INTRODUCTION TO HYDROLOGIC MODELING USING HEC-HMS

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October 8, 2014

SEMINAR OUTLINE

- Overview of hydrologic modeling using HEC-HMS
- HEC-HMS technical capabilities
- Components of a HEC-HMS hydrologic model
- Introduction to HEC-HMS
- HEC-HMS example problems
  - Group example (simple detention)
  - Individual examples (complex detention)

HYDROLOGIC MODELING OVERVIEW

U.S. Environmental Protection Agency

USDA

US Army Corps of Engineers

Hydrologic Engineering Center

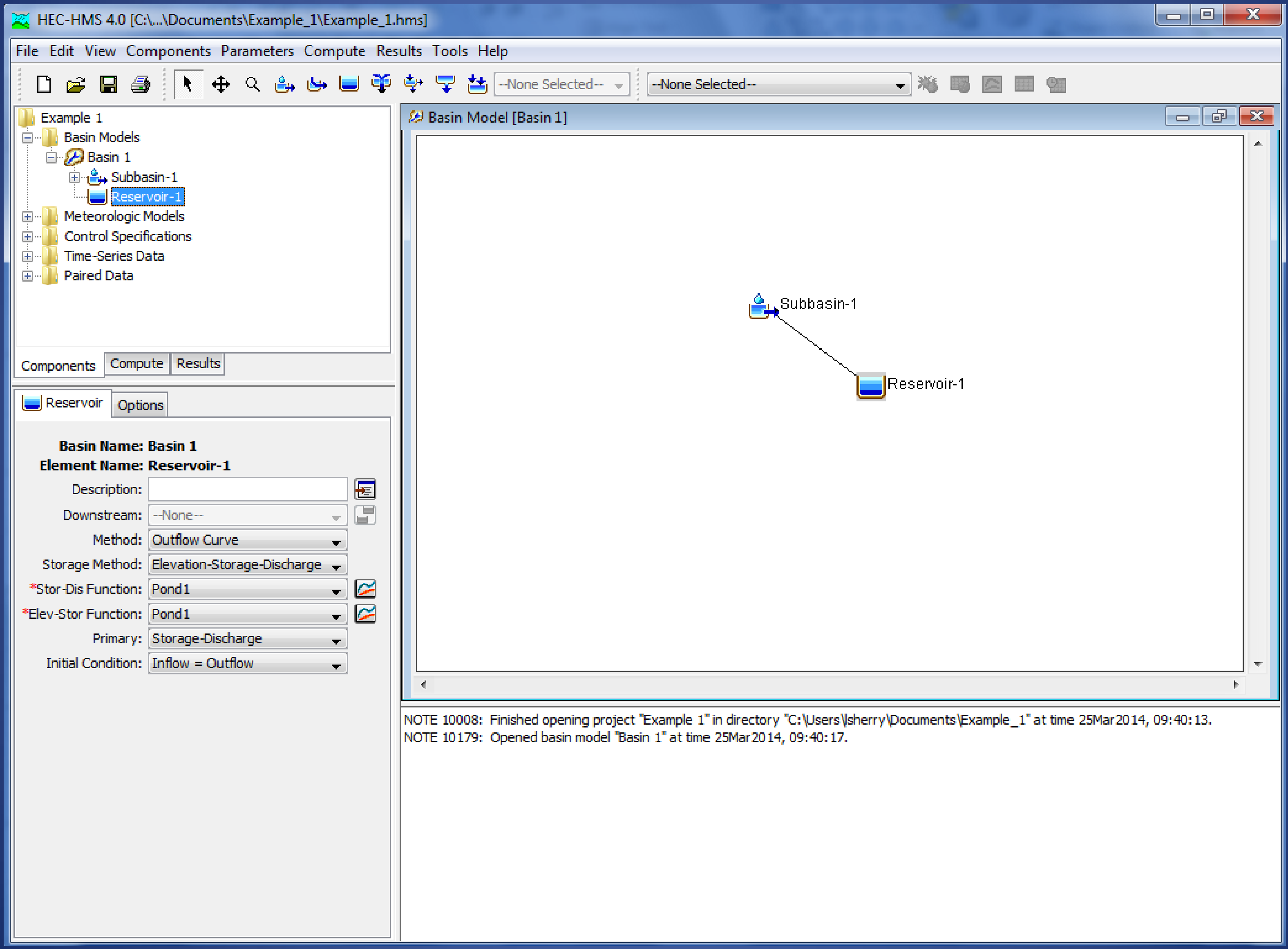
A. Recent History (State-of-the-Practice)

1. DOS based - batch data models (before 1990)
2. Pre- and post processors (1990-1995)
3. Windows pre- and post-processors (1993-1997)
4. Windows GUI models (present)
5. GIS based models (present and future)

HEC-1 IN DOS

```
KKPondB3
KM
RS     1.     STOR       0.
SV     0.     0.45     2.42     2.60     3.25     4.07     5.72
SE 758.2    760.0    762.0   762.11    762.5    763.0    764.0
SQ    1.1      1.4      1.8     1.81     14.9    200.6   2219.7
*
KK     B2
KM        RUNOFF FROM B2
BA 0.011
LS      0       81       0
UD 0.564
*
KK BatFO Sum of B1 and B2 as B area crosses Fair Oaks Rd
HC      2
*
KK     B1
KM        RUNOFF FROM B1
BA 0.135
LS      0       75       0
UD 0.540
*
KKB atWB Sum of all B areas at West Branch DuPage River
HC      2
*
KK  C6   RUNOFF FROM  C6
BA0.022
LS      0       83       0
UD0.330
*
KKPondC6
```

HEC-HMS IN WINDOWS



HEC-HMS WEBSITE

- The latest version of HEC-HMS is available for download at the following website:

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

- Additional information available on website:
  - Quick Start Guide
  - User’s Manual
  - Technical Reference Manual
  - Release notes

TECHNICAL CAPABILITIES

Precipitation

- gaged storms
- design storms

- lumped (precipitation and losses spatially averaged over the subbasin), or
- linear-distributed (precipitation and losses specified for grid cells for radar R/F data)

TECHNICAL CAPABILITIES

Rainfall Losses (abstractions)

- initial/constant
- SCS curve number
- SMA (5 layer)
- Green and Ampt
- exponential
- gridded SCS & SMA
- deficit/constant rate (DC) and gridded DC

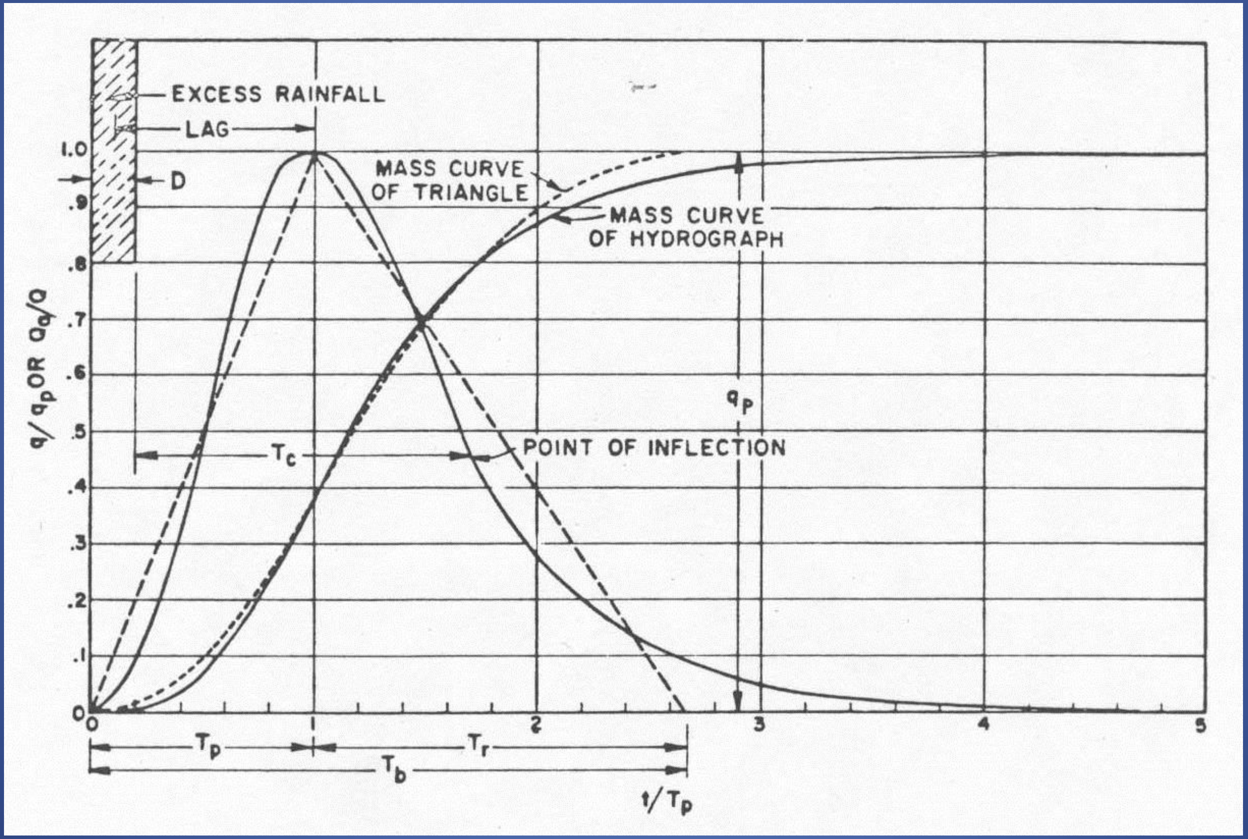
TECHNICAL CAPABILITIES

Runoff Transformation

- unit hydrograph (user specified UH or S-graph, Clark, Snyder, or SCS methods)
- modified Clark (for gridded meteorological data)
- kinematic wave (up to 2 overland flow planes, 2 collector channels, and a main channel)

SCS UNIT HYDROGRAPH

Hydrologic modeling in the WMO must use the SCS unit hydrograph (shown below).



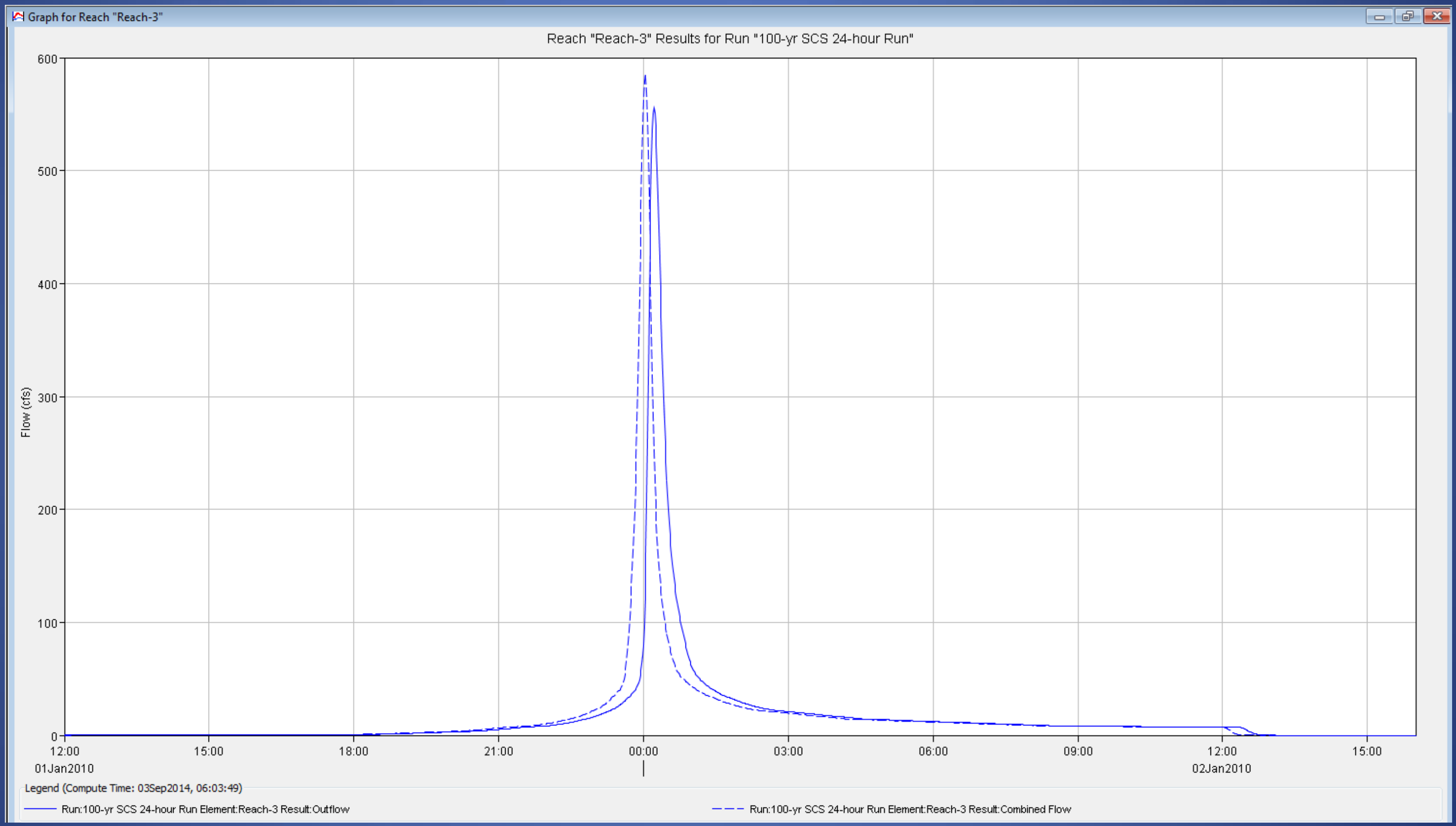
The rainfall hyetograph is used with the unit hydrograph to develop the storm hydrograph using hydrograph convolution.

TECHNICAL CAPABILITIES

Routing (channel)

- simple lag
- straddle-stagger
- modified Puls
- kinematic wave
- Muskingum
- Muskingum-Cunge (standard shapes)
- Muskingum-Cunge (8 pt.)

Channel Routing



Trib Area = 110 acres, Routing using Muskingum Cunge
L = 3200 ft, S = 0.009, *n* = 0.08, Trapezoid with W = 60’ and 2H:1V

RESERVOIR ROUTING CAPABILITIES

- Attenuation of a hydrograph from any storage element (ponds, wetlands, infiltration devices)
- Outflow calculations from either 1) user supplied storage-outflow, elev-storage-outflow, or elev-area-outflow; or 2) user supplied elev-storage or elev-area and defined outlet structures (up to 10 spillways and 10 outlets). Note: Spillway outfow can also be determined from user supplied elev-discharge data.

RESERVOIR ROUTING CAPABILITIES (cont.)

- Outlets can be orifices or culverts (up to 9 shapes from FHWA design charts which will compute outlet control)
- Backwater Effects (constant or elev-discharge)
- Dam Break and Pump Capabilities
- Reservoir Dam Seepage

RESERVOIR ROUTING METHOD

Modified Puls Routing ==> Limitations:

- No rule-operational gates allowed
- Monotonically Increasing Relationship Between Storage and Outflow
- No ponds in series (unless constant tailwater)

METHODOLOGY USED BY HEC-HMS

$$I - O = \frac{\Delta S}{\Delta t}$$

Where: I = inflow; O = outflow; S = storage; and t = time interval

$$I(\Delta t) - O(\Delta t) = \Delta S$$

If t_1 and t_2 are used to indicate time t and Δt

$$\frac{(I_1 + I_2)\,\Delta t}{2} - \frac{(O_1 + O_2)\,\Delta t}{2} = S_2 - S_1$$

Rearranging knowns and unknowns yields:

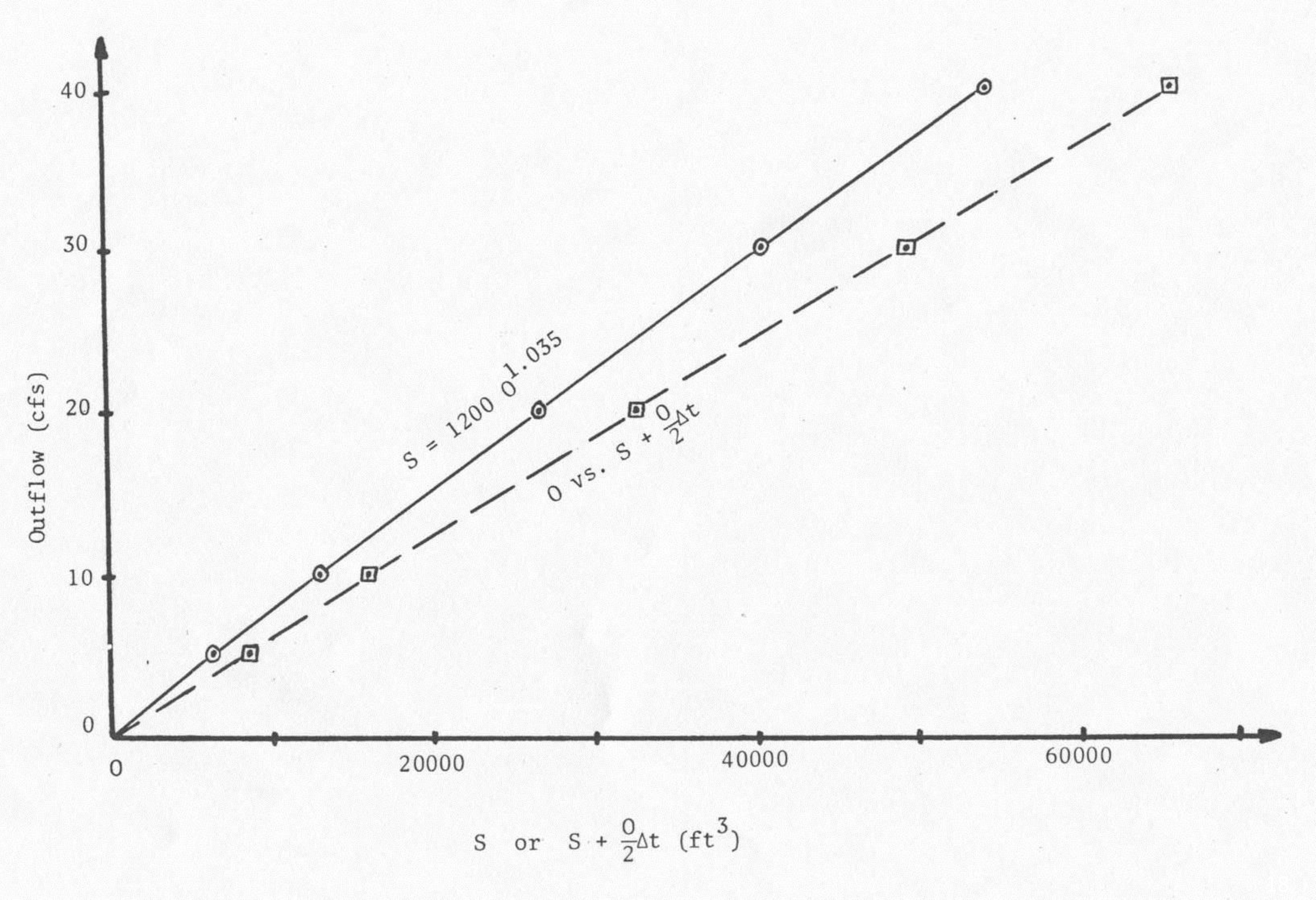
$$\frac{(I_1 + I_2)\,\Delta t}{2} + S_1 - \frac{O_1\,\Delta t}{2} = S_2 + \frac{O_2\,\Delta t}{2}$$

METHODOLOGY USED BY HEC-HMS

- The procedure used to solve this equation is known as the storage indication method or Modified-Puls method. We know the inflows at all times, the initial storage S_1 and the initial outflow O_1. After solving for S_2 and O_2 these become the inputs for the next time step. The solution procedure uses curves of

$S + \dfrac{O_2 \Delta t}{2}$ as shown on the next slide:

METHODOLOGY USED BY HEC-HMS



METHODOLOGY USED BY HEC-HMS

- The routing of the hydrographs through the facility procedure shown in Tabular form:

TABLE 16. Computation of Reservoir Outflow Hydrograph for Example 14-1

(1) Time (min)	(2) Inflow (cfs)	(3) Average Inflow (cfs)	(4) $0.5(I_1+I_2)\Delta t$	(5) $S_1 - 0.5O_1$ $S-0.5\,O\,\Delta t$	(6) $S_2 + \frac{O_2}{2}$ $S+0.5\,O\,\Delta t$	(7) Outflow (O) (cfs)	(8) Storage (S) (ft^3)
0	0 - I_1					0	0
		7.5	4500	0	4500		
10	15 - I_2					2.7	3200
		25.0	15000	2390 *	17390		
20	35					10.9	14000
		32.5	19500	3270	22770		
30	30					14.0	18700
		27.5	16500	14500	31000		
40	25					19.0	25300
		20.0	12000	19600	31600		
50	15					19.5	26000
		10.0	6000	20150	26150		
60	5					16.0	21200
		2.5	1500	16400	17900		
70	0					11.0	14500
		0	0	11200	11200		
80	0					7.0	9000
		0	0	6900	6900		
90	0					4.0	5000
		0	0	3800	3800		
100	0					2.0	3000

Eqn 37

col 4 + col 5

Fig 21

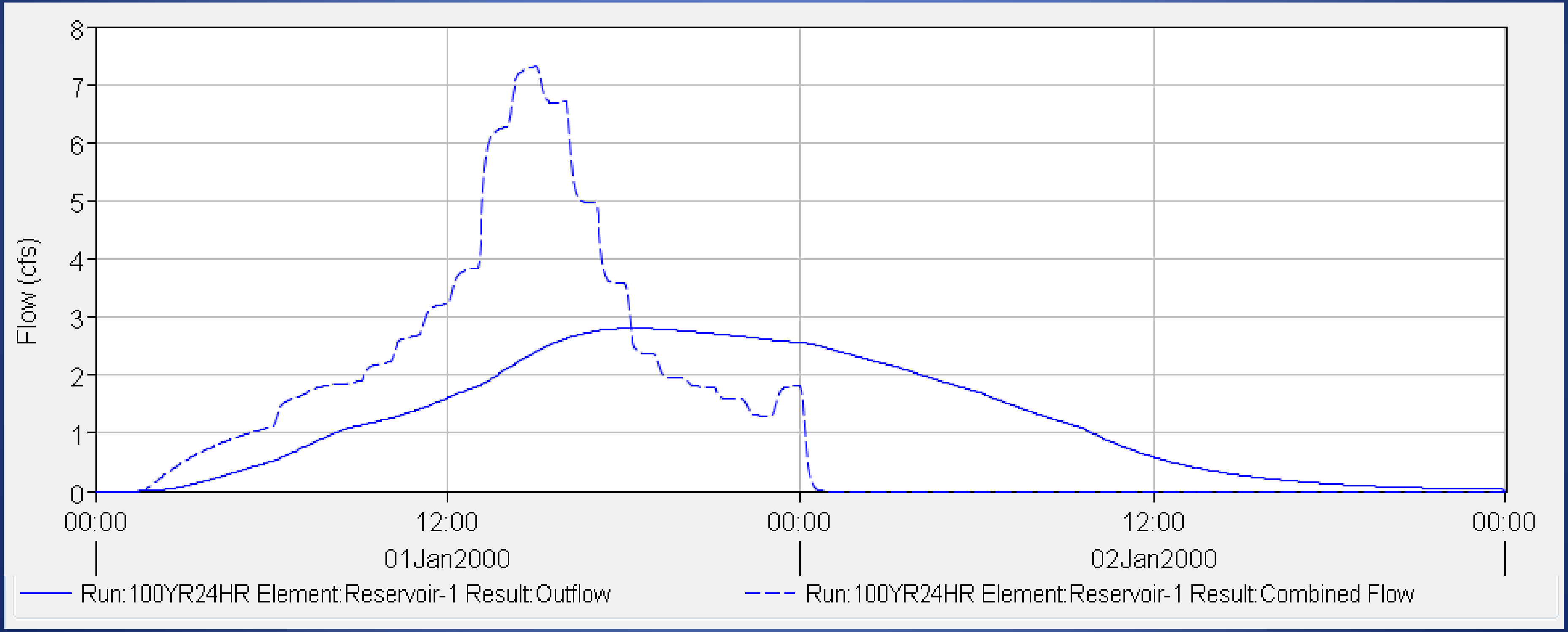
$S = 1200\,O^{1.035}$

col 7

$* \; 3200 - 0.5O = 3200\,ft^3 - (0.5)\,2.7\,\frac{ft^3}{sec} \times 10\,min \times \frac{60\,sec}{min} = 2390\,ft^3$

METHODOLOGY USED BY HEC-HMS

- The inflow and outflow hydrographs computed by HEC-HMS are shown graphically

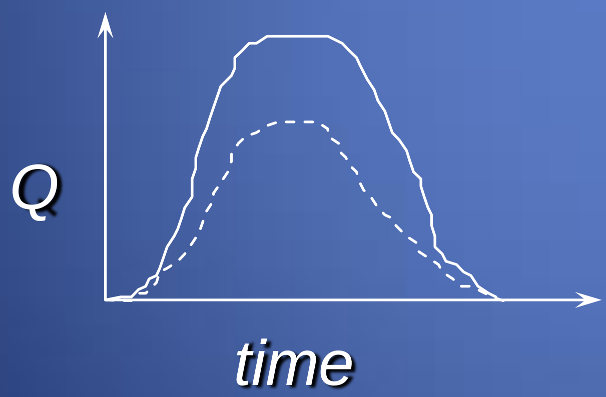


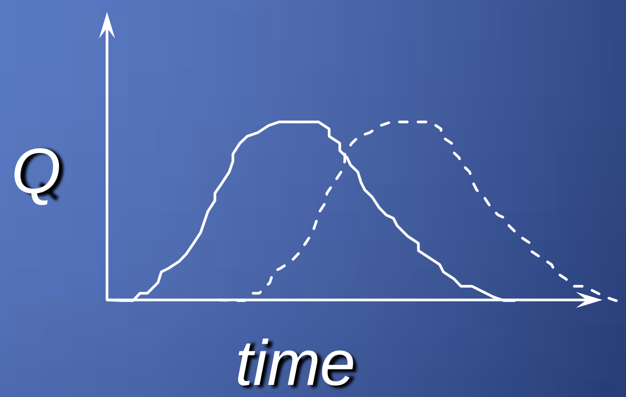
CALIBRATION & VALIDATION

What model parameters would you change if...

measured

modeled





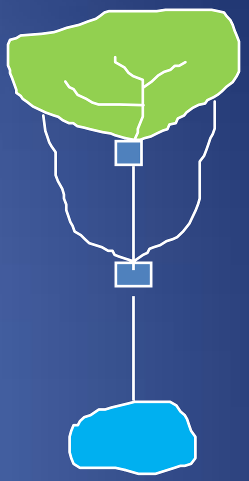
TECHNICAL CAPABILITIES

Additional Capabilities

- diversions and sinks
- base flow and pumps
- GIS connection
- evapotranspiration
- snowfall/snow melt
- reservoir routing (w/tailwater) and dam breach
- parameter optimization
- hot start – use data from end of previous run
- land surface erosion and sediment transport*
- customizable graphs and reports*

  * future versions

HEC-HMS MODEL STRUCTURE



Project Requirements
(Operational and
Data Structure)

Meteorological Model
(precipitation, snowmelt,
and evapotranspiration)

Time Series Data
(e.g., precipitation)

Basin Model
(hydrologic elements
are interconnected to
represent watershed)

Paired Data
(e.g., reservoir data)

Control Specifications
(start time, end time,
and time interval)

HEC-HMS MODEL COMPONENTS

- Basin Model
  - Physical components of a watershed (subbasins, reservoirs, reaches, etc.)
- Meteorologic Model
  - Specify precipitation events to be simulated by the hydrologic model
  - Can include snowmelt and evapotranspiration
- Control Specifications
  - Start time, end time, and time interval

***You need all 3 components to complete a successful simulation in HEC-HMS**

INPUT DATA COMPONENTS

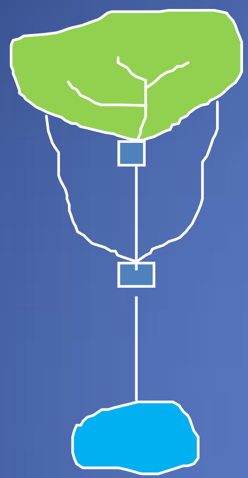
Time Series Data

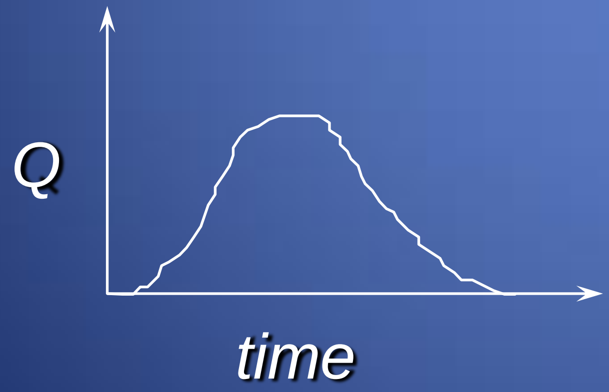
- Precipitation gages
- Discharge gages
- Stage gages
- Temperature gages
- Etc.

Paired Data

- Storage-discharge
- Elevation-storage
- Inflow-diversion
- Cross sections
- Etc.

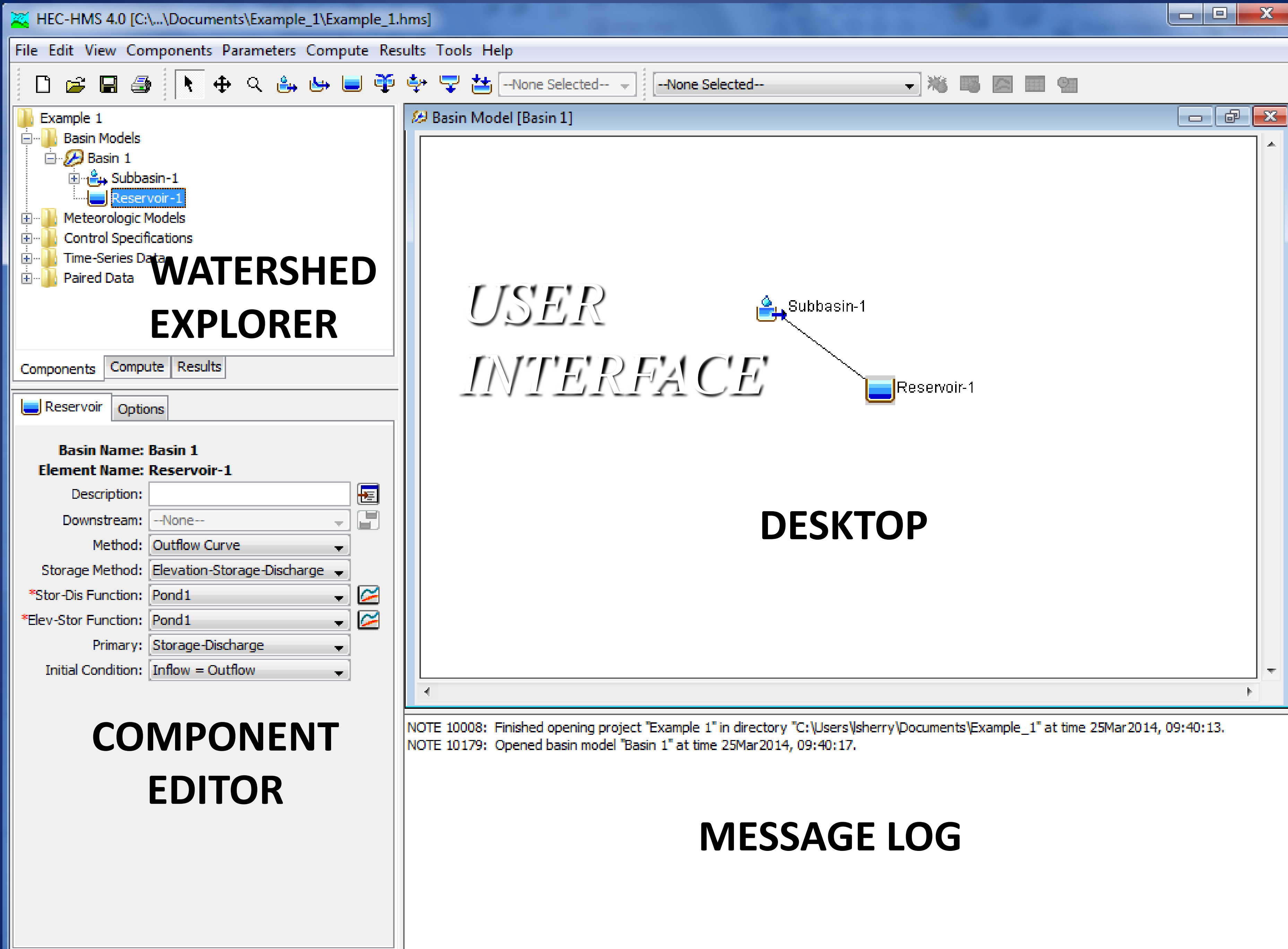
WORKING WITH HEC-HMS





Application Steps

- create a new project
- enter Basin Model data
- enter time series & paired data
- enter Met. Model data
- enter Control Specifications
- create and execute a run
- view results (global and element summary tables, time series tables and graphs, and results from multiple elements and multiple runs)
- exit program


HEC-HMS 4.0 [C:\...\Documents\Example_1\Example_1.hms]
File Edit View Components Parameters Compute Results Tools Help
--None Selected--
--None Selected--
Example 1
Basin Models
Basin 1
Subbasin-1
Reservoir-1
Meteorologic Models
Control Specifications
Time-Series Data
Paired Data
WATERSHED
EXPLORER
Components
Compute
Results
Reservoir
Options
Basin Name: Basin 1
Element Name: Reservoir-1
Description:
Downstream: --None--
Method: Outflow Curve
Storage Method: Elevation-Storage-Discharge
*Stor-Dis Function: Pond1
*Elev-Stor Function: Pond1
Primary: Storage-Discharge
Initial Condition: Inflow = Outflow
COMPONENT
EDITOR
Basin Model [Basin 1]
USER
INTERFACE
Subbasin-1
Reservoir-1
DESKTOP
NOTE 10008: Finished opening project "Example 1" in directory "C:\Users\lsherry\Documents\Example_1" at time 25Mar2014, 09:40:13.
NOTE 10179: Opened basin model "Basin 1" at time 25Mar2014, 09:40:17.
MESSAGE LOG

EXAMPLE PROBLEM #1 (GROUP)

Goal of Example:

- Enter Input Data
  - Subbasin Information
  - Rainfall Data
  - Reservoir (Detention) Information
- Run HEC-HMS
  - 100-Year, 24-Hour Storm Event
  - Additional Storm Events
- View Output and Results
  - Tabular Output
  - Flow and Stage Hydrographs

EXAMPLE PROBLEM #1 (GROUP)

Given the following information, determine the required detention volume based on the WMO.

Site Information:

- Site Area = 5 acres
- CN = 93, Proposed Site is 80% Impervious
- Tc = 15 minutes, SCS Lag Time = 9 minutes
- Assume no unrestricted releases from the site

EXAMPLE 1 – STEP 1

Step 1: Determine the required volume control storage for the site.

The curve number for the site is 93, with a total impervious area of 4 acres (80%). The required volume control storage, V_c, for the site is calculated as:

$$V_c = 1'' \times \frac{1 \text{ foot}}{12 \text{ inches}} \times 4 \text{ acres} = 0.33 \text{ acre-feet}$$

EXAMPLE 1 – STEP 2

Step 2: Determine the CN reduction corresponding to volume control calculated in Step 1.

Using the CN Adjustment Calculator spreadsheet, the adjusted curve number is 86.22 (it was assumed that only the required 1” of volume control storage would be provided).

RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR

Site Information:

Total Site Area, A_w (ac) =	5	Total Impervious Area, A_I (ac) =	4
Runoff, R (in) =	6.75		
P = rainfall depth (in) =	7.58		
CN =	93		
S =	0.75		
Runoff Volume Over Watershed, V_w (ac-ft) =	2.81		

Volume of GI Provided:

Control Volume, V_R =	0.33	ac-ft	1" of volume over impervious area
Additional Volume, V_{GI} =	0.00	ac-ft	Additional volume over the required 1"

Adjusted Volume Over Watershed, $V_{ADJ} = V_W - V_R - V_{GI}$

V_{ADJ} (ac-ft) =	2.48

Adjusted Runoff Over Watershed, $R_{ADJ} = \frac{V_{ADJ}}{A_W}$

R_{ADJ} (in) =	5.95
S_{ADJ} =	1.60
Adjusted CN for detention calcs, CN_{ADJ} =	86.22

*Blue values are entered by user

EXAMPLE 1 – STEP 3

Step 3: Determine the allowable release rate from the site.

Maximum allowable release rate = 0.30 cfs/acre x 5 acres = 1.50 cfs

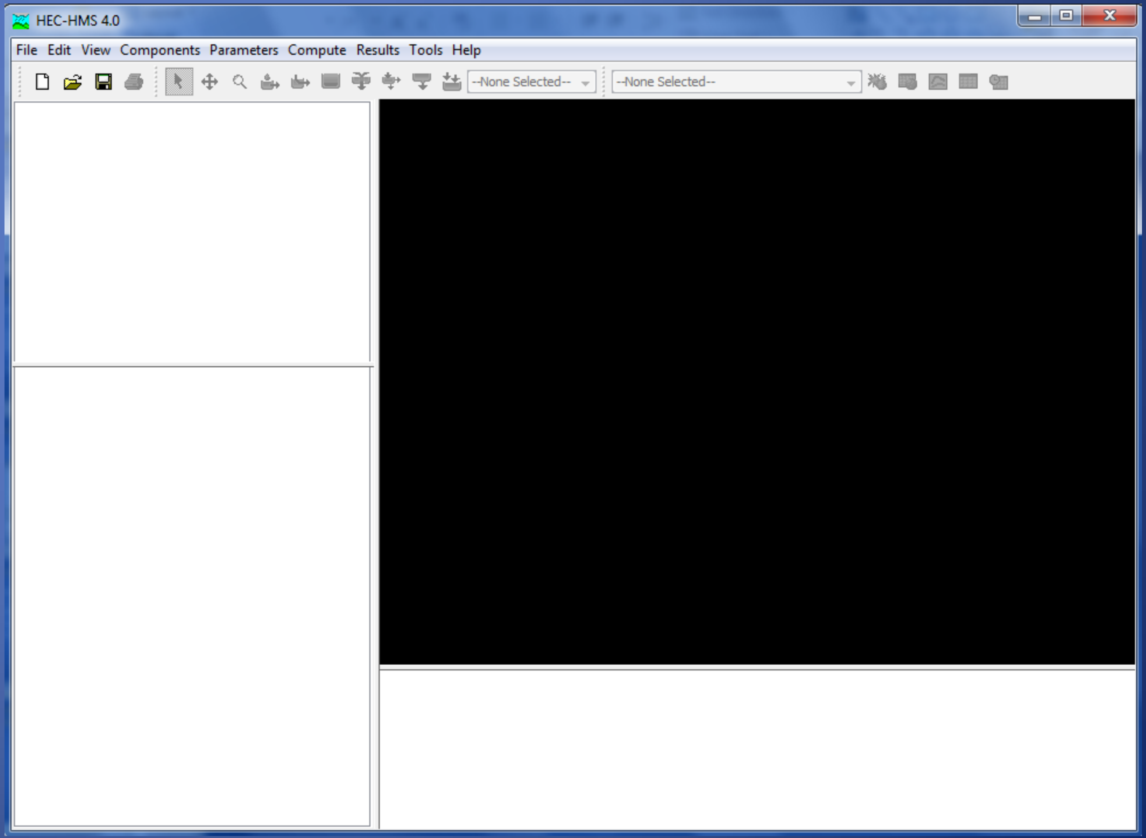
Maximum allowable release rate – unrestricted release rate = net allowable release rate

The net allowable release rate = 1.50 cfs – 0.00 cfs = 1.50 cfs

GETTING STARTED
THE INITIAL HEC-HMS SCREEN

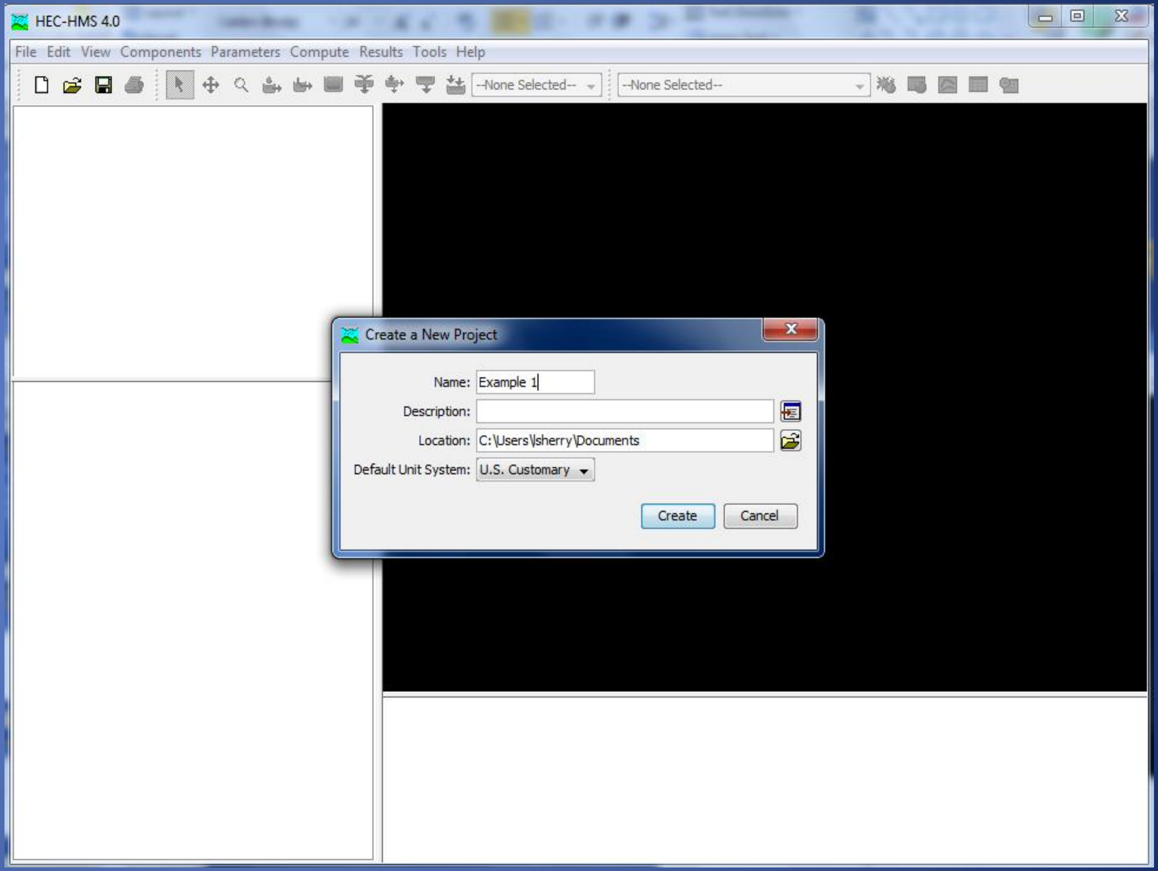
- Double-click on the HEC-HMS icon on your desktop

- The following HEC-HMS Screen comes up:



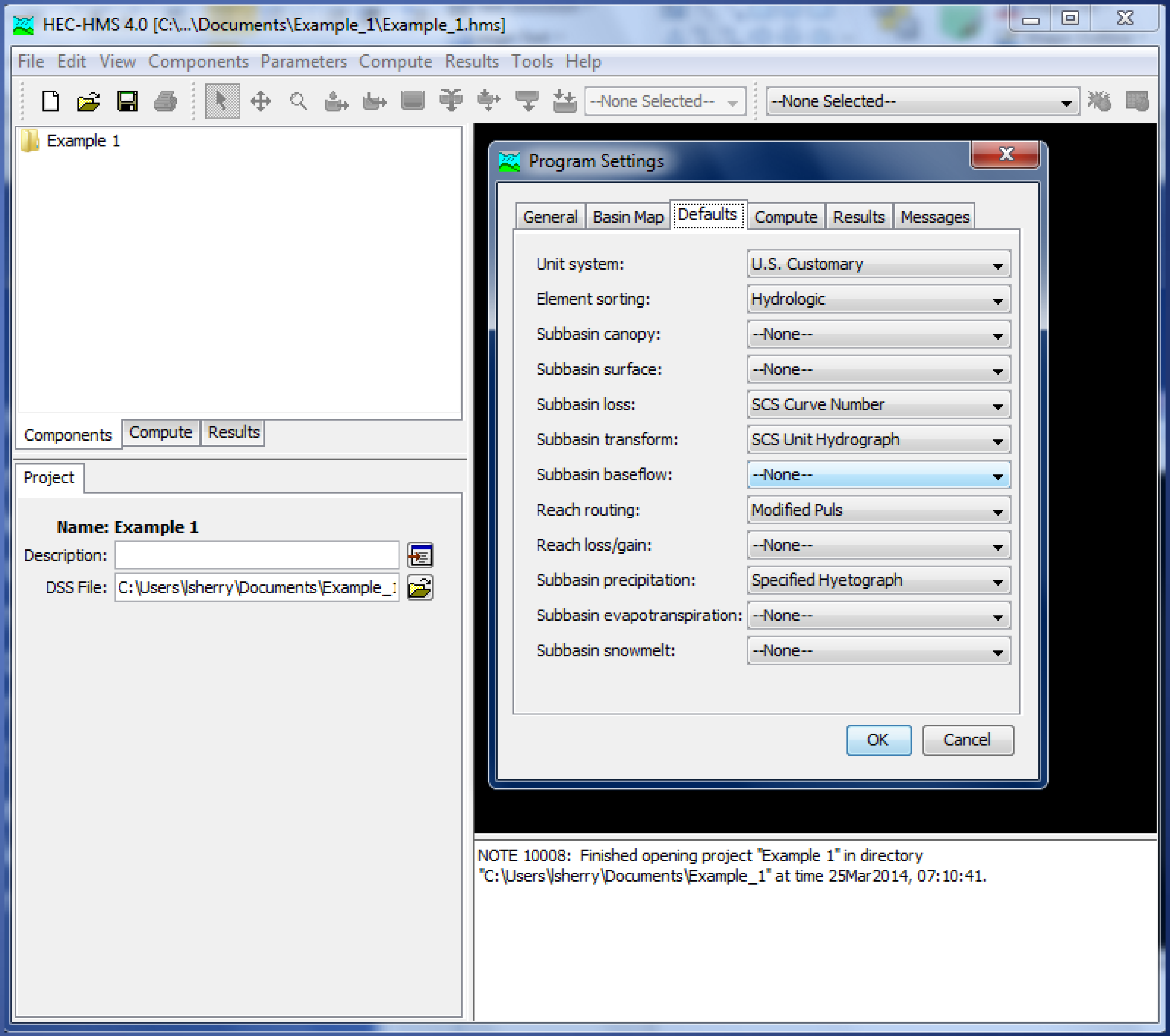
HEC-HMS – SETTING UP A NEW PROJECT

- Click on the “**File**” menu
- From the drop down menu, select “New”
- Name the new project “Example 1”
- Be sure to set the Default Unit System to “U.S. Customary”



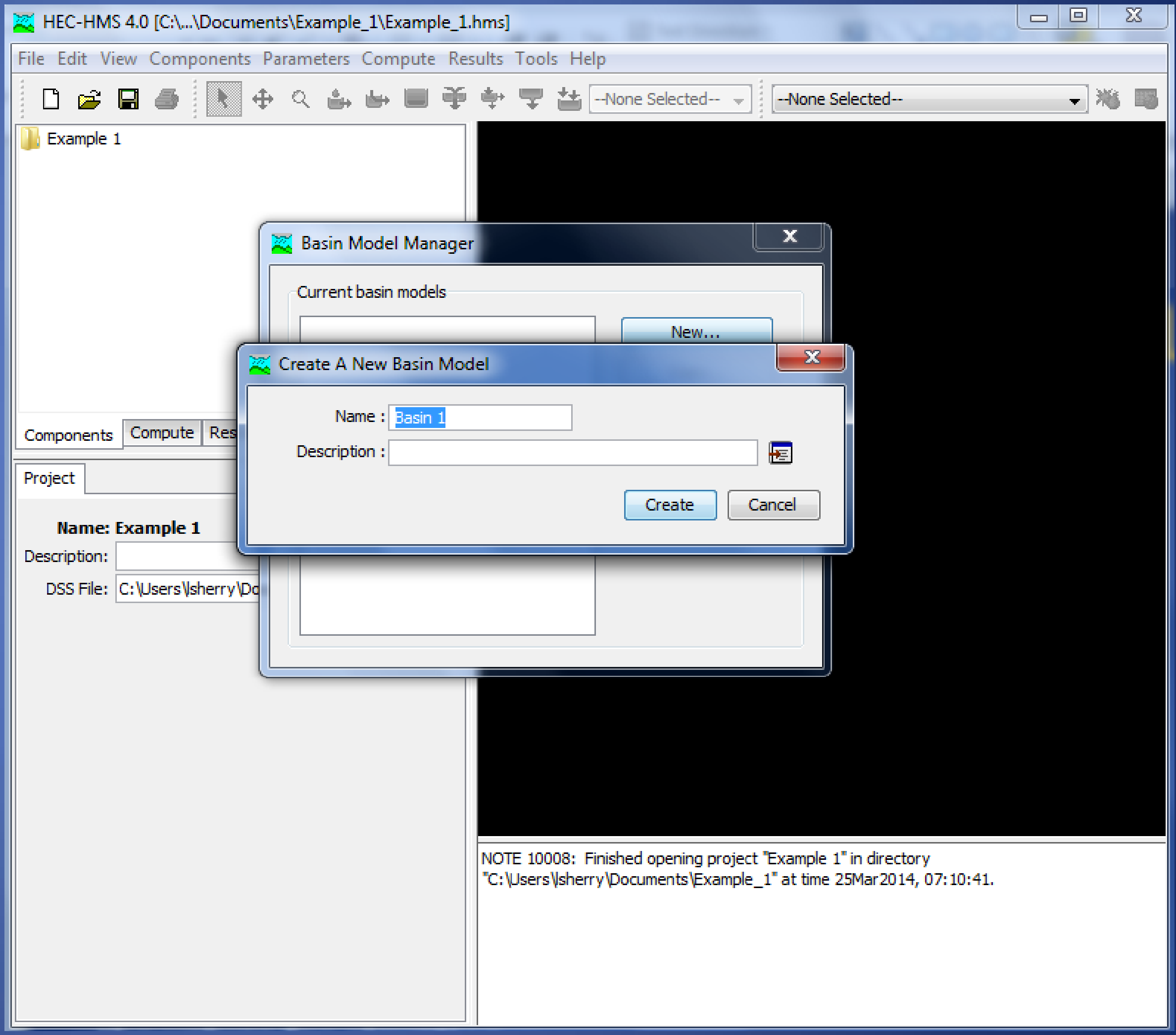
SETTING UP PROJECT DEFAULTS

- Under the ***Tools*** Menu, go to ***Program Settings*** and go to the ***Defaults*** tab
- Specify *SCS Curve Number* for ***Subbasin loss***, *SCS Unit Hydrograph* for ***Subbasin transform***, *Modified Puls* for ***Reach routing***, and *Specified Hyetograph* for ***Subbasin precipitation***
- Then go to the ***Results*** tab and make sure that the values for elevation, volume, flowrate, and depth are taken to <u>**2**</u> decimal places.



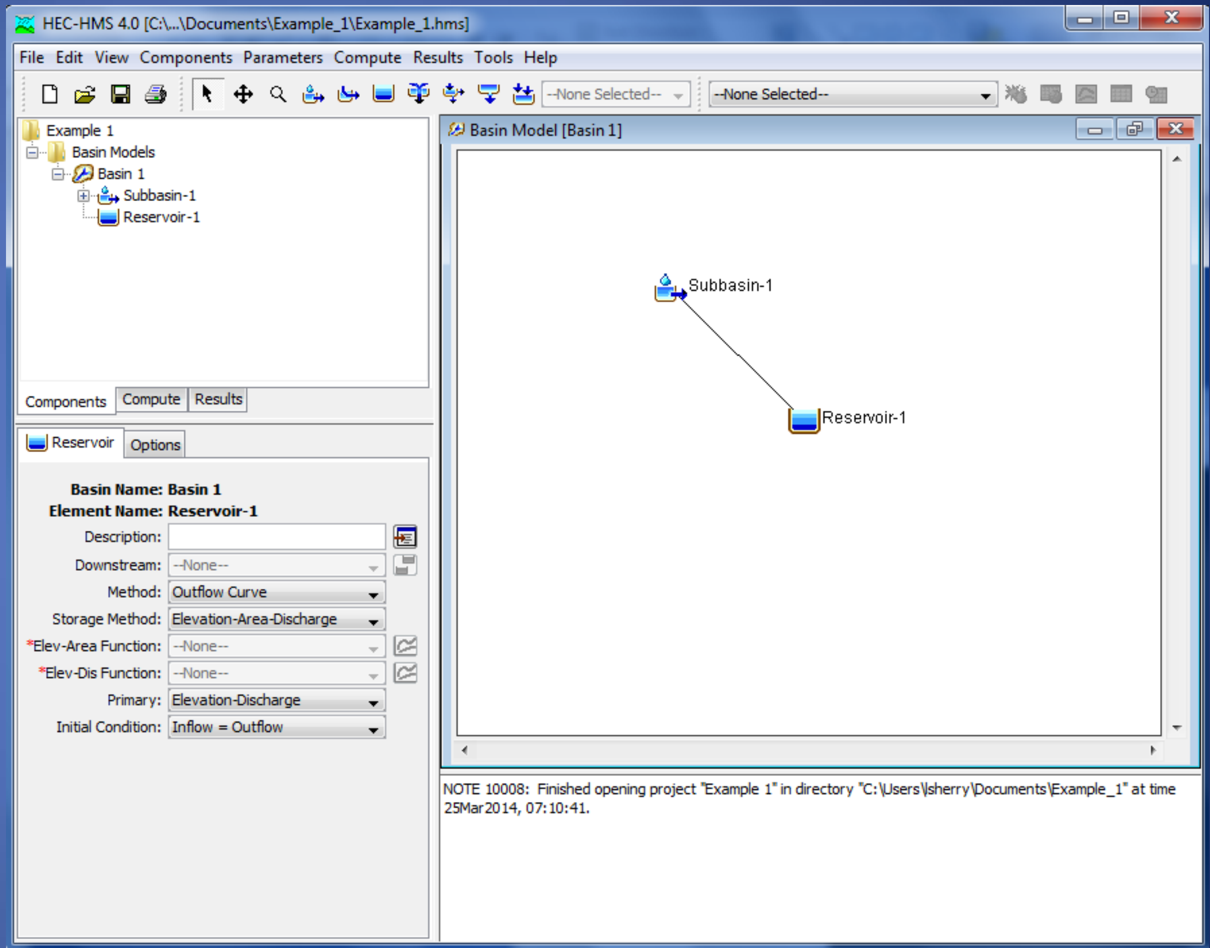
CREATING A BASIN MODEL

- Under the ***Components*** tab, go to ***Basin Model Manager***
- Select "New" and name it "Basin 1"



ADDING BASIN MODEL COMPONENTS

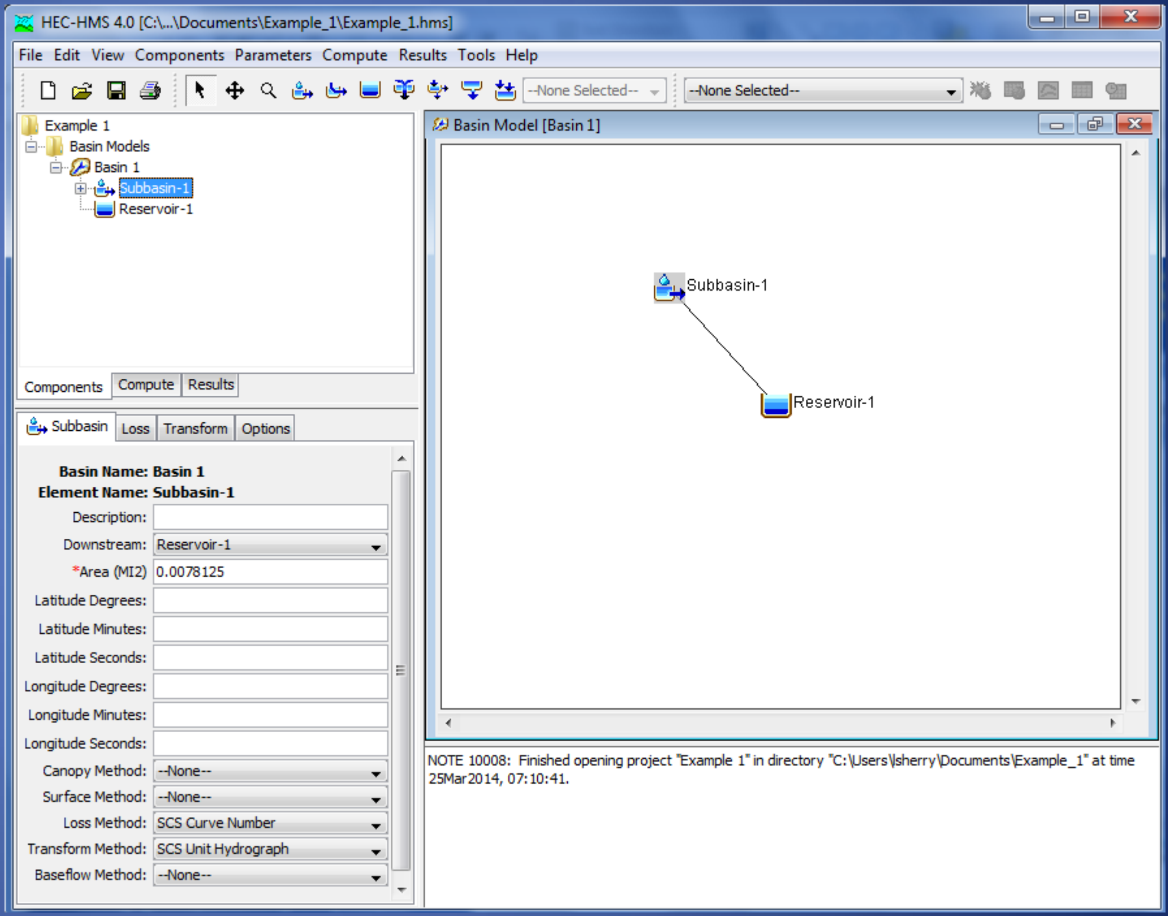
- Click on the ***Subbasin Creation Tool*** at the top of the screen to add a subbasin to the *Basin Model*
- Click on the ***Reservoir Creation Tool*** to add a reservoir to the *Basin Model*
- To route the subbasin through the reservoir, right-click on the subbasin and select “Connect Downstream” and click on the reservoir



ENTERING SUBBASIN DATA

- Click on *Subbasin-1* and the data entry tabs will appear at the lower left corner
- For ***Area***, enter 0.0078125 mi^2 (5 acres)
- Under the ***Loss*** tab, enter the reduced CN of 86.22
- Under the ***Transform*** tab, enter the SCS Lag time of 9 minutes

  (Lag time = 0.6 * Tc)



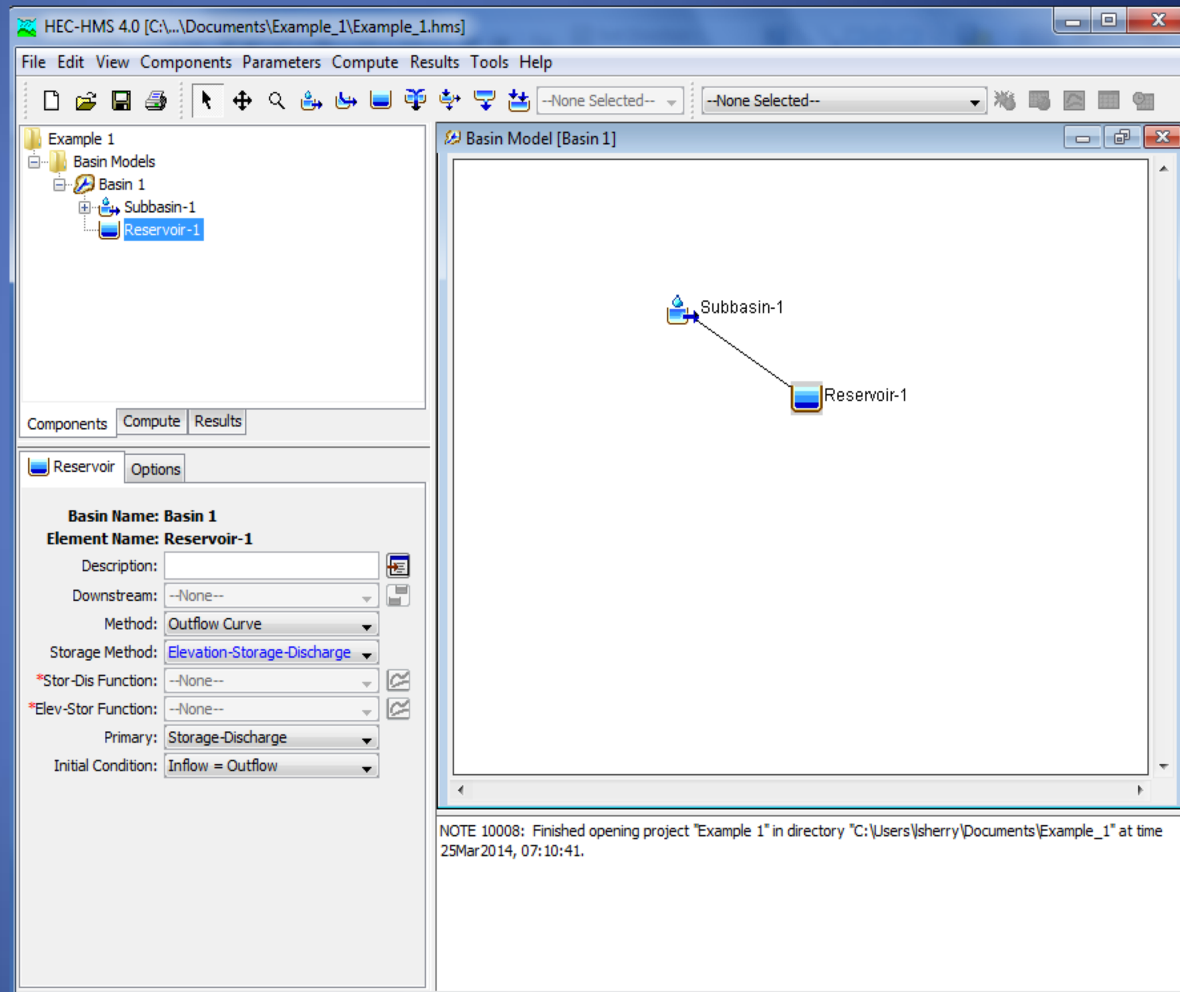
ENTERING RESERVOIR DATA

- Click on *Reservoir-1* and the data entry tabs will appear at the lower left corner

- For ***Method***, enter *Outflow Curve*

- For Storage Method, select *Elevation-Storage-Discharge*

- Note that the Storage-Discharge and Elevation-Storage Functions are missing. This is the next step.



