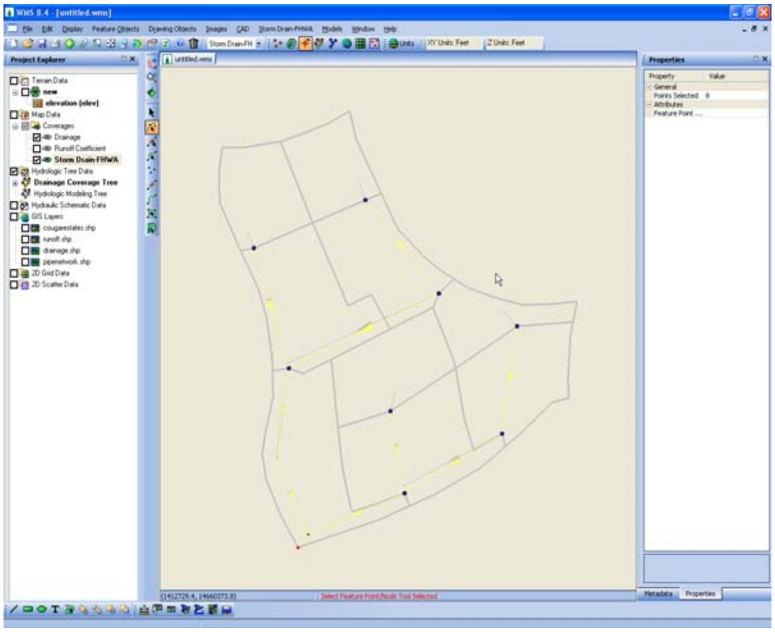
WMS

v. 8.4

WMS 8.4 Tutorial

Storm Drain Modeling – Storm Drain: Rational Design

Learn how to analyze or design a storm drain network using the storm drain model



Objectives

Build a rational method hydrologic model and compute sub-basin flows. Import storm drain network information and link the storm drains to the hydrologic model. Run the flows from the hydrologic model through the storm drain model using the FHWA storm drain analysis engine.

Prerequisite Tutorials

- Watershed Modeling – Rational Method Interface
- Editing Elevations – Using TINs

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models
- Storm Drain

Time

- 30-60 minutes

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1 Contents

2 Introduction

Storm Drain is a hydraulic analysis and design program for storm drain systems. Developed by the Federal Highway Administration (FHWA), Storm Drain provides hydraulic engineers with a quick and accurate method of computing the capacity of an existing system, or designing a system to meet a given set of input flows. The Storm Drain interface in WMS uses the same HYDRA program that has been distributed by the FHWA as part of their HYDRAIN computer program package for the past several years.

3 Objectives

In this exercise, we will set up a drainage simulation based on the Rational Method for a proposed subdivision. The objective of this exercise is to teach you the basic steps for defining a Storm Drain input file, running the numeric model, and viewing the results. These steps include the following:

1. Define runoff coefficients
2. Define the drainage area
3. Compute flows for each basin using the Rational Method
4. Import a pipe network
5. Define the necessary parameters for the network
6. Link nodes from the drainage network to their corresponding nodes in the pipe network
7. Assign elevations to the pipe network

8. Save the Storm Drain input file and run the simulation
9. View the solution

4 Defining Runoff Coefficients

4.1 Reading in the Subdivision Layout and Elevations

We will open a shapefile containing the geography of the proposed subdivision. Also, to help us in defining elevations and slopes for the drainage area, we will open a TIN (Triangulated Irregular Network) for the area:

1. Close all instances of WMS
2. Open WMS
3. Select ***File* | *Open***
4. Locate the folder ***C:\Program Files\WMS84\tutorial\stormrat***
5. Open *"cougarestates.tin"*
6. Right-click on the Coverages folder in the Project Explorer
7. Select ***New Coverage*** from the pop-up menu
8. Change the Coverage type to Runoff Coefficient
9. Select OK
10. Select ***File* | *Open***
11. Open *"cougarestates.shp"*
12. Switch to the *GIS* module
13. Select ***Mapping* | *Shapes->Feature Objects***
14. Select Yes to use all visible shapes
15. Select Next
16. Ensure that the Runoff coefficient is mapped
17. Select Next and then Finish
18. Hide *cougarestates.shp* by deselecting it in the Project Explorer

4.2 Defining the Runoff Coefficients

We will turn off the display of the TIN in order to better distinguish the subdivision polygons.

