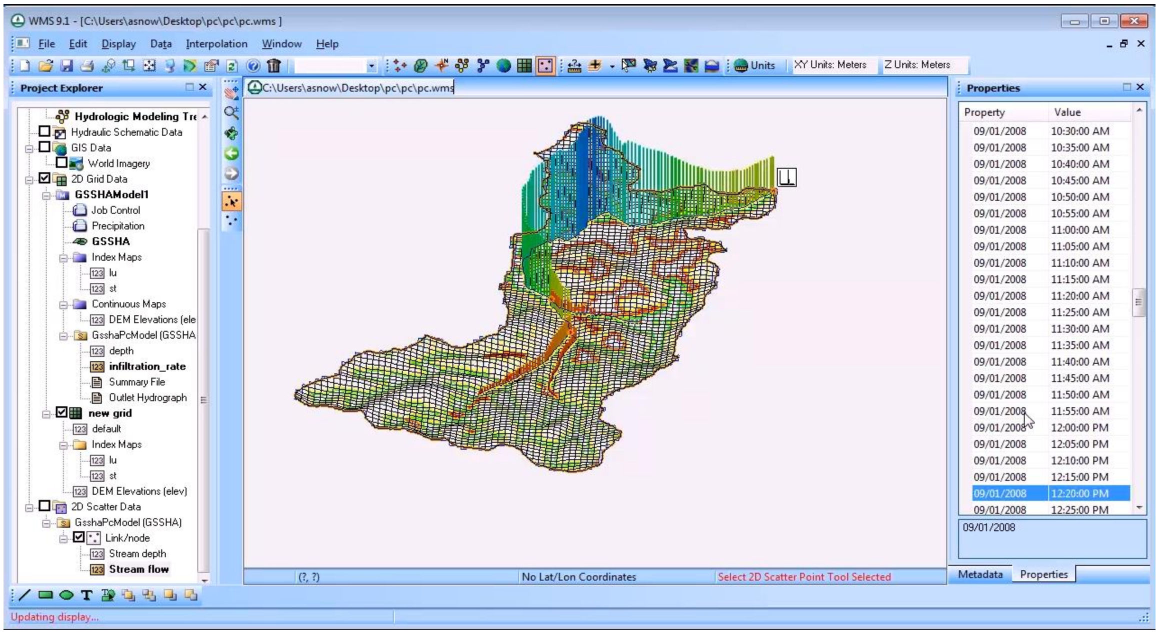
v. 11.0

WMS 11.0 Tutorial

Upgrading an HEC-HMS Model to a GSSHA Model

Learn how to convert an HEC-HMS model or any other delineated watershed to a GSSHA model using WMS



Objectives

This tutorial shows how to use WMS to convert an HMS model of a watershed near Park City, Utah to a GSSHA model. After building a GSSHA model, view the GSSHA output using the rich suite of watershed visualization tools available in the WMS interface.

Prerequisite Tutorials

- Developing a GSSHA Model using the Hydrologic Modeling Wizard

Required Components

- Data
- Drainage
- Map
- Hydrology
- 2D Grid
- GSSHA

Time

- 15–30 minutes

1 Introduction

WMS supports several commonly used hydrologic, hydraulic, and storm drain models. If having built a model using one of the hydrologic models supported by WMS, save the model data to another hydrologic model by following the steps in the hydrologic modeling wizard. WMS can even be used to convert a lumped parameter hydrologic model to a distributed hydrologic model. The distributed hydrologic model GSSHA, developed by the US Army Corps of Engineers, is one of the most advanced distributed hydrologic models available and is supported by WMS.

In this tutorial, an existing HEC-HMS model will be converted to a GSSHA model using WMS. The model watershed is located in Park City, Utah.

1.1 Getting Started

Start with importing an existing HEC-HMS project file and viewing the watershed.

1. Select *File* **| Open** to bring up the *Open* dialog.
2. Locate the *data files* folder for this tutorial, and select the "pc.wms" file.
3. Click **Open** to import the project.
4. In the Project Explorer, turn off " Soil Type" under " Map Data".
5. In the Project Explorer, right-click on " Drainage" and select **Zoom to Layer**.

The Graphics Window should appear similar to Figure 1.