ENTERING RESERVOIR DATA

- Using the spreadsheet available on the MWRD website, the following stage-discharge relationship was determined for the proposed detention basin:

Stage (ft)	Discharge (cfs)
600	0.00
601	0.61
602	0.92
603	1.15
604	1.34
605	1.50

PROPOSED CONDITIONS

ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Example 1
PROJ. NO.:	WMO Training
DESCRIPTION:	Detention Basin 1
FILENAME:	Orifice.xlsx
DATE:	31-Jul-14

OUTLET:	ORIFICE:	5.07	IN. DIA. @ ELEV	600
	WEIR:	12	FEET WIDE @ ELEV	605

ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$

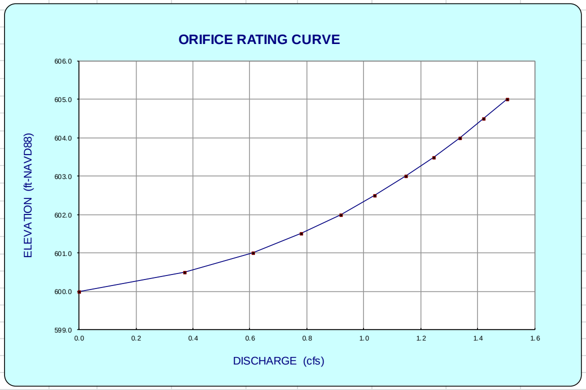
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

<u>HYDRAULIC DIMENSIONS</u>

	# 1
ORIFICE AREA (ft^2)	0.1402
ORIFICE DIAMETER (in)	5.07
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	600.00
TAILWATER OR CENTROID (ft-NAVD88)	600.211
WEIR LENGTH (ft)	12.00
WEIR COEFFICIENT	3.0
WEIR ELEV. (ft-NAVD88)	605.0

<u>ELEVATION-DISCHARGE RELATIONSHIP</u>

Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
600.0	0.00	0.00	0.00
600.5	0.37	0.00	0.37
601.0	0.61	0.00	0.61
601.5	0.78	0.00	0.78
602.0	0.92	0.00	0.92
602.5	1.04	0.00	1.04
603.0	1.15	0.00	1.15
603.5	1.24	0.00	1.24
604.0	1.34	0.00	1.34
604.5	1.42	0.00	1.42
605.0	1.50	0.00	1.50
605.5	1.58	12.73	14.31
606.0	1.65	36.00	37.65



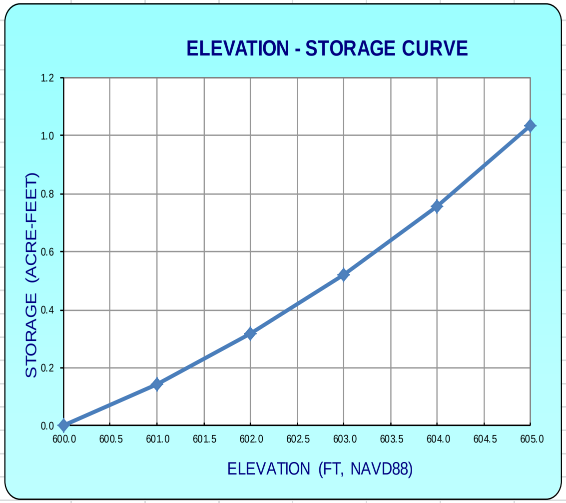
ENTERING RESERVOIR DATA

- Using the spreadsheet available on the MWRD website, the following stage-storage relationship was determined for the proposed detention basin:

Stage (ft)	Storage (ac-ft)
600	0.00
601	0.14
602	0.32
603	0.52
604	0.76
605	1.04

POND:	Pond 1		
JOB NO.	TGM		Side Slopes
PROJECT:	Example 1		1
FILE:	Storage.xls		4
DATE:	8/4/2014		

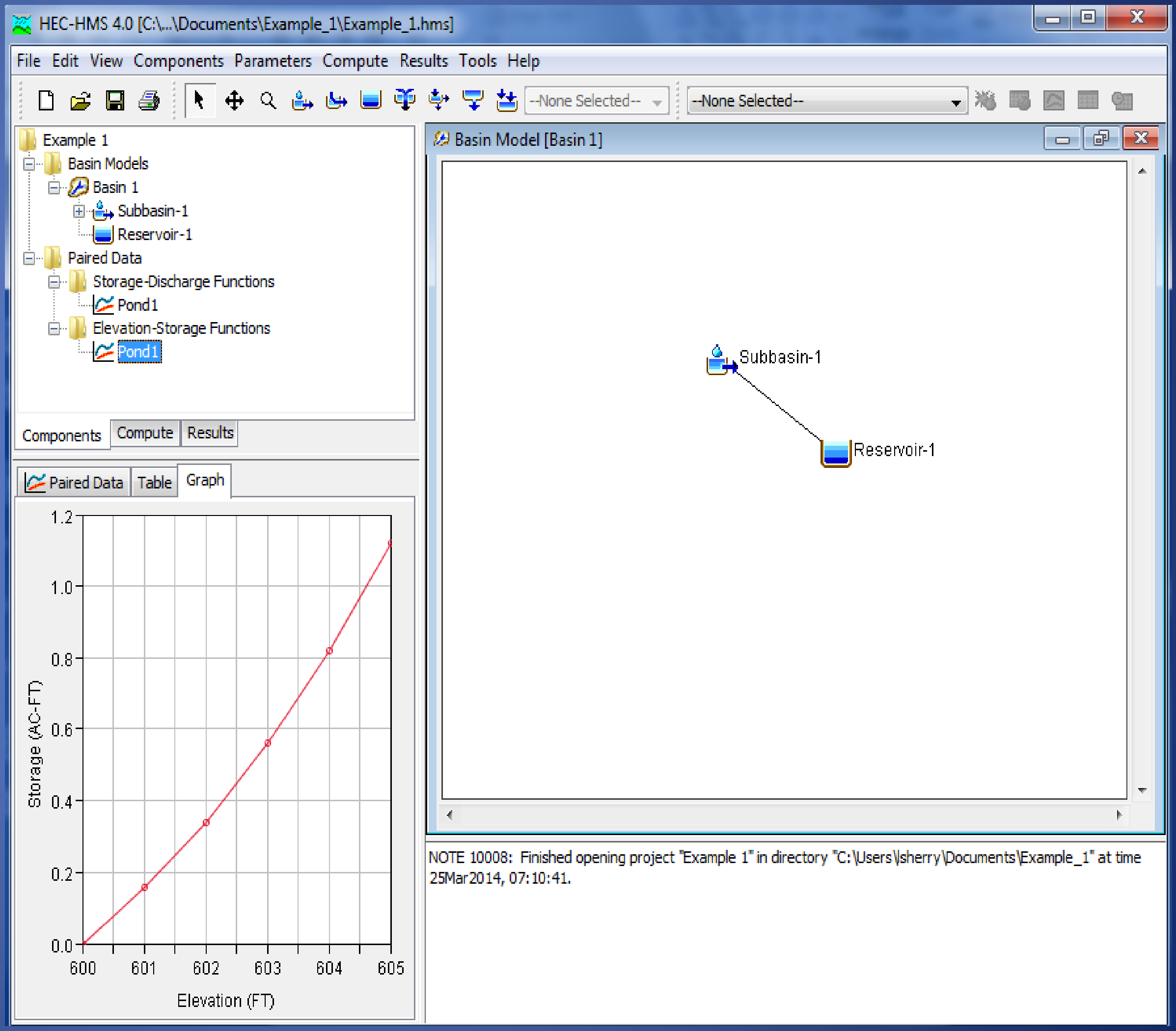
Elevation (ft)	Area (ft^2)	Area (ac)	Average Area (ac)	Incremental Storage (ac-ft)	Cummulative Storage (ac-ft)
600.00	5,539	0.127			0.000
			0.142	0.14	
601.00	6,794	0.156			0.14
			0.174	0.17	
602.00	8,400	0.193			0.32
			0.205	0.21	
603.00	9,500	0.218			0.52
			0.237	0.24	
604.00	11,123	0.255			0.76
			0.278	0.28	
605.00	13,100	0.301			1.04



Elevation (ft, NAVD88)	Storage (ac-ft)
600.00	0.000
601.00	0.14
602.00	0.32
603.00	0.52
604.00	0.76
605.00	1.04

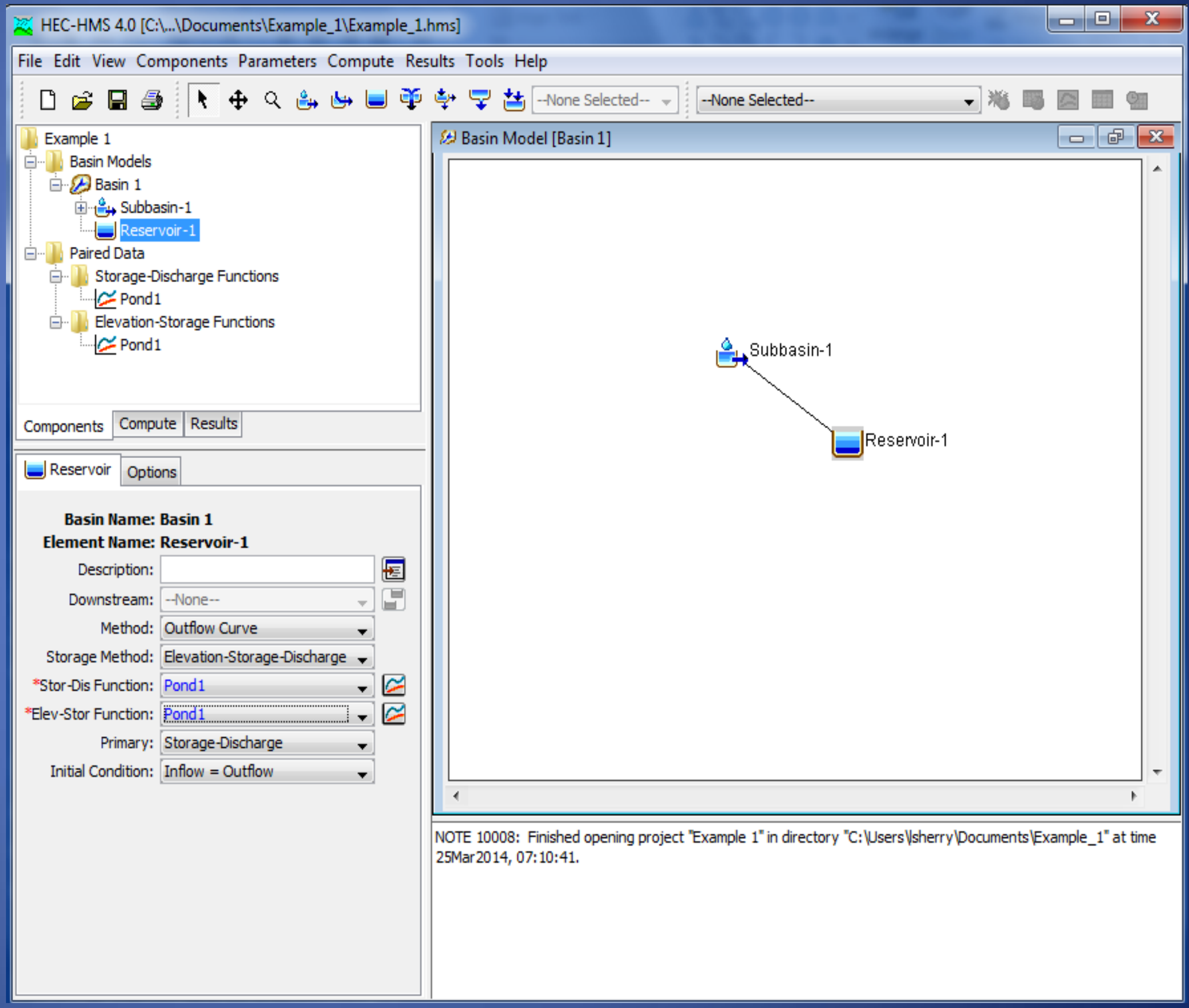
ENTERING RESERVOIR DATA

- Under the ***Components*** tab, select ***Paired Data Manager***
- Add a new *Storage-Discharge* and *Elevation-Storage* function. Name each of them "Pond 1"
- Under the ***Table*** tab, enter the appropriate elevation, storage, and discharge values
- Plots of the relationships are available under the ***Graph*** tab



ENTERING RESERVOIR DATA

- The last step is assigning the *Paired Data* to *Reservoir-1*
- For the ***Stor-Dis Function***, select the *Paired Data* from the drop-down menu
- For the ***Elev-Stor Function***, select the *Paired Data* from the drop-down menu
- For ***Primary***, select *Storage-Discharge*
- For ***Initial Condition***, select *Inflow = Outflow*

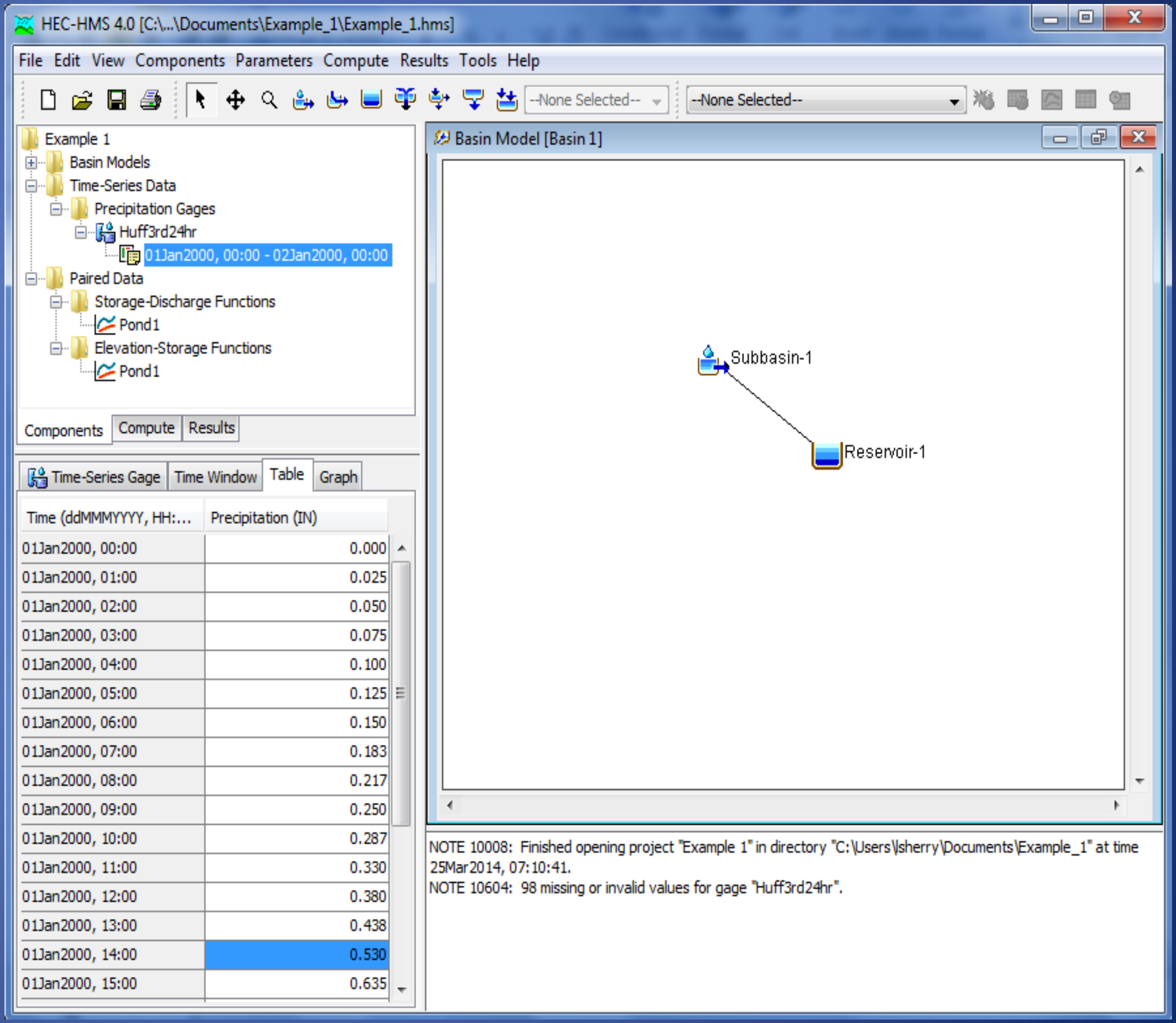


ENTERING RAINFALL DATA

- In HEC-HMS, rainfall data is entered as a combination of ***Time-Series Data*** and the ***Meteorologic Model***
- The ***Time-Series Data*** reflects the rainfall distribution (Huff quartile distributions or actual rainfall records)
- ***Time-Series Data*** cannot be entered in user-specified increments, interpolation of points on the Huff curves may be necessary for some storm events
- The ***Meteorologic Model*** defines the rainfall depths and which subbasins those depths are applied

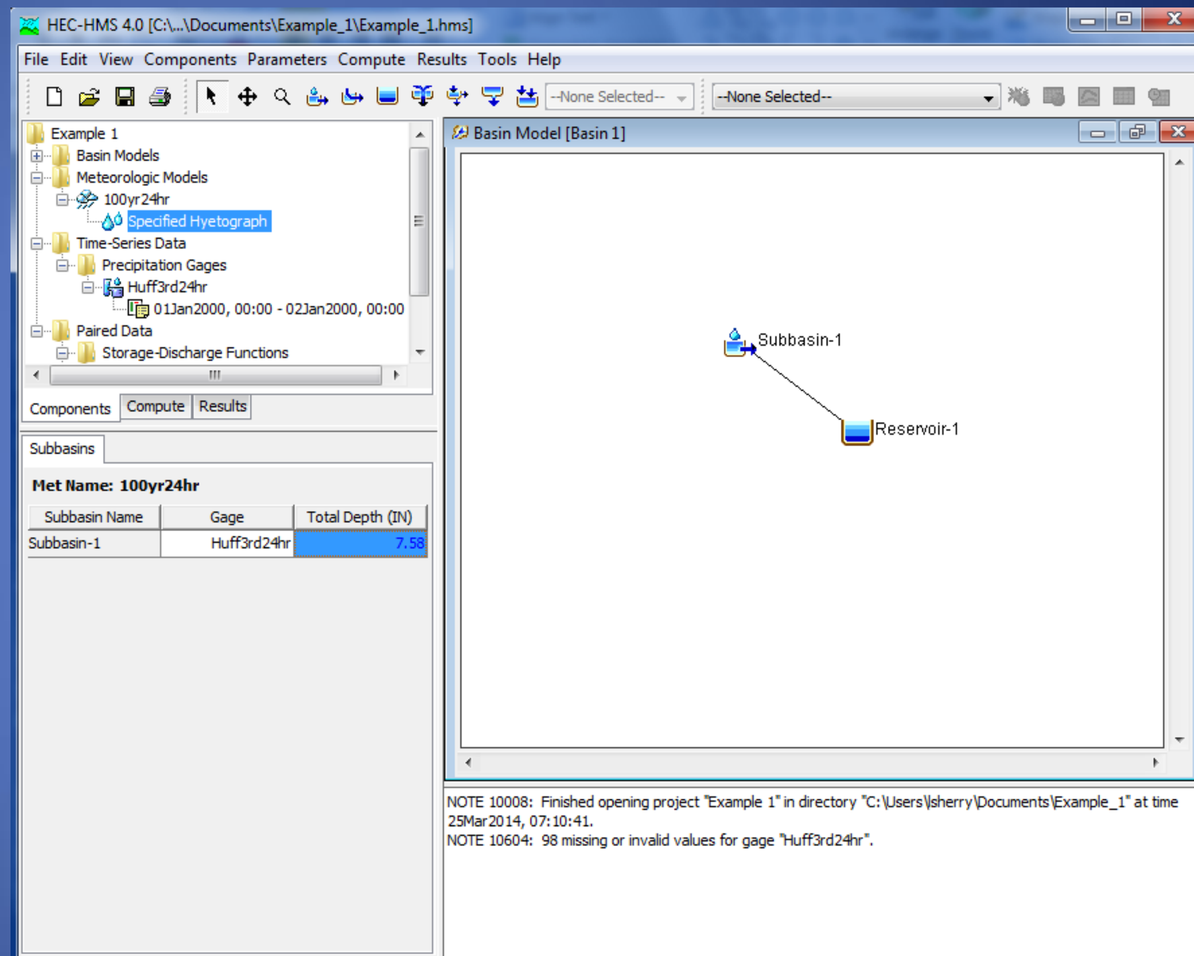
ENTERING TIME-SERIES DATA

- From the ***Components*** menu, select ***Time-Series Data Manager*** to create a new ***Precipitation Gage*** named “Huff3rd24hr”
- Under the ***Time-Series Gage*** tab, select *Manual Entry*, *Cumulative Inches*, and *1-hour* increments
- Under the ***Time Window*** tab, run the storm from 01Jan2000 through 02Jan2000 (24-hour duration)
- Enter the Huff 3rd Quartile Distribution for the 24-hour duration from the handout
- Use the ***Graph*** tab to see a plot of the distribution



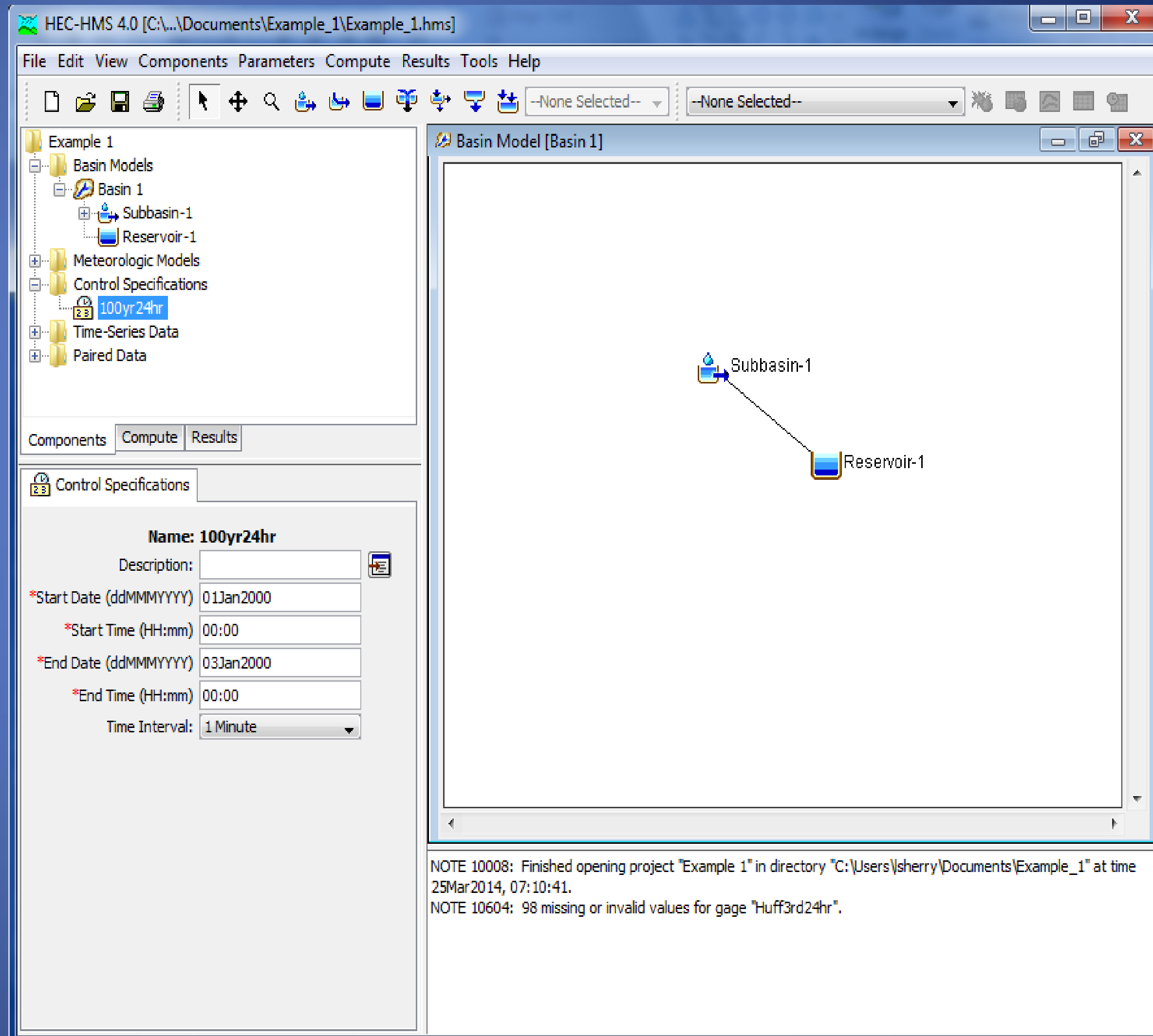
CREATING THE METEOROLOGIC MODEL

- From the ***Components*** tab, create a new ***Meteorologic Model*** named "100yr24hr"
- Under the ***Meteorology Model*** tab, make sure the ***Replace Missing*** is ***Set to Default***
- Under the ***Basins*** tab, select ***Yes*** under ***Include Subbasins***?
- Under the ***Options*** tab, select ***Yes*** for ***Total Override***
- Under the ***Specified Hyetograph*** tab, select the rainfall distribution that we previously created and enter the 100-year, 24-hour rainfall depth.



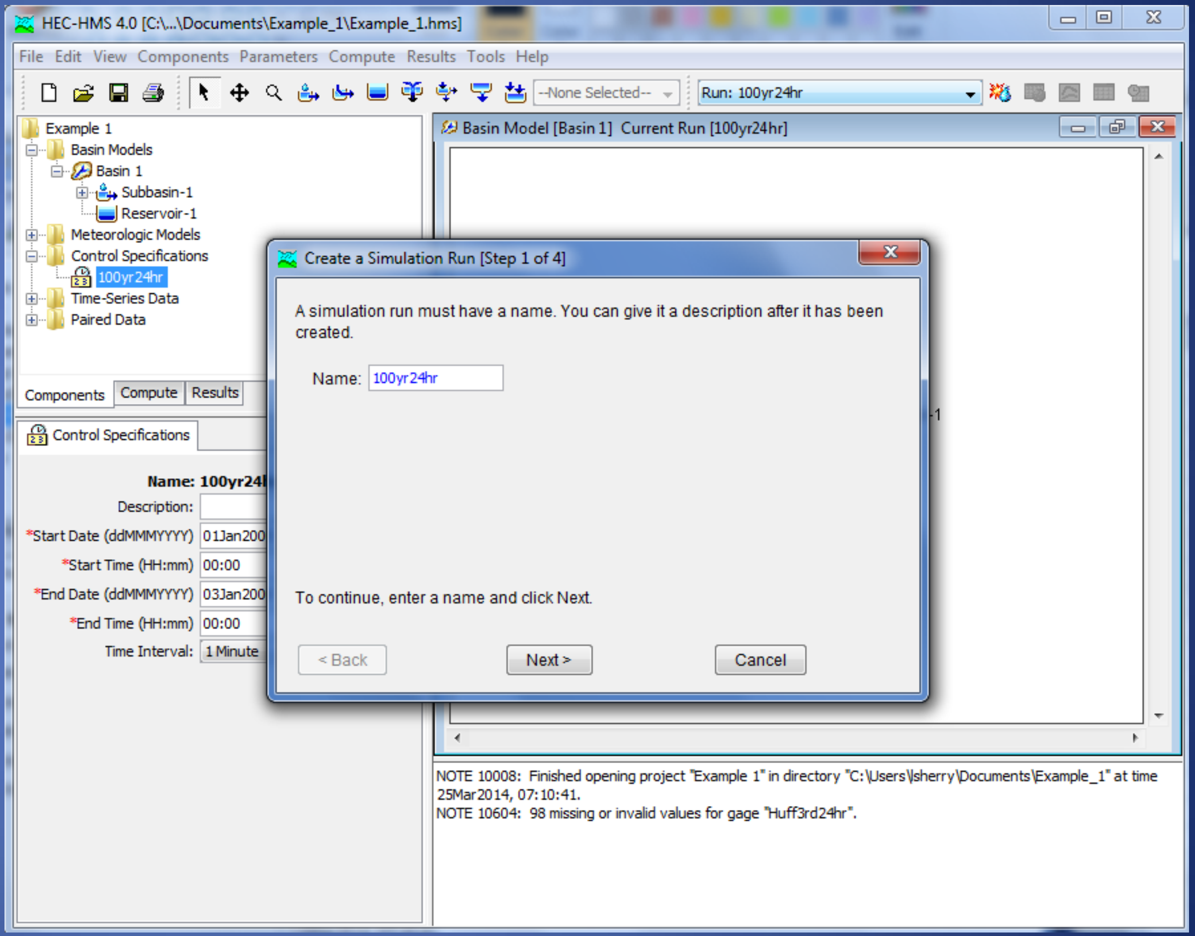
CREATING THE CONTROL SPECIFICATIONS

- We still need the specify how long to run the model for and how often we want to see output…this is performed under the ***Control Specifications***
- Under the ***Components*** menu, select ***Control Specifications Manager*** to create a new one named "100yr24hr"
- Specify 01Jan2000 through 03Jan2000 (remember we're running a 24-hour storm event)
- Under ***Time Interval***, specify 1 minute



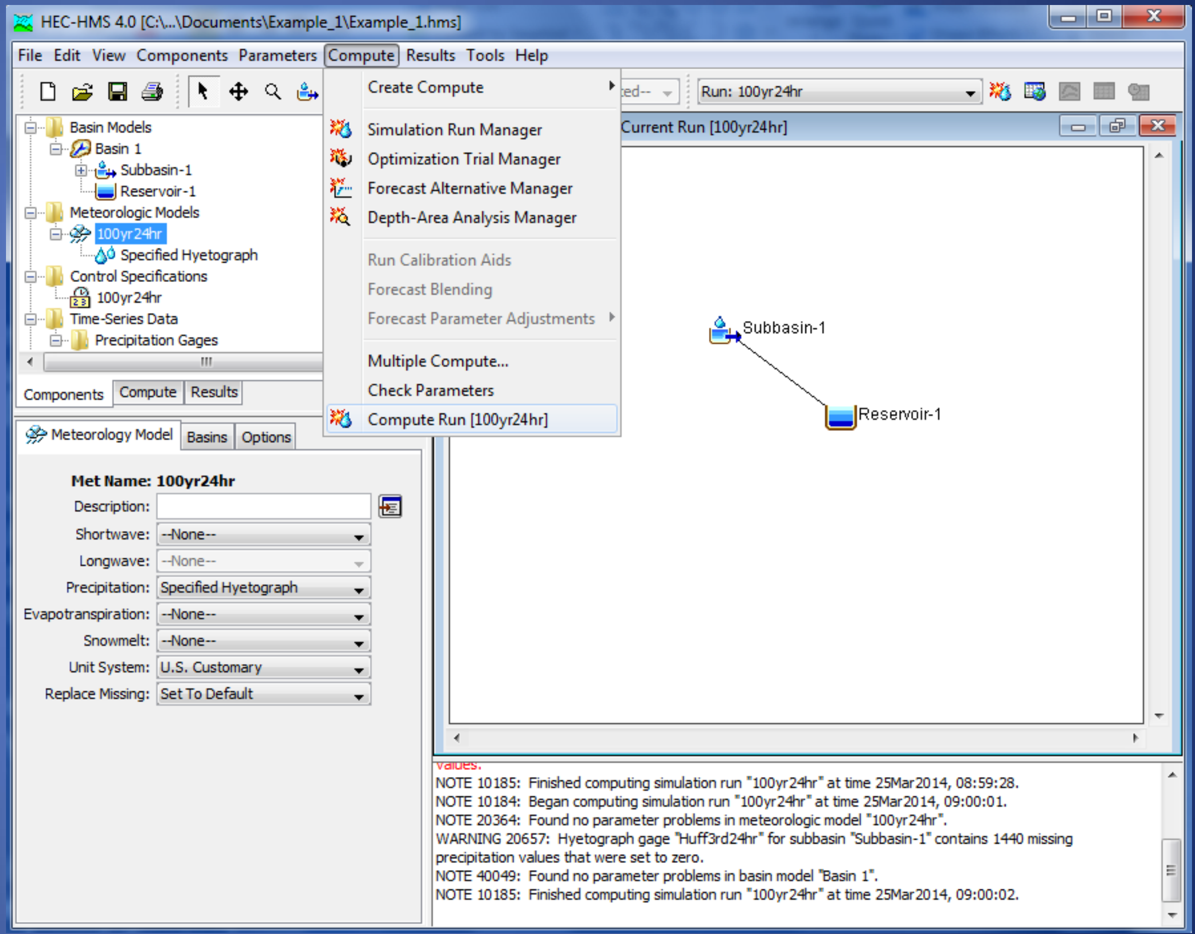
CREATING THE SIMULATION RUN

- A *Simulation Run* is a combination of:
  - ***Basin Model***
  - ***Meteorologic Model***
  - ***Control Specifications***
- To create a new *Simulation Run*, select ***Create Compute > Simulation Run*** under the ***Components*** menu
- Name the run "100yr24hr" and click ***Next***
- Specify the ***Basin Model***, ***Meteorologic Model***, and ***Control Specifications*** that we've just created



RUNNING THE SIMULATION

- Under the ***Compute*** menu, select ***Compute Run [100yr24hr]***
- All errors, warnings, and notes are shown in the lower right hand window
- If there are errors, they will show up in red and the simulation will not run successfully

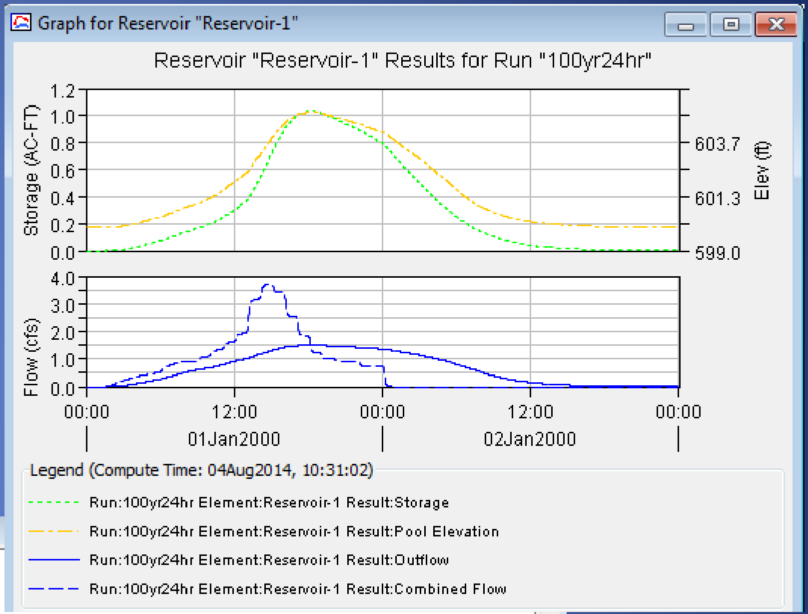


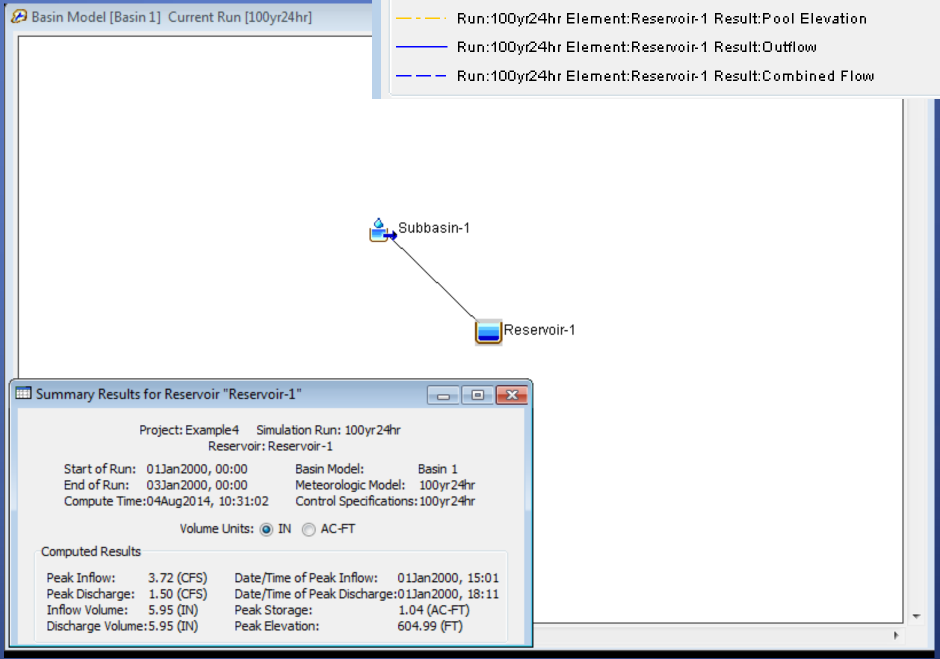
VIEWING RESULTS

- If the *Simulation Run* was successful, right-click on the components of the ***Basin Model*** to view individual results

- Results are available as a ***Graph***, ***Summary Table***, or ***Time-Series Table***

- To view the results for all model components at once, choose ***Global Summary Table*** under the ***Results Menu***



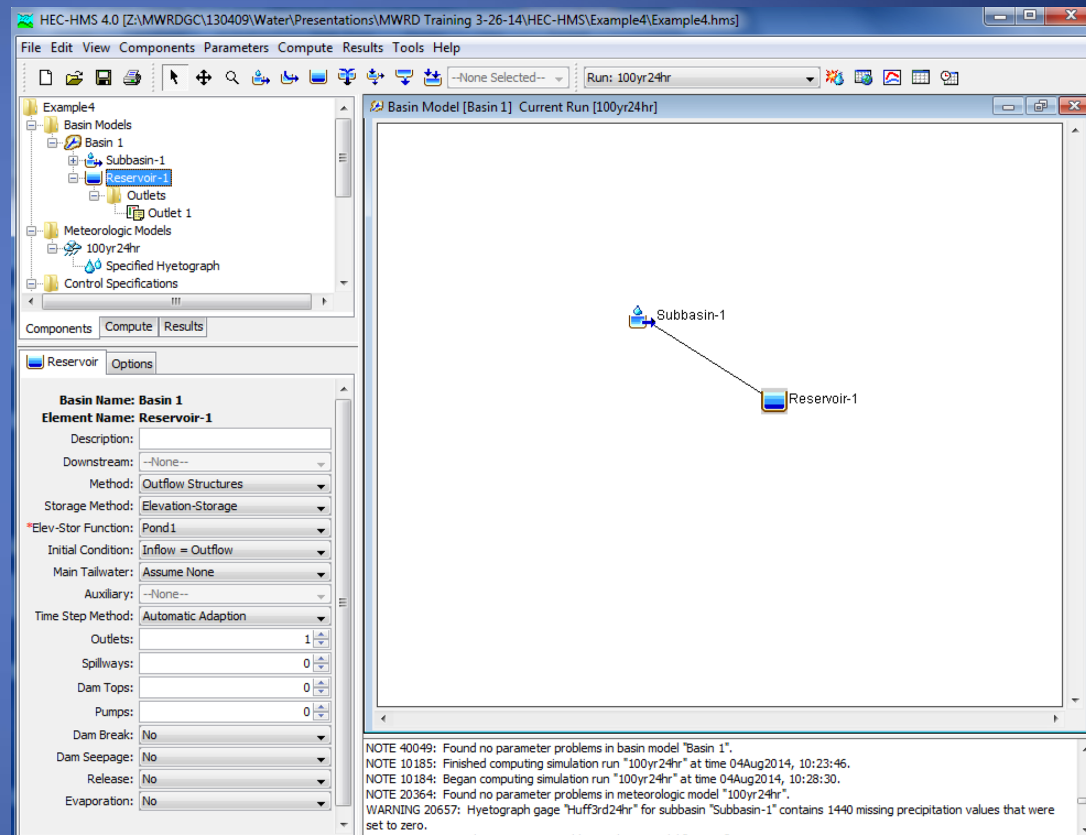


EXAMPLE 1 RESULTS

- What is the peak elevation in the proposed detention basin for the 100-year, 24-hour storm event?_605.0 ft_____
- What is the peak 100-year, 24-hour release rate from the proposed detention basin?_1.50 cfs_____
- Does the proposed detention basin meet the requirements of the WMO? _YES_____

RESERVOIR OUTLET STRUCTURES

- Instead of specifying a stage-discharge relationship, HEC-HMS can calculate the outflow based on user-specified structure data
- Under the ***Reservoir-1*** tab, select ***Outflow Structures*** under ***Method***
- For the ***Initial Condition***, assume ***Inflow = Outflow***
- Under ***Main Tailwater***, select ***None***
- Under ***Outlets,*** specify ***"1"***



RESERVOIR OUTLET STRUCTURES

- Use the following restrictor information to enter the outlet structure in HEC-HMS:

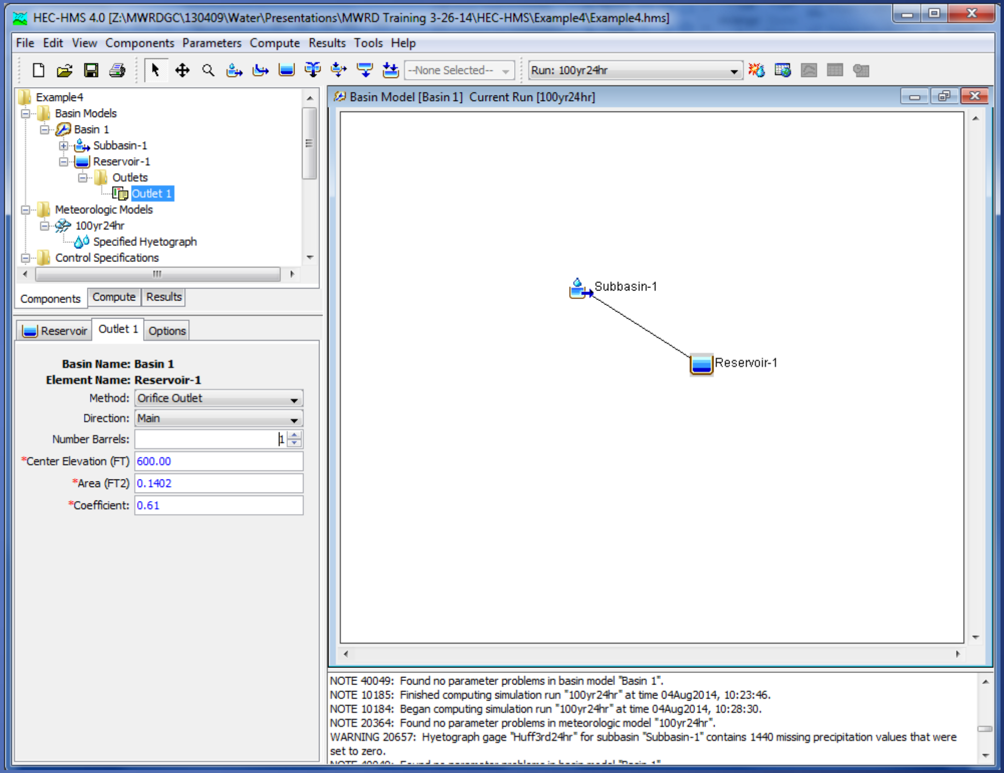
  Diameter = 5.07 in

  Discharge Coefficient = 0.61

  Invert Elevation = 600.00

- Once you've entered the outlet information, rerun the model for the 100-year, 24-hour storm event.

- How do the results compare to the previous simulation?



EXAMPLE PROBLEM #2 (INDIVIDUAL)

Determine the required detention volume for the proposed development described below:

- Total Project Area = 10 acres
- Composite CN = 94, Reduced CN = 87.59
- 75% Impervious Area
- Time of Concentration = 15 minutes
- Unrestricted Area = 0.3 acres
- CN = 74
- Time of Concentration = 10 minutes

See Handout

EXAMPLE 2 – STEP 1

<u>Step 1</u>: Determine the required volume control storage for the site.

The curve number for the site is 94, with a total impervious area of 7.5 acres (75%). The required volume control storage, V_c, for the site is calculated as:

$$V_c = 1'' \times \frac{1 \text{ foot}}{12 \text{ inches}} \times 7.5 \text{ acres} = 0.63 \text{ acre-feet}$$

EXAMPLE 2 – STEP 2

Step 2: Determine the CN reduction corresponding to volume control calculated in Step 1.

Using the CN Adjustment Calculator spreadsheet, the adjusted curve number is 87.59 (it was assumed that only the required 1” of volume control storage would be provided).

RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR

Site Information:

Total Site Area, A_w (ac) =	10			Total Impervious Area, A_i (ac) =	7.5
Runoff, R (in) =	6.86				
P = rainfall depth (in) =	7.58				
CN =	94				
S =	0.64				
Runoff Volume Over Watershed, V_w (ac-ft) =	5.72				

Volume of GI Provided:

Volume Control Storage, V_R =	0.63	ac-ft	1" of volume over impervious area
Additional Volume, V_{GI} =	0.00	ac-ft	Additional volume over the required 1"

Adjusted Volume Over Watershed, $V_{ADJ} = V_W - V_R - V_{GI}$

V_{ADJ} (ac-ft) =	5.10

Adjusted Runoff Over Watershed, $R_{ADJ} = \frac{V_{ADJ}}{A_W}$

R_{ADJ} (in) =	6.11
S_{ADJ} =	1.42
Adjusted CN for detention calcs, CN_{ADJ} =	87.59

*Blue values are entered by user

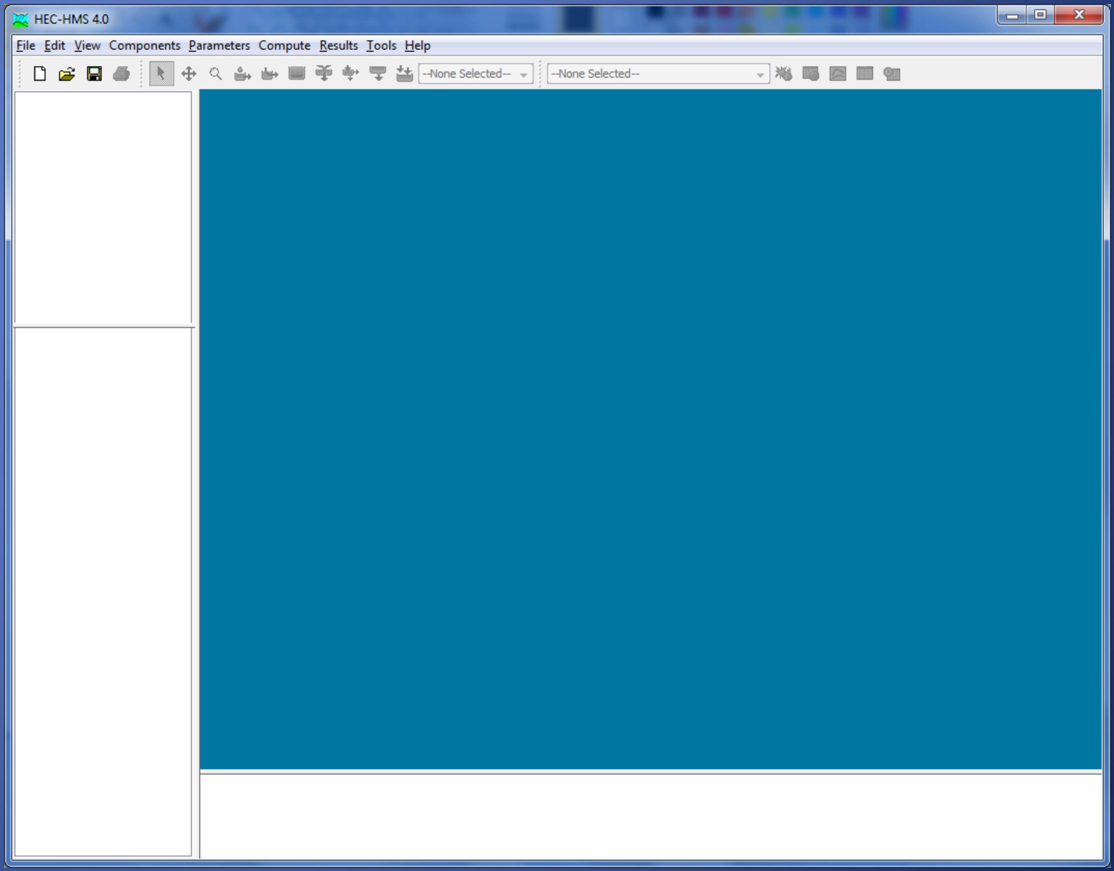
EXAMPLE 2 – STEP 3

Step 3A: Determine the 100-yr, 24-hr peak flow rate from the unrestricted area.

GETTING STARTED
THE INITIAL HEC-HMS SCREEN

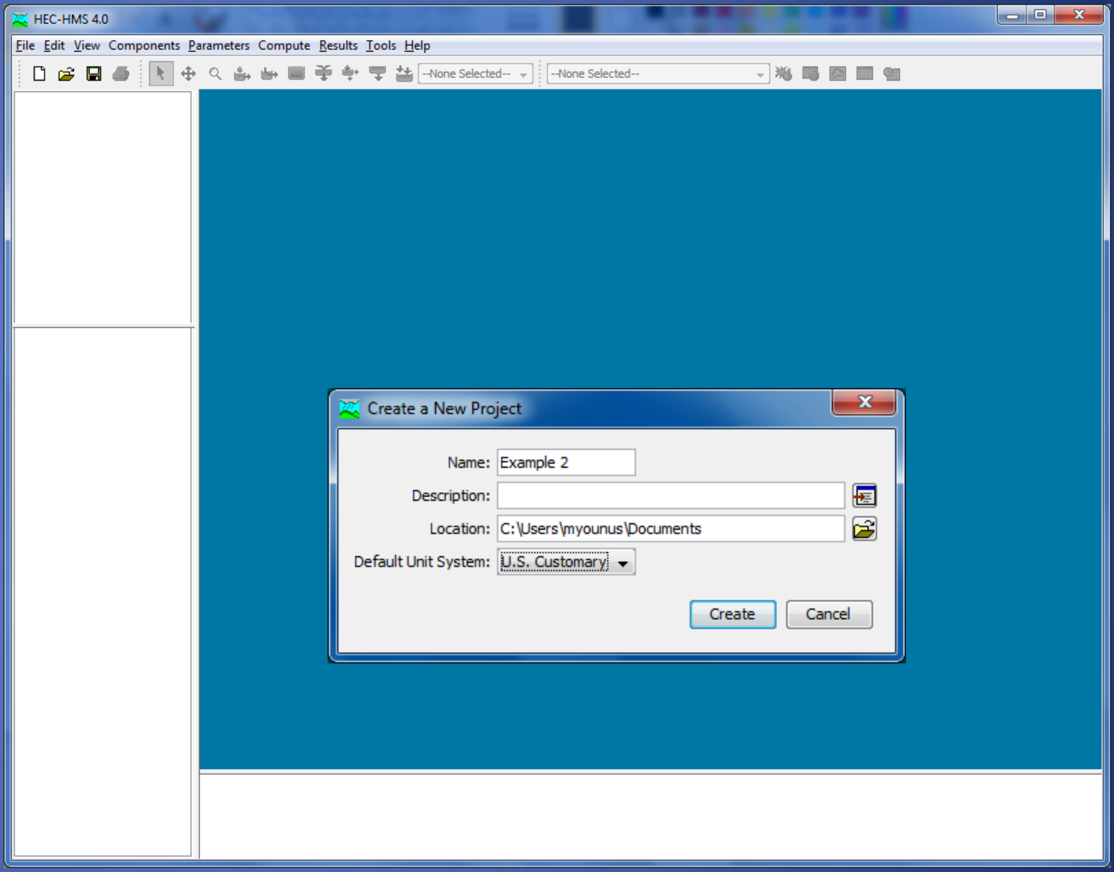
- Double-click on the HEC-HMS icon on your desktop

- The following HEC-HMS Screen comes up:



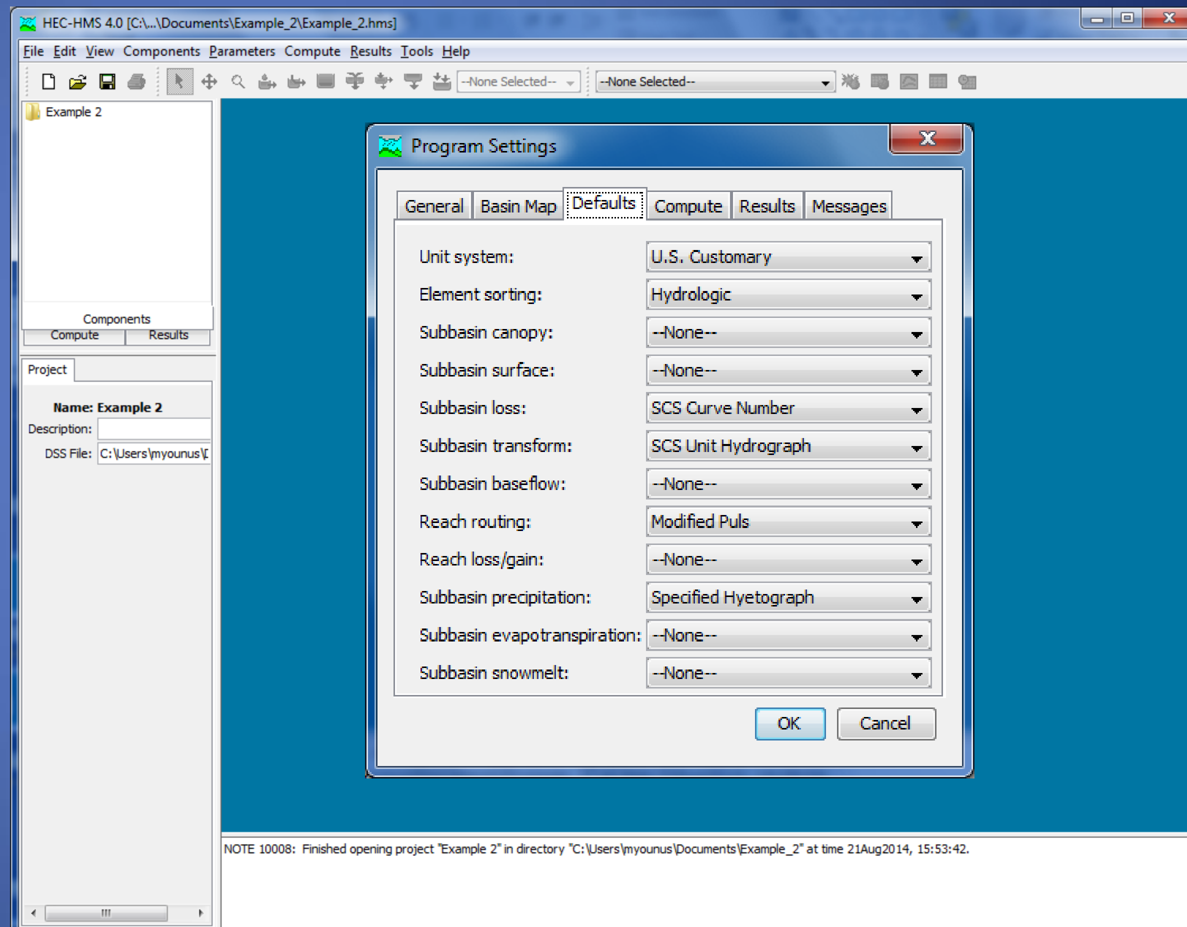
HEC-HMS – SETTING UP A NEW PROJECT

- Click on the “**File**” menu
- From the drop down menu, select “New”
- Name the new project “Example 2”
- Be sure to set the Default Unit System to “U.S. Customary”



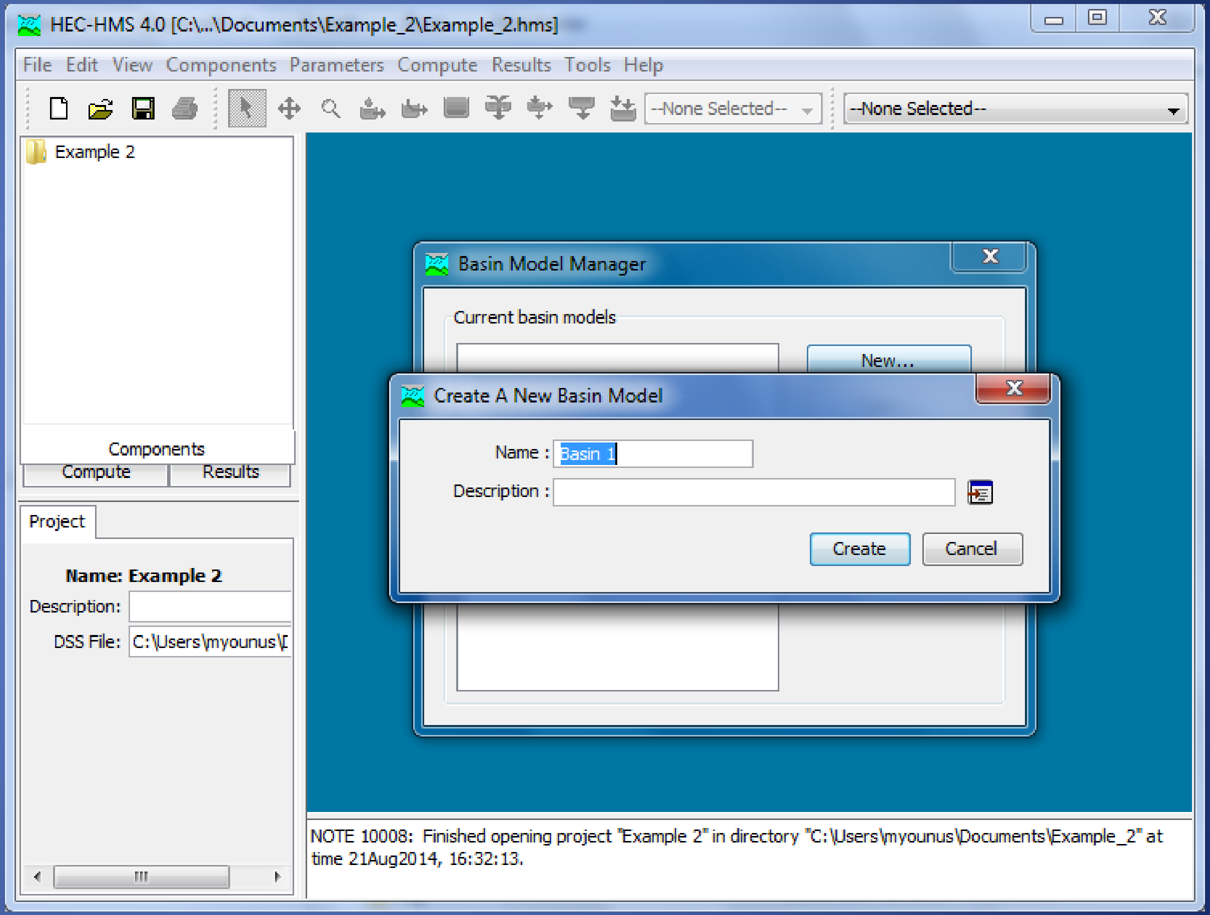
SETTING UP PROJECT DEFAULTS

- Under the ***Tools*** Menu, go to ***Program Settings*** and go to the ***Defaults*** tab
- Specify *SCS Curve Number* for ***Subbasin loss***, *SCS Unit Hydrograph* for ***Subbasin transform***, *Modified Puls* for ***Reach routing***, and *Specified Hyetograph* for ***Subbasin precipitation***
- Then go to the ***Results*** tab and make sure that the values for elevation, volume, flowrate, and depth are taken to **2** decimal places.



CREATING A BASIN MODEL

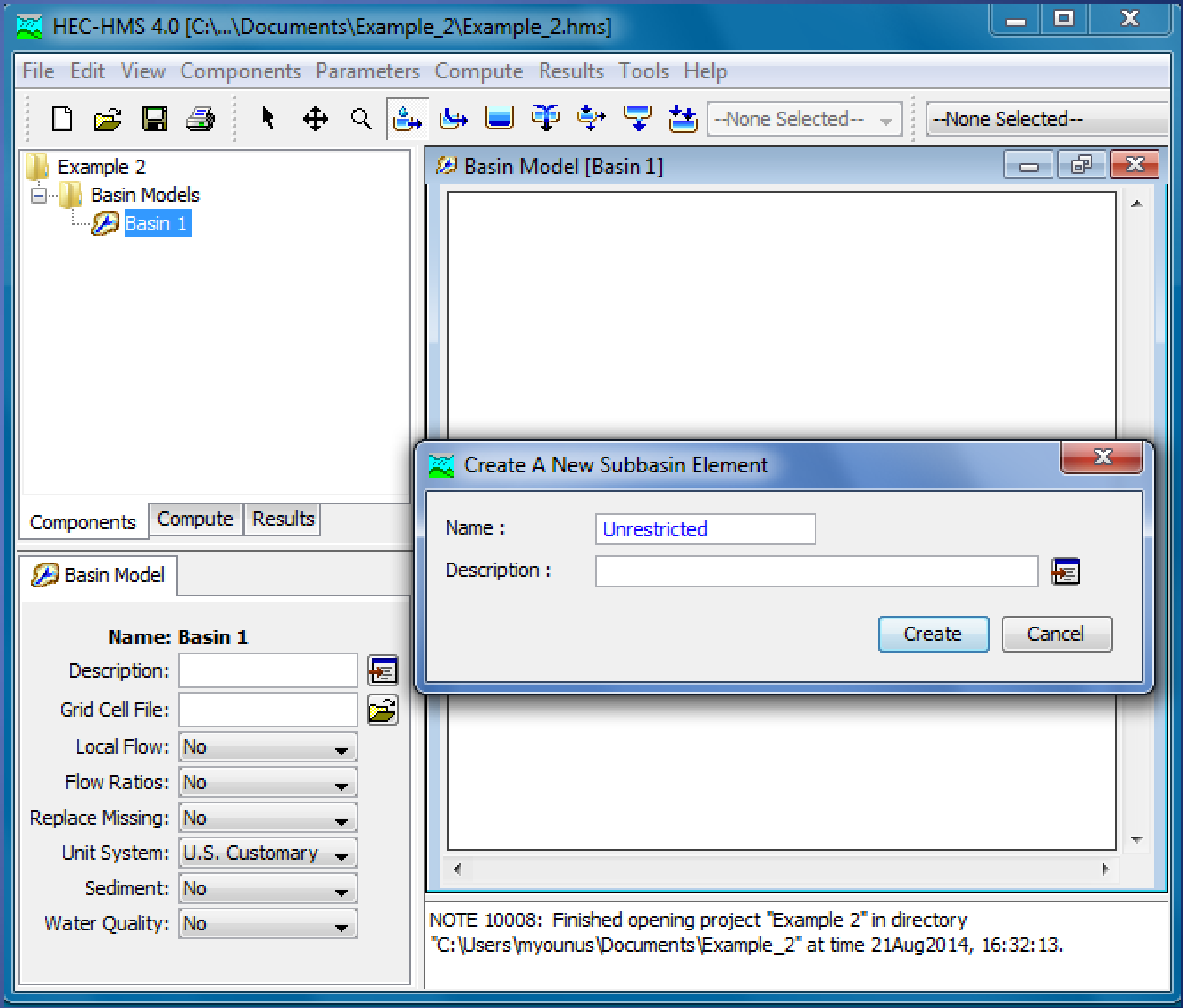
- Under the ***Components*** tab, go to ***Basin Model Manager***
- Select "New" and name it "Basin 1"



ADDING BASIN MODEL COMPONENTS

Subbasin: “Unrestricted”

- Click on the ***Subbasin Creation Tool*** at the top of the screen to add a subbasin to the *Basin Model.*
- Enter Subbasin Name as “Unrestricted”, and click at Create.

