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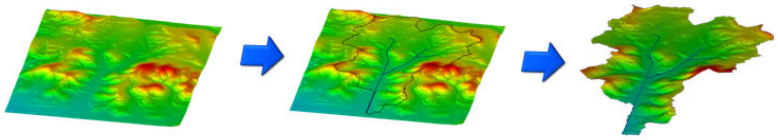
Watershed Modeling With DEMs: The Rest of the Story

Lesson 7



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DEM Delineation:
The Rest of the Story

- DEM Fill for some cases when merging DEMs
- Delineate Basins Wizard
- Smoothing boundaries
- Representing roads, railroads, canals, etc.
- Delineation of an interior, local depression
- DEM Attributes
  - Editing Flow Directions
- Editing Elevations
- Creating computation arcs for longest flow paths
- Computing storage capacity curves
- Computing time-area curves

Now that you have the basic idea of delineation down it is time to talk about a few of the limitations, how to work around them, and some of the extra things you can do to in order to develop a hydrologic model. The next several slides will discuss in a little more detail the items listed here.

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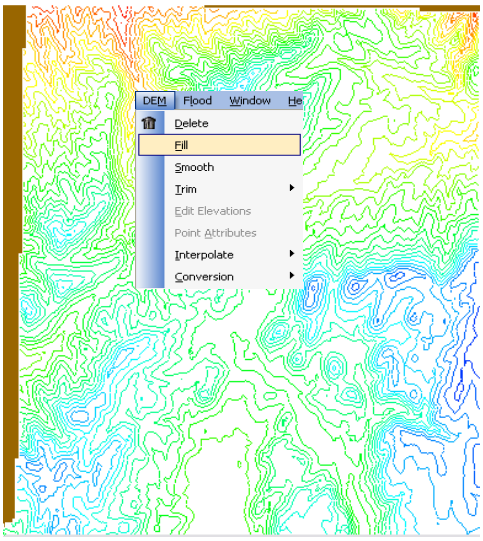
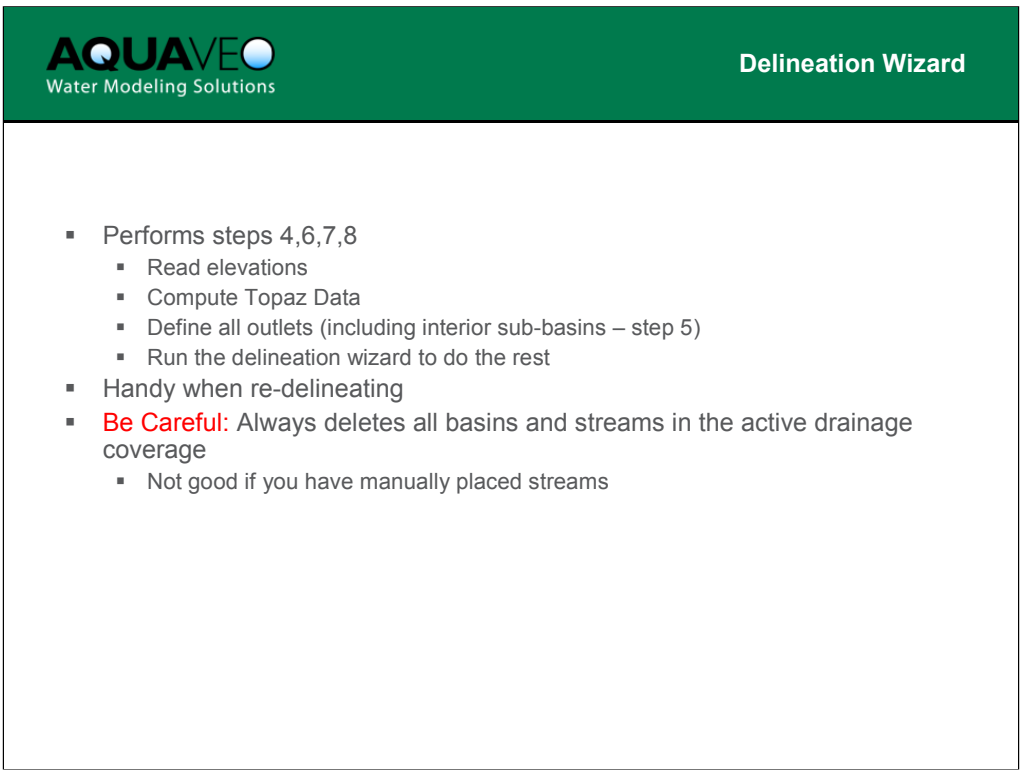
DEM | Fill