1. Toggle the check box for the "new" TIN off in the Project Explorer
2. Switch to the *Map* module
3. Choose the *Select Feature Polygon* tool
4. Double-click on the lower left polygon

5. Enter a runoff coefficient of 0.6
6. Select OK
7. Assign Runoff Coefficients for the remaining polygons as shown in Figure 4-1

Figure 4-1: Assigning runoff coefficients.

5 Defining the Drainage Area

First, we will initialize the Storm Drain interface. Initializing Storm Drain tells WMS to make available additional features needed to build a Storm Drain model. Then we will read in pre-defined drainage boundaries and set up drainage inlets and a drainage outfall.

5.1 Initializing Storm Drain

1. Change the Model drop-down box located at the top of the WMS interface to Storm Drain-FHWA
2. Select ***Storm Drain | New Simulation***

5.2 Creating the Drainage Coverage

1. Select the "Drainage" coverage in the Project Explorer
2. Select ***File | Open***
3. Open *"runoff.shp"* and *"drainage.shp"*
4. Switch to the *GIS* module
5. Select ***Mapping | Shapes->Feature Objects***

6. Select Yes to use all visible shapes
7. Select Next, Next, Next, and then Finish

Figure 5-1 shows how the layout should look.

8. Hide *runoff.shp* and *drainage.shp* by deselecting their icons in the Project Explorer

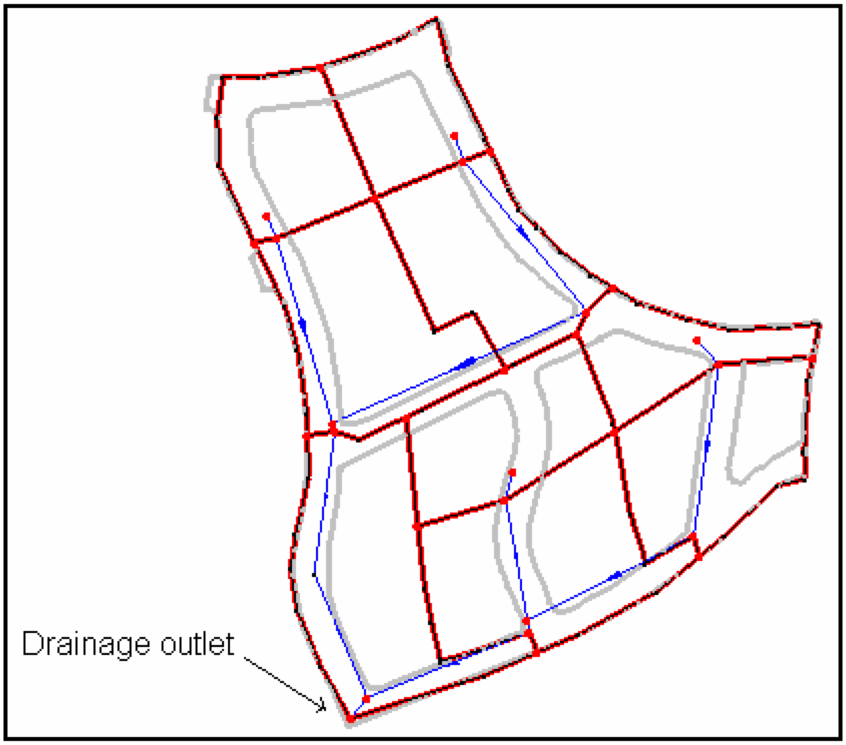

Figure 5-1: Drainage basins and streams for the subdivision.

