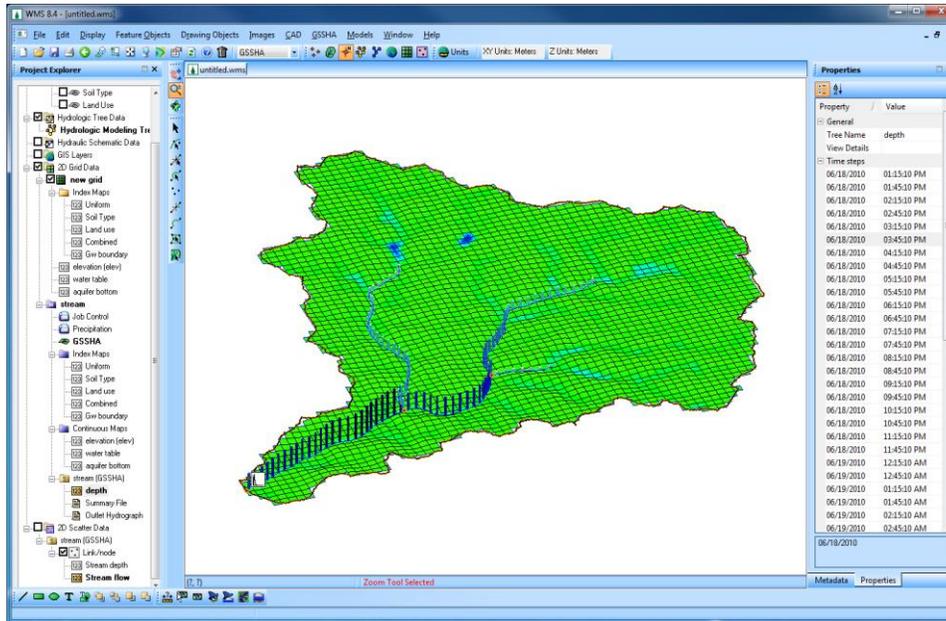


## WMS 11.0 Tutorial

# GSSHA – Subsurface Tile Drains

Add tile and storm drains to an existing GSSHA model



## Objectives

Learn how to add storm and tile drain networks and associated data to an existing GSSHA model with a long term simulation and a groundwater simulation defined.

### Prerequisite Tutorials

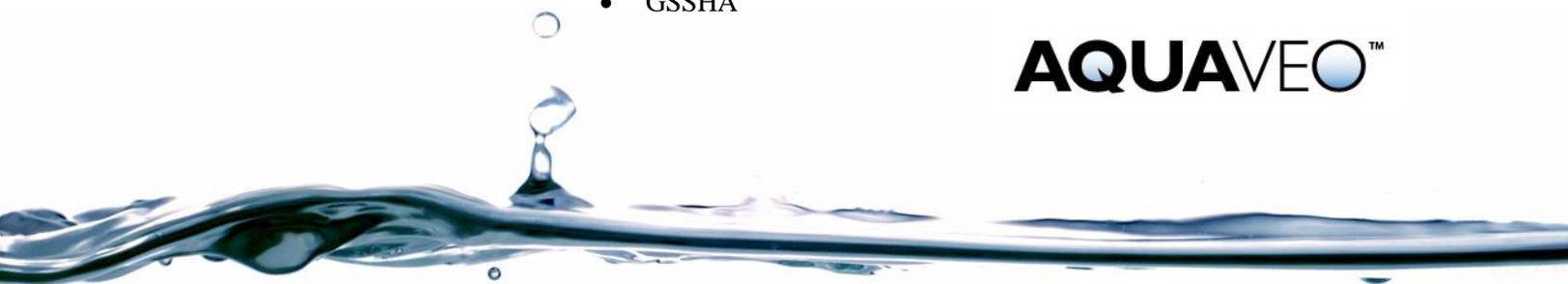
- Groundwater Modeling in GSSHA

### Required Components

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

### Time

- 15–30 minutes



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## 1 Introduction

This tutorial demonstrates how GSSHA can be used to simulate subsurface tile drains. An existing model that has a long term simulation and groundwater processes defined will be used. A network of tile drains will be added and the model will be ran to determine the effect of the tile drains on the subsurface flow.

## 2 Getting Started

Open a WMS project file for the Eau Galle watershed.

1. Make the **2D Grid Module**  active.
2. Select *GSSHA / Open Project File...* to bring up the *Open* dialog.
3. Locate the *data files* folder for this tutorial, and select the file “TileBase.prj” file.
4. Click **Open** to import the project.
5. In the Project Explorer, turn off the display of “ Map Data” then turn on the “ GSSHA” and “ GSSHA Storm Drain” coverages.
6. Select *GSSHA | Save Project File* to open the *Save GSSHA Project File* dialog.
7. Enter “tiledrain.prj” as the *File name* and click **Save**.