When some DEMs are tiled together (or perhaps for other reasons) some of the DEM cells in the gap between them may not be correctly filled in with elevations. The Fill command in the DEM menu will linearly interpolate across such regions (generally only one cell thickness) so that problems do not occur with the delineation algorithms. If there are larger regions (thicker than one cell) you may have to select the area you wish to interpolate in order for WMS to process it. No Data cells on the boundaries are not interpolated.



Because the previously defined 8-step process is repeated so often a delineation wizard command has been added to the DEM delineation menu. The wizard simply combines the majority of the later steps since they are almost always run in succession anyway. You will be prompted for a threshold, and for the units at the appropriate times during the execution of the wizard.

The wizard should only be used when doing a straightforward delineation that does not require any edits or stream arc changes as will be illustrated in the next few slides. This is because each time the delineation wizard is run all feature objects (except the outlet points) are deleted. If you have manually entered some stream arcs then they will be deleted when you run the wizard.

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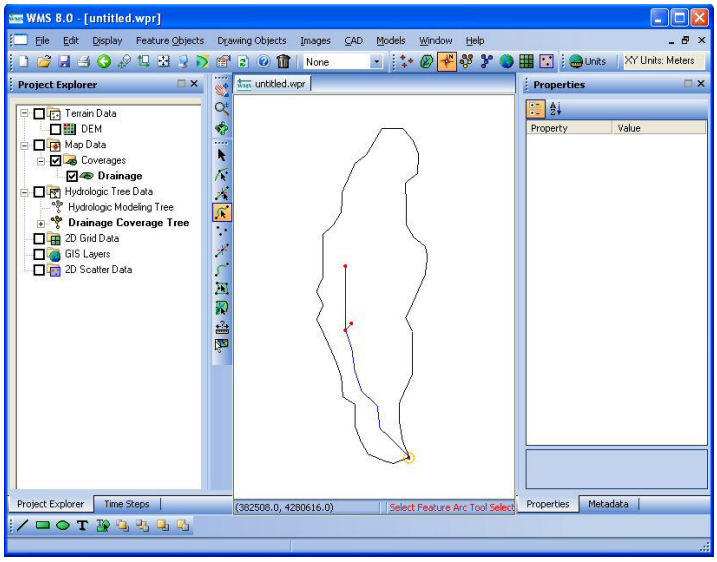
Smoothing Streams and Boundaries



When converting flow accumulation cells to stream arcs and DEM basin boundaries to polygons a vertex is place at the center of the DEM point (streams) and around the edges (boundaries) as if you were to digitize each vertex separately. This results in a very artificial looking boundary, especially if you zoom in close on a boundary edge. While this is okay for engineering calculations of area and distance, it does not look right and may cause others who know less about DEMs and watershed modeling to question your work.

You can smooth the streams and boundaries by redistributing the vertices to a larger spacing and having a cubic spline fit through the new set of vertices. You can select individual arcs, or use the Edit | Select All command to select all of the arcs at once. The result will have little effect on the basin area and will greatly enhance the visual appearance of the stream and boundary arcs.