Before defining nodes as storm drains/drainage outlets, we will hide the Runoff Coefficient coverage in order to simplify the screen display

9. Toggle the visibility check box for the Runoff Coefficient coverage off in the Project Explorer
10. Ensure that Drainage is the active coverage
11. Choose the *Select Feature Point/Node* tool 
12. Double-click on the node labeled Drainage Outlet in Figure 5-1
13. Change the Point Type to Drainage Outlet and select OK
14. While holding the SHIFT key, select each of the nodes labeled as Storm Drains in Figure 5-2. These points correspond to manhole locations in the pipe network. Be sure to select the nodes that intersect with the basin boundary lines.

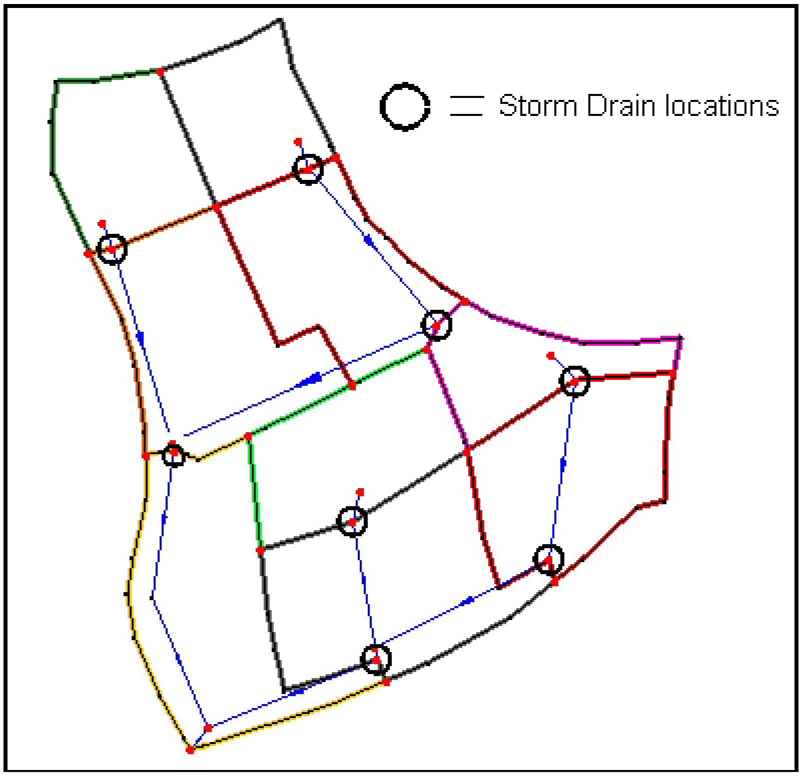

Figure 5-2: Storm Drain node locations.

15. Select ***Feature Objects | Attributes***
16. Change the Point type to Storm drain inlet
17. Click the Properties button
18. Change the Inlet Type to Curb opening in sump condition
19. Enter the dimensions shown in Table 5-1

Table 5-1: Values for the curb parameters.

Length	Width of Depression	Height	Inlet depression
4.0	3.0	1.0	0.25

20. Select OK twice to exit both dialogs
21. Select ***Feature Objects | Compute Basin Data***
22. Click the Current Coordinates button
23. Set the horizontal and vertical units as U.S. Survey Feet
24. Select OK
25. Set Basin Areas to Acres and Distances to Feet
26. Select OK

5.3 Computing Runoff Coefficients

Composite runoff coefficients must be computed for each drainage area. A weighted average for each drainage area is calculated from data in the Runoff Coefficient coverage. To compute the basin runoff coefficients:

1. Switch to the *Hydrologic Modeling* module
2. Select ***Calculators | Compute GIS Attributes***
3. Set the Computation type as Runoff coefficients
4. Select OK

Composite runoff coefficients for each drainage area are computed and displayed on the screen.