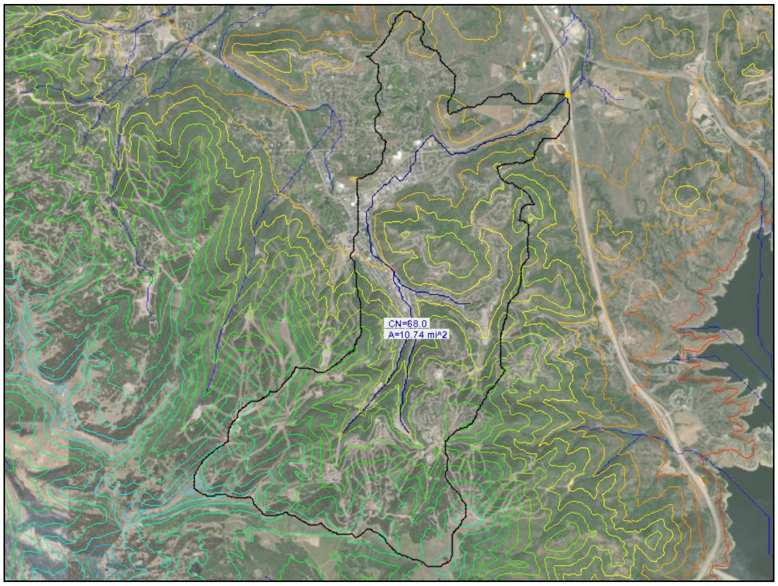


Figure 1 Initial project

2 Hydrologic Modeling Wizard

Now to open the *Hydrologic Modeling Wizard*.

1. Click on the **Hydrologic Modeling Wizard** macro to start the *Hydrologic Modeling Wizard*.
2. In the left window of the wizard, click *Select Model*.

2.1 Select Model

Now to begin building a GSSHA model.

1. Set *Select the desired model* to “GSSHA”.
2. Click **Initialize Model Data**.
3. Click **Next** to continue to the *Define and Smooth Streams* section of the wizard.

2.2 Define and Smooth Streams

GSSHA is a model that includes a 2D overland flow hydrologic model that interacts with a 1D hydraulic model. Before building the 2D grid that discretizes the hydrologic model, it’s a good idea to define the attributes for the streams in the watershed and initialize the stream elevations so the 2D grid elevations correspond to the stream elevations used in the 1D hydraulic model. It’s also important to define stream channel attributes such as Manning’s roughness and cross section information so GSSHA can run the necessary stream hydraulic computations. In this section, define the stream cross section, set the spacing between stream nodes, and initialize the stream elevations so no adverse slopes exist along the stream.

1. In the Project Explorer, turn off “ GIS Data”.

2. Using the **Select a stream branch** tool, click on the most downstream stream arc in the model.

All the stream arcs should be selected.

3. Click **Set Selected Arc Attributes** to open a *Properties* dialog.
4. Set all the arc attributes to the following:
    a. *Type* to "Trapezoidal channel"
    b. *Manning's n* to "0.04"
    c. *Depth* to "1" m
    d. *Bottom width* to "2" m
    e. *Side slope* to "2" H:V
5. Leave other values at the default and click **OK** to close the *Properties* dialog.
6. Select **Yes** when told about renumbering links.
7. Select **All** to use all arcs in the GSSHA coverage.
8. Select **Redistribute Vertices on All Streams** to open the *Redistribute Vertices* dialog.
9. Make certain *Specify* is set to "Specified Spacing", enter "60" for the *Average spacing*, and turn on *Use Cubic Spline*.
10. Click **OK** to exit the *Redistribute Vertices* dialog.
11. Using the **Select one or more streams** tool, select one continuous stream segment from the outlet to the upstream end of the stream as shown in Figure 2-1

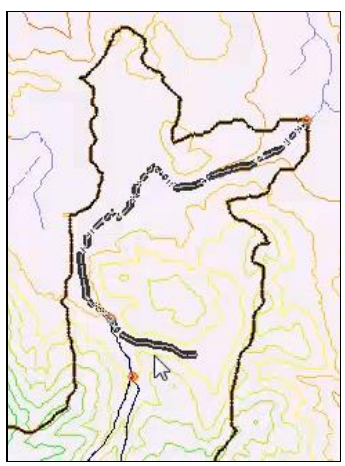


Figure 2-1: Select Continuous Stream Segment

12. Click **Smooth Selected Stream Segments** to open the *Smooth GSSHA Streams* dialog.
13. Click **Interpolate stream elevations** until the stream has no negative or horizontal slopes (Figure 2-2).