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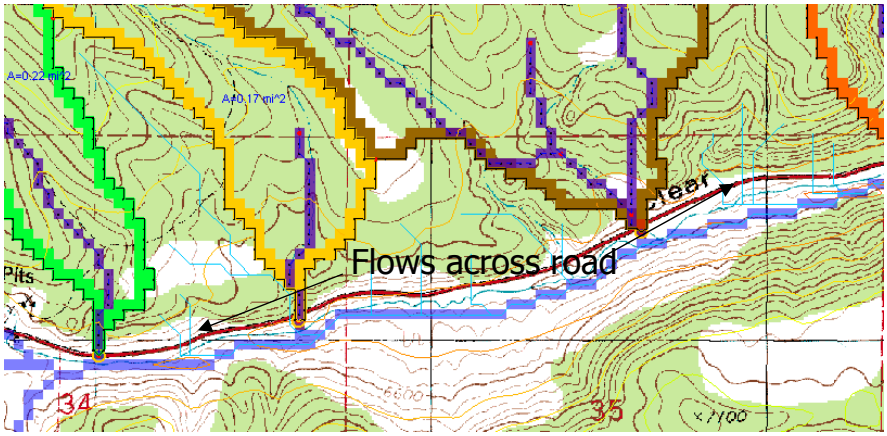
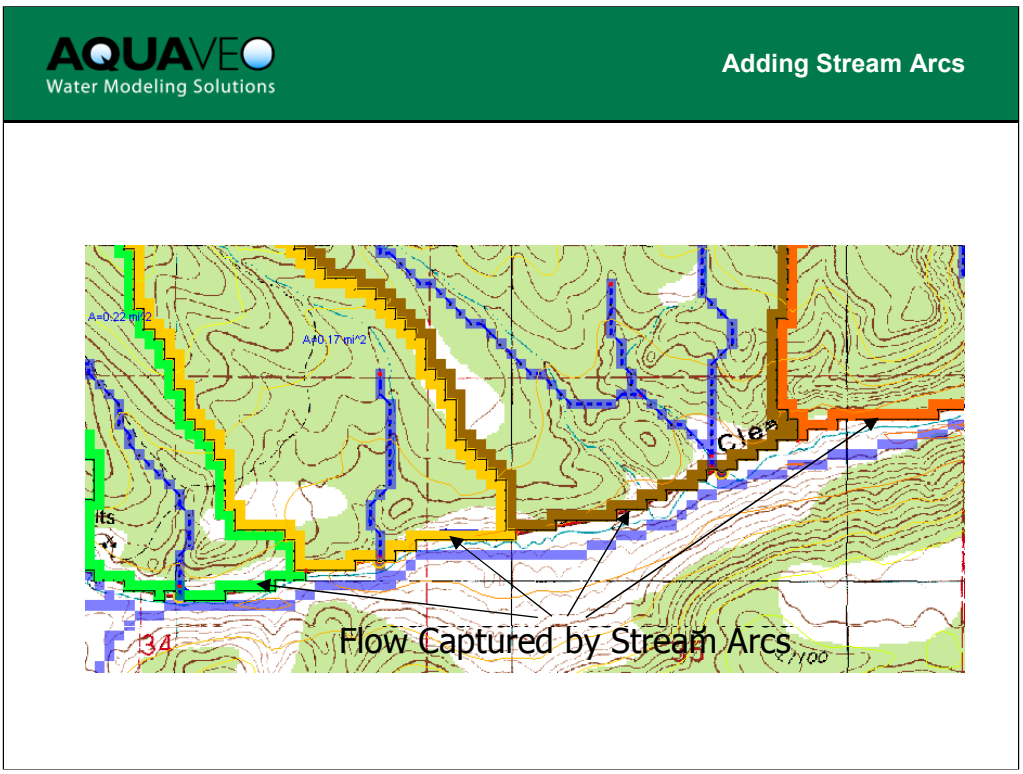
DEM Delineation Limitations

- Roads, railroads, canals, etc.



DEMs rarely have the kind of resolution necessary to capture linear features like roads, railroads, canals, etc. Flow paths tend to run across such features rather than parallel to them as we would expect.



In reality, when WMS defines basins, it traces a flow path until it reaches a stream in order to classify its basin. You can take advantage of this by entering stream arcs along the road in order to "capture" the flow that would otherwise cross the road. As you define these arcs along the road remember that you will need one coming from each sub-basin. You will have to use your best judgment based on the surrounding topography (or perhaps personal knowledge of the site) to know where one basin ends and another begins. Always remember that streams should be digitized from downstream to upstream.