5.4 Entering Times of Concentration

The Time of Concentration for a basin can be calculated using a Time Computation. For this exercise, however, it is assumed that the TC values have already been calculated, and we will input them manually.

1. Change the Model drop-down box (located towards the top of the WMS interface) to Rational
2. Choose the *Select Basin* tool
3. Double-click on the basin icon for the basin in the lower left-hand corner of the subdivision
4. Enter 14 for the Time of Concentration (minutes)
5. Select each of the remaining drainage basins and assign Time of Concentration values using Figure 5-3 as a guide

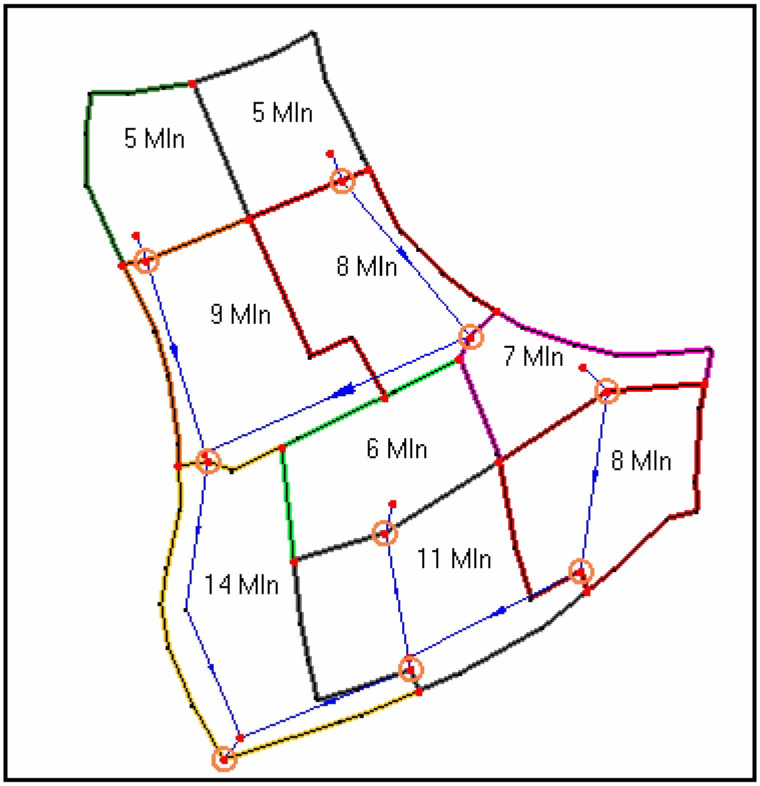

Figure 5-3: TC values for the drainage areas.

6. Select OK to close the Rational Method dialog

We have now set up a traditional rational simulation for the Cougar Estates subdivision. The only remaining step is to define the IDF curves. This step will be included as part of the Storm Drain process. We will now import a pre-defined pipe network, assign properties to the network, and link it to the Drainage coverage.

6 Importing the Pipe Network

As mentioned above, we will be importing a pipe network to use in our Storm Drain simulation. This network was defined as a shapefile, and will be converted to feature objects in WMS. WMS can also open DXF files and convert them to feature objects. Alternatively, users can manually create a pipe network using the Create Feature Arc tool.

1. Right-click on the Coverages folder in the Project Explorer
2. Select ***New Coverage***
3. Change the Coverage type to Storm Drain-FHWA
4. Select OK
5. Select ***File* | *Open***
6. Open *"pipenetwork.shp"*
7. Switch to the *GIS* module

8. Select ***Mapping | Shapes->Feature Objects***
9. Select Yes to use all visible shapes
10. Select Next, Next, and Finish
11. Hide *pipenetwork.shp*

6.1 Entering Job Control Data

1. Switch to the Map module 
2. Select ***Storm Drain | Job Control***
3. Enter "Storm Drain Rational" for the Title
4. Choose the English option for the Units
5. Click on the Pipe Data Properties button

This dialog allows users to define a set of pipe properties that will be applied to all pipes in the network. In addition to assigning pipe properties on a global scale, users can define specific properties to individual pipes, or to a group of pipes by selecting them with the Select Feature Arc tool and selecting the Attributes command from the Feature Objects menu. For this exercise, we will simply define global pipe properties.