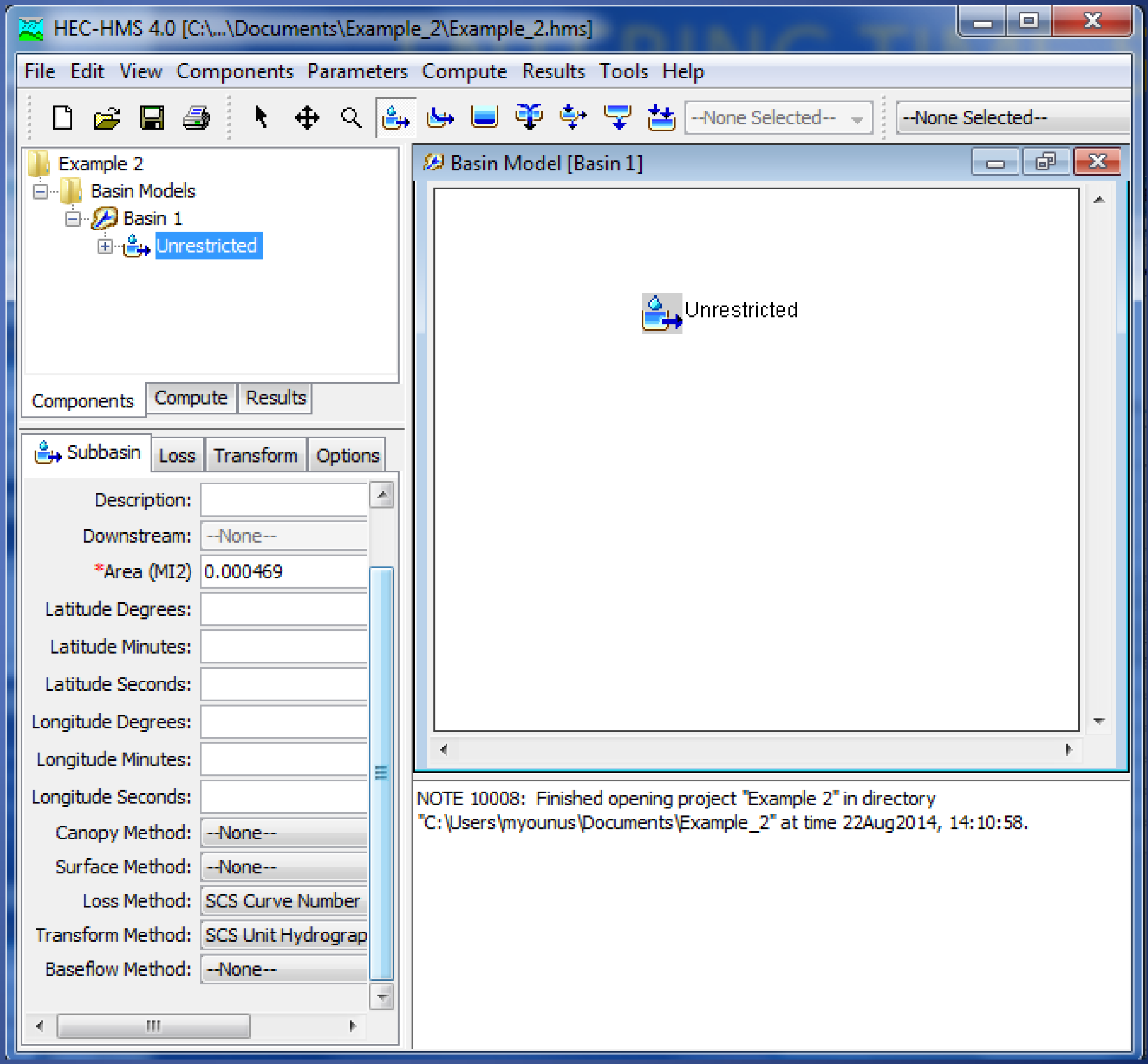


ENTERING SUBBASIN DATA

- Click on *Unrestricted* and the data entry tabs will appear at the lower left corner

- For ***Area***, enter 0.000469 mi^2

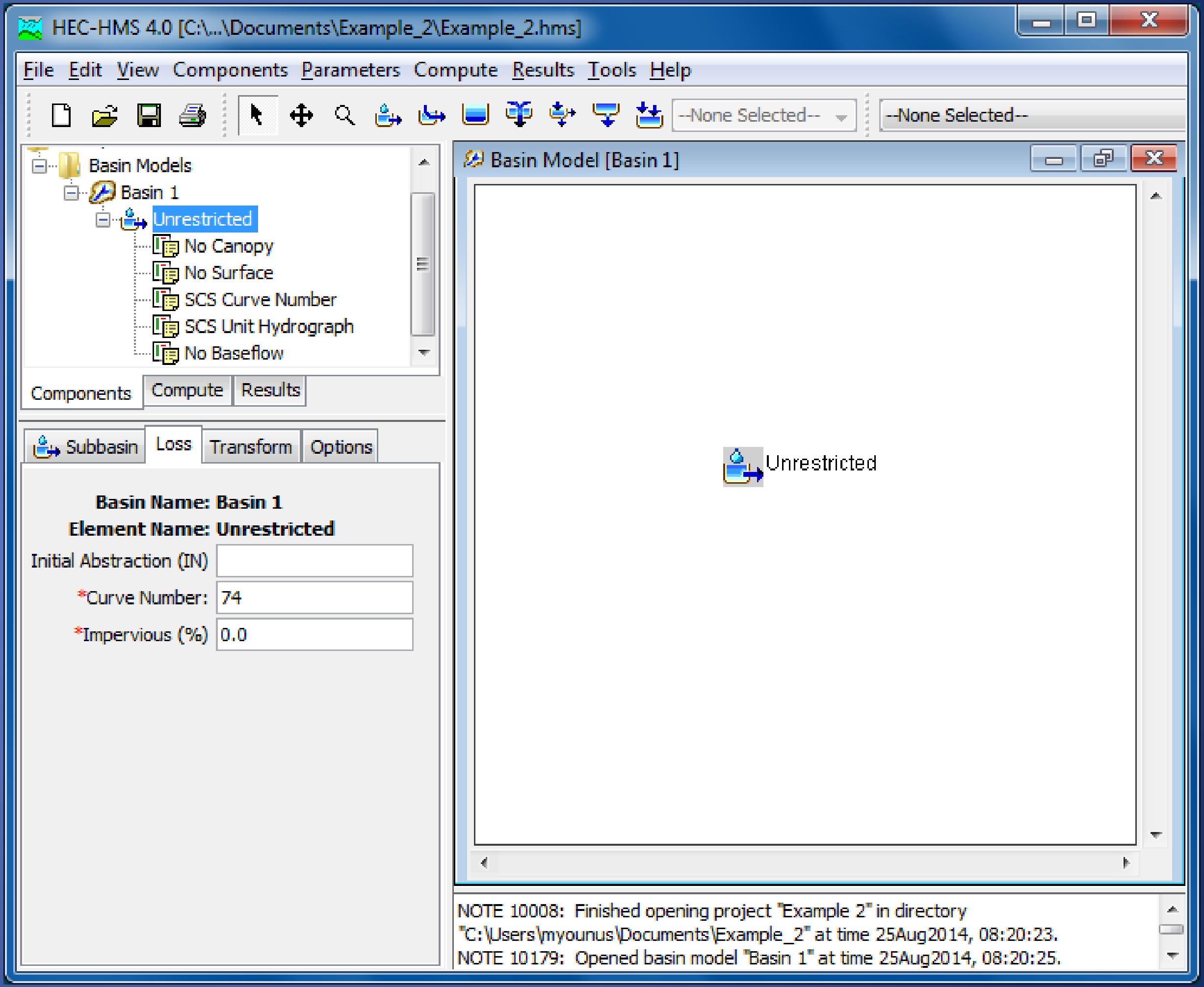
  (0.3 acres)



ENTERING SUBBASIN DATA

Continue …

- Under the ***Loss*** tab, enter the reduced CN of 74

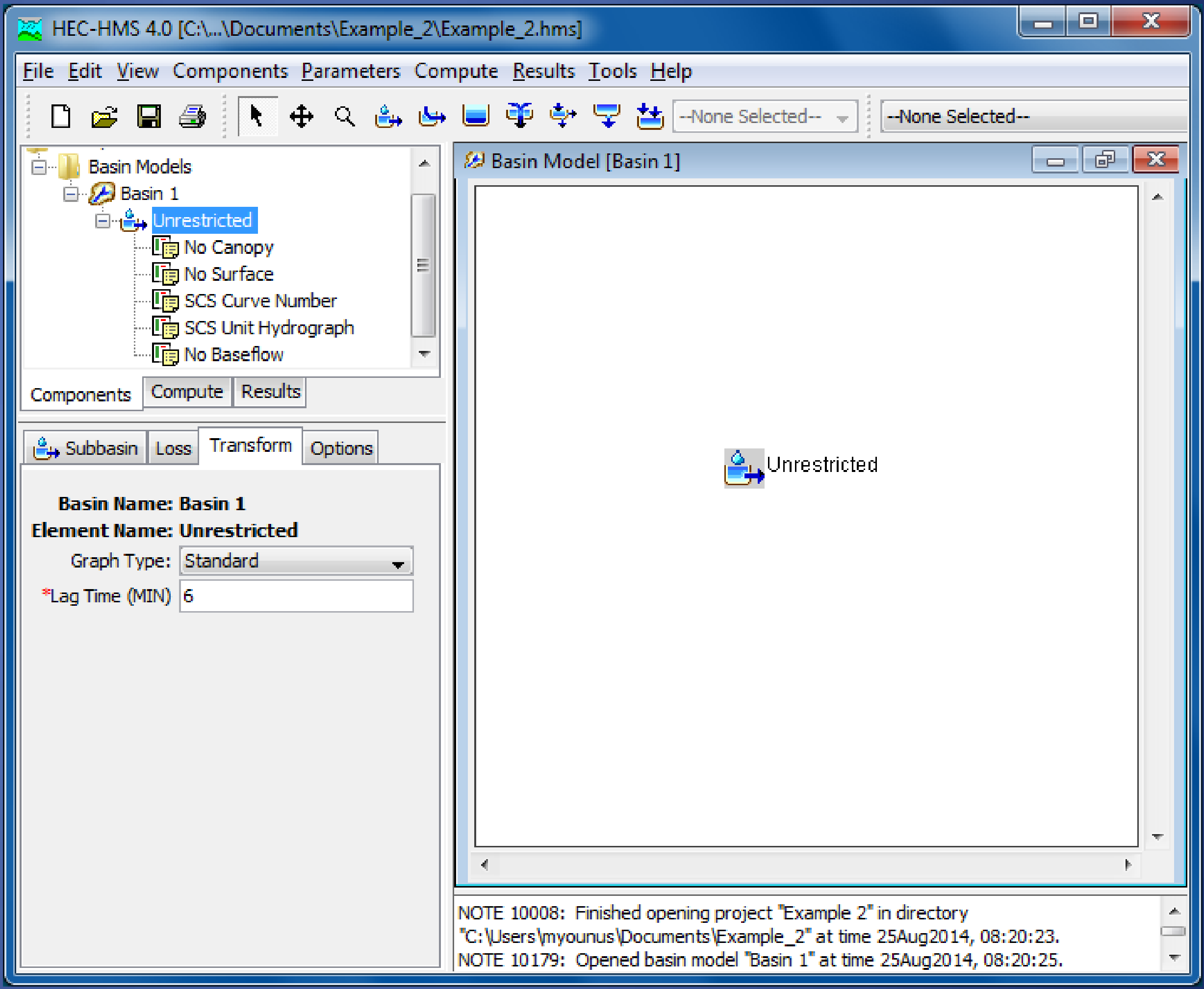


ENTERING SUBBASIN DATA

Continue …

- Under the ***Transform*** tab, enter the SCS Lag time of 6 minutes

  (Lag time = 0.6 * Tc)

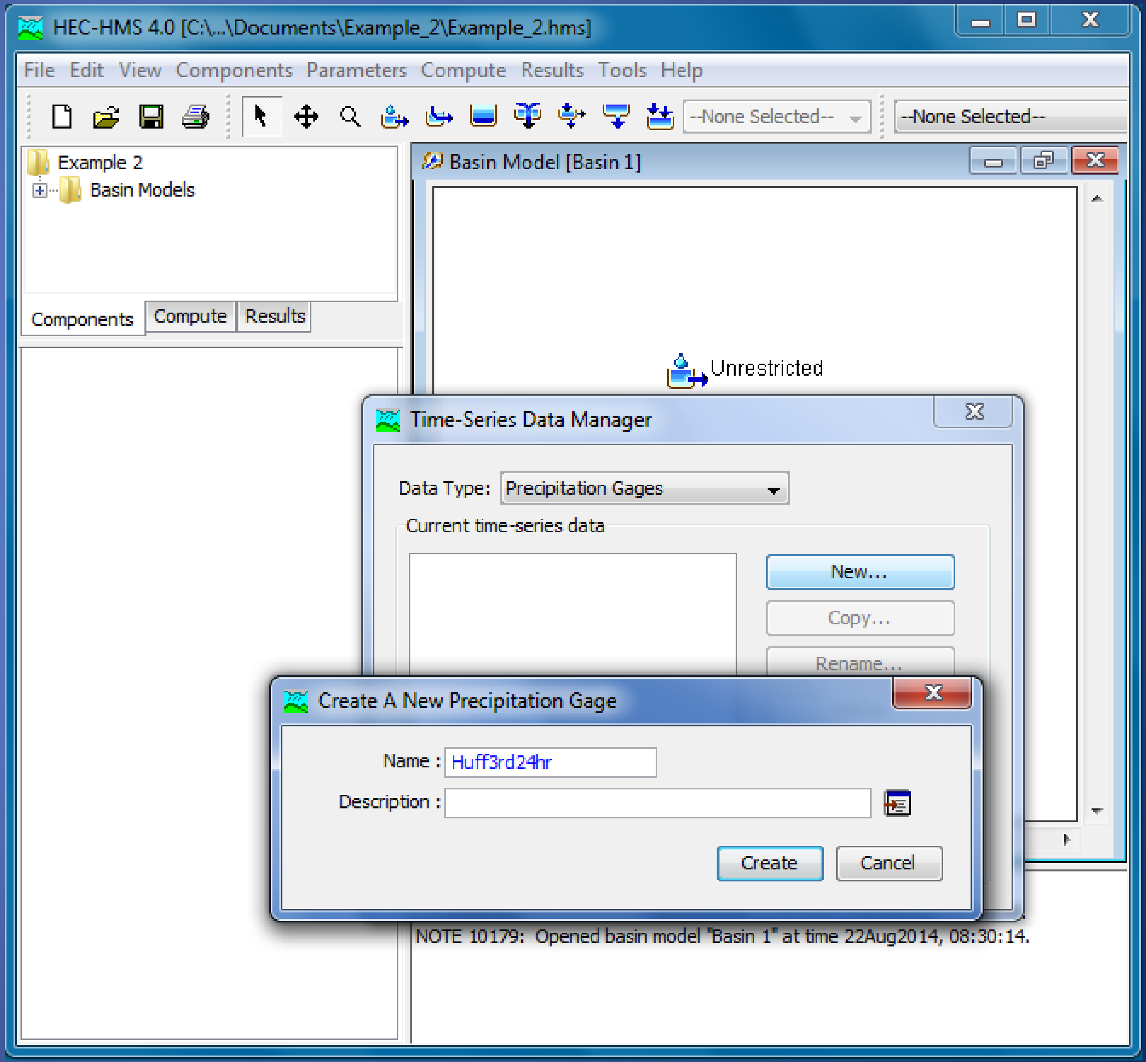


ENTERING RAINFALL DATA

- In HEC-HMS, rainfall data is entered as a combination of ***Time-Series Data*** and the ***Meteorologic Model***
- The ***Time-Series Data*** reflects the rainfall distribution (Huff quartile distributions or actual rainfall records)
- ***Time-Series Data*** cannot be entered in user-specified increments, interpolation of points on the Huff curves may be necessary for some storm events
- The ***Meteorologic Model*** defines the rainfall depths and which subbasins those depths are applied

ENTERING TIME-SERIES DATA

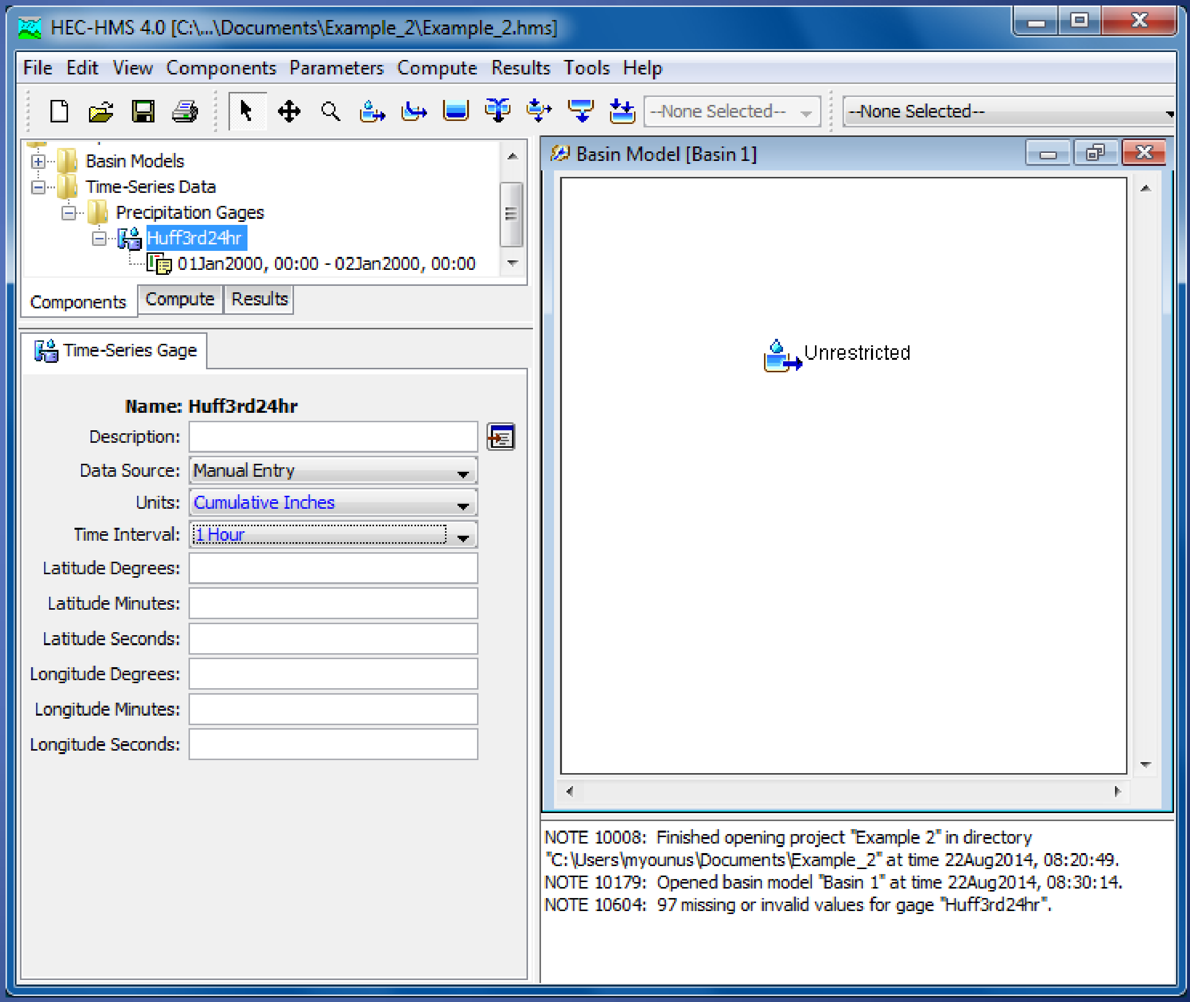
- From the ***Components*** menu, select ***Time-Series Data Manager*** to create a new ***Precipitation Gage*** named "Huff3rd24hr"



ENTERING TIME-SERIES DATA

Continue …

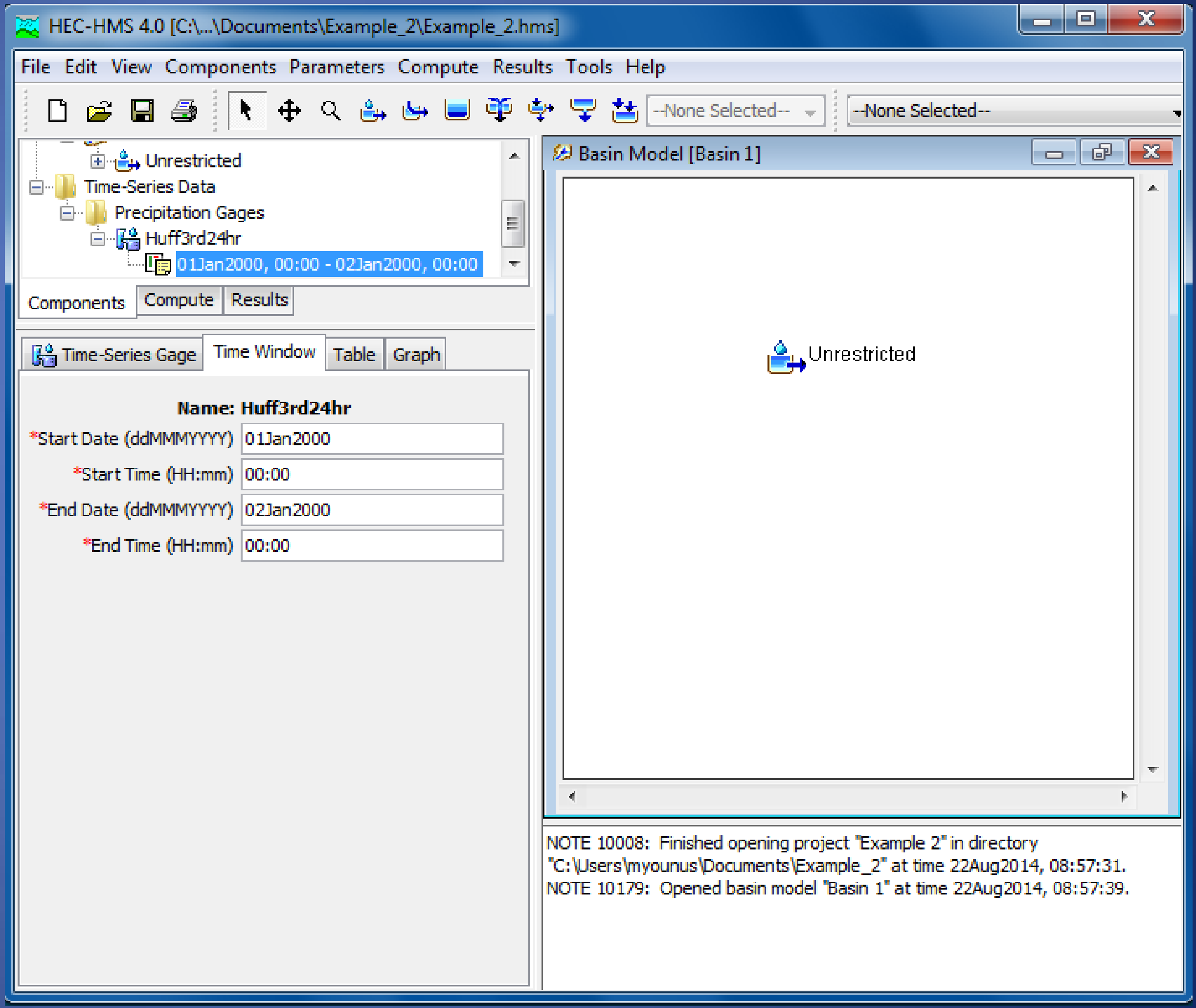
- Under the ***Time-Series Gage*** tab, select *Manual Entry*, *Cumulative Inches*, and *1-hour* increments



ENTERING TIME-SERIES DATA

Continue …

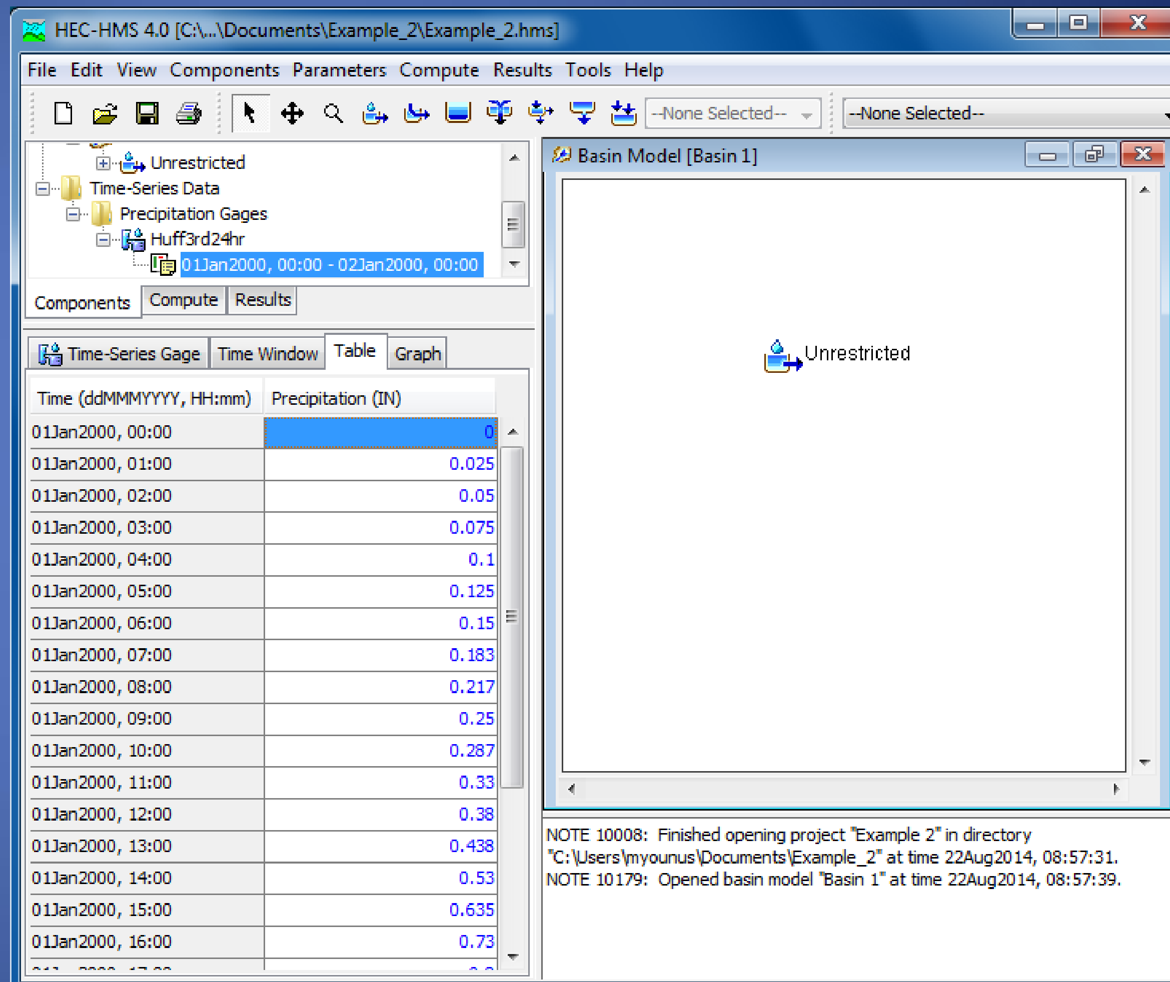
- Under the ***Time Window*** tab, run the storm from 01Jan2000 through 02Jan2000 (24-hour duration)



ENTERING TIME-SERIES DATA

Continue …

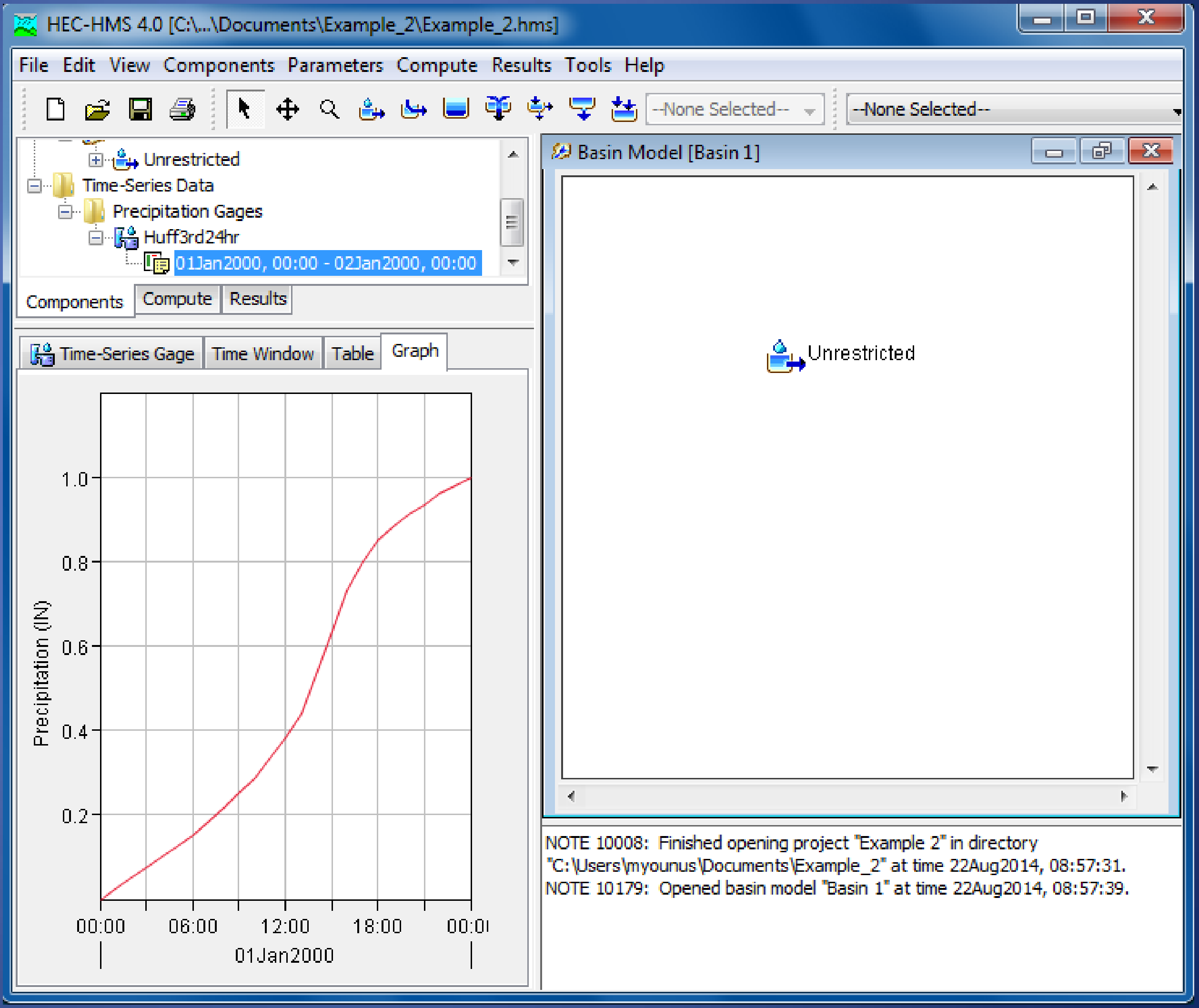
- Under the ***Table Tab***, Enter the Huff 3rd Quartile Distribution for the 24-hour duration from the handout



ENTERING TIME-SERIES DATA

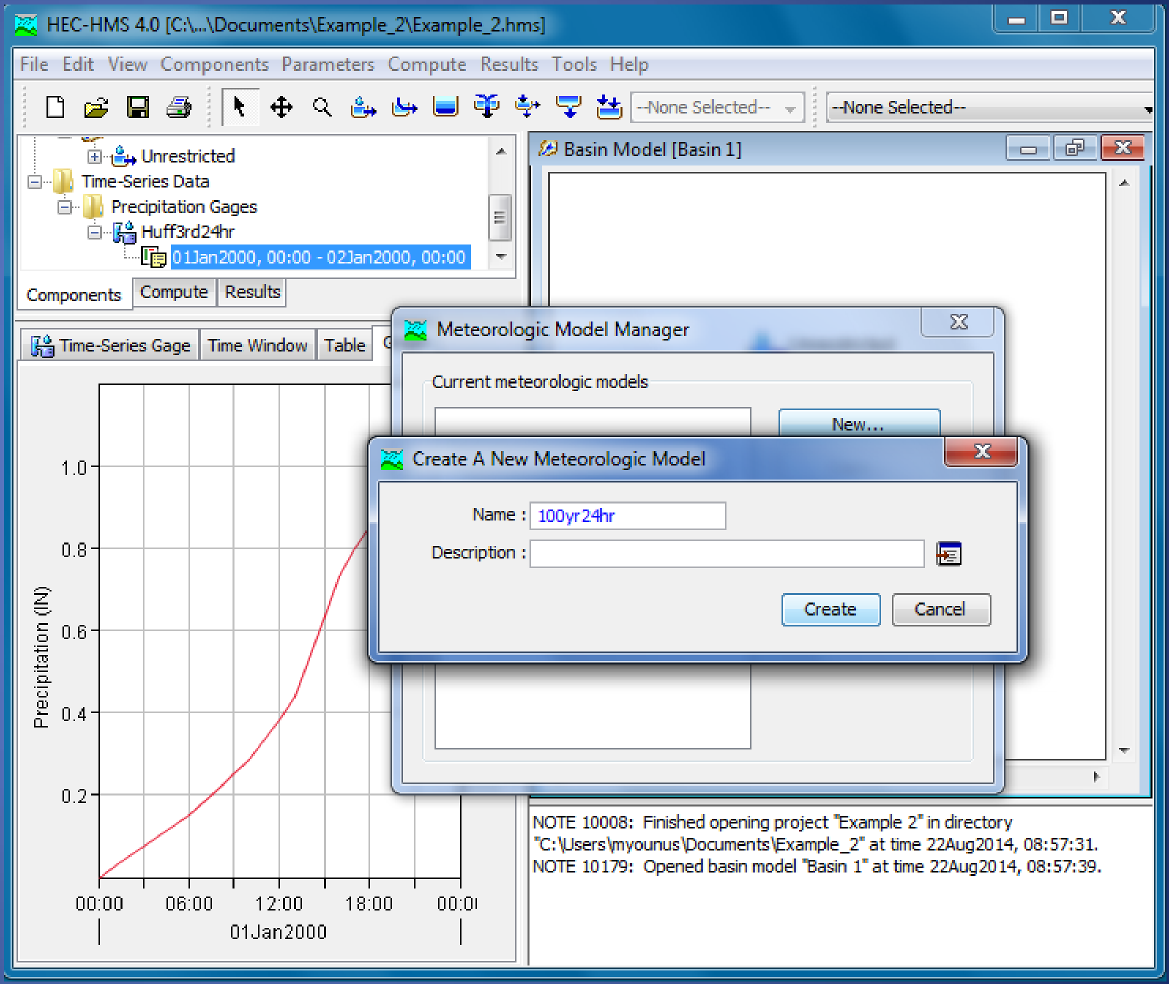
Continue …

- Use the ***Graph*** tab to see a plot of the distribution



CREATING THE METEOROLOGIC MODEL

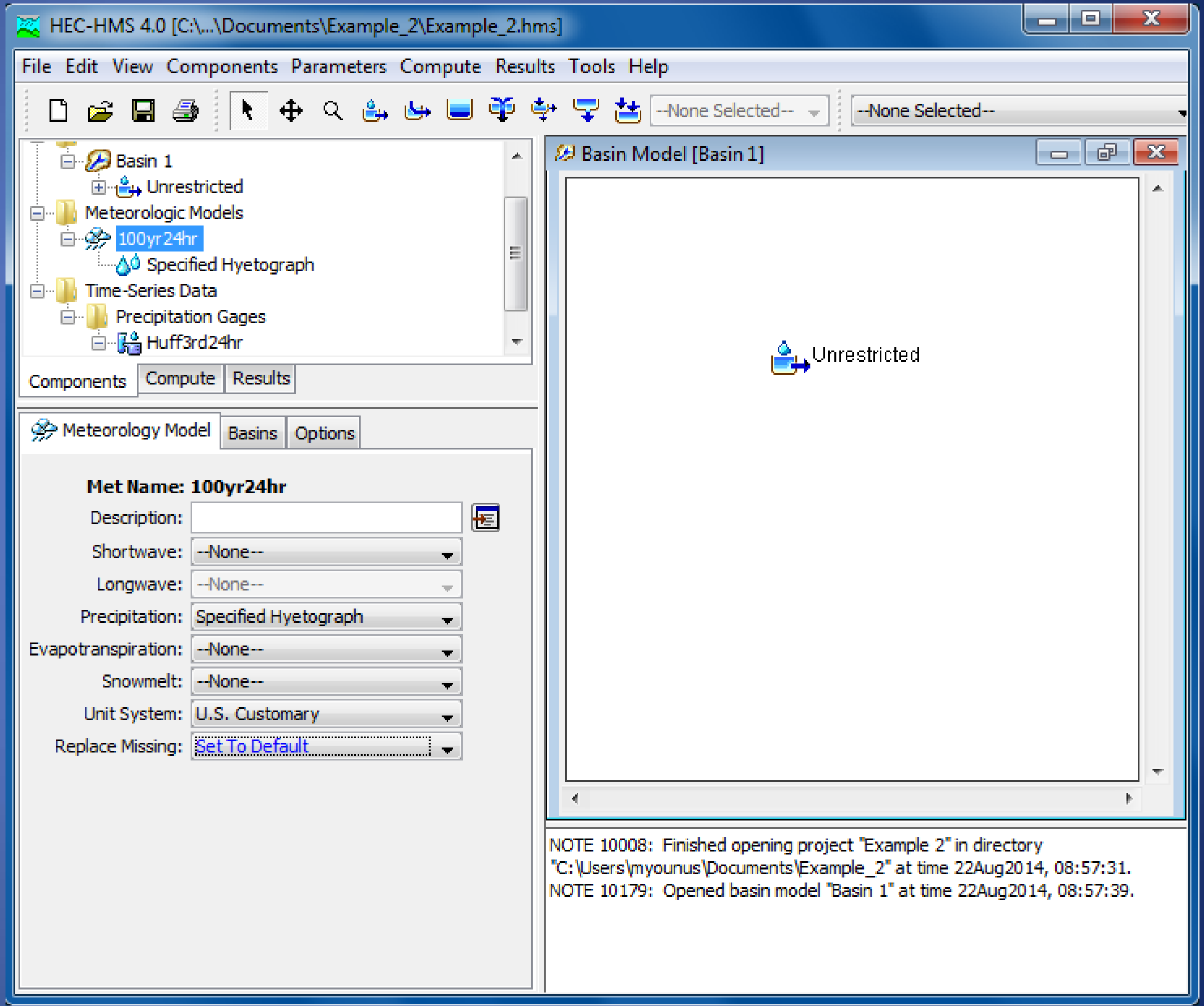
- From the ***Components*** tab, create a new ***Meteorologic Model*** named “100yr24hr”



CREATING THE METEOROLOGIC MODEL

Continue …

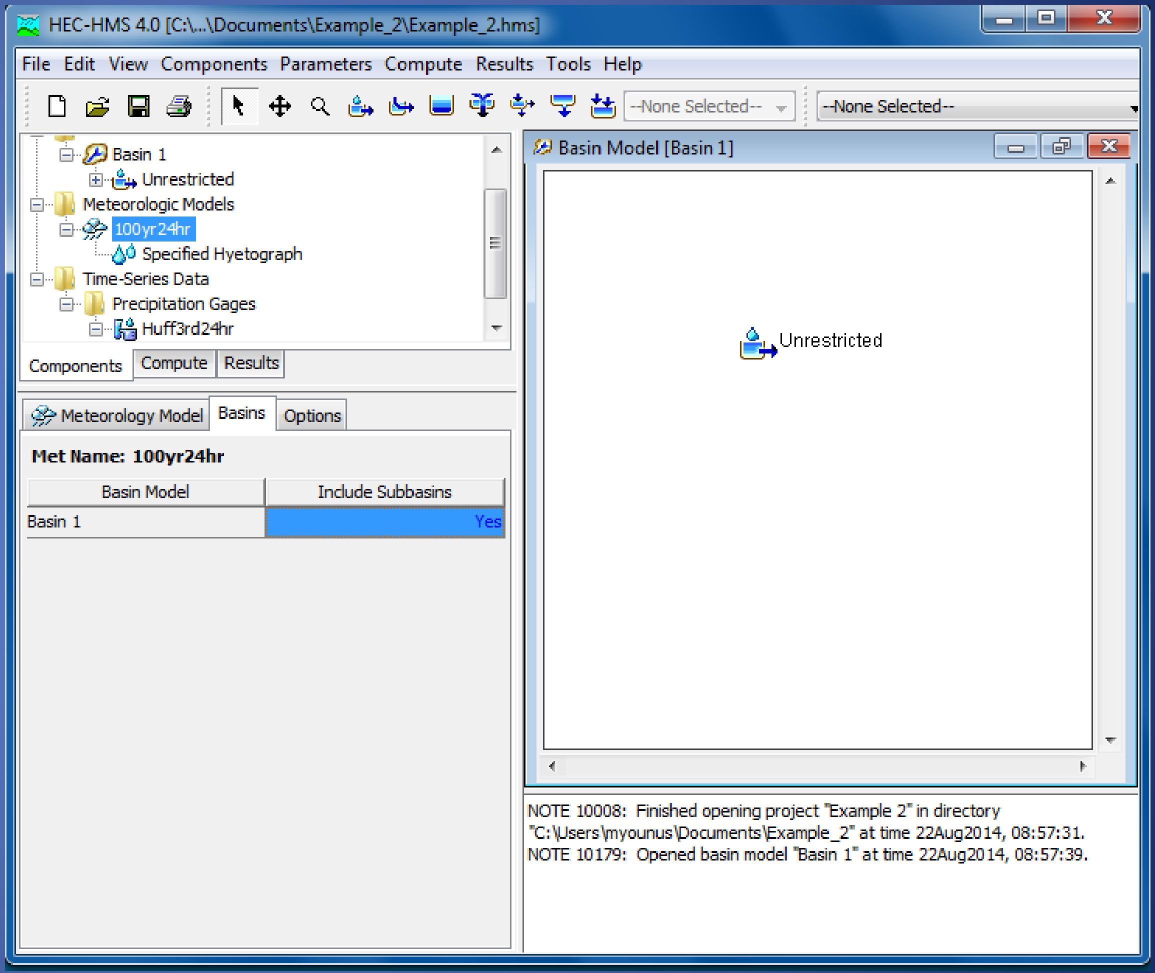
- Under the ***Meteorologic Model*** tab, make sure the ***Replace Missing*** is ***Set to Default***



CREATING THE METEOROLOGIC MODEL

Continue …

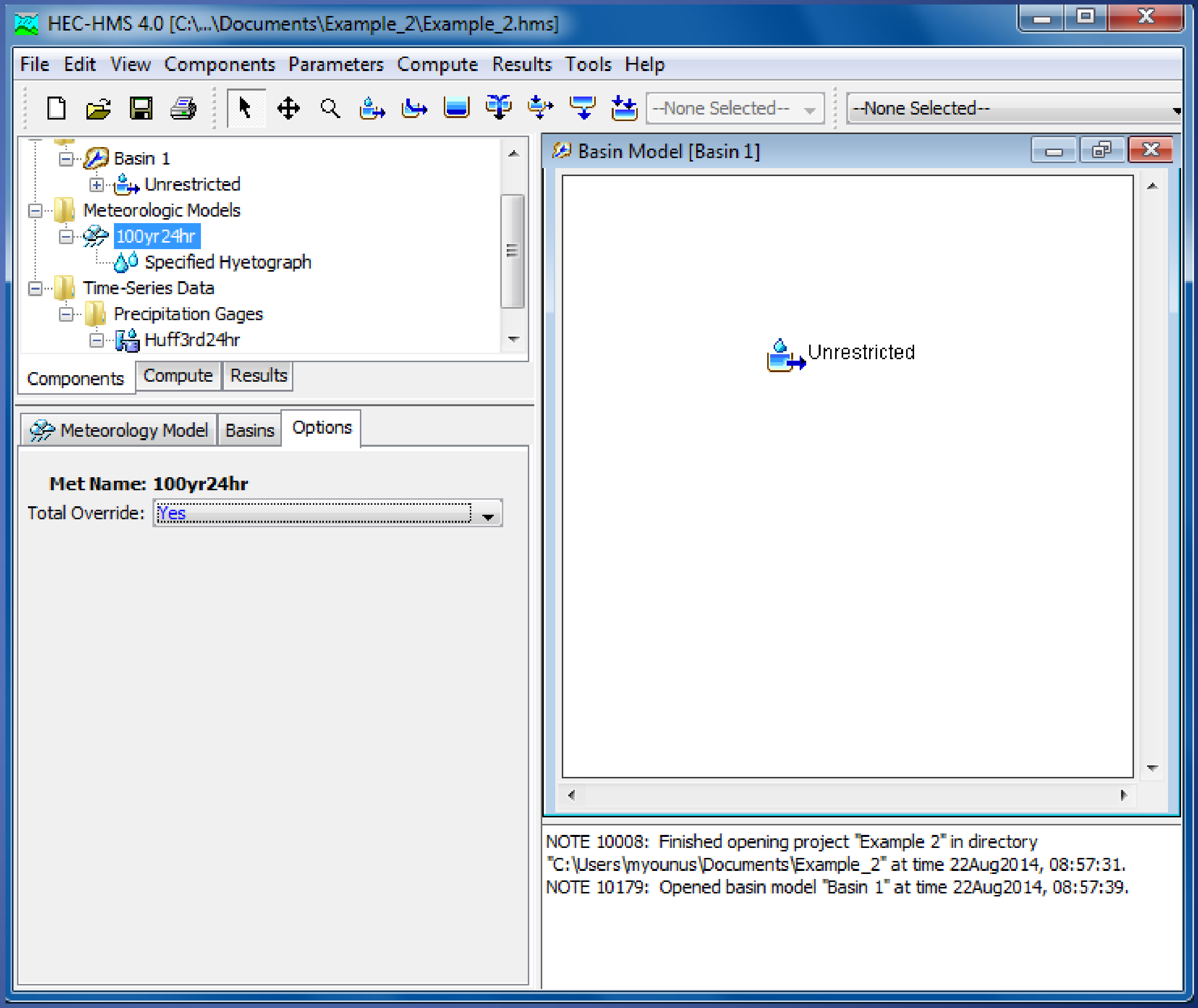
- Under the ***Basins*** tab, select ***Yes*** under ***Include Subbasins***?



CREATING THE METEOROLOGIC MODEL

Continue …

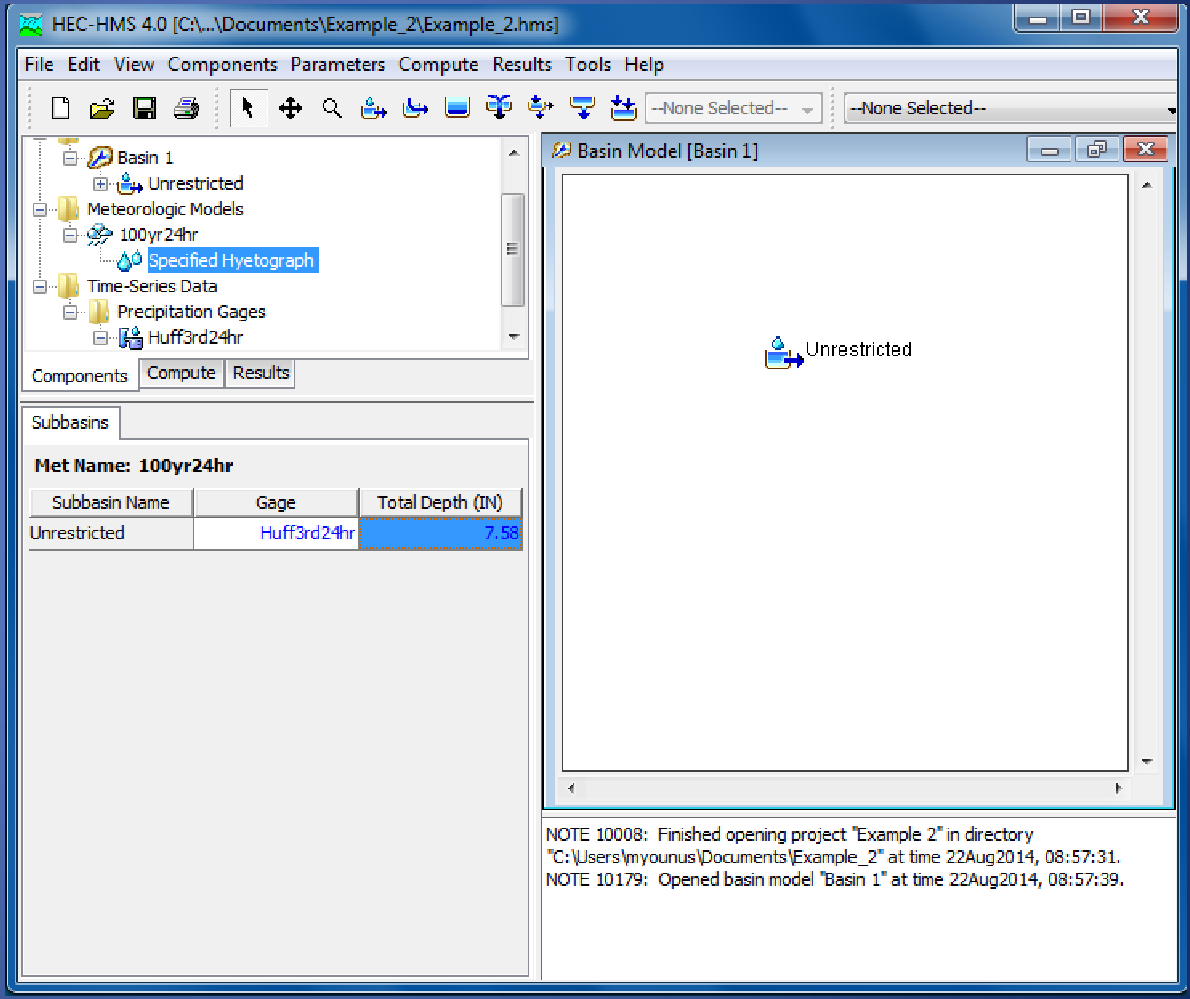
- Under the ***Options*** tab, select ***Yes*** for ***Total Override***



CREATING THE METEOROLOGIC MODEL

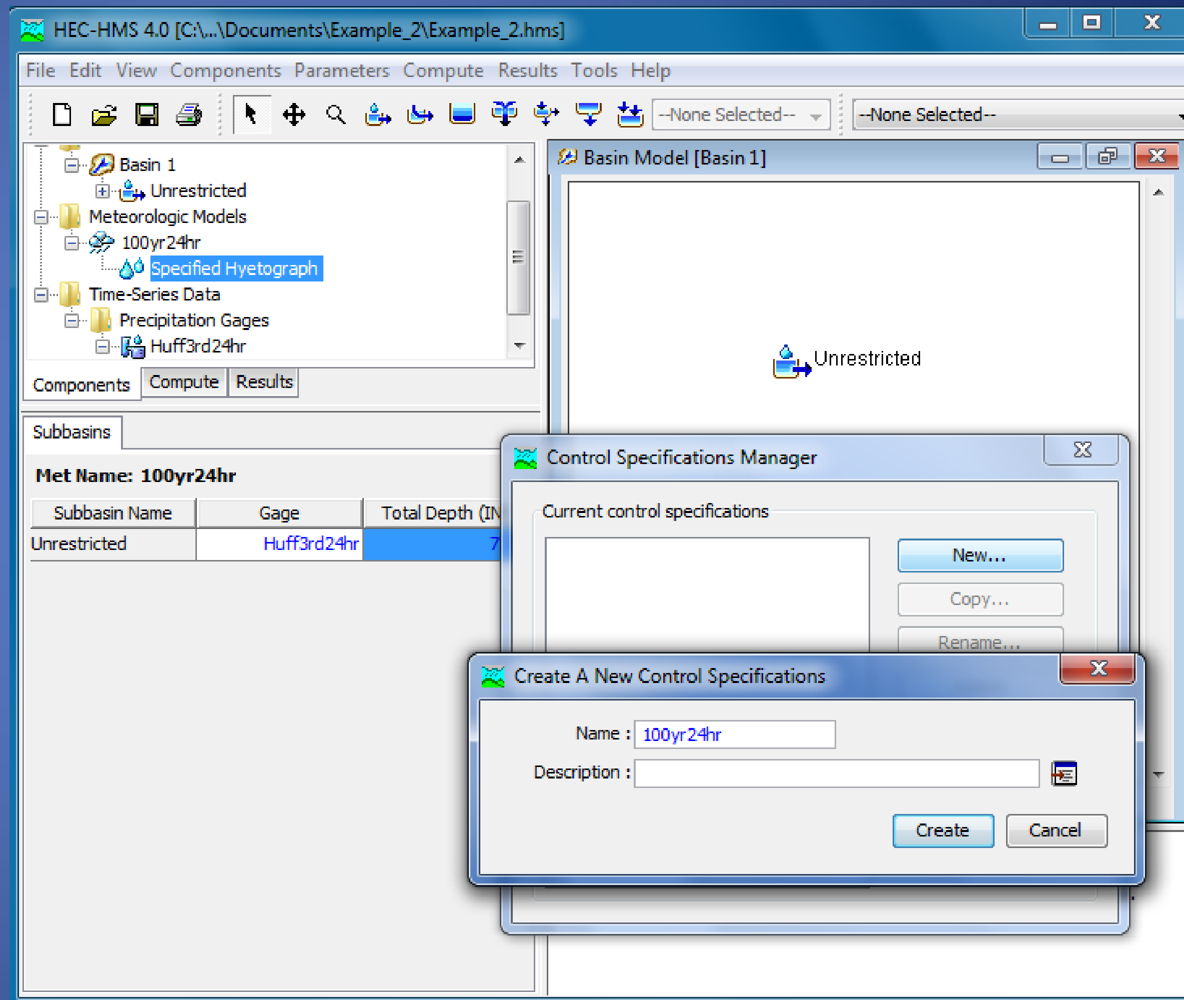
Continue …

- Under the ***Specified Hyetograph*** tab, select the rainfall distribution that we previously created and enter the 100-year, 24-hour rainfall depth.