It may be necessary to click the button several times to remove all negative or horizontal slopes in the streams. If building a GSSHA model for a project, modify negative slopes manually so the stream thalweg data is not significantly modified. The stream segment selected in Figure 2-1 should look like Figure 2-2.

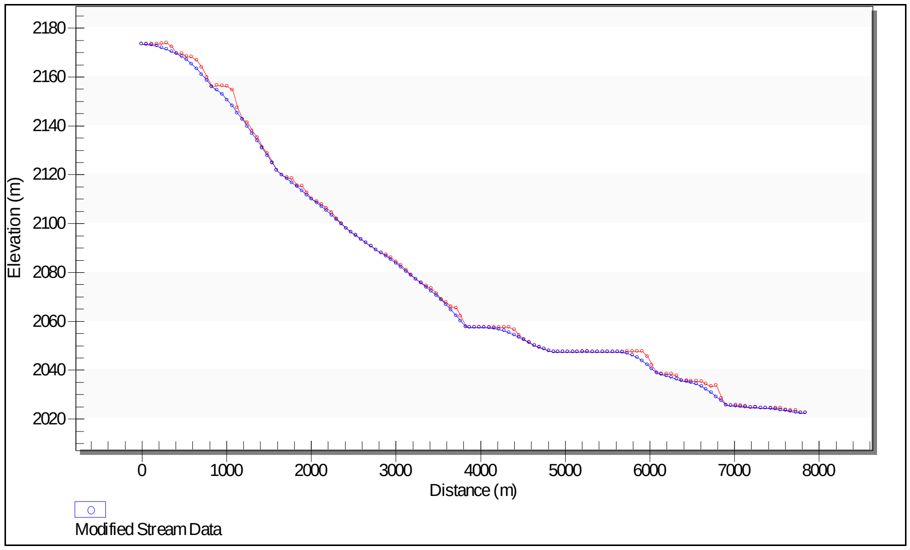


Figure 2-2: Smoothing Stream Segments

14. When done, click **OK** to close the *Smooth GSSHA Streams* dialog.
15. Repeat steps 11–14 for each of the three continuous stream segments in the model.
16. Click **Next** to continue to the *Create 2D Grid* section of the wizard.

2.3 Create 2D Grid

Next, create the 2D grid to discretize the hydrologic model domain using a 90 meter cell size.

1. In the *X-dimension* field, enter “90” m.
2. Select **Create 2D Grid** to open the *Background Elev Interpolation* dialog.
3. Accept the default settings and select **OK** to close the *Background Elev Interpolation* dialog.
4. If asked if to delete existing background DEM, select **No**.

The grid should look like Figure 2-3.

5. Click **Next** to continue to the *Job Control* section of the wizard.

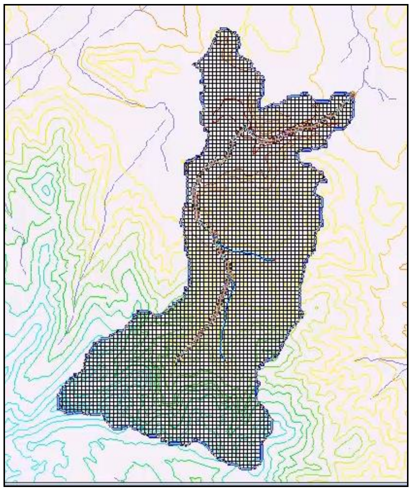


Figure 2-3: 2D Grid

2.4 Job Control

Define a start and end time for the model simulation. This model will run for two days with a 10 minute time increment.

