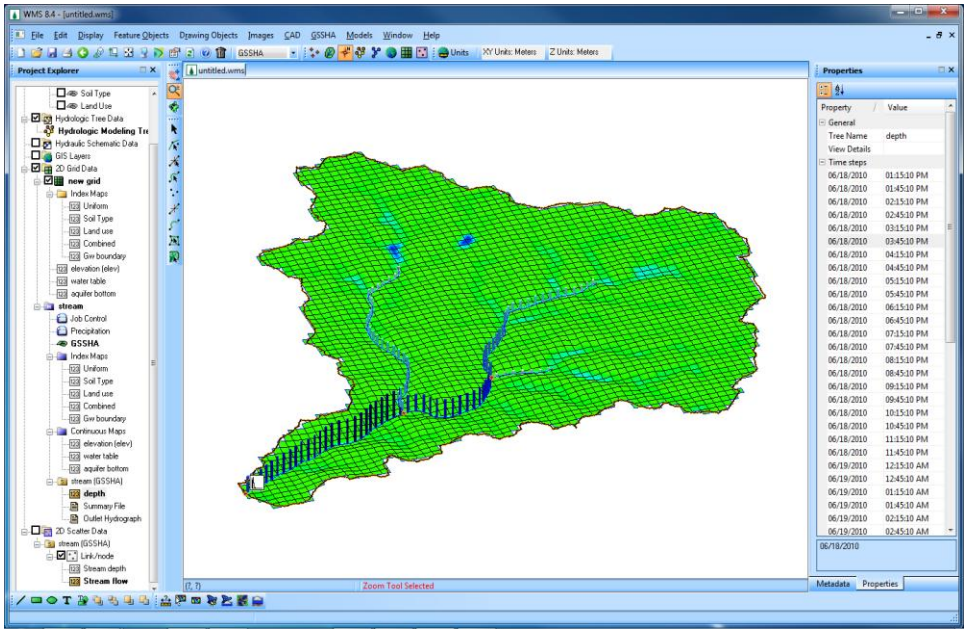
WMS

v. 9.1

WMS 9.1 Tutorial

GSSHA – Groundwater – Subsurface Tile and Storm 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

- 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 this workshop you will see how GSSHA can be used to simulate sub surface storm and tile drains. You will begin with an existing model that has a long term simulation and ground water processes defined and add storm and tile drain information. In the first part of this workshop, you will add a small storm drain network and run the model. You will then add a network of tile drains and re-run the model to determine the effect of the tile drains on the subsurface flow.

3 Open an Existing GSSHA Project

Open a WMS project file for the Eau Galle watershed.

1. In the ***2D Grid Module***  , select ***GSSHA | Open Project File…***
2. Locate the ***GSSHA Distributed Hydrologic modeling*** folder in your tutorial files. If you have used default installation settings in WMS, the tutorial files will be located in ***\My documents\WMS90\GSSHA Tutorials\.***
3. Browse and open the file ***\GSSHA Distributed Hydrologic modeling\ Subsurface\base.prj***.
4. Save the project as ***\GSSHA Distributed Hydrologic modeling\Personal\ Subsurface\stormdrain.prj***.
5. Turn off the display of all the coverages except the *GSSHA* coverage.

