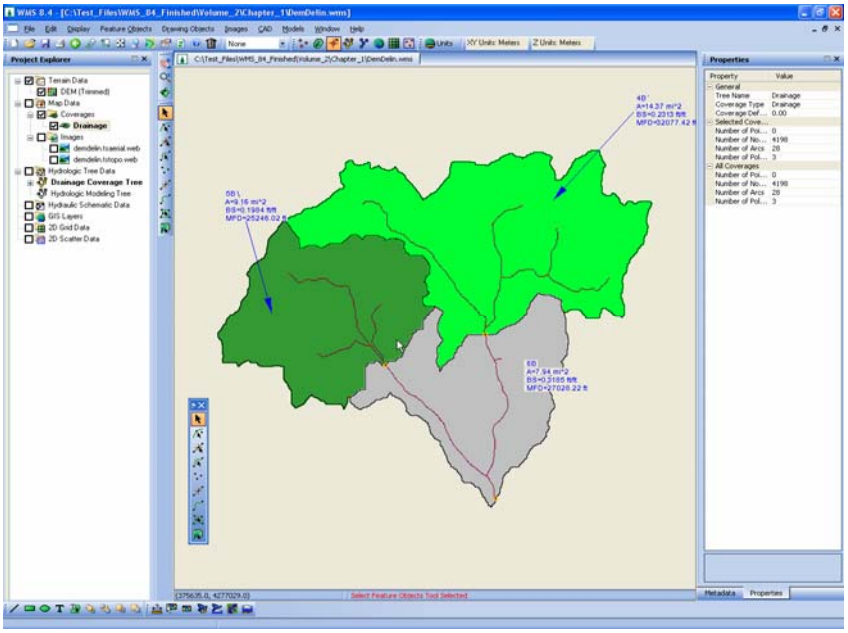
WMS

v. 8.4

WMS 8.4 Tutorial

Watershed Modeling – DEM Delineation

Learn how to delineate a watershed using the hydrologic modeling wizard



Objectives

Read a digital elevation model, compute flow directions, and delineate a watershed and sub-basins using outlet points.

Prerequisite Tutorials

- Introduction – Images
- Introduction – Basic Feature Objects
- Editing Elevations – DEM Basics

Required Components

- Data
- Drainage
- Map

Time

- 30-60 minutes

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1 Contents

2 Introduction

Watershed delineation from DEMs is straightforward and relatively simple, provided the project area is not entirely flat or completely dominated by man-made structures (you cannot expect the DEM method to work if there is no relief in the DEM elevations themselves). This exercise teaches DEM delineation using the hydrologic modeling wizard, a step-by-step delineation approach that makes the process even simpler.

3 Objectives

In this exercise you will learn the basics of DEM delineation using the hydrologic modeling wizard. This includes the following:

1. Importing DEM Data
2. Computing flow paths and flow accumulations
3. Delineating watersheds from DEMs
4. Delineating sub-basins within a watershed

4 Setting up a Project with the Hydrologic Modeling Wizard

4.1 Starting the Hydrologic Modeling Wizard

1. Locate the icon for the *Hydrologic Modeling Wizard* at the bottom of your WMS window. Click the icon to open the wizard 