1. Set *Starting date* to "9/1/2008".
2. Set Starting time to "12:00:00 AM".
3. Set *Ending date* to "9/3/2008".
4. Set *Ending time* to "12:00:00 AM".
5. Set *Time interval* to "2" seconds.
6. Click **Set Job Control Data**.
7. Click **Next** to go to the *Define Land Use and Soil Data* section of the wizard.
8. Click **Next** to go to the *Hydrologic Computations* section of the wizard.

2.5 Hydrologic Computations

It's important to define land cover and soil type for each cell of the watershed. This is so the correct Manning's roughness values and infiltration parameters can be defined for each cell. WMS has tools for assigning readily available land use and soil type information to each cell using the *GSSHA Maps* tool.

1. Select **Compute Index Mapping Tables** to open the *GSSHA Maps* dialog.
2. Select "Land use Grid" under *Input Coverages (1).*
3. Set the *Index map name* to "Land Use".
4. Select **Coverages→Index Map**.
5. Select "Soil Type" under *Input Coverages (1)*
6. Set the *Index map name* to "Soil Type".
7. Select **Coverages→Index Map**.

8. Select **Done** to close the *GSSHA Maps* dialog and open the *GSSHA Map Table Editor* dialog.

Now that land use ID's and soil textures have been assigned to each cell, Manning's roughness values can be assigned to each of the land use ID's.

9. In the *Roughness* tab, select "LandUse" for the *Using index map* option.
10. Select **Generate IDs** to populate the table below.

Infiltration parameters can be assigned to the soil textures so GSSHA can compute the amount of rainfall that infiltrates into the soil and the runoff velocities between each of the 2D grid cells.

11. Select the *Infiltration* tab
12. Select **Yes** at the warning the dialog to open the *GSSHA Job Control Parameters* dialog.
13. Turn on *Green + Ampt with soil moisture distribution* in the *Infiltration* section
14. Select **OK** to close the *GSSHA Job Control Parameters* dialog.
15. Select "SoilType" for the *Using index map* option.
16. Select **Generate IDs** to populate the table below.
17. Select the *Initial Moisture* tab and repeat steps 15–16
18. Click **Import Table** to bring up an *Open* dialog.
19. Select the *"G*sshaPcModel.cmt" file in the *GSSHA* folder for this tutorial and click **Open** to import the data.

Notice the values are filled inside the tables under the *Roughness*, *Infiltration*, and *Initial Moisture* tabs.

20. Select **Done** to close the *GSSHA Map Table Editor* dialog.

Now to turn on channel routing in the model and to turn on some additional output parameters to enhance model visualization after running GSSHA.

21. Select **Edit Parameters** to open the *GSSHA Job Control Parameters* dialog.
22. Turn on *Diffusive wave* in the *Channel routing computation scheme* section
23. Select **Output Control** to open the *GSSHA Output Control* dialog.
24. Under *Gridded datasets* turn on *Infiltration rate*.
25. Under *Link/Node datasets* turn on *Channel depth* and *Channel flow*.
26. Change the *Write frequency* to "15" minutes.
27. Change the *Hydrograph Write frequency* to "5" minutes.
28. Change the *Output units* to *English (cfs)*
29. Click **OK** to close the *GSSHA Output Control* dialog.
30. Click **OK** to close the *GSSHA Job Control Parameters* dialog.
31. Click **Next** to continue to the *Define Precipitation* section of the wizard.

2.6 Define Precipitation

One last step in setting up the model is to define a storm event. This model will use a standard Type II 24-hour precipitation distribution with a precipitation depth of 3.13 inches, or 79.5 mm. This precipitation value was determined from NOAA atlas 14.

1. Click **Define Precipitation** to open the *GSSHA Precipitation* dialog.
2. Select “Hyetograph” under *Rainfall event(s).*
3. Select **Define Distribution** to open the *XY Series Editor*.
4. Select “typeII-24hour” under *Selected Curve*
5. Select **OK** to close the *XY Series Editor*.
6. In the *Average Depth (mm)* row, type “79.5” mm (3.13 in).
7. Click **OK** to close the *GSSHA Precipitation* dialog.
8. Click **Next** to continue to the *Clean Up Model* section of the wizard.

2.7 Clean Up Model

The **Clean Up Model** button runs some common tasks that are often performed to clean up the display and check the model before running it. The model is cleaned up and no errors are detected in the HMS model.