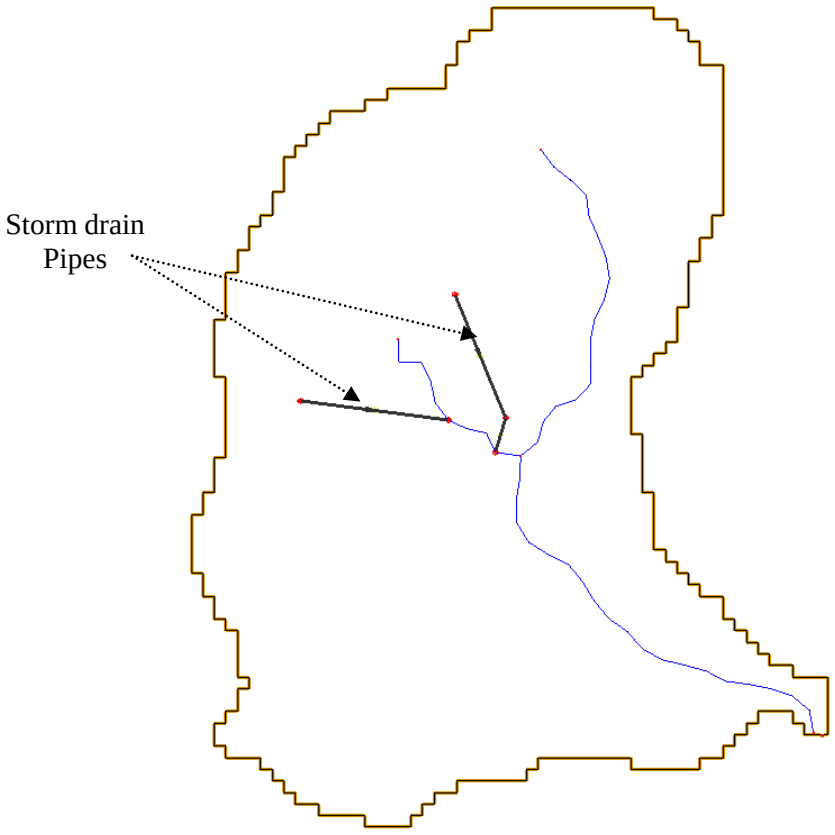
4 Adding Storm Drains to the Groundwater Model

The storm drains are generally used to collect the overland flow and convey it to natural streams or to a treatment facility. In this workshop, we will create a simple storm drain network and run the model.

1. In the ***2D Grid Module*** , select ***GSSHA |Job Control***.
2. Turn the *Storm/tile drain* toggle on to specify this as a storm/tile drain simulation.
3. Click *OK*.

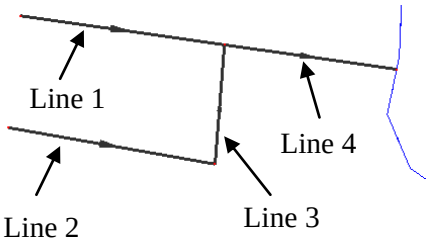
4.1 Creating Storm Drain Arcs

You will create a pipe network as shown in the following figure. To get the pipes at the right places, you will need to import a background image that has the pipe layout. Trace the pipe arcs so that the network is similar to the network shown in the following image.



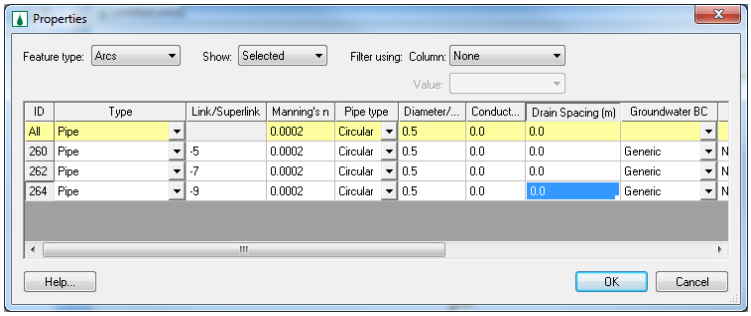
1. Turn off the display of *2D Grid Data* by checking off in the data tree. This helps you better visualize the storm drains in the background image.
2. Select ***File | Open*** and open the file ***\GSSHA Distributed Hydrologic modeling\Subsurface\Images\StormDrains.jpg***.
3. You might NOT see a lot of change when the background image is loaded because the image exactly resembles your watershed. But you should see the pipe arcs displayed and some text showing the pipe node elevations.
4. Click on the *GSSHA* coverage to make it active.

