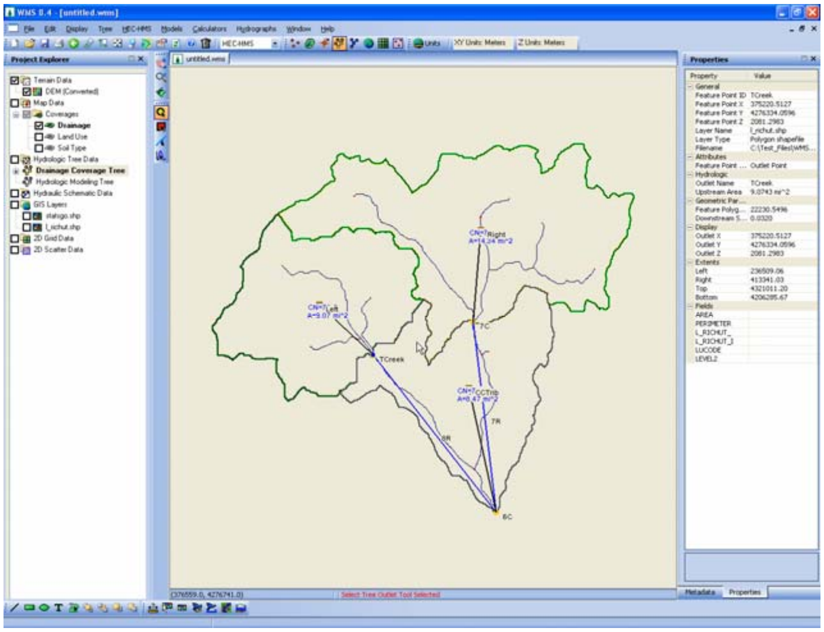
v. 8.4

*WMS 8.4 Tutorial*

# ***Watershed Modeling – HEC-HMS Interface***

Learn how to setup a basic HEC-HMS model using WMS



## Objectives

Build a basic HEC-HMS model from scratch using a DEM, land use, and soil data. Compute the geometric and hydrologic parameters required to run your HEC-HMS model. Divide your single watershed into multiple sub-basins and define reach and reservoir routing between sub-basins.

## Prerequisite Tutorials

- Watershed Modeling – DEM Delineation

## Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

## Time

- 30-60 minutes

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# 1 Contents



# 2 Introduction

WMS includes a graphical interface to HEC-HMS. This tutorial is similar to the HEC-1 tutorial. Geometric attributes such as areas, lengths, and slopes are computed automatically from the digital watershed. Parameters such as loss rates, base flow, unit hydrograph method, and routing data are entered through a series of interactive dialog boxes. Once the parameters needed to define an HMS model have been entered, an input file with the proper format for HMS can be written automatically.

Since only parts of the HMS input file are defined in this chapter, you are encouraged to explore the different available options of each dialog, being sure to select the given method and values before exiting the dialog. Unlike HEC-1, you will need to export the HMS files from WMS and then run the HMS graphical user interface to view the results. In order to do this you should have the most recent version of HMS installed.

# 3 Objectives

As a review, you will delineate a watershed from a DEM. You will then develop a simple, single basin model using the delineated watershed to derive many of the parameters. Land use and soil shapefiles (downloaded from the Internet) will be used to develop a SCS curve number (CN) value. After establishing the initial HMS model, other variations will be developed, including defining multiple basins with reach routing and including a reservoir with storage routing.

# 4 Delineating the Watershed

Since the land use, soil type, and DEM data for our watershed all originate in the Geographic coordinate system, we will begin by opening them together and converting them to UTM coordinates. The land use and soil type data were downloaded from the Environmental Protection Agency (EPA) website. The DEM data used for this watershed were previously downloaded from the National Elevation Dataset website as was demonstrated in the DEM Basics exercise (Volume 1, chapter 4).

1. Close all instances of WMS
2. Open WMS
3. Select ***File | Open***
4. Locate the folder ***C:\Program Files\WMS84\tutorial\hec-1***
5. Select *NED GRIDFLOAT Header (*.hdr)* from the Files of type list of file filters
6. Open *"67845267.hdr"*
7. Select *OK*
8. When prompted if you want to convert the current coordinates select *No*

## 4.1 Create Land Use and Soil Coverages

1. Right-click on the Coverages folder in the Project Explorer
2. Select ***New Coverage***
3. Change the coverage type to *Land Use*
4. Select *OK*
5. Create a new coverage once again and set its coverage type to *Soil Type*

## 4.2 Open the Soils Data

1. Make sure the *Soil Type* coverage is active in the Project Explorer
2. Right-click on *GIS Layers* in the Project Explorer and select ***Add Shapefile Data***
3. Open *"statsgo.shp"*
4. If a dialog appears regarding coordinate conversion select ***No***

5. Right-click on *statsgo.shp* layer in the Project Explorer
6. Select ***Open Attribute Table***

Notice that the table has three fields named AREA, PERIMETER, and MUID

7. Select *OK*

## 4.3 Join Soils Database File Table to Shapefile Table

1. Right-click on *statsgo.shp* in the Project Explorer
2. Select ***Join Table to Layer***
3. Open *"statsgoc.dbf"*
4. Ensure that Shapefile Join Field and Table Join Field are both set to *MUID*
5. Change the Table Data Field to *HYDGRP*
6. Select *OK*
7. Right-click on *statsgo.shp* in the Project Explorer
8. Select ***Open Attribute Table***

Notice that the HYDGRP field is now a part of the shapefile.

