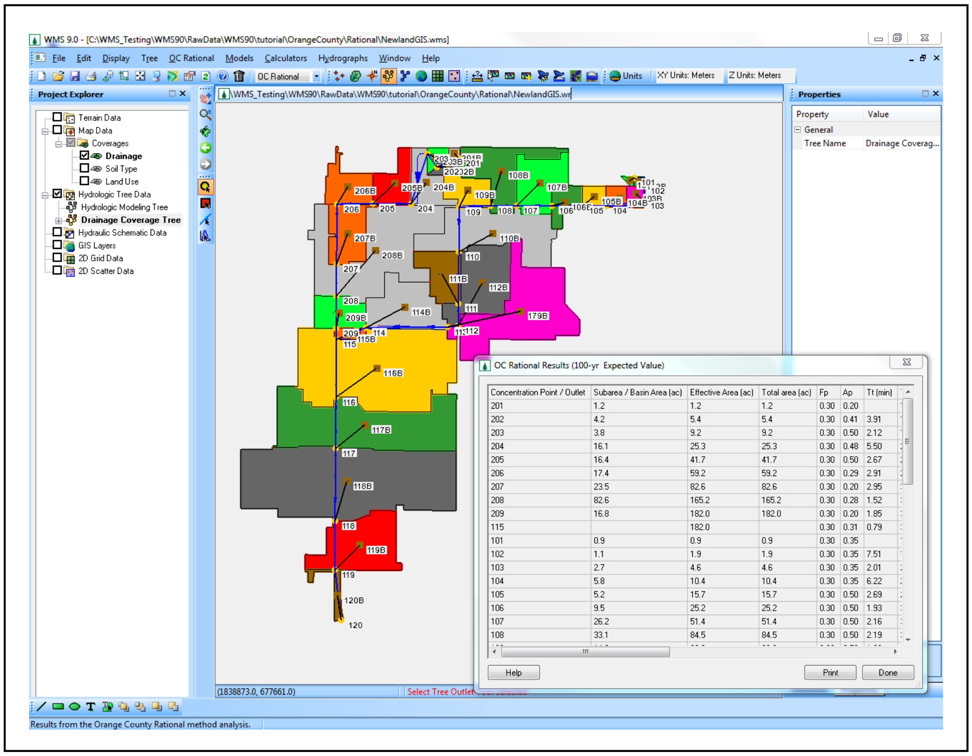
v. 10.1

WMS 10.1 Tutorial

Modeling – Orange County Rational Method –GIS

Learn how to define a rational method hydrologic model for Orange County (California) from GIS data



Objectives

This tutorial shows how to define data for and run a rational method model for a watershed in Orange County.

Prerequisite Tutorials

- Watershed Modeling – Advanced DEM Delineation Techniques

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

Time

- 30-45 minutes

1 Introduction

WMS has many features and tools that will help get the most use out of digital terrain and GIS data for delineating sub-areas and computing loss rates. This exercise demonstrates how to use WMS to use GIS data to automate rational and unit hydrograph analyses and shows how to compute Orange County loss rates (Fm and Ybar) with soil type and land use GIS data. Refer to the following tutorials in the standard WMS tutorials for an in depth treatment of GIS data:

- Images (2 Introduction-Images)
- Basic Feature Objects (3 Introduction-BasicFeatureObjects)
- Advanced Feature Objects (6 Introduction-AdvancedFeatureObjects)
- Time of Concentration Calculations and Computing a Composite CN (9 WatershedModeling-TimeConcAndCN)

2 GIS Data

2.1 Open Project File

1. Open WMS. If WMS is already open, select *File* | **New**, then select **No** if asked to save changes.
2. Select *File* | **Open…**
3. In the *Open* dialog, locate the "OrangeCounty\Rational" folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
4. Select "NewlandGIS.wms" and click **Open**.
5. Toggle off the "Land Use" and "Soil Type" coverages in the Project Explorer.
6. Select the **Frame** macro.