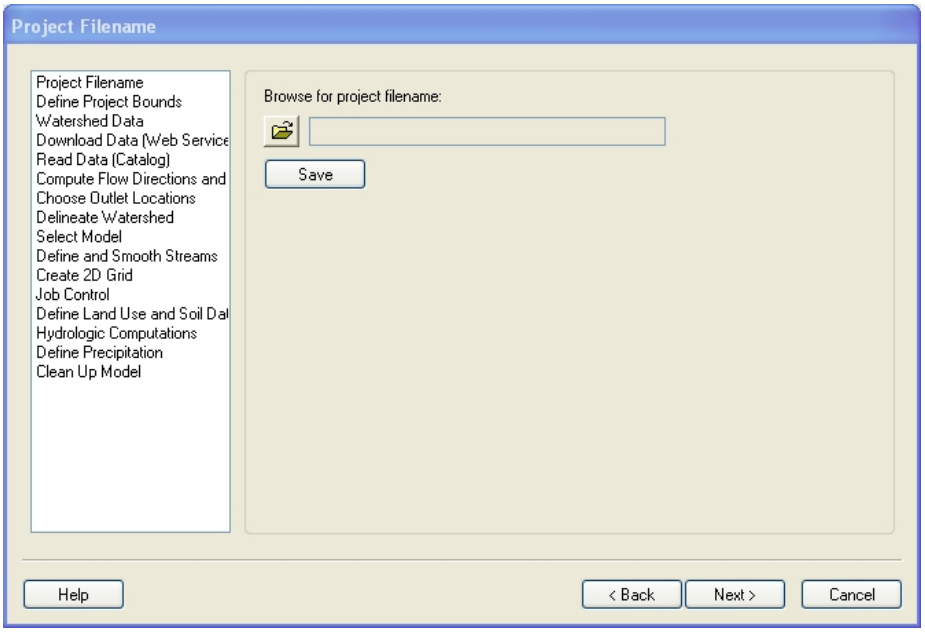

Figure 4-1: Hydrologic Modeling Wizard

The Hydrologic Modeling Wizard window shown in Figure 4-1 consists of two sections. The list box on the left shows the steps needed to set up a hydrologic model. The area on the right is used to perform specific tasks associated with the selected step. Clicking *Next* > in the wizard will walk you through the steps of the wizard sequentially. However, you may move to any step in the wizard at any time by clicking on the associated heading on the left. Also, the Hydrologic Modeling Wizard window is a non-modal window, meaning it lets you interact with the main menus and graphics window while it is open.

4.2 Project Filename

1. Make sure *Project Filename* is the current window in the Hydrologic Modeling Wizard
2. Click on the file browser button to browse to a path location and select a filename for the project 
3. Name the project "*DemDelineation.wms*" and click *Save*
4. Click *Next* > to advance to the next step

4.3 Define Project Bounds

1. Under Project coordinate system, select *Define…*

2. Select the *Global Projection* option
3. Click on the *Set Projection* button
4. In the Select Projection dialog set:
   - Projection to *UTM*
   - Datum to *NAD83*
   - Planar Units to *METERS*
   - Zone to *12 (114°W - 108°W – Northern Hemisphere)*
5. Select *OK*
6. Set the Vertical Projection to *Local* and Vertical Units to *Meters*
7. Select *OK*
8. Under Project boundary, click on the *Define…* button
9. In the Microsoft Virtual Earth Map Locator window, enter a latitude of **38.6469** and a longitude of **-112.4291** and click *Jump to location*
10. Zoom in or out, as necessary, until the Virtual Earth window looks similar to Figure 4-2 and then select *OK*