9. Select *OK*

## 4.4 Convert Soil Shapefile Data to Feature Objects

1. Choose the *Select Shapes* tool 
2. Draw a selection box around the DEM extents
3. Select ***Mapping | Shapes -> Feature Objects***
4. Select *Next*

This window shows all of the attribute fields in the soils shape file. Because this file was derived from a standard NRCS statsgo file you will notice that the hydrologic soil groups field is named HYDGRP and so WMS will automatically map this to be the soil type. If the attribute field were named anything other than HYDGRP then you would have to manually map it using the drop down list in the spreadsheet.

5. Make sure the HYDGRP field is mapped to the SCS soil type attribute
6. Select *Next*
7. Select *Finish*
8. Clear the selected polygons by single-clicking somewhere beyond the extents of the shapefile polygons
9. Hide the *statsgo.shp* file by toggling off its check box in the Project Explorer

## 4.5 Open the Land Use Data

1. Select the *Land Use* coverage in the Project Explorer to designate it as the active coverage
2. Right-click on GIS Layers in the Project Explorer and select ***Add Shapefile Data***
3. Open *"l_richut.shp"*
4. Choose the *Select Shapes* tool 
5. Draw a selection box around the DEM extents
6. Select ***Mapping | Shapes -> Feature Objects***
7. Select *Next*
8. Make sure the LUCODE field is mapped to the Land use attribute
9. Select *Next*
10. Select *Finish*
11. Hide the *l_richut.shp* file by toggling off its check box in the Project Explorer

## 4.6 Convert/Set the Coordinate System of the Data

1. Select ***Edit | Coordinate Conversion***
2. Select the *Specify* option in the *Current Projection* section of the *Reproject Current* dialog
3. Select *Set Projection*
4. Set *Projection* to *Geographic*, and *Datum* to *NAD 83*
5. Select *OK*
6. Set Vertical Units to *Meters*
7. In the *New Projection* section select *Global Projection*
8. Select *Set Projection*
9. Set *Projection* to *UTM*, *Datum* to *NAD 83*, *Planar Units* to *METERS*, and *Zone* to *12 (114°W - 108°W – Northern Hemisphere)*
10. Select *OK*
11. Set vertical units to *Meters*
12. Select *OK* to convert the data
13. Since we will not be using them until later, hide the *Land Use* and *Soil Type* coverages by toggling off their check boxes in the Project Explorer
14. Select the *Drainage* coverage from the Project Explorer to make sure it is the active coverage

## 4.7 Delineate the Watershed

1. Select the *Drainage* module
2. Select the *Frame* macro
3. Select ***DEM | Compute Flow Direction/Accumulation...***
4. Select *OK*
5. Select *OK* in the Units dialog
6. Select *Close* once TOPAZ finishes running (you may have to wait a few seconds to a minute or so)
7. Select the *Zoom* tool
8. Zoom in by dragging a box as illustrated in Figure 4-1

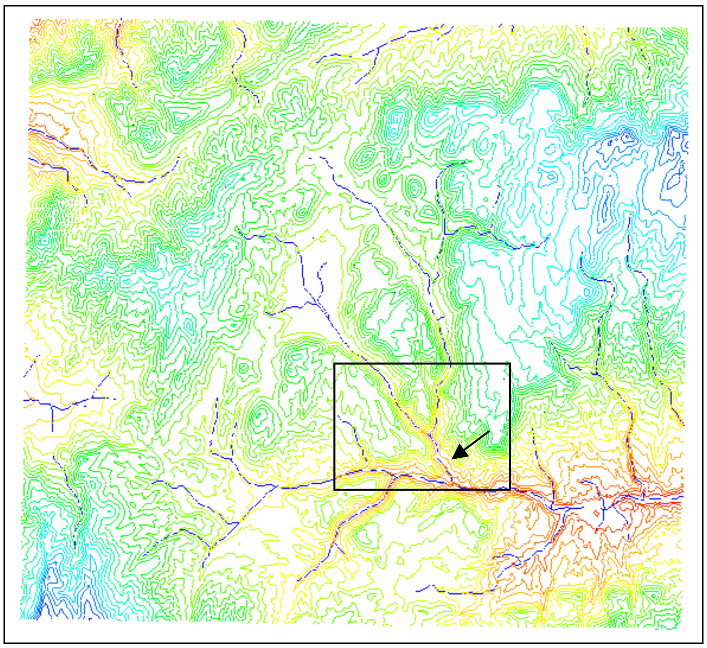


*Figure 4-1: Zoom in on the area bounded by the rectangle above*

9. Select the *Create Outlet Point* tool
10. Create a new outlet point where the tributary you just zoomed in on separates from the main stream as illustrated by the arrow in Figure 4-1. Make certain that the outlet point is on the tributary and not part of the main stream. Also, the outlet needs to be inside one of the flow accumulation (blue) cells. WMS will move the outlet to the nearest flow accumulation cell if you do not click right in one of the flow accumulations cells.
11. Select the *Frame* macro
12. Select ***DEM | Delineate Basins Wizard***
13. Select *Delineate Watershed*
14. Select *Cancel*