6. Change the Pipe type to Concrete-Smooth

When a user specifies a pipe type, WMS fills in an appropriate Manning's n roughness value based on that pipe type. Users can also enter/edit the Manning's n value directly in this dialog. Users can change the Manning's n values that are assigned to the various Pipe Types. These values can be accessed and edited by opening the Display Options dialog, choosing Map Data, and changing the Active Coverage field to Storm Drain.

7. Enter the values displayed in Figure 6-1

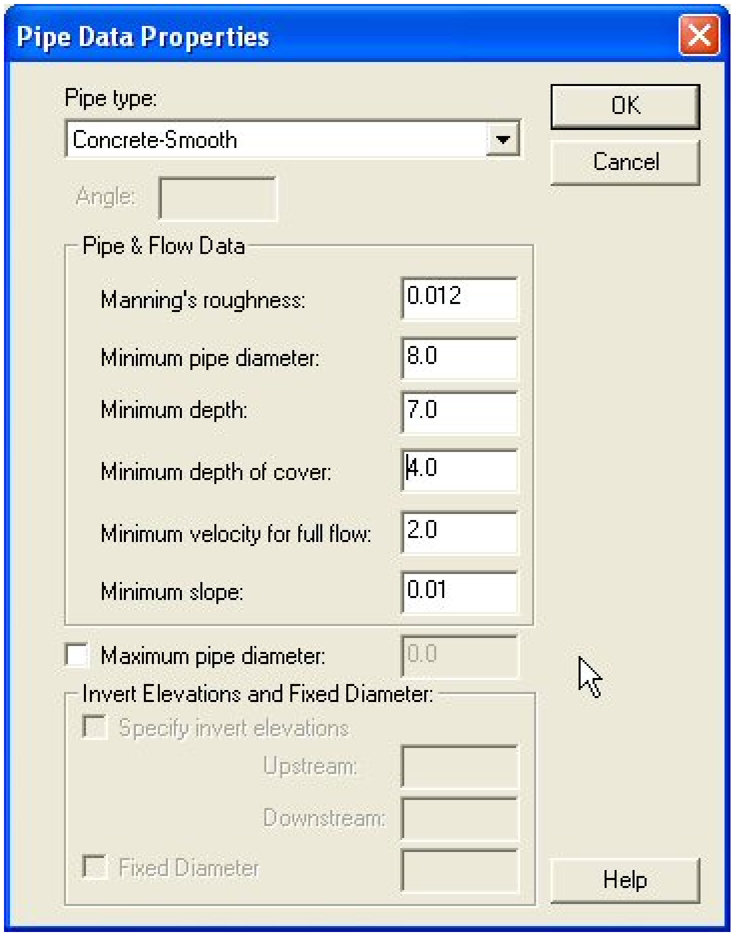

Figure 6-1: Pipe property values for the pipe network.

8. Select OK to exit the Pipe Data Properties dialog

6.2 Defining Rainfall Data

1. Click on the Rainfall Data button
2. Select the Run Compute IDF Curve Dialog option
3. Select OK
4. Choose the User Supplied Data option as the IDF curve computation
5. Click the Define Storm Data button
6. Change the Recurrence value to 25 yr
7. Enter the precipitation values shown in Figure 6-2

