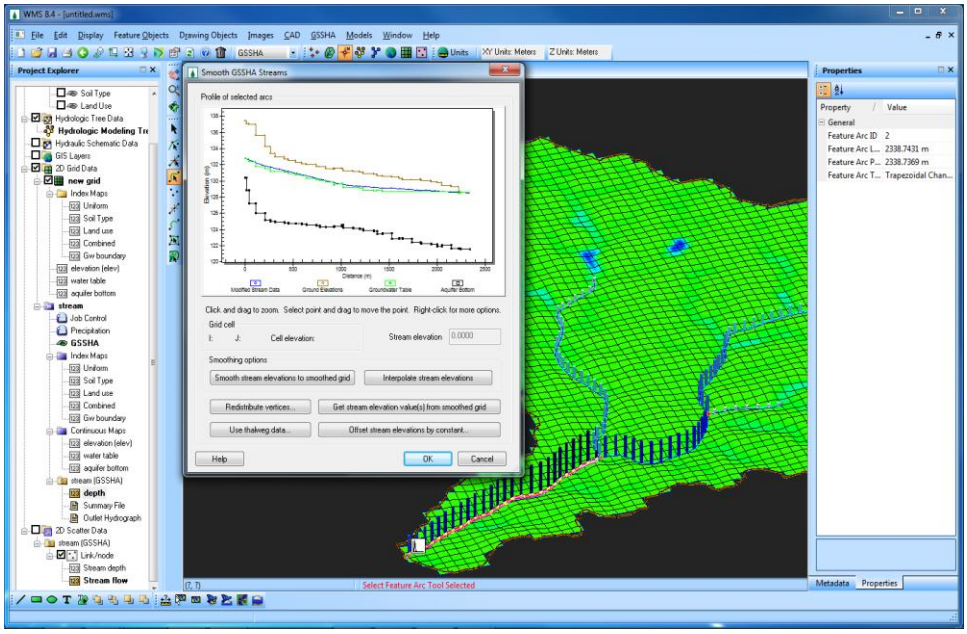
WMS

v. 8.4

WMS 8.4 Tutorial

GSSHA – Groundwater – Advanced Groundwater Modeling in GSSHA

Add advanced groundwater features to an existing GSSHA model



Objectives

In this tutorial, you learn how to add advanced groundwater interactions such as stream interaction, wells, and specified head boundary conditions to an existing GSSHA model.

Prerequisite Tutorials

- GSSHA – Groundwater – Groundwater Modeling in GSSHA

Required Components

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

Time

- 30-60 minutes

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1 Contents

2 Introduction

In the previous workshop you learned how a basic groundwater simulation can be developed in GSSHA. In this workshop, you learn about some more advanced topics in groundwater simulation.

3 Open an Existing GSSHA Project

You will continue working with the same model that you developed in the previous workshop. If your model in the previous workshop did not work right or you closed it, you may open it from ***C:\Training\Groundwater\GW.prj***.

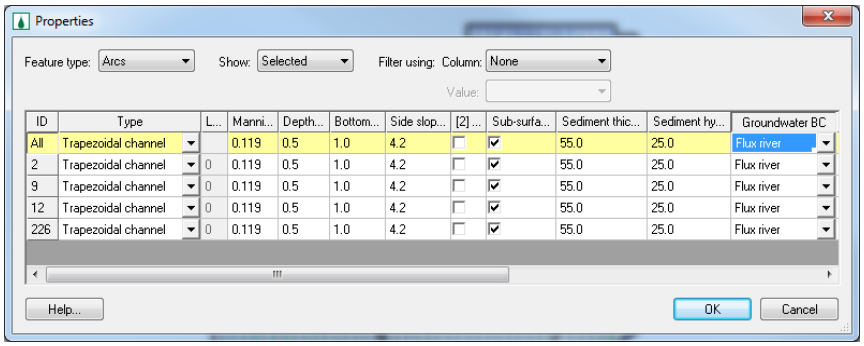
1. Save the project as ***C:\Training\Personal\Groundwater\GWAdv.prj***.
2. Turn off the display of all the coverages except GSSHA coverage.

