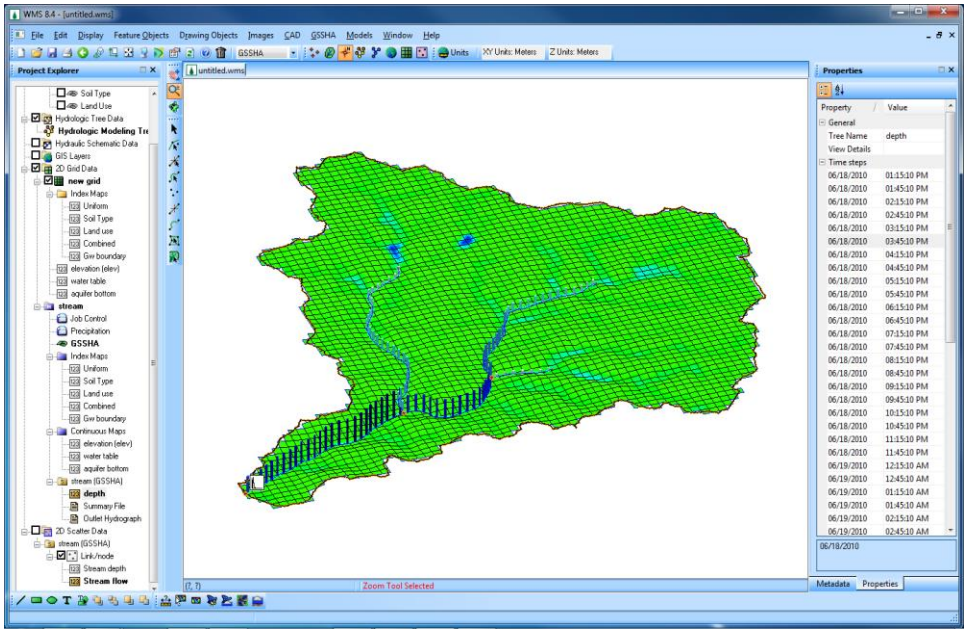
WMS

v. 10.1

WMS 10.1 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 Introduction

This workshop demonstrates how GSSHA can be used to simulate sub surface storm and tile drains. An existing model that has a long term simulation and ground water processes defined will be used, and storm and tile drain information will be added. In the first part of this workshop, a small storm drain network will be added and the model will be run. A network of tile drains will be added and the model will be rerun to determine the effect of the tile drains on the subsurface flow.

2 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 ***Subsurface***, ***Personal***, and ***Tables*** folders for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
3. Browse and open the file ***Subsurface\base.prj***.
4. Save the project as ***Personal\ Subsurface\stormdrain.prj***.
5. Turn off the display of all the coverages except the *GSSHA* coverage.

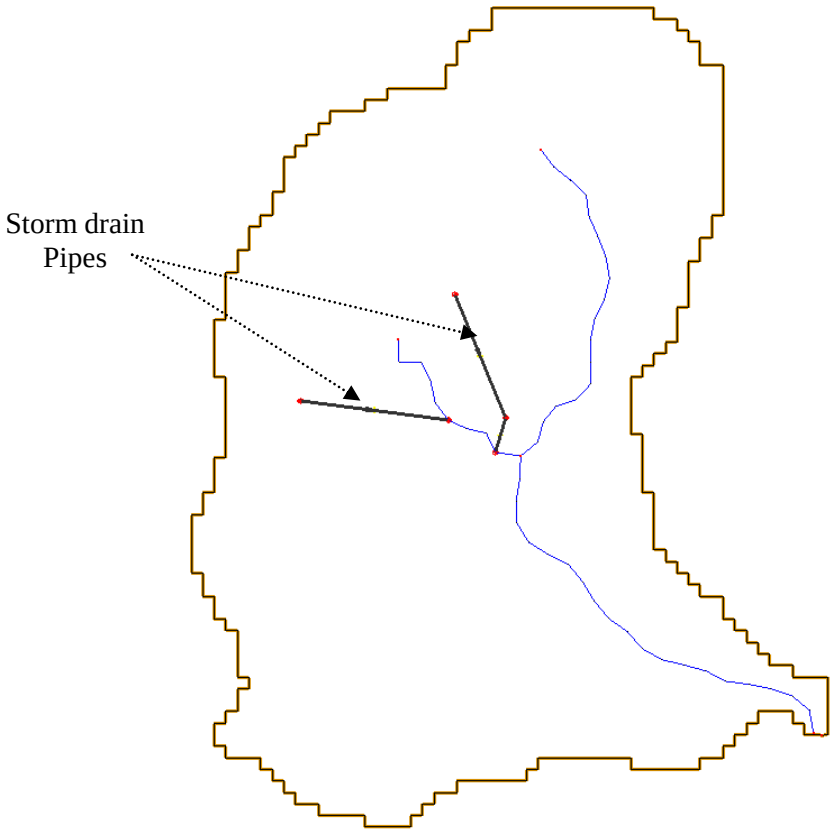
3 Adding Storm Drains to the Groundwater Model

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, a simple storm drain network will be created and the model will be run.