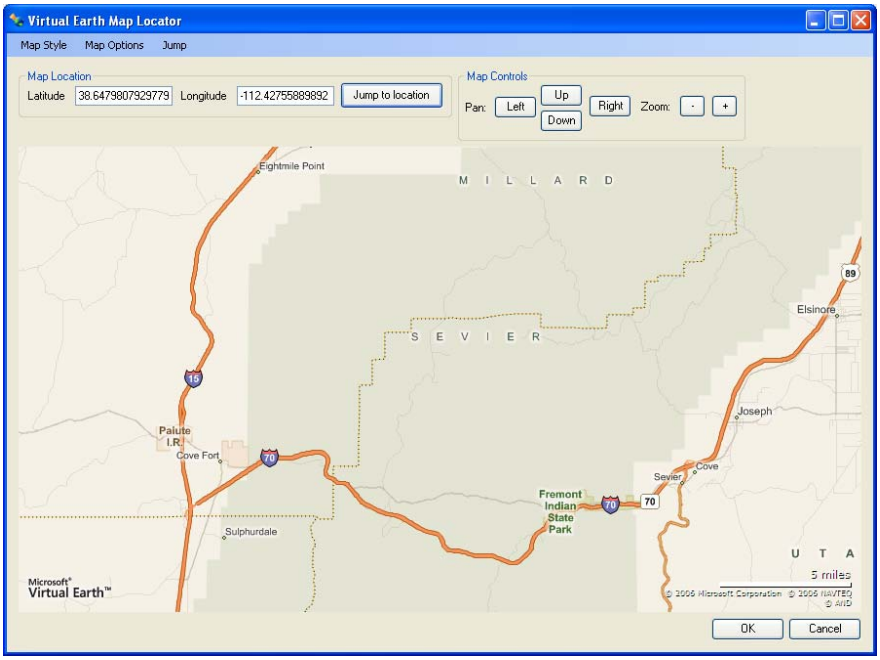

Figure 4-2: Project Bounds in Virtual Earth

11. Click *Next* > to advance to the next step

Watershed Data using Web Services

This section requires a working internet connection. Proceed directly to section 4.4 if a working internet connection is not available.

1. Toggle on the *Web Services* option for the data source

2. Click *Next* > to advance to the next step
3. In the Data Type column of the Web Services spreadsheet, toggle on the options for *NED 1/3 Arc Sec data*, *TerraServer aerial photo*, and *TerraServer topo*
4. Click the *Browse…* button next to NED data
5. Name the file "*ned.zip*" and click *Save*
6. Click the *Browse…* button next to TerraServer aerial photo
7. Name the file "*aerial.jpg*" and click *Save*
8. Click the *Browse…* button next to TerraServer topo
9. Name the file "*topo.jpg*" and click *Save*
10. Make sure that all other Data Type options are toggled off
11. Click *Download Data from Web*

WMS will proceed to download the requested data for the project area that was specified.

12. Click *OK* on the Importing NED Gridfloat File dialog to read the DEM into WMS

WMS reads the projection data that comes with the DEM and converts the DEM coordinates to the project coordinate system specified in section 4.3. Next WMS will acquire the TerraServer images.

13. Select *Yes* if asked to generate pyramids

Once the image files have been downloaded from Web Services, WMS automatically opens the files into your WMS project.

14. Click *Next* > to advance to the next step
15. Skip section 4.4

4.4 Watershed Data by Reading Files

This section should only be completed if you were unable to complete section 0. To read in a set of four 30-meter DEMs from the 1:24000 series, complete the following steps:

1. Click on the ***File | Open*** button 
2. Locate the folder ***C:\Program Files\WMS84\tutorial\demdelin***
3. Open *"josephpeak.dem"*
4. In the Importing USGS DEMs dialog, click the *Add* button
5. Add the following three DEMs (remember that you can hold the CTRL key down and add more than one at once, or use the *Add* button to add each additional one before selecting *OK*):
   - "marysvalecanyon.dem"
   - "redridge.dem"
   - "trailmountain.dem"

6. For Thinning factor enter **3**

Thinning the resolution of the DEMs will reduce the density of elevation points so that your computer will process the DEM data faster. The resolution of points in the 30-meter DEMs is too dense for the purposes of this exercise, so you will not lose any accuracy by thinning.

7. Select *OK*
8. Click *Next* > to advance to the next step

4.5 Trimming the DEM

Trimming the DEM so that it encompasses the extents of the project area reduces the computational time required for watershed delineation. You may need to move the Hydrologic Modeling Wizard dialog so that it does not hide the data displayed in the main WMS graphics window.

1. Right-click on *DEM* in the Terrain Data section of the Project Explorer and select ***Trim | Polygon…***
2. Select the option to *Enter a polygon interactively*
3. Select *OK*
4. Trace around the rectangle shown in Figure 4-4 if you completed section 512.512 (Watershed Data using Web Services) or Figure 4-4 if you completed section 4.4 (Watershed Data by Reading Files) clicking on each corner and double-clicking to end