CREATING THE CONTROL SPECIFICATIONS

- We still need the specify how long to run the model for and how often we want to see output…this is performed under the ***Control Specifications***
- Under the ***Components*** menu, select ***Control Specifications Manager*** to create a new one named “100yr24hr”

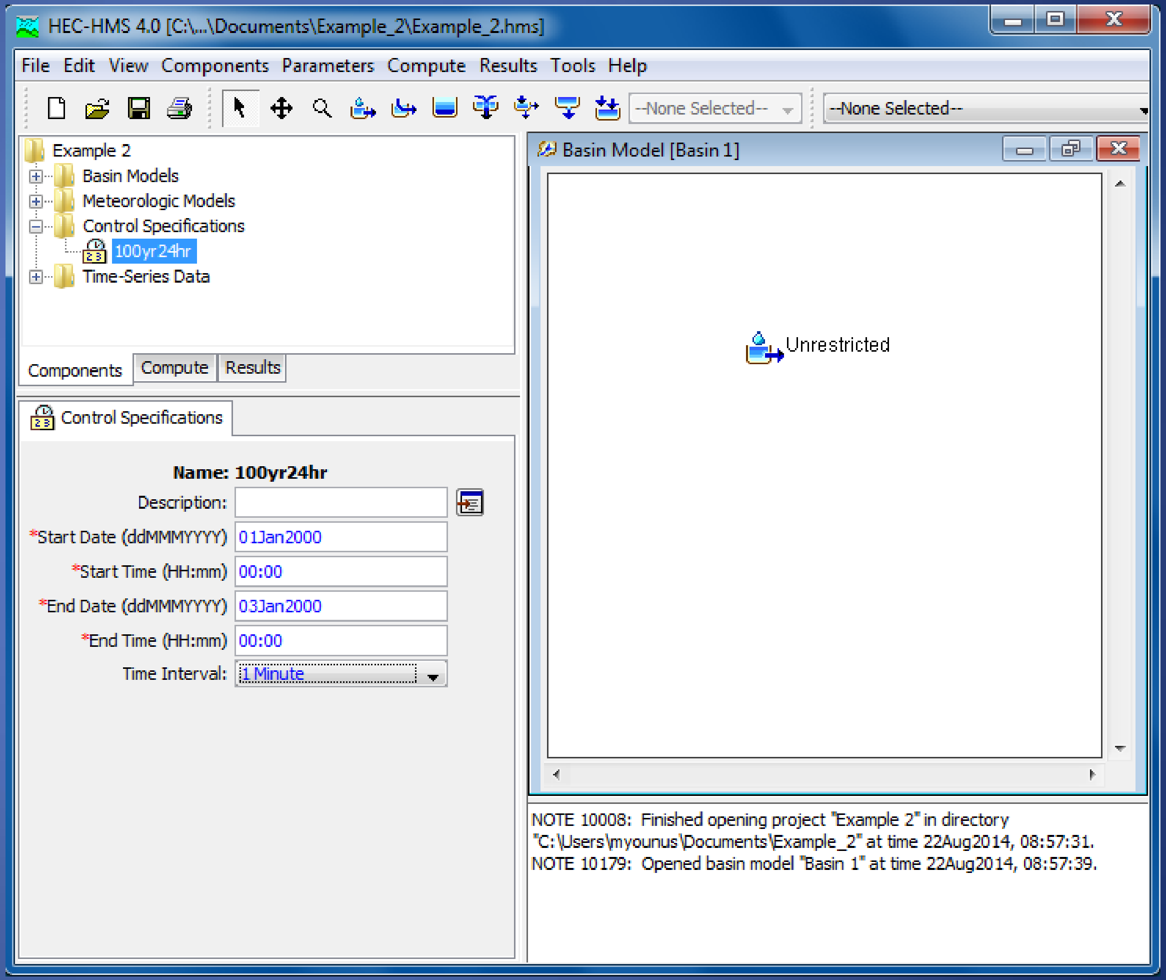


CREATING THE CONTROL SPECIFICATIONS

Continue …

- Specify 01Jan2000 through 03Jan2000 (remember we're running a 24-hour storm event)

- Under ***Time Interval***, specify 1 minute



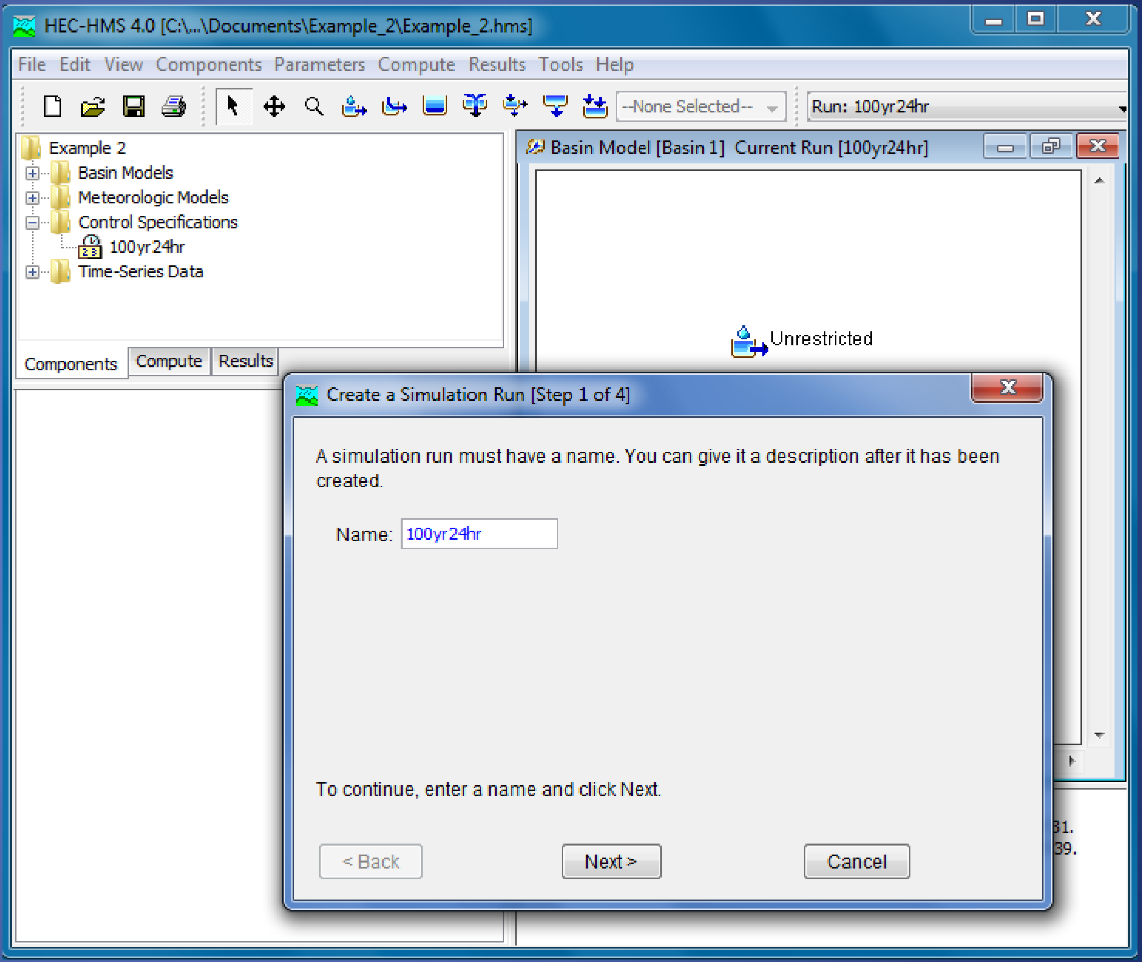
CREATING THE SIMULATION RUN

- A *Simulation Run* is a combination of:
  - ***Basin Model***
  - ***Meteorologic Model***
  - ***Control Specifications***

- To create a new *Simulation Run*, select ***Create Compute > Simulation Run*** under the ***Components*** menu

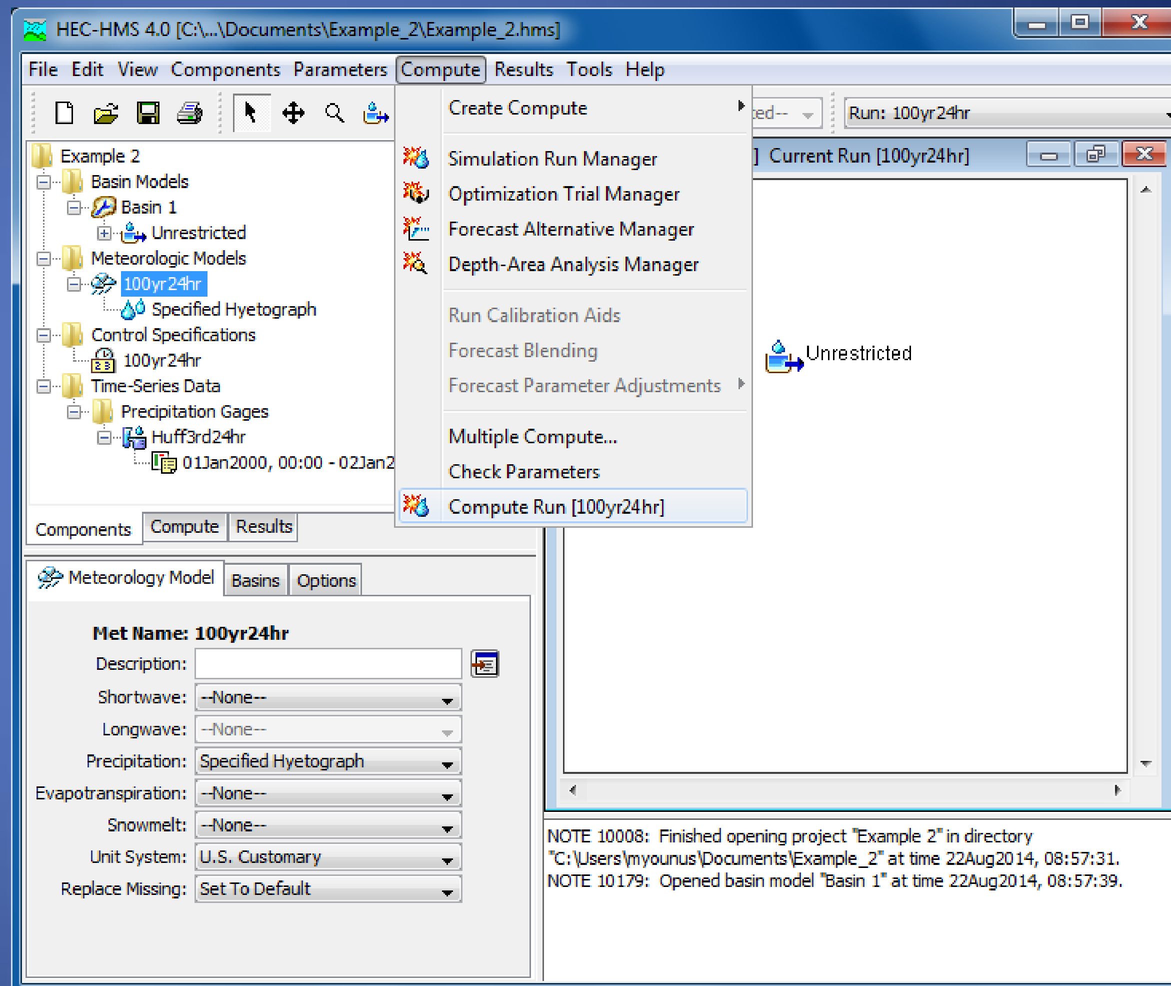
- Name the run "100yr24hr" and click ***Next***

- Specify the ***Basin Model***, ***Meteorologic Model***, and ***Control Specifications*** that we've just created



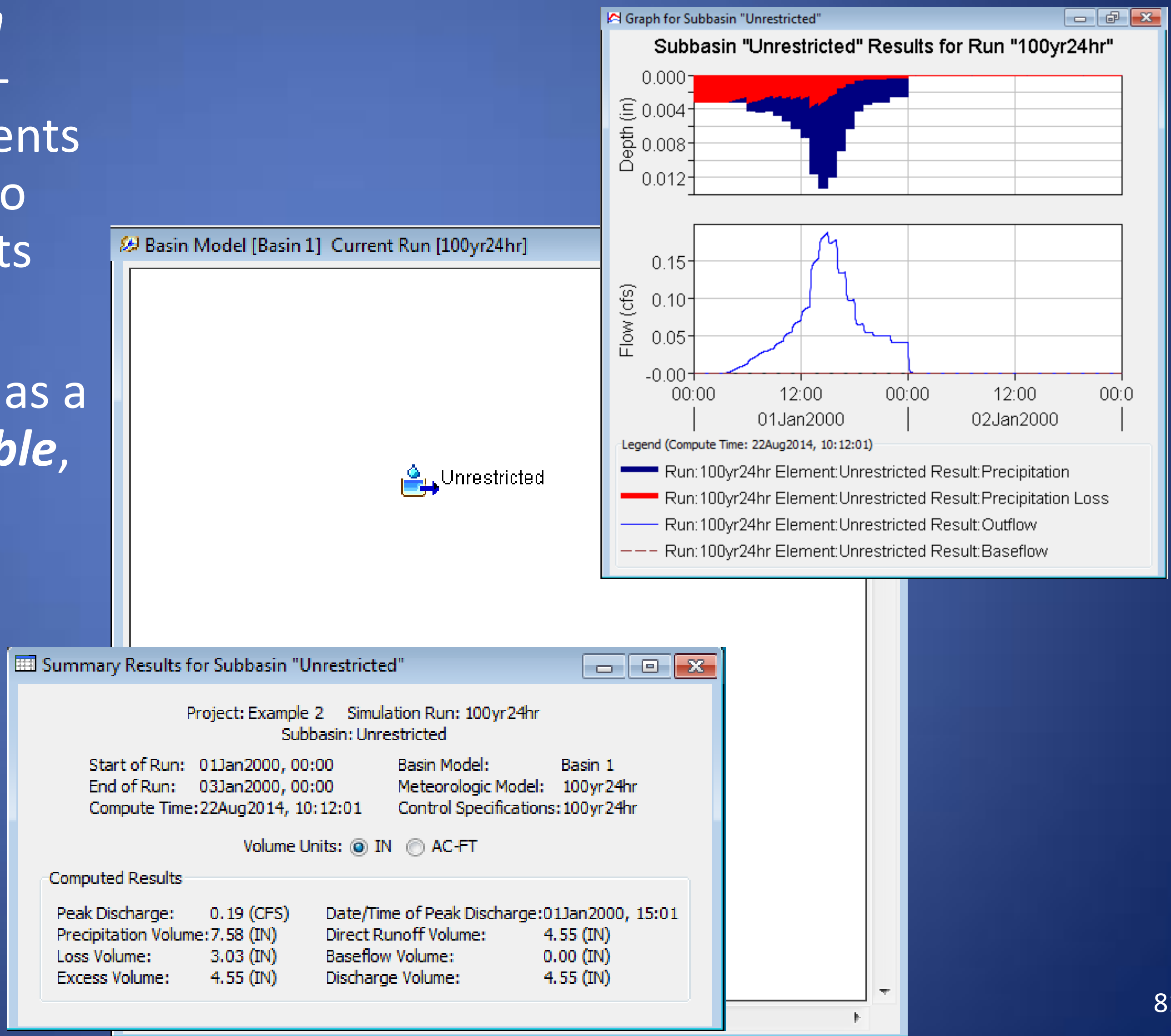
RUNNING THE SIMULATION

- Under the ***Compute*** menu, select ***Compute Run [100yr24hr]***
- All errors, warnings, and notes are shown in the lower right hand window
- If there are errors, they will show up in red and the simulation will not run successfully



VIEWING RESULTS

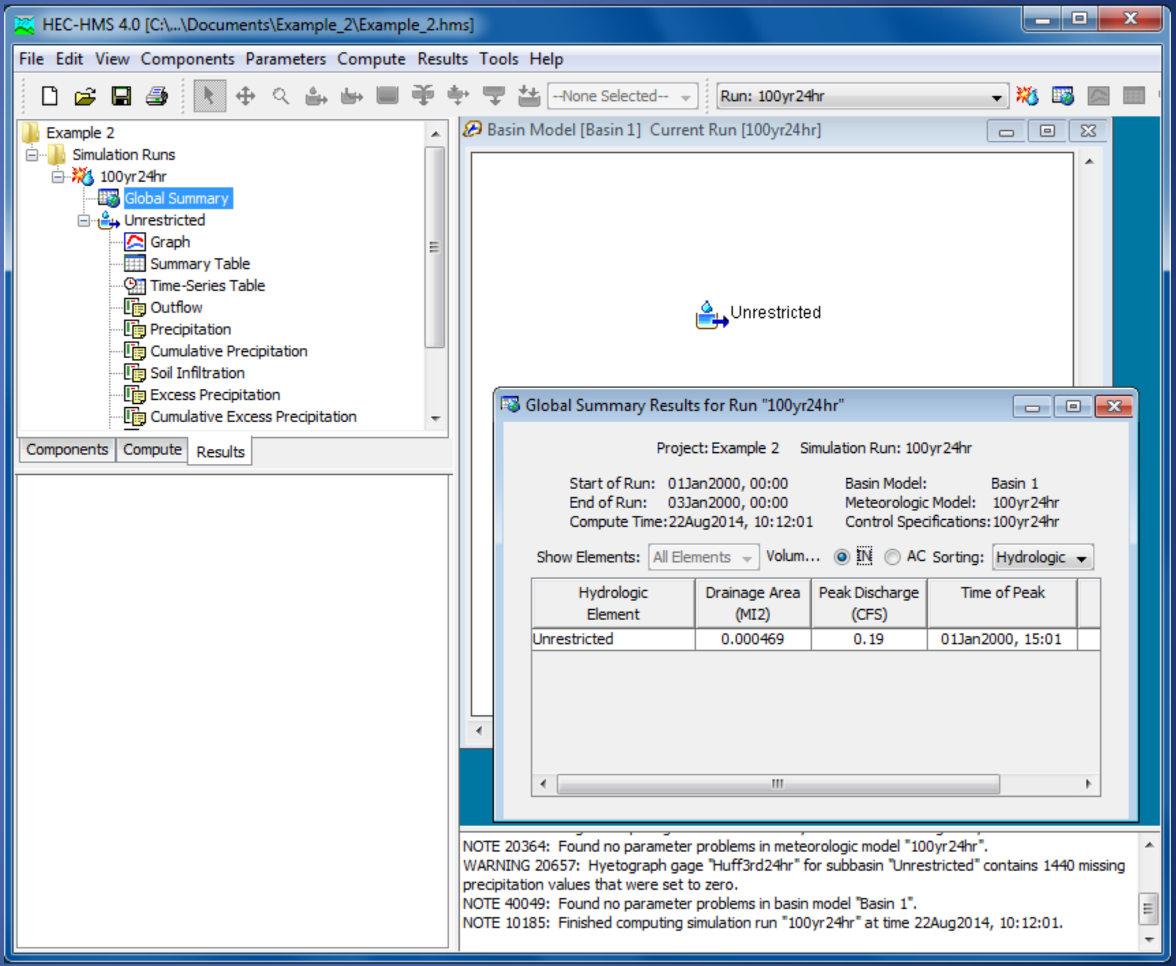
- If the *Simulation Run* was successful, right-click on the components of the ***Basin Model*** to view individual results
- Results are available as a ***Graph***, ***Summary Table***, or ***Time-Series Table***



VIEWING RESULTS

Continue…

- To view the results for all model components at once, choose ***Global Summary Table*** under the ***Results Menu***



EXAMPLE 2 – STEP 4

Determine Net Release Rate:

The unrestricted 100-yr, 24-hr flowrate for the site = 0.19 cfs

Net Release Rate = 0.3 cfs/acre X 10 acres – 0.19 cfs

= 2.81 cfs

EXAMPLE 2 – STEP 5

Adding Basin Model Components

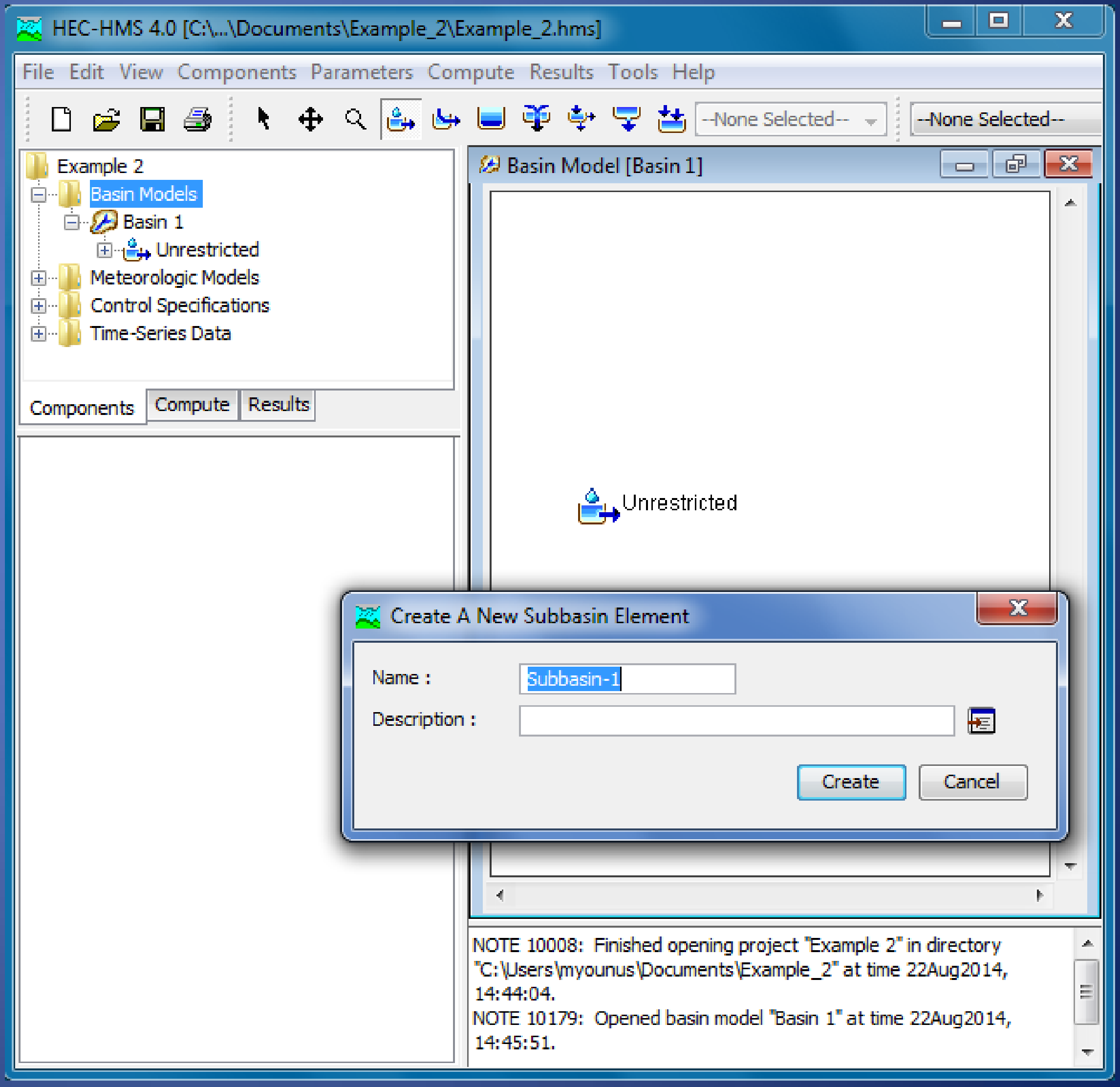
- Subbasin-1 (Project Site)
- Reservoir-1 (Detention Facility)

ADDING BASIN MODEL COMPONENTS

Subbasin: “Subbasin-1”

- Click on the ***Subbasin Creation Tool*** at the top of the screen to add a subbasin to the *Basin Model.*

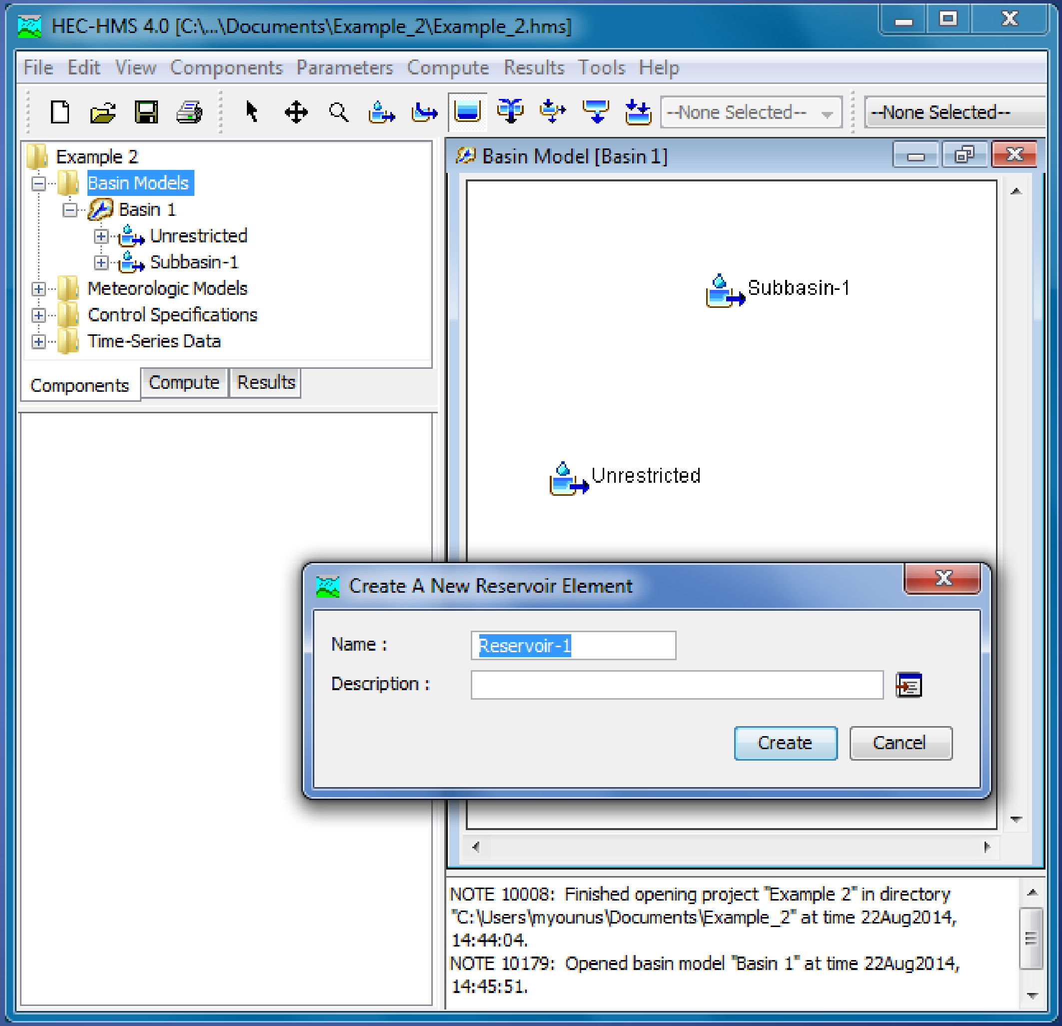
- Enter Subbasin Name as “Subbasin-1”, and click at Create.



ADDING BASIN MODEL COMPONENTS

Reservoir: “Reservoir-1”

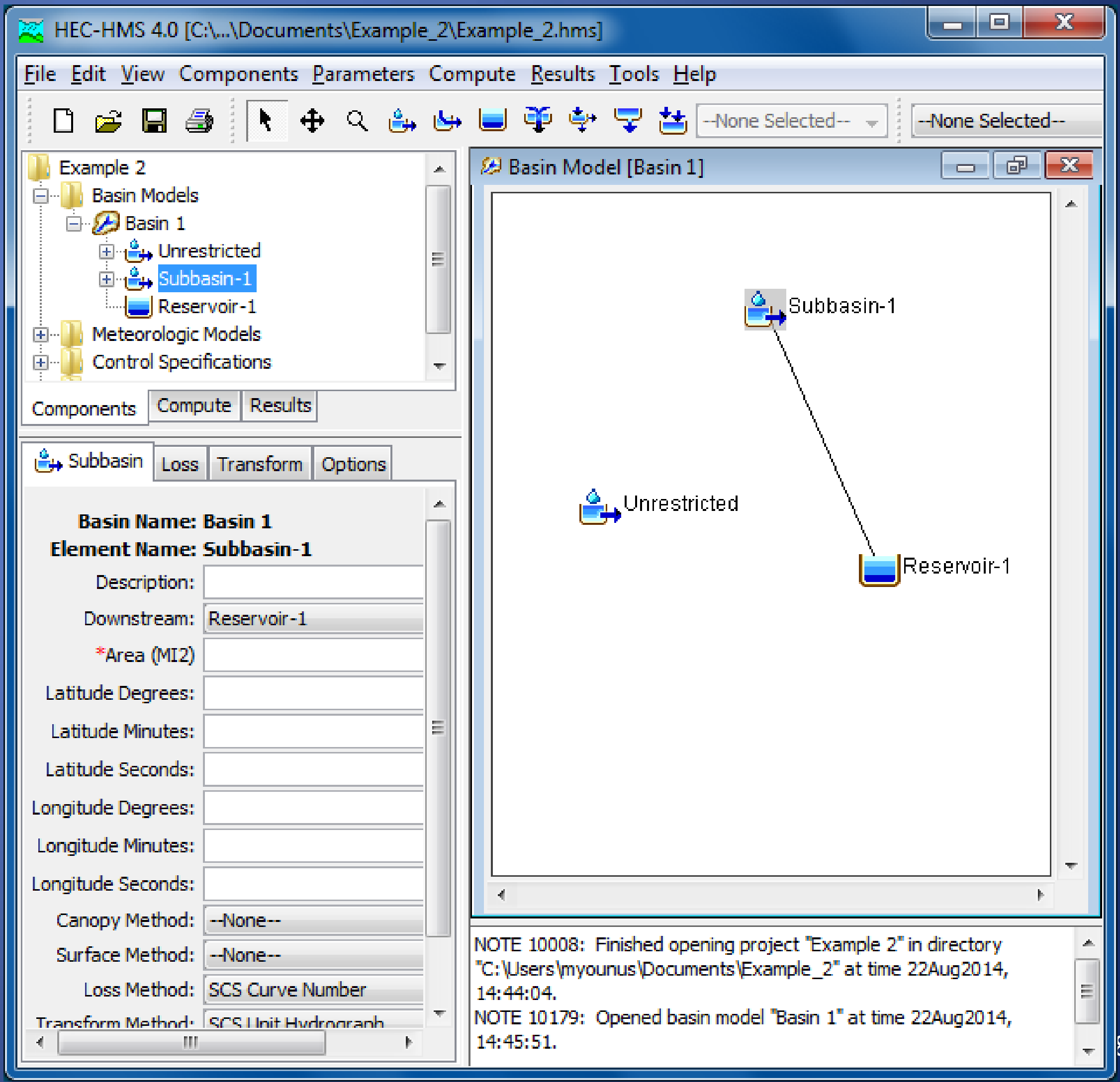
- Click on the ***Reservoir Creation Tool*** at the top of the screen to add a subbasin to the *Basin Model.*
- Enter Reservoir Name as “Reservoir -1”, and click at Create.



ADDING BASIN MODEL COMPONENTS

Connecting Subbasin-1 to Reservoir-1

- To route the subbasin through the reservoir, right-click on the subbasin and select “Connect Downstream” and click on the reservoir.

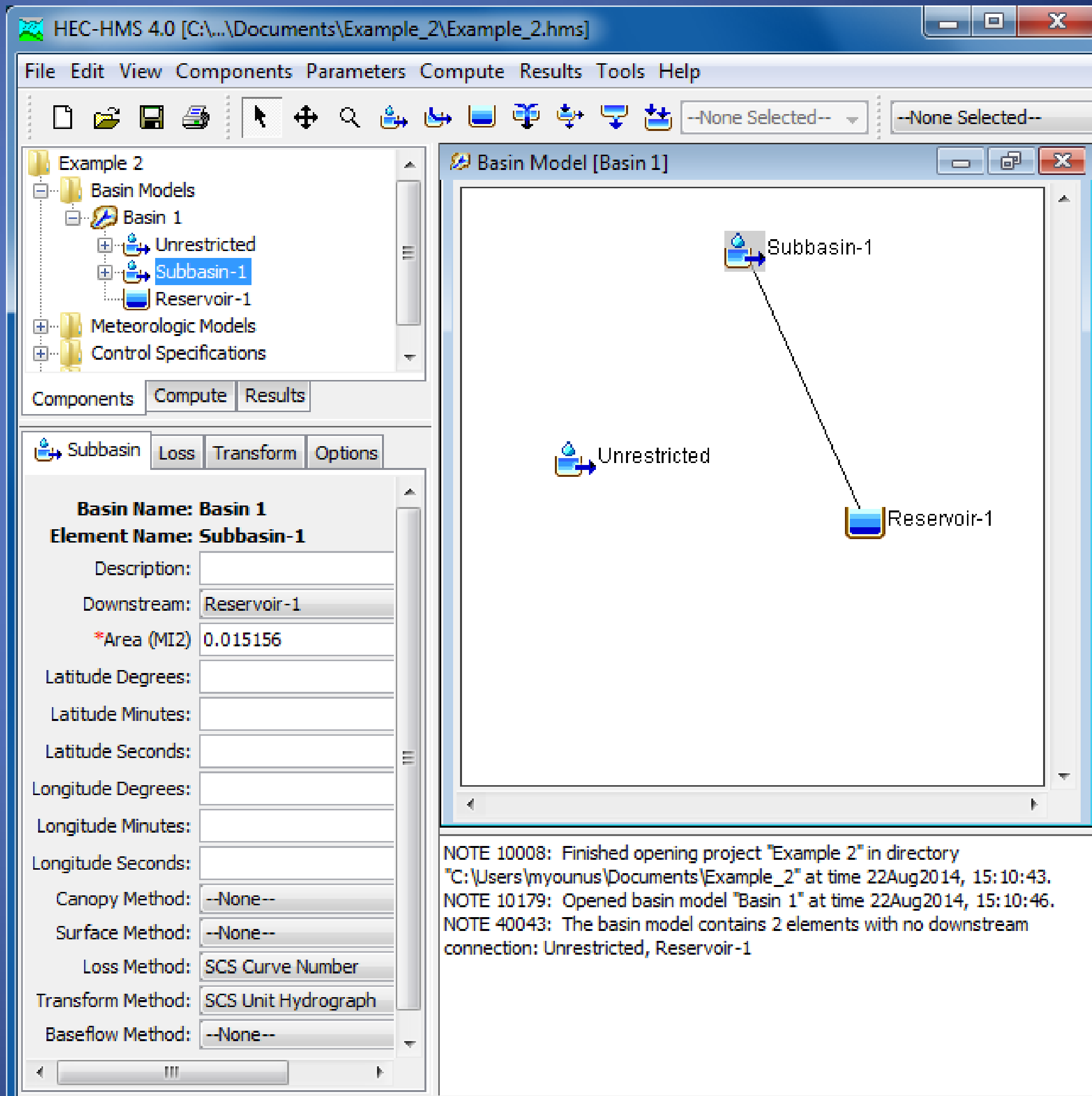


ENTERING SUBBASIN DATA

- Click on *Subbasin-1* and the data entry tabs will appear at the lower left corner

- For ***Area***, enter 0.015156 mi^2

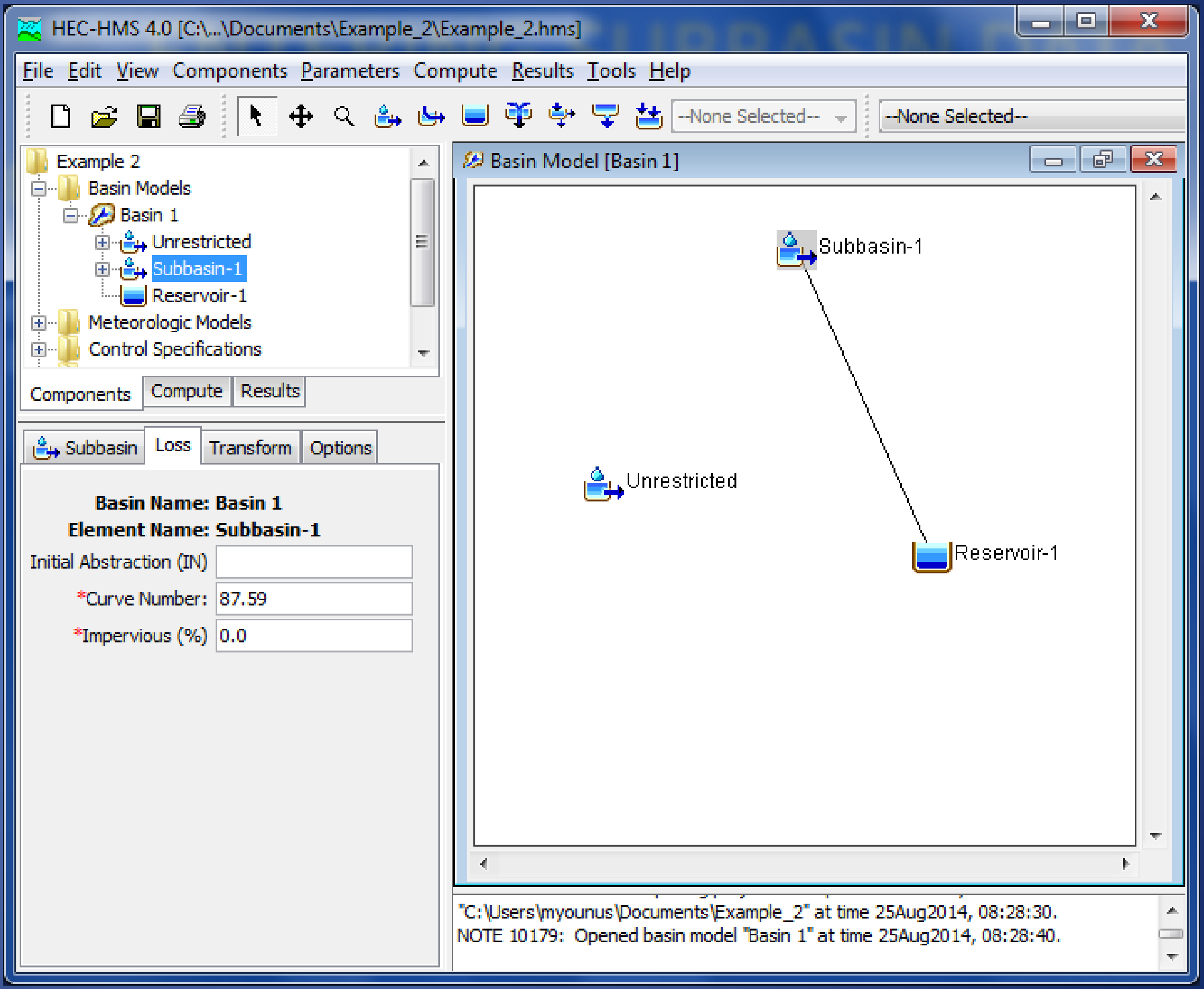
  (9.7 acres)



ENTERING SUBBASIN DATA

Continue…

- Under the ***Loss*** tab, enter the reduced CN of 87.59

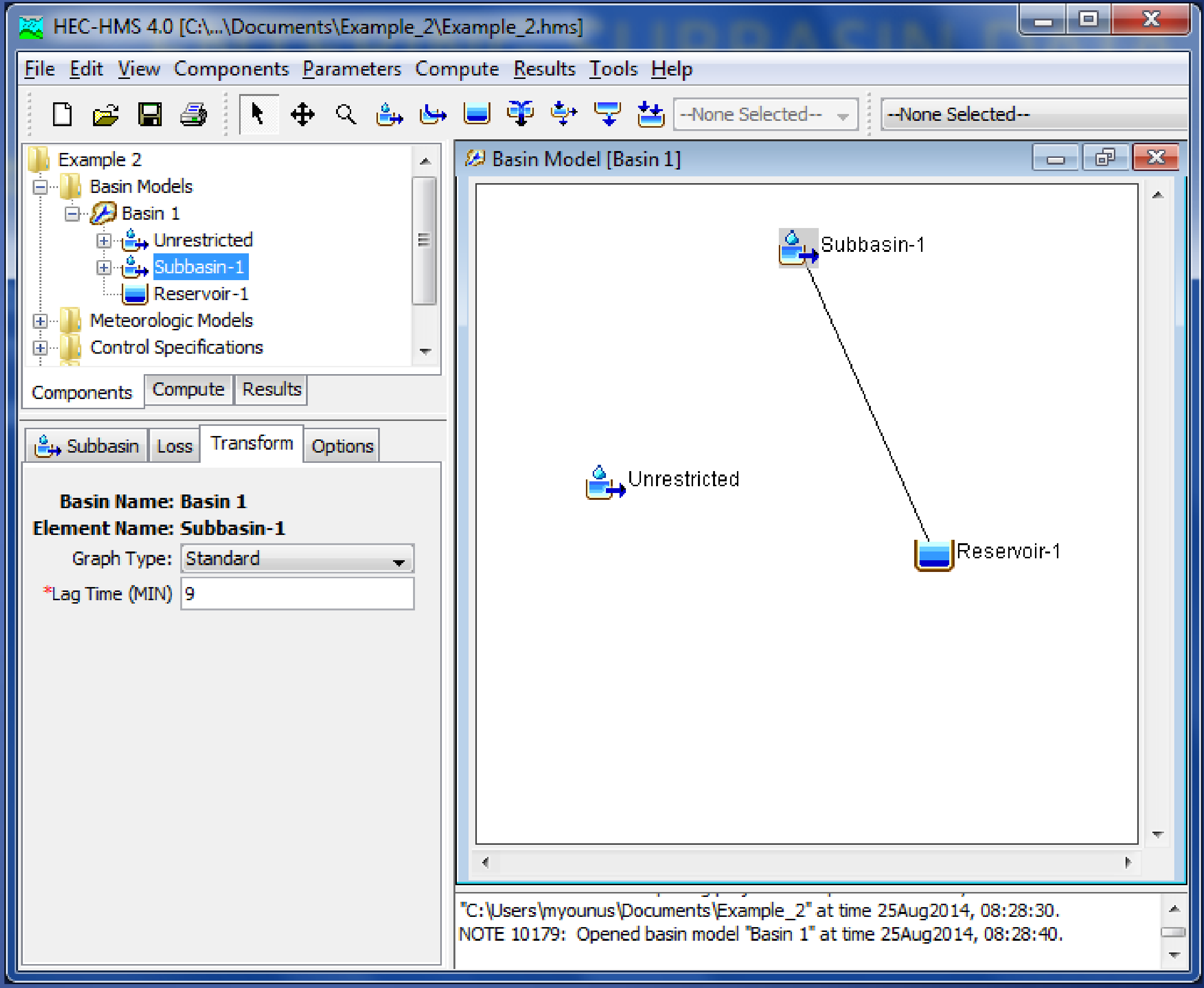


ENTERING SUBBASIN DATA

Continue …

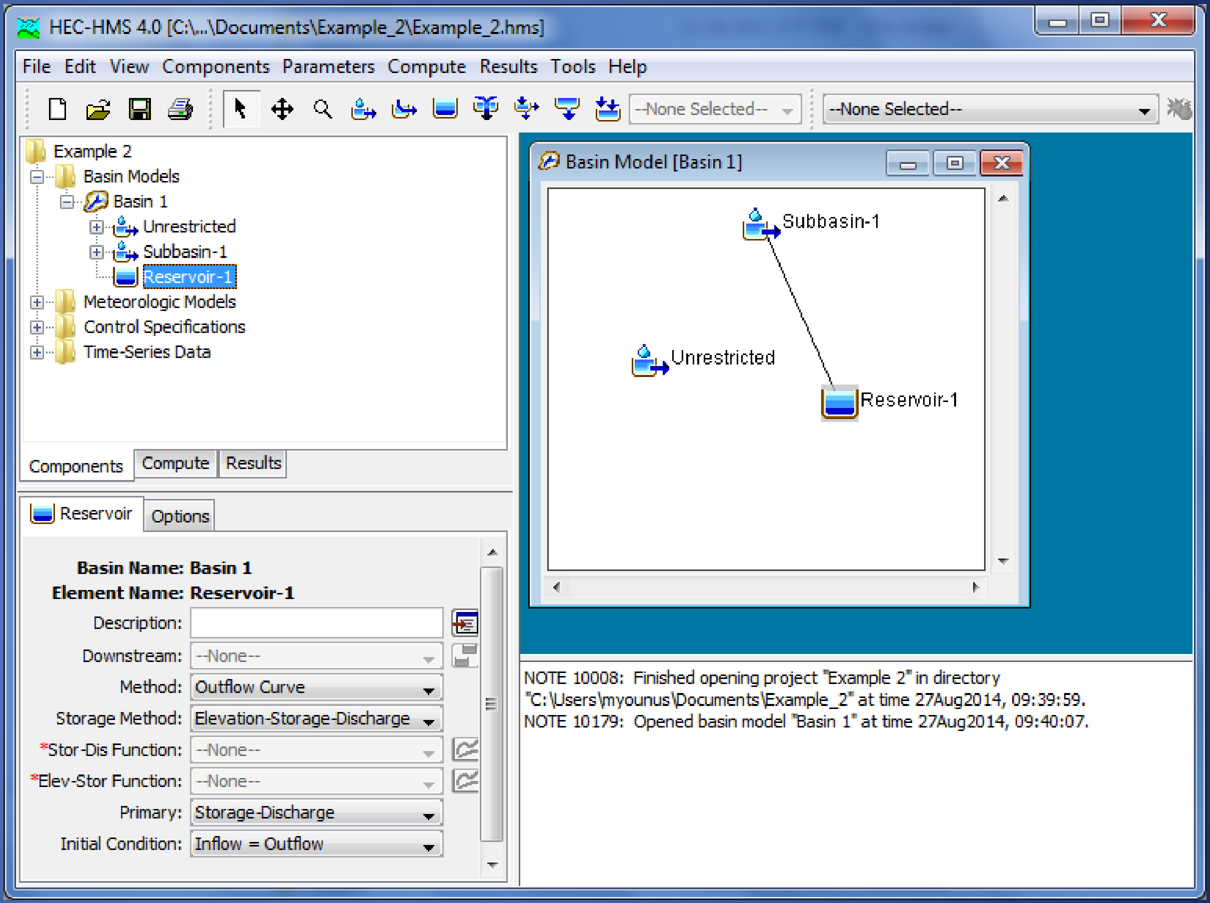
- Under the ***Transform*** tab, enter the SCS Lag time of 9 minutes

  (Lag time = 0.6 * Tc)



ENTERING RESERVOIR DATA

- Click on *Reservoir-1* and the data entry tabs will appear at the lower left corner
- For ***Method***, enter *Outflow Curve*
- For Storage Method, select *Elevation-Storage-Discharge*
- Note that the Storage-Discharge and Elevation-Storage Functions are missing. This is the next step.



ENTERING RESERVOIR DATA

- Using the spreadsheet available on the MWRD website, the following stage-discharge relationship was determined for the proposed detention basin:

Stage (ft)	Discharge (cfs)
700	0.00
701	1.09
702	1.69
703	2.13
704	2.49
705	2.81

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME: Example 2
PROJ. NO.: TGM
DESCRIPTION: Detention Basin 1
FILENAME: Orifice.xlsx
DATE: 22-Aug-14

OUTLET:

ORIFICE:	6.96	IN. DIA. @ ELEV		700
WEIR:	12	FEET WIDE	@ ELEV	705

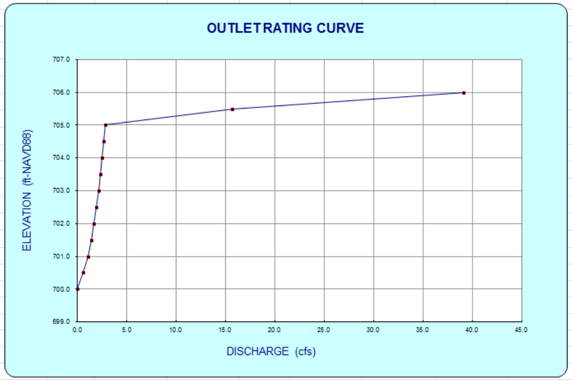
ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.2642
ORIFICE DIAMETER (in)	6.96
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	700.00
TAILWATER OR CENTROID (ft-NAVD88)	700.290
WEIR LENGTH (ft)	12.00
WEIR COEFFICIENT	3.0
WEIR ELEV. (ft-NAVD88)	705.0

ELEVATION-DISCHARGE RELATIONSHIP

Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
700.0	0.00	0.00	0.00
700.5	0.59	0.00	0.59
701.0	1.09	0.00	1.09
701.5	1.42	0.00	1.42
702.0	1.69	0.00	1.69
702.5	1.92	0.00	1.92
703.0	2.13	0.00	2.13
703.5	2.32	0.00	2.32
704.0	2.49	0.00	2.49
704.5	2.65	0.00	2.65
705.0	2.81	0.00	2.81
705.5	2.95	12.73	15.68
706.0	3.09	36.00	39.09



ENTERING RESERVOIR DATA

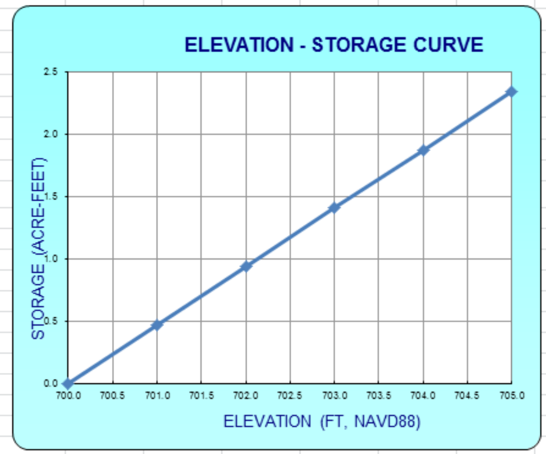
- Using the spreadsheet available on the MWRD website, the following stage-storage relationship was determined for the proposed detention basin:

Stage (ft)	Storage (ac-ft)
700	0.00
701	0.47
702	0.94
703	1.41
704	1.88
705	2.35

POND: Pond 1
JOB NO. TGM
PROJECT: Example 2
FILE: Storage.xls
DATE: 8/22/2014

Side Slopes
1
4

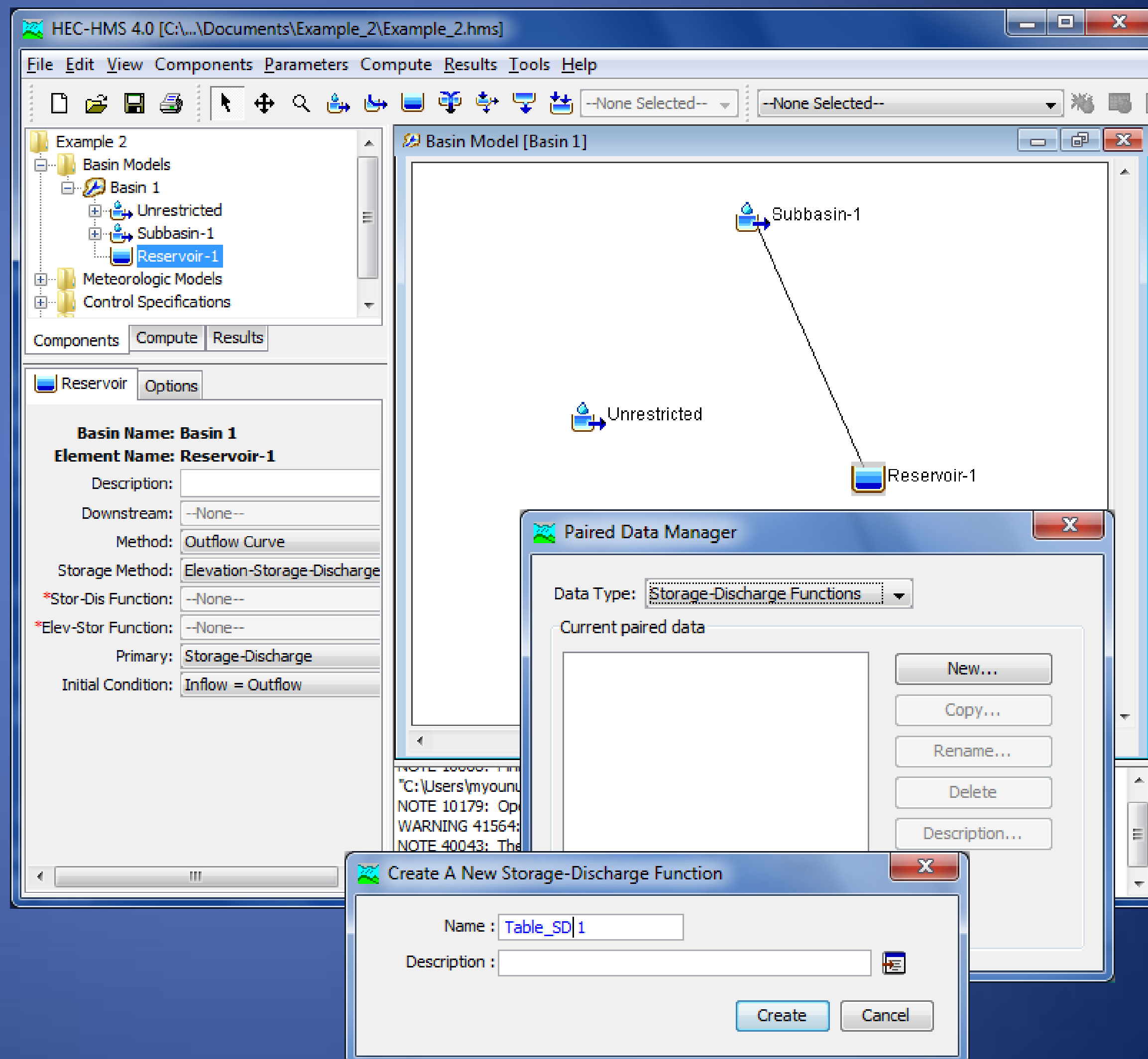
Elevation (ft)	Area (ft^2)	Area (ac)	Average Area (ac)	Incremental Storage (ac-ft)	Cummulative Storage (ac-ft)
700.00	6,120	0.470			0.000
			0.470	0.47	
701.00	7,436	0.470			0.47
			0.470	0.47	
702.00	8,879	0.470			0.94
			0.470	0.47	
703.00	10,451	0.470			1.41
			0.470	0.47	
704.00	12,151	0.470			1.88
			0.470	0.47	
705.00	13,978	0.470			2.35



Elevation (ft, NAVD88)	Storage (ac-ft)
700.00	0.000
701.00	0.47
702.00	0.94
703.00	1.41
704.00	1.88
705.00	2.35

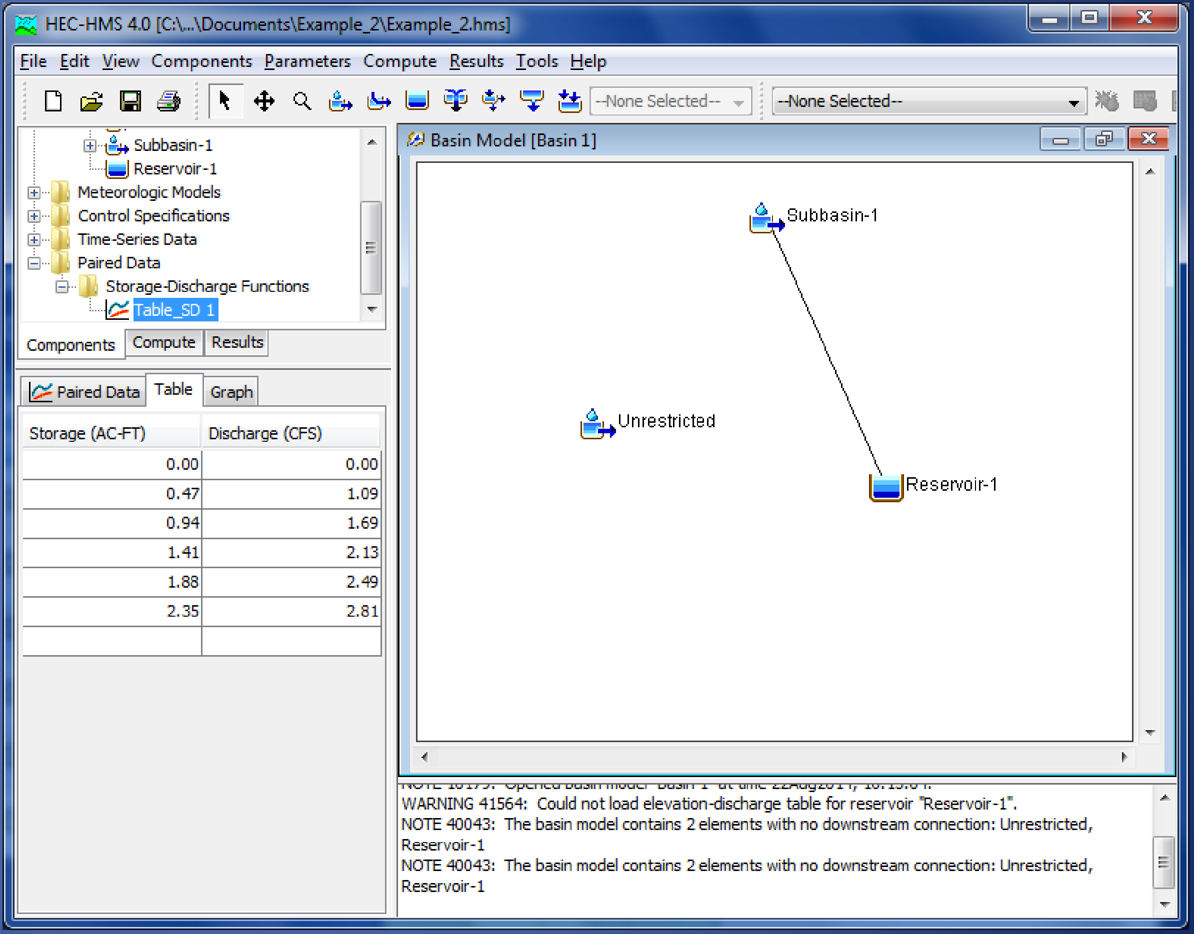
ENTERING RESERVOIR DATA

- Under the ***Components*** tab, select ***Paired Data Manager***
- Add a new *Storage-Discharge*. Enter Name as “Table_SD 1”



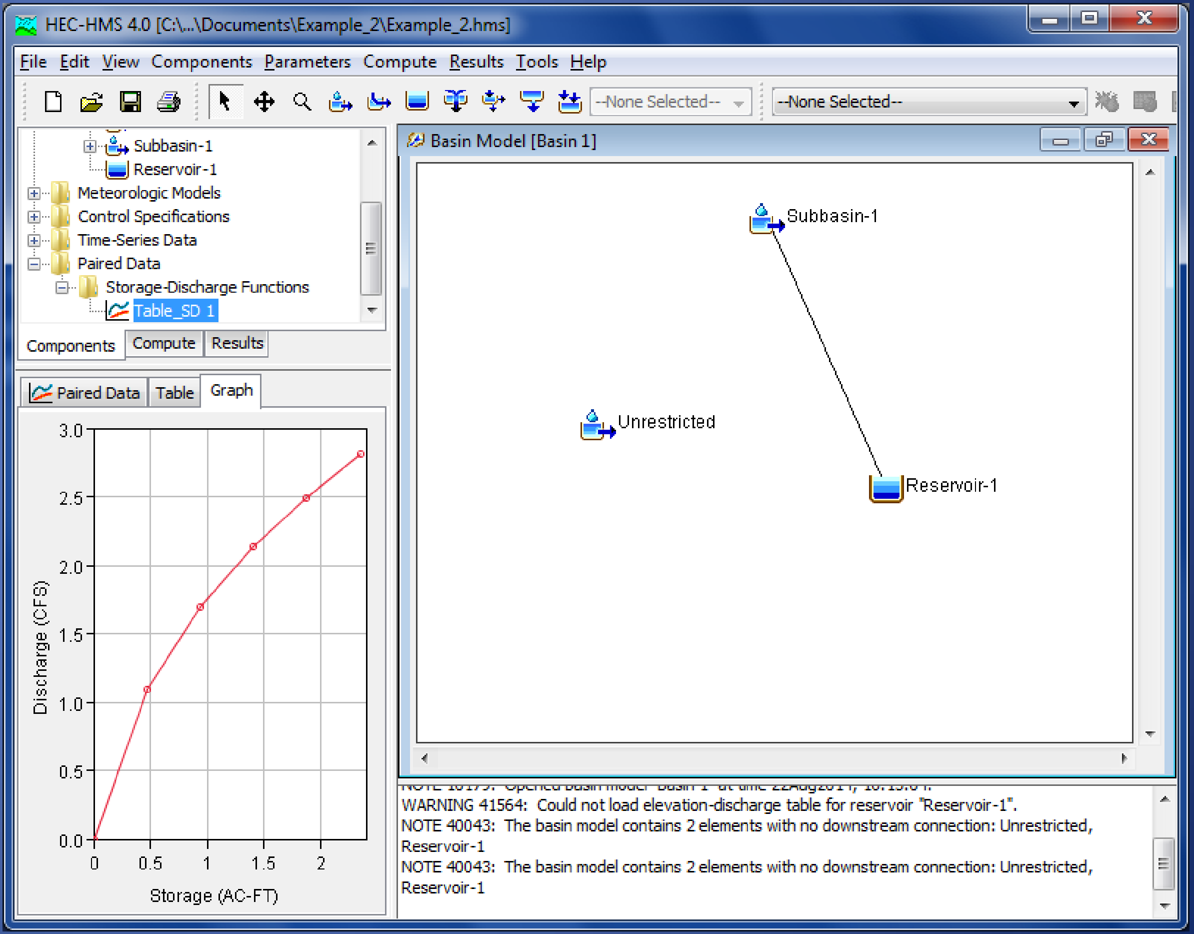
ENTERING RESERVOIR DATA

- Under the ***Table*** tab, enter the appropriate Storage-Discharge values



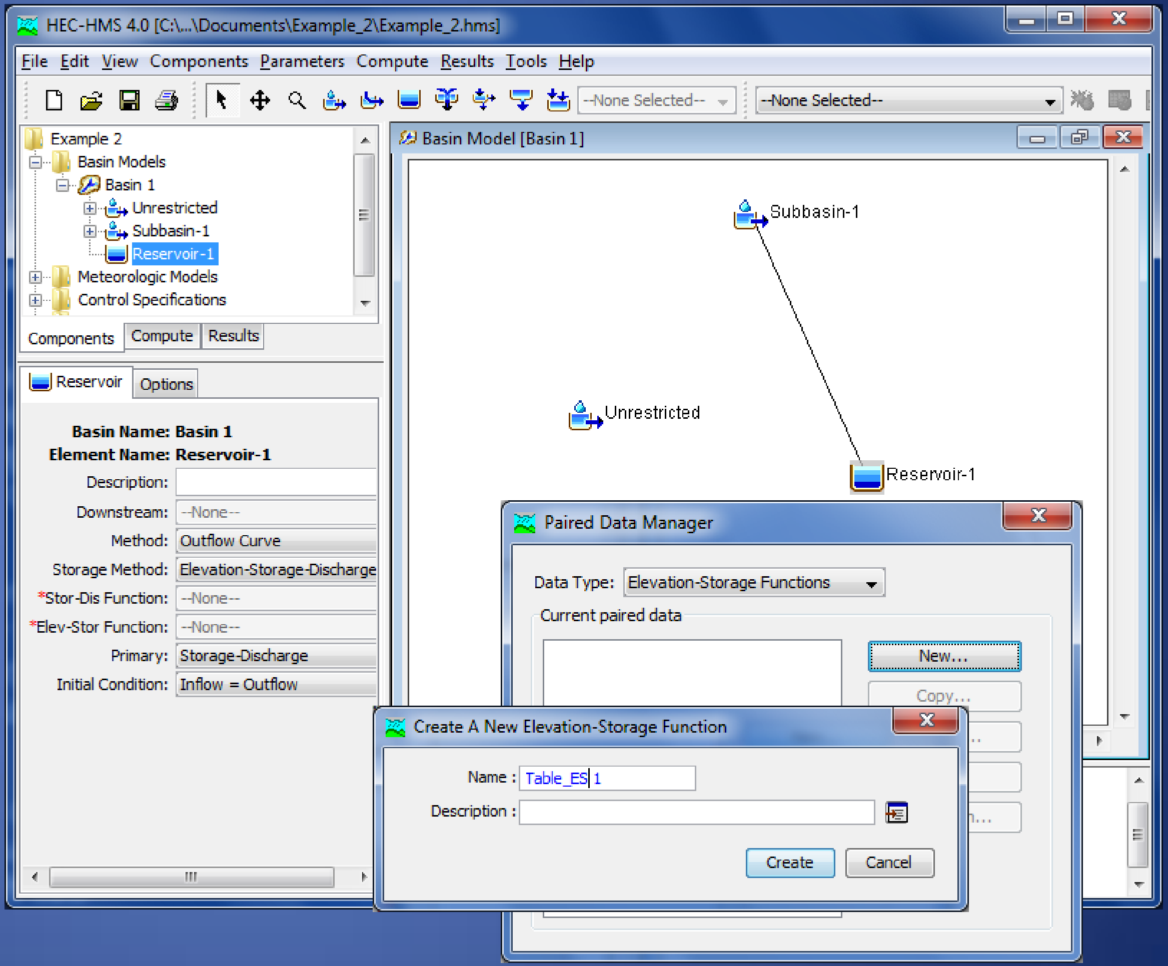
ENTERING RESERVOIR DATA

- Plots of the relationships are available under the ***Graph*** tab



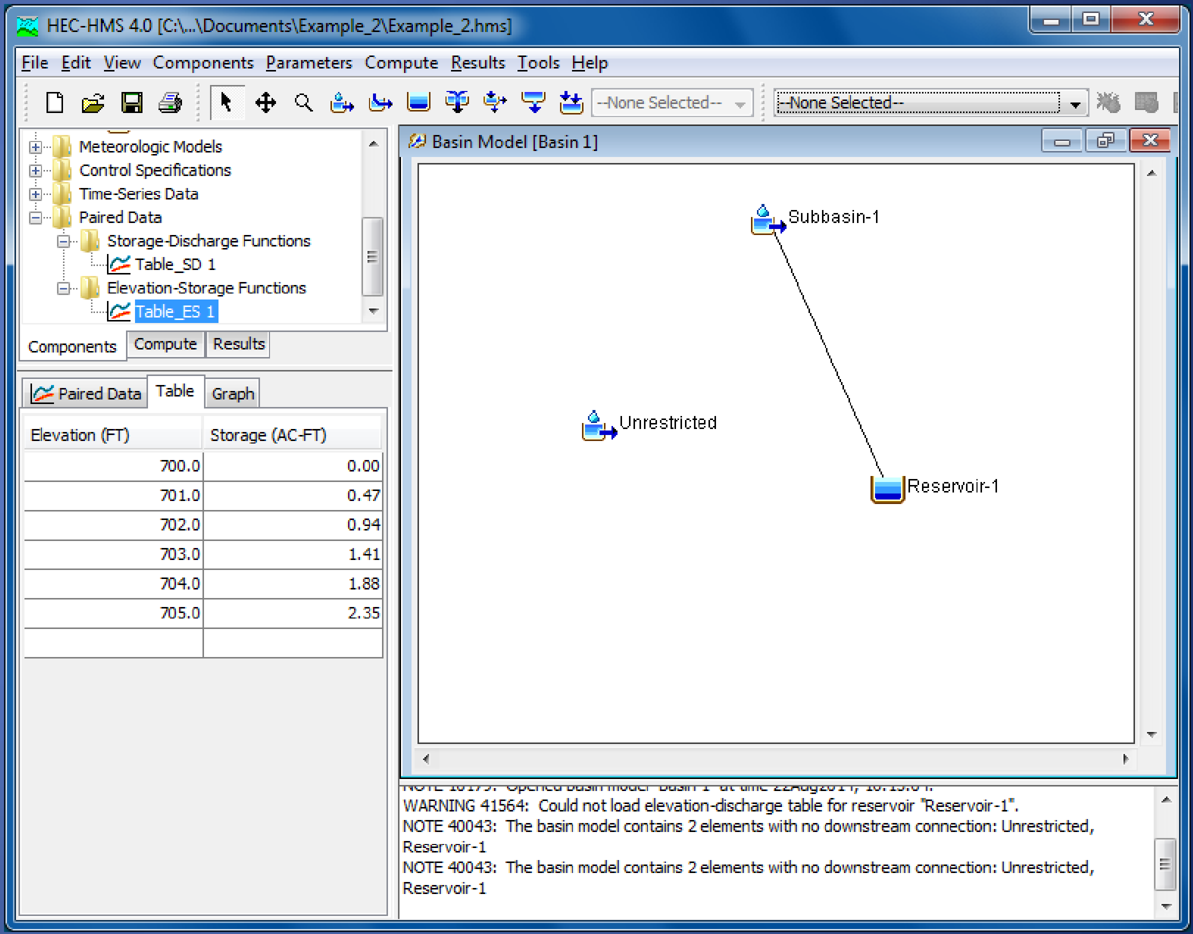
ENTERING RESERVOIR DATA

- Under the ***Components*** tab, select ***Paired Data Manager***
- Add a new *Elevation-Storage* function. Enter Name as“Table_ES 1”



