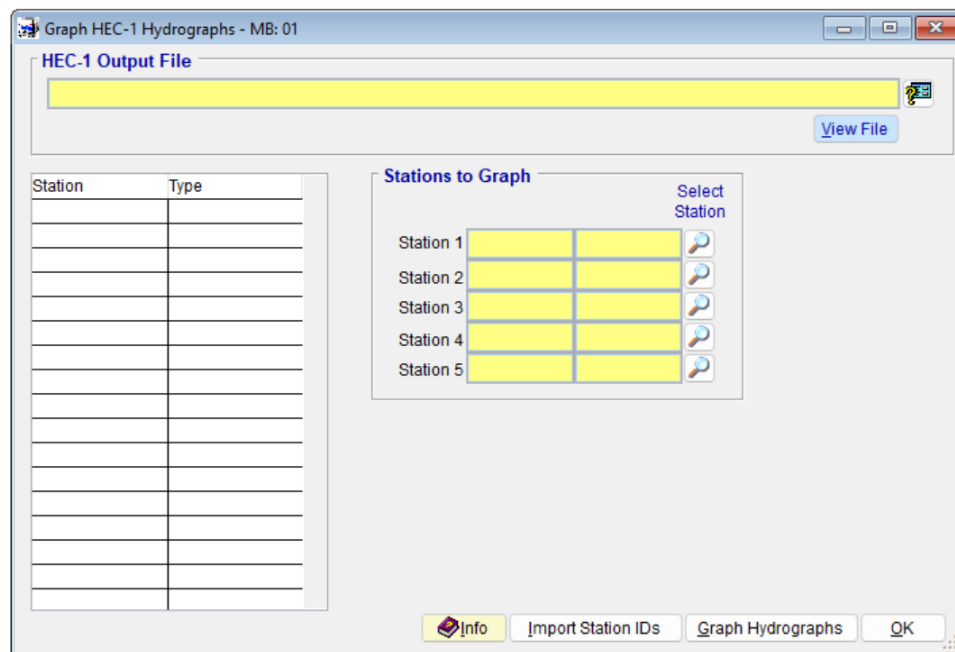
Year	Volume (ac-ft)	Stage (ft)	Q (cfs)
2	151.20	91.02	506
5	205.60	92.11	778
10	286.20	93.72	1181
25	374.40	94.37	1343
50	438.40	94.69	1423
100	606.00	95.21	1553

Info Print... MB OK

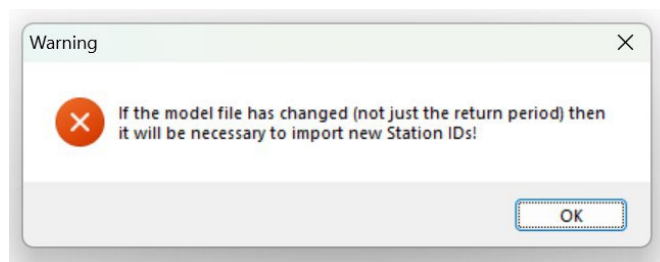
2. Click "OK" to close the form.

19. Graph Hydrographs

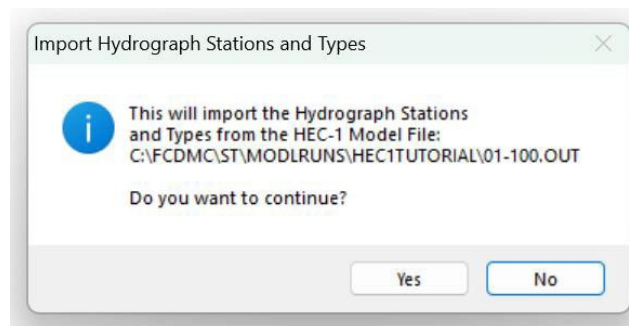
1. Select Hydrology => *HEC-1* => *Graph Hydrographs*