The project should appear similar to Figure 1.

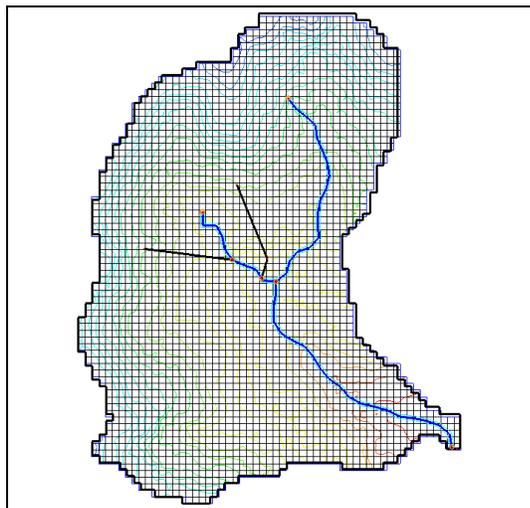


Figure 1 Initial project

### 3 Adding Subsurface Tile Drains to the Groundwater Model

Tile drains are generally used in agricultural fields to lower the water table by draining water into a network of pipes. GSSHA treats tile drains and storm drains the same way, but the conductance of the materials around the pipe should be high in the case of tile drains.

#### 3.1 Creating Tile Drains

1. Turn off the display of “ 2D Grid Data” in the Project Explorer.

This helps better visualize the storm drains in the background image.

2. Select *File / Open* to bring up an *Open* dialog.
3. Select the file “TileDrains.jpg” and click **Open** to import the image.
4. **Zoom**  into the area where the pipes are shown in the background image.
5. Make sure the “ GSSHA Storm Drain” coverage is active by selecting it.
6. Using the **Create Feature Arc**  tool, trace the tile drain network using the red arcs in the background image as a guide. Make sure to create the tile drains in the downstream to upstream direction.
7. If a dialog appears saying the storm drain junction is out of date, click **Yes** to renumber the junctions.

Once finished tracing the arcs, the network should look similar to Figure 2.

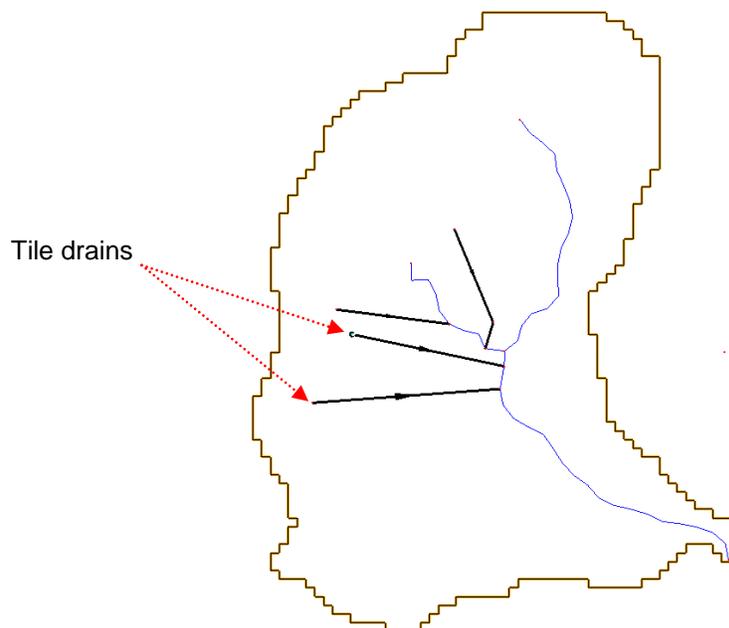


Figure 2 Tile drain locations

8. Using the **Select Feature Point/Node**  tool, select an individual node in the tile drain network.

9. In the Properties window to the right side of WMS main window, change the *Feature Point Z* value to match the value shown in the background image for the node.
10. Repeat steps 8–9 for each of the nodes in the tile drain network.
11. In the Project Explorer, turn off “ TileDrain.jpg” to hide the background image.
12. Select all the tile drain arcs using the **Select feature Arc**  tool.
13. Select *Feature Objects* / **Redistribute** to open the *Redistribute Vertices* dialog.
14. Select “Specified Spacing” for the *Spacing* and enter an *Average spacing* of “20” meters.
15. Click **OK** to close the *Redistribute Vertices* dialog.
1. With the pipe arcs still selected, select *Feature Objects* / **Attributes** to open the *Properties* dialog.
2. For all the arcs property, set the following:
  - *Type* to “Pipe”
  - *Manning's n* to “0.0002”
  - *Pipe type* to “Circular”
  - *Diameter* to “0.5” meters
  - *Conductance* to “25.0” cm per hour
  - *Drain Spacing* to “5.0” meters
16. Click **OK** to close the *Properties* dialog.
17. Select the **Refresh**  and **Zoom**  around the pipe network.
3. Select *Display* | **Display Options** to open the *Display Options* dialog.
4. Select Map Data from the list on the left.
5. Make certain the *Coverage Type* is set to “GSSHA Storm Drain” and then turn on the *Stream Arrows* option.
6. Click **OK** to close the *Display Options* dialog..
7. Check the flow directions for each pipe in the storm drain network, represented by an arrow head. If any arcs have an arrow pointing in the upstream direction, right-click on the arc and select **Reverse Directions**.