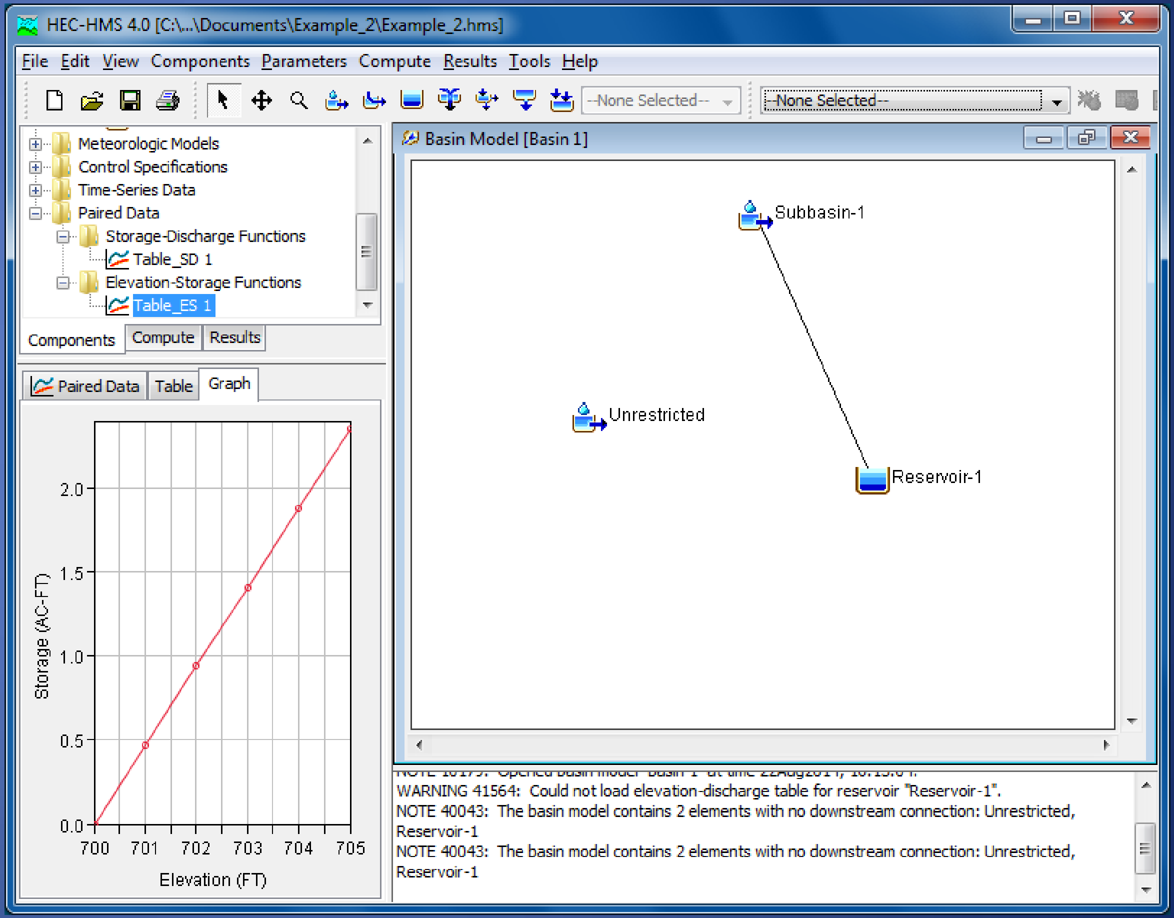
ENTERING RESERVOIR DATA

- Under the ***Table*** tab, enter the appropriate elevation-storage values



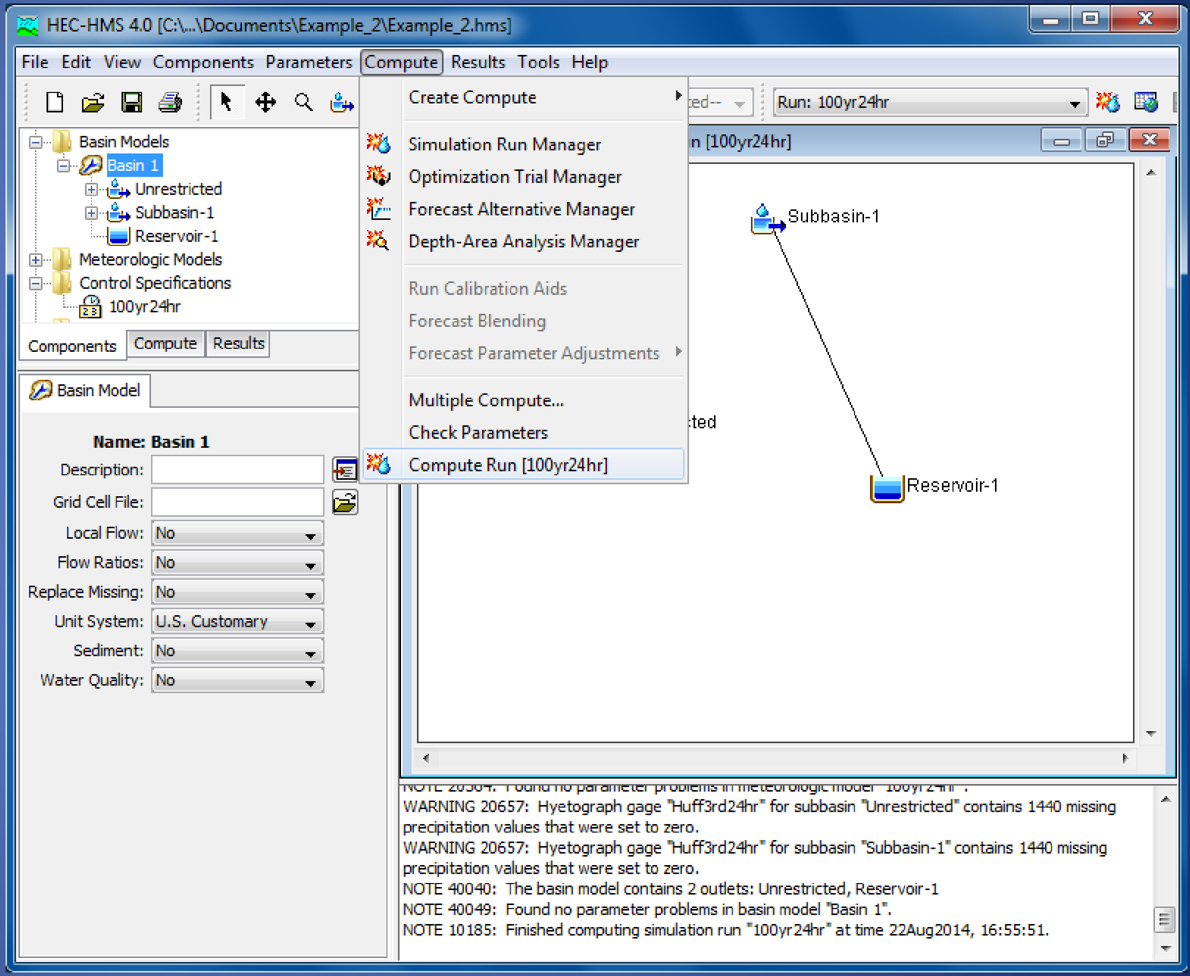
ENTERING RESERVOIR DATA

- Plots of the relationships are available under the ***Graph*** tab



RUNNING THE SIMULATION

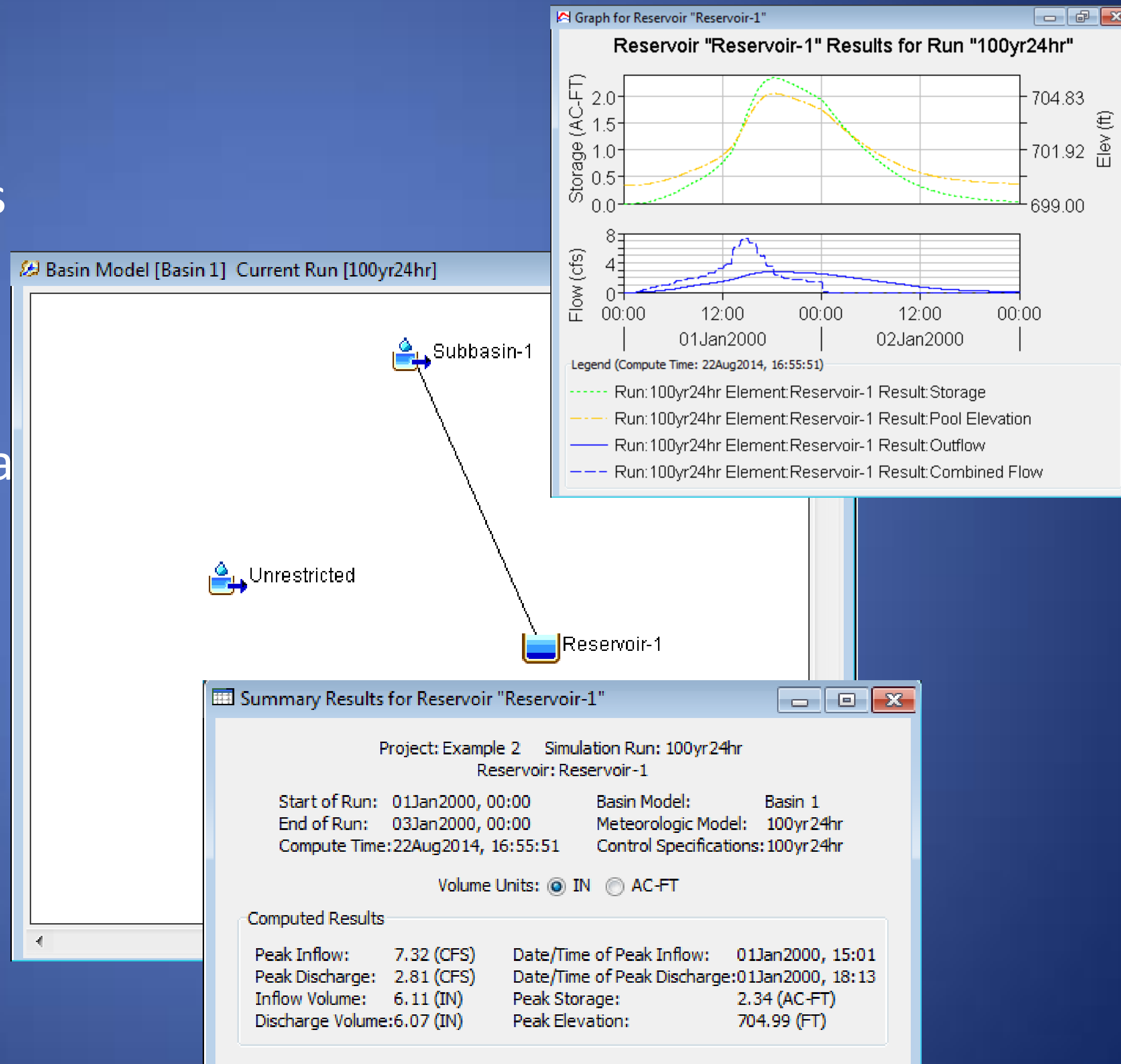
- Under the ***Compute*** menu, select ***Compute Run [100yr24hr]***
- All errors, warnings, and notes are shown in the lower right hand window
- If there are errors, they will show up in red and the simulation will not run successfully



VIEWING RESULTS

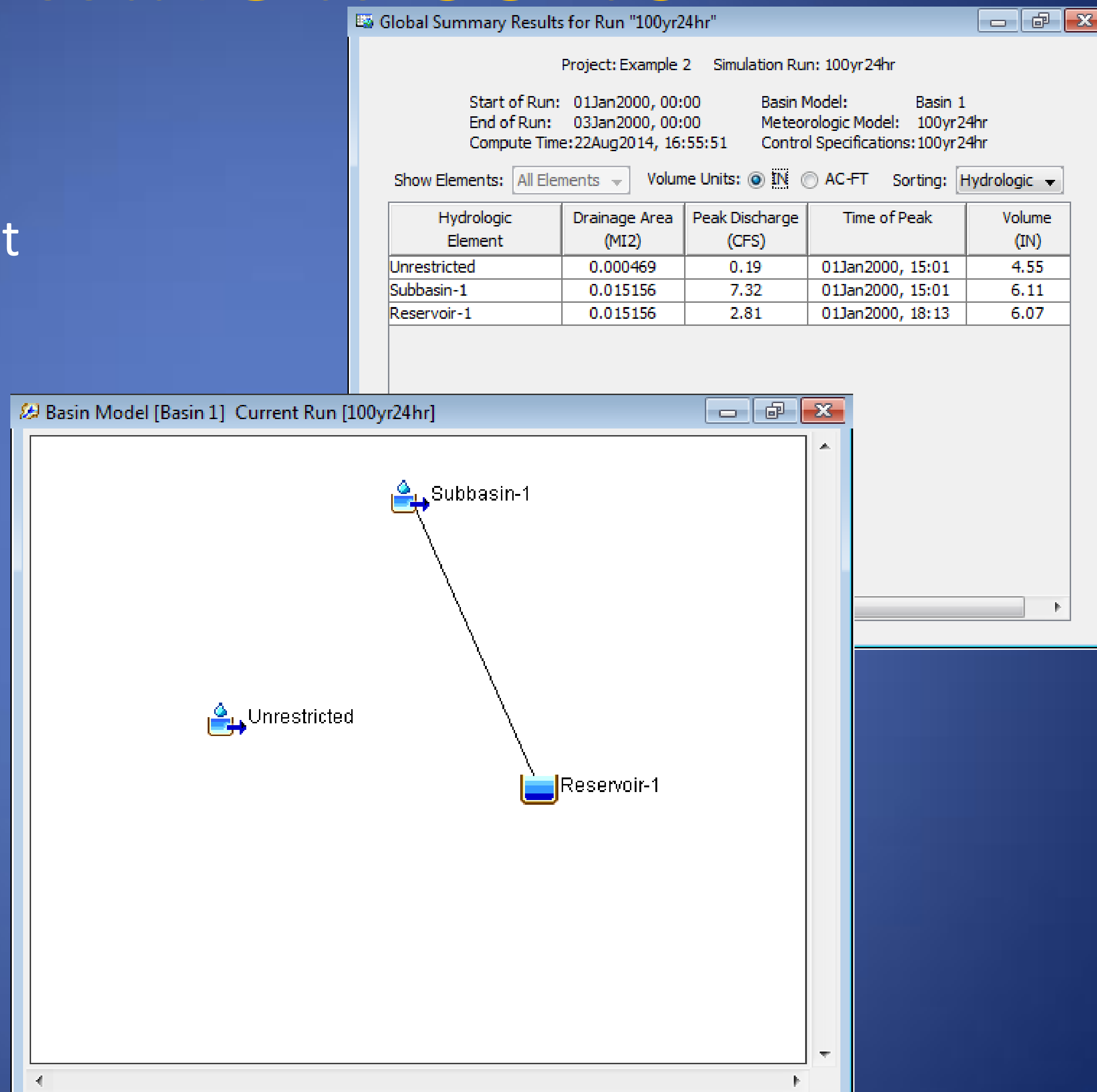
- If the *Simulation Run* was successful, right-click on the components of the ***Basin Model*** to view individual results

- Results are available as a ***Graph***, ***Summary Table***, or ***Time-Series Table***



VIEWING RESULTS

- To view the results for all model components at once, choose ***Global Summary Table*** under the ***Results Menu***



EXAMPLE 2 RESULTS

- What is the peak elevation in the proposed detention basin for the 100-year, 24-hour storm event? <u>705 ft</u>

- What is the peak 100-year, 24-hour release rate from the proposed detention basin? <u>2.81 cfs</u>

- Does the proposed detention basin meet the requirements of the WMO? <u>Yes</u>

EXAMPLE PROBLEM #3 (INDIVIDUAL)

Assuming there are 20 acres of offsite tributary area to the site in Example #2, determine the peak 100-year flowrate (on-site and off-site) that must be bypassed through the detention basin overflow weir.

- Offsite Area = 20 Acres
- CN = 81
- Time of Concentration = 30 minutes

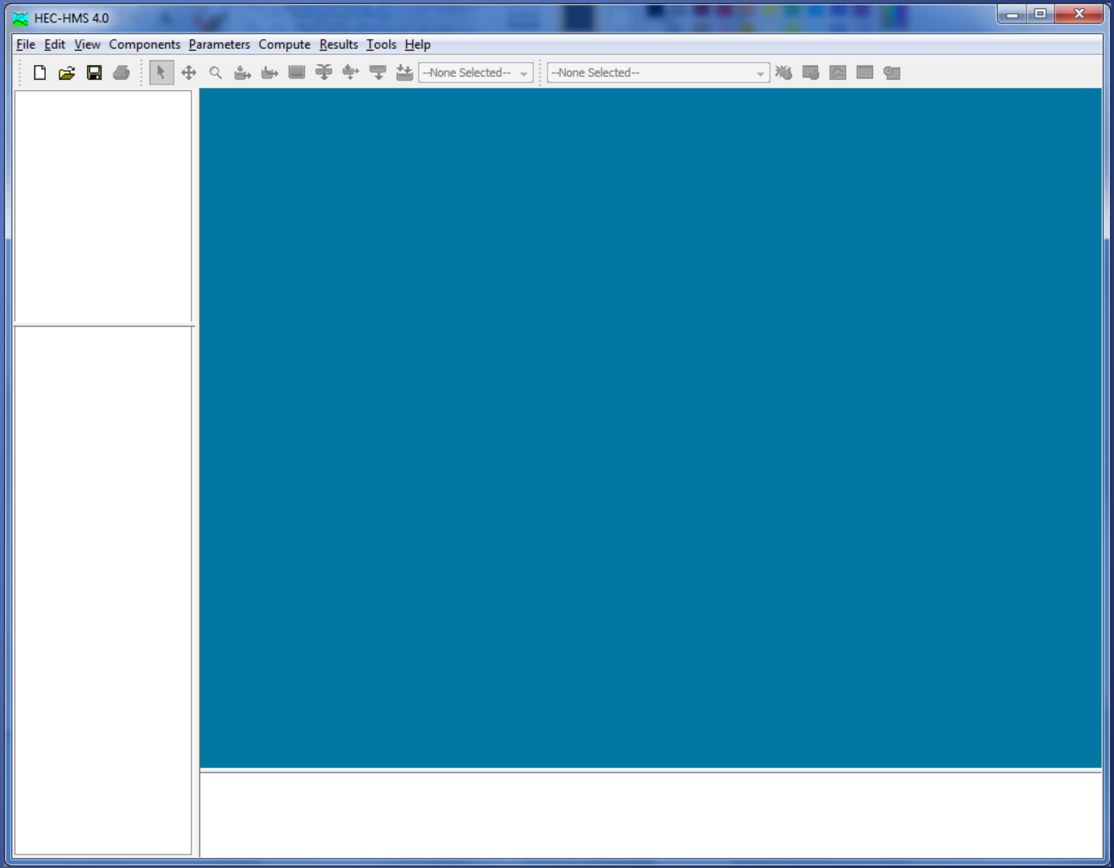
Run the 100-year, 1-, 12-, and 24-storm events

Storm Event	Peak Flowrate (cfs)
100-Year, 1-Hour	
100-Year, 12-Hour	
100-Year, 24-Hour	

GETTING STARTED
THE INITIAL HEC-HMS SCREEN

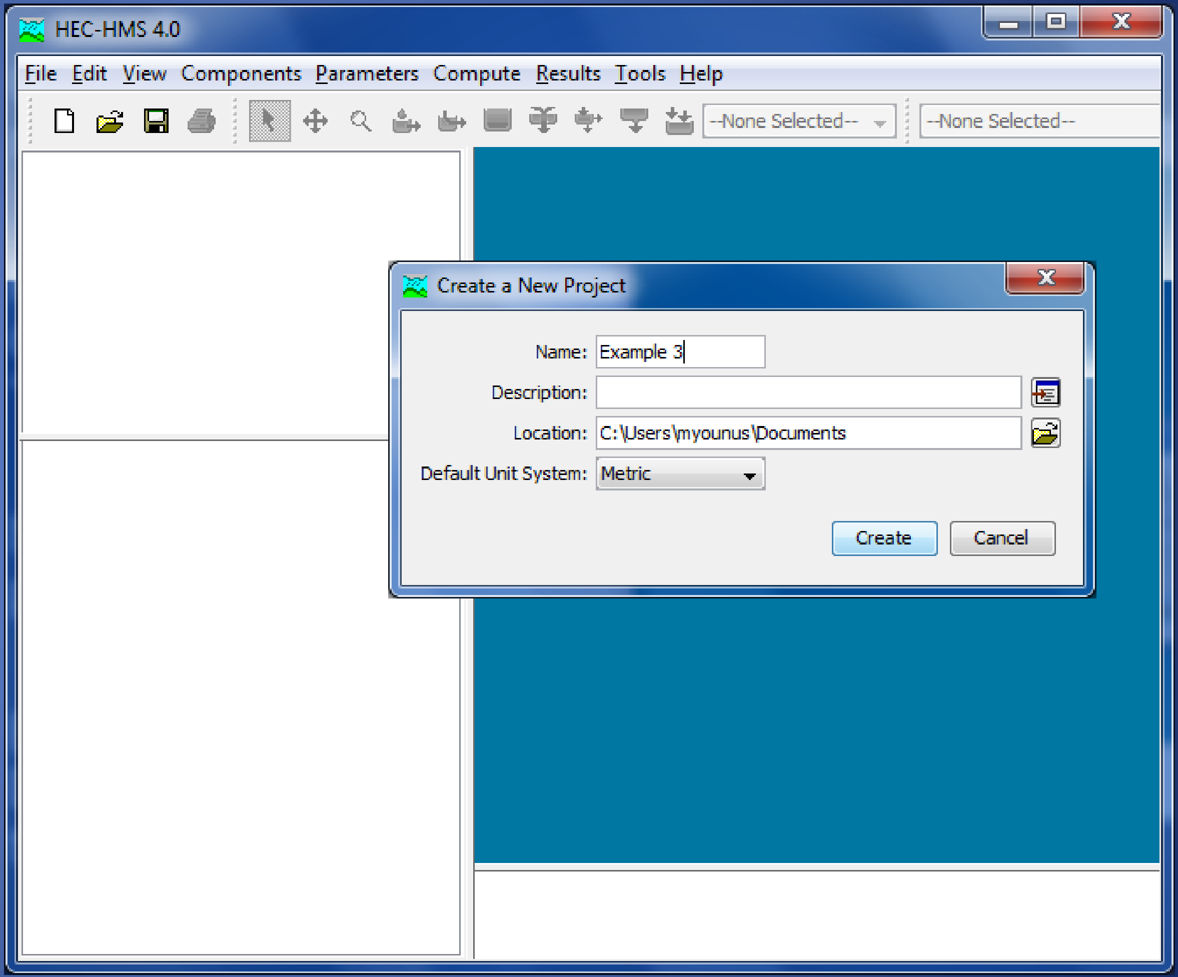
- Double-click on the HEC-HMS icon on your desktop

- The following HEC-HMS Screen comes up:



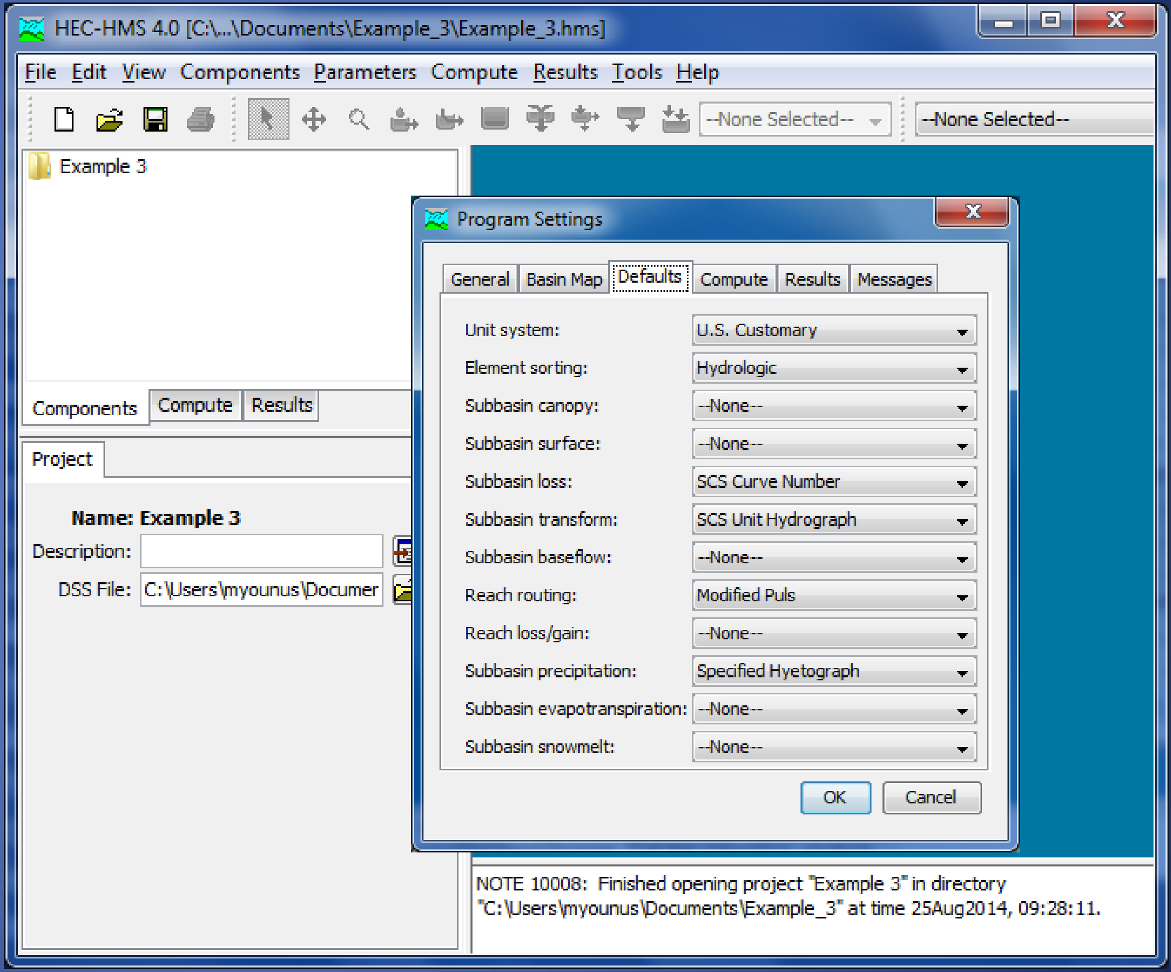
HEC-HMS – SETTING UP A NEW PROJECT

- Click on the "**File**" menu
- From the drop down menu, select "New"
- Name the new project "Example 2"
- Be sure to set the Default Unit System to "U.S. Customary"



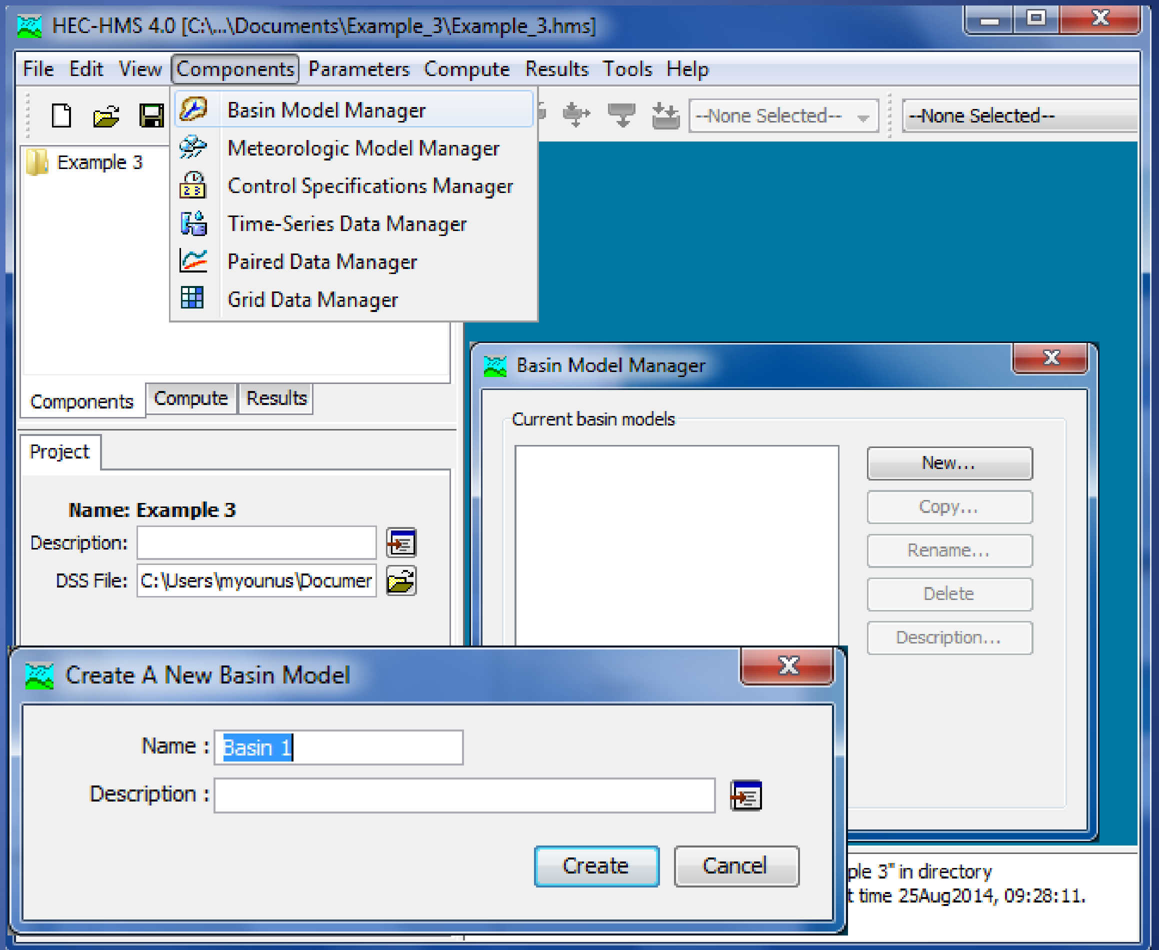
SETTING UP PROJECT DEFAULTS

- Under the ***Tools*** Menu, go to ***Program Settings*** and go to the ***Defaults*** tab
- Specify *SCS Curve Number* for ***Subbasin loss***, *SCS Unit Hydrograph* for ***Subbasin transform***, *Modified Puls* for ***Reach routing***, and *Specified Hyetograph* for ***Subbasin precipitation***
- Then go to the ***Results*** tab and make sure that the values for elevation, volume, flowrate, and depth are taken to **2** decimal places.



CREATING A BASIN MODEL

- Under the ***Components*** tab, go to ***Basin Model Manager***
- Select "New" and name it "Basin 1"

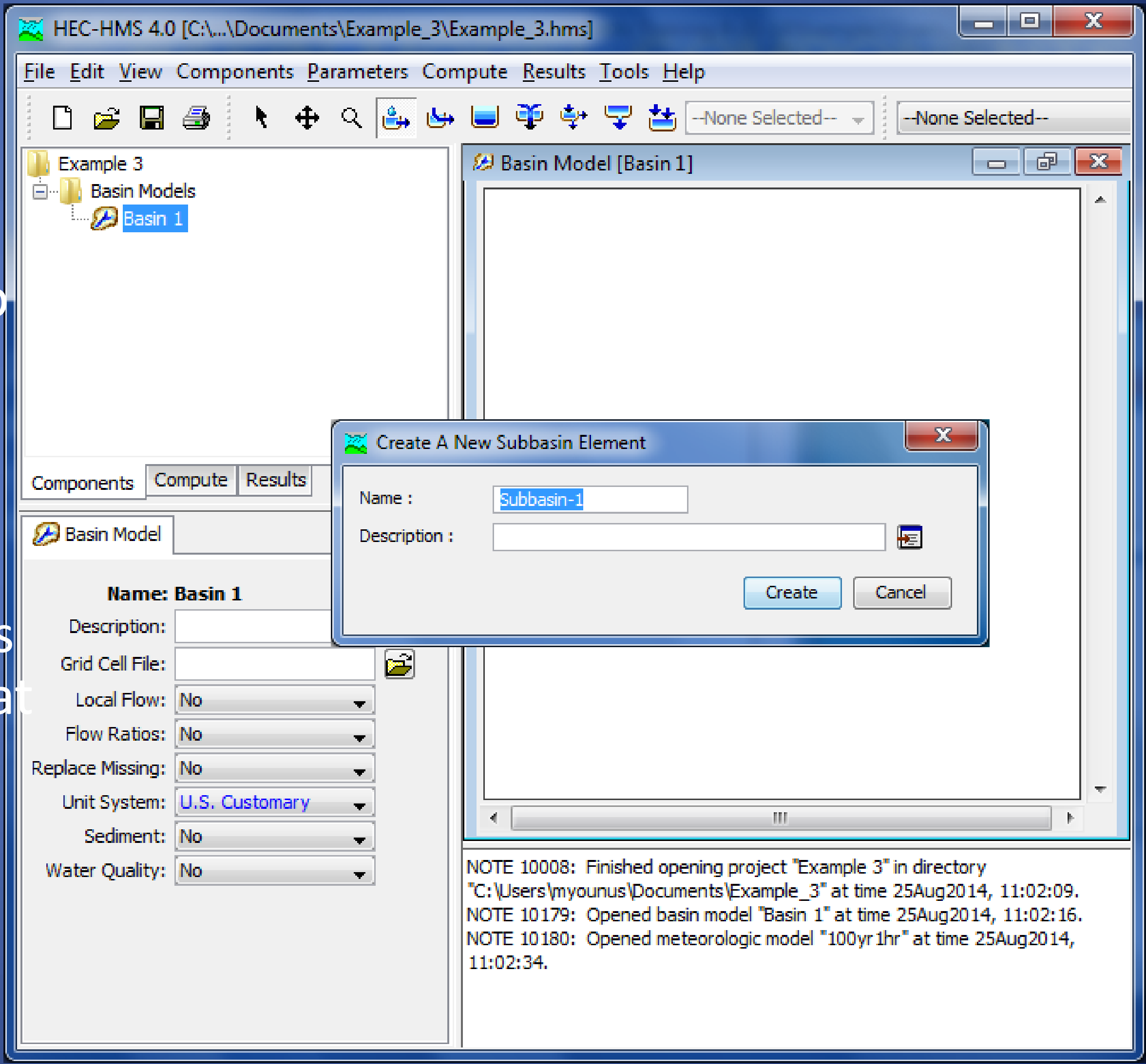


ADDING BASIN MODEL COMPONENTS

Subbasin: “Subbasin 1”

- Click on the ***Subbasin Creation Tool*** at the top of the screen to add a subbasin to the *Basin Model.*

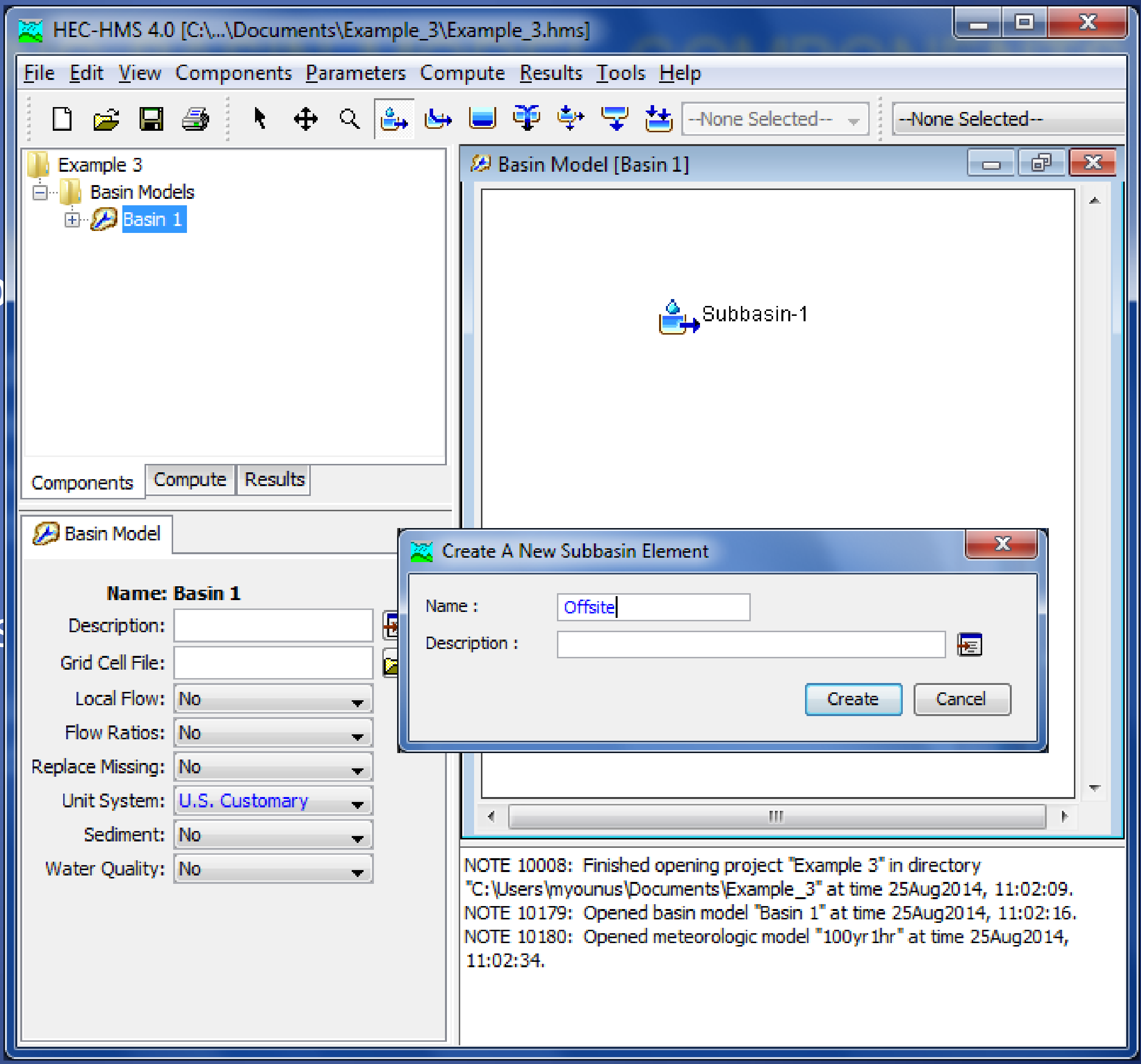
- Enter Subbasin Name as “Subbasin 1”, and click at Create.



ADDING BASIN MODEL COMPONENTS

Subbasin: "Offsite"

- Click on the ***Subbasin Creation Tool*** at the top of the screen to add a subbasin to the *Basin Model.*
- Enter Subbasin Name as "Offsite", and click at Create.

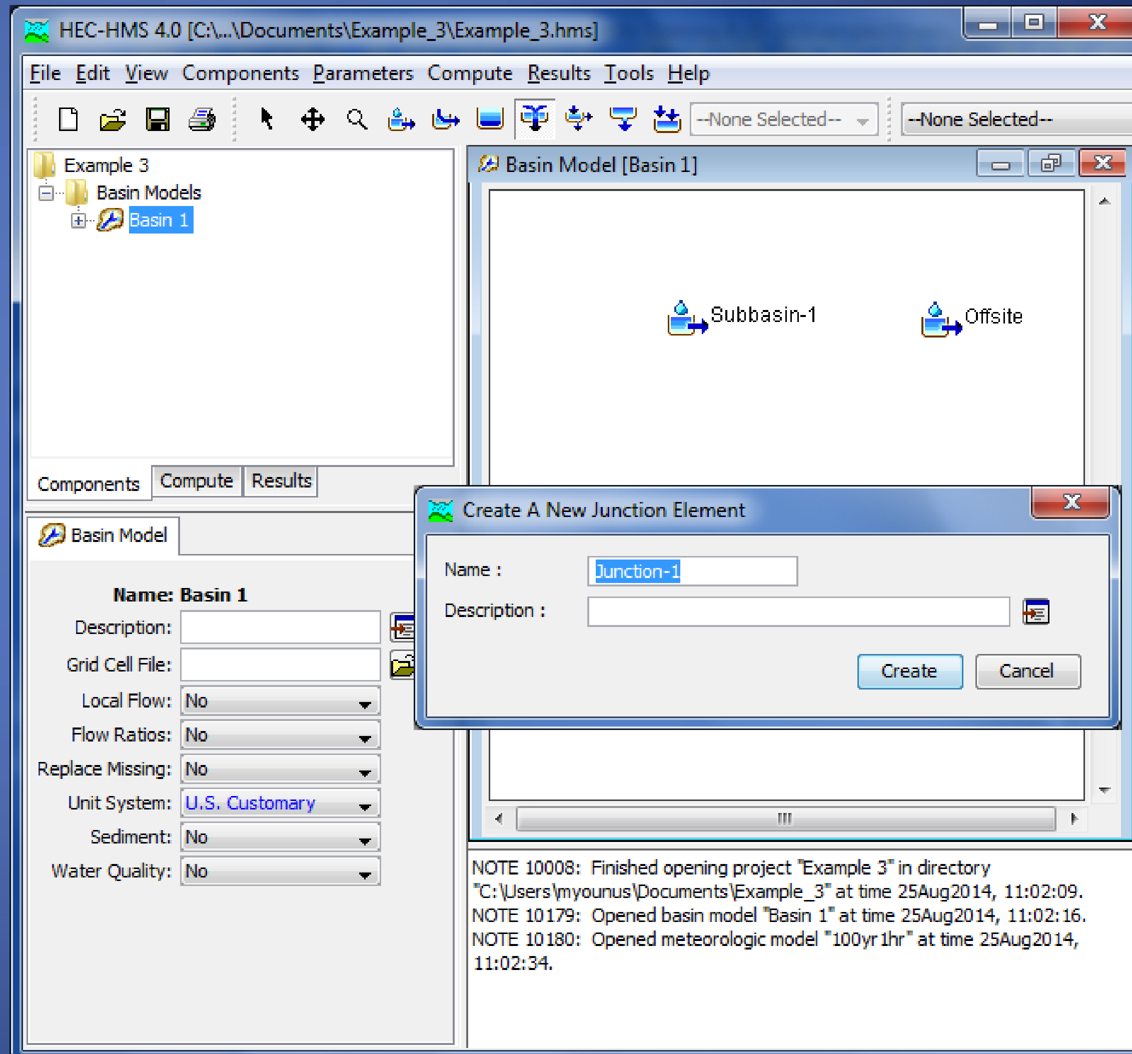


ADDING BASIN MODEL COMPONENTS

Junction: “Junction 1”

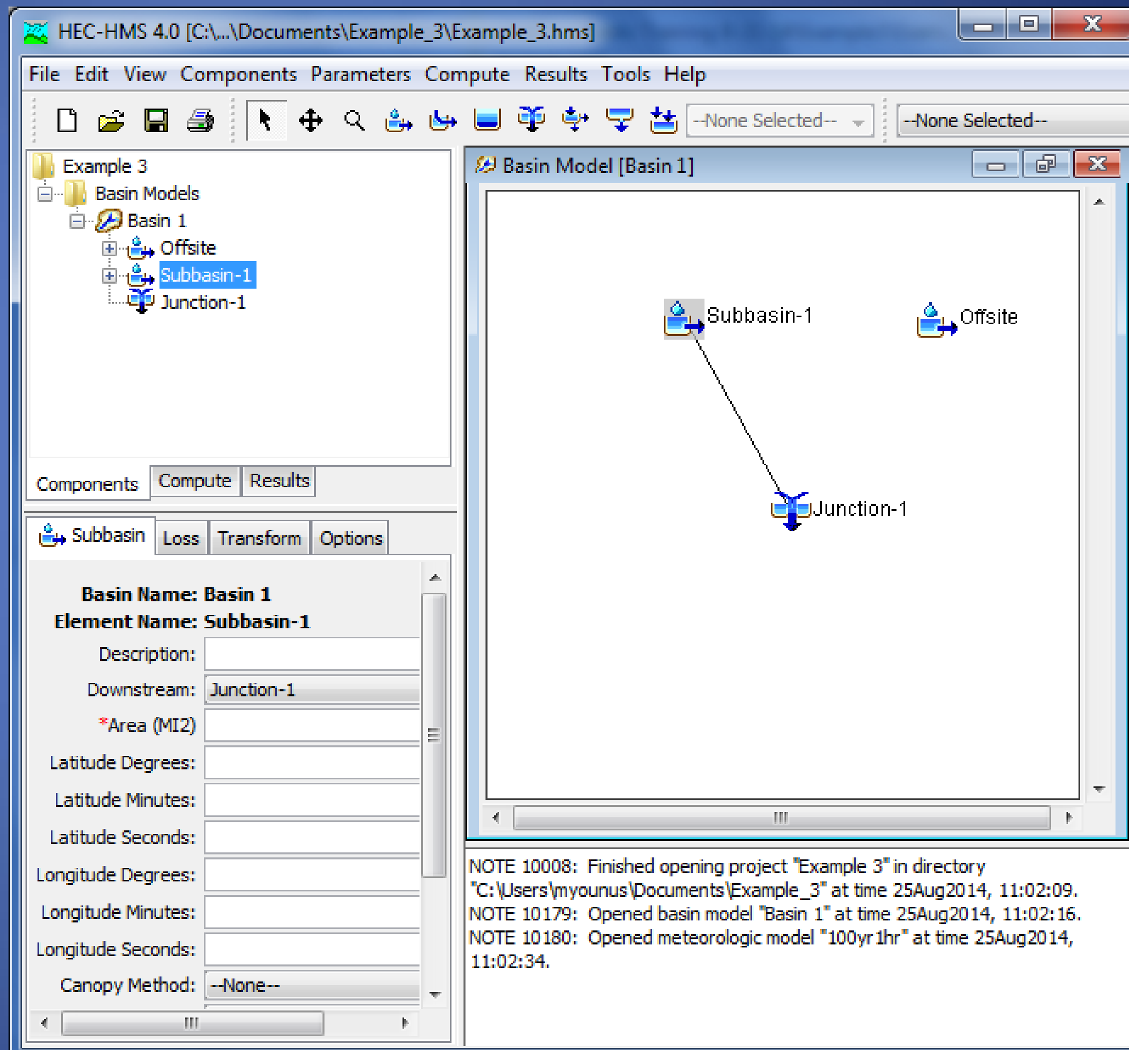
- Click on the ***Junction Creation Tool*** at the top of the screen to add a Junction to the *Basin Model.*

- Enter Subbasin Name as “Junction 1”, and click at Create.



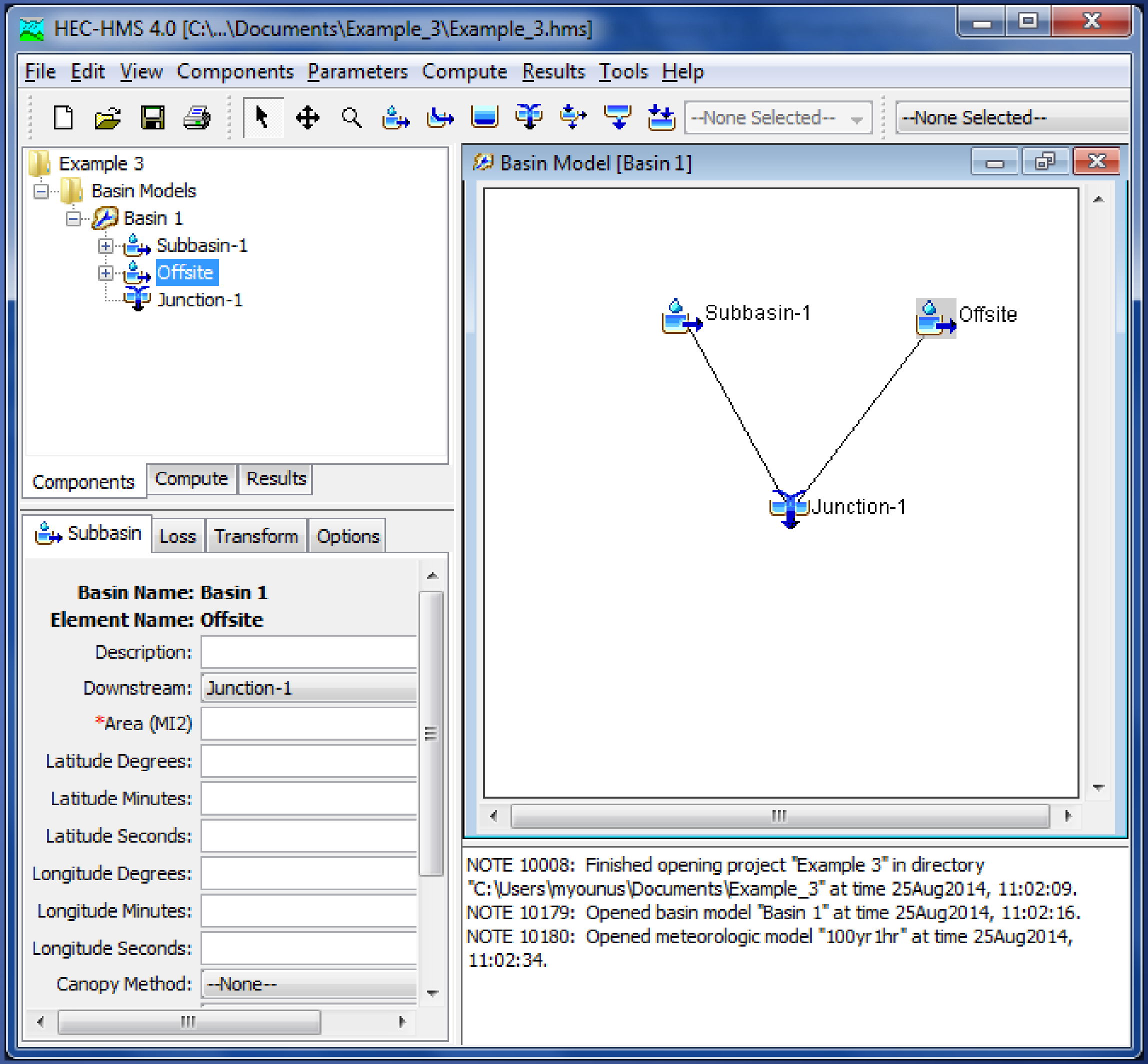
CONNECTING SUBBASIN-1 TO JUNCTION-1

- Right-click on the subbasin-1 and select “Connect Downstream” and click on the Junction-1.



CONNECTING OFFSITE TO JUNCTION-1

- Right-click on the Offsite and select “Connect Downstream” and click on the Junctions.



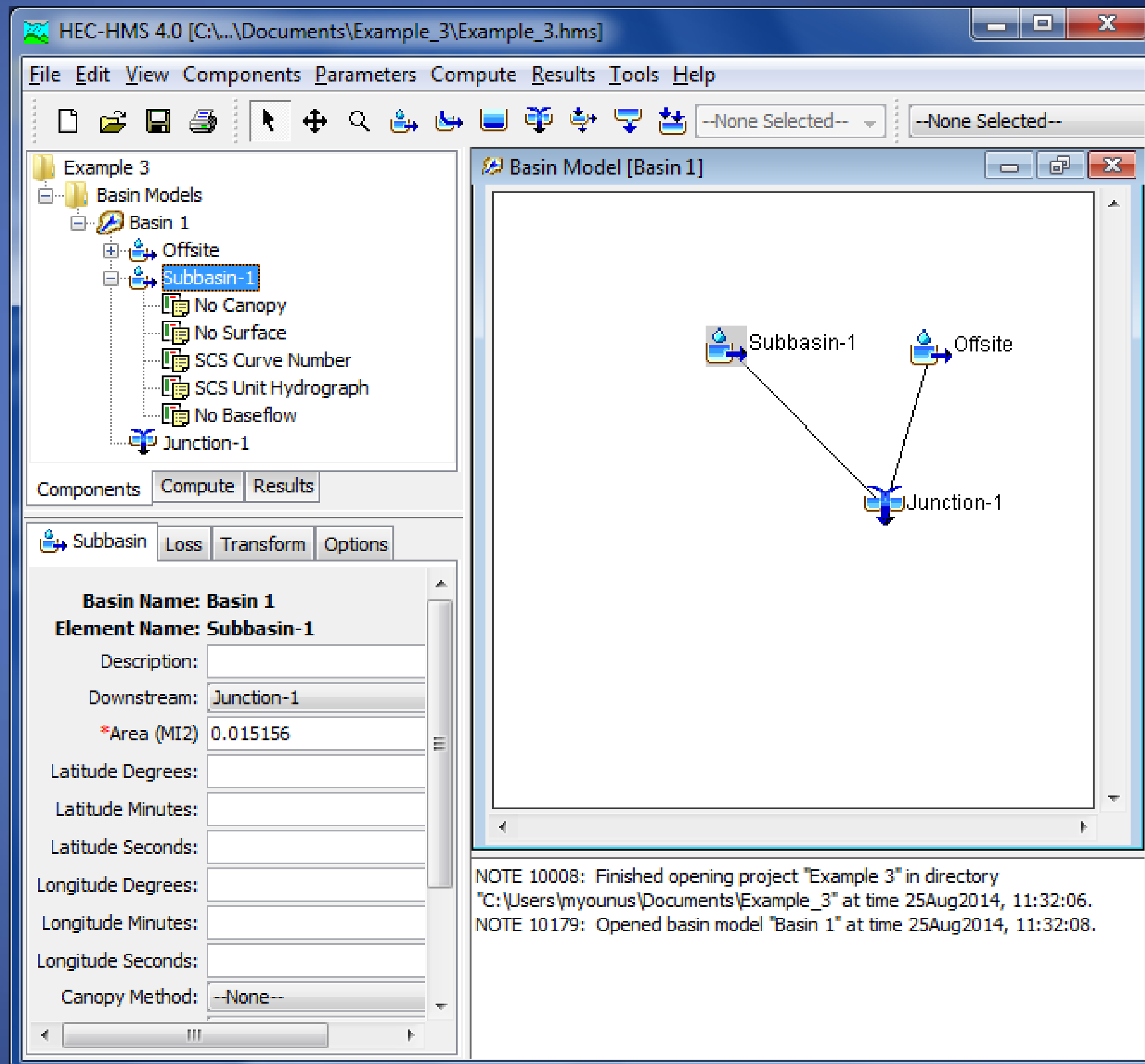
ENTERING SUBBASIN DATA

Subbasin-1

- Click on *Subbasin-1* and the data entry tabs will appear at the lower left corner

- For ***Area***, enter 0.015156 mi^2

  (9.7 acres)

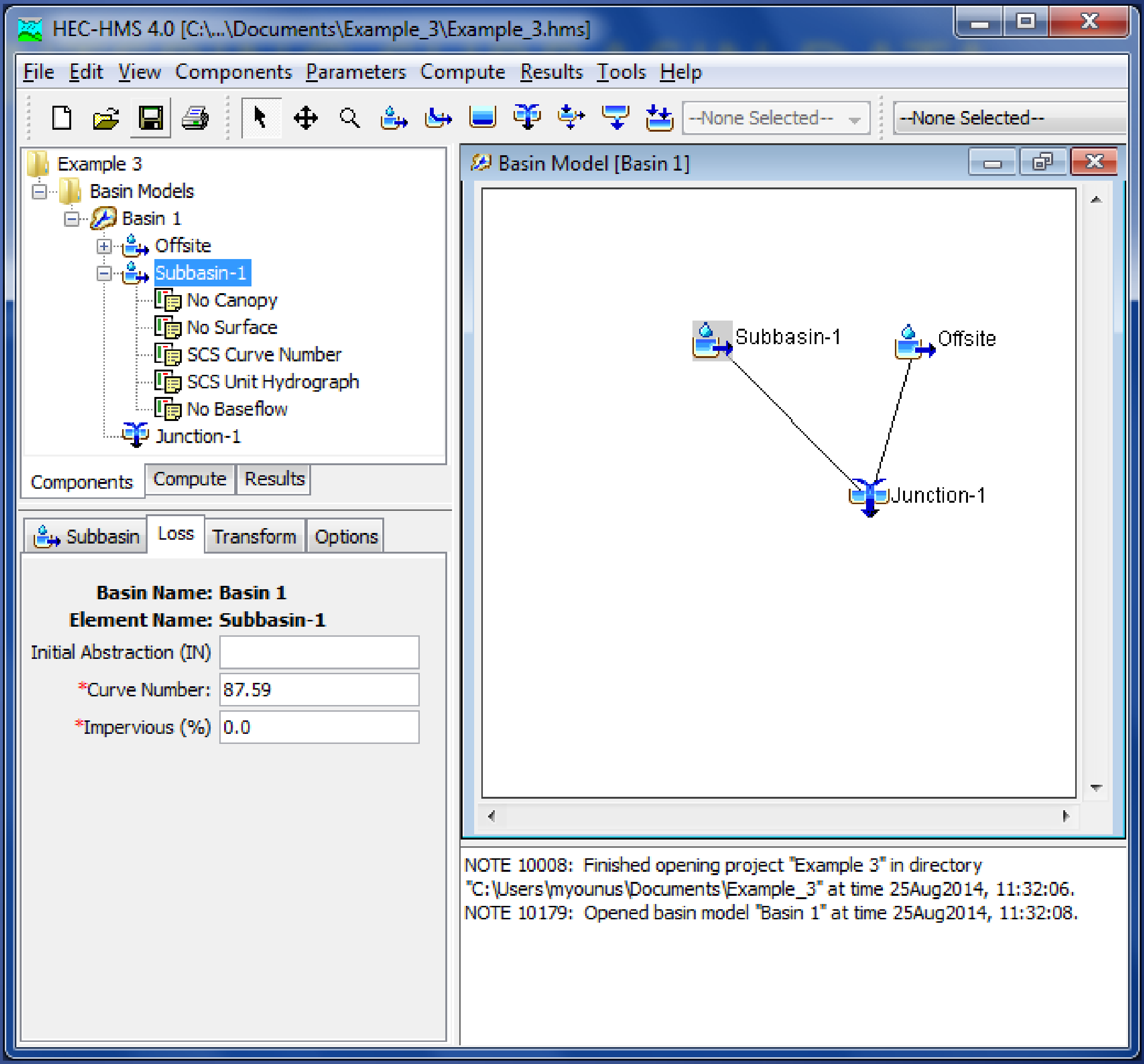


ENTERING SUBBASIN DATA

Subbasin-1

Continue …

- Under the ***Loss*** tab, enter the reduced CN of 87.59



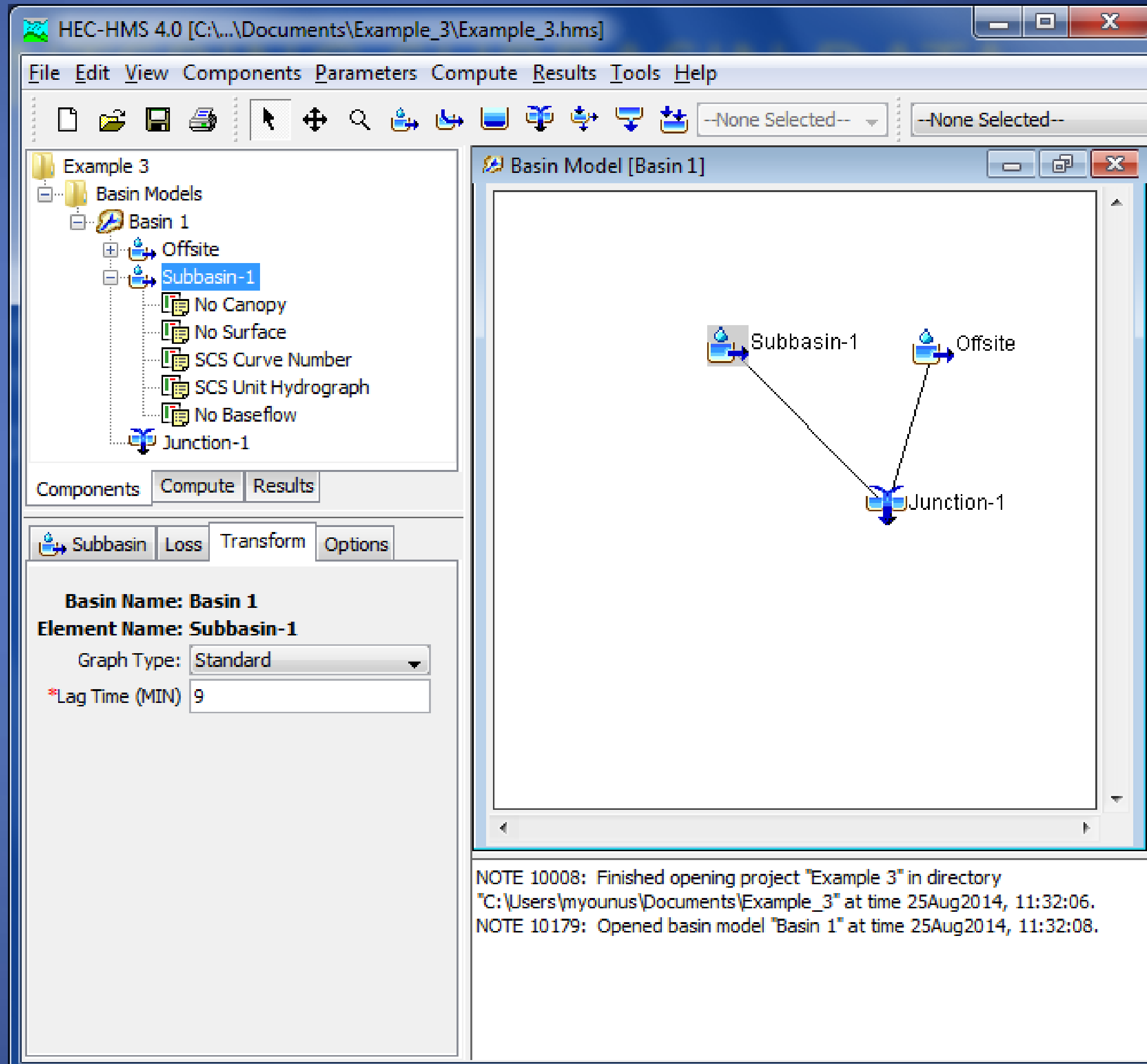
ENTERING SUBBASIN DATA

Subbasin-1

Continue …

- Under the ***Transform*** tab, enter the SCS Lag time of 9 minutes

  (Lag time = 0.6 * Tc)



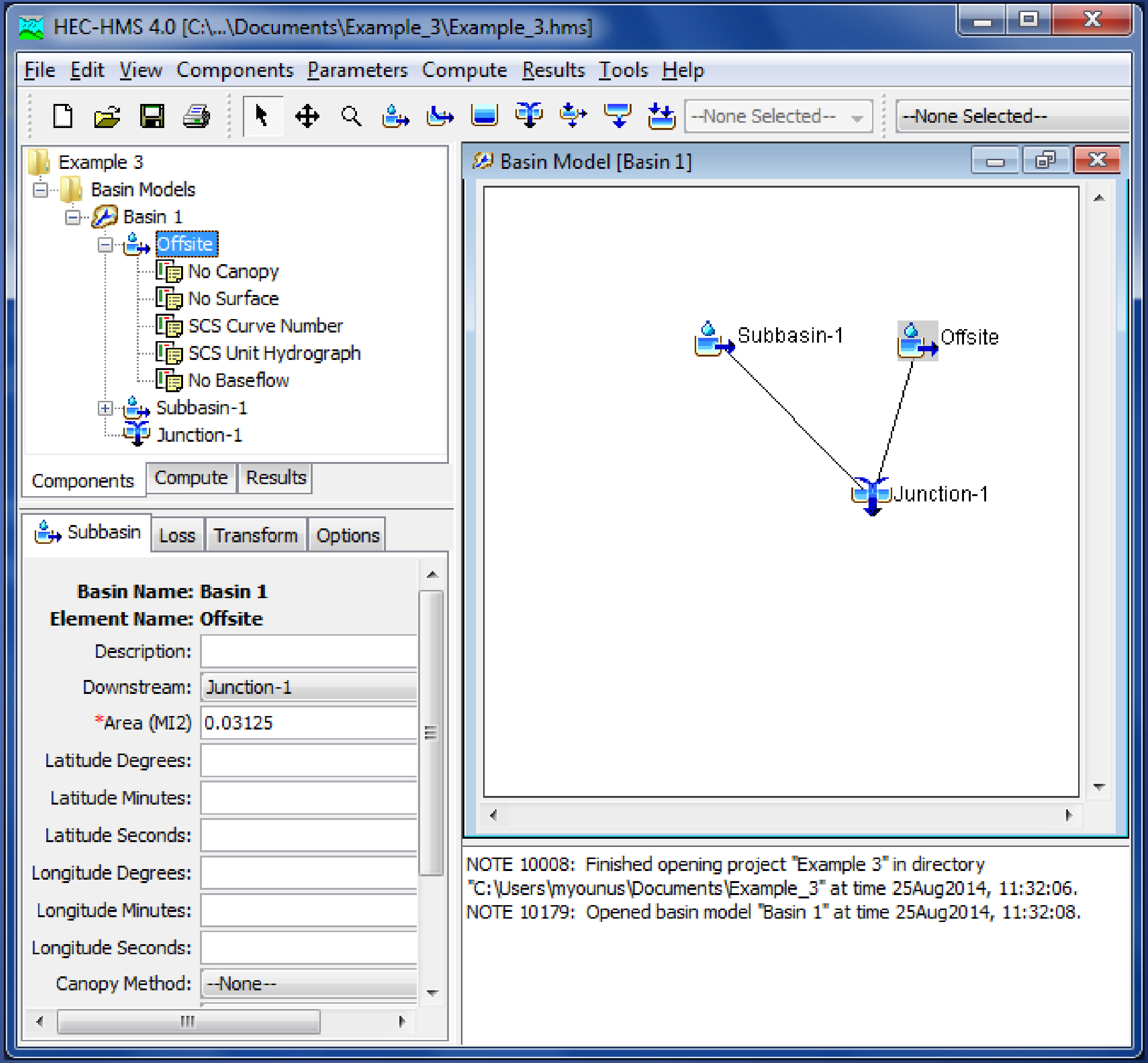
ENTERING SUBBASIN DATA

Offsite

- Click on *Offsite* and the data entry tabs will appear at the lower left corner

- For ***Area***, enter 0.03125 mi^2

  (20.0 acres)