Once you have created these streams by hand do not use the delineation wizard as it will start from just the outlet points and eliminate the work you have just completed.

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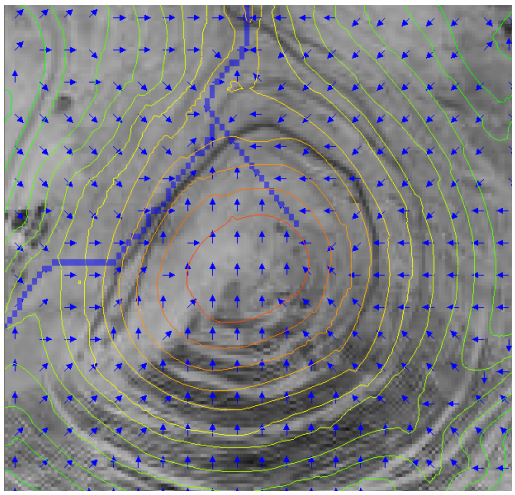
DEM Delineation Limitations

- Interior depressions



The first step in a grid-based delineation process like TOPAZ is to create a depressionless DEM. In other words, it is assumed that any depression exists in the DEM because of a lack of resolution. This makes it impossible to delineate natural depressions such as the one shown in this picture using the standard delineation procedures.

This is a picture of the Bingham Copper Mine, one of the largest open pit mines in the world.

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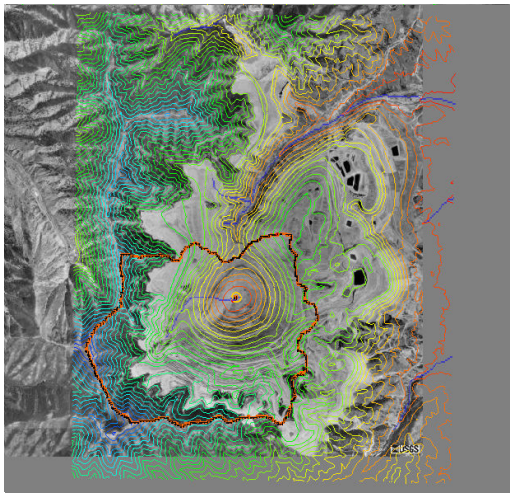
Using a Depression Point

- Depression point
- Run TOPAZ
- Define short stream
- Define basins
- Convert to polygons
- Compute basin data



WMS allows you to define a depression point at a known depression on your DEM so that you can delineate the area of the depression. What really happens is that TOPAZ defines flow directions until the "edge" of the DEM (i.e. a NODATA cell) is reached. When you identify a depression point, WMS writes it to the TOPAZ input as a NODATA cell and therefore the smoothing is not done and you are able to compute the flow directions towards the depression rather than filling it up.

In general follow the steps listed on this slide when you want to delineate a depression area on a DEM:

• Read in your DEM

• Define the depression point by selecting the select DEM tool and double-clicking on the DEM cell representing the depression location.

• Run TOPAZ

• Define a short stream segment coming out of the depression

• Define basins

• Convert basin boundaries to polygons

• Compute basin data

Do not use the delineation wizard in conjunction with these manual edits.

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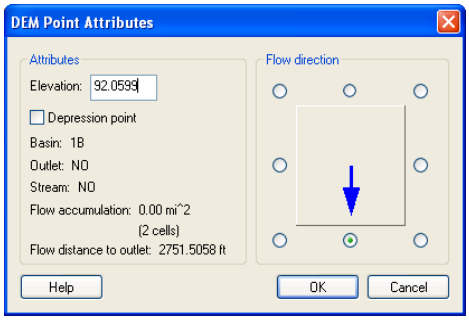
DEM Attributes

- Elevation
- Depression Point
- Drainage
  - Basin
  - Outlet
  - Stream
  - Flow Accumulation
  - Flow Distance
  - Flow Direction



Besides an elevation, WMS stores many other attributes for each DEM point. These include flags that indicate which basin it belongs to, whether or not it is classified as a stream (under a stream arc) or outlet point, the flow direction, accumulation, and travel distance to the outlet. You can view these attributes and edit some of them using the DEM Point Attributes dialog. Occasionally you may discover that the flow directions are incorrect because of a lack of elevation resolution. You can manually alter the flow direction in a small area in order to get the result that you know "on the ground" is true.