4 Adding Streams to the groundwater model

The basic groundwater model that you developed in the previous workshop did not have the stream routing option turned on. In this workshop, you will turn on stream routing and define a groundwater boundary condition for the streams. Because a significant amount of water goes into the subsurface flow from the channel, you will also enable subsurface flow from the channel bottom.

1. Click on the *GSSHA* coverage in the *Project Explorer* to select it.
2. Click on the *Select Feature Line Branch Tool*  and double click at the downstream most arc of the channel network (the one that is connected to the watershed outlet). This will open the channel *Properties* dialog with all stream arcs selected.

3. For all segments, change the channel type to *Trapezoidal channel*, *Manning's n* to 0.119. *Depth* to 0.5m, *Bottom Width* to 1m and *Side Slope* to 4.2.
4. For all segments, turn on the *Sub-surface losses/gains* option and enter 55 cm for *Sediment Thickness* and 25 cm/hr for *sediment hydraulic conductivity*.
5. Change the *Groundwater BC* to *Flux River*. See the following figure.

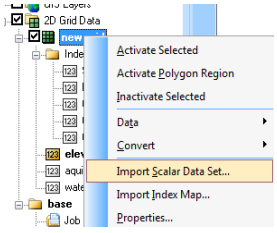


3. Click OK.
4. In the GSSHA *Job Control* dialog (*2D Grid Module*, *GSSHA | Job Control*), select the *Diffusive Wave* option for channel routing. Click *OK* to close the *Job Control* dialog.
5. In the *Project Explorer*, under *2D Grid Data*, click on the *Gw Boundary* index map. As you select it, you will see a single-colored index map on the WMS display which represents a generic groundwater BC. This map needs to be regenerated for the river flux boundary condition you just defined on the stream arcs.
6. Right click on the *Gw boundary* index map and select *Regenerate*. You can now see different-colored cells that represent the channel network.

5 Import a Hotstart file for groundwater elevations

Using the output dataset from one model as an input to another model is called a *Hotstart* in GSSHA. In this workshop, you will use the final groundwater elevation from the previous workshop as a hotstart file for the starting groundwater head of this model.

1. In the *Project Explorer*, click on the *2D Grid Data* folder to select it.
2. Right click on the *new grid* folder directly under the *2D Grid data* and select *Import Scalar dataset*
3. Select *GRASS ASCII grid file* and click *OK*.
4. Browse and open the file ***C:\Training\Personal\Groundwater\GWHotStart.ggd.*** This file was saved in the previous workshop. If you have not completed the previous workshop, you can open the ***Groundwater\GW.prj*** GSSHA project file, run this project in GSSHA, and follow the last step in the previous workshop to get the GSSHA hot start file.

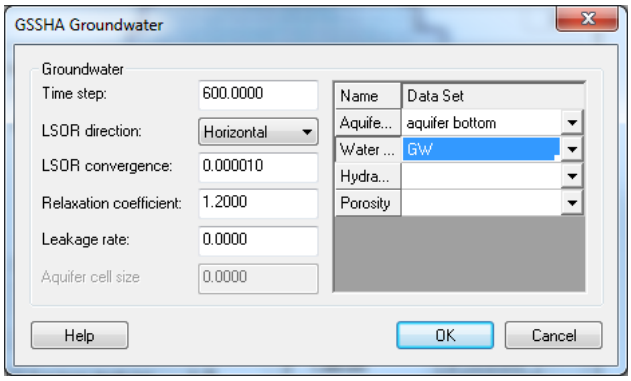


NOTE that in the *Open* dialog, you might need to change the file type to *All Files (*.*)*.

5. In the *Project Explorer*, under *2D Grid data* you should see a *GWAdv* GSSHA model. Right click the *Continuous Maps* folder under this model and

assign the *GWHotStart* dataset. This will list the *GWHotStart* dataset which you imported as a hotstart file as one of the continuous maps for the *GWAdv* model.

6. In the GSSHA *Job Control*, Click on *Edit Parameters* button next to *Groundwater*.
7. Assign *GWHotStart* for the *Water Table*.