You have now completed the delineation of a single watershed. In order to make the view clearer for defining the hydrologic model you can turn off many of the DEM and other display options.

15. Right-click on *DEM* in the Project Explorer and select ***Display Options***
16. On the DEM tab, toggle off the display for *Watershed*, *Stream*, *Flow Accumulation*, and *DEM Contours*
17. On the Map tab, toggle *Vertices* off
18. Select *OK*

# 5 Single Basin Analysis

The first simulation will be defined for a single basin. You will need to enter the global, or Job Control parameters as well as basin and meteorological data.

## 5.1 Setting up the Job Control

Most of the parameters required for a HEC-HMS model are defined for basins, outlets, and reaches. However, there are some "global" parameters that control the overall simulation and are not specific to any basin or reach in the model. These parameters are defined in the WMS interface using the Job Control dialog.

1. Switch to the *Hydrologic Modeling* module
2. HEC-1 should be the default model, so change the default model to HEC-HMS by selecting it from the drop down list of models found in the Edit Window
3. Select ***HEC-HMS | Job Control***
4. Enter *"Clear Creek Tributary"* in the Name: field
5. In the Description: field you can enter Your name

By default the simulation is set to run for 24 hours starting from today's date at 15 minute intervals. We want to run this simulation for 25 hours at five minute intervals.

6. Add one hour to the Ending time
7. Change the Time interval to *5 Minutes*
8. Select the Basin Options tab
9. Enter *"Clear Creek Tributary"* in the Name: field
10. Set the Basin Model Units to *US customary (English),* which should already be the default

Setting the computation units DOES NOT cause any units conversion to take place. You are simply telling HEC-1 that you will provide input units in English units (sq. miles for area, inches for rain, feet/miles for length) and expect results of computation to be in English units (cfs). If you specify Metric then you must ensure that input units are metric (sq. kilometers, mm for rain, meters/kilometers for length) and results will be in metric (cms).

11. Select the Meteorological Options tab
12. Enter *"Clear Creek Tributary"* in the Name: field

You will note that HEC-HMS includes advanced options for long term simulation and local inflows at junctions, but we will not explore these options in this model.

13. Select *OK*

## 5.2 Setting up the Meteorological Data

In HEC-1 precipitation is handled as a Basin Data attribute, however for HEC-HMS precipitation is defined separately in the Meteorological Data. This is because of the ability of HEC-HMS to model long term simulations that require additional information and often a lot more input.

1. Select ***HEC-HMS | Meteorological Parameters***
2. Set the Precipitation Method to *SCS Hypothetical Storm*
3. Set the Storm Selection to *Type II*
4. Set the Storm Depth to *1.8* (inches)
5. Select *OK*

## 5.3 Setting up the Basin Data Parameters

In the first simulation you will treat the entire watershed as a single basin.

1. Select the *Select Basin* tool 
2. Double-click on the brown basin icon labeled 1B. Double-clicking on a basin or outlet icon always brings up the parameter editor dialog for the current model (in this case HEC-HMS)
3. Notice that the area has been calculated (in this case in sq. miles because we are performing calculations in English units).
4. Change the name to *CCTrib*
5. Enter "*Main Branch*" in the description.

Displaying and Showing options allows you to see only those variables for which you wish to enter data. For example in this case toggling on the Loss Rate Method allows you to pick which method you want to use (in this case the method we want is the default). You then toggle the display for the different parameters associated with a given methodology from the show column. In our case we can now see in the Properties window the Loss Rate Method and the parameters for the SCS Curve Number method.

The HMS-Properties window is versatile in that it allows you to see properties for all or selected basins, junctions, reaches, reservoirs, etc.

6. Toggle on the Display of the *Loss Rate Method* option
7. Toggle the *SCS Curve Number* from the Show column in the Display options window
8. Enter an SCS Curve Number of **70**. We will compute a CN value from actual land use and soil files later.

For the SCS CN method initials losses are estimated as 20% of the maximum storage value computed from the CN when the initial loss is zero. If you wish to override this computation then you would enter a value other than zero. For now we will assume there is no impervious area.