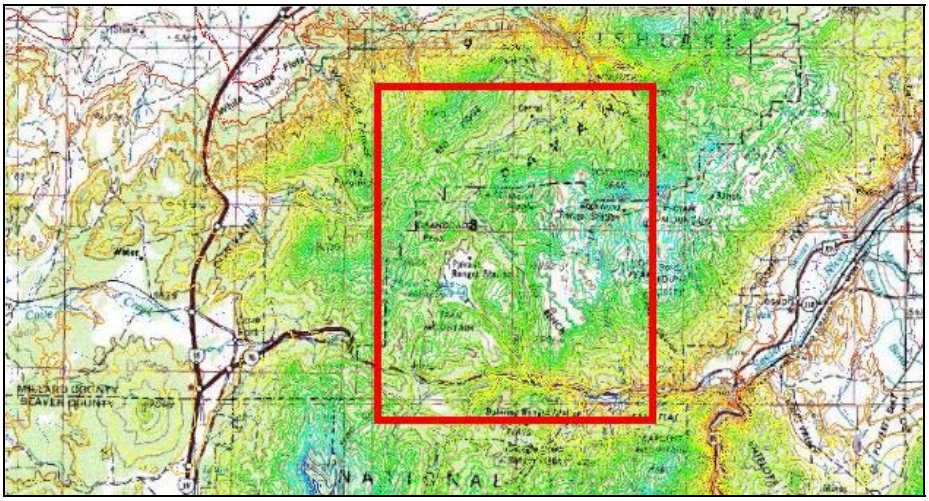

Figure 4-3: DEM Trim Area for Web Services Data

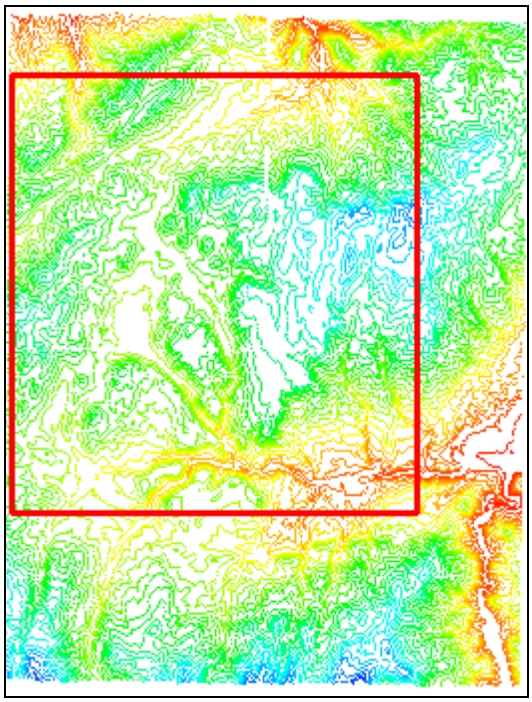

Figure 4-4: DEM Trim Area

5. Toggle off the *Images* folder in the Map Data section of the Project Explorer, if necessary
6. Select the *Frame* macro

4.6 DEM Fill Command

The DEM Fill command is useful for filling gaps in DEM data. It interpolates missing (no data) values using inverse distance weighting of the neighboring eight cells. This functionality is useful when tiling multiple DEMs files together in WMS, particularly if a thinning factor is applied when the DEMs are read. It is not necessary to use this command on seamless DEMs obtained from the NED. If you obtained seamless NED data by successfully completing section 7073816.3081340 (Watershed Data using Web Services), then skip this section.

1. Select ***Display | Display Options***
2. In the *DEM Data* tab toggle on the *No Data Cells* option
3. Select *OK*
4. Right-click on *DEM (Trimmed)* in the Terrain Data section of the Project Explorer and select ***Fill***

Interior No Data cells disappear as elevations at those locations are interpolated using the surrounding cells.

5. Select ***Display | Display Options***
6. In the *DEM Data* tab toggle off the *No Data Cells* option
7. Select *OK*

5 Watershed Delineation using the Hydrologic Modeling Wizard

5.1 Compute Flow Directions and Accumulations

WMS computes flow directions and flow accumulations to create streams on the DEM using a program called TOPAZ.

1. Make sure the option to *Write TOPAZ files to a temp directory* is selected
2. Set the computational units for sub-basin areas to *Square Miles*
3. Set the computational units for distances to *Feet*
4. Select *Compute TOPAZ*
5. Click *Close* when TOPAZ terminates
6. Set Min flow accumulation threshold to **2.0** mi^2
7. Select *Apply to Display*

Notice how the display of flow accumulations cells changes.