8. Click *OK* and *OK* again.

6 Save and Run the Model

1. Save the project as ***C:\Training\Personal\Groundwater\GWAdv.prj***.
2. Run GSSHA and visualize the results.

7 Visualize the Results

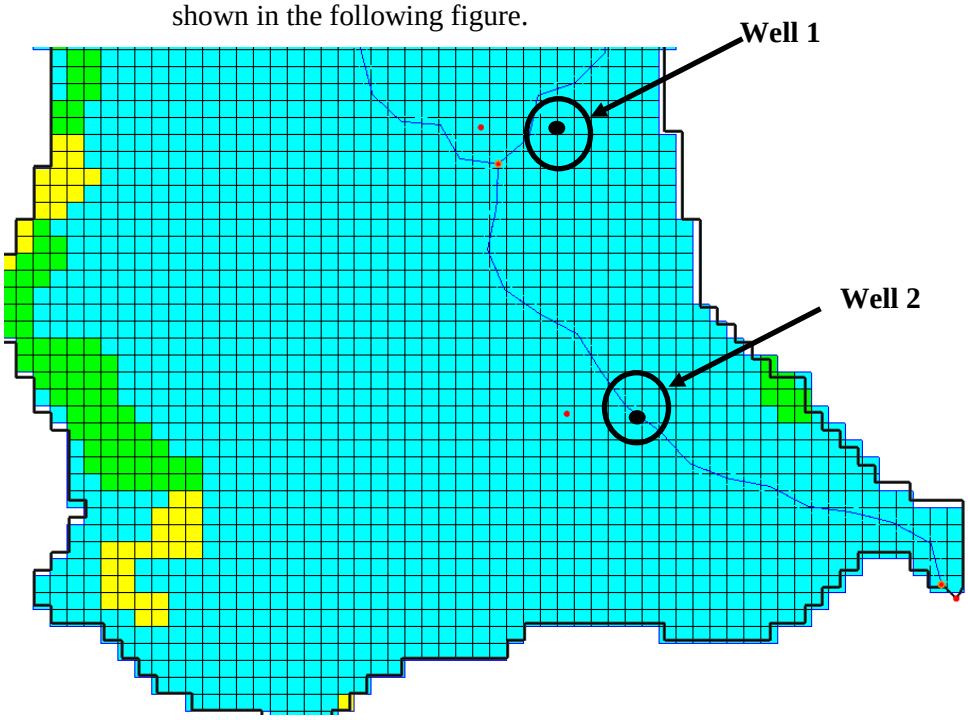
1. Once done running, open the hydrograph plot and copy the ordinates to the *With Streams* column in the *Data* tab in the spreadsheet ***C:\|Training\Groundwater\GWResults.xls.***
3. Compare the values and hydrograph plot with the previous case where you did not have the streams turned on.
4. Step through the time steps of the *groundwater_head* map to see how the water surface changes during your simulation.
5. Open the summary file and scroll down to find the *SIMULATION TOTALS* at the end of the file. Copy the information in the SIMULATION TOTALS section of the file to the *Simulation Totals* sheet under the *With Streams* column of ***C:\Training\Groundwater\ GWResults.xls***. Observe any differences in the final values and think about why these differences might have occurred in your current model.
6. This is an optional step. You **MAY** import the file ***C:\Training \Personal\Groundwater\GWAdv.wte*** (a GRASS ASCII Grid), which is the final water table at the end of the model simulation, and compare this file with the initial water table elevation dataset (GW) using the data calculator.

8 Add Wells to the Groundwater Model

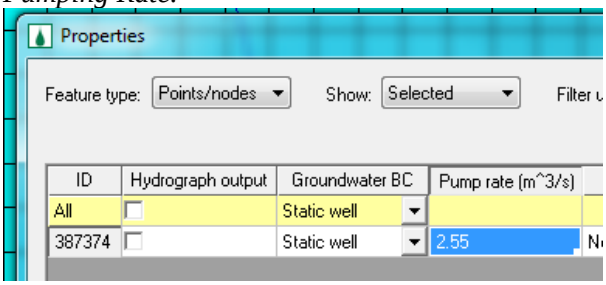
GSSHA can be used to simulate the effects of pumping wells on groundwater heads. In this section, you will add two wells in the model that we have been building.

