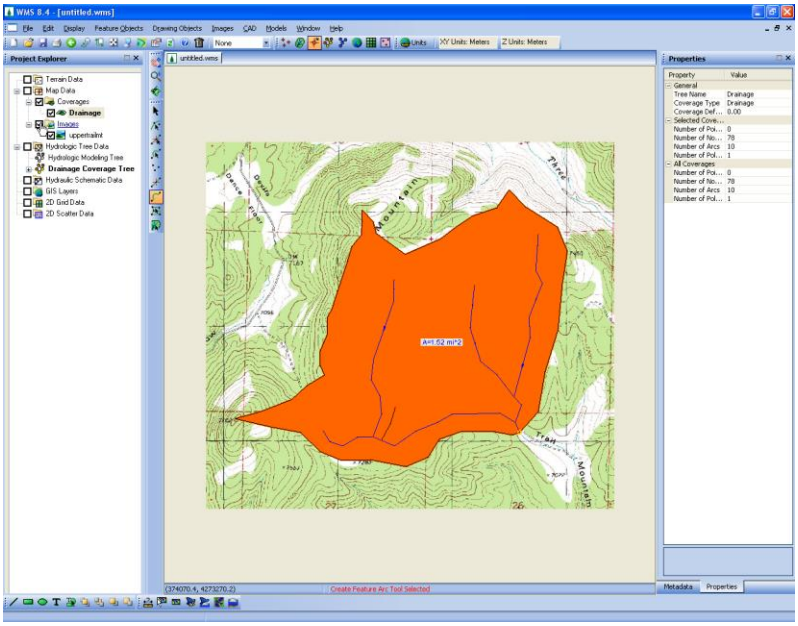
WMS

v. 10.1

WMS 10.1 Tutorial

Introduction – Advanced Feature Objects

Learn how to do advanced operations with feature objects



Objectives

Use feature object drainage coverages for manual watershed delineation. Import and edit CAD data to define a watershed.

Prerequisite Tutorials

- Introduction – Basic Feature Objects

Required Components

- Data
- Drainage
- Map
- Hydrology

Time

- 30–60 minutes

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1 Introduction

In the "Introduction – Basic Feature Objects" tutorial, feature points, lines, and polygons were created and organized into coverages and feature object attributes were explored. This tutorial continues showing how to apply those concepts with a focus on the drainage coverage—the primary coverage type used in WMS to develop watershed models.

This tutorial discusses and demonstrates using feature object drainage coverages for watershed delineation, using advanced feature object editing functions, assigning appropriate feature object attributes, and importing and editing feature objects from CAD data

2 Getting Started

Starting WMS new at the beginning of each tutorial is recommended. This resets the data, display options, and other WMS settings to their defaults. To do this:

1. If necessary, launch WMS.
2. If WMS is already running, press *Ctrl-N* or select *File* | **New…** to ensure that the program settings are restored to their default state.
3. A dialog may appear asking to save changes. Click **No** to clear all data.

The graphics window of WMS should refresh to show an empty space.

3 Defining a Watershed with Feature Objects

By using a combination of stream arcs, outlet nodes, and basin polygons, the entire watershed can be developed without the use of a digital terrain model. The watershed can be to scale or a schematic. If it is not to scale, polygon areas and stream lengths will not be valid for a hydrologic model.

Here, the Aspen Grove watershed will be created from an image of a scanned paper map with clearly marked streams and basin boundaries.

1. Select *File* | **Open** to bring up the *Open* dialog.
2. Select "Image Files (*.img)" from the *Files of type* drop-down.

3. Browse to the *\featureadv\featureadv* directory and select "aspentrc.img".
4. Click **Open** to import the image file and exit the *Open* dialog.
5. If asked whether to generate image pyramids, click **No**.

A portion of a USGS quad map will be displayed with basin boundaries outlined in red and the stream network in black.

7. Right-click on "aspentrc.tif" in the Project Explorer and select ***Set Transparency…*** to bring up the *Image Transparency* dialog.
8. Set the *Transparency* to "65%" and click **OK** to close the *Image Transparency* dialog.

The map image should now be somewhat faded (Figure 1).