8. Set Min flow accumulation threshold to **0.5** mi^2
9. Select *Apply to Display*
10. Set Min flow accumulation threshold to **1.0** mi^2
11. Select *Apply to Display*
12. Click *Next* > to advance to the next step

5.2 Choose Outlet Locations

1. Zoom in around the area shown in Figure 5-1
2. Choose the *Create Outlet Point* tool in the Hydrologic Modeling Wizard 

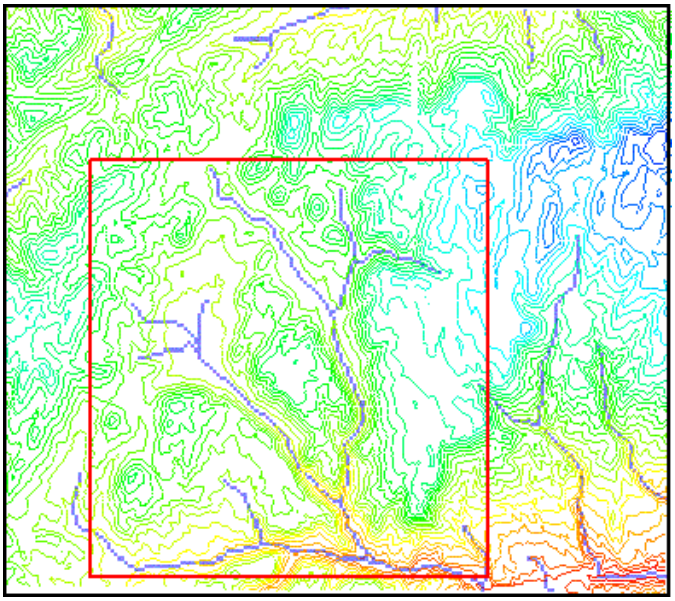

Figure 5-1: DEM Zoom Area

3. Place the outlet just upstream of the stream junction shown in Figure 5-2

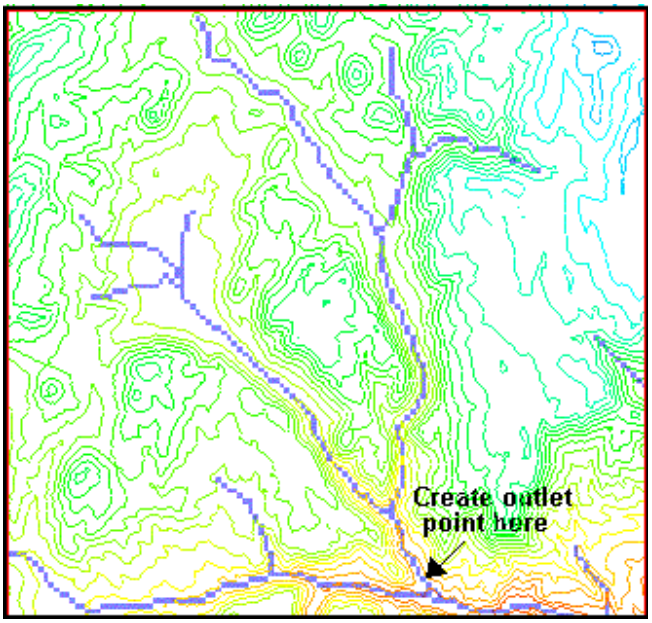

Figure 5-2: Drainage Outlet Location

4. Click *Next* > to advance to the next step

Delineate Watershed

1. Verify that the stream threshold value is **1.0** mi^2
2. Leave the Computation Units with their default values
3. Select *Delineate Watershed*

When you select Delineate Watershed, WMS digitizes stream arcs using the DEM streams, which are DEM cells with flow accumulations greater than the stream threshold value, defines the basin boundary, and computes geometric parameters for the basin including basin area, average basin slope, mean basin elevation, and maximum flow distance.

Since we won't be setting up a hydrologic model in this exercise, we don't need to complete the rest of the steps in the wizard. However, we would like to go back and create sub-basins.