If you closed the project or did not finish the model, you may open it from ***C:\Training\Groundwater\GWAdv.prj.***

1. Save the project as ***C:\Training\Personal\Groundwater\GWAdvWells.prj.***
2. Turn off the display of all the coverages except the *GSSHA* coverage.
3. In the *Project Explorer*, click on the *GSSHA* coverage to select it.
4. Select the *Create Feature Point Tool* and click on the two cells shown in the following figure.



5. Click on the *Select Feature Point/Node* Tool and double click on *Well 1* (see above figure). This will open the *Properties* dialog.
6. In the *Groundwater BC* column, select *Static Well.* Enter 2.55 m^3/s for the *Pumping Rate.*



7. Click OK.
8. Similarly, double click on *Well 2* and select *Dynamic well.* Click on the open button to the right of the Dynamic well selection, under *Pump rate,* which will open the *XY Series Editor* window.
9. Outside of WMS, browse and open the spreadsheet ***C:\Training\Groundwater\PumpingRate.xls.*** Copy all the data and paste it into the *XY Series Editor*.
10. Click *OK* and *OK* again.

11. Select the *Gw Boundary* Index map in the *Project Explorer* and *Regenerate* it.
12. This will create an index map for the wells. This new index map will be selected, causing a change in the display of the boundary condition index map. All the boundary conditions can be viewed by selecting the *Gw Boundary* index map.

9 Import the Hotstart File for the Groundwater Table

1. In the *Project Explorer*, click on *2D grid data* to select it.
2. Right click on *new grid* folder (under *2D Grid Data*) and select *Import Scalar Data Set*
3. Select *GRASS ASCII grid file* and click *OK*.
4. Browse and open the file ***C:\Training\Personal\Groundwater\hotstart_file.*** Note that in the *Open* dialog, you might need to change the file type to *All Files (*.*).*
5. In the project explorer, right-click on the hotstart_file dataset and rename the dataset to *GWAdv*.
6. In the *Project Explorer*, under *2D Grid data* you should see the *GWAdvWells* GSSHA project. Right click on the *Continuous Maps* folder under this model and Assign the *GWAdv* dataset. Notice that this adds the *GWAdv* dataset as a continuous map in the *GWAdvWells* model.
7. In the GSSHA *Job Control*, Click on the *Edit Parameters* button next to *Groundwater*.
8. Assign *GWAdv* for the *Water Table.*
9. Click *OK* and *OK* again.

10 Save and Run the Model

1. Save the project as ***C:\Training\Personal\Groundwater\GWAdvWells.prj***
2. Run GSSHA and visualize the results.

11 Visualize the Results

1. When GSSHA has finished running, open the hydrograph plot and copy the ordinates to the *With Wells* column in the *Data* tab in the spreadsheet ***C:\|Training\Groundwater\GWResults.xls.***
2. Compare the results with the results from the previous models which did not simulate wells.
3. Step through the maps of *groundwater_head* and see how the water surface changes over the period of your simulation.
4. Open the summary file and scroll down to find the *SIMULATION TOTALS* at the end of the file. Copy the information in the SIMULATION TOTALS section of the file to the *Simulation Totals* sheet under the *With Wells* column of ***C:\Training\Groundwater\ GWResults.xls***. Observe any differences in the final values and think about why these differences might have occurred in your current model.
5. This is an optional step. You **MAY** import the file ***C:\Training \Personal\Groundwater\GWAdvWells.wte*** (a GRASS ASCII Grid), which

is the final water table at the end of model simulation, and compare this file with initial water table elevation dataset (GWAdv) using the data calculator.