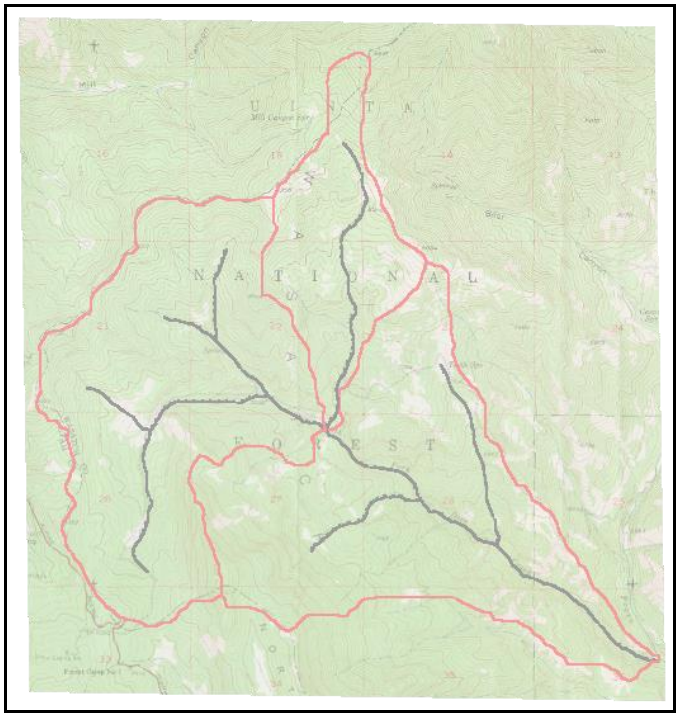

Figure 1 Background map image

3.1 Creating Basin Boundaries

Begin by creating the basin boundaries. It does not matter whether the basins or streams are created first.

1. Switch to the **Map** module.
2. Select the **Create Feature Arc** tool.
3. Select *Feature Objects* | **Attributes…** to bring up the *Feature Arc Type* dialog.
4. In the *Type* section, select *Generic* and click **OK** to close the *Feature Arc Type* dialog.

Start by digitizing the entire watershed boundary. Then, digitize the interior sub-basin boundaries. Practice good topology by ensuring that arcs are fully connected at each location where the arcs intersect.

5. Start the arc by clicking on the outlet location in the lower right corner, and continue to click along the exterior red lines to trace the entire watershed boundary.
6. Click on the starting point to end the arc.

When digitizing arcs, it is often helpful to use the mouse wheel to zoom in and out by scrolling or pan around by holding down the mouse wheel and dragging.

7. Click in the center of the watershed where all the interior red lines intersect.
8. Continue to click along one of the red lines to trace one of the sub-basin boundaries. Click on the exterior watershed arc to end the arc.
9. Repeat steps 7–8 for the other two interior red lines making sure to start at the same central point and end at the exterior watershed boundary.

When finished there should be three areas enclosed by arcs that represent the watershed and sub-basin boundaries (Figure 2, with nodes and vertices turned on in the *Display Options* dialog).

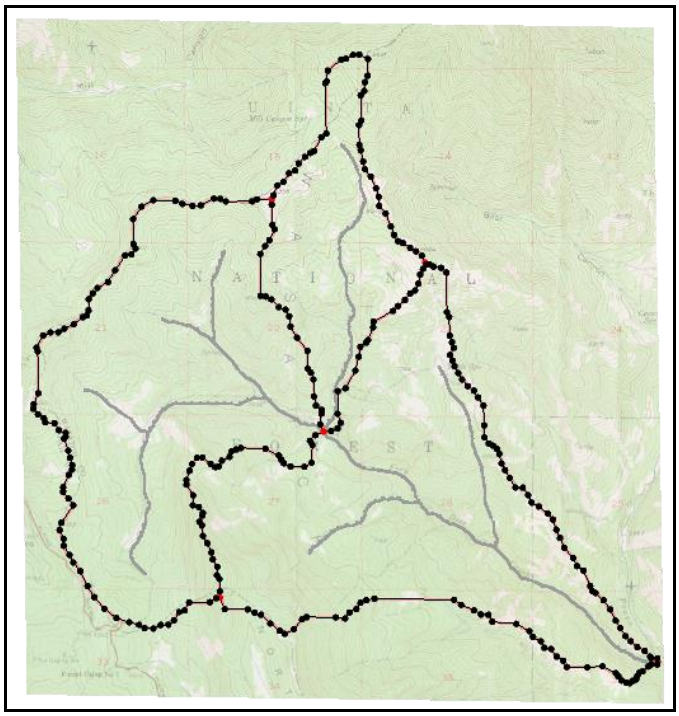

Figure 2 All the boundary arcs digitized

3.2 Creating the Stream Network

The stream network is created in much the same way the basin boundaries were. The only thing to note is that in the upper basin the basin boundary comes very close to the stream. It is recommended to zoom in on this region in order to avoid conflicts with the snapping tolerance.