2. Select the HEC-1 output file.

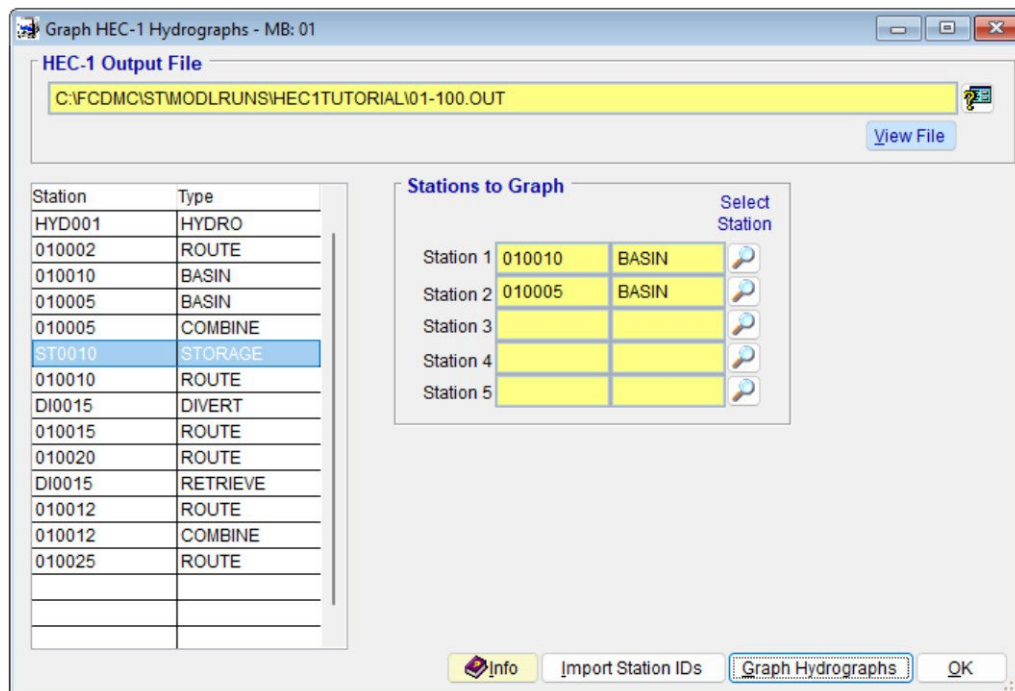
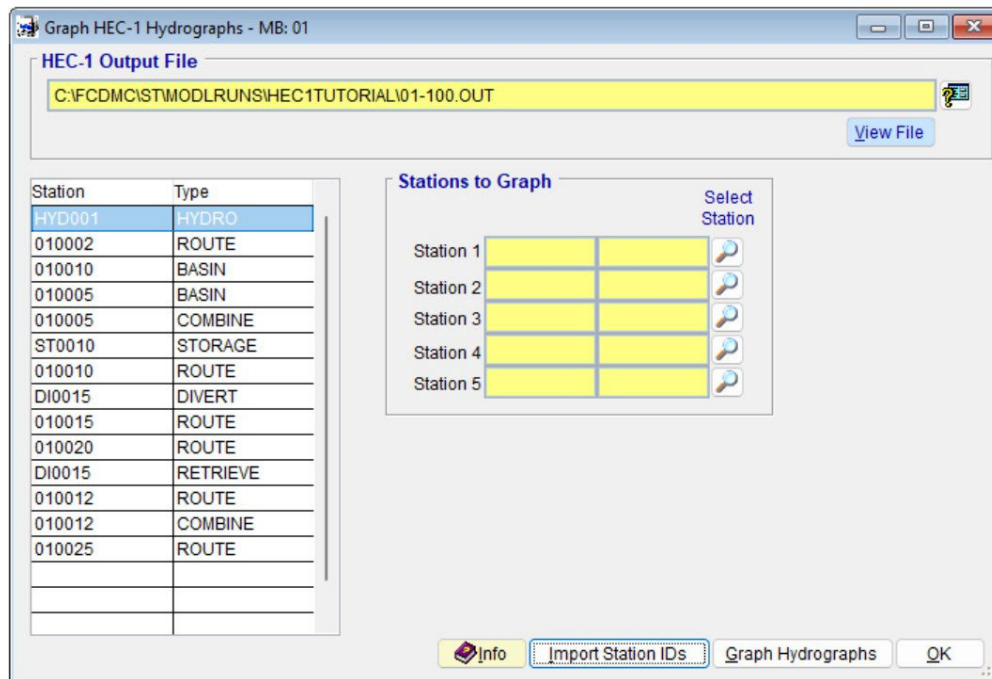