5. Zoom into the area where the pipes are shown in the background image.
6. Select *Create Feature Arc tool* and trace arcs over the pipe networks, drawing the arcs from downstream to upstream. As you create the pipe network, double-click at each bend in the pipe network to end the arc and start a new one. Make sure you start and begin at the exact locations shown in the background image (start and end at the small node locations) so the node elevations are correct.
7. Take the following points into consideration while drawing the pipe network:
    - Draw the arcs in the downstream to upstream direction.
    - Each arc should be a straight line–there should be no vertices in the storm drain network. If there is a bend in the storm drain network, double click to end the arc (line) and begin a new arc. See the following figure for an example:



    - The pipes drain into the natural streams in your model (the most downstream points in your storm drain network are nodes on the stream arcs).
    - The pipes cannot form a closed loop (WMS does not support closed storm drain networks in a GSSHA coverage).
8. Zoom into the area where the pipes begin and end. You should be able to see the elevation for each node displayed in the background image.
9. While still in the *Map module*, click on the *Select Feature Point/Node tool* and select each individual node in your storm drain network and assign the node elevation as shown in the background image.
10. The elevation for the node can be changed by changing the *Feature Point Z* value in the *Properties* window to the right side of WMS main window.
11. Do this for each node in the storm drain network you just added. The elevations of the nodes where the pipe arcs enter the streams are automatically assigned by WMS.
12. Turn off the display of the background image.
13. Still in the *Map module*, select all the storm drain pipe arcs you added using the *Select feature Arc tool*.
14. Select ***Feature Objects | Redistribute***.
15. Enter a spacing of 20 meters and select *OK*.
16. With the pipe arcs still selected, select ***Feature Objects | Attributes***.
17. For all the arcs, set the
    - *Type* to *Pipe*
    - *Manning's n* to 0.0002
    - *Pipe type* to *Circular*
    - *Diameter* to 0.5 m
    - *Conductance* to 0.0 per meter of media around pipe and

- *Drain Spacing* to 0 m.



18. After defining these attributes, Click *OK*.
19. Select the *Refresh button* and zoom around the pipe network. Check the flow directions for each pipe in your storm drain network, represented by an arrow head. If you see any arc with 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.
20. Select the nodes where the pipes are connected to the stream using the *Select Feature Point/Node tool* (Hold shift key and click) and edit their attributes. Set the attributes as follows:
    - *Manhole area* to 1.0 m^2
    - *Inlet type* to *Empty to channel*
    - *Weir length* to 0.1 m and
    - *Orifice diameter* to 0.1 m.
    - Leave all other fields the same. If you want a hydrograph output at these nodes, you may toggle the option under *Hydrograph output* column.
21. Click OK.
22. Select the remaining nodes (all the other nodes in the storm drain network pipes that do not intersect the stream) in the network and edit their attributes. Set the attributes as follows:
    - *Manhole area* to 1.0 m^2
    - *Inlet type* to *6 grate inlets*
    - *Weir length* to *0.1 m and*
    - *Orifice diameter* to *0.1 m.*
23. Click *OK*.

4.2 Assigning Pipe and Node Parameters

After you have defined all the arc (Super-Link) and node (Super-Junction) data for each of the pipes in your 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, you can edit these transferred data values. 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 your storm or tile drain network. Deleting the pipes

will delete the pipes and nodes from your arc, but you should re-initialize the pipes from the arc geometry after making any changes that need to be made or WMS may not write the correct pipe and node attributes for the selected arc.

1. For ***each*** of the 3 storm drain pipe arcs in your model (the arcs you drew in a previous step), do the following:
    a. Select the *Select feature Arc tool*  .
    b. Select one of the arcs.
    c. Select ***Feature Objects | Attributes.***
    d. Select the *Edit Pipes and Nodes* button.
    e. In the Pipe and Node Parameters dialog, click *Initialize Pipes from Arc Geometry*. On your selected arc (this represents a super-link) notice that a node is created for each vertex or node.
    f. Select the *OK* button.

5 Save and Run the Model

You have now defined the storm drain network. Save the GSSHA project and run it.