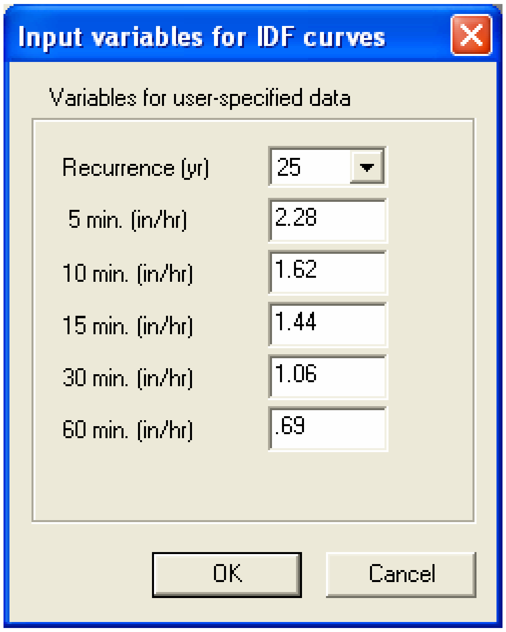

Figure 6-2: Values for computing the 25 yr IDF curve.

8. Select OK
9. Highlight the line corresponding to the 25-yr precipitation values from the window in the upper right-hand corner of the dialog
10. Select Done
11. Select OK twice to return to the WMS interface
12. Switch to the *Hydrologic Modeling* module
13. Choose the *Select Basin* tool
14. Double-click on the basin labeled 4B

Notice that the intensity value computed in the Storm Drain interface has been copied here as well, and Q is now computed for the basin.

15. Select OK to exit the Rational Method dialog

6.3 Defining the Outfall and Manhole Locations

1. Click on the Storm Drain coverage in the Project Explorer to select it
2. Choose the *Select Feature Point/Node* tool
3. Double-click on the node in the lower left-hand corner of the subdivision as shown in Figure 6-3

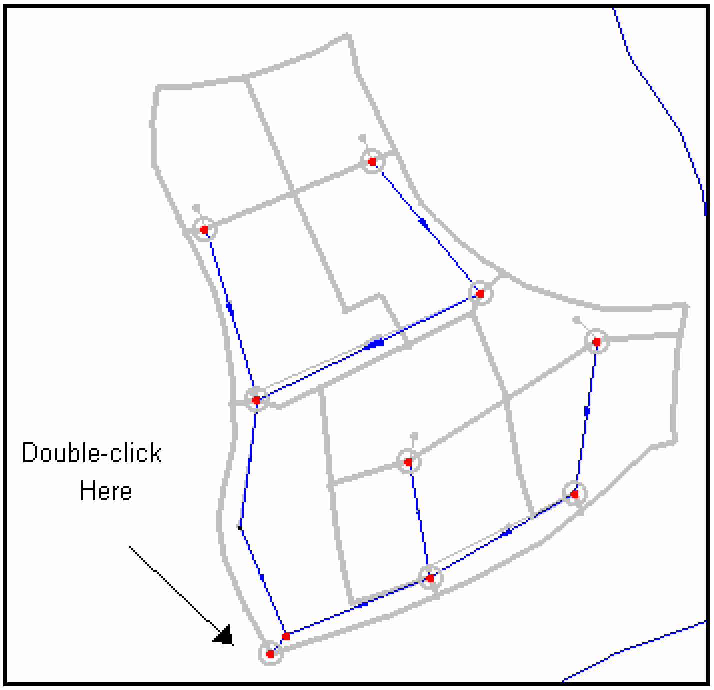

Figure 6-3: Outfall location.

4. Change the node type to Outfall
5. Select OK
6. Multi-select the nodes indicated in Figure 6-4 as Mahhole Locations by holding down the SHIFT key as you select each node

