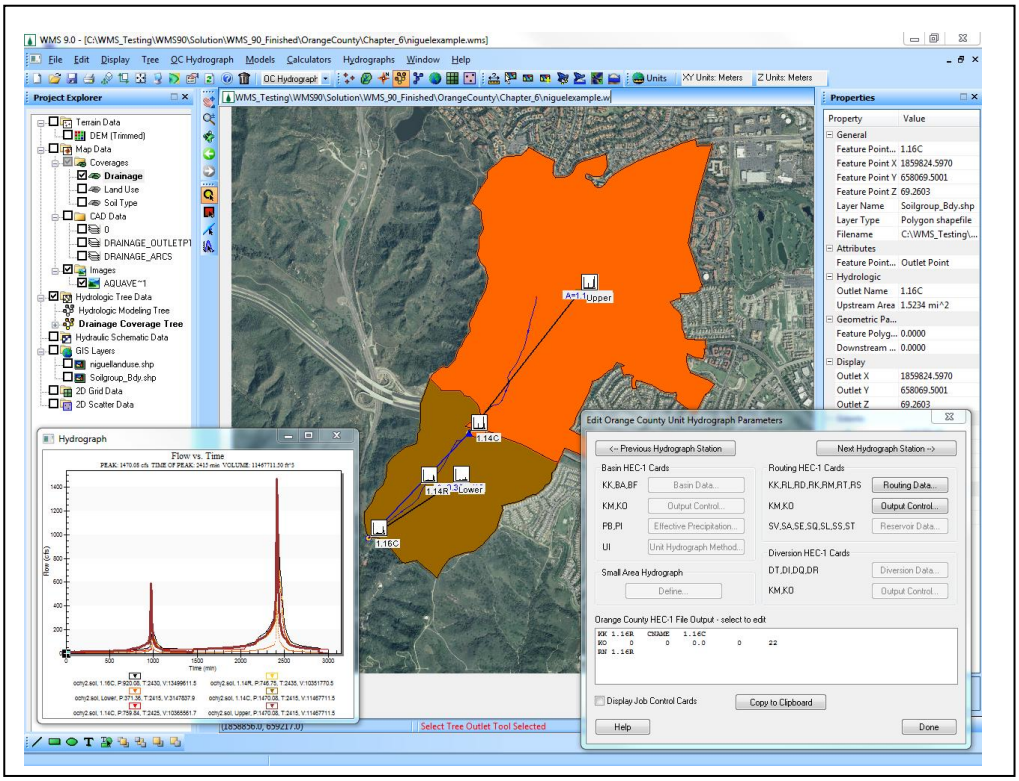
WMS

v. 10.1

WMS 10.1 Tutorial

Modeling – Orange County Unit Hydrograph – GIS

Learn how to define a unit hydrograph model for Orange County (California) from GIS data



Objectives

This tutorial shows how to define a map-based Orange County unit hydrograph model in WMS using pre-delineated watershed boundaries in CAD format. It shows how to correlate the imported boundaries with a DEM and how to extract information needed to run the Orange County unit hydrograph model.

Prerequisite Tutorials

- Watershed Modeling – Advanced DEM Delineation Techniques

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

Time

- 45-60 minutes

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1 Introduction

An Orange County unit hydrograph analysis is performed by entering job control parameters, defining a storm event, and then entering parameters associated with each drainage sub-area in order to run a HEC-1 simulation. Effective precipitation is computed by selecting the event type and applying losses, which can be calculated by overlaying data on soil type and land use coverages with the drainage basin boundary. Routing data is entered at drainage outlets (concentration points). It is possible to use GIS data in WMS to expedite the development of spatial data, which plays an integral part in the modeling process.

2 GIS Data

2.1 CAD Data

1. Open WMS. If WMS is already open select *File* **|** **New** then click **No** if asked to save changes.
2. Select *Display* **|** **Display Projection...** to open the *Display Projection* dialog.
3. Toggle on *Global Projection* and click on the **Set Projection** button.