12 Add Outside Boundary Conditions

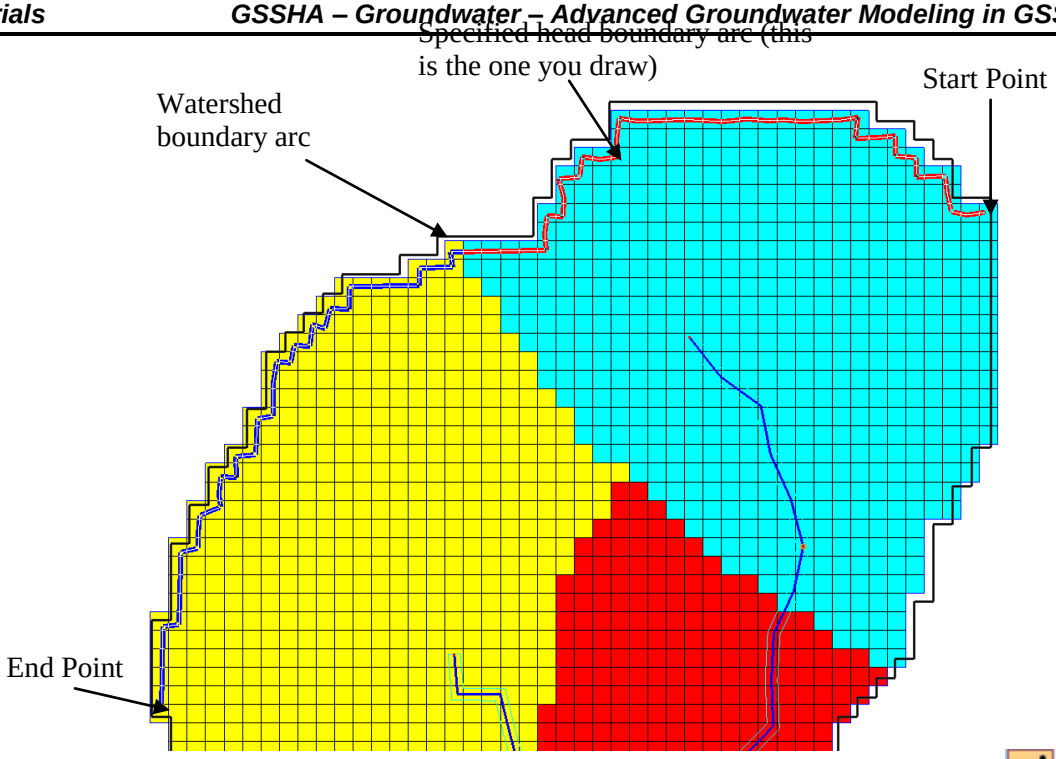
In all of the groundwater models built so far, we have been assuming that the watershed boundary is a *No Flow* boundary condition. In this exercise, we will define a specified head boundary condition to the watershed boundary and re-run the model.

The grid cells that have a specified head boundary condition need to be selected using an arc. You can select these cells either by modifying an existing arc or by creating a new arc.

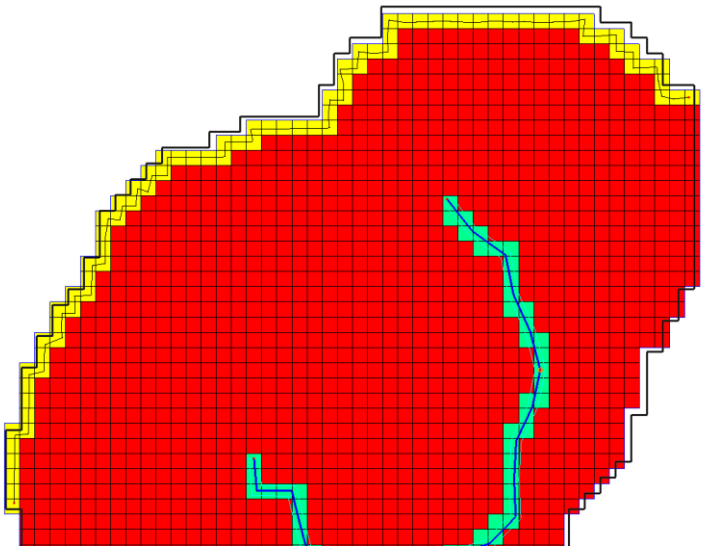
In this workshop, you will create a new arc that represents the specified head boundary.