1. Save the project as ***\GSSHA Distributed Hydrologic modeling\Personal\Subsurface\stormdrain.prj***
2. Select ***GSSHA|Run GSSHA***

6 Results Visualization

1. Turn on the display of the 2D grid data if it is turned off.
2. When GSSHA has finished and the solution has been read, look at the hydrograph plot. The peak discharge does not change by a large amount from the base model but there is a difference in the runoff volumes between the models.
3. Under the solution folder, select the dataset *groundwater_head* and toggle through the time steps to see the variation in GW head contours.
4. Open the summary file and notice the amount of water flowing into and out of the superlinks (storm drain pipes).
5. Open the hydrograph plot at the outlet and export hydrograph ordinates to a spreadsheet located at ***\GSSHA Distributed Hydrologic modeling\ SubSurfaceComparison.xls.*** Paste the data under storm drain column.
6. A plot that compares the results from base model will be generated. Toggle to another tab and view differences.

7 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.

7.1 Open an Existing GSSHA Project

Open a WMS project file for the Eau Galle watershed.

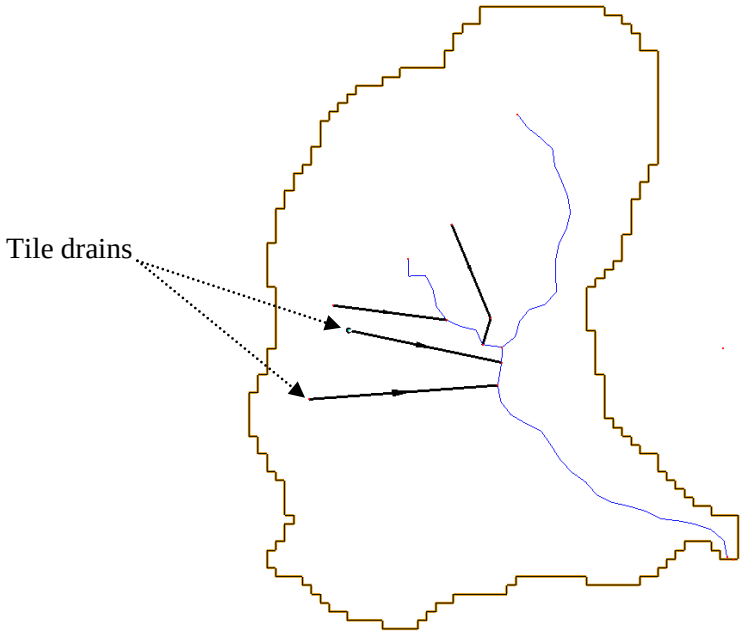
1. In the ***2D Grid Module*** , select ***GSSHA | Open Project File…*** Browse and open the file ***\GSSHA Distributed Hydrologic modeling\ Subsurface\TileBase.prj***.
2. Save the GSSHA model that you created in the previous section as ***\GSSHA Distributed Hydrologic modeling\Personal\Subsurface\ tiledrain.prj***.

7.2 Create Tile drains

3. Turn off the display of all other coverages except the *GSSHA* coverage.
4. Turn off the display of 2D grid data.
5. Open the background image located at ***\GSSHA Distributed Hydrologic modeling\Subsurface\ Images\TileDrains.jpg.***
6. Once the background image loads, zoom into the area where the new pipes are shown.
7. Click on GSSHA coverage.
8. Using *Create Feature Arc tool* , trace the tile drain network (exactly as shown using the red arcs in the background image) as you traced the storm drain network in the previous section.

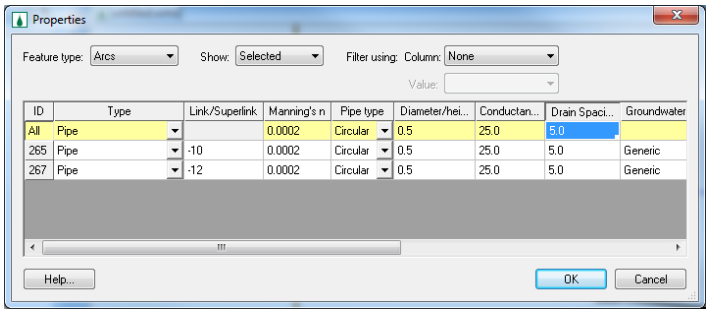
Note: You do not have to change anything for the storm trains that you added in the previous model. Just create the tile drain arcs.