4. The *Select Projection* dialog will appear. Change *Projection* to "State Plane Coordinate System".
5. Change *Zone* to "California Zone 6 (FIPS 406)".
6. Change *Datum* to "NAD 83".
7. Verify that the *Planar Units* are "Meters".
8. Select **OK** on the *Select Projection* dialog.
9. Select **OK** on the *Display Projection* dialog.
10. Select *File* | **Open…**
11. In the *Open* dialog, locate the "OrangeCounty\UnitHydro" folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
12. Open "NiguelCreek.dxf".
13. In the Project Explorer, right-click on NiguelCreek.dxf under the *GIS Data* folder.
14. Select *CAD To* | **Feature Objects…**.
15. The *CAD → Feature Objects* dialog will appear. Select **OK**.
16. Select **OK** in the *Clean Options* dialog.
17. The *Coverage Properties* dialog will appear. Enter "Niguel Creek Drainage" in the *Name* field.
18. Select **OK**.
19. Toggle off the display of the "CAD Data" folder in the Project Explorer.
20. Use the **Select Feature Arc** tool to select the top stream arc indicated in Figure 1.

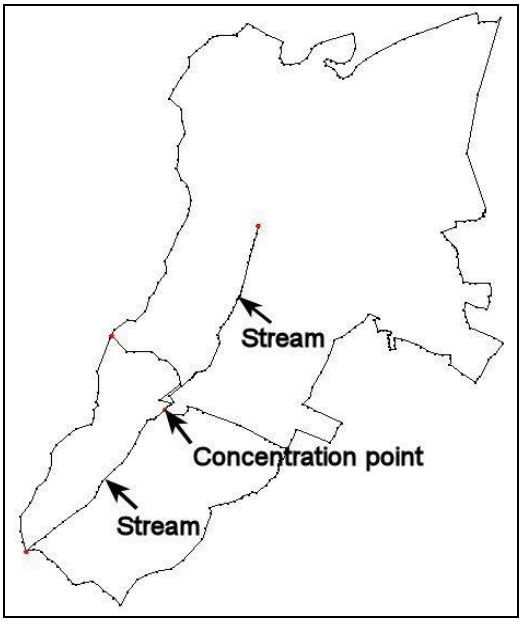


Figure 1 GIS data

21. Select *Feature Objects* | **Attributes…**
22. In the *Feature Arc Type* dialog, change the *Type* to *Stream* then click **OK**.
23. Use the **Select Feature Point/Node** tool to select the concentration point labeled in Figure 1.
24. Select *Feature Objects* | **Attributes…**
25. In the *Drainage Feature Point Type* dialog, change the *Type* to *Drainage outlet*.
26. Select **OK**.
27. Use the **Select Feature Arc** tool to select the bottom stream arc indicated in Figure 1.
28. Select *Feature Objects* | **Attributes…**
29. In the *Feature Arc Type* dialog, change the *Type* to *Stream* then click **OK**.
30. Select *Feature Objects* | **Build Polygon**.
31. Select **OK** to use all arcs.

2.2 DEM Data

1. Select *File* | **Open…**
2. In the *Open* dialog, select "LagunaBeach.asc" and "SanJuanCapistrano.asc" and click **Open**.
3. In the *Importing ArcInfo Grid* dialog, select **OK**.
4. **Zoom** in around the background image and sub-area boundaries.
5. Switch to the **Terrain Data** module.
6. Select *DEM* | *Trim* | **Polygon…**
7. Choose "Enter a polygon interactively" in the *Polygon Selection Options* dialog.
8. Select **OK**.
9. Use the left mouse button to click points and create a polygon that encompasses the background image and sub-area boundaries. Double-click on the last point to end the polygon and trim the DEM.
10. Switch to the **Drainage** module.
11. Select *DEM* | **Polygon Basin IDs → DEM**.
12. Select *DEM* | **Compute Basin Data**.
13. In the *Parameters units* section of the *Units* dialog, verify that *Basin Areas* are "Square miles" and *Distances* are "Feet" then click **OK**.
14. Toggle off the display of the DEM ("SanJuanCapistrano, LagunaBeach") in the Project Explorer.

2.3 Background Image

If unable to connect to the internet, skip section 2.3.

Using an Internet connection, load a background image (Aerial photo or a topo map) for the project site. WMS uses built in web services tool to load such images.

1. Select the **Get Online Maps** tool located in the *Add GIS Data* drop-down menu in the Get Data menu bar. The *Get Online Maps* dialog will appear.
2. Select *World Imagery* and click **OK**.
3. WMS will load the background image file. It will take few moments depending upon the internet connection. Once done, an aerial photo is added to the background.

Open a nice looking color image. Choose to use either this image or the image downloaded in the previous section.