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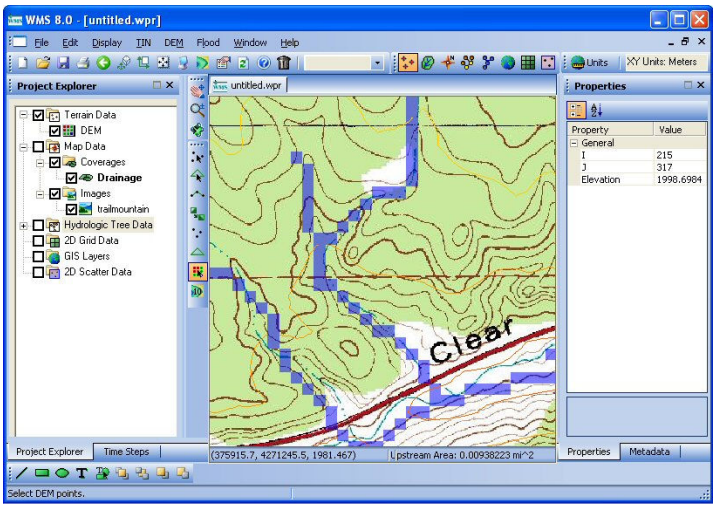
Editing Flow Directions



Because of the resolution of a DEM you may encounter localized errors in the flow accumulations. In this particular instance there are two places where the stream "jumps" the bank according to the USGS blue lines. In one case the flow ends up in an entirely different sub-watershed. When local edits are sufficient (this doesn't work very well if a large number of changes need to be made) to correct the flow problems, you can manually modify the flow directions of individual DEM points using the DEM Attributes dialog. WMS will automatically check to ensure that a change does not result in a circular flow path. After each edit you will be prompted whether you want to re-compute the flow accumulations. You do not have to do it after each edit, but when you are finished making edits, you MUST re-compute the flow accumulations so that the changed flow directions can be updated in the flow accumulation calculations.

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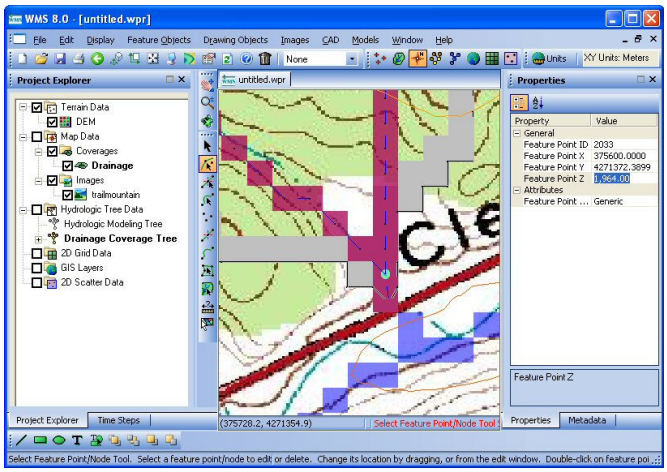
Editing DEM Elevations

- Single points
  - Select
  - Edit Z



While you would not want to selectively edit a large number of DEM points, it is useful from time to time to alter the elevation of a DEM point near the stream or some other location. This can be done using the select DEM point/region tool, selecting the DEM point, and editing the elevation in the Z edit field of the Properties Window.