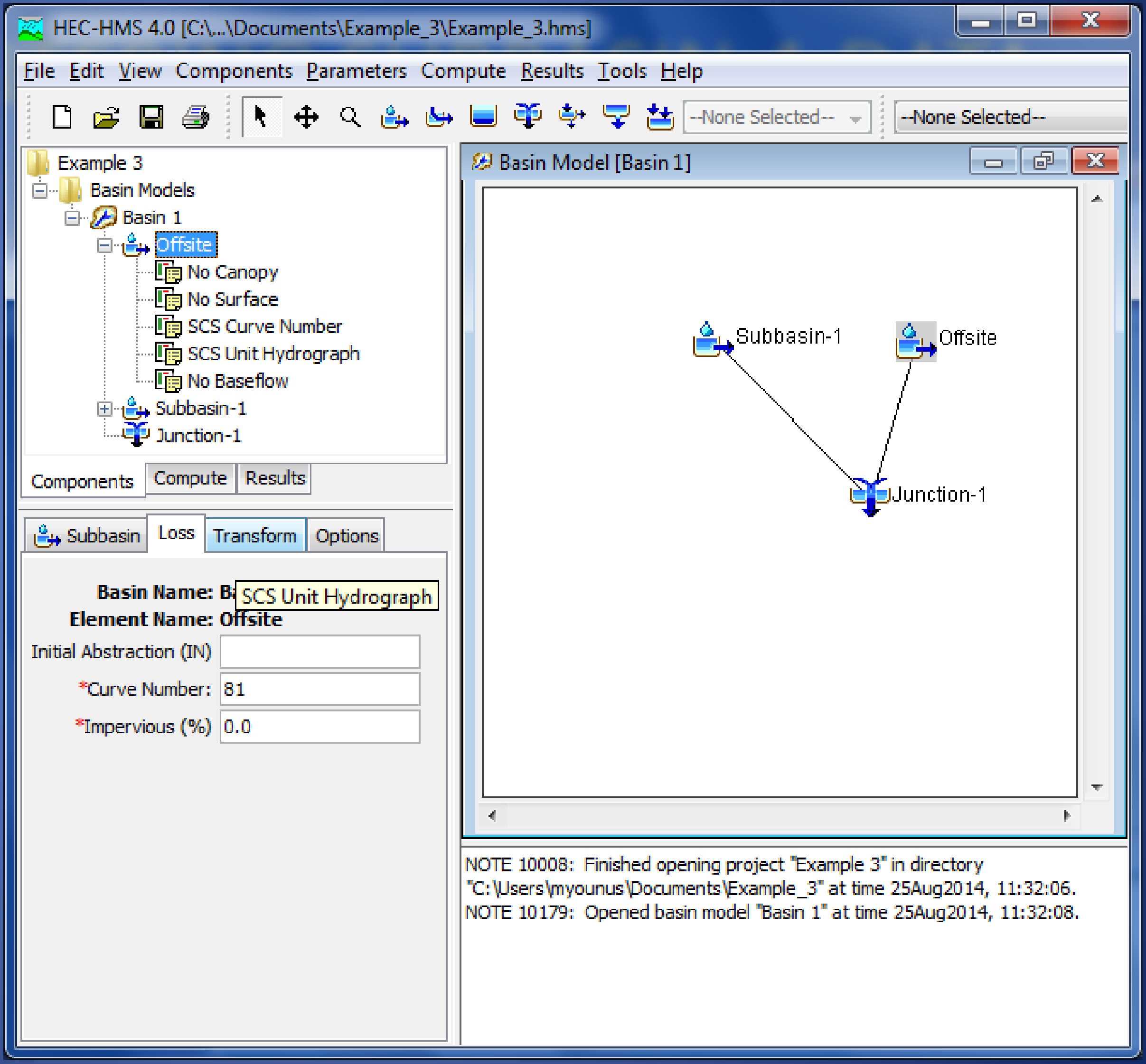


ENTERING SUBBASIN-1 DATA

Offsite

Continue …

- Under the ***Loss*** tab, enter the reduced CN of 81



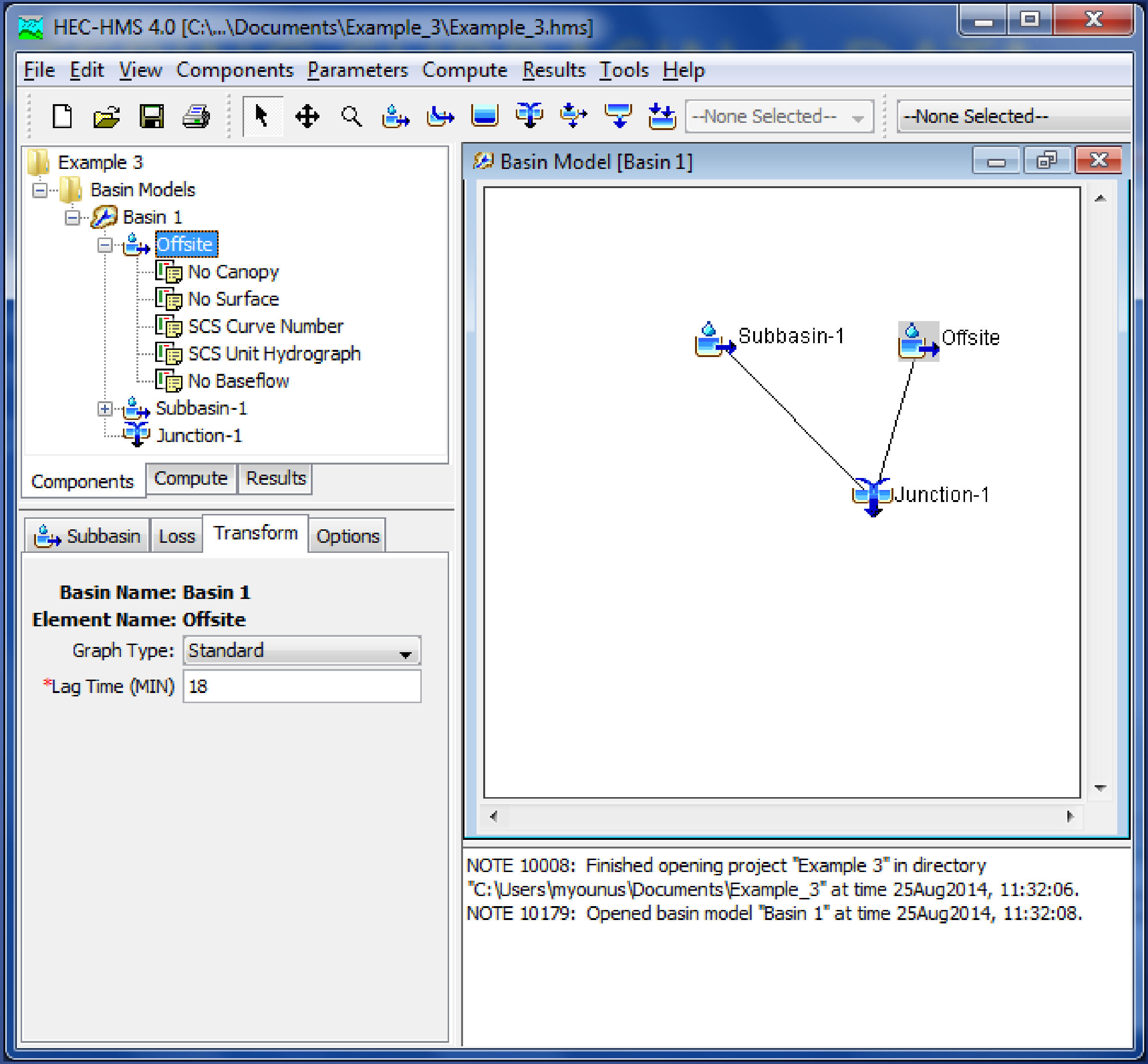
ENTERING SUBBASIN-1 DATA

Offsite

Continue …

- Under the ***Transform*** tab, enter the SCS Lag time of 18 minutes

  (Lag time = 0.6 * Tc)

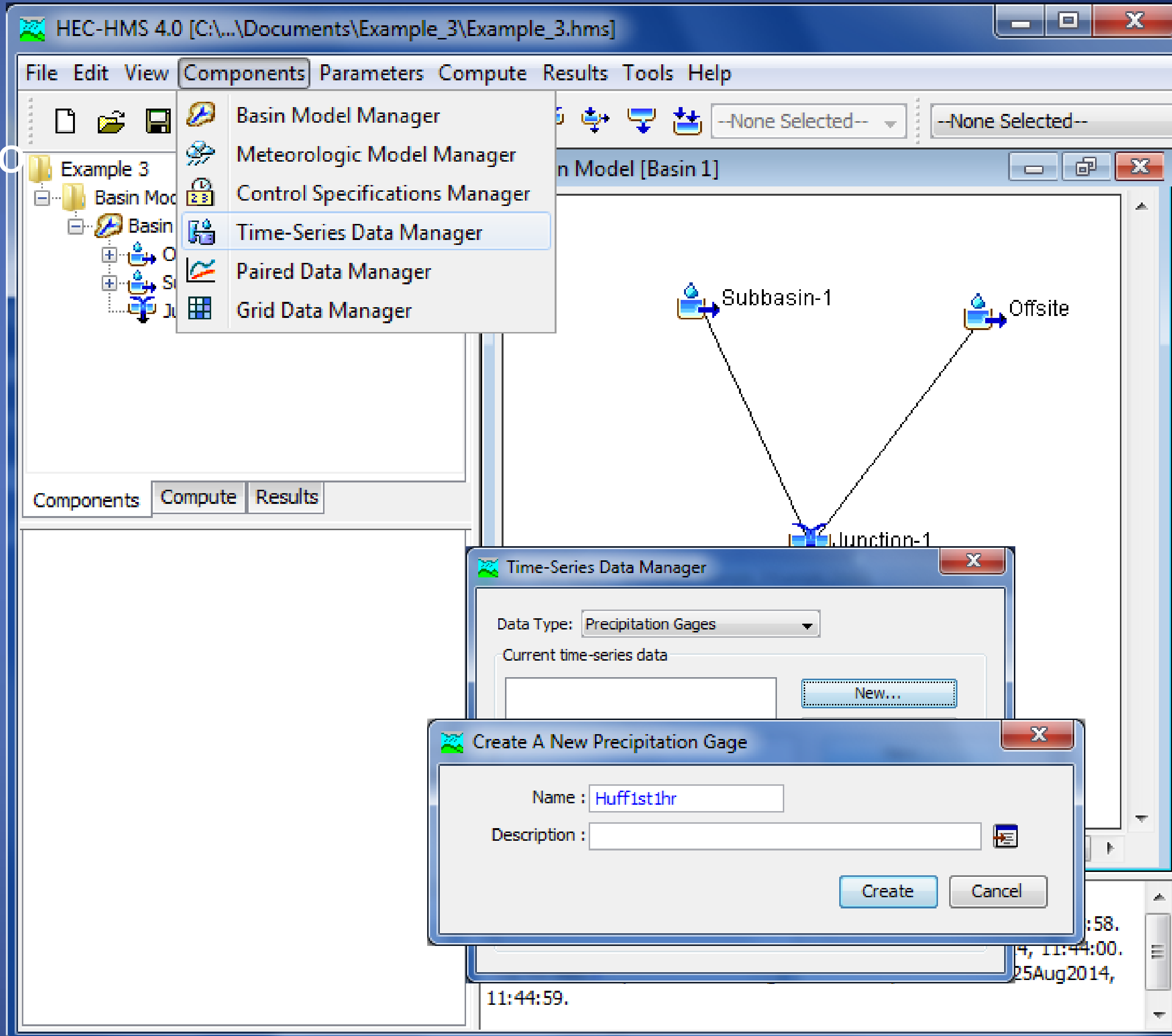


ENTERING RAINFALL DATA

- In HEC-HMS, rainfall data is entered as a combination of ***Time-Series Data*** and the ***Meteorologic Model***
- The ***Time-Series Data*** reflects the rainfall distribution (Huff quartile distributions or actual rainfall records)
- ***Time-Series Data*** cannot be entered in user-specified increments, interpolation of points on the Huff curves may be necessary for some storm events
- The ***Meteorologic Model*** defines the rainfall depths and which subbasins those depths are applied

ENTERING TIME-SERIES DATA

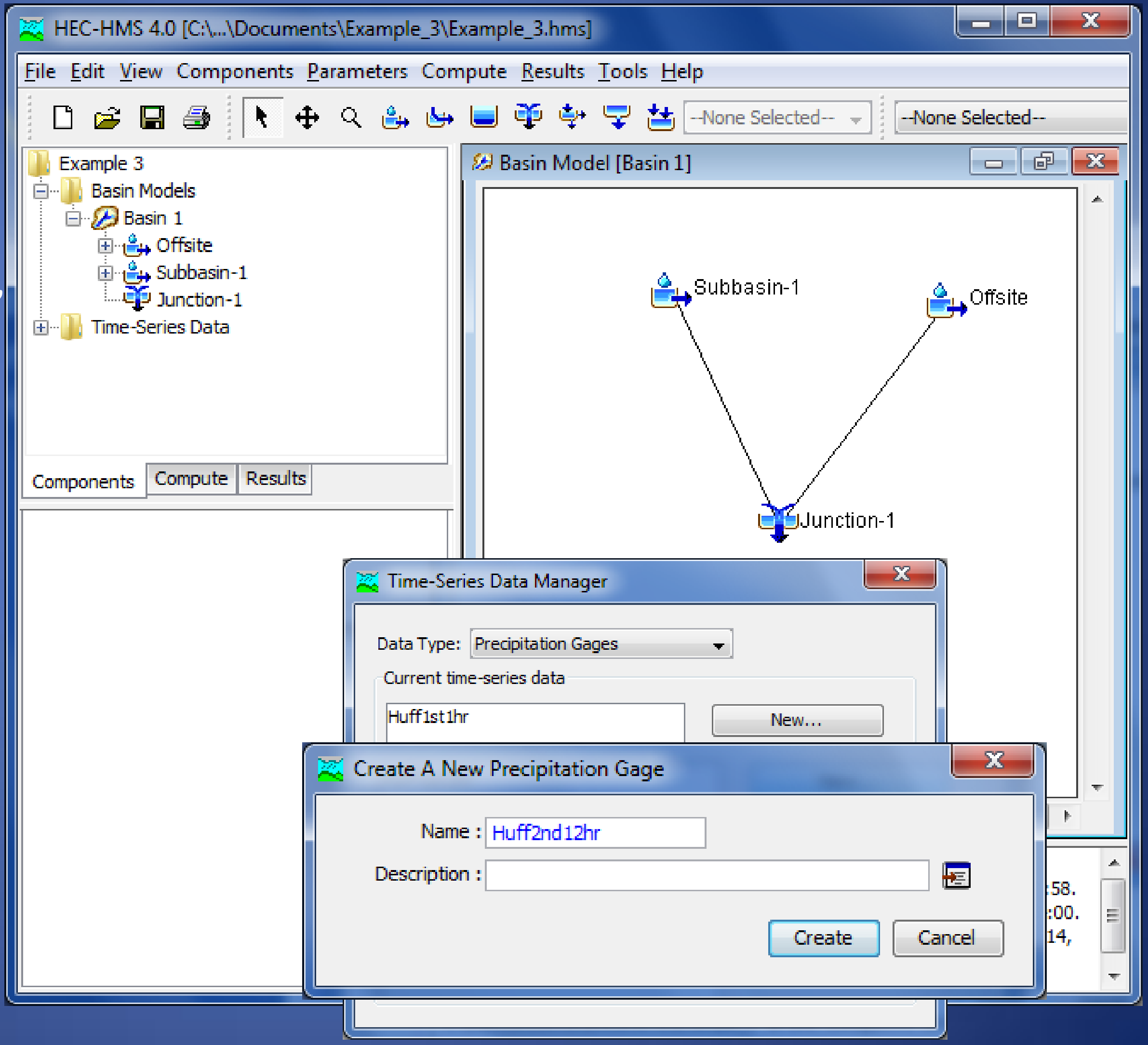
- From the ***Components*** menu, select ***Time-Series Data Manager*** to create a new ***Precipitation Gage*** named "Huff1st1hr"



ENTERING TIME-SERIES DATA

Continue …

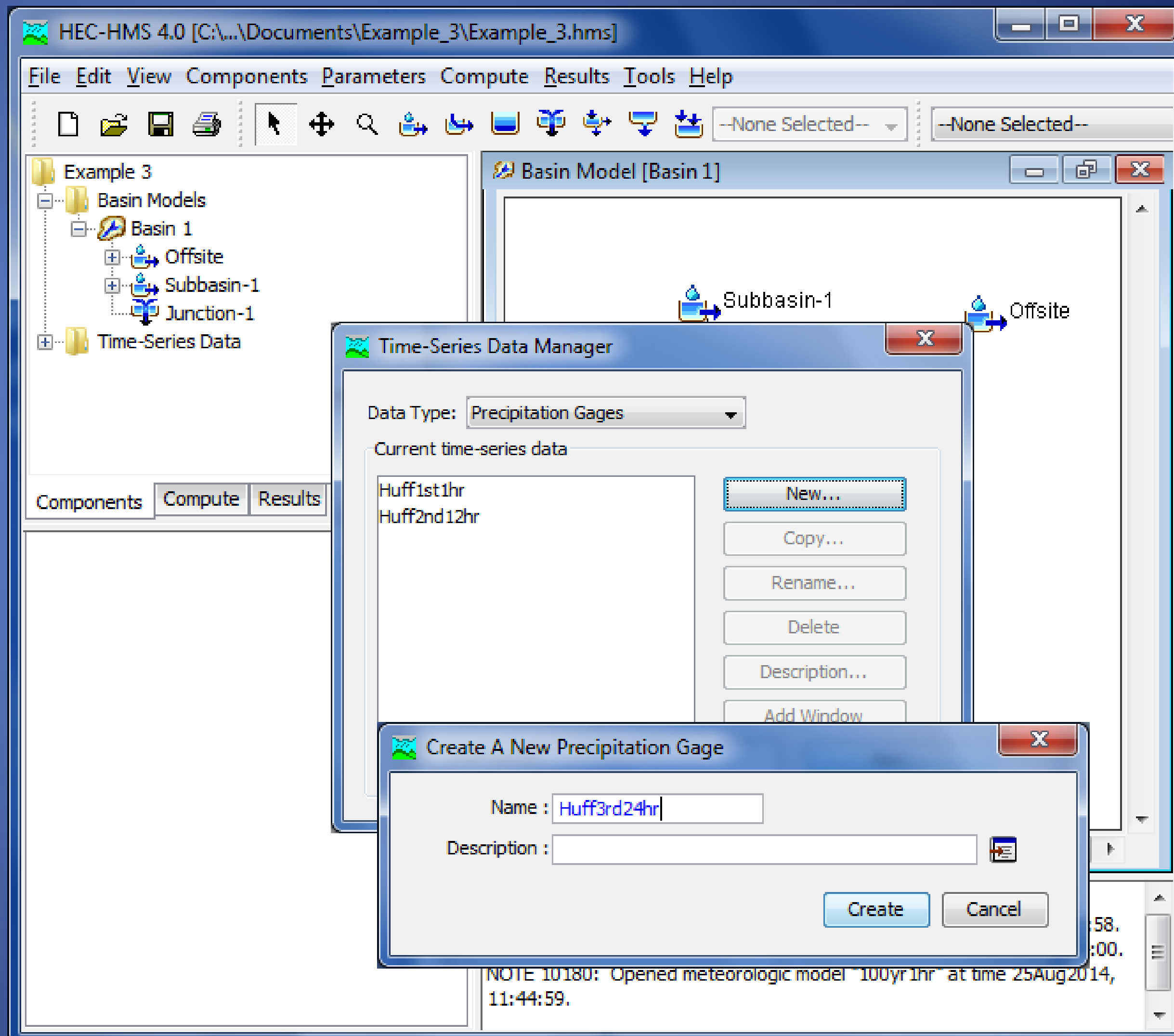
- From ***Time-Series Data Manager dialog box*** click new and enter name as “Huff2nd12hr”



ENTERING TIME-SERIES DATA

Continue …

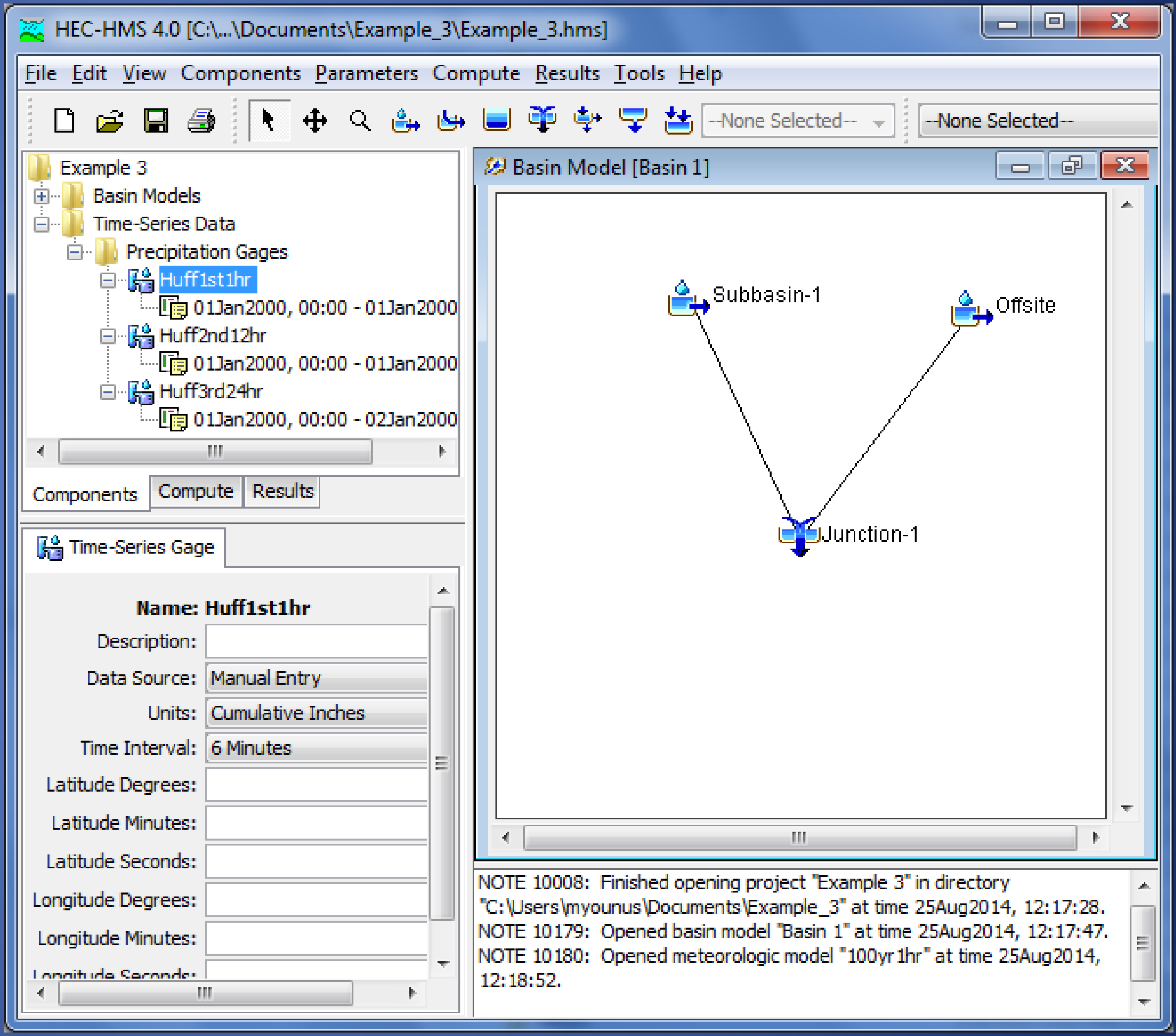
- From ***Time-Series Data Manager dialog box*** click new and enter name as “Huff3r24hr”



ENTERING TIME-SERIES DATA

Continue …

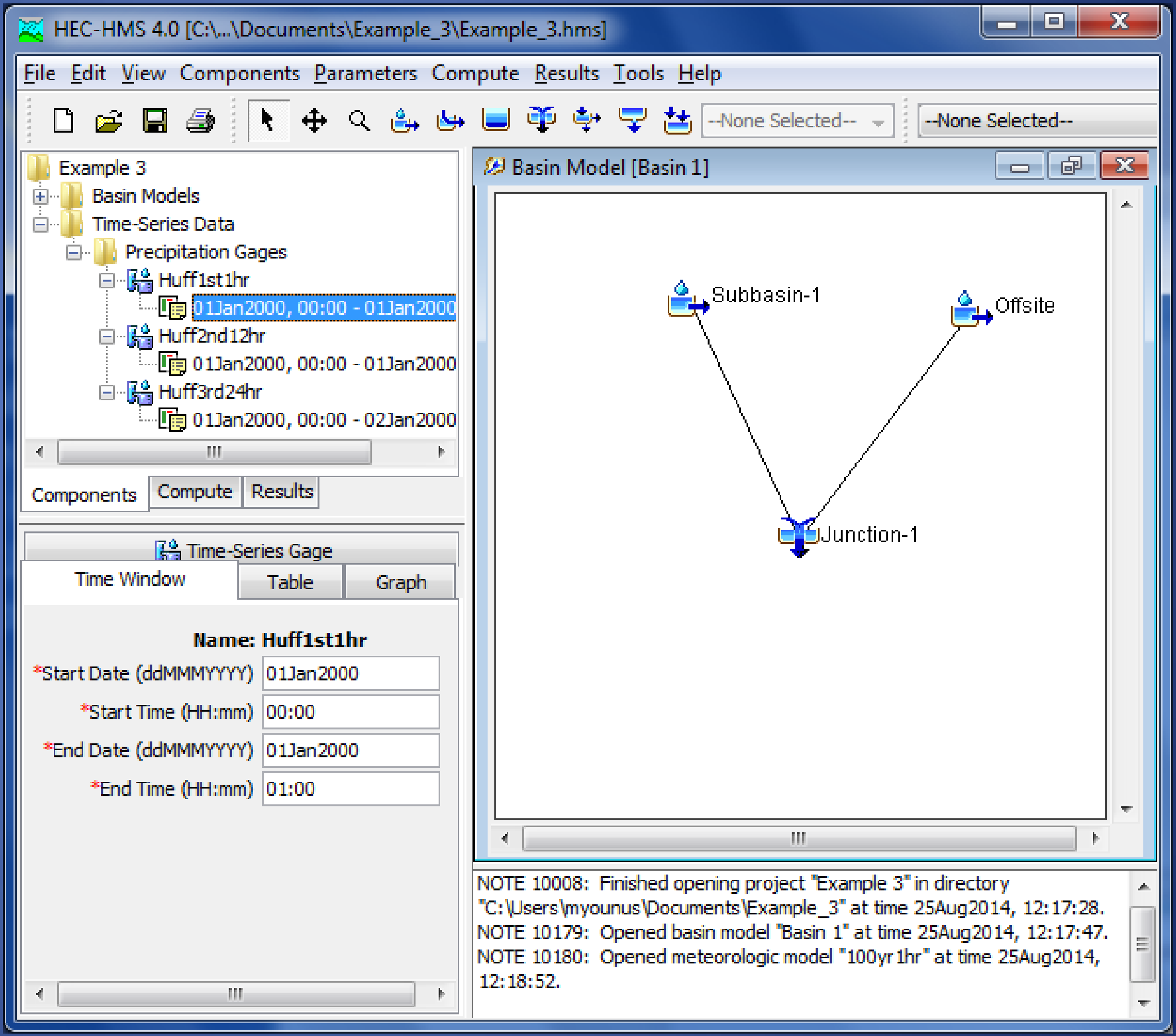
- Select Precipitation Gage “Huff1st1hr”
- Under the ***Time-Series Gage*** tab, select *Manual Entry*, *Cumulative Inches*, and 6-minute increments



ENTERING TIME-SERIES DATA

Continue …

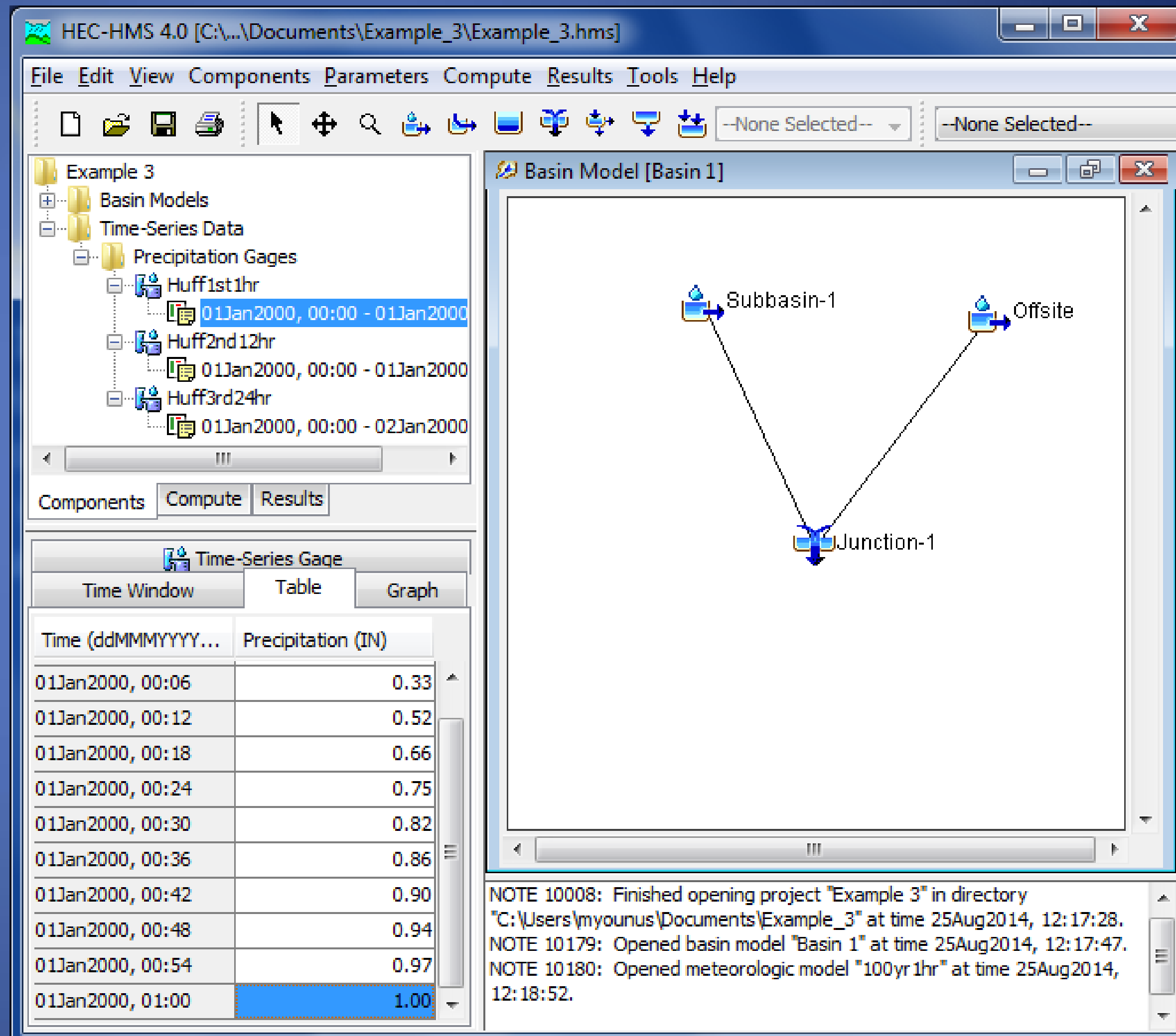
- Under the ***Time Window*** tab, run the storm from 01Jan2000 00:00 through 01Jan2000 01:00 (1-hour duration)



ENTERING TIME-SERIES DATA

Continue …

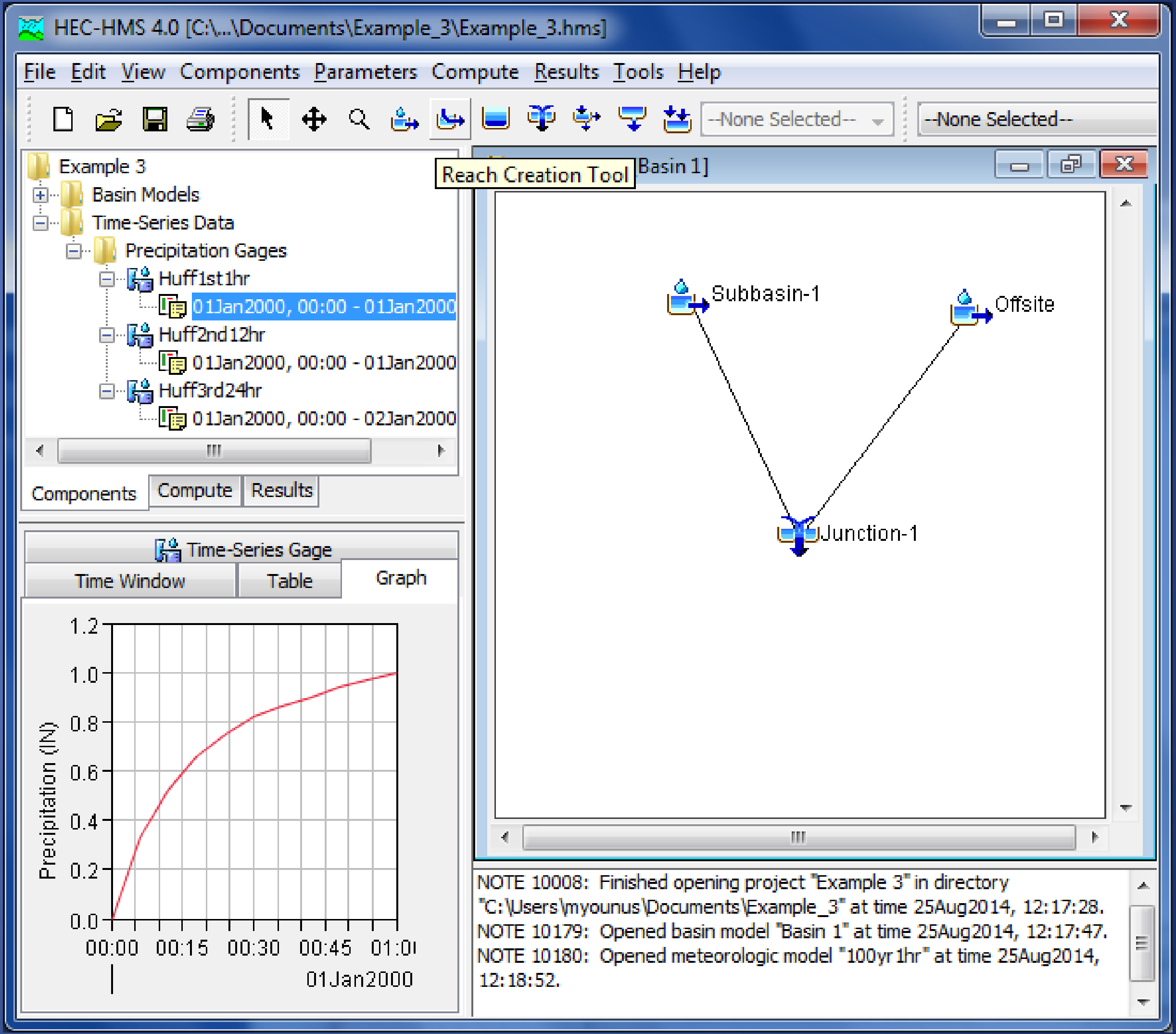
- Under the ***Table Tab***, Enter the Huff 1st Quartile Distribution for the 1-hour duration from the handout



ENTERING TIME-SERIES DATA

Continue …

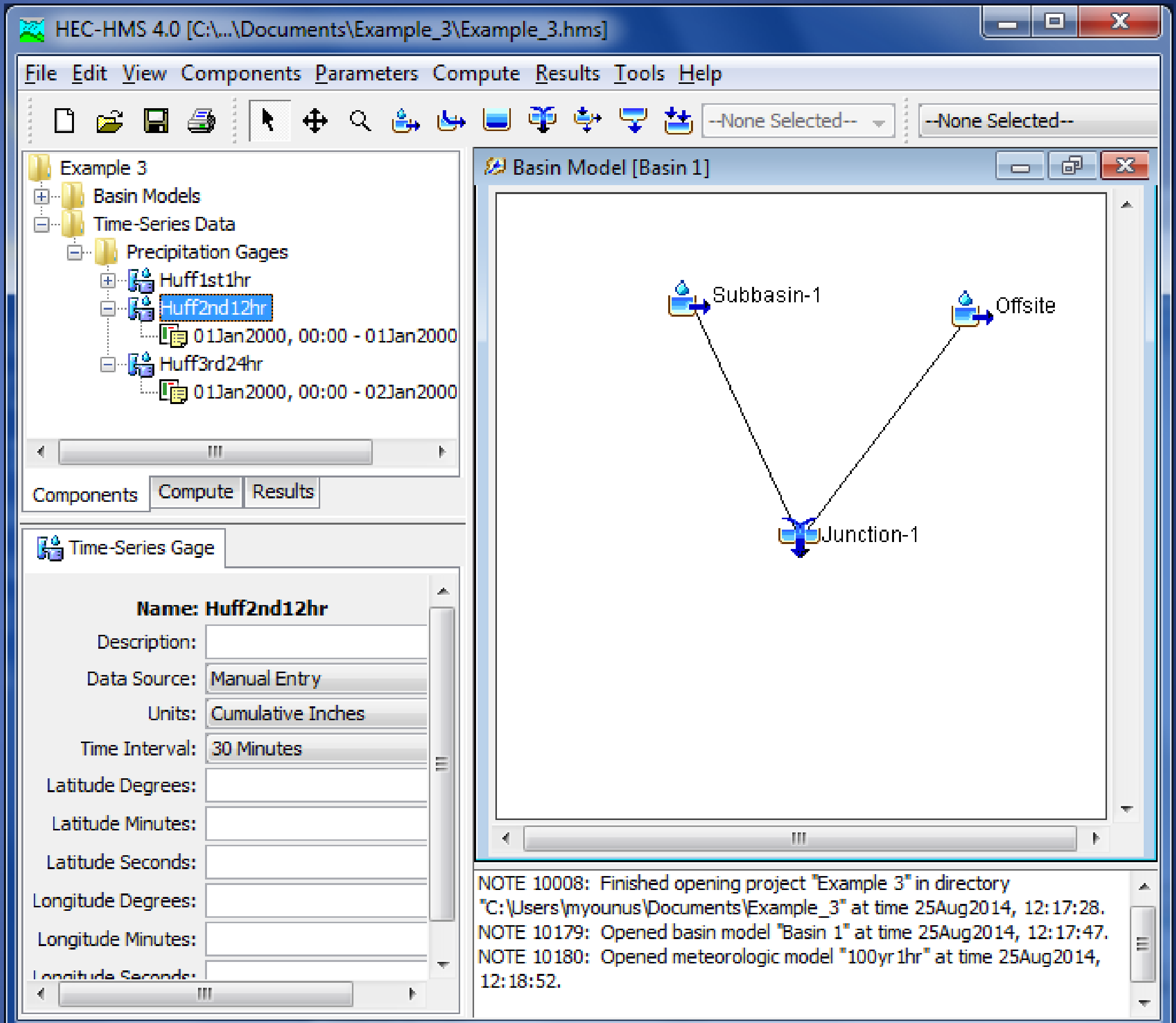
- Use the ***Graph*** tab to see a plot of the distribution



ENTERING TIME-SERIES DATA

Continue …

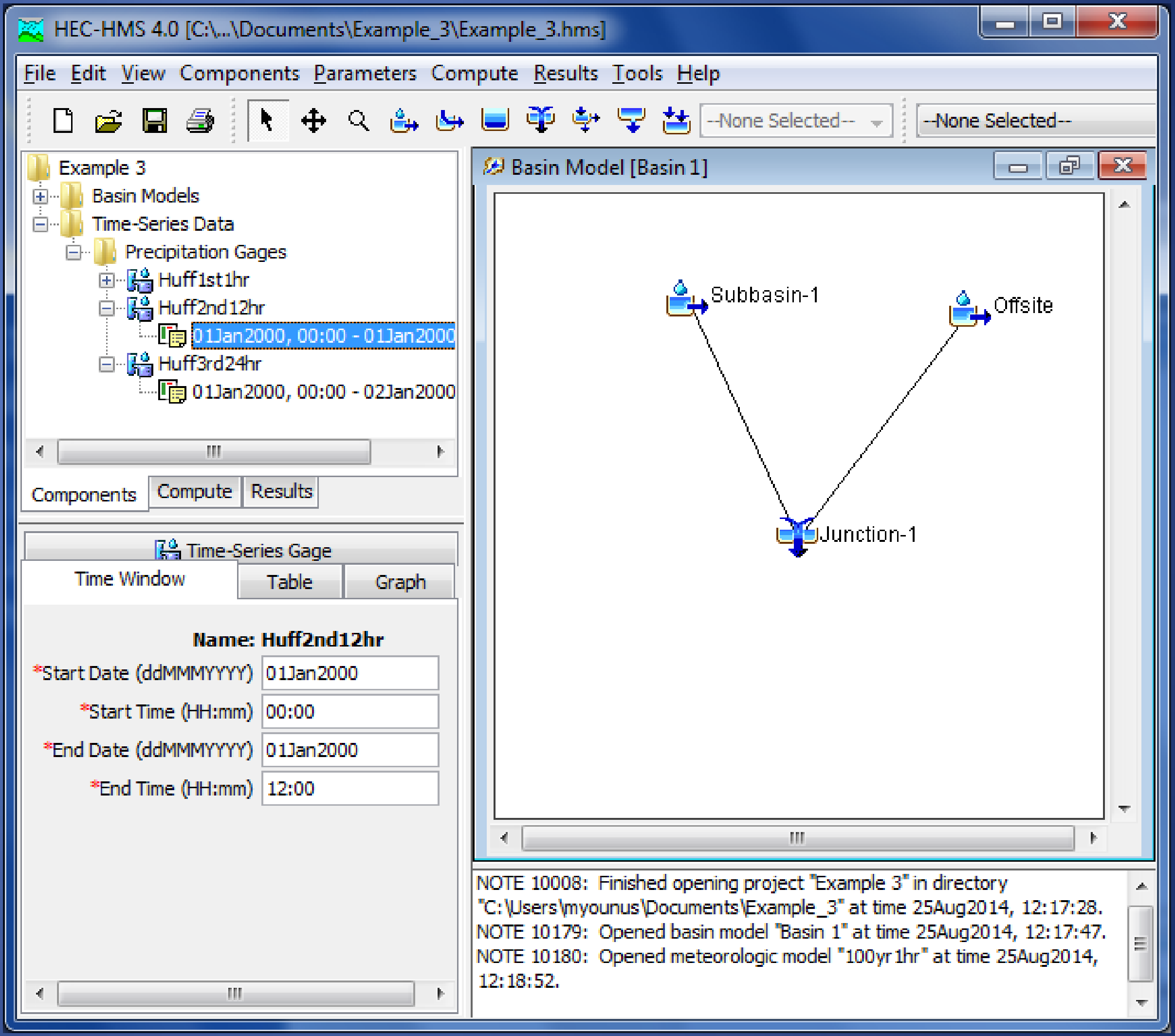
- Select Precipitation Gage "Huff2nd12hr"
- Under the ***Time-Series Gage*** tab, select *Manual Entry*, *Cumulative Inches*, and 30 minute increments



ENTERING TIME-SERIES DATA

Continue …

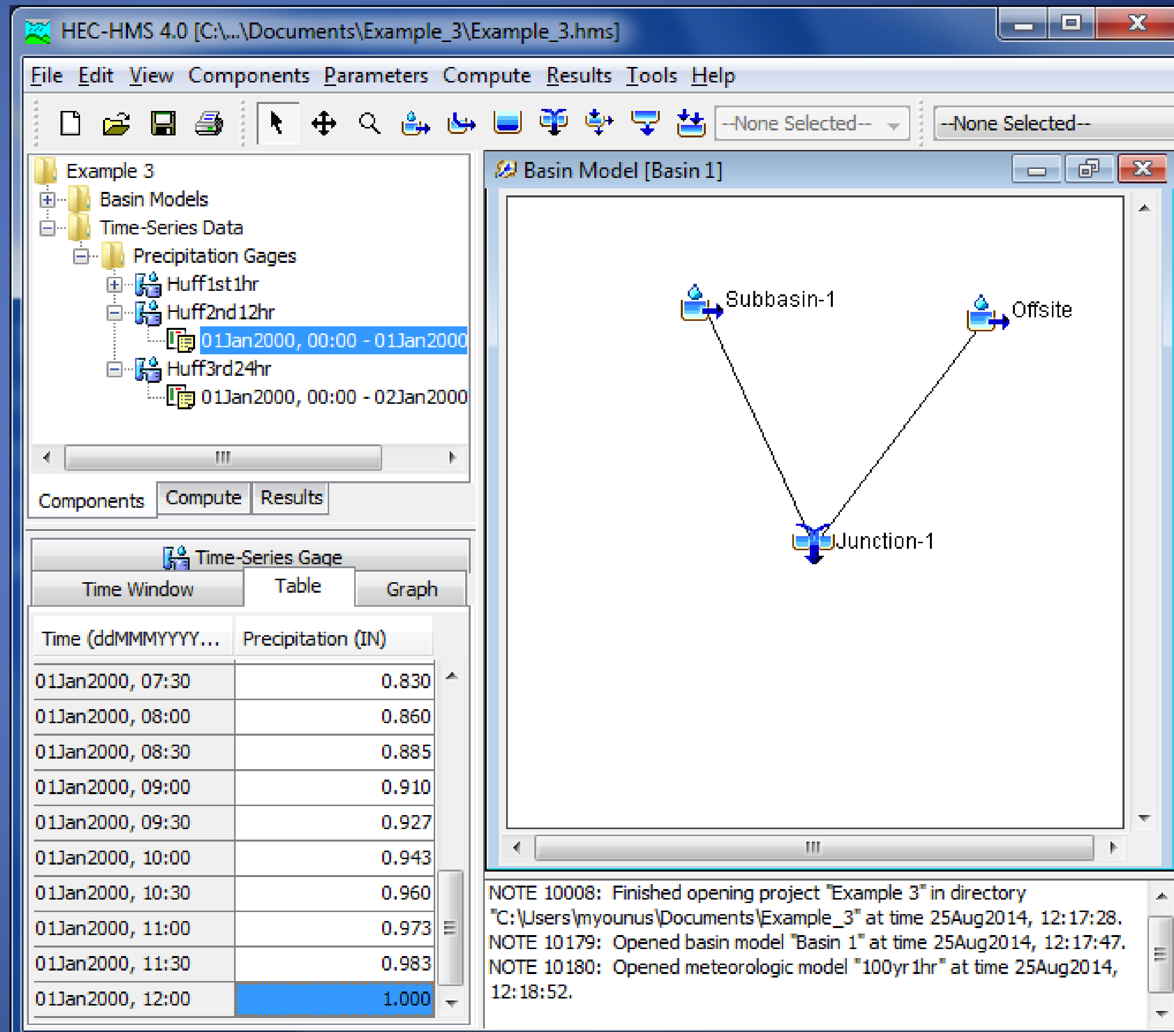
- Under the ***Time Window*** tab, run the storm from 01Jan2000 00:00 through 01Jan2000 12:00 (12-hour duration)



ENTERING TIME-SERIES DATA

Continue …

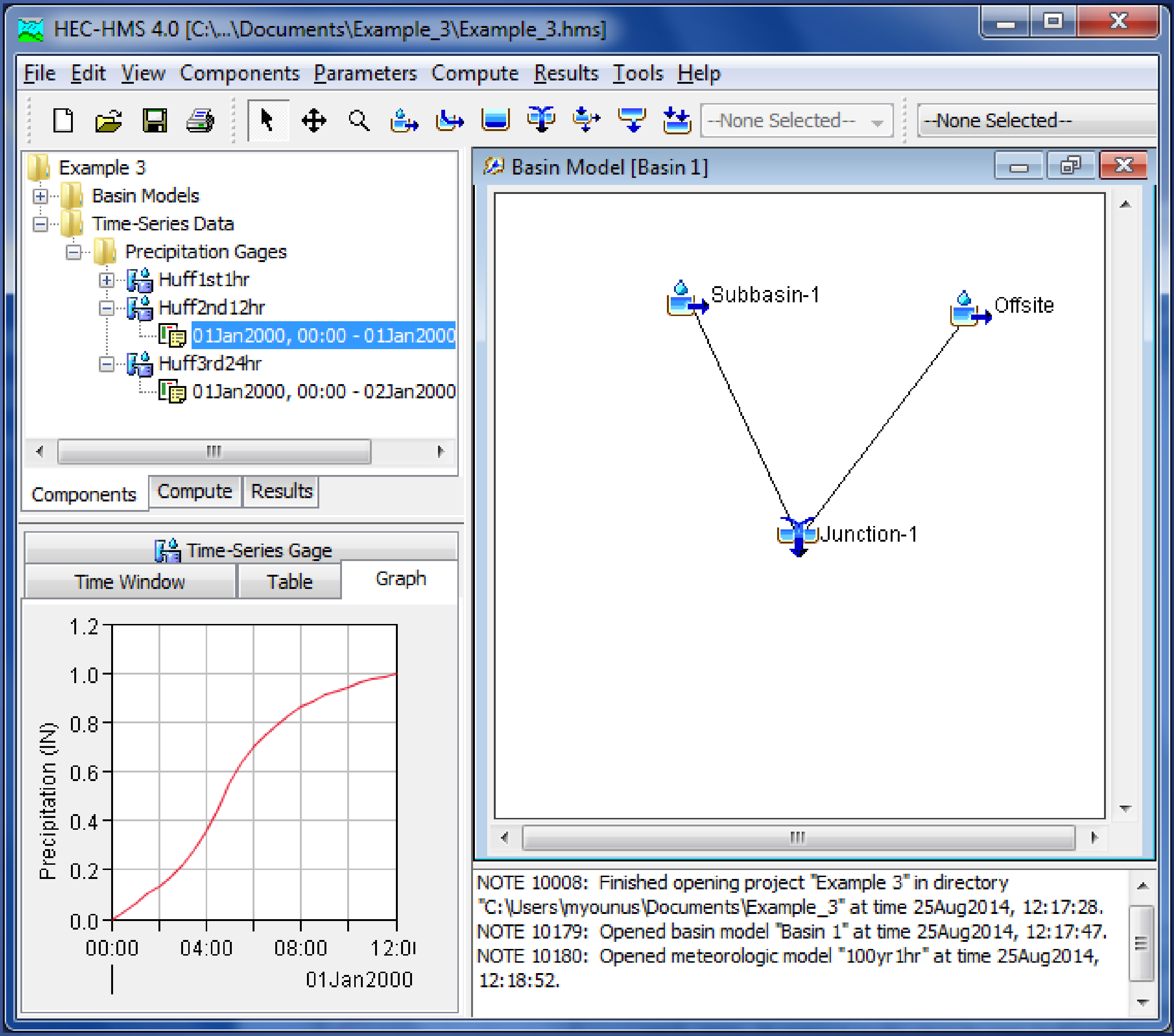
- Under the ***Table Tab***, Enter the Huff 2nd Quartile Distribution for the 12-hour duration from the handout



ENTERING TIME-SERIES DATA

Continue …

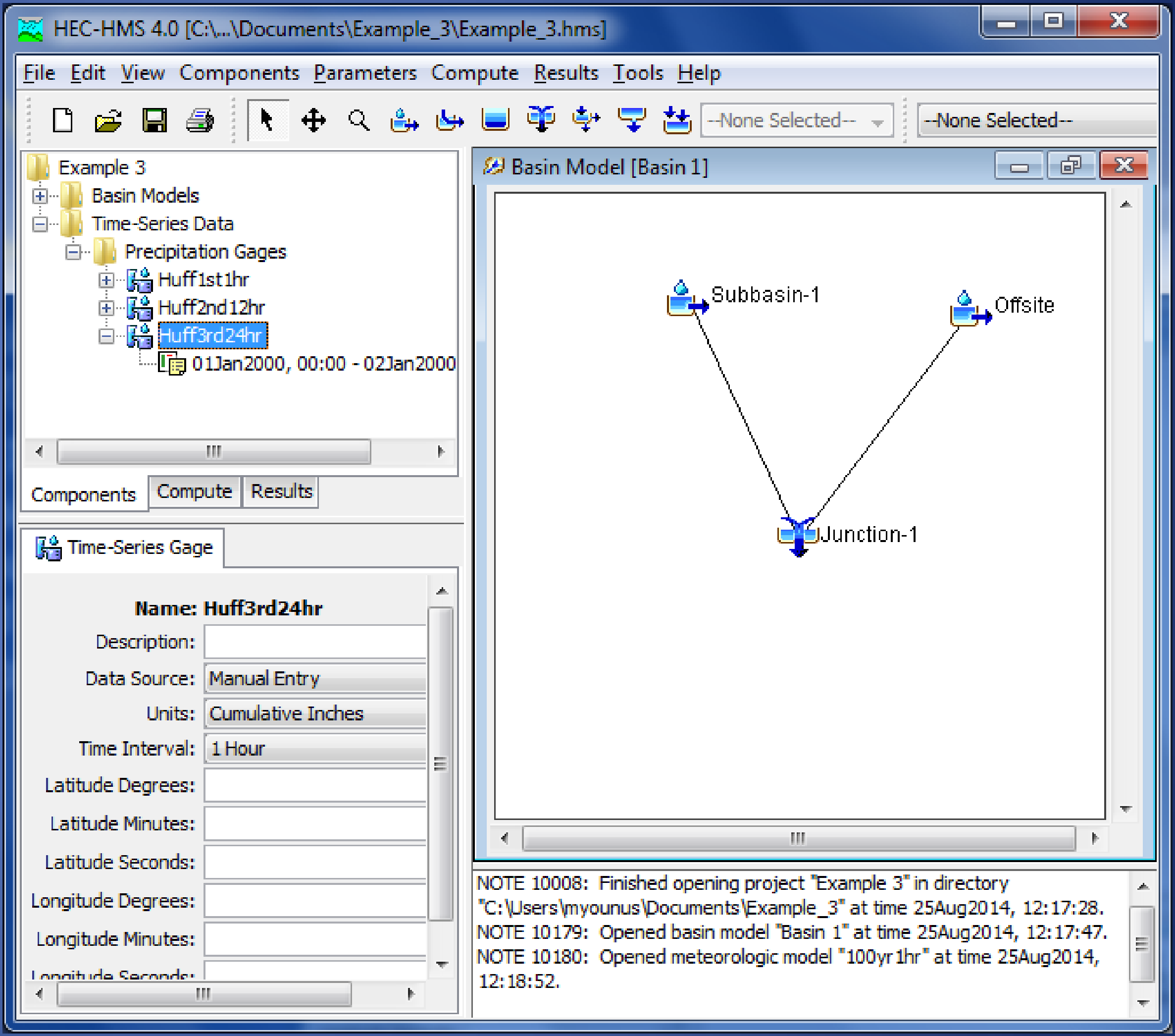
- Use the ***Graph*** tab to see a plot of the distribution



ENTERING TIME-SERIES DATA

Continue …

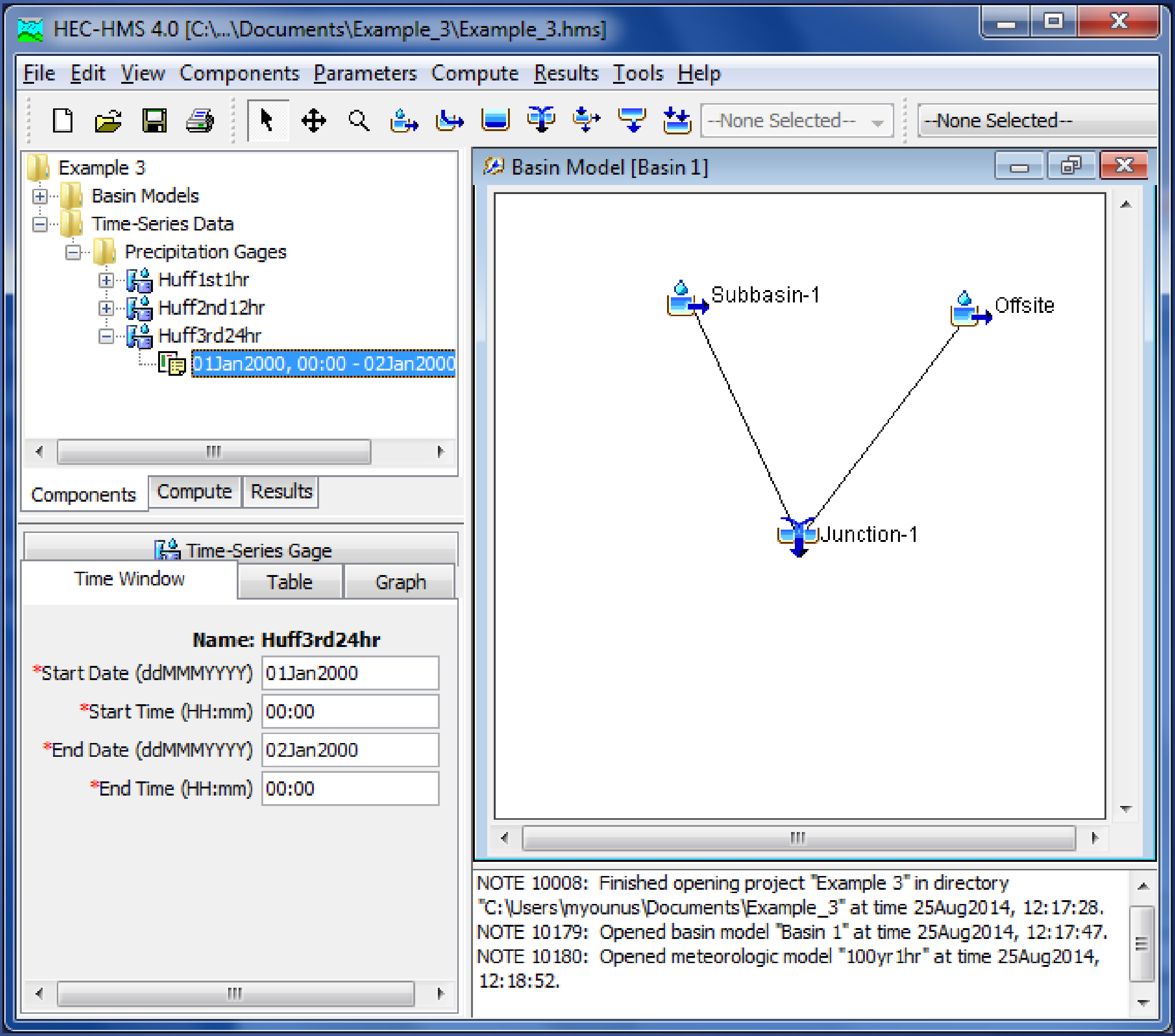
- Select Precipitation Gage "Huff3rd24hr"
- Under the ***Time-Series Gage*** tab, select *Manual Entry*, *Cumulative Inches*, and 1 hour minute increments



ENTERING TIME-SERIES DATA

Continue …

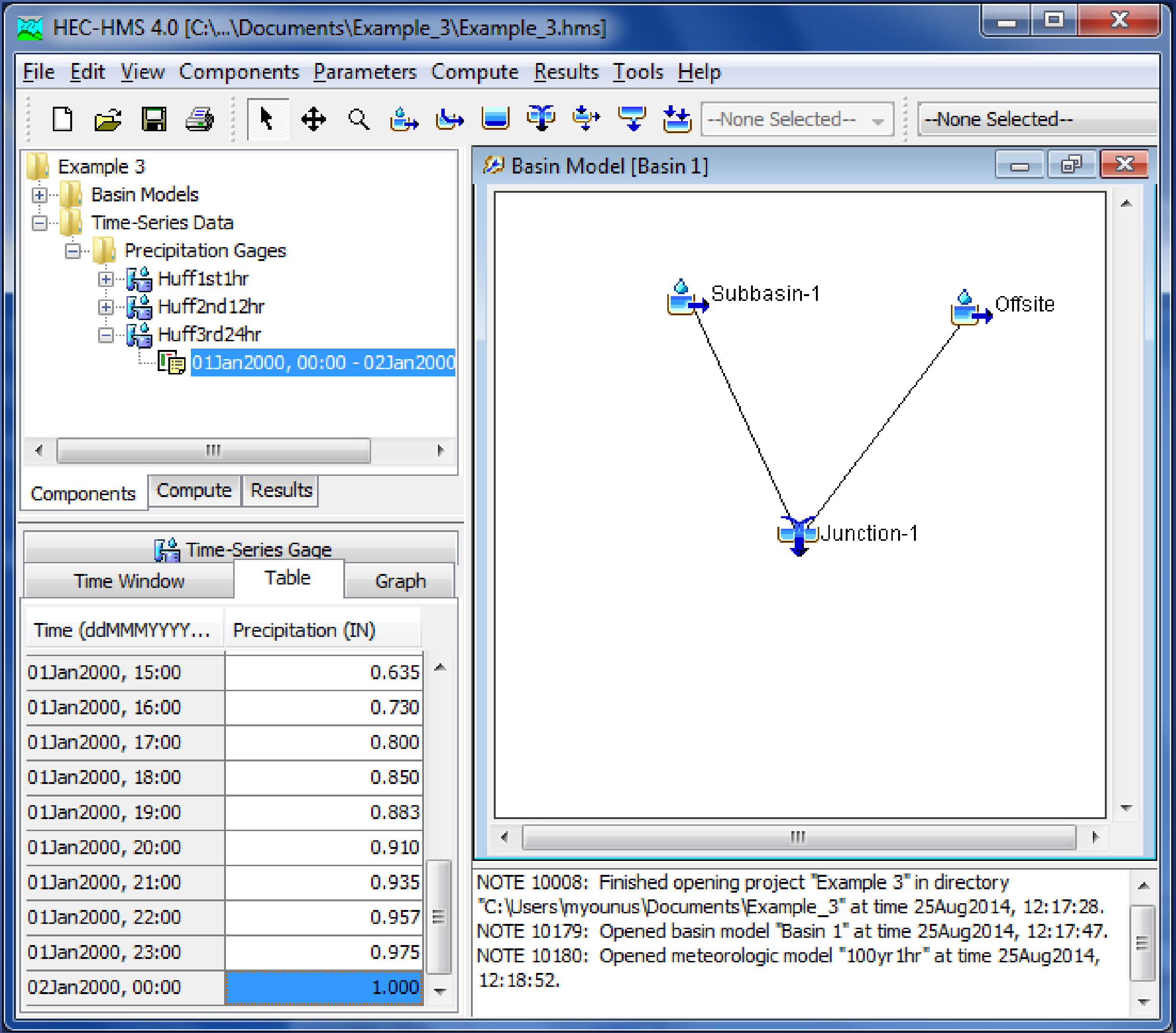
- Under the ***Time Window*** tab, run the storm from 01Jan2000 00:00 through 02Jan2000 00:00 (24-hour duration)