1. Select *Feature Objects* | **Attributes…** to bring up the *Feature Arc Type* dialog.
2. In the *Type* section, select *Stream* and click **OK** to close the *Feature Arc Type* dialog.

Begin by digitizing the main channel and two branches in the lower right basin. Then, digitize the main channels and branches in the two upper basins. When creating stream arcs, always remember to digitize from downstream to upstream to ensure that the stream arc direction is defined correctly.

While creating the stream arcs, take care when digitizing the stream where it comes close to the basin edge. If clicking too close to the basin edge arc, WMS snaps the stream to the basin edge. This causes a message stating the stream is illegal to appear and the stream has to be redrawn. To avoid snapping to the basin edge, zoom in to a sufficient level so the arc will not snap to the basin edge while creating the stream arc.

3. Click **Display Options** to bring up the *Display Options* dialog.
4. Select "Map Data" from the list on the left.
5. On the *Map* tab, turn on *Points/Nodes* and *Vertices*, then click **OK** to close the *Display Options* dialog.
6. Begin by clicking on the outlet point (the node) in the lower right corner on the exterior watershed boundary, continuing to click along the stream line to trace the main channel in the lower right basin.
7. End the arc by clicking on the central node, where all the sub-basin boundary arcs intersect (Figure 3).

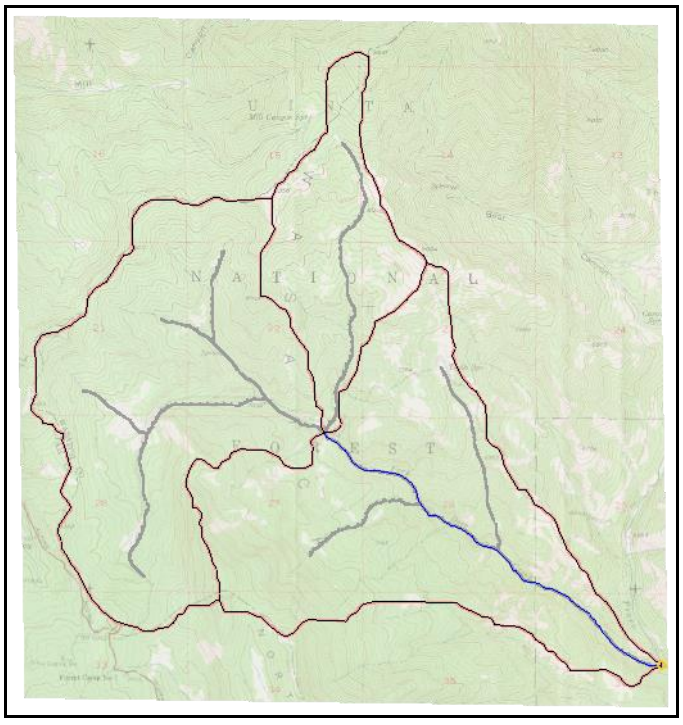

Figure 3 Sub-basin and lower main channel arcs

6. Create the right branch in the lower sub-basin by clicking on the main channel arc where it intersects the branch, and continue clicking upstream to the end of the branch.
7. Double-click where the branch ends to end the arc.
8. Repeat steps 6–7 to create the left branch in the lower sub-basin.
9. **Zoom** in on central node area (Figure 4).

Figure 4 Junction of main channel in Aspen Grove Watershed

11. Select the **Create Feature Arc** tool.

To create the stream arc for the upper right sub-basin:

Begin by clicking on the central node where all the sub-basin boundary arcs and lower main channel arc intersect, continuing to click along the stream line to trace the stream in the upper right basin. Zoom in using the scroll wheel, as necessary, to avoid snapping to the basin edge.

12. Double-click at the end of the stream line to end the arc.

The single stream arc for the upper right basin has been created. Next, create the stream arcs for the upper left basin.

14. Start by clicking on the central node and continue clicking along any of the stream lines to trace the stream, double-clicking to end the arc at the end of the stream.
15. Finish digitizing the remaining branches in the upper left basin by tracing all of the remaining black line branches in that basin. Remember to digitize from downstream to upstream.

The project should appear similar to the following (Figure 5, with nodes and vertices turned off so the streams are more visible).