9. Toggle on the Display of the *Transform* option (you may have to scroll vertically in the Display options window)
10. Show the *SCS* parameters by toggling this option on in the Display options window)
11. Scroll horizontally in the Properties window and choose the *Compute* button under Basin Data (the SCS transform method is the default)
12. Set the Computation Type to *Compute Lag Time* (the default)
13. Set the Method drop down list to *SCS Method* (near the bottom of the list)
14. Select *OK* to update the computed lag time for the SCS dimensionless method (scroll horizontally to view if you would like)
15. Select *OK*

You now have all of the parameters set to run a single basin analysis.

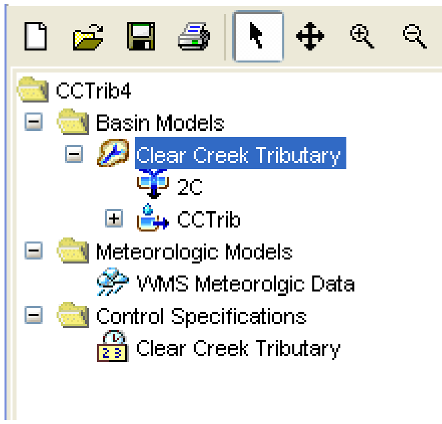
## 5.4 Running HEC-HMS

Whenever you run an HEC-HMS simulation, you must save the information created in WMS to HEC-HMS files and then load it as a project in HEC-HMS. This tutorial is not a comprehensive review of HEC-HMS but should give you an idea of how to open a project created by WMS, run an analysis and view some basic results.

1. Right click on *Drainage Coverage Tree* in the Project Explorer and select ***Save HMS File*** or Select **HEC-HMS |*Save HMS File***
2. Change the HMS project file to *CCTrib*
3. Start HEC-HMS on your computer
4. Select ***File |Open***
5. Select the *Browse* button and browse to the location where you just saved your HMS Project from WMS (by default this will be in the hec-1 directory of your tutorial files)
6. Select the *CCTrib.hms* project file
7. From the HEC-HMS project explorer expand the Basin Models, Meteorologic Models and Control Specifications folders
8. Expand the Clear Creek Tributary basin model and then select it

The basin model map should appear and your project explorer should look something like the picture below.




9. Select ***Compute | Create Simulation Run***
10. Change the Run Name to *CCTrib 1*
11. Click *Next*, *Next*, *Next* and *Finish* to set up the simulation run
12. Select ***Compute | Select Run | Select Run -> CCTrib 1***
13. Select ***Compute | Compute Run [CCTrib 1]*** or the Compute Current Run macro 
14. When finished computing select *Close*
15. Select the CCTrib basin under the Clear Creek Tributary basin model from the HEC-HMS project explorer
16. Select ***Results | Global Summary Table*** and explore
17. Select ***Results | Element Graph*** and explore
18. Select ***Results | Element Summary Table*** and explore
19. Select ***Results | Element Time-Series Table*** and explore

You now have a completed HEC-HMS simulation for a single basin and the resulting hydrograph for the CCTrib subbasin element should look something like the one shown in Figure 5-1.

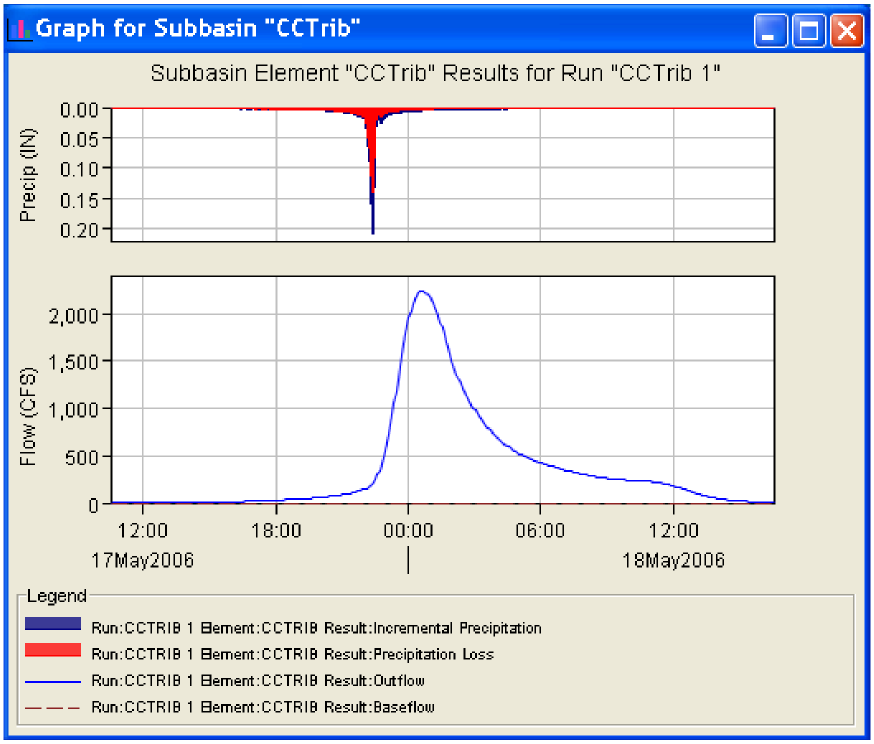



*Figure 5-1: Solution hydrograph for HEC-HMS simulation*

20. You may continue to explore the HEC-HMS input parameters passed from WMS and computed results or any other options
21. When finished close the Global and Element summary tables and graph windows and exit HEC-HMS by selecting ***File* | *Exit***
22. Select *Yes* when prompted to save the project.