ENTERING TIME-SERIES DATA

Continue …

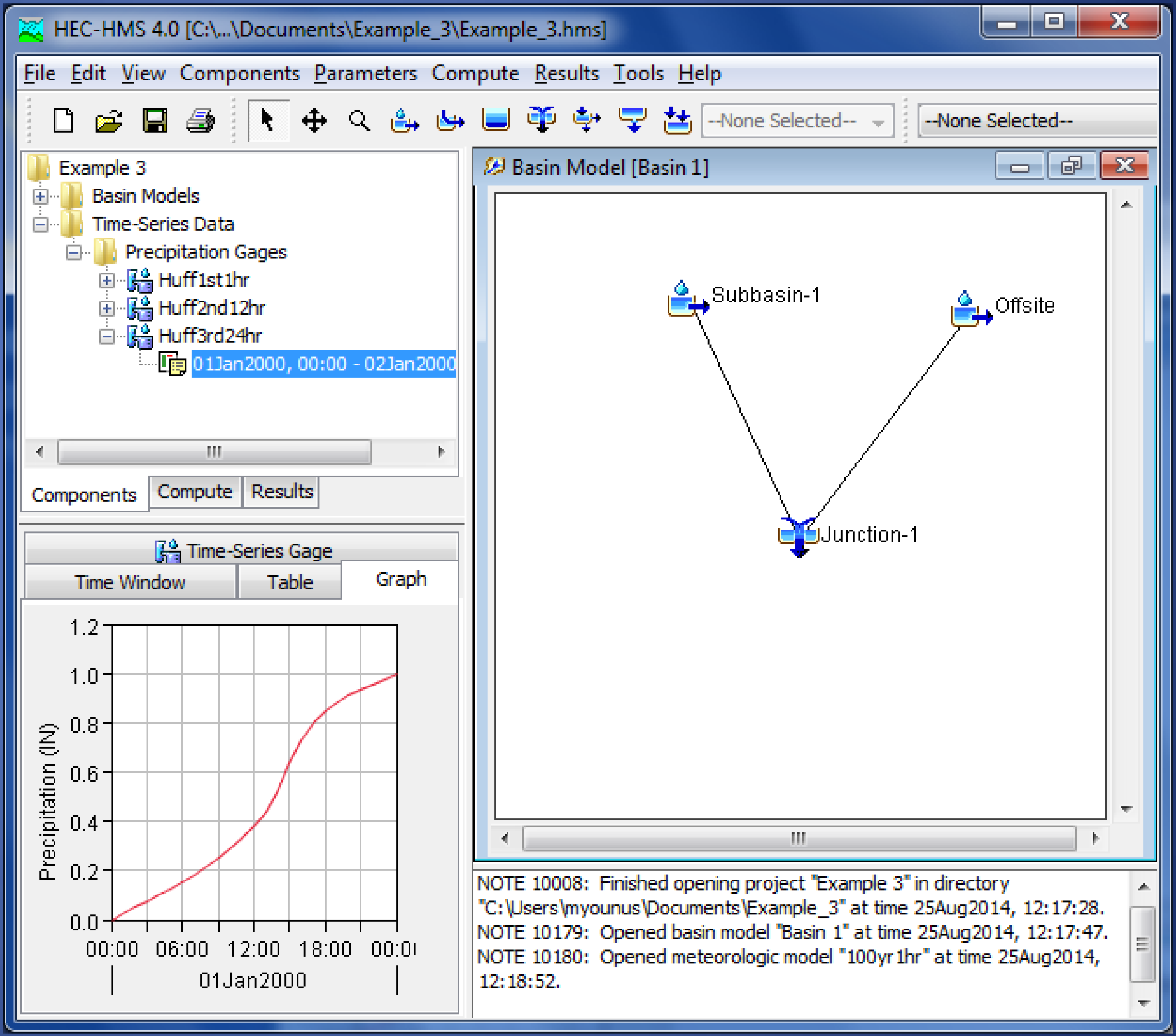
- Under the ***Table Tab***, Enter the Huff 3rd Quartile Distribution for the 24-hour duration from the handout



ENTERING TIME-SERIES DATA

Continue …

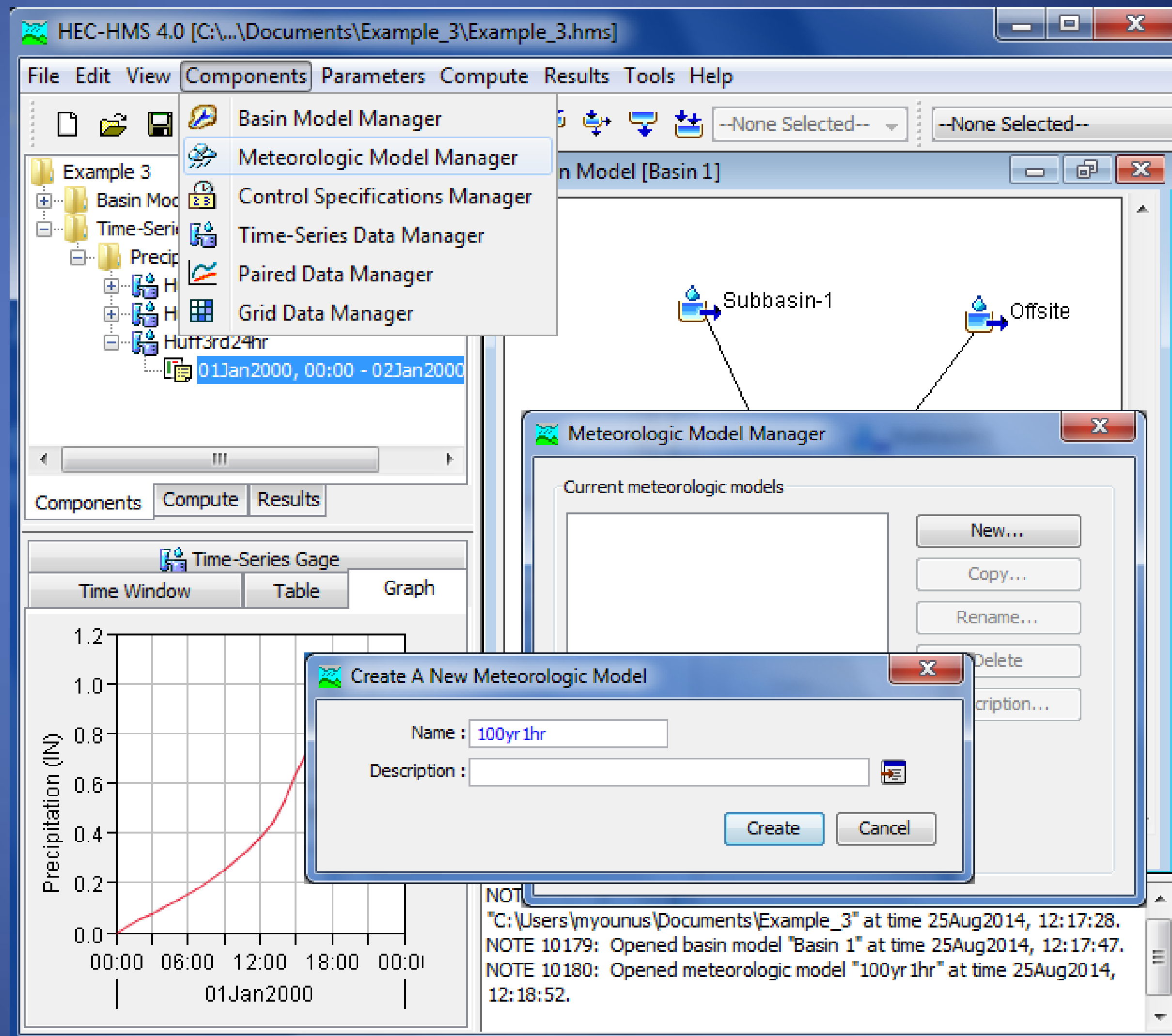
- Use the ***Graph*** tab to see a plot of the distribution



CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,1HR

- From the ***Components*** tab, create a new ***Meteorologic Model*** named “100yr1hr”

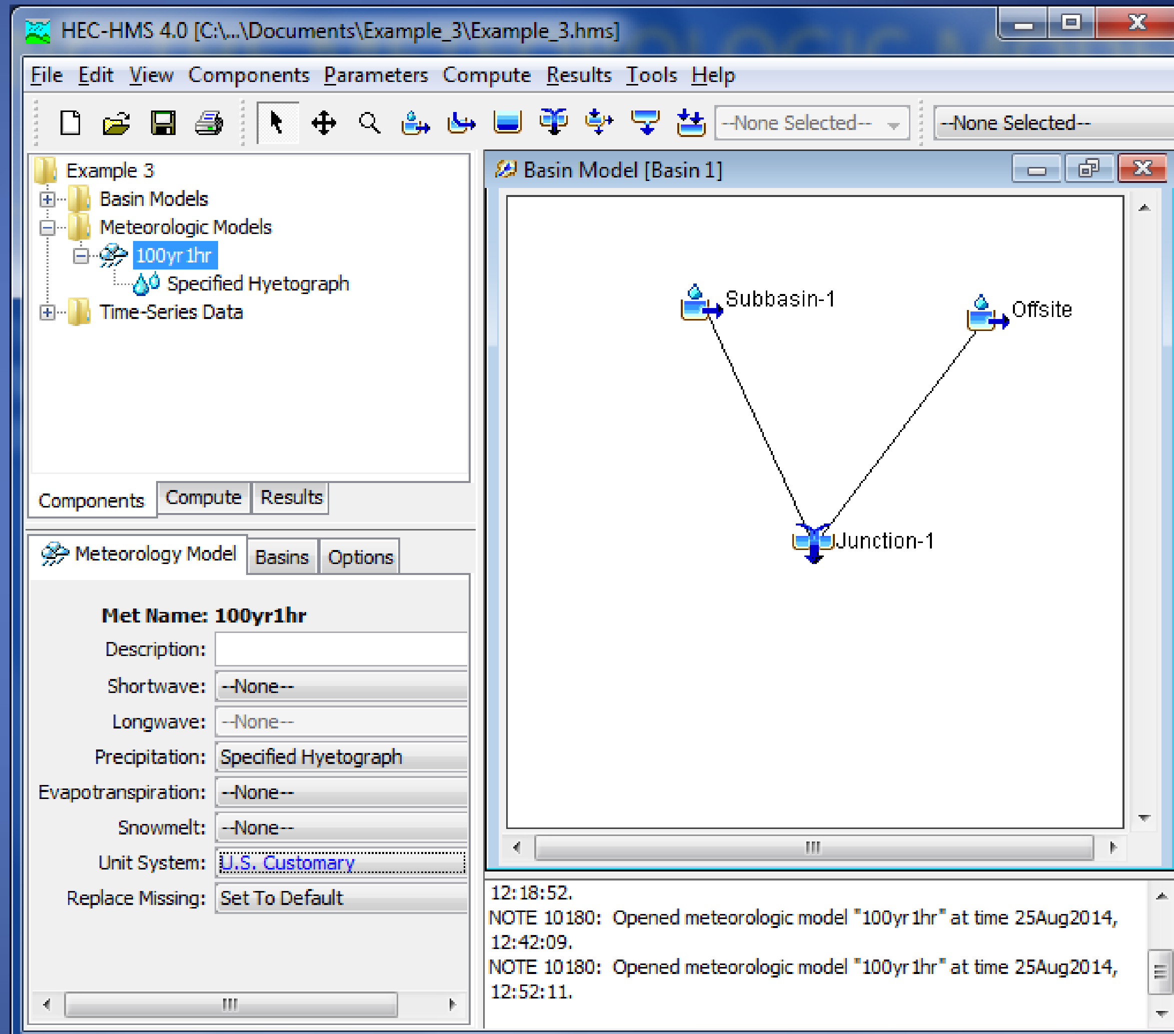


CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,1HR

Continue …

- Under the ***Meteorologic Model*** tab, make sure the ***Replace Missing*** is ***Set to Default***

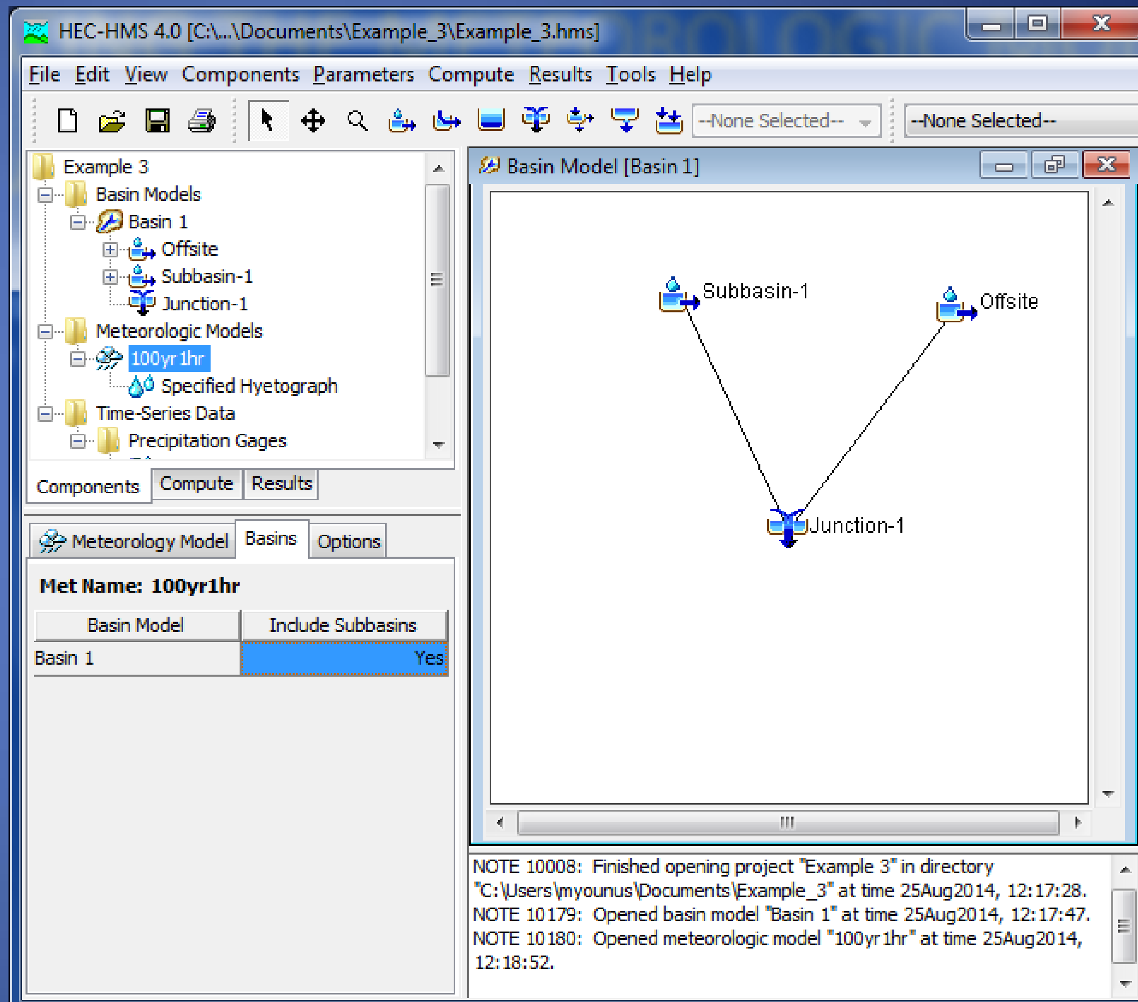


CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,1HR

Continue …

- Under the ***Basins*** tab, select ***Yes*** under ***Include Subbasins***?

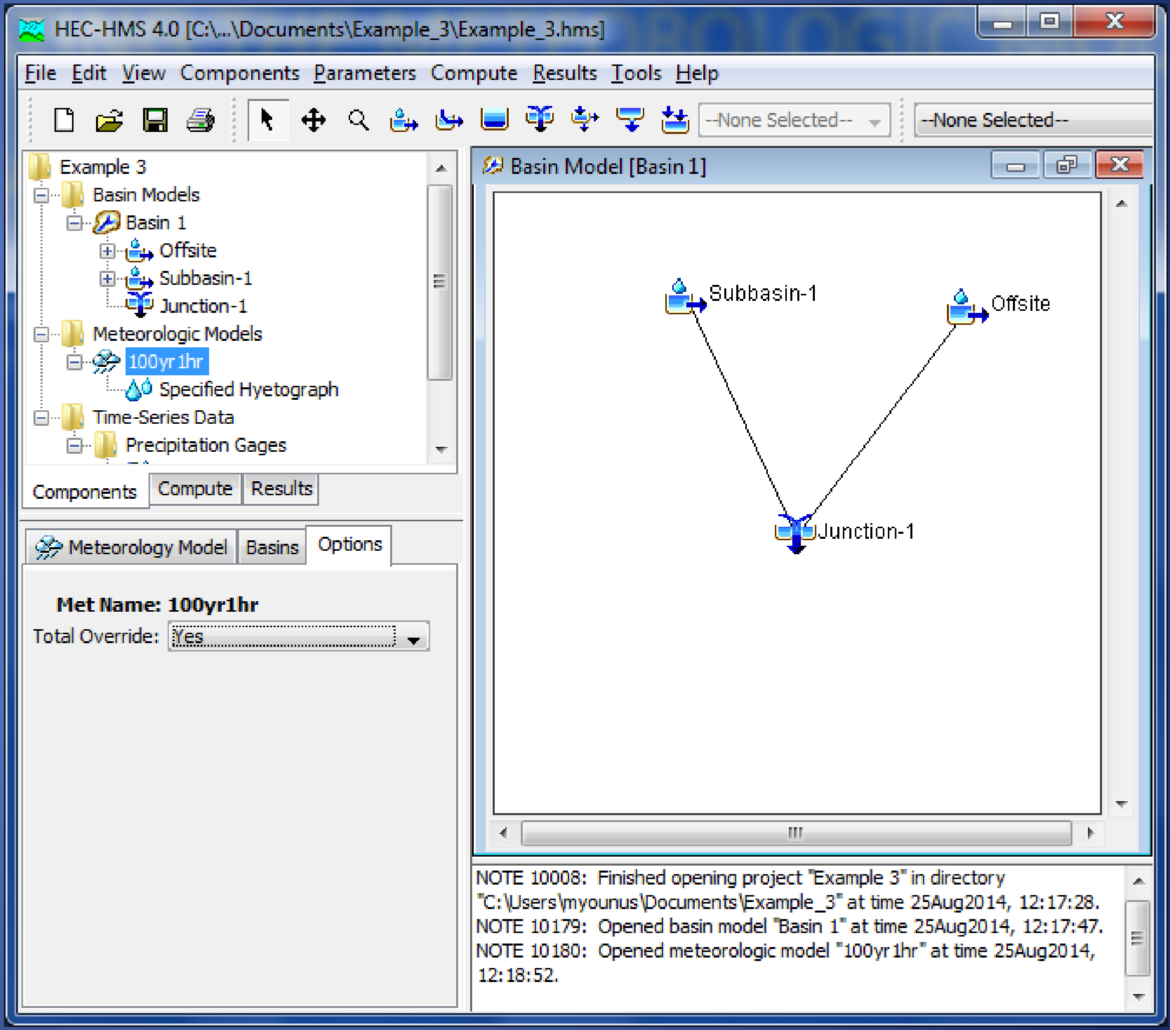


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,1HR

Continue …

- Under the ***Options*** tab, select ***Yes*** for ***Total Override***

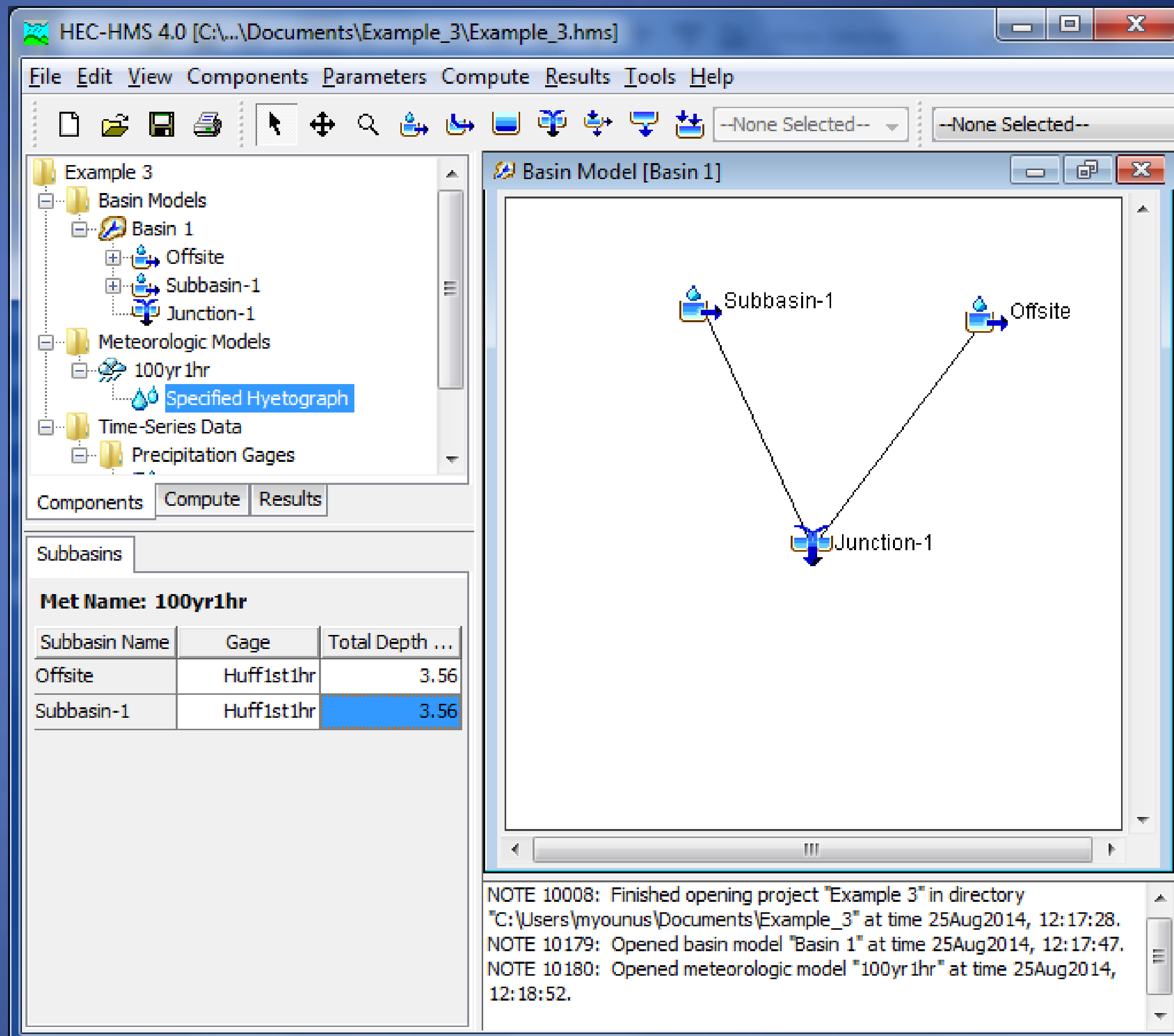


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,1HR

Continue …

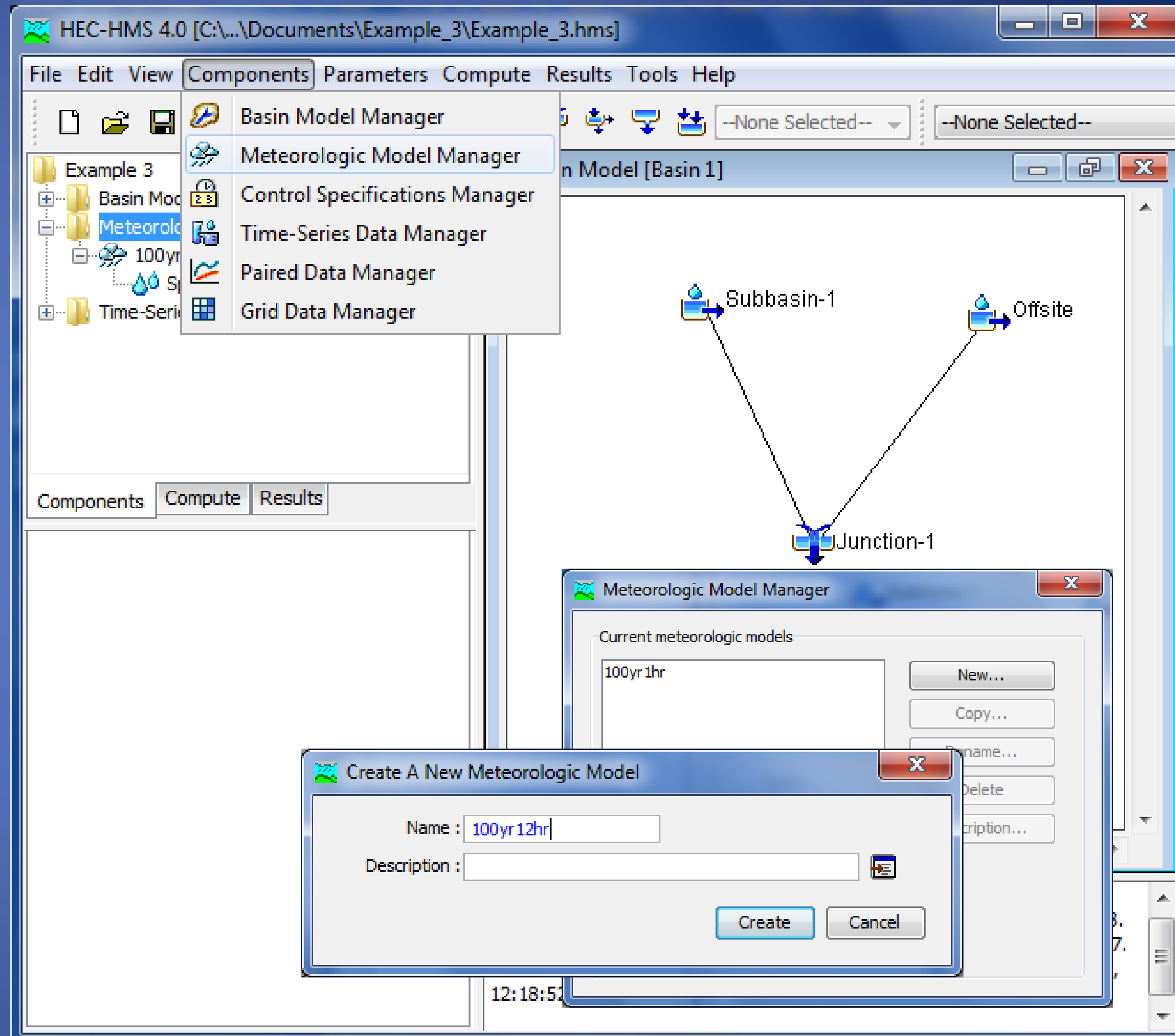
- Under the ***Specified Hyetograph*** tab, select the rainfall distribution that we previously created and enter the 100-year, 1-hour rainfall depth.



CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,12HR

- From the ***Components*** tab, create a new ***Meteorologic Model*** named “100yr12hr”

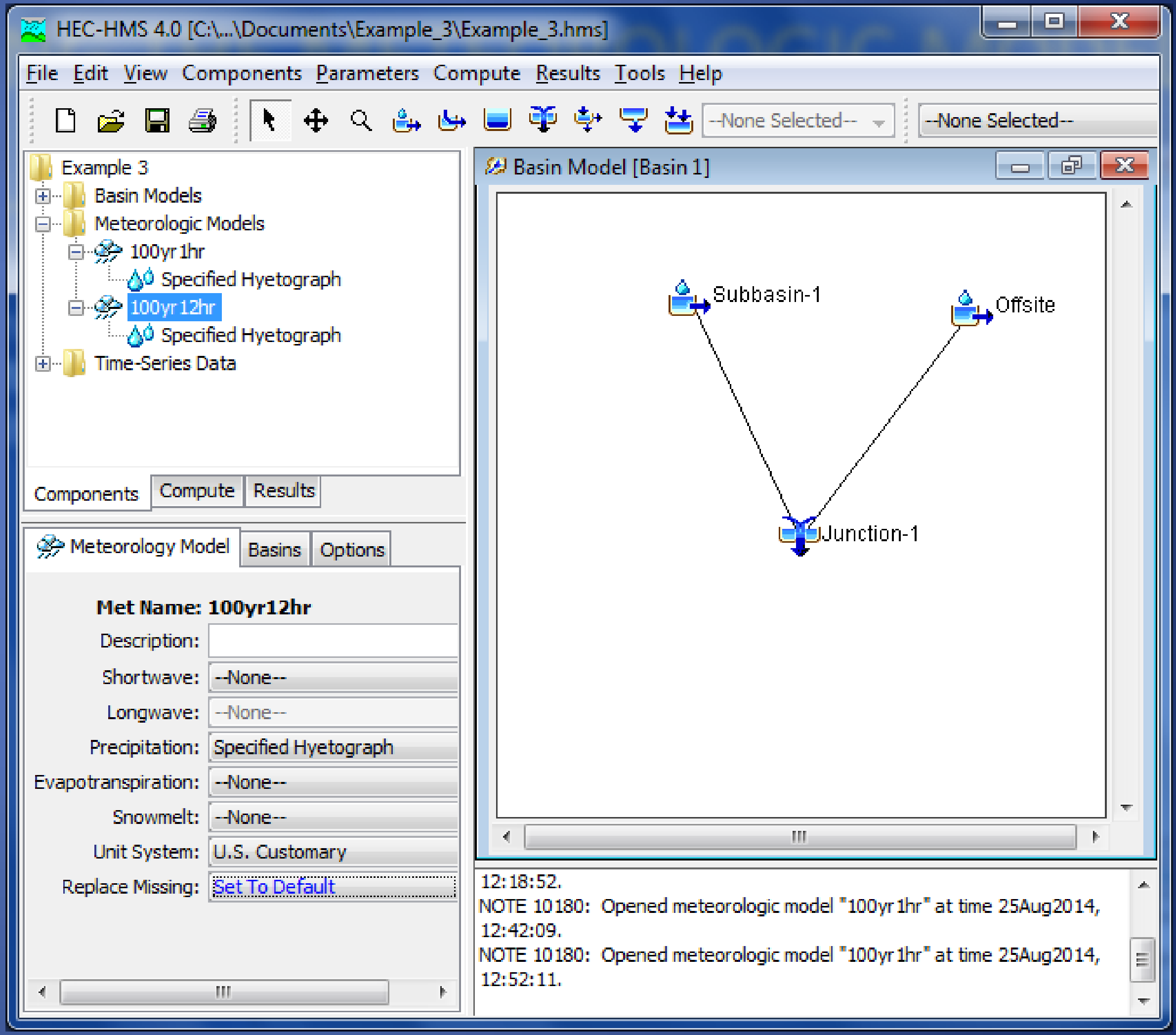


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,12HR

Continue …

- Under the ***Meteorologic Model*** tab, make sure the ***Replace Missing*** is ***Set to Default***

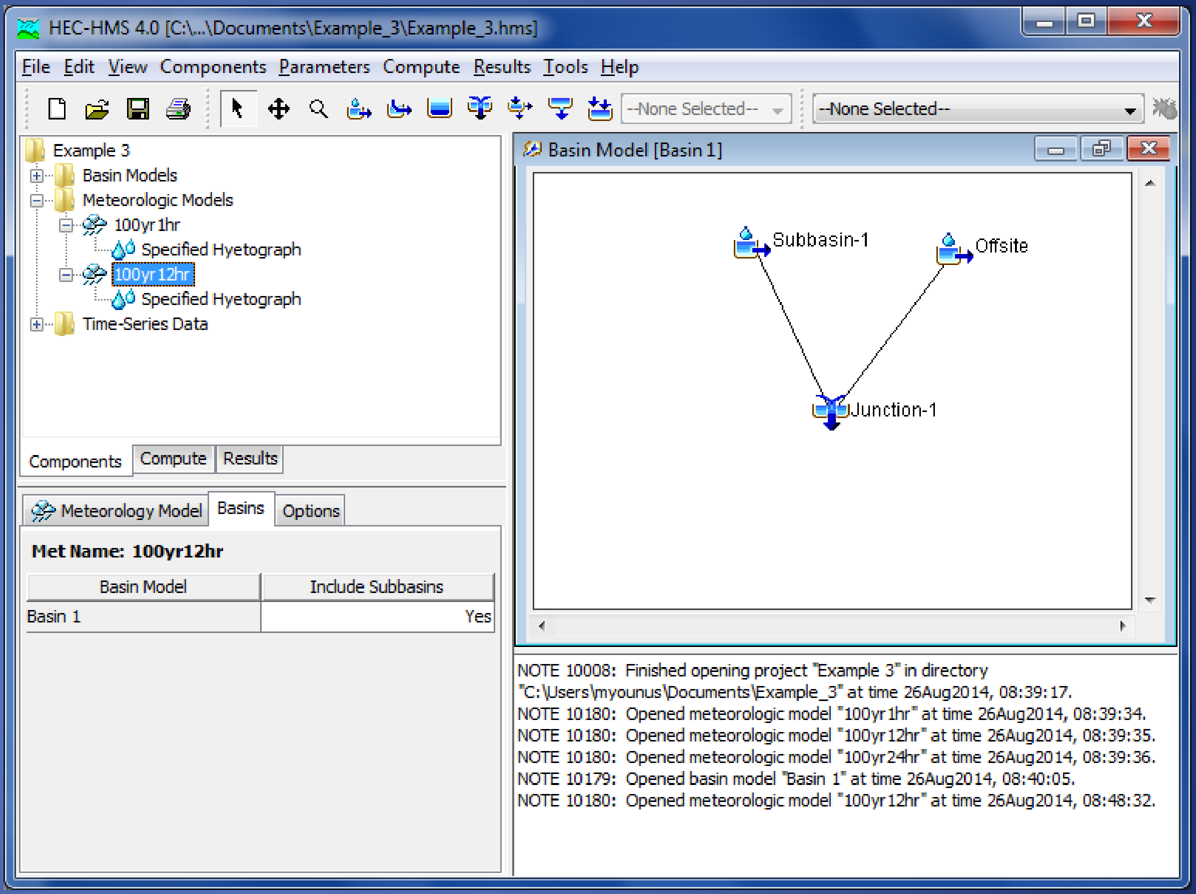


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,12HR

Continue …

- Under the ***Basins*** tab, select ***Yes*** under ***Include Subbasins***?

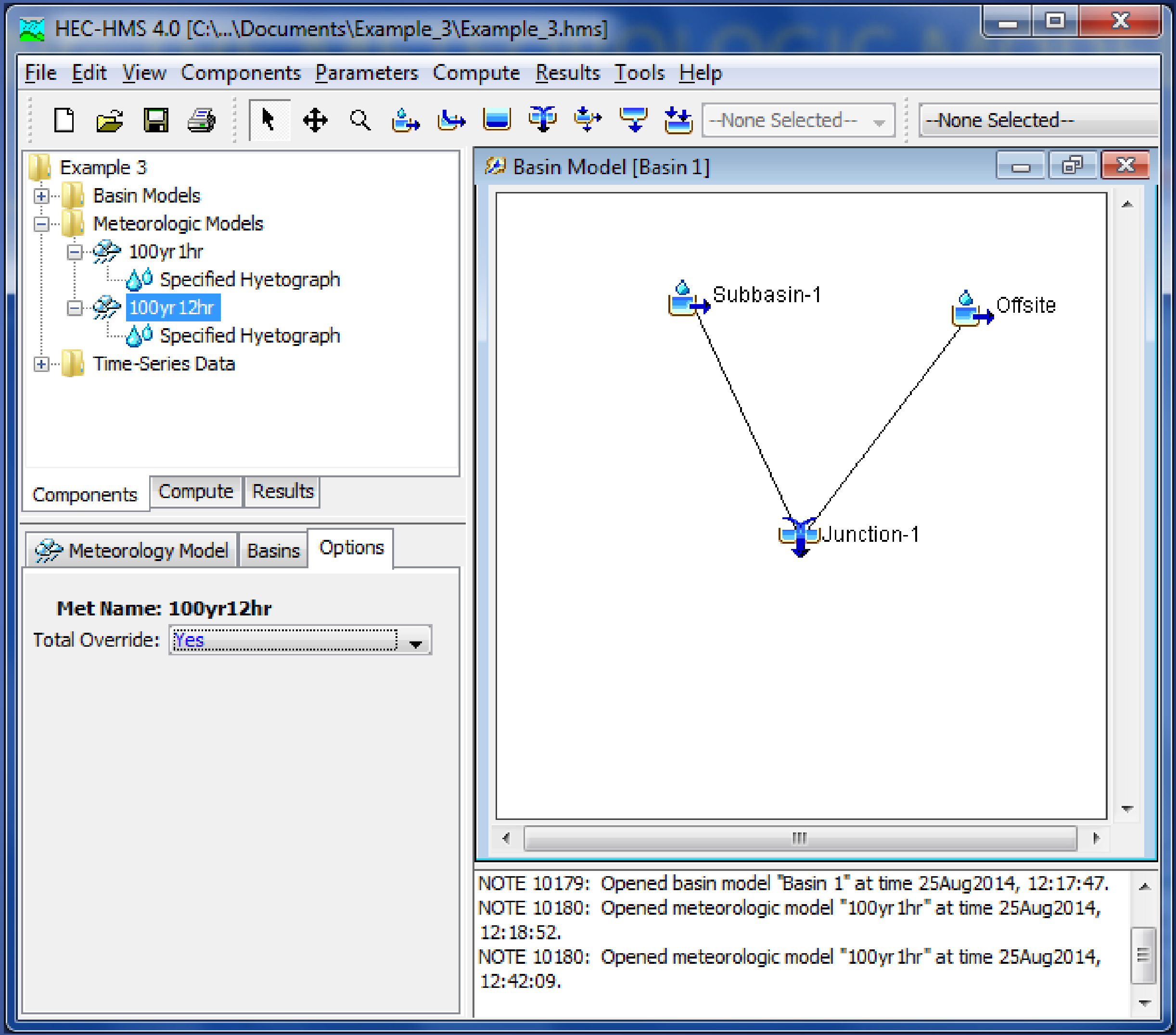


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,12HR

Continue …

- Under the ***Options*** tab, select ***Yes*** for ***Total Override***

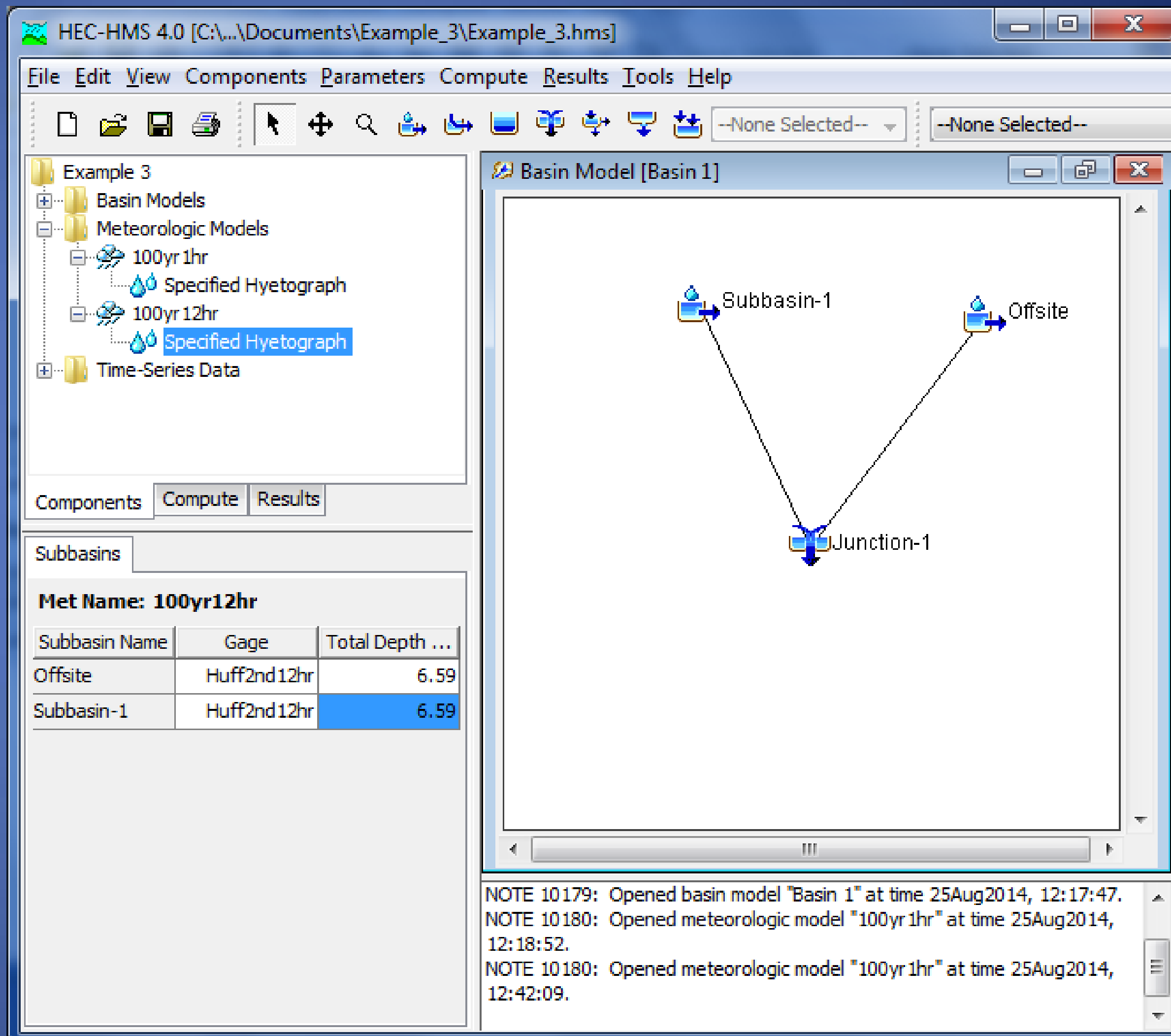


CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,12HR

Continue …

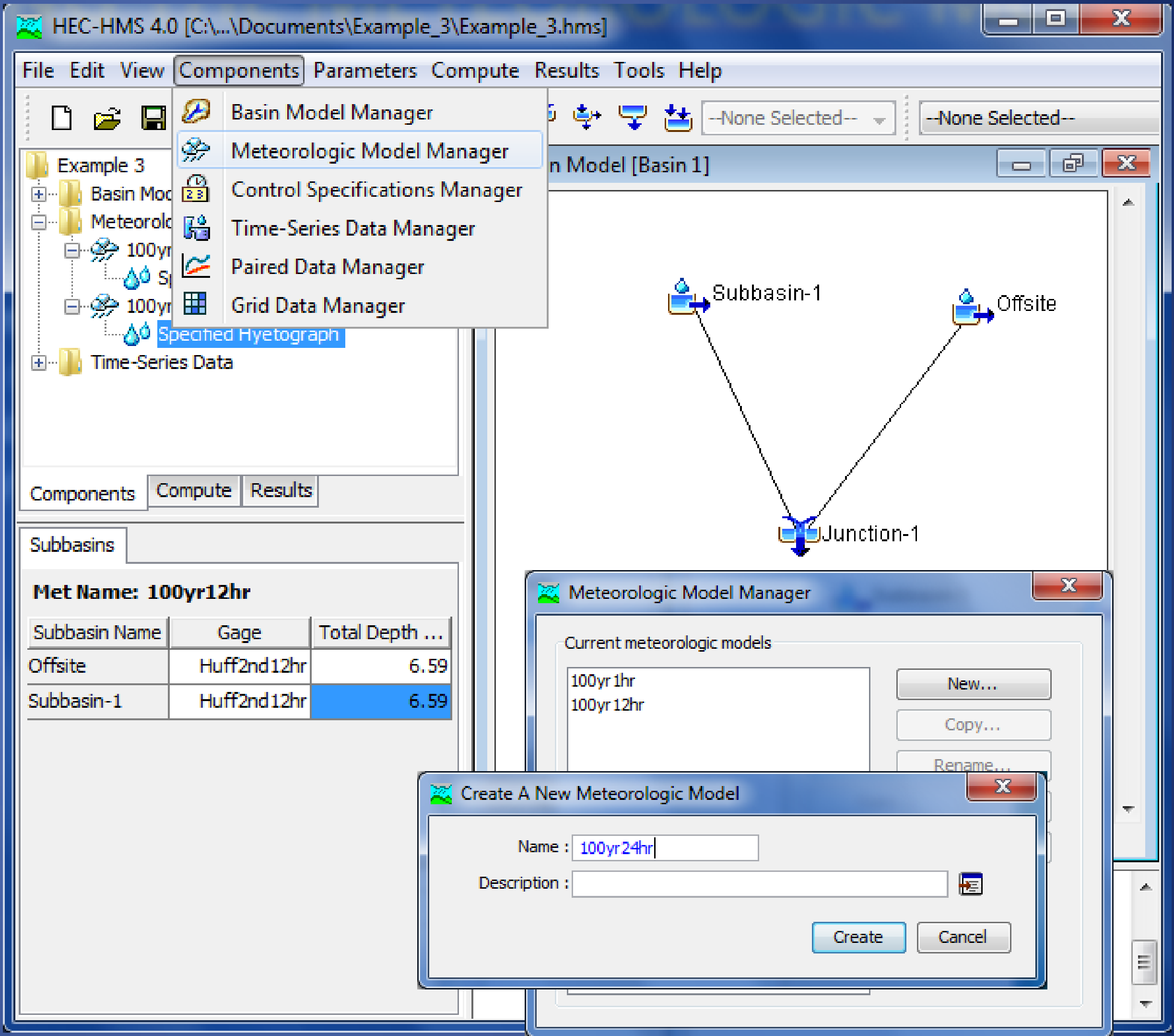
- Under the ***Specified Hyetograph*** tab, select the rainfall distribution that we previously created and enter the 100-year, 1-hour rainfall depth.



CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,24HR

- From the ***Components*** tab, create a new ***Meteorologic Model*** named "100yr12hr"

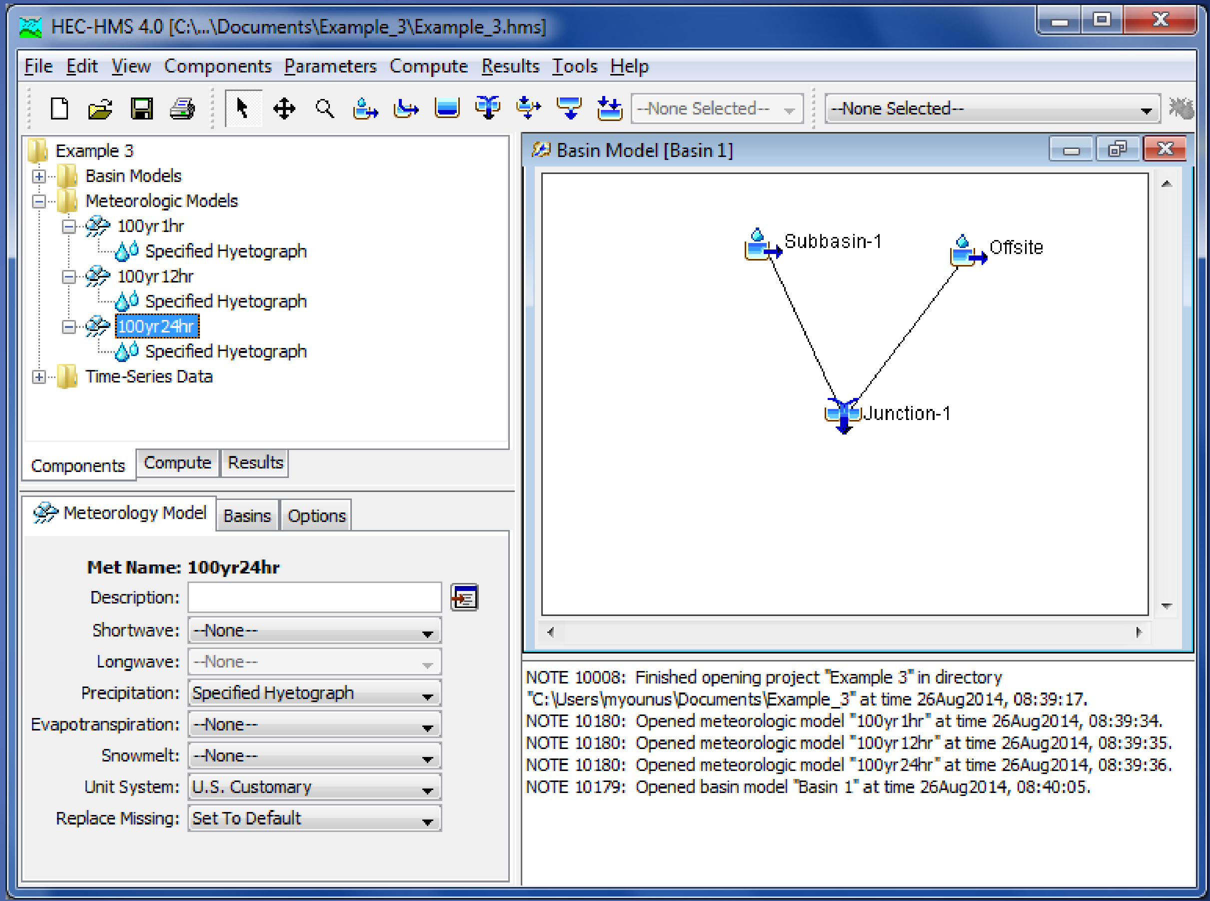


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,24HR

Continue …

- Under the ***Meteorologic Model*** tab, make sure the ***Replace Missing*** is ***Set to Default***

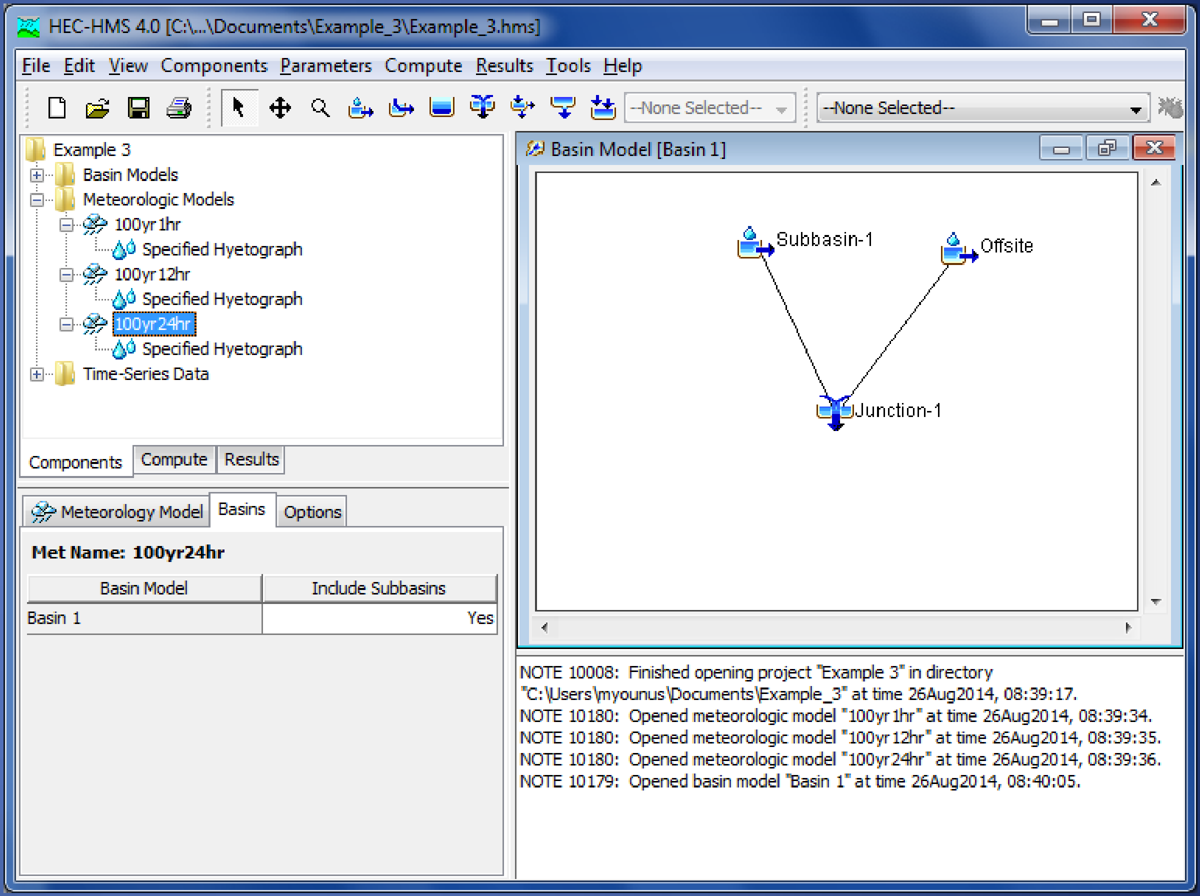


CREATING THE METEOROLOGIC MODEL

STORM EVENT:
100YR,24HR

Continue …

- Under the ***Basins*** tab, select ***Yes*** under ***Include Subbasins***?

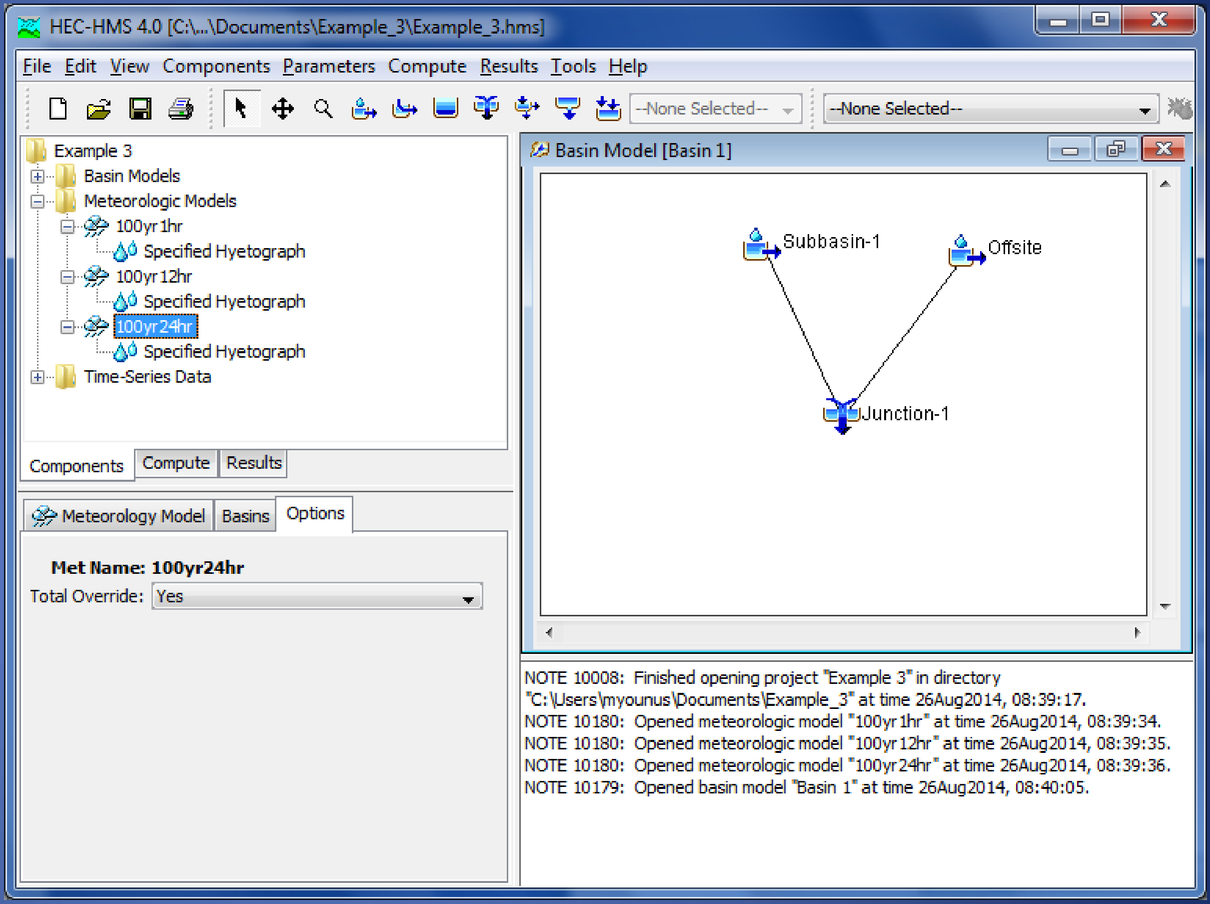


CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,24HR

Continue …

- Under the ***Options*** tab, select ***Yes*** for ***Total Override***

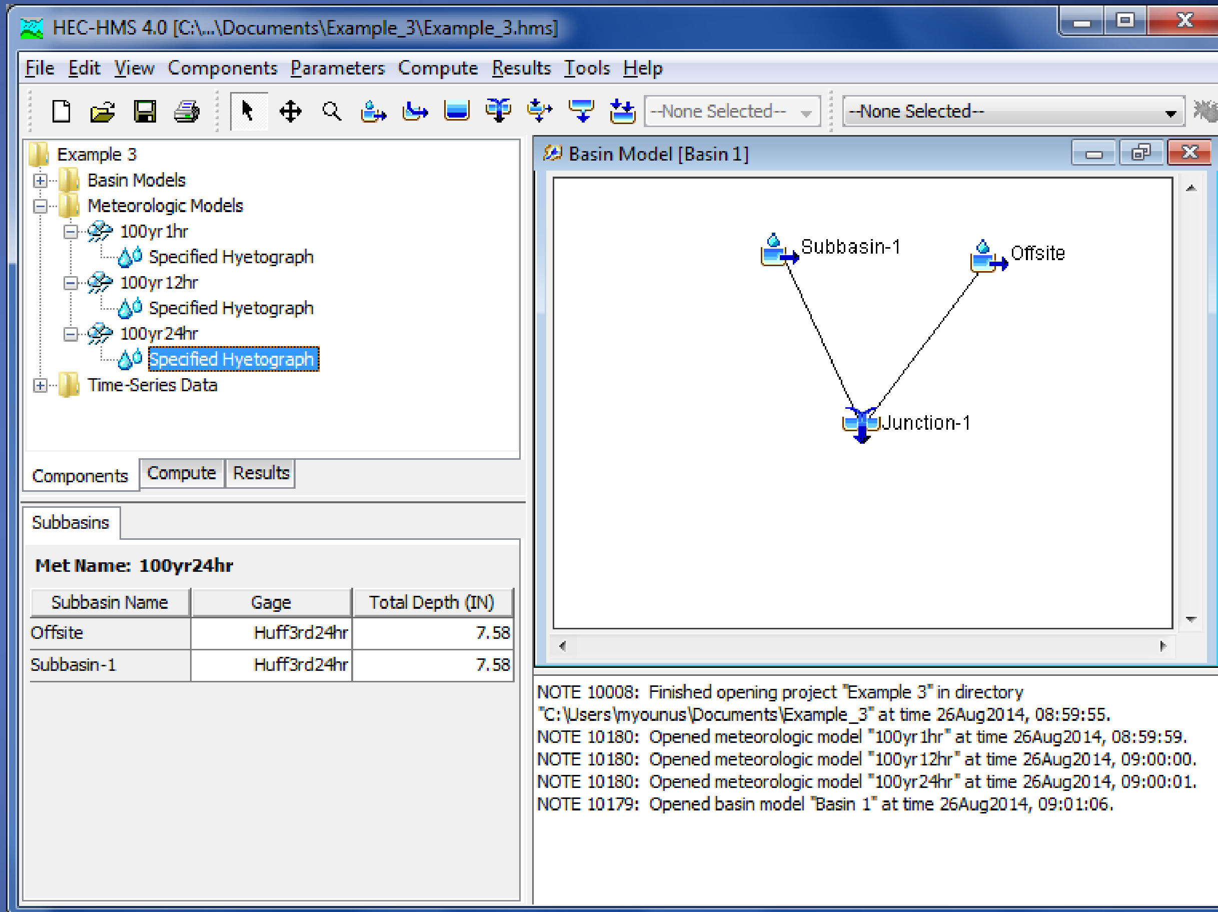


CREATING THE METEOROLOGIC MODEL

STORM EVENT: 100YR,24HR

Continue …

- Under the ***Specified Hyetograph*** tab, select the rainfall distribution that we previously created and enter the 100-year, 1-hour rainfall depth.