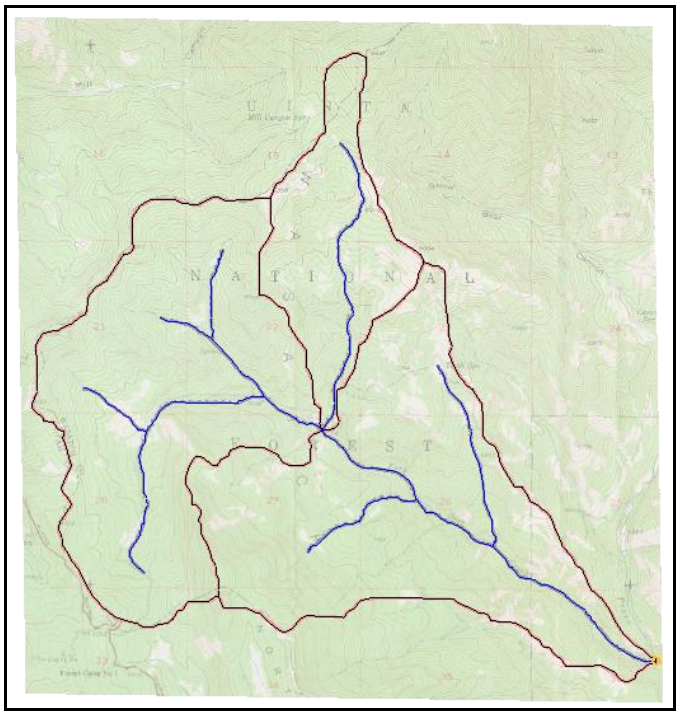

Figure 5 All streams and basin boundaries digitized

In order to define separate basins at the central junction node, convert the node at the junction to an outlet node. To do this, follow the steps below.

17. Using the **Select Feature Point/Node** tool, right-click on the central junction node in the center of the watershed and select **Attributes…** to bring up the *Drainage Feature Point Type* dialog.
18. In the *Type* section, select *Drainage outlet* and click **OK** to close the *Drainage Feature Point Type* dialog.
19. Click anywhere away from a node to deselect the central junction node.

Notice that the node has changed to an outlet node (Figure 6).

20. **Frame** the project.

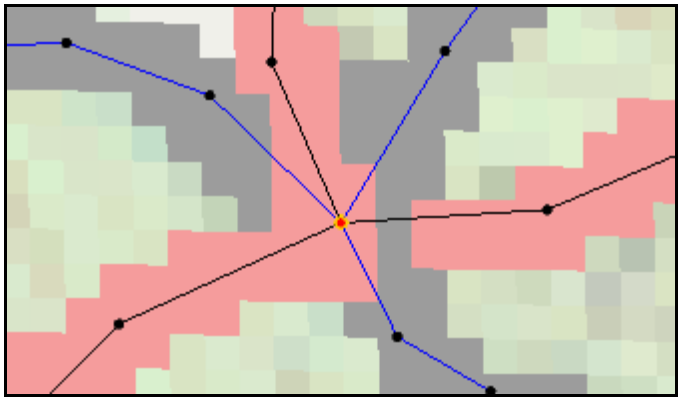

Figure 6 The sub-basin outlet node

3.3 Building Polygons

At this point the watershed boundaries are only arcs. Now create the polygon topology.

1. Right-click on the "Drainage" coverage and select **Build Polygon**.
2. When asked to use all arcs, click **OK**.

Note that WMS excludes the stream arcs when building polygons.

3. Using the **Select Feature Polygon** tool, double click on the lower sub-basin to bring up the *Drainage Feature Polygon Type* dialog.
4. In the *Type* section, select *Drainage* boundary and click **OK** to close the *Drainage Feature Polygon Type* dialog.
5. Repeat steps 3–4 for the two upper sub-basin polygons.

The project should appear similar to Figure 7.