# 6 Computing the CN Using Land Use and Soils Data

In the initial simulation you estimated a CN, but with access to the Internet it is simple to compute a composite CN based on digital land use and soils files. This was demonstrated in more detail in the Advanced Feature Objects exercise (Volume 1, chapter 6), but you will go through the steps here as a review.

## 6.1 Computing a Composite CN

At the beginning of this tutorial you loaded digital land use and soils files for the purpose of calculating a CN. In addition to this data, you must have a table defined that relates CN values for each of the four different hydrologic soil groups (A, B, C, D) for each land use. This is described in detail at the gsda website (http://www.xmswiki.com/wiki/GSDA:GSDA), and in the Advanced Feature Objects exercise (Volume 1, chapter 6). For this exercise you will read in an existing file (you can examine it in a text editor if you wish) and compute the CN numbers.

1. While it is not necessary to have the *Land Use* and *Soil Type* coverages displayed for the computations to work you may wish to make them visible again by toggling on their check boxes in the Project Explorer

2. Select the *Drainage* coverage to make sure it is the active coverage
3. Select the *Hydrologic Modeling* module 
4. Select ***Calculators | Compute GIS Attributes***
5. Select the *Import* button to load the mapping table
6. Select *OK* to overwrite the current definition
7. Find and open the file named *"scsland.tbl"*
8. Select *OK* to compute the CN from the land use and soils layers

You should see the computed CN displayed in the Runoff Curve Number Report and above the area label in the WMS graphics window.

9. Close the Runoff Curve Number Report

## 6.2 Running HEC-HMS

You can now run another simulation to compare the results with the modified CN value.

1. Right click on *Drainage Coverage Tree* in the Project Explorer and select ***Save HMS File*** or Select **HEC-HMS |*Save HMS File***
2. Name the HMS project file *CCTribCN* and Save
3. Start HEC-HMS on your computer
4. Select ***File |Open***
5. Select the *Browse* button and browse to the location where you just saved your HMS Project from WMS (by default this will be in the hec-1 directory of your tutorial files)
6. Select the *CCTribCN.hms* project file
7. From the HEC-HMS project explorer expand the Basin Models, Meteorologic Models and Control Specifications folders
8. Expand the Clear Creek Tributary basin model and then select it
9. Select ***Compute | Create Simulation Run***
10. Change the Run Name to *CCTribCN 1*
11. Click *Next*, *Next*, *Next*, and *Finish* to set up the Run
12. Select ***Compute | Select Run | CCTribCN 1***
13. Select ***Compute | Compute Run [CCTribCN 1]*** or the Compute Current Run macro 
14. When finished computing select *Close*
15. Select the CCTrib basin under the Clear Creek Tributary basin model from the HEC-HMS project explorer
16. Select ***Results | Global Summary Table*** and explore
17. Select ***Results | Element Graph*** and explore

18. Select ***Results | Element Summary Table*** and explore
19. Select ***Results | Element Time-Series Table*** and explore

You may continue to explore the HEC-HMS input parameters passed from WMS and computed results or any other options

20. When finished close the Global and Element summary tables and graph windows and exit HEC-HMS by selecting ***File | Exit***
21. Select *Yes* when prompted to save the project.

# 7 Adding Sub-basins and Routing

You will now subdivide the watershed into two upper basins and one lower basin and define routing for the reaches that connect the upper basins to the watershed outlet.