If you closed or did not complete the previous model, you may open it from ***C:\Training\Groundwater\GWAdvWells.prj.***

1. Save the GSSHA project as ***C:\Training\Personal\Groundwater\GWAdvBdry.prj.***
2. Turn off the display of all the coverages except the *GSSHA* coverage.
3. In the *Project Explorer*, click on the *GSSHA* coverage to select it.
4. Select the *Create Feature Arc Tool*  and draw an arc starting from the point shown in the following figure and intersect each grid cell along the boundary until you reach the end point.
5. While drawing the boundary arc, follow these guidelines:
   - Do not intersect the arc you are drawing with the watershed boundary arc. This will end the arc at the point of intersection.
   - Make sure that you intersect each grid cell along the edge of the watershed model.
   - Make sure you make a continuous selection of grid cells (do not draw the arc so that a cell is missed in between).
   - It is a good idea to use the zoom tool or the mouse scroll wheel (press the wheel down to pan or scroll to zoom in/out) while creating the arc to center your view on the section of the screen where you are working.



6. Once you have traced the arc, click on *Select Feature Arc Tool* and double click on the Specified head boundary arc to open the *Properties* dialog.
7. Change the Groundwater BC property for the arc to *Constant head.* GSSHA will read the head elevation from the water table data.
8. Click OK.
9. Select the *Gw Boundary* Index map in the *Project Explorer* and *Regenerate* it.
10. If properly created, your specified head boundary will be displayed for the *Gw boundary* index map as shown in the following figure.
    NOTE: if you missed a few cells along the boundary, you may edit the location of the vertices along the arc using *Select Feature Vertex* tool and regenerate the *Gw boundary* index map.



13 Import Hotstart File for Groundwater Elevations

1. In the *Project Explorer*, click on the *2D grid data* folder to select it.
2. Right click on *new grid* folder which is right under *2D Grid data* and select *Import Scalar dataset*.
3. Select *GRASS ASCII grid file* and click *OK*.
4. Browse to and open the file ***C:\Training\Personal\Groundwater\ hotstart_file.*** **Note** that in the *Open* dialog, you might need to change the file type to *All Files (*.*)*.
5. In the project explorer, right-click on the hotstart_file dataset and rename the dataset to *GWAdvWells*.
6. In the *Project Explorer*, under *2D Grid data* you should see the *GWAdvBdry* GSSHA project. Right click on the *Continuous Maps* folder under this model and Assign the *GWAdvWells* dataset. Notice that this lists the *GWAdvWells* dataset which you imported as a hotstart file as one of the continuous maps.
7. In the GSSHA *Job Control*, Click on the *Edit Parameters* button next to *Groundwater*.
8. Assign the *GWAdvWells* data set to the *Water table*.
9. Click *OK* and *OK* again.

14 Save and Run the Model

We are now ready to run the model.

1. Save the project as ***C:\Training\Personal\Groundwater\GWAdvBdry.prj***
2. Run GSSHA and visualize the results.

15 Visualize the Results

1. When GSSHA has finished running, open the hydrograph plot and copy the ordinates to the *Static Head BC* column in the *Data* tab in the spreadsheet ***C:\|Training\Groundwater\GWResults.xls.***
2. Compare the results with the results from the previous models which did not simulate the outside boundary conditions.
3. Step through the maps of *groundwater_head* and see how the water surface changes over the period of your simulation.
4. Open the summary file and scroll down to find the *SIMULATION TOTALS* at the end of the file. Copy the information in the SIMULATION TOTALS section of the file to the *Simulation Totals* sheet under the *Static Head BC* column of ***C:\Training\Groundwater\ GWResults.xls***. Observe any differences in the final values and think about why these differences might have occurred in your current model.
5. This is an optional step. You **MAY** import the file ***C:\Training \Personal\Groundwater\GWAdvBdry.wte*** (a GRASS ASCII Grid), which is the final water table at the end of model simulation and compare this file with initial water table elevation dataset (GWAdvWells) using the data calculator.