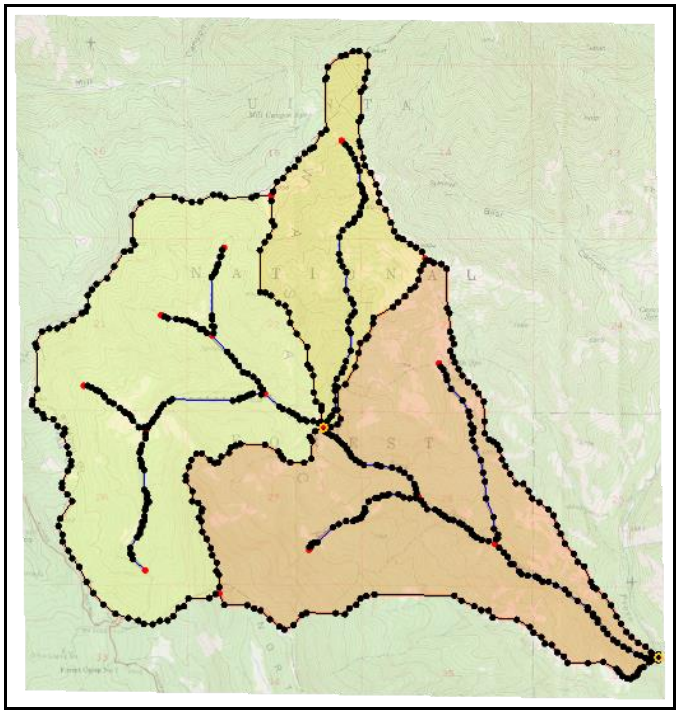

Figure 7 The sub-basin polygons have been built

3.4 Updating Geometric Parameters

1. Right-click on "Drainage" in the Project Explorer and select **Display Options…** to bring up the *Display Options* dialog.
2. Select "Map Data" from the list on the left.
3. On the *Map* tab, turn on *Color Fill Polygons* and click **OK** to close the *Display Options* dialog.

Computing the basin data transfers the basin area and stream lengths and computes them in appropriate units for hydrologic modeling. This allows the polygon area to be used in any of the hydrologic modeling interfaces.

4. Right-click on "Drainage" and select **Compute Basin Data…** to bring up the *Units* dialog.

This dialog computes areas, perimeters, and centroids for each of the sub-basins and assigns these values to the hydrologic modeling tree

5. In the *Model units* section, click **Current Projection…** to bring up the *Display Projection* dialog.
6. In the *Horizontal* section, select *No projection*.
7. Select "Meters" from the *Units* drop-down.
8. In the *Vertical* section, select "Meters" from the *Units* drop-down and click **OK** to close the *Display Projection* dialog.
9. In the *Parameter units* section, select "Square miles" from the *Basin Areas* drop-down.
10. Select "Feet" from the *Distances* drop-down.
11. Click **OK** to compute the sub-basin data and close the Units dialog.

The basin data labels should now appear on the screen (Figure 8). These labels can be turned on in the *Display Options* dialog.

The basin model has been prepared and could now be used to develop a hydrologic model. Developing a hydrologic model is outside the scope of this tutorial, so this model will not be developed further here.

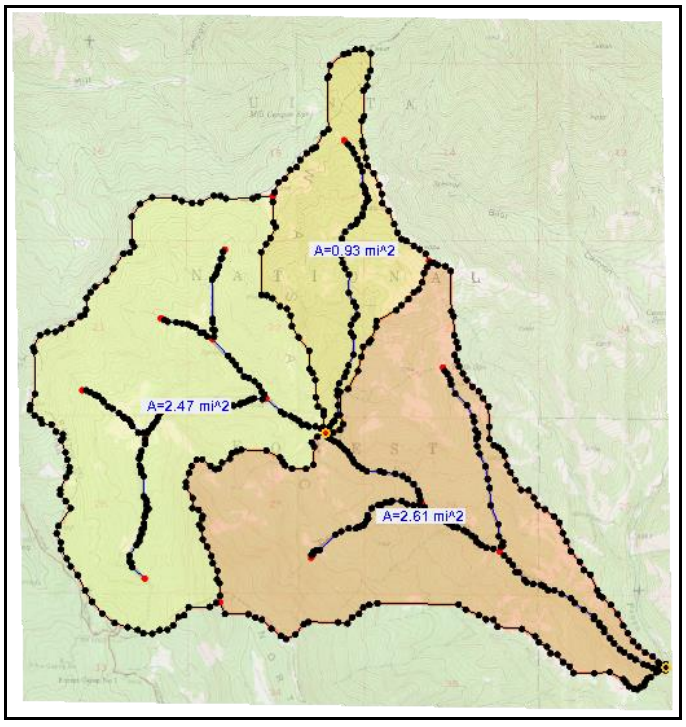

Figure 8 Each sub-basin has a computed area

4 More Basin Delineation

In this section, the techniques demonstrated in Section 3 are applied, but without the pre-traced basin and stream delineations. Instead of using the trace lines, this section demonstrates placing the basin boundary and stream arcs using a topographical map. Refer back to the steps in Section 3 as needed to complete this section.

1. Click **New** to reset WMS to the default settings and close the previous project.
2. Click **No** when asked to save changes.
3. Click **Open** to bring up the *Open* dialog.
4. Select "JPEG Image File (*.jpg;*jpeg)" from the *Files of type* drop-down.
5. Select "uppertrailmt.jpg" and click **OK** to exit the *Open* dialog and import the image.
6. If prompted to build image pyramids, click **No**.

A portion of a scanned topographic map that has already been georeferenced should appear (Figure 9).