1. Turn off the option to *Remove NULL DEM cells*
2. Click **Clean Up Model** to open the *GSSHA Model Check* dialog.
3. Select **Done** to close the *GSSHA Model Check* dialog and start the *Model Wrapper*.
4. Click **Close** when the *Model Wrapper* finishes
5. Click **Next** to continue to the *Run Hydrologic Model* section of the wizard.

2.8 Save and run GSSHA model

After completing the hydrologic model, save and run the GSSHA model.

1. Next to *Input file* select to bring up the *Select Model Inpute File Name* dialog.
2. Enter ”GsshaPcModel.prj” as the *File name* and click **Save**.
3. Select **Run the Simulation** to open the *GSSHA Run Options* dialog.
4. Select **OK** to close the *GSSHA Run Option* dialog and start the *Model Wrapper*.
5. Click **Close** when the *Model Wrapper* finishes and wait for WMS to read the solution. If there is an error running the model, track down the error and fix the problem with the model.
6. Select **Finish** to close the wizard

3 Visualizing GSSHA Output

Once having run the GSSHA model, WMS has a rich set of tools that allow visualizing overland flow depths, infiltration rates, stream flows, and stream depths. To contour any of these computed maps at any time during the simulation, select the output map to visualize (such as the depth map) and scroll through the times in the properties window to view the contours of overland flow depth, infiltration, stream flow, or stream depth at each time step. There are various display options that can be set to enhance the display of these dataset contours when scrolling through the time steps.

Turn on a background map and use the background map as a reference to determine where watershed phenomena occur. Also view cylindrical contours representing stream depth and view the storm flood wave along the stream.

1. Turn off the " pc.gm_ned10.web" in the Project Explorer under " Terrain Data".
2. Turn on " World Imagery" under " GIS Data".
3. Under " GsshaPcModel (GSSHA)", select " depth".
4. In the Properties window, step through the dataset time steps. Use the down arrows to step through the times.

Notice how the contours change when stepping through the times.

5. Under " GsshaPcModel (GSSHA)", select " infiltration_rate".
6. Repeat step 4.
7. Using the **Rotate** tool, rotate the view so it looks similar to Figure 3-1.

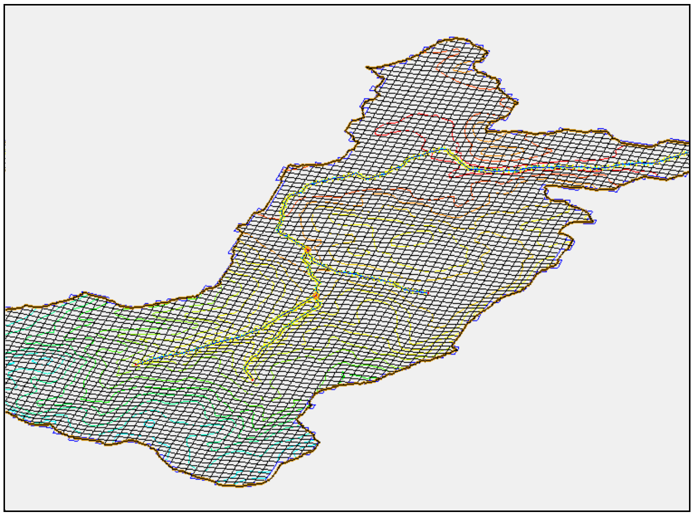


Figure 3-1: Rotated GSSHA Model

8. Click **Display Options** to open the *Display Options* dialog.
9. Select *2D Scatter Data* from the box on the left.
10. Turn on the 2D Scattered Data *contours*.
11. Enter a *Radius* of "15" and a *Z-magnification* of "50".

12. Select **OK** to close the *Display Options* dialog.
13. Under " 2D Scatter Data", select " Stream Flow" dataset and step through the times of this dataset starting on 9/1/2008 at 10:00 AM.

Notice the cylinders representing stream water surface elevations.

4 Conclusion

The WMS Hydrologic Modeling Wizard can be used to convert an HMS model to a GSSHA model. After building a GSSHA model, use WMS' suite of visualization tools to visualize watershed processes anywhere in the watershed. It is also possible to export an animation of a watershed process to Google Earth.