3. Since the model file has not changed, this is not necessary. Click OK.
4. Click "Import Station IDs".

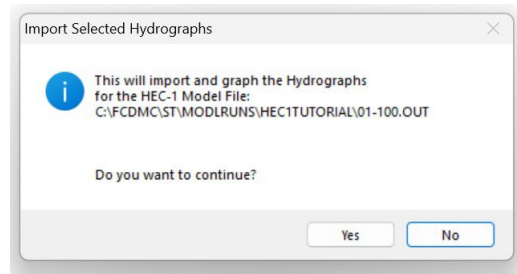


5. Click "OK" to continue.

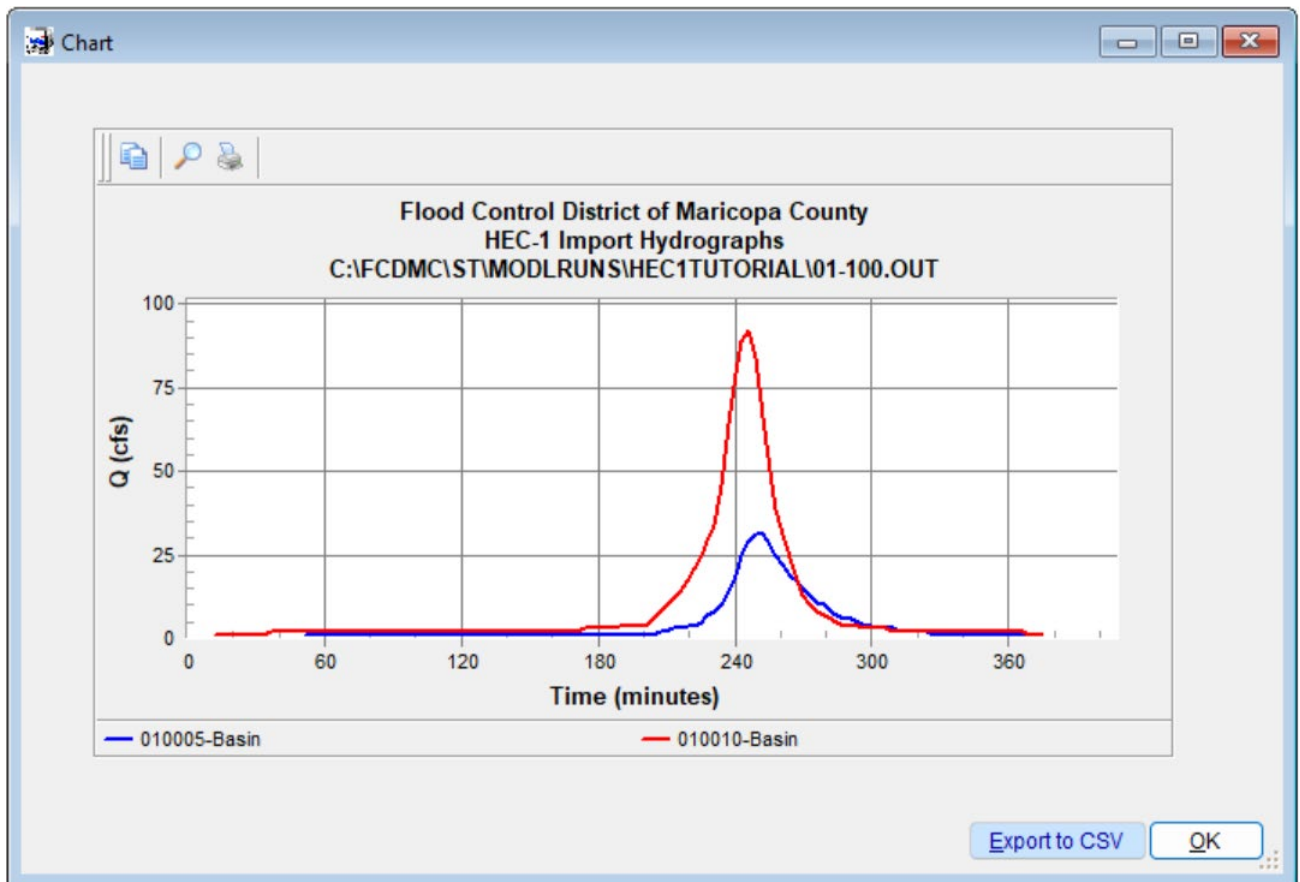
- Now that all available hydrographs are shown, up to 5 hydrographs can be selected for graphing. Select the hydrographs by highlighting it on the left and clicking the appropriate hour-glass on the right as show below.



- Click “*Graph Hydrographs*” to graph the selected hydrographs.