## 7.1 Delineating the Sub-basin

1. Select the *Zoom* tool
2. Create a zoom box around the region identified by a box in Figure 7-1

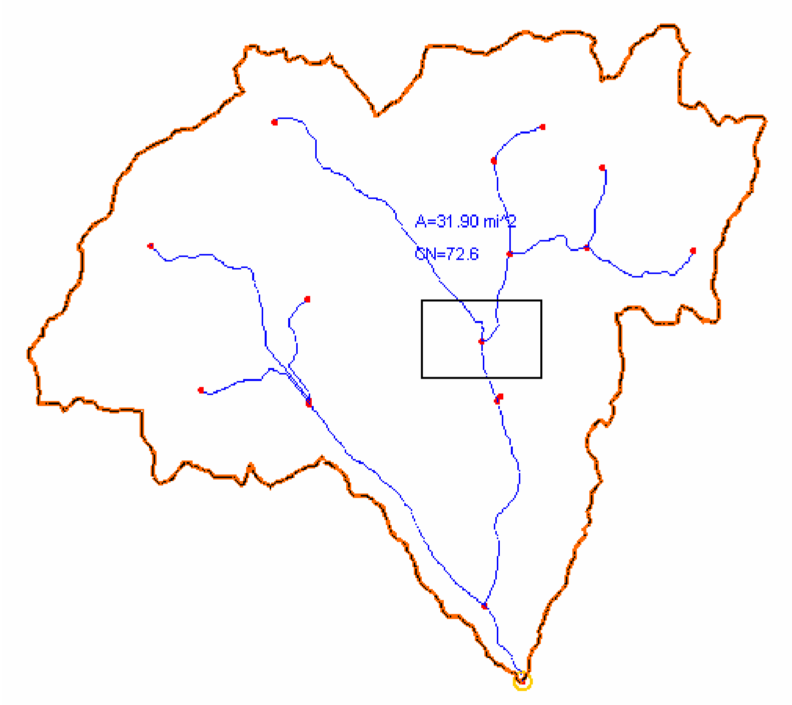
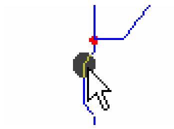



*Figure 7-1: Zoom in on the area indicated by the rectangle.*

3. Right-click on the *Drainage* coverage in the Project Explorer and select ***Display Options***
4. On the Map tab toggle on *Vertices*
5. Select *OK*
6. Select the *Drainage* module

7. Select the *Select Feature Vertex* tool



8. Select the vertex that is just below the main branching point you just zoomed in around
9. Select ***DEM* | *Node* <-> *Outlet***

You created the outlet point just below the branch in order to have a single upstream basin. If you wanted a separate basin for each upstream branch you could define the branching node to be an outlet. Thus, WMS would automatically assume that you want separate basins for each branch, so we have created a node just downstream of the branch and defined it as the outlet for the upper basin.

10. Select the *Frame* macro
11. Select the *Zoom* tool
12. Create a zoom box around the region identified by a box in Figure 7-2

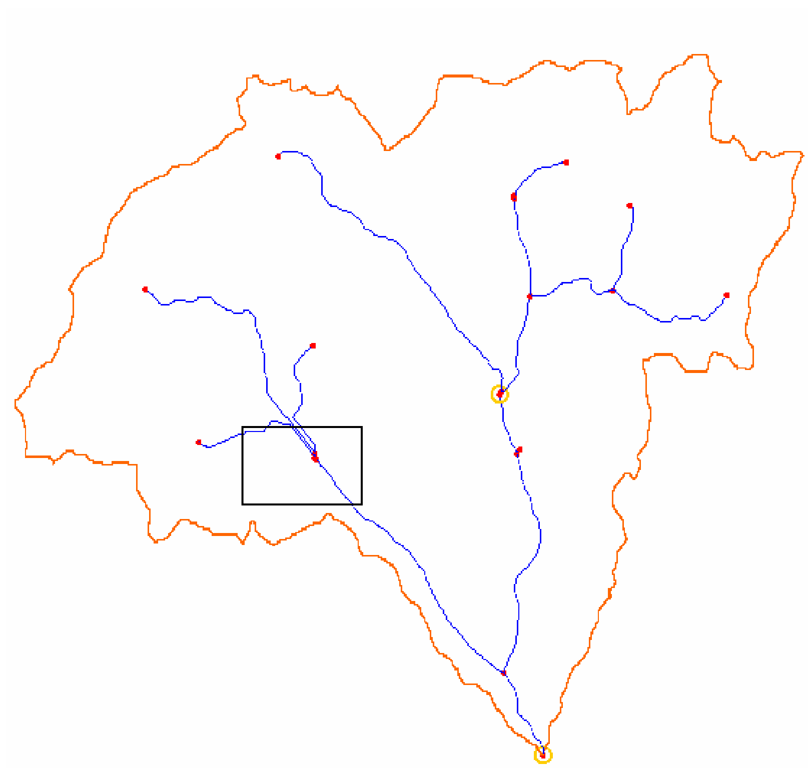
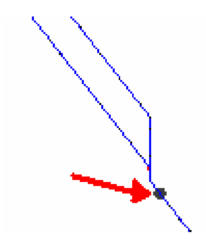


*Figure 7-2: Zoom in on the area indicated by the rectangle*



13. Select the *Select Feature Vertex* tool
14. Select the vertex that is just below the feature node where the streams branch
15. Select ***DEM* | *Node* <-> *Outlet***
16. Select the *Frame* macro
17. Select ***DEM* | *Delineate Basins Wizard***
18. Select *Delineate Watershed*

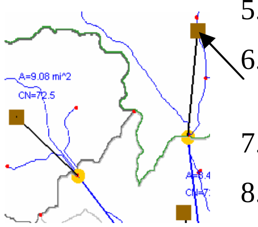
 

19. Select *OK* to delete and recreate feature data
20. Select *Cancel*

## 7.2 Updating the Basin Parameters

You will have to recompute the CN values and define precipitation and lag time for the basins.