1. Select *File* | **Open…**
2. In the *Open* dialog, select "NiguelCreek.jpg" and click **Open**.

2.4 Land Use Data

1. Right-click on the "Coverages" folder in the Project Explorer and select **New Coverage**.
2. In the *Properties* dialog, change the *Coverage type* to "Land Use" then click **OK**.
3. Switch to the **GIS** module.
4. Select *Data* | **Add Shapefile Data…** which will open the *Select Shapefile* dialog.
5. Open "niguellanduse.shp".
6. Select *Mapping* | **Shapes → Feature Objects**.
7. Select **Yes** to use all visible shapefiles for mapping.
8. The *GIS to Feature Objects Wizard* will appear. Select **Next**, **Next**, **Finish**.
9. Toggle off the display of "niguellanduse.shp" in the Project Explorer.

2.5 Soil Type Data

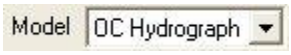
1. Right-click on the "Coverages" folder in the Project Explorer and select **New Coverage**.
2. In the *Properties* dialog, change the *Coverage type* to "Soil Type" then click **OK**.
3. Select *Data* | **Add Shapefile Data…** which will open the *Select Shapefile* dialog.
4. Open "Soilgroup_bdy.shp".
5. **Zoom** in around background image and the sub-area boundaries.
6. Use the *Select Shapes* tool to drag a box that encompasses the background image and sub-area boundaries
7. Select *Mapping* | **Shapes → Feature Objects**. Select **Yes** to use all visible shapefiles for mapping.
8. The *GIS to Feature Objects Wizard* will appear. Select **Next**.

9. In the *Type* column choose "SCS soil type" for *Mapping*.
10. Select **Next**, then select **Finish**.
11. Toggle off the display of "Soilgroup_Bdy.shp" in the Project Explorer.
12. Select *File* **|** **Save** .
13. For *File name* enter "NiguelExample.wms" and select **Save** to save a WMS project file.

3 Global Unit Hydrograph Parameters

3.1 Enter Job Control Parameters

1. Select the "Niguel Creek Drainage" coverage to make it active in the Project Explorer.
2. Switch to the **Hydrologic Modeling** module.



3. Make sure that the *Model* combo box at the top of the screen is set to "OC Hydrograph".
4. Select *OC Hydrograph* **|** **Job Control**. The *HEC-1 Job Control* dialog will open.
5. For *Computational time interval* (min) enter "5".

This value defines the computational time interval that will be used for computing the storm distribution and unit hydrograph.

6. Change the *Number of hydrograph ordinates* to "300".
7. Toggle on *Expected value (50% confidence interval)* then click **OK**.

3.2 Compute Losses

The *Compute GIS Attributes* dialog will automatically appear because there is GIS data in WMS and *Expected value* in the *Job Control* dialog is active. The expected value toggle changes the precipitation input, which affects loss calculations.

1. Verify that the Soil Type coverage will be used for determining soil type and the Land Use coverage will be used for determining land use.
2. Click on the **Import** button.
3. Select **OK** to overwrite the current land use table, which is displayed in the *Mapping* section of the *Compute GIS Attributes* dialog.
4. The *Open* dialog will appear. Open "ocland.txt".
5. Select **OK**.
6. The *Select Orange County GIS losses output file* dialog will appear. Choose a filename for saving the GIS loss calculation details and select **Save**.

The GIS calculator computes losses by overlaying the soil type and land use coverages with the drainage coverage and using the percent impervious and curve number values in the land use mapping table to compute composite Fm and Ybar loss values. A land use

mapping table of curve numbers representing the proper antecedent moisture condition (AMI I, AMC II, or AMC III) should be used.

3.3 Define Storm

1. Select *OC Hydrograph* | **Define Storm…**
2. In the *Orange County Storm* dialog, change the *Frequency* to "100 year".

This is the storm event that will be used to compute the effective precipitation.

3. Select **OK**.

The *Compute GIS Data* dialog will automatically appear again because changing the storm frequency also changes the precipitation input, which alters loss calculations.

4. Select **OK**.
5. The *Select Orange County GIS losses output file* dialog will appear. Choose a filename for saving the GIS loss calculation details and select **Save**.