In WMS, storm drain and tile drain pipe arcs should be created in the downstream to upstream direction.

8. Using the **Select Feature Point/Node**  tool, select the nodes where the pipes are connected to the stream (hold the *Shift* key down to select multiple nodes).
9. Select *Feature Objects* | **Attributes** to open the *Properties* dialog.
10. Set the attributes as follows:
  - *Manhole area* to “1.0” m<sup>2</sup>

- *Inlet type* to “Empty to channel”
  - *Weir length* to “0.1” m
  - *Orifice diameter* to “0.1” m
  - Leave all other fields the same.
  - **Note:** If a hydrograph output is desired at the nodes where the pipes enter the stream, go to the GSSHA coverage, add nodes where the pipes enter the stream, and toggle on the option under the *Hydrograph output* column.
18. Click **OK** to close the *Properties* dialog.
  11. Using the **Select Feature Point/Node**  tool, select all the nodes except where the pipes are connected to the stream.
  12. Select *Feature Objects* | **Attributes** to open the *Properties* dialog.
  13. Set the attributes as follows:
    - *Manhole area* to “1.0” m<sup>2</sup>
    - *Inlet type* to “6 grate inlets”
    - *Weir length* to “0.1” m
    - *Orifice diameter* to “0.1” m
  19. Click **OK** to close the *Properties* dialog.

### 3.2 Assigning Pipe and Node Parameters

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After defining all the arc (Super-Link) and node (Super-Junction) data for each of the pipes in the model, WMS can transfer attributes associated with the Super-Link (arc) and Super-Junctions (arc nodes) to the generated pipes and nodes. After this transfer, the transferred data values can be edited. Node ground surface elevations are extracted from the 2D grid elevations at the location of each node or vertex on the selected arc. These pipes and nodes are written to the GSSHA Storm Pipe Network (.spn) file when the GSSHA project is written. It is important to define pipe and node parameters for all the pipe arcs in the storm or tile drain network. Deleting the pipes will delete the pipes and nodes from the arc. Once changes are made, re-initialize the pipes from the arc geometry or WMS may not write the correct pipe and node attributes for the selected arc.

For both of the tile drain pipe arcs in the model (the arcs drawn in a previous section), do the following:

1. Using the **Select Feature Arc**  tool, select one of the pipe arcs.
2. Select *Feature Objects* / **Attributes** to open the *Properties* dialog.
3. Select the  button under *Edit Pipes and Nodes* to open the *Pipe and Node Parameters* dialog.
4. Click **Initialize Pipes from Arc Geometry**.

On the selected arc (this represents a super-link) notice that a node is created for each vertex or node.

5. Select **OK** to close the *Pipe and Node Parameters* dialog.

6. Select **OK** to close the *Properties* dialog.
7. Repeat steps 1–6 for the other pipe arc.

## 4 Save and Run the Model

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The tile drain network has now been defined. The model has both storm and tile drains. Save the GSSHA project and run it.

1. Select *GSSHA* | **Save Project File** to open the *Save GSSHA Project File* dialog.
2. Enter “tiledrain\_final.prj” as the *File name* and click **Save**.
3. Select *GSSHA* | **Run GSSHA** to open the *GSSHA Run Options* dialog.
4. Click **OK** to start the *Model Wrapper* dialog.
5. When the model finishes running, click **Close** to exit the *Model Wrapper* and to load in the solution.

## 5 Results Visualization

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Once done running, review the results.

1. In the Project Explorer, turn on the display of “ 2D Grid Data” .
2. Using the **Select Hydrographs**  tool, double-click on the hydrograph icon at the outlet location to bring up a hydrograph plot.
3. When done reviewing the hydrograph, close the window.
4. In the Project Explorer, right-click the “ groundwater\_head” dataset and select **Contour Options** to open the *Contour Options* dialog.
5. Change the *Contour Method* to “Color Fill” and click **OK** to close the *Contour Options* dialog.
6. In the Project Explorer, select the “ groundwater\_head” dataset and toggle through the time steps to see how the groundwater head varied with time.

## 6 Conclusion

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This concludes the “GSSHA – Subsurface Tile Drains” tutorial. Feel free to experiment with other tile drains, or exit the program.