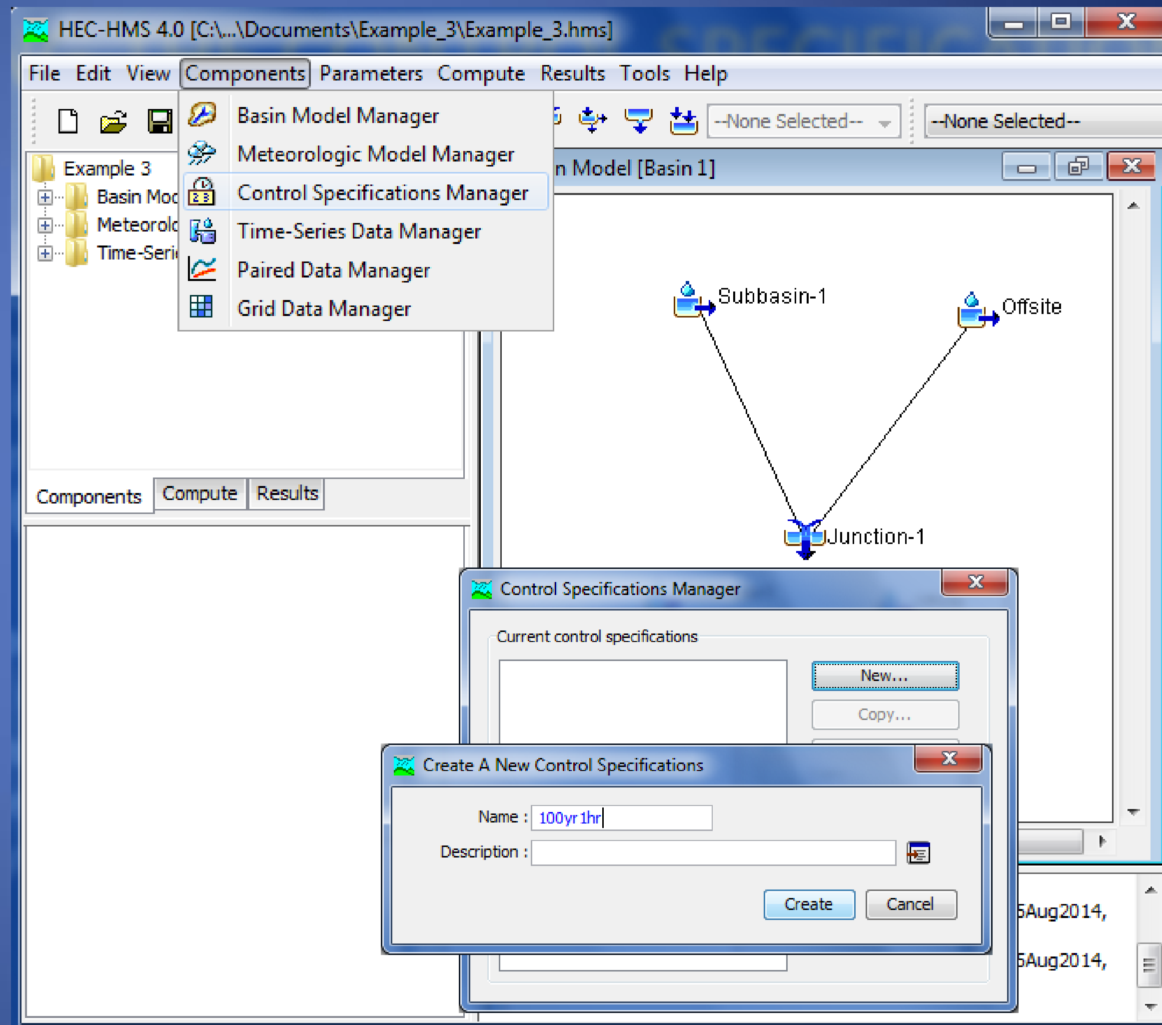


CREATING THE CONTROL SPECIFICATIONS

100yr,1hr

- We still need the specify how long to run the model for and how often we want to see output…this is performed under the ***Control Specifications***

- Under the ***Components*** menu, select ***Control Specifications Manager*** to create a new one named “100yr1hr”

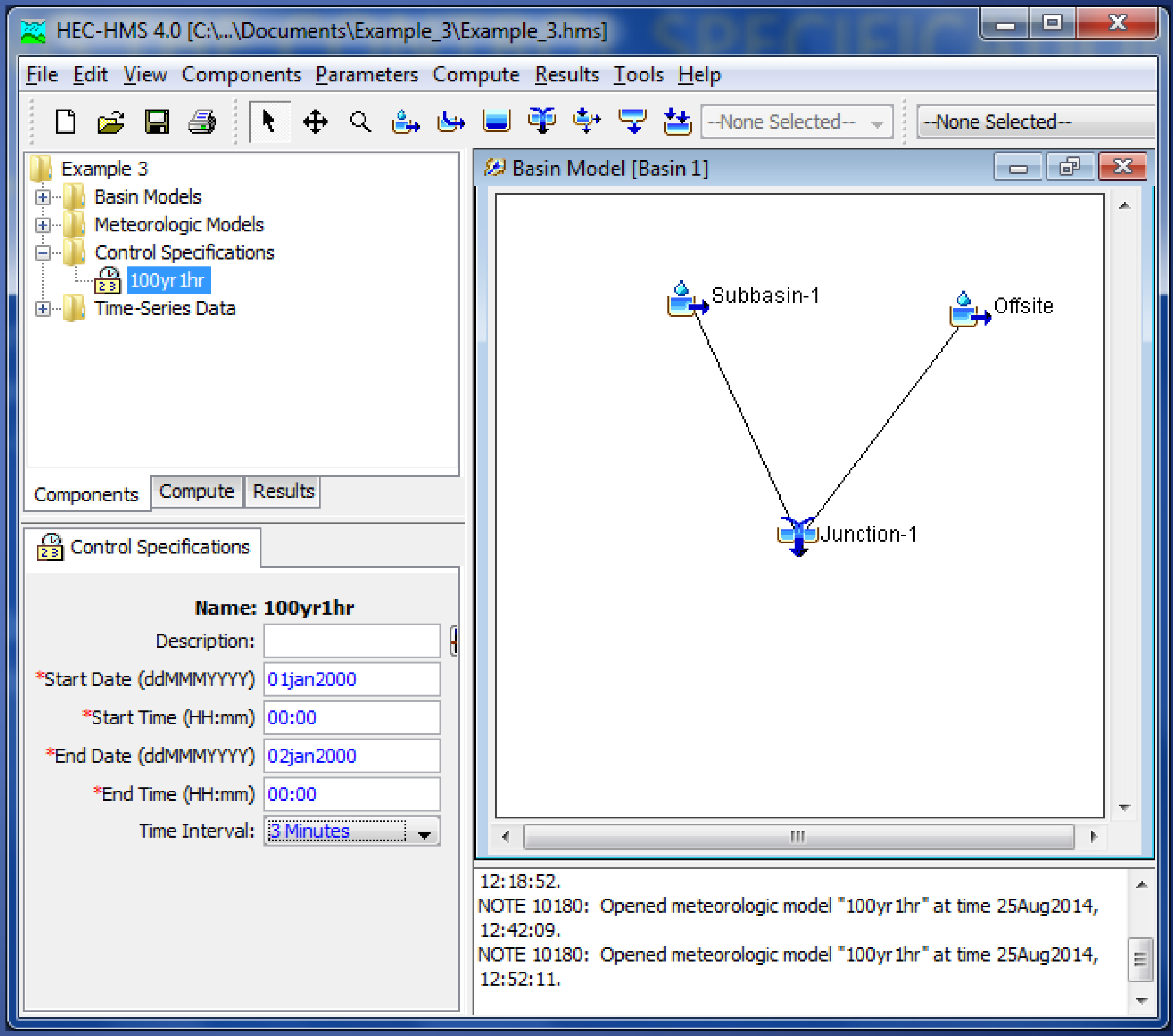


CREATING THE CONTROL SPECIFICATIONS

100yr,1hr

Continue …

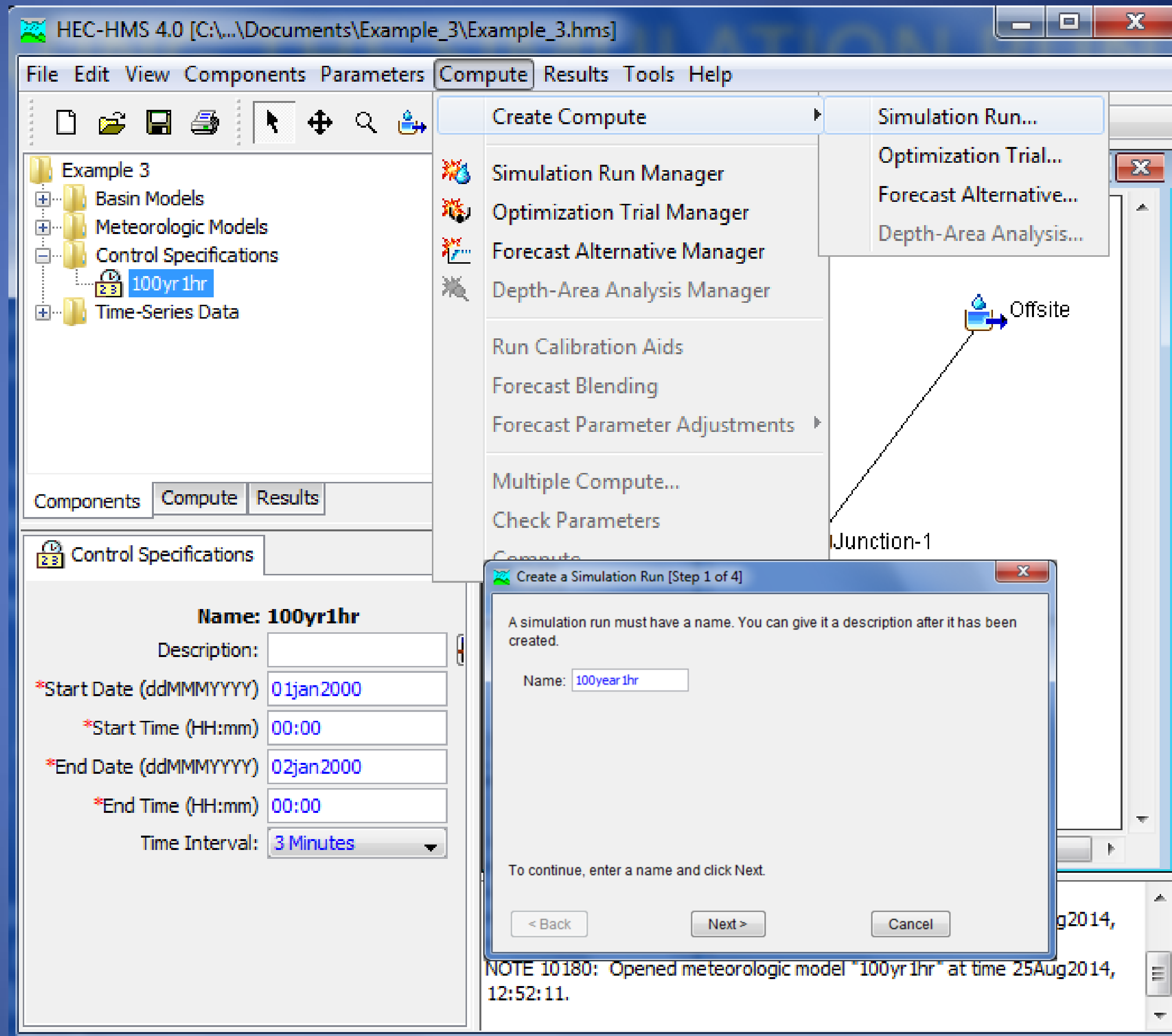
- Specify 01Jan2000 through 02Jan2000
- Under ***Time Interval***, specify 3 minute



CREATING THE SIMULATION RUN

100yr,1hr

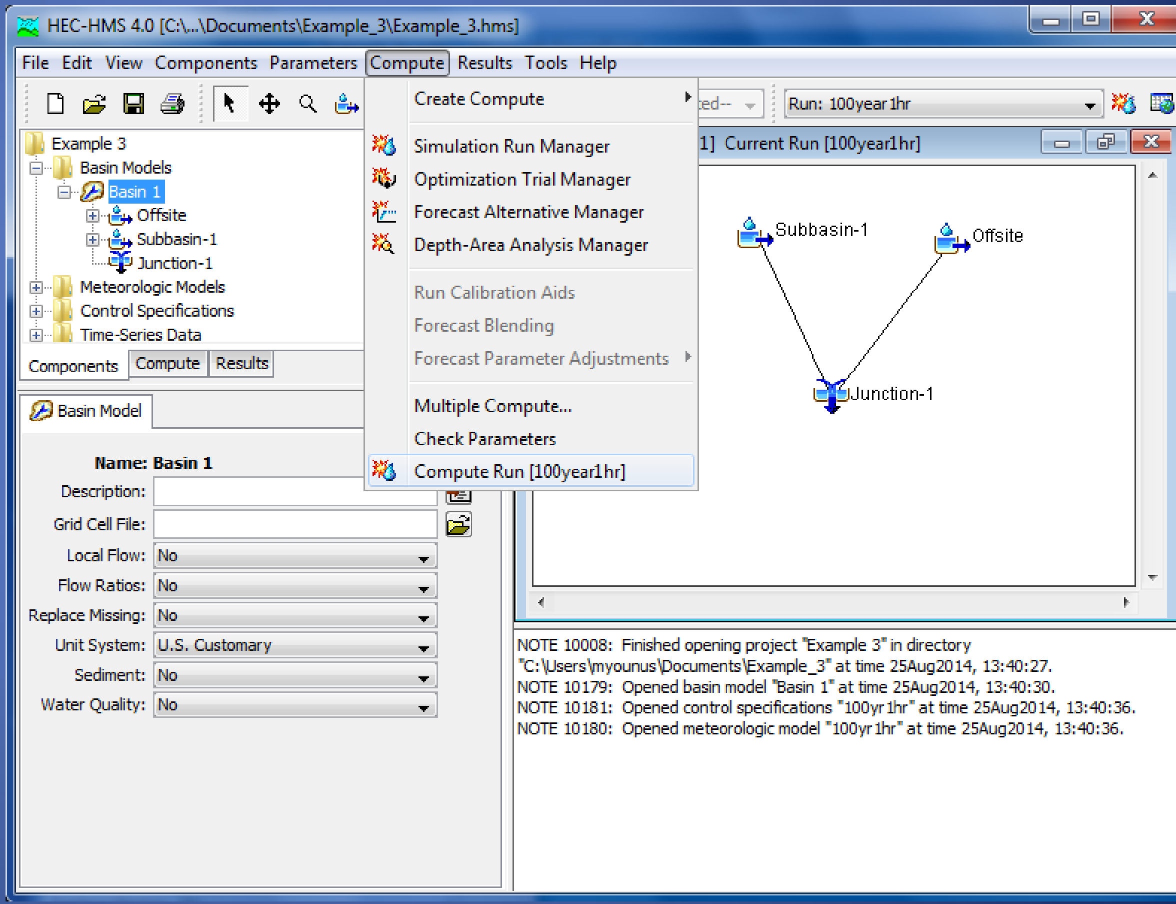
- A *Simulation Run* is a combination of:
  - ***Basin Model***
  - ***Meteorologic Model***
  - ***Control Specifications***
- To create a new *Simulation Run*, select ***Create Compute > Simulation Run*** under the ***Components*** menu
- Name the run “100yr1hr” and click ***Next***
- Specify the ***Basin Model***, ***Meteorologic Model***, and ***Control Specifications*** that we’ve just created for 100yr1hr storm event



RUNNING THE SIMULATION

100yr,1hr

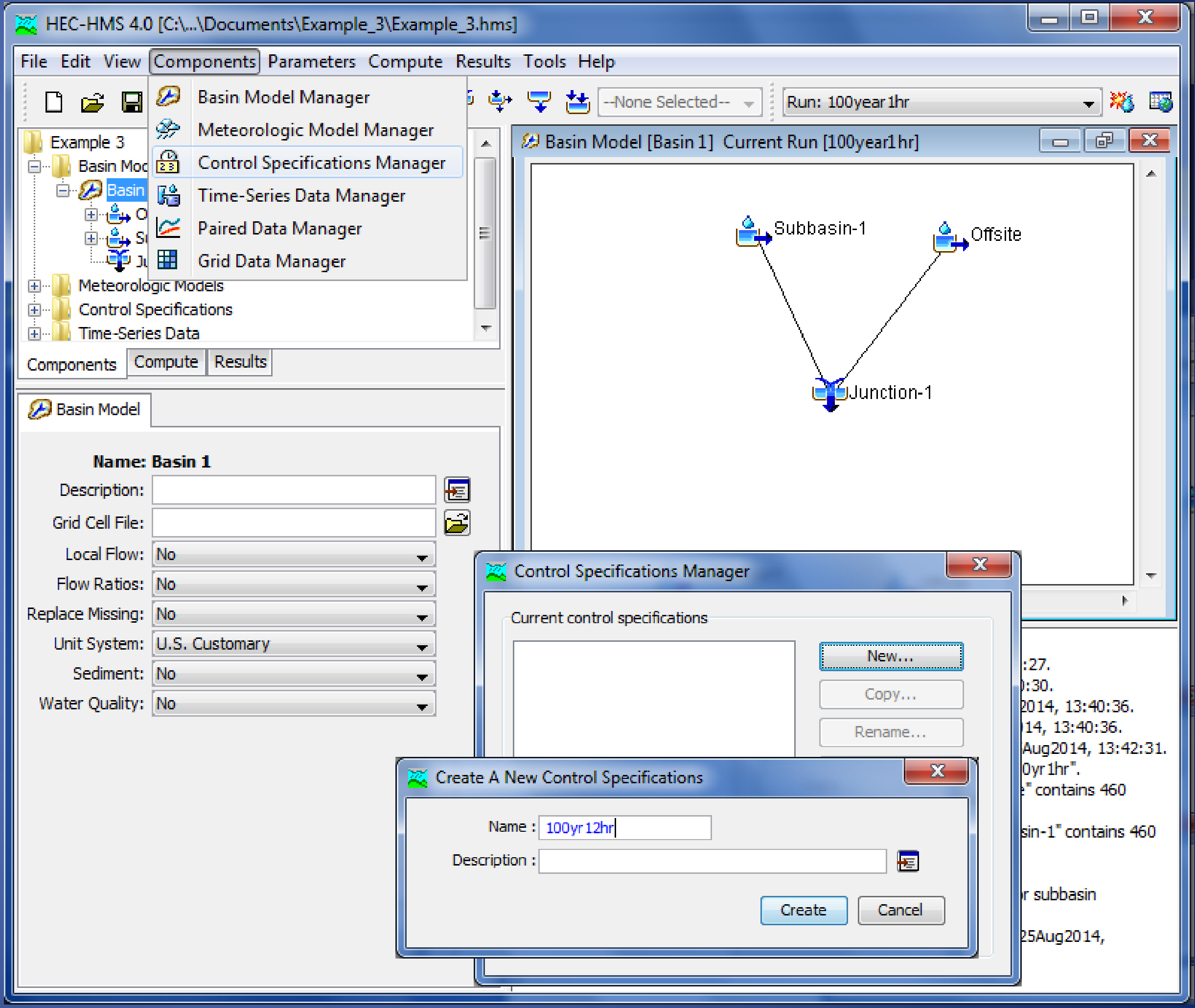
- Under the ***Compute*** menu, select ***Compute Run [100yr1hr]***
- All errors, warnings, and notes are shown in the lower right hand window
- If there are errors, they will show up in red and the simulation will not run successfully



CREATING THE CONTROL SPECIFICATIONS

100-yr, 12-hr

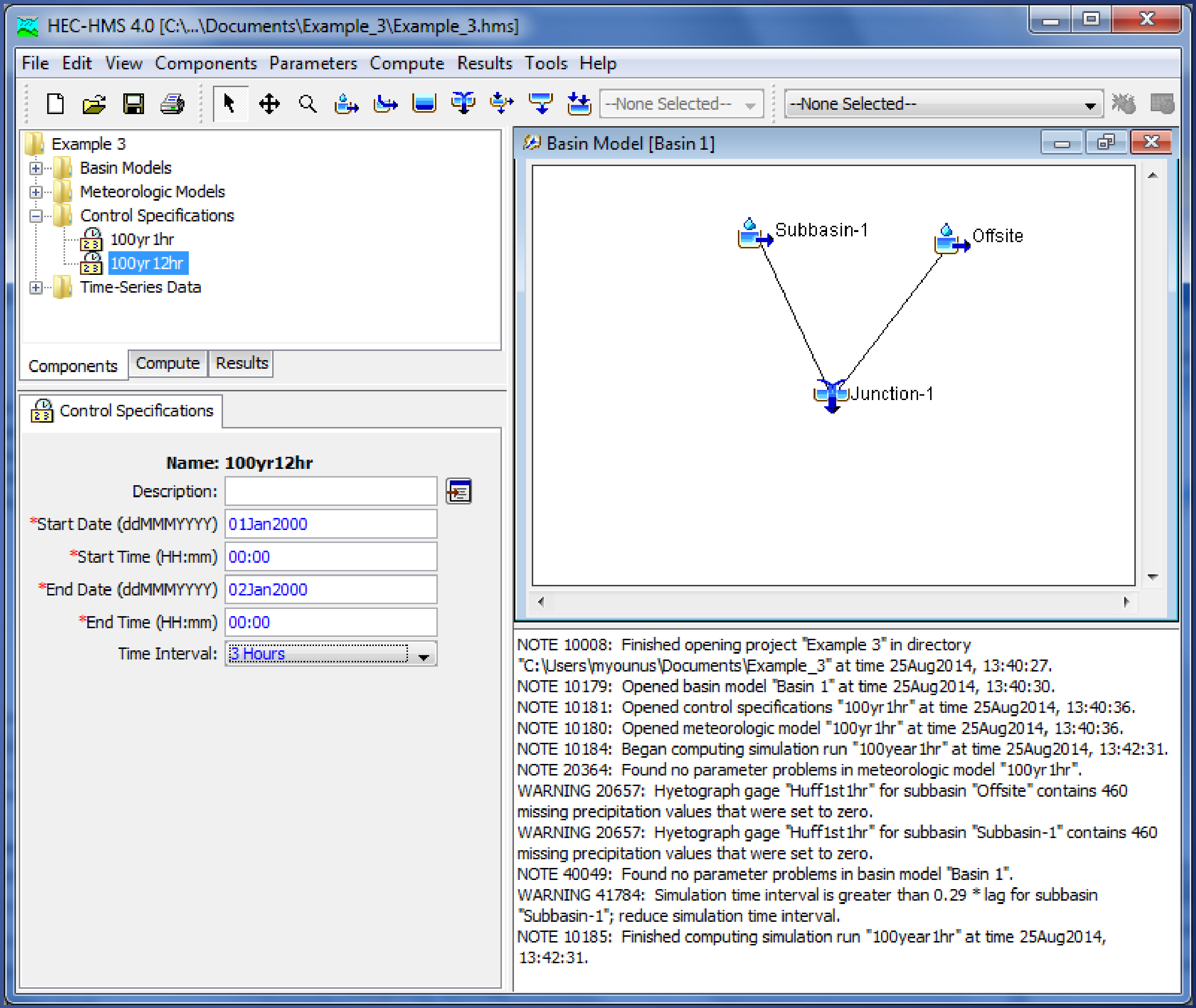
- Under the ***Components*** menu, select ***Control Specifications Manager*** to create a new one named “100yr12hr”



CREATING THE CONTROL SPECIFICATIONS

Continue …

- Specify 01Jan2000 through 02Jan2000
- Under ***Time Interval***, specify 3 minute



CREATING THE SIMULATION RUN

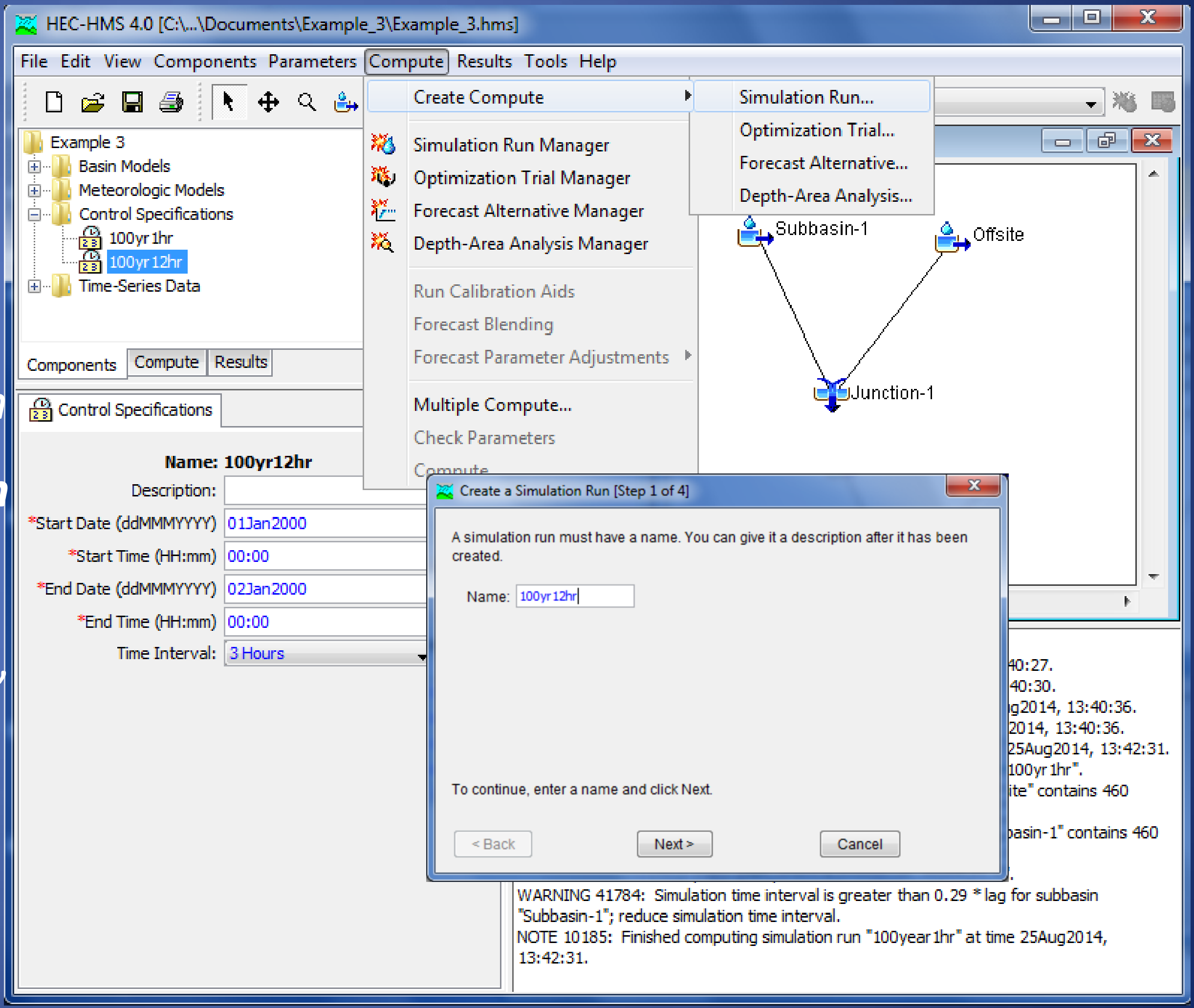
100-yr, 12-hr

- A *Simulation Run* is a combination of:
    - ***Basin Model***
    - ***Meteorologic Model***
    - ***Control Specifications***

- To create a new *Simulation Run*, select ***Create Compute > Simulation Run*** under the ***Components*** menu

- Name the run “100yr12hr” and click ***Next***

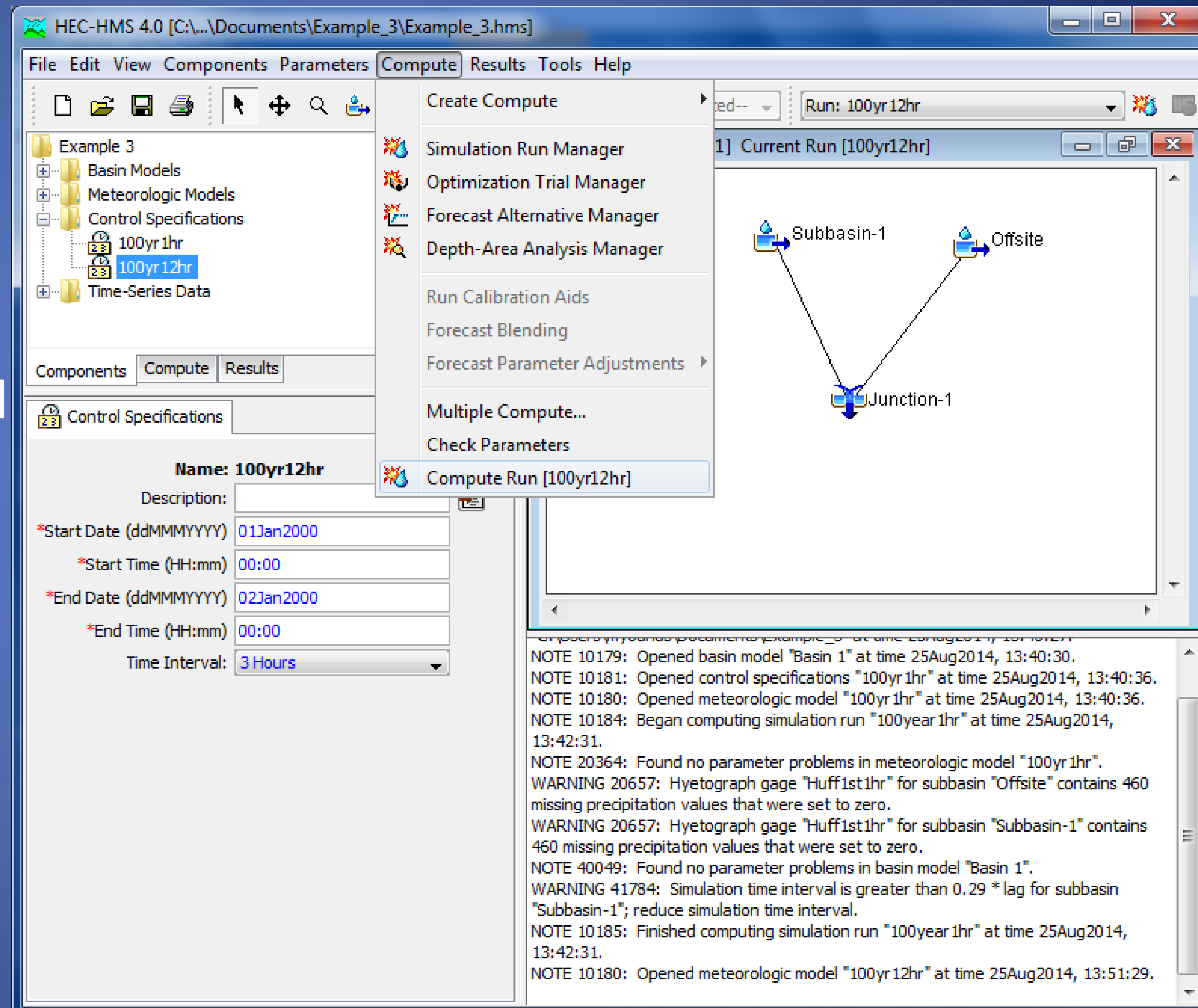
- Specify the ***Basin Model***, ***Meteorologic Model***, and ***Control Specifications*** that we’ve just created for 100yr12hr storm event



RUNNING THE SIMULATION

100-yr, 12-hr

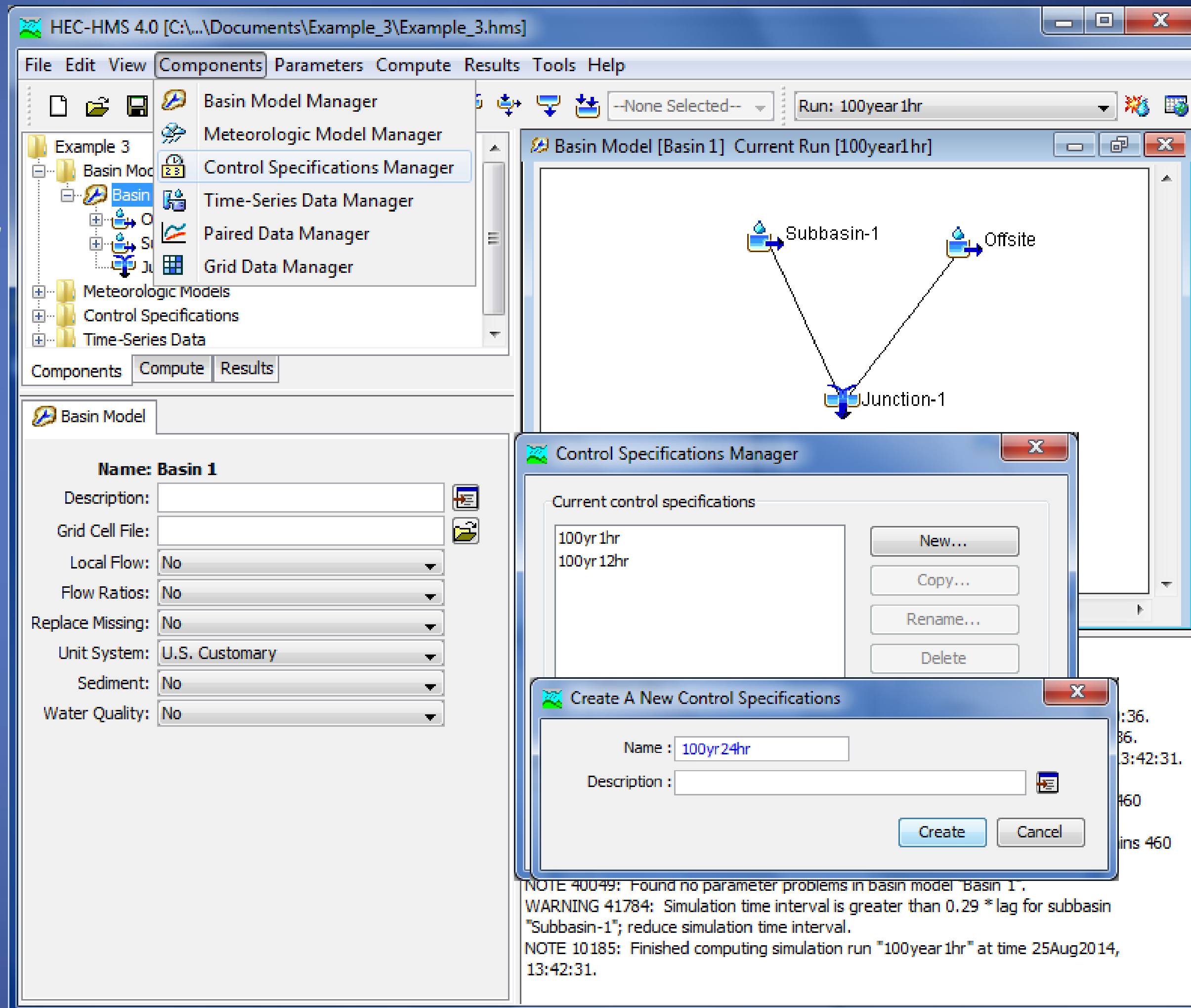
- Under the ***Compute*** menu, select ***Compute Run [100yr12hr]***
- All errors, warnings, and notes are shown in the lower right hand window
- If there are errors, they will show up in red and the simulation will not run successfully



CREATING THE CONTROL SPECIFICATIONS

100-yr, 24-hr

- Under the ***Components*** menu, select ***Control Specifications Manager*** to create a new one named “100yr24hr”

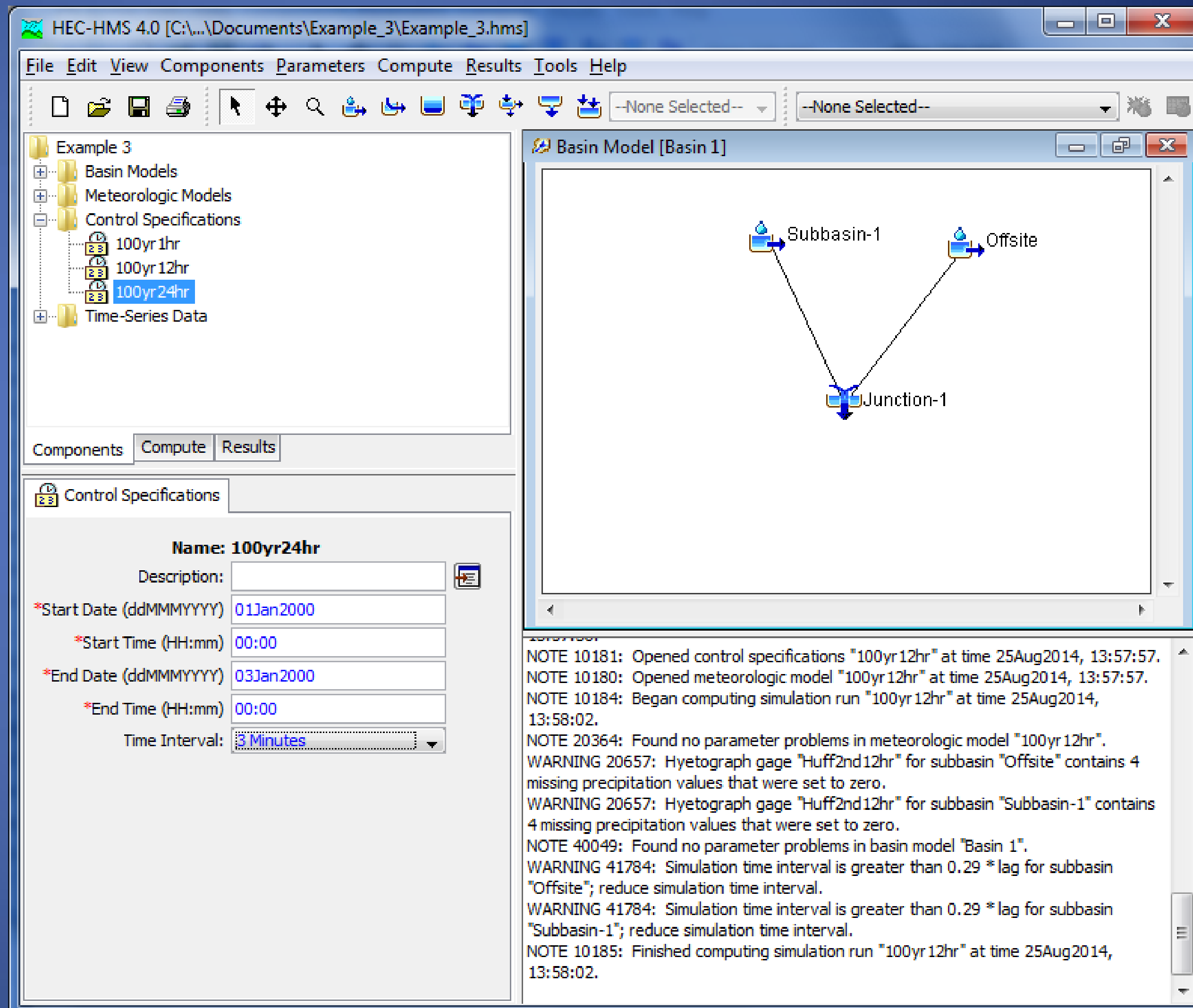


CREATING THE CONTROL SPECIFICATIONS

100-yr, 24-hr

Continue …

- Specify 01Jan2000 through 02Jan2000
- Under ***Time Interval***, specify 3 minute



CREATING THE SIMULATION RUN

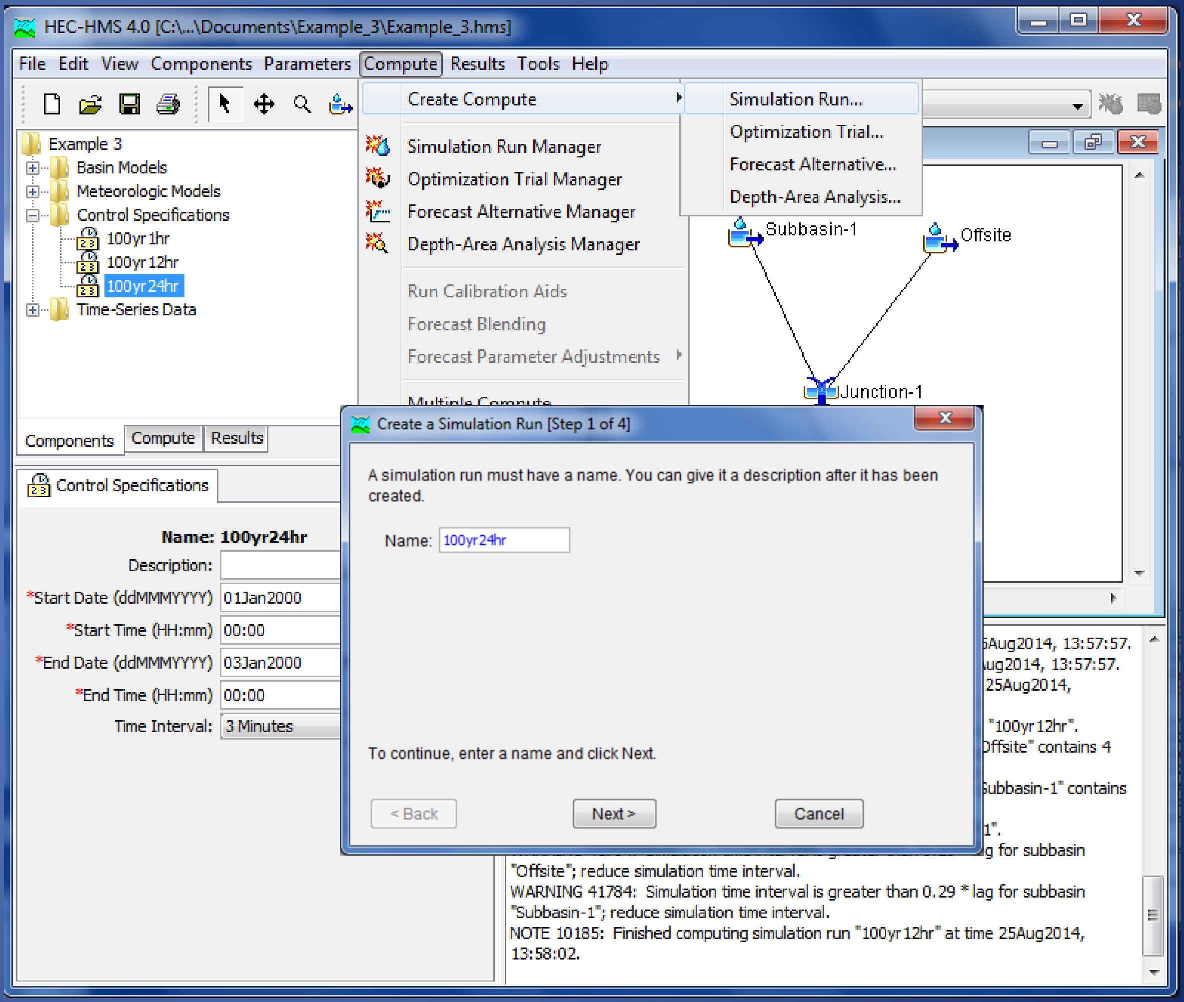
100-yr, 24-hr

- A *Simulation Run* is a combination of:
  - ***Basin Model***
  - ***Meteorologic Model***
  - ***Control Specifications***

- To create a new *Simulation Run*, select ***Create Compute > Simulation Run*** under the ***Components*** menu

- Name the run “100yr24hr” and click ***Next***

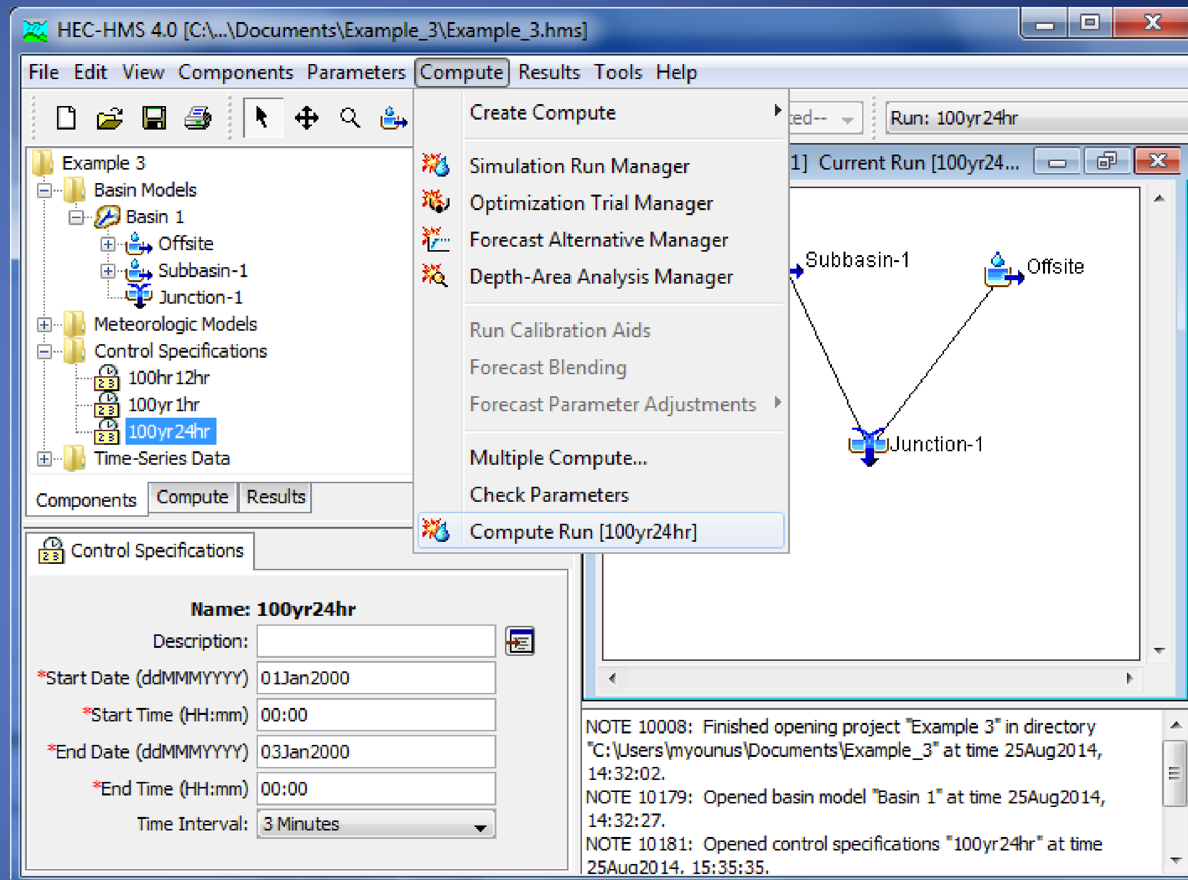
- Specify the ***Basin Model***, ***Meteorologic Model***, and ***Control Specifications*** that we’ve just created for 100yr24hr storm event



RUNNING THE SIMULATION

100-yr, 24-hr

- Under the ***Compute*** menu, select ***Compute Run [100yr24hr]***
- All errors, warnings, and notes are shown in the lower right hand window
- If there are errors, they will show up in red and the simulation will not run successfully

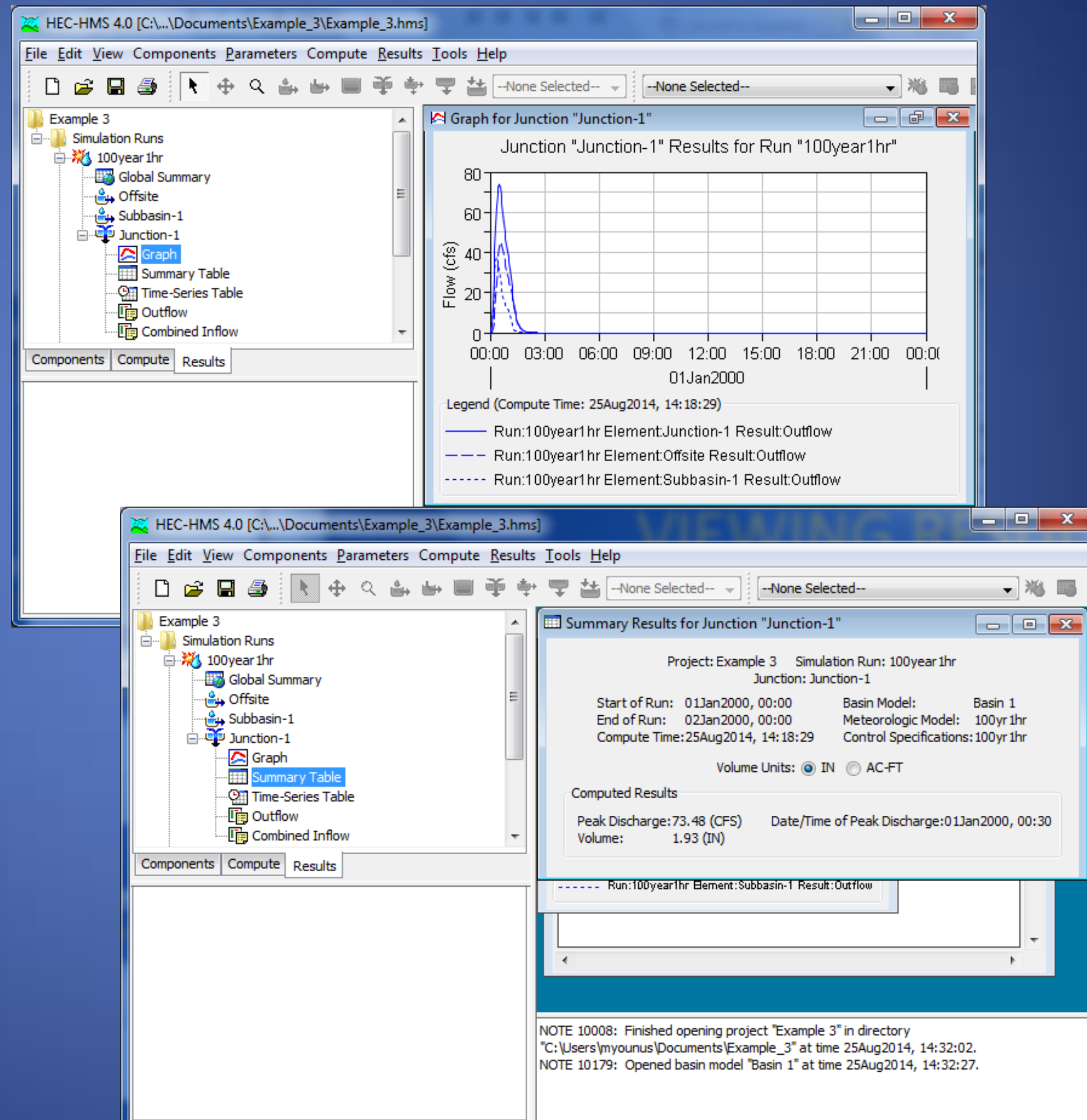


VIEWING RESULTS

100-yr, 1-hr

- If the *Simulation Run* was successful, right-click on the components of the ***Basin Model*** to view individual results

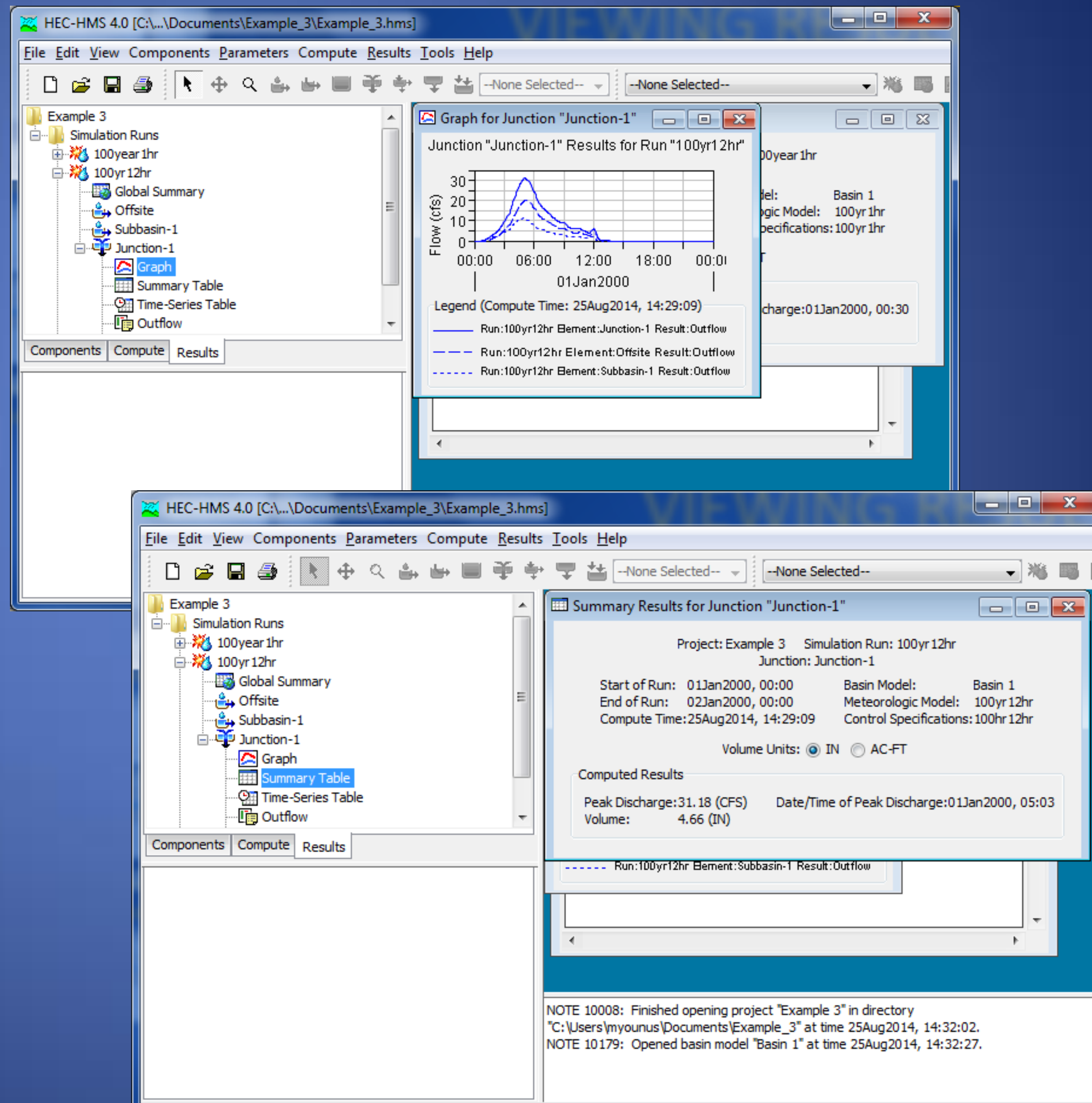
- Results are available as a ***Graph***, ***Summary Table***, or ***Time-Series Table,*** under **Result Tab**.



VIEWING RESULTS

100-yr, 12-hr

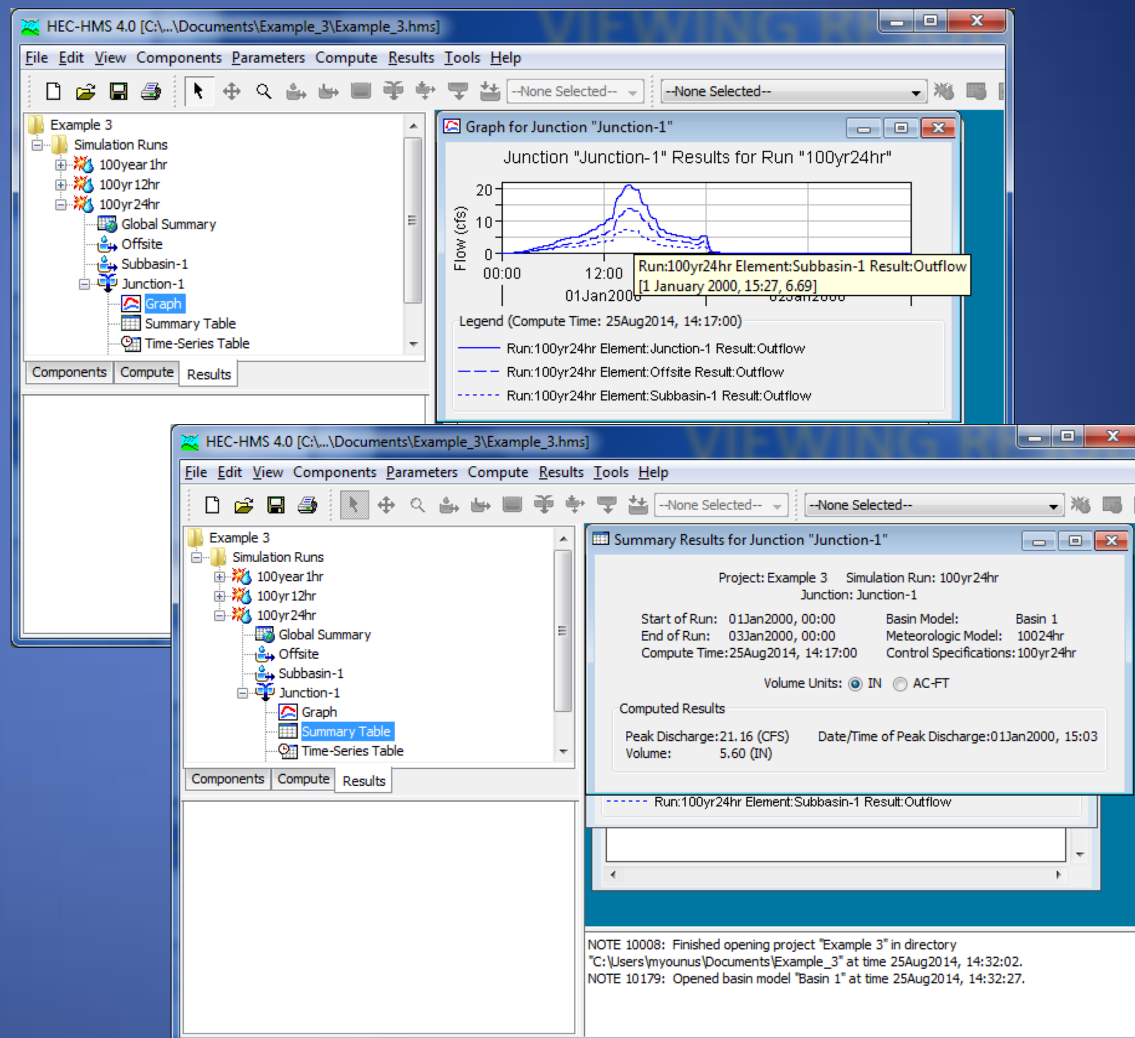
- If the *Simulation Run* was successful, right-click on the components of the ***Basin Model*** to view individual results
- Results are available as a ***Graph***, ***Summary Table***, or ***Time-Series Table,*** under ***Result Tab***.



VIEWING RESULTS

100-yr, 24-hr

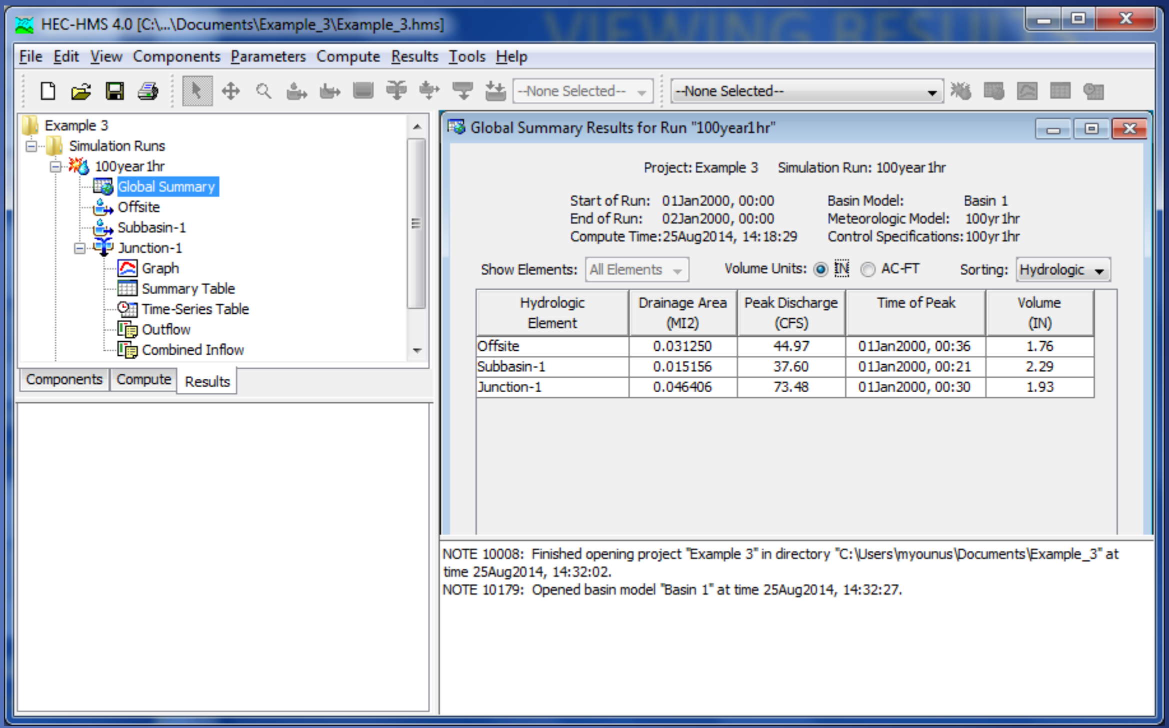
- If the *Simulation Run* was successful, right-click on the components of the ***Basin Model*** to view individual results
- Results are available as a ***Graph***, ***Summary Table***, or ***Time-Series Table,*** under ***Result Tab***.



VIEWING RESULTS (GLOBAL SUMMARY)

100-yr, 1-hr

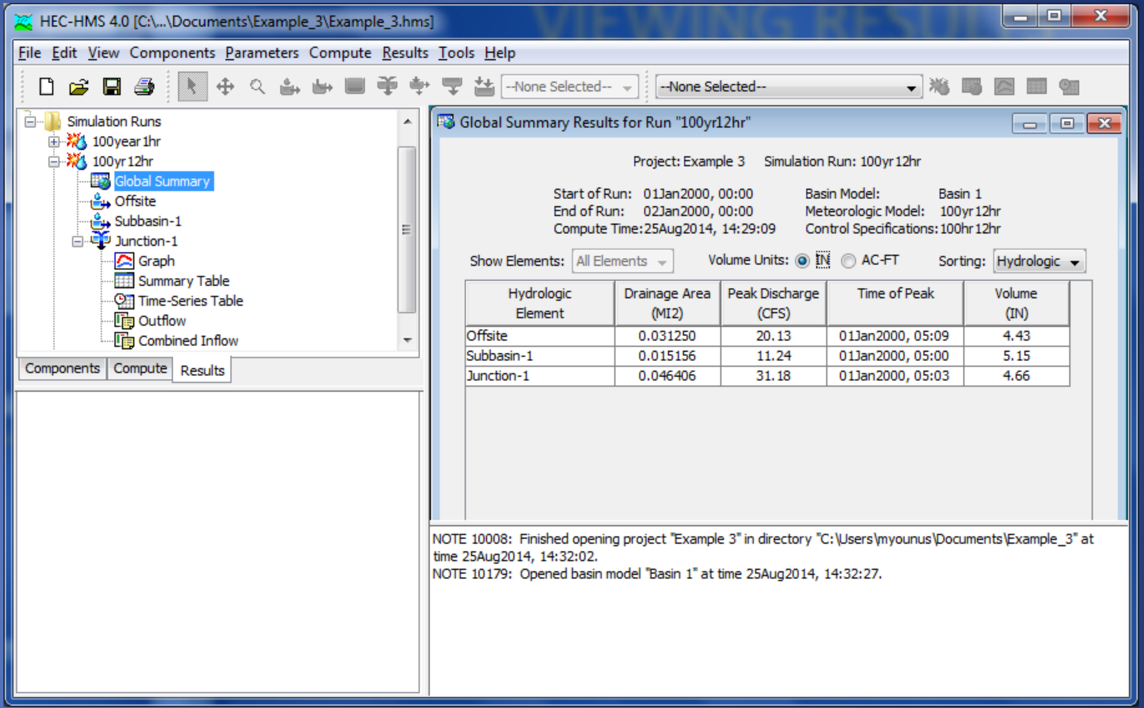
- To view the results for all model components at once, choose ***Global Summary Table*** under the **Results Menu**



VIEWING RESULTS (GLOBAL SUMMARY)

100-yr, 12-hr

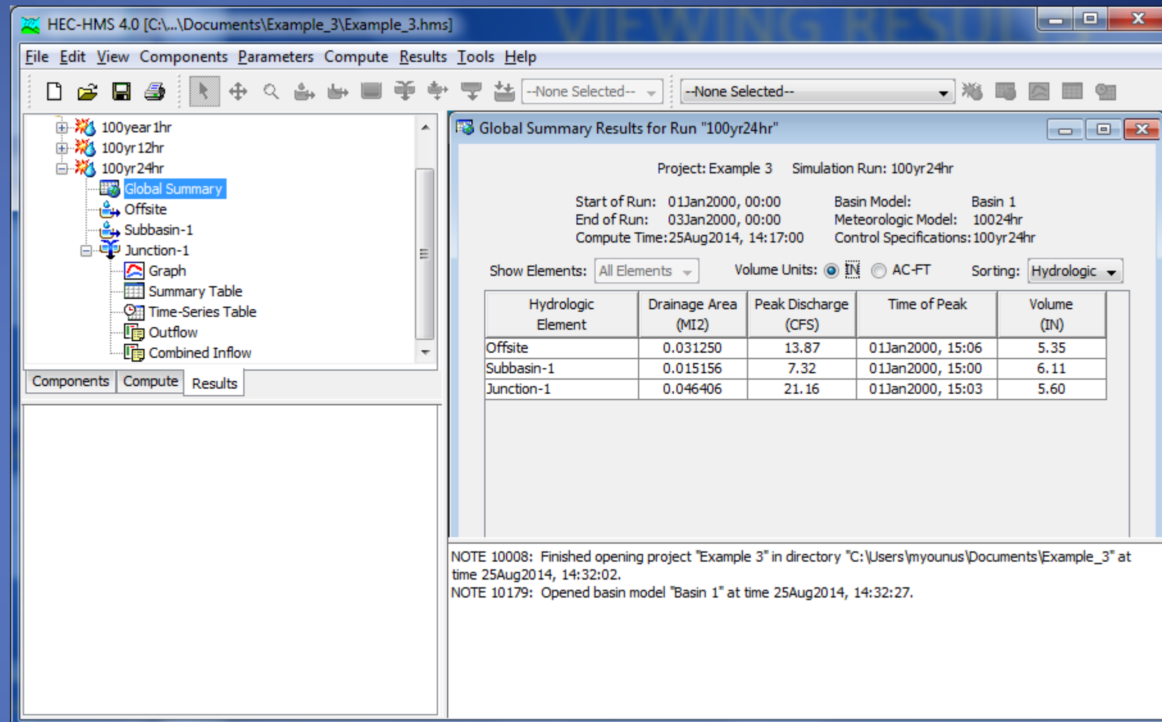
- To view the results for all model components at once, choose ***Global Summary Table*** under the **Results Menu**



VIEWING RESULTS (GLOBAL SUMMARY)

100-yr, 24-hr

- To view the results for all model components at once, choose ***Global Summary Table*** under the **Results Menu**



EXAMPLE 3 RESULTS

Storm Event	Peak Flowrate (cfs)
100-Year, 1-Hour	73
100-Year, 12-Hour	31
100-Year, 24-Hour	21