4 Sub-area Parameters

4.1 Basin Data – Upper

1. Toggle off the display of the "Land Use" and "Soil Type" coverages and the "Images" folder in the Project Explorer.
2. Select the **Frame** macro.
3. Use the **Select Basin** tool to select the upper sub-area.
4. Select *OC Hydrograph* | **Edit Parameters…**
5. The *Edit Orange County Unit Hydrograph Parameters* dialog will appear. Click the **Basin Data…** button to edit sub-area parameters including name, area, and base flow in the *Hec-1 Basin Data* dialog.
6. For *Basin name* enter "Upper".
7. Select **OK**.

4.2 Effective Precipitation – Upper

1. Click the **Effective Precipitation…** button.

The computational time interval (min) from the Job Control is displayed, and the *Orange County Precipitation Wizard* will automatically open.

2. Click the **Compute Mountainous** button to compute the fraction of terrain that is above 2000 ft in order to use weighted precipitation values. The Compute button will compute this value only if a digital terrain model (DTM) exists.

The point precipitation and area-reduction factors to be used in computing the effective precipitation are displayed in a spreadsheet.

If precipitation values change (from computing the Mountainous fraction) or losses are not yet computed, click the Compute Losses button to use the GIS calculator to compute losses. This command only needs to be done once because composite loss values for each drainage sub-area are computed.

3. Click the **Next** button.

A plot of the effective precipitation is displayed. Right-click on the plot in order to view values or maximize the display of the plot.

4. Select **Done**.

4.3 Unit Hydrograph – Upper

1. Click the **Unit Hydrograph Method…** button.
2. In the *Orange County Unit Hydrograph* dialog, enter a *Lag time* of "0.209" hours.

The time of concentration (hours) will automatically be computed as lag time divided by 0.8.

The time of concentration that is entered here will generally come from the Rational method analysis of the same drainage sub-area.

3. Toggle on *Valley developed* and enter "0.78".
4. Toggle on *Valley undeveloped* and enter "0.22".

A unit hydrograph can be calculated by using any combination of weighted S-graphs.

5. Click the **Plot Unit Hydrograph** button to compute and display the unit hydrograph.

Right-click on the plot in order to view values or maximize the display of the plot.

6. Select **OK** to recompute the unit hydrograph using the currently displayed values in the dialog.

Scroll through and view the HEC-1 cards that are written in the bottom of the *Edit Orange County HEC-1 Parameters* dialog.

4.4 Basin Data – Lower

1. Use the **Select Basin**  tool to select the lower sub-area. It may be necessary to move the *Edit Orange County HEC-1 Parameters* dialog around on the screen in order to view and select the sub-area.
2. Click the **Basin Data…** button to edit sub-area parameters including name, area, and base flow in the *HEC-1 Basin Data* dialog.
3. For *Basin name* enter "Lower"
4. Select **OK**.

4.5 Effective Precipitation – Lower

1. Click the **Effective Precipitation…** button.

2. The *Orange County Precipitation Wizard* will appear. Select **Next**, then **Done**.

4.6 Unit Hydrograph – Lower

1. Click the **Unit Hydrograph Method…** button.
2. In the *Orange County Unit Hydrograph* dialog, enter a *Lag time* of "0.261" hours.
3. Toggle on *Valley developed* and enter "0.11".
4. Toggle on *Valley undeveloped* and enter "0.89".
5. Select **OK**.

5 Concentration Point Data (Routing)

5.1 Edit Parameters

1. Select the concentration point for the lower sub-area
2. Click on the Routing Data button
3. Change the Routing name to "1.16R"
4. Change the Combining name to "1.16C"
5. Select **OK**.

5.2 Convex Routing

1. Without closing the dialog, select the concentration point for the upper sub-area.
2. Click on the **Routing Data** button to define routing.
3. In the *HEC-1 Routing Data* dialog, change the *Routing name* to "1.14R".
4. Change the *Combining name* to "1.14C".
5. For *Routing type* select "Convex (RV)".

Notice that geometric parameters such as channel length and slope are automatically computed when basin data is computed and a digital terrain model exists.

6. Enter a *N* value of "0.035".
7. Enter a *WD* value of "1.0".
8. Enter a *Z* value of "5.0".
9. Select **OK**.
10. Select **Done** in the *Edit Orange County Unit Hydrograph Parameters* dialog.