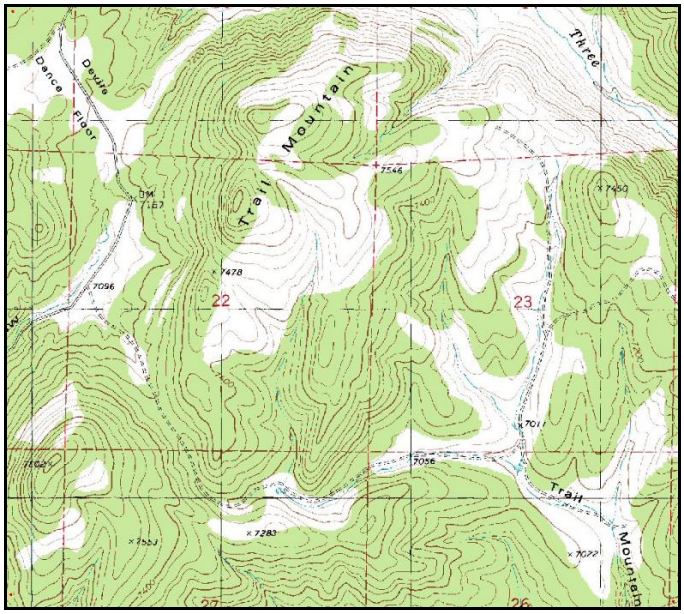

Figure 9 Imported topographical map

4.1 Single Basin Delineation

1. Delineate the watershed boundary as a single basin similar to the boundary arcs shown in Figure 10. Make sure the boundary arc is a Generic arc (Section 3.1, steps 1–6).
2. Digitize the streams. Remember to make sure to set the feature arc attribute type to *Stream* and to digitize the stream arcs from downstream to upstream (Section 3.2, steps 1–16).
3. Add the basin outlet (Section 3.2, steps 17–20).

4. Build polygons once the arcs that form the boundary have been created (Section 3.3).
5. Compute the basin data, making sure the model units are *Meters* (Section 3.4). The final watershed should have an area of about 1.5 square miles.

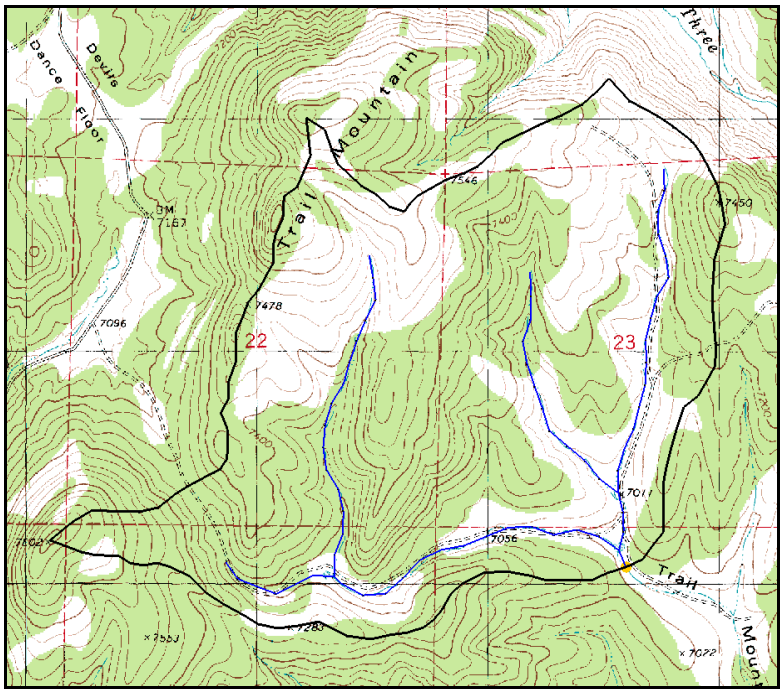

Figure 10 Upper Trail Mountain Watershed delineated as a single basin

4.2 Adding Sub-basins

Once the watershed has been successfully digitized as a single basin, add two interior outlets as indicated in Figure 11 and digitize the sub-basin boundaries. Note in Figure 11 that the sub basin on the left side is defined by converting the vertex just below the junction of the stream to an outlet, thus treating that branch as a single basin. The outlet for the two right sub-basins is placed on the node defining the junction of the streams, thus creating a separate basin for each upstream branch.

1. For the left side basin a vertex will need to be converted to a node.

Remember that a vertex can be converted to a node by selecting it with the **Select Feature Vertex** tool, right-clicking on it and then selecting **Vertex → Node** (or select **Vertex → Outlet** to convert it directly to a drainage outlet).