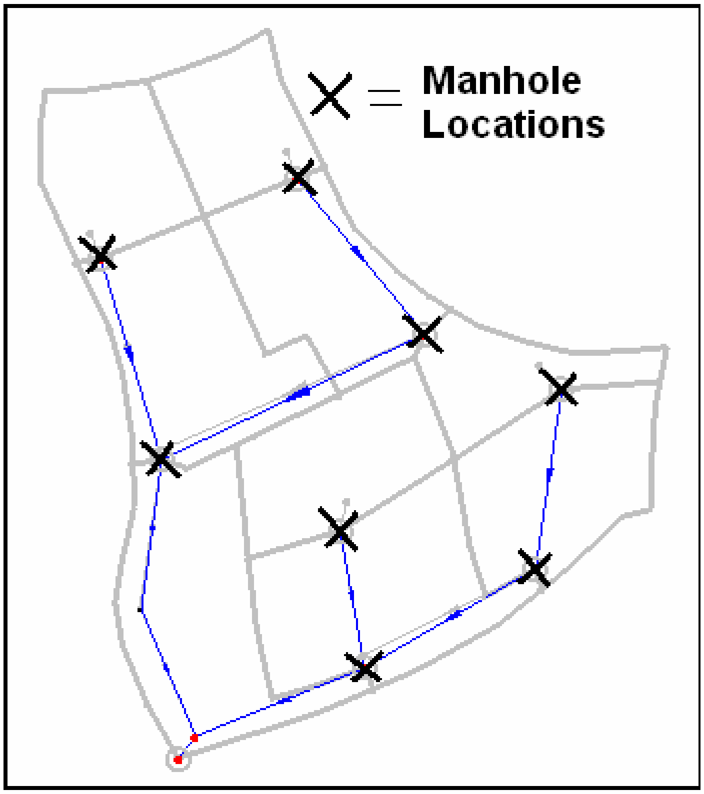

Figure 6-4: Manhole locations.

7. Select ***Feature Objects | Attributes***
8. Change the node type to Access Hole
9. Enter 4.0 as the Access hole width
10. Change the Bench Type to Flat Bench
11. Select OK

The Pipe Drain Network is now defined

7 Linking Nodes and Assigning Elevations

To properly portray the relationship between the Drainage coverage and the Storm Drain coverage, we need to explicitly define links between their corresponding nodes. We also need to assign elevations to all linked nodes. Elevations can either be defined manually, or with the use of a background TIN or DEM. We will use the TIN that we opened earlier in this exercise for assigning elevations.

1. Select ***Storm Drain-FHWA | Link Nodes***
2. Click the Auto Link button. This will link the storm drain inlets from the Drainage coverage to the manholes in the Storm Drain coverage. All nodes should be linked except the one node just upstream of the outfall. This node is a pipe junction and is not associated with a storm drain inlet.
3. Select OK

4. Select ***Storm Drain-FHWA | Assign Pipe Elevations***. This command automatically assigns elevations to nodes based on an underlying TIN or DEM, if one is present.

With Drainage and Storm Drain nodes linked together and elevations assigned to our pipe network, we are ready to save the Storm Drain model.

8 Saving the Simulation and Running Storm Drain

1. Select ***File | Save As***
2. Make sure the Save as type filter is set to WMS XMDF Project Files (*.wms)
3. Enter "wms_storm_rat" for the File name
4. Select Save
5. Select ***Storm Drain-FHWA | Save Simulation***
6. Save the file as *"wms_st_r"*
7. Select ***Storm Drain-FHWA | Run Simulation***
8. Verify that the input file name is wms_st_r.hda
9. Verify the output file name is wms_st_r.lst

The input and output file name prefixes can be up to 8 characters in length. If you enter an input file name longer than 8 characters, Storm Drain will not run. If you enter an output file name longer than 8 characters, it is truncated to 8 characters when Storm Drain writes the file. Also all directory names in the path of the input/output files cannot contain more than 8 characters.

10. Select OK
11. Once Storm Drain (HYDRA) has finished running, select Close
12. Select OK
13. Select ***File | Edit File***
14. Open *"wms_st_r.lst"*
15. Select OK to open the file with Notepad

By browsing through this file, you will see all of the parameters calculated by the Storm Drain (HYDRA) model, such as recommended pipe diameters, pipe invert elevations, flows, velocities, and hydraulic grade line computations.

9 Close Notepad