5.3 Storage Routing (Modified Puls)

1. Select *Tree* | *Add* | **Reservoir**.

2. Double-click on the concentration point labeled 1.14C. The *Edit Orange County Unit Hydrograph Parameters* dialog will reappear.
3. Click on the **Reservoir Data…** button.
4. In the *Reservoir Routing Data* dialog, choose *Reservoir* and click on the **Define** button.
5. The *HEC-1 Reservoir Routing Options* dialog will appear. In the *Outflow* section of the dialog choose *Known outflow*.
6. Toggle on *SE* and click on the **Define** button. The *XY Series Editor* will appear.
7. Enter the values in the Elevation column of Table 1 (Notice there is no data for an elevation of 10).

Table 1: Elevation, storage, discharge values

Elevation (SE)	Outflow (SQ)	Volume (SV)
0.0	0.0	0.0
1.0	5.0	2.0
2.0	10.0	4.0
3.0	16.0	6.0
4.0	19.0	8.0
5.0	22.0	10.0
6.0	24.0	12.0
7.0	26.0	14.0
8.0	28.0	17.0
9.0	30.0	20.0
11.0	33.0	24.0
12.0	35.0	28.0
13.0	35.02	30.0
14.0	139.0	32.0
15.0	319.0	36.0
16.0	440.0	38.0
17.0	477.0	40.0
18.0	545.0	44.0
19.0	632.0	48.0
20.0	736.0	52.0

8. Select **OK**.
9. Toggle on *SQ* and click the **Define** button. The *XY Series Editor* will appear.
10. Enter the values in the Outflow column of Table 1.
11. Select **OK**.
12. In the *Volume* section of the dialog choose *Known volume*.
13. Toggle on *SE* and click the **Define** button. The *XY Series Editor* will appear.
14. Change the *Selected curve* to "1.14C Outflow elev". Select **OK**.
15. Toggle on *SV* and click the **Define** button. The *XY Series Editor* will appear.
16. Enter the values in the Volume column of Table 1.

17. Select **OK**.
18. Select **OK** in the *HEC-1 Reservoir Routing Options* dialog.
19. Select **OK** in the *Reservoir Routing Data* dialog.
20. Select **Done** in the *Edit Orange County Unit Hydrograph Parameters* dialog.

6 Running the Simulation

1. Select *OC Hydrograph* | **Run Simulation…**
2. In the *HEC-1 Run Options* dialog, click the **browse** button next to the Input File.
3. In the *Select HEC-1 Input File* dialog, enter a filename and click **Save** (this specifies the file name but does not actually save it).
4. Verify that *Save file before run* is toggled on.
5. Select **OK**. A new window will open and the program will run.
6. Select **Close** once HEC-1 finishes running (wait a few seconds to a minute or so)
7. Double-click on a hydrograph window to view the hydrograph in the plot window. Use the **SHIFT** key to select multiple hydrographs to view at once. Draw a smooth curve using these hydrograph ordinates in order to determine the peak discharge at outlined on page E-40 of the Orange County Hydrology Manual.

7 Multi-day Storm Event

7.1 Define Storm

1. Select *OC Hydrograph* | **Define Storm…**
2. In the *Orange County Storm* dialog, change *Event type* to "Multi-day event with flow-through detention".
3. Select **OK**.
4. Select **OK** to recompute Orange County losses.
5. Choose a filename for saving the GIS loss calculation details and select **Save**.
6. Select **Yes** to recompute effective precipitation for sub-areas.

7.2 Job Control

1. Select *OC Hydrograph* | **Job Control…** The *HEC-1 Job Control* dialog will appear.
2. Change *Number of hydrograph ordinates* to "600".
3. Select **OK**.

7.3 Run Simulation

1. Select *Hydrographs* | **Delete All**.
2. Select *OC Hydrograph* | **Run Simulation…**
3. In the *HEC-1 Run Options* dialog, click the **browse** button next to the Input File.
4. In the *Select HEC-1 Input File* dialog, enter a filename and click **Save** (this specifies the file name but does not actually save it).
5. Verify that *Save file before run* is toggled on.
6. Select **OK**.
7. Select **Close** once HEC-1 finishes running (wait a few seconds to a minute or so)
8. Double-click on a hydrograph window to view the hydrograph in the plot window. Use the **SHIFT** key to select multiple hydrographs to view at once.

8 Conclusion

This exercise demonstrated:

- How to define a map-based Orange County unit hydrograph model in WMS using pre-delineated watershed boundaries in CAD format.
- How to correlate the imported boundaries with a DEM
- How to extract the needed information to run the Orange County unit hydrograph model

If desired, continue to experiment with WMS and the OC Hydrographics model or exit the program.