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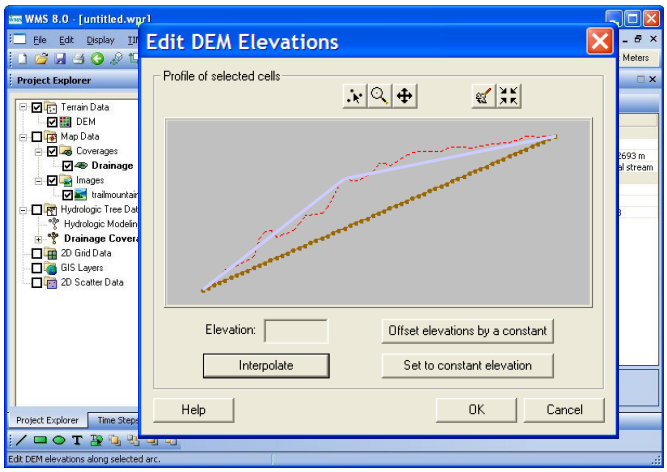
Editing DEM Elevations

- Stream burning
  - Select arc
  - Interpolate
  - Offset
  - Break arc?



Because DEMs are not sampled directly along streams, it is impossible to obtain a DEM where the stream beds are correct. This is because when interpolating along a regular grid one point may be in the stream, but then a diagonal or other adjacent "stream" point may be on the bank relative to the first. As the grid elevations of the DEM "meander" in and out of the stream according to the resolution, the elevations of the stream bed according to the DEM fluctuate up and down.

Burning in a stream is the process of selecting all DEM points along an arc and lowering them by a constant value, or interpolating linear from the first to the last in order to "smooth" out the stream bed. When interpolating, it may be helpful to break the arc used for editing into smaller segments according to major breaks in slope.

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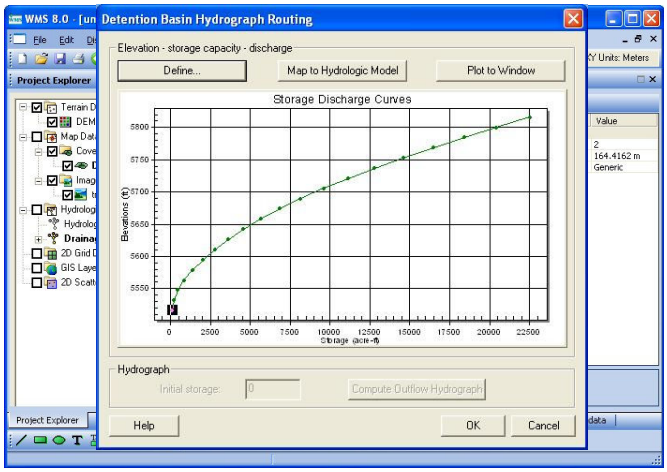
Editing DEM Elevations

- Embankments
  - Select arc
  - Interpolate
  - Adjust
  - Elevation vs Storage



You can also do the opposite of stream burning by raising the elevations along a selected arc. This is a great tool to use if you wish to raise the embankment created by a road, or want to model a proposed dam site. When using this to generate a storage capacity curve behind an embankment it is a good idea to lower the center cell, or outlet creating a gap if you will in the embankment where you want flow to "escape."

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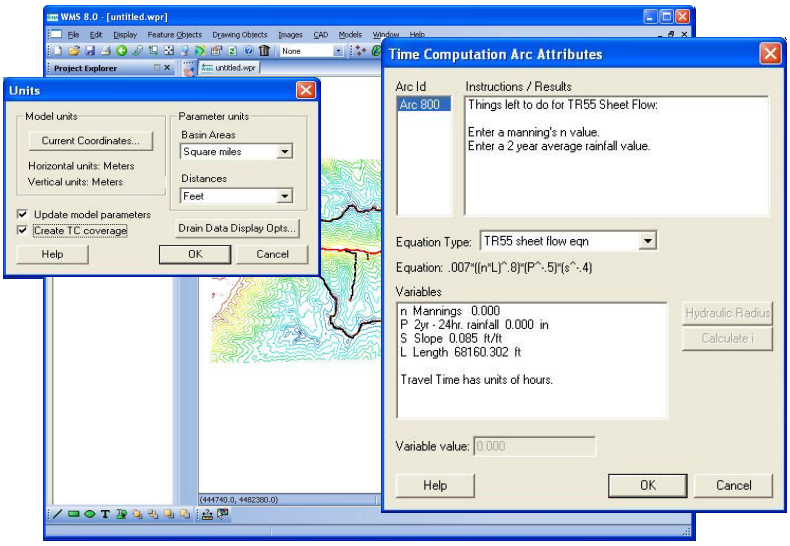
Creating Time Computation Arcs