2. Be sure to change the attribute of the node defining the outlets to type *Drainage Outlet* (Section 3.2, steps 17–20).
3. Digitize the sub-basin boundaries with *Generic* type feature arcs and rebuild the basin polygons when done (Sections 3.1 and 3.3)
4. Compute the basin data again (Section 3.4).

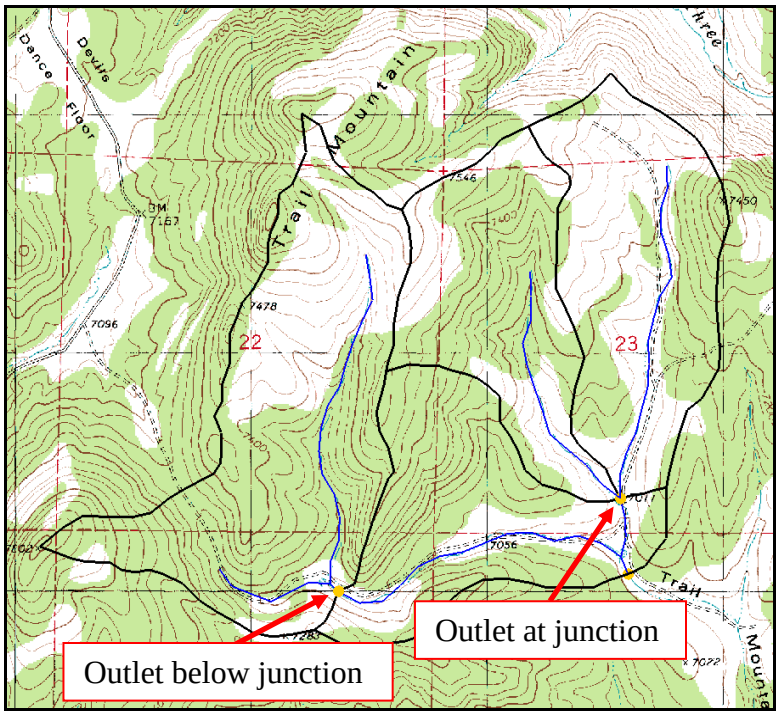

Figure 11 Upper Trail Mountain Watershed delineated with sub-basins

5 Creating Feature Objects from CAD Data

CAD data for an area may be available, and DWG and DXF data can be automatically converted to feature objects in WMS. Shape files follow a similar process.

1. Select *File* | **New** to reset to the default settings.
2. Click **No** when asked to save changes
3. Switch to the **Map** module.
4. Select *File* | **Open…** to bring up the *Open* dialog.
5. Select "DXF/DWG Files (*.dxf;*.dwg)" from the *Files of type* drop-down.
6. Select "af.dwg" and click **Open** to exit the Open dialog.
7. Right click on "af.dwg" and select *CAD to* | **Feature Objects…** to bring up the *CAD → Feature Objects* dialog.

This dialog shows a check mark for each layer that will be converted to feature objects.

8. Click **OK** to accept the defaults, close the *CAD → Feature Objects* dialog, and open the *Clean Options* dialog.
9. Click **OK** to accept the defaults, close the *Clean Options* dialog, and open the *Properties* dialog.
10. Click **OK** to accept the coverage type and name and close the *Properties* dialog.
11. Right-click on "CAD Data" and select **Remove**.

The project should appear similar to Figure 12.

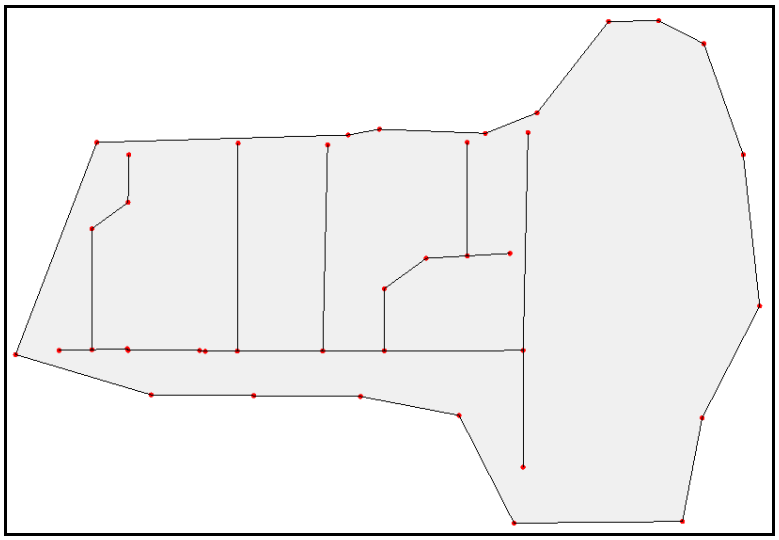

Figure 12 Imported DWG file showing drainage basin and stream network

Because these lines were created in a CAD program, the streams may not have been created using the WMS conventions for direction. Fix any such problems by, using the **Reorder Streams** command. By selecting the most downstream node in a stream network and invoking the **Reorder Streams** command, WMS reorders all arcs downstream to upstream from the selected node.

