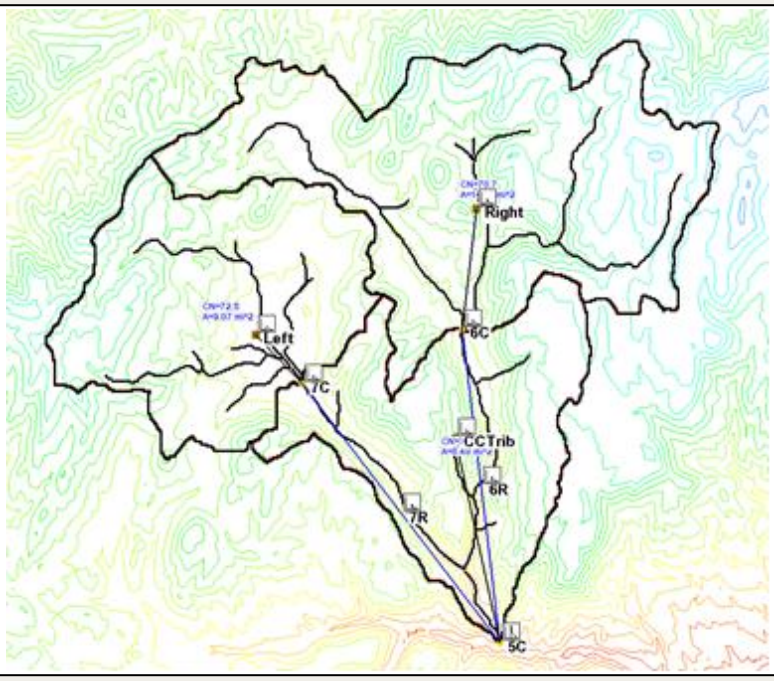
WMS 11.4 Tutorial

HEC-1 Modeling Reservoirs

Learn how to route through a reservoir in HEC-1



Objectives

Using a previously delineated watershed, learn how to create a reservoir in WMS and how to use HEC-1 to route a hydrograph through a reservoir.

Prerequisite Tutorials

- DEM Delineation
- HEC-1 Modeling

Required Components

- WMS Core
- HEC-1 Model

Time

- 15–30 minutes

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1 Introduction

Oftentimes it is useful to model the effects of a reservoir either for design purposes or to see how a current reservoir affects the outlet flow of a watershed. A reservoir will attenuate flow in the watershed, thereby flattening the peak of the hydrograph and allowing for more controlled flow. This tutorial demonstrates how to model reservoir routing in HEC-1.

2 Getting Started

Starting WMS new at the beginning of each tutorial is recommended. This resets the data, display options, and other WMS settings to their defaults. To do this:

1. If necessary, launch WMS.
2. If WMS is already running, press *Ctrl-N* or select *File* | **New…** to ensure that the program settings are restored to their default state.
3. A dialog may appear asking to save changes. Click **Don't Save** to clear all data.

The Graphics Window of WMS should refresh to show an empty space.

4. Click **Open** to bring up the *Open* dialog.
5. Change the *Files of type* to "WMS XMDF Project File (*.wms)".
6. Navigate to *hec-1\hec-1* and **Open** "Routing.wms" to close the *Open* dialog and import the project file.

3 Modeling a Reservoir in HEC-1

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.

3.1 Defining a Reservoir in Combination with Routing

One of the routing methods available in HEC-1 is storage routing, which can be used to define reservoir routing. In this case, Muskingum-Cunge routing is already being used to move the hydrograph through the reach connecting the upper left basin to the watershed outlet. Therefore, the outlet must be defined as a reservoir so that the hydrograph can be routed through the reservoir before routing it downstream.

1. Switch to the **Hydrologic Modeling Module**.
2. Using the **Select outlet** tool, select the upper left basin outlet.

3. Right-click on the selected outlet and select *Add* **| Reservoir**.

Notice that the icon for the outlet changed to a blue triangle, indicating it is now a reservoir (Figure 1).