One of the options available any time you compute basin data is to "Create a TC coverage." This option is off by default, but if you turn it on then WMS will create arc(s) in each basin that represent the longest flow path within the basin. These arcs will be placed in a new time computation coverage and you can then set the equations used for travel time computations.

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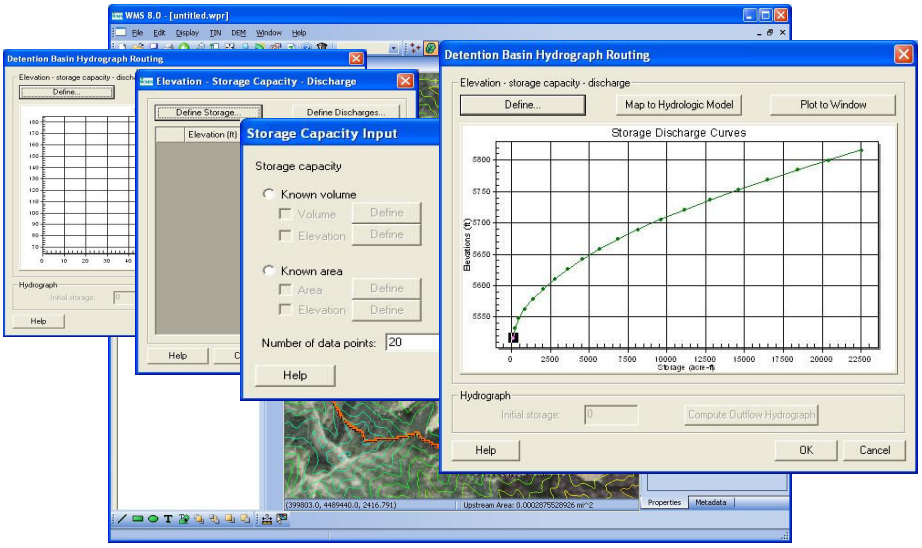
Storage Capacity Curves



It is often useful to calculate the volume below a certain elevation so that a storage capacity curve can be developed. WMS allows you to enter a reservoir height and then calculate up to ten incremental values of volume vs storage based on the low point within the basin and the entered water surface elevation. You must delineate the basin prior to this so that WMS does not search for areas that are outside of your watershed.

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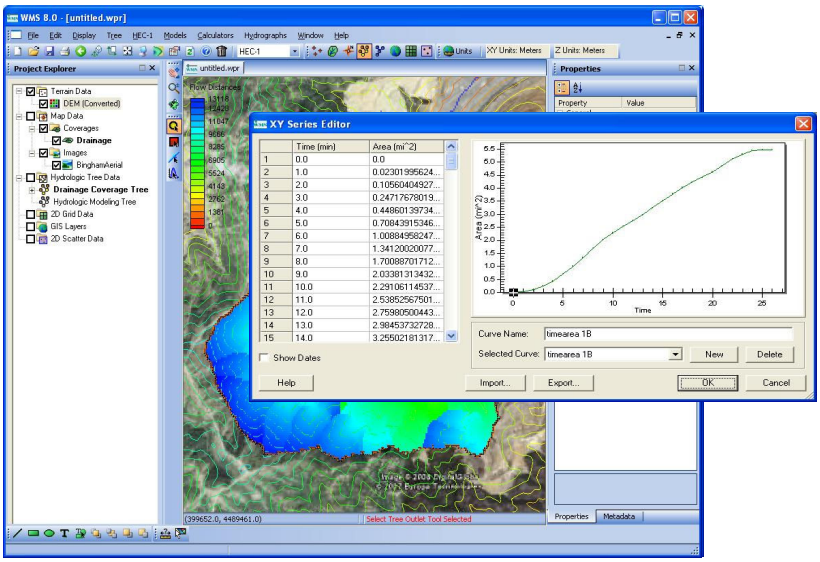
Time Area Curves