1. Select the *Hydrologic Modeling* module
2. Select ***Calculators* | *Compute GIS Attributes***
3. Select *OK* and the CN values will be updated for all basins (they are actually very similar in this case because of there is one dominant soil polygon that covers the watershed)
4. Close the Curve Number report




5. Select the *Select Basin* tool
6. Double-click on the upper right basin icon to bring up the HMS Properties dialog
7. Set the Show: option to *All*
8. Change the name of the upper right basin to *Right*
9. Change the name of the upper left basin to *Left*
10. Change the name of the lower basin to *CCTrib*
11. Toggle on the Display of the *Loss Rate Method* and Show *SCS Curve Number*

Because the CN values have been computed automatically you do not need to change anything here.

12. Toggle on the Display of *Transform* methods and Show *SCS*
13. For each basin choose the Define button under Compute Basin Data and define the equation and use the *Compute Lag Time* computation method with the *SCS Method*

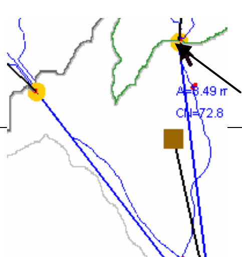
You should now have a computed lag time for each basin (all about 1 hour)

14. Select *OK*

## 7.3 Setting up the Routing Parameters

If you were to run HEC-HMS right now (you can if you want), you would see that the hydrographs from the upper basins would be combined with the lower basin hydrograph at the watershed outlet without any lag or attenuation because you have not yet set the routing parameters. You will now define a routing method, which will instruct HEC-HMS to compute lag and attenuation on the upper basin hydrographs before adding them to the lower hydrograph.

Routing for a reach is always defined at the upstream outlet of the reach in WMS.




1. Select the *Select Outlet* tool

2. Double-click on the outlet (the yellow circle icon) of the upper right basin
3. Make sure the Type field at the top left of the dialog is set to *Reaches*
4. Set the Show option to *Selected* again
5. Toggle on the Display of *Method* and Show *Muskingum Cunge Std.*
6. Change the Routing Method to *Muskingum Cunge.*
7. Set the bottom width field to be **5** (five feet wide)
8. Set the side slope value to be **1** (1:1 side slope)
9. Set the Manning's roughness (N) to be **0.05** (this is fairly rough, but we want to exaggerate the routing effects for this exercise)


10. Select *OK*
11. Double-click on the outlet of the upper left basin
12. Make sure the Type field at the top left of the dialog is set to *Reaches*
13. Change the Routing Method to *Muskingum Cunge.*
14. Set the bottom width field to be **5** (five feet wide)
15. Set the side slope value to be **1** (1:1 side slope)
16. Set the Manning's roughness (N) to be **0.05** (this is fairly rough, but we want to exaggerate the routing effects for this exercise)
17. Select *OK*

## 7.4 Running HEC-HMS

You now have everything defined to run a three basin HEC-HMS analysis that includes routing the upper basins through the reaches connecting them to the watershed outlet.

1. Right click on *Drainage Coverage Tree* in the Project Explorer and select ***Save HMS File*** or Select **HEC-HMS |*Save HMS File***
2. Name the HMS project file *CCTribRoute* and Save
3. Start HEC-HMS on your computer
4. Select ***File |Open***
5. Select the *Browse* button and browse to the location where you just saved your HMS Project from WMS (by default this will be in the hec-1 directory of your tutorial files)
6. Select the *CCTribRoute.hms* project file
7. From the HEC-HMS project explorer expand the Basin Models, Meteorologic Models and Control Specifications folders
8. Expand the Clear Creek Tributary basin model and then select it
9. Select ***Compute | Create Simulation Run***
10. Change the Run Name to *CCTribRoute 1*
11. Click *Next*, *Next*, *Next*, and *Finish* to set up the simulation run

12. Select ***Compute* | *Select Run* | *Select Run CCTribRoute 1***
13. Select ***Compute* | *Compute Run [CCTribRoute 1]*** or the Compute Current Run macro
14. When finished computing select *Close*
15. Select different elements (basins, junctions, reaches) and view results
16. Select ***Results* | *Global Summary Table*** and explore
17. Select ***Results* | *Element Graph*** and explore
18. Select ***Results* | *Element Summary Table*** and explore
19. Select ***Results* | *Element Time-Series Table*** and explore

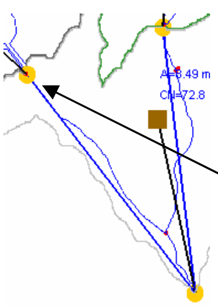
You may continue to explore the HEC-HMS input parameters passed from WMS and computed results or any other options

20. When finished close the Global and Element summary tables and graph windows and exit HEC-HMS by selecting ***File* | *Exit***
21. Select *Yes* when prompted to save the project.

# 8 Modeling a Reservoir in HEC-HMS

There is an existing small reservoir at the outlet of the upper left basin. It has a storage capacity of 1000 ac-ft at the spillway level and 1540 ac-ft at the dam crest.