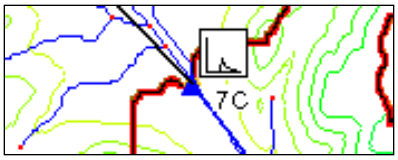

Figure 1 Reservoir indicated by a blue triangle

3.2 Setting up the Reservoir Routing Parameters

In order to define reservoir routing with HEC-1, elevation vs. storage (storage capacity curve) and elevation vs. discharge rating curves must be defined. Values can be entered directly, or hydraulic structures can be entered and the values computed. In this tutorial, enter the values directly. Use the same elevation values for both curves (this is common, but not a requirement in HEC-1).

For this tutorial, no outflow is desired until the elevation in the reservoir reaches the spillway. Since HEC-1 linearly interpolates between consecutive points on the elevation-discharge and elevation-volume curves, enter 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. Using the **Select outlet** tool, double-click on the reservoir outlet point to bring up the *Edit HEC-1 Parameters* dialog.
2. In the *Routing HEC-1 Cards* section, click **Reservoir Data…** to bring up the *Reservoir Routing Data* dialog.
3. Enter “Tcreek” as the *Reservoir name*.
4. Select *Reservoir* under *Type of storage routing*.
5. Click **Define** to bring up the *HEC-1 Reservoir Routing Options* dialog.
6. In the *Volume* section, select *Known volume* and turn on *SV* and *SE*.

This section allows defining of the reservoir storage capacity by entering elevations and their corresponding volumes.

7. Click **Define** to the right of *SV* to bring up the *XY Series Editor* dialog.

Separate XY series for volumes, elevations, and discharges will now be defined using this dialog.

8. At the bottom right, click **New** to create a new curve.
9. Enter “Volume” as the *Curve Name*.
10. In an external spreadsheet program, open the “reservoir.xls” file found in the *hec1\hec1* directory.
11. Copy the numbered contents in the “Outflow” column.
12. In WMS in the *XY Series Editor* dialog, right-click in the empty cell on row *1* in the *Volume (ac-ft)* column and select **Paste**.

The copied numbers should now be on rows *1-7* in the *Volume (ac-ft)* column.

13. *Shift*-select rows *8* through *20* in the *Volume (ac-ft)* column and **Delete** them.

The values for those rows should change from “0.0” to blank.

14. Click **OK** to close the *XY Series Editor* dialog.
15. Click **Define** to the right of *SE* to bring up the *XY Series Editor* dialog.
16. Using the numbers in the “Elevation” column in the external “reservoir.xls” spreadsheet, repeat steps 8–14. Use “Elevation” as the *Curve Name* in step 9.
17. In the *Outflow* section, select *Known outflow* and turn on *SQ* and *SE*.
18. Click **Define** to the right of *SQ* to bring up the *XY Series Editor* dialog.
19. Using the numbers in the “Discharge” column in the external “reservoir.xls” spreadsheet, repeat steps 8–14. Use “Discharge” as the *Curve Name* in step 9.
20. In the *Outflow* section, click **Define** to the right of *SE* to bring up the *XY Series Editor* dialog.

Rather than creating a new curve, use the previously defined elevation curve.

21. Select “Elevation” from the *Selected Curve* drop-down.
22. Click **OK** to close the *XY Series Editor* dialog.

Clicking Plot SQ-SE or Plot SV-SE generates elevation-discharge or elevation-volume curves (respectively) in a separate *HEC Plot* dialog. This curve can be exported, printed, or controlled in the same way as a hydrograph or any other plot in a plot window.

23. Click **OK** to close the *HEC-1 Reservoir Routing Options* window.

The last input needed to define reservoir routing is the initial condition type of the reservoir, defined as an elevation, a discharge, or a volume. Using the data just entered, HEC-1 can determine the initial condition of the other two. For this tutorial, set the initial condition as an elevation four feet below the top of the spillway (which has an elevation of “6822.0”).

24. Under *Initial condition type*, select *ELEV*.
25. Enter “6818.0” as the *RSVRIC* (reservoir initial condition).
26. Click **OK** to close the *Reservoir Routing Data* dialog.
27. Click **Done** to close the *Edit HEC-1 Parameters* dialog.