A time area curve can be estimated in WMS by the distance traveled. WMS computes the travel distance from each DEM cell to the outlet when computing basin data and these data can be contoured or converted to a time area curve.

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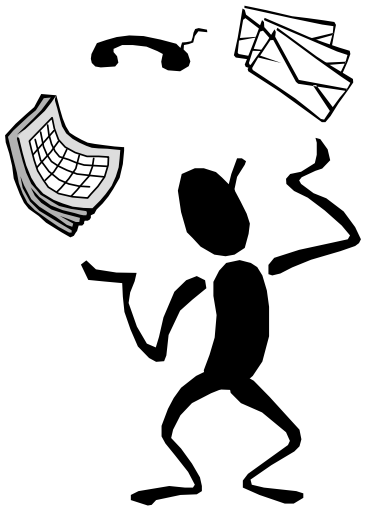
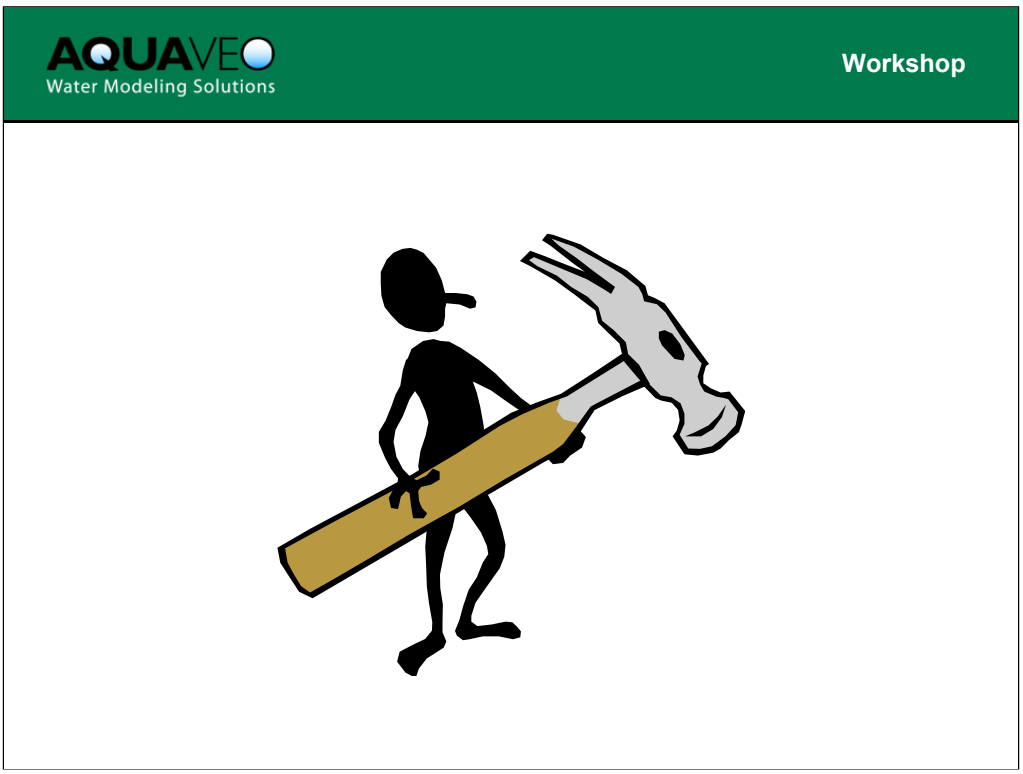
Demonstration





The files that will be used for this workshop can be found in the tutorials directory under **demedit**.