1. Switch to the **Map** module.
2. Using the **Select Feature Point/Node** tool, right-click on the leftmost node in the interior of the basin and select **Reorder Streams** (Figure 13) .

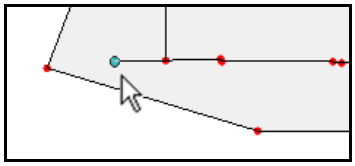

Figure 13 Leftmost node

3. Using the **Select Feature Line Branch** tool, select the arc attached to the left-most node (the node just used to reorder the streams, see Figure 14).

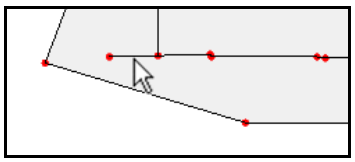

Figure 14 Select this arc

4. Select *Feature Objects* | **Attributes…** to bring up the *Feature Arc Type* dialog.
5. In the *Type* section, select *Stream* and click **OK** to close the *Feature Arc Type* dialog.

Each stream now flows in the proper direction, toward the drainage outlet at the left of the stream network. This outlet needs to be snapped to the basin boundary.

6. Using the **Select Feature Point/Node** tool, right-click on the leftmost node (Figure 15) in the stream network and select **Clean…** to bring up the *Clean Options* dialog.

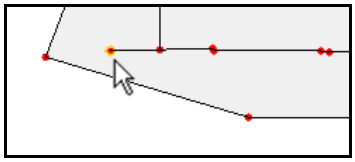

Figure 15 Outlet node to clean

7. Turn on *Snap selected nodes* and click **OK** to close the *Clean Options* dialog.
8. Select the node on the basin boundary just to the left of the drainage outlet node (Figure 16) to snap the outlet to the basin boundary node.

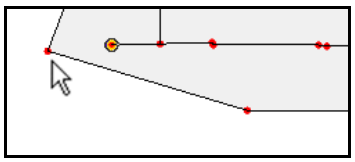

Figure 16 Boundary outlet node

9. Right-click on "CAD layers" and select **Build Polygon**.
10. Click **OK** when asked to use all arcs.
11. Select *Feature Objects* | **Compute Basin Data…** to bring up the *Units* dialog.
12. Click **OK** to accept the defaults, compute the data, and close the *Units* dialog

This set of streams and basins is now properly ordered and connected and is ready to be used for hydrologic analysis (Figure 17).

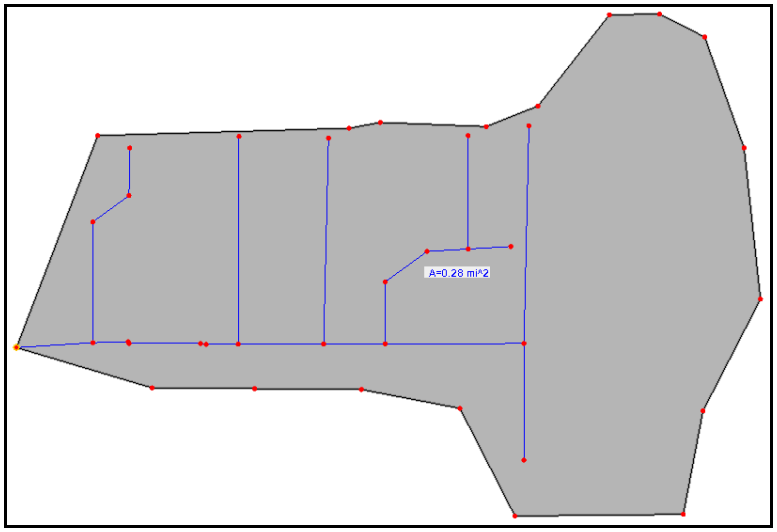

Figure 17 Drainage basin with computed data

6 Conclusion

This concludes the "Introduction – Advanced Feature Objects" tutorial. The following topics were discussed and demonstrated:

- Using feature object drainage coverages for watershed delineation
- Assigning appropriate feature object attributes
- Using CAD data to generate feature objects