5.3 Create Sub-basins

1. On the left side of the Hydrologic Modeling Wizard select the heading *Choose Outlet Locations* or select the < *Back* button to return to the previous step
2. Zoom in around the area shown in Figure 5-3

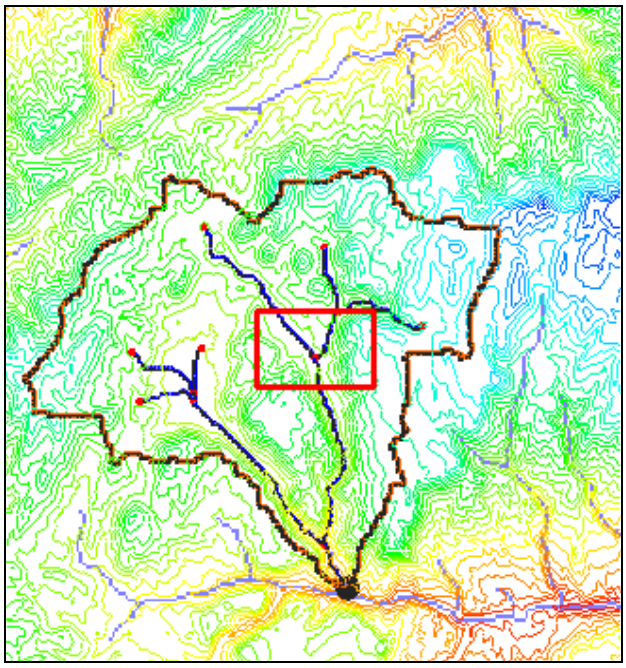

Figure 5-3: Zoom Area

3. Choose the *Create Outlet Point* tool from the wizard window 
4. Create another outlet at the location shown in Figure 5-4, just below the stream junction.

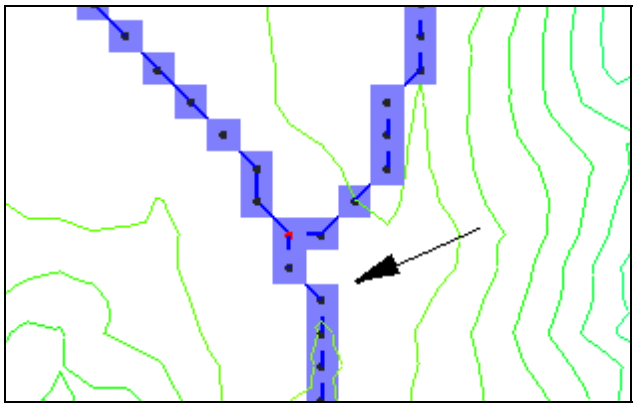

Figure 5-4: Node Location

5. Select the *Frame* macro
6. Zoom in around the branch shown in Figure 5-5

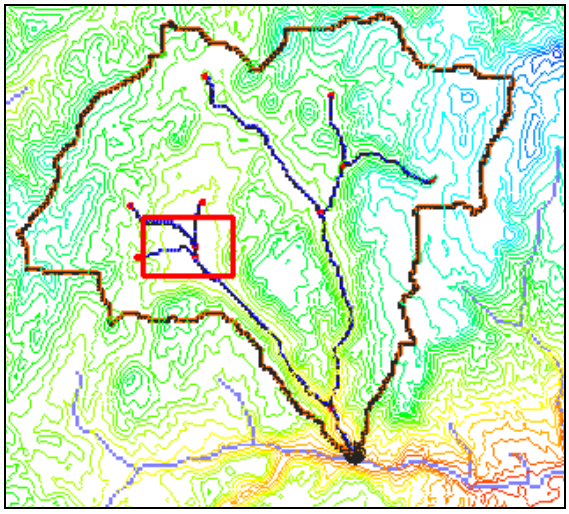

Figure 5-5: Zoom Area

7. Choose the *Create Outlet Point* tool from the wizard window
8. Place an outlet immediately downstream of the most downstream feature node you can see, as shown in Figure 5-6