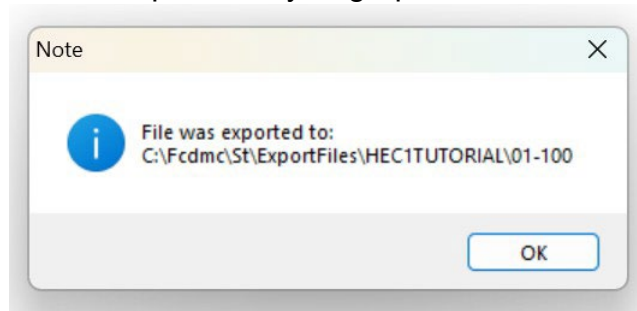


8. Click “Yes” to continue.

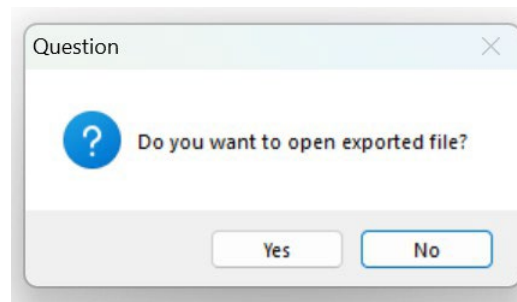


Export Hydrographs

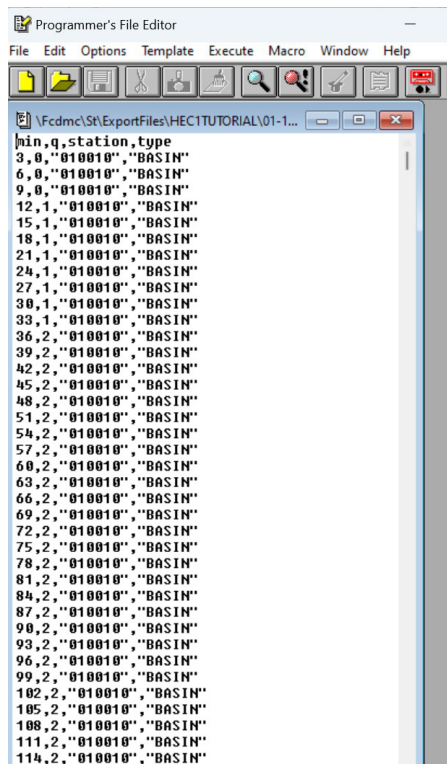
9. Click “Export to CSV” to export the hydrograph data to a CSV file.



10. Click “OK” to continue.



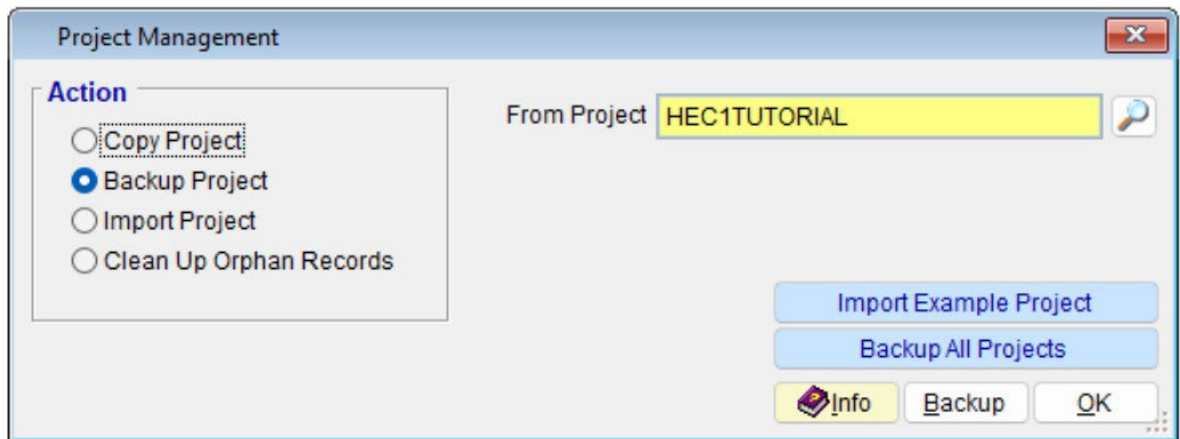
11. Click “Yes” to open CSV file.



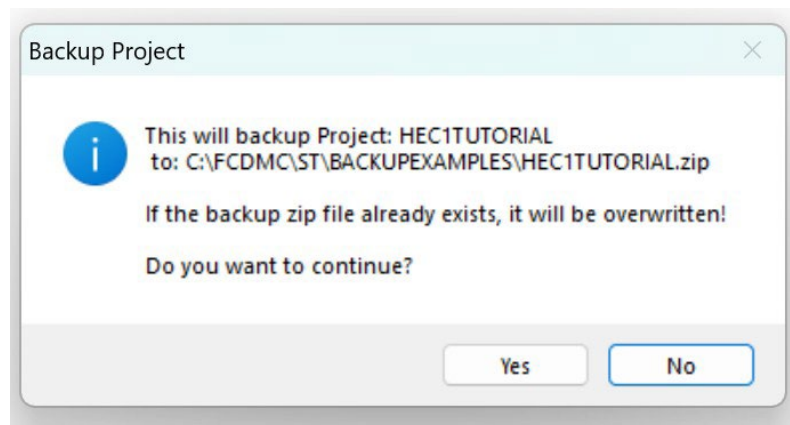
Note, each hydrograph’s data continues after the first hydrograph’s data.

20. Backup Project

1. Select *File* => *Project Management* to access the *Project Management* module.
2. Select '*Backup Project*' as the *Action* and HEC1TUTORIAL as the project (use the adjacent icon to select).
3. Click '*Backup*' and select the folder where your backup file should go.



4. Click "OK" when the folder has been selected.



5. Click "Yes" to continue.
6. Click "OK" to close the form.