3.3 Running HEC-1

At this point, save and run the HEC-1 file with the defined reservoir.

1. Select *HEC-1* **| Run Simulation…** to bring up the *HEC-1 Run Options* dialog.
2. Under *Input file*, click  to open the *Select HEC-1 Input File* dialog.
3. Select “HEC-1 Files (*.hc1)” from the *Save as type* drop-down.
4. Enter “Reservoir.hc1” as the *File name* and click **Save** to close the *Select HEC-1 Input File* dialog.
5. Turn on *Save file before run* and click **OK** to close the *HEC-1 Run Options* dialog and open the *Model Wrapper* dialog.
6. Once HEC-1 is finished, turn on *Read solution on exit* and click **Close** to import the solutions and close the *Model Wrapper* dialog.

7. Use the **Select hydrograph** tool while pressing the *Shift* key to select all of the hydrographs, double-clicking on the last hydrograph to open the *Hydrograph* dialog (Figure 2).
8. Close all *Hydrograph* dialogs once done reviewing them.

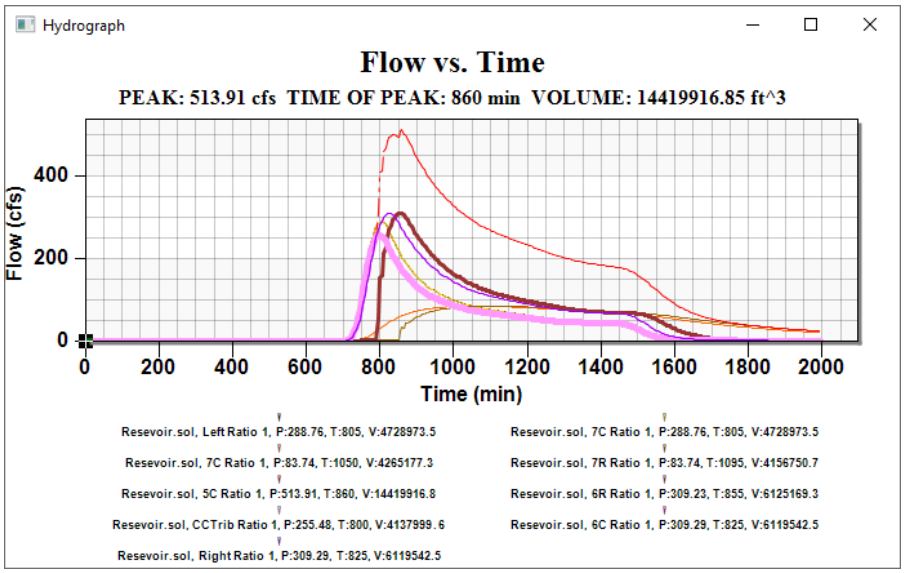

Figure 2 Hydrographs with reservoir

4 Reviewing Output

While WMS facilitates setting up a HEC-1 model and computing a result, it is not a substitute for understanding the basic theory and equations used in HEC-1. For further detail and information, consult texts on hydrologic modeling and read the HEC-1 manual found in the documents directory distributed with WMS.

A HEC-1 output file is also generated with each simulation. Review it in order to better understand how the model works.

1. Select *File* | **Edit File…** to bring up the *Open* dialog.
2. Select “Reservoir.out” and click **Open** to exit the *Open* dialog and open the *View Data File* dialog. If the *Never ask this again* option was previously checked, this dialog will not appear. If this is the case, skip to step 4.
3. Select the desired text editor from the *Open With* drop-down and click **OK** to close the *View Data File* dialog and open the output file in the desired text editor.
4. Review the file to understand what information HEC-1 saves to the output file.

If there are errors running HEC-1 simulations, the reasons for the errors are often recorded within the OUT file.

5. When finished reviewing the OUT file, close the text editor.

5 Conclusion

This concludes the “HEC-1 Modeling Reservoirs” tutorial. The key concepts discussed and demonstrated include:

- Defining routing parameters
- Routing a hydrograph through a reservoir
- Saving HEC-1 input files
- Reading hydrograph results