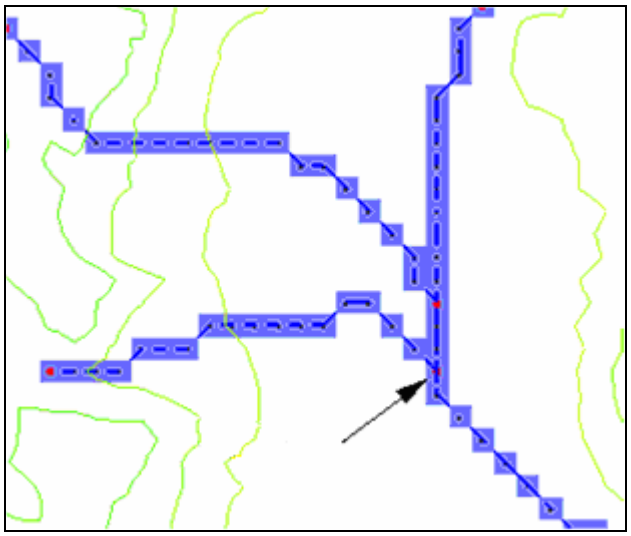

Figure 5-6: Change the indicated node to an outlet.

9. Select the *Frame* macro
10. Click *Next* > to advance to the next step
11. Select *Delineate Watershed*
12. Click *OK* to delete all existing feature data and recreate
13. Click *Close* to close the Hydrologic Modeling Wizard

5.4 Save the WMS Project File

1. Select ***File*** | ***Save***
2. Click *No* when prompted to save image files in the project directory

6 Delineation Display Options

WMS has several options for displaying DEMs and the results of basin delineation from a DEM. In this section you will explore a few of these options.

6.1 Display Flow Paths

1. Switch to the *Drainage* module
2. Select the *Flow Path* tool

Click anywhere on the DEM. WMS will use the DEM flow directions to trace the entire flow path. The flow paths will disappear as soon as another tool is selected.

3. Select ***Display*** | ***Toolbars*** | ***Map Tools*** to show the Map Tools toolbar
4. Choose the *Select Feature Polygon* tool
5. Select any one of the drainage basin polygons
6. Select ***DEM*** | ***Draw Flow Patterns***

Flow paths for each of the DEM cells within the selected drainage basin polygon are displayed until another tool is selected.

7. Select ***Display | Display Options***
8. In the *Drainage Data* tab toggle on the *Flow Patterns* option
9. Select *OK*

Flow paths for each of the DEM cells in the selected drainage basin are displayed. Notice that the flow paths are always displayed, even when another tool is selected.

10. Select ***Display | Display Options***
11. In the *Drainage Data* tab toggle off the *Flow Patterns* option
12. Select *OK*

6.2 Basin Labels

1. Make sure the *Drainage* module is selected
2. Select ***Display | Display Options***
3. In the *Drainage Data* tab toggle on the *Basin Names*, *Basin Slopes*, and *Max Flow Distance* options
4. Select *OK*

You may want to move the basin labels displaying the area, slope, etc. to more convenient locations in the graphics window.

5. Choose the *Move Basin Label* tool
6. Move the label to another point in the basin just by clicking on any point within the basin
7. Click on any point within a basin and drag the mouse to display the basin label with an arrow

6.3 Display Options

When you are finished using the elevation data, you may want to turn the DEM contours and extra streams displays off.

1. Right-click on *DEM* in the Project Explorer and select ***Display Options***
2. Uncheck the *Flow Accumulation*, *Color Fill Drainage Basins*, *Fill Basin Boundary Only*, and *DEM Contours* options
3. Select *OK*

6.4 Color Fill Basins

WMS also allows you to fill in each basin with a different color. This is useful when the background image does not need to be showing.

1. Right-click on the *Drainage* coverage and select *Zoom to Layer*

2. Right-click on the *Drainage* coverage and select ***Display Options*** 
3. Check the *Color Fill Polygons* option
4. Select *OK*

7 More Basin Delineation

In this exercise you have learned the most basic use of WMS: to delineate a watershed from a DEM. It would be a good idea to practice again using a DEM of your own choosing.

Follow these steps using your own data (using the previous sections for a more specific outline):

1. Start WMS, or choose the ***File | New*** option if continuing
2. Use the Hydrologic Modeling Wizard to guide you through the delineation process
3. Experiment with some of the display settings to get a nice final map
4. Save a project file of your work

8 Conclusion

In this exercise you should have learned how to use DEM data in WMS. This includes the following:

1. Importing DEM Data
2. Computing flow paths and flow accumulations
3. Delineating watersheds from DEMs
4. Delineating sub-basins within a watershed