## 8.1 Defining a Reservoir in Combination with Routing



One of the routing methods available in HEC-HMS is Storage routing, which can be used to define reservoir routing. However, in this case we are already using Muskingum-Cunge routing to move the hydrograph through the reach connecting the upper left basin to the watershed outlet so we must define the outlet as a reservoir so that we can route the hydrograph through the reservoir before routing it downstream.

1. Select the *Select Outlet* tool
2. Select the outlet of the upper left basin
3. Right-click on the outlet and select ***Add* | *Reservoir***

## 8.2 Setting up the Reservoir Routing Parameters

In order to define reservoir routing with HEC-HMS you must define elevation vs. storage (storage capacity curve) and elevation vs. discharge rating curves. You can enter values directly, or enter hydraulic structures and compute the values, but in this exercise you will enter the values directly. You will use the same elevation values for both curves.

For this example we want to have no outflow until the elevation in the reservoir reaches the spillway. Since HEC-HMS linearly interpolates between consecutive points on the elevation-discharge and elevation-volume curves we will "trick" it by entering two points on the curves at essentially the same elevation (6821.99 ft and 6822 ft) with the first having no outflow and the second having the discharge over the spillway (640 cfs) as defined for this dam.

1. Double-click on the reservoir outlet point (it is now represented as a triangle since you have defined a reservoir at this location)
2. Change the Reservoir name to *Tcreek*
3. Set the Method drop down to be *Elevation-Storage-Discharge*

What you need to input to define reservoir routing is the initial conditions of the reservoir. The initial condition can be defined as an elevation, a discharge, or a volume. For this example we will set the initial condition to an elevation four feet below the top of the spillway (the spillway corresponds to elevation 6822).

4. Set the Initial drop down to be *Elevation*
5. Enter *6818* for the Initial Value (this should be the default already)
6. Select the *Define Elevation-Storage* button
7. Select *New*
8. Change the name of the new curve to *"Elevation-Storage"*
9. In the first seven entry fields in the first column enter the following values: *6803, 6808, 6813, 6818, 6821.99, 6822, 6825* (feet of elevation)
10. In the first seven entry fields in the second column enter the following values: *0, 200, 410, 650, 999.99, 1000, 1540* (acre-feet of volume)
11. Select *OK*
12. Select the *Define Storage-Discharge* button

You will define separate XY series for Volumes, Elevations, and Discharges using the XY Series editor.

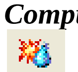
13. Select *New*
14. Change the name of the new curve to *"Storage-Discharge"*
15. In the first seven edit fields in the first column enter the values *0, 200, 410, 650, 999.99, 1000, 1540* (acre-ft of volume)
16. In the first seven entry fields in the second column enter the following values: *0, 0, 0, 0, 639.99, 640, 7000* (cubic feet per second of flow). There is no outflow until the water reaches the spillway.
17. Select *OK*
18. Select *OK*

## 8.3 Running HEC-HMS

You now have everything defined to run a three basin HEC-HMS analysis that includes routing the upper basins through the reaches connecting them to the watershed outlet.

1. Right click on *Drainage Coverage Tree* in the Project Explorer and select ***Save HMS File*** or Select **HEC-HMS |*Save HMS File***
2. Name the HMS project file *CCTribReservoir* and Save

3. Start HEC-HMS on your computer
4. Select ***File |Open***
5. Select the *Browse* button and browse to the location where you just saved your HMS Project from WMS (by default this will be in the hec-1 directory of your tutorial files)
6. Select the *CCTribReservoir.hms* project file
7. From the HEC-HMS project explorer expand the Basin Models, Meteorologic Models and Control Specifications folders
8. Expand the Clear Creek Tributary basin model and then select it
9. Change the Run Name to *CCTribReservoir 1*
10. Click *Next*, *Next*, *Next*, and *Finish* to set up the simulation run
11. Select ***Compute | Create Simulation Run***
12. Select ***Compute | Select Run | Select Run CCTribReservoir 1***
13. Select ***Compute | Compute Run [CCTribReservoir 1]*** or the Compute Current Run macro 
14. When finished computing select *Close*
15. Select different elements (basins, junctions, reaches, reservoirs) and view results
16. Select ***Results | Global Summary Table*** and explore
17. Select ***Results | Element Graph*** and explore
18. Select ***Results | Element Summary Table*** and explore
19. Select ***Results | Element Time-Series Table*** and explore

You may continue to explore the HEC-HMS input parameters passed from WMS and computed results or any other options

20. When finished close the Global and Element summary tables and graph windows and exit HEC-HMS by selecting ***File | Exit***
21. Select *Yes* when prompted to save the project.

# 9 Conclusion

This concludes the exercise defining HEC-HMS files and displaying hydrographs. The concepts learned include the following:

- Entering job control parameters
- Defining basin parameters such as loss rates, precipitation, and hydrograph methodology a watershed analysis
- Defining routing parameters
- Routing a hydrograph through a reservoir
- Saving and running HEC-HMS simulations