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*.

3.1 Creating Storm Drain Arcs

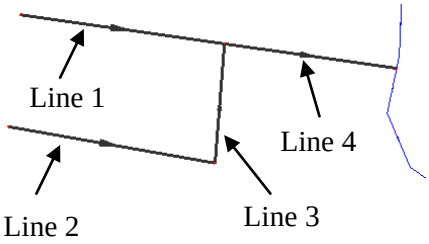
Create a pipe network as shown in the following figure. To get the pipes at the right places, import a background image that has the pipe layout. Trace the pipe arcs so that the network is similar to the network shown in the following image.



1. Turn off the display of *2D Grid Data* in the data tree. This helps better visualize the storm drains in the background image.
2. Select ***File*** | ***Open*** and open the file ***Subsurface\Images\StormDrains.jpg***.
3. A lot of change may not be visible when the background image is loaded because the image exactly resembles the watershed. The pipe arcs and some text showing the pipe node elevations should be displayed.
4. Right-click on the *Coverages* folder and select ***New Coverage***.
5. Change the *Coverage type* to *GSSHA Storm Drain* and select *OK*.
6. Under the ***stormdrain*** GSSHA model folder, right-click on <***NONE***> and select ***Assign*** | ***GSSHA Storm Drain***.
7. Zoom into the area where the pipes are shown in the background image.
8. Make sure the *GSSHA Storm Drain* coverage is active by selecting it.

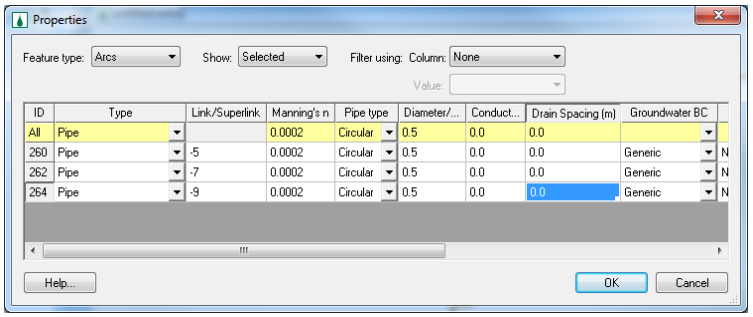
   Then, select *Create Feature Arc tool* and trace arcs over the pipe networks, drawing the arcs from *downstream* to *upstream*. While creating the pipe network, double-click at each bend in the pipe network to end the arc and start a new one. Make sure to start and begin at the exact locations shown in the background image (start and end at the small node locations) so the node elevations are correct.
9. 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 the model (the most downstream points in the 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).

10. Zoom into the area where the pipes begin and end. The elevation for each node displayed in the background image should be visible.
11. While still in the *Map module*, click on the *Select Feature Point/Node tool*  and select each individual node in the storm drain network and assign the node elevation as shown in the background image.
12. 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.
13. Do this for each node in the new storm drain network.
14. Turn off the display of the background image.
15. Still in the *Map module*, select all the storm drain pipe arcs added using the *Select feature Arc tool*  .
16. Select ***Feature Objects* | *Redistribute***.
17. Enter a spacing of 20 meters and select *OK*.
18. With the pipe arcs still selected, select ***Feature Objects* | *Attributes***.
19. 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 cm per hour and
    - *Drain Spacing* to 0.0 m.



20. After defining these attributes, Click *OK*.
21. Select the *Refresh button* and zoom around the pipe network. Go to the ***Display Options*** and turn on the *Stream Arrows* option to display flow directions. 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.
22. 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 the 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.
    - 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.
23. Click OK.
24. 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 the 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.*
25. Click *OK*.

3.2 Assigning Pipe and Node Parameters

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, 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 the storm or tile drain network. Deleting the pipes will delete the pipes and nodes from the arc. However, the pipes from the arc geometry should be reinitialized 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 the model (the arcs drawn 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 the selected arc (this represents a super-link) notice that a node is created for each vertex or node.
f. Select the *OK* button.