9. After you are done tracing the arcs, the network should look similar to the following figure.



10. Enter the 2 elevations of the nodes for the tile drains that you just drew. The node elevations are displayed in the background image.
11. You may now turn off the display of background image.
12. Still in the *Map module*, select all the ***tile drain arcs*** using the *Select feature Arc tool* .

13. Select ***Feature Objects | Redistribute***.
14. Enter a spacing of 20 meters and select *OK*.
15. With the pipe arcs still selected, select ***Feature Objects | Attributes***.
16. Set the attributes to the following.
    - *Type* to *Pipe*
    - *Manning's n* to 0.0002
    - *Pipe type* to *Circular*
    - *Diameter* to 0.5 m
    - *Conductance* to 25 per meter of media around pipe and
    - *Drain Spacing* to 5 m.
    - Leave everything else the same.



17. After defining these attributes, Click OK.
18. Select the *Refresh button* and zoom in around the tile drain network (if you have zoomed out). Check the flow directions for each pipe in your tile drain network, represented by an arrow head. If you see any arc with an arrow pointing in the upstream direction, right click on the arc and select *Reverse Directions*.
19. Select the nodes connected to the stream using the *Select Feature Point/Node tool* and set their attributes to the following:
    - *Manhole area* to 1.0 m^2
    - *Inlet type* to *Empty to channel*
    - *Weir length* to 0.1 m and
    - *Orifice diameter* to 0.1 m.
    - Again, if you want the hydrograph output at these nodes, you may toggle the option under the *Hydrograph output column*.
20. Click *OK* after you are done defining the attributes.
21. Select the remaining nodes in network and edit their attributes. Set the attributes as follows:
    - *Manhole area* to 1.0 m^2
    - *Inlet type* to *6 grate inlets*
    - *Weir length* to *0.1 m and*
    - *Orifice diameter* to *0.1 m.*
22. Click *OK*.

7.3 Assigning Pipe and Node Parameters

After you have defined all the arc (Super-Link) and node (Super-Junction) data for each of the pipes in your 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, you can edit these transferred data values. 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 your storm or tile drain network. Deleting the pipes will delete the pipes and nodes from your arc, but you should re-initialize the pipes from the arc geometry after making any changes that need to be made or WMS may not write the correct pipe and node attributes for the selected arc.

2. For ***each*** of the 2 tile drain pipe arcs in your model (the arcs you drew in a previous step), do the following:
    a. Select the *Select feature Arc tool*  .
    b. Select one of the arcs.
    c. Select ***Feature Objects | Attributes.***
    d. Select the *Edit Pipes and Nodes* button.
    e. In the Pipe and Node Parameters dialog, click *Initialize Pipes from Arc Geometry*. On your selected arc (this represents a super-link) notice that a node is created for each vertex or node.
    f. Select the *OK* button.

8 Save and Run the Model

You have now defined the tile drain network. Your model has both storm and tile drains. Save the GSSHA project and run it.

1. Save the project as ***\GSSHA Distributed Hydrologic modeling\ Personal\Subsurface\tiledrain.prj***
2. Select ***GSSHA | Run GSSHA***

9 Results Visualization

1. Turn on the display of the 2D grid data if it is turned off.
2. When GSSHA has finished and the solution has been read, notice the hydrograph plot. Compare the peak flow and runoff volumes with those in the storm drain only model.
3. Notice how the groundwater head varies.
4. Notice whether there are any differences in the overland flow depth contours.
5. Open the summary file and notice the amount of water flowing into and out of the superlinks.
6. Notice the interaction between the superlinks, streams and groundwater table.
7. Open the hydrograph plot at the outlet and export hydrograph ordinates to a spreadsheet located at ***\GSSHA Distributed Hydrologic modeling \SubSurfaceComparison.xls.*** Paste the data under tile drain column.
8. A plot that compares the results from base model and storm drain will be generated. Toggle to another tab and view differences.