4 Save and Run the Model

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

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

5 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 ***tables\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.

6 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.

6.1 Open an Existing GSSHA Project

Open a WMS project file for the Eau Galle watershed.

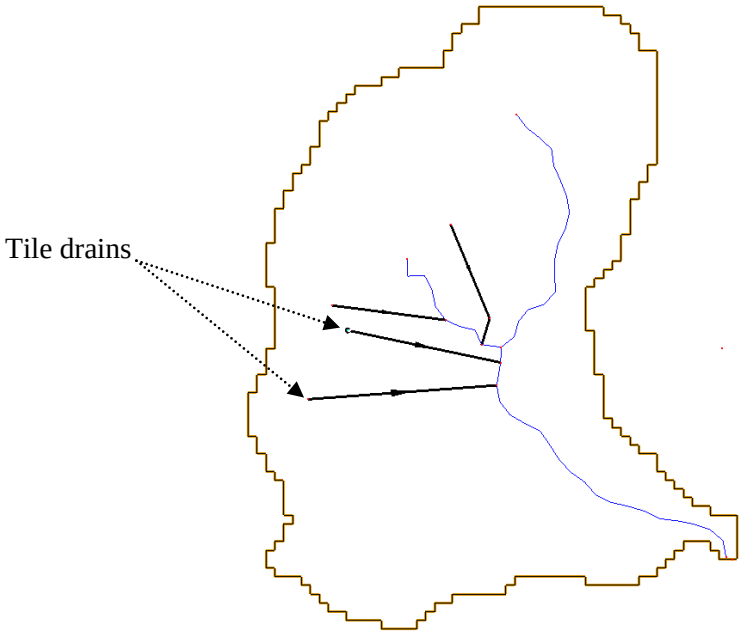
1. Save the GSSHA model that created in the previous section as ***Personal\Subsurface\ tiledrain.prj***.
2. If the previous section was not completed successfully, in the ***2D Grid Module***  , select ***GSSHA | Open Project File….*** Browse and open the file ***Subsurface\TileBase.prj***. Save this file as described in step 1.

6.2 Create Tile drains

3. Turn off the display of all other coverages except the *GSSHA* and *GSSHA Storm Drain* coverages.
4. Turn off the display of ***2D Grid Data***.
5. Open the background image located at ***Subsurface\Images\TileDrains.jpg***.
6. Once the background image loads, zoom into the area where the new pipes are shown.
7. Click on *GSSHA Storm Drain* coverage.
8. Using *Create Feature Arc tool* , trace the tile drain network (using the red arcs in the background image as a guide) just as done with the storm drain network in the previous section. Make sure to create the storm drains in the downstream to upstream direction.

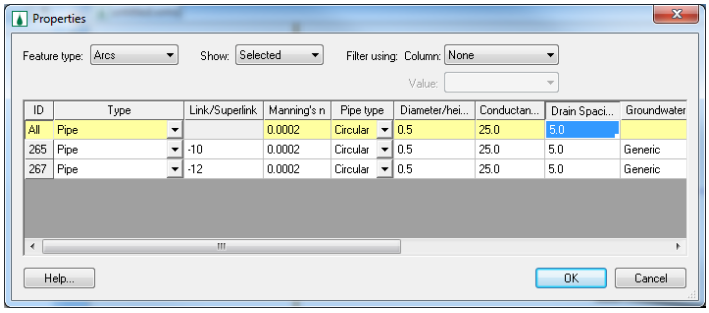
Note: The storm drains that added in the previous model do not require any changes. Just create the tile drain arcs.

9. Once finished tracing the arcs, the network should look similar to the following figure.



10. Enter the upstream and downstream elevations of the nodes for the tile drains just drawn. The node elevations are displayed in the background image.
11. Feel free to turn off the display of background image.
12. Still in the *Map module*, select only 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 cm per hour 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 around the pipe network. Go to the ***Display Options*** and turn on the *Stream Arrows* option to display flow directions. Check the flow directions for each pipe in the storm drain network, represented by an arrow head. If there are any arcs 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.
19. Select the nodes connected to the stream using the *Select Feature Point/Node tool* and set the 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 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.
20. Click *OK* once done defining the attributes.
21. Select the remaining nodes in network and edit the 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*.

6.3 Assigning Pipe and Node Parameters

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.

2. For ***each*** of the 2 tile drain pipe arcs in the model (the arcs drawn 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 the selected arc (this represents a super-link) notice that a node is created for each vertex or node.
    f. Select the *OK* button.

7 Save and Run the Model

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

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

8 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 ***Tables\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.