This WMS project file includes GIS data stored in three different coverages: Drainage, Land Use, and Soil Type. The geometric properties of the sub-areas and reaches were already computed using the Drainage coverage and stored in the WMS project file. Figure 1 shows the drainage coverage and the area calculated for each sub-area.

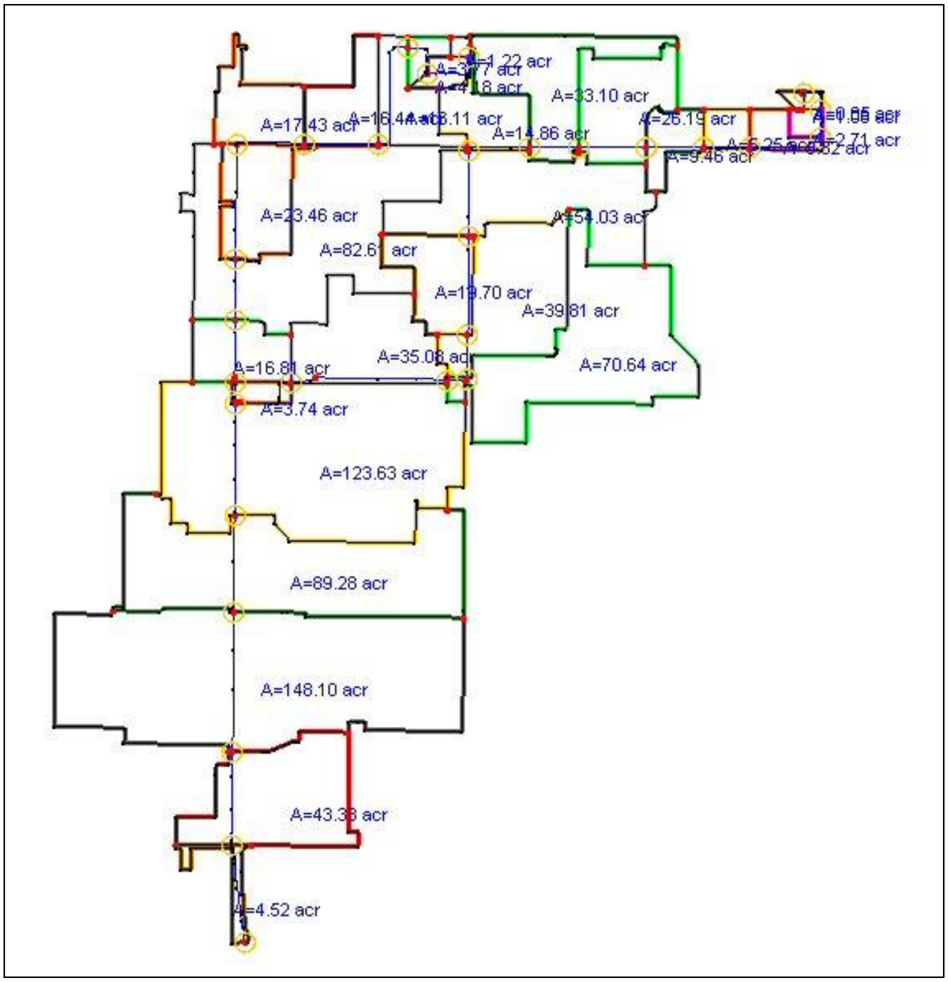


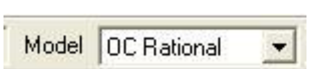
Figure 1 Newland drainage coverage

1. Select *Display* | **Display Options…** to open the *Display Options* dialog.
2. Select *Drainage Data* from the menu on the left and toggle off *Basin Areas*.
3. Select **OK**.

3 Global Job Control Parameters

Before running a model, the global parameters must be set. These parameters include the return-period of the storm event and whether or not an expected value analysis is being run. These parameters can be set in the Job Control dialog (Figure 2).

1. Switch to the **Hydrologic Modeling** module.



2. Make sure the *Model* combo box is set to "OC Rational".
3. Select *OC Rational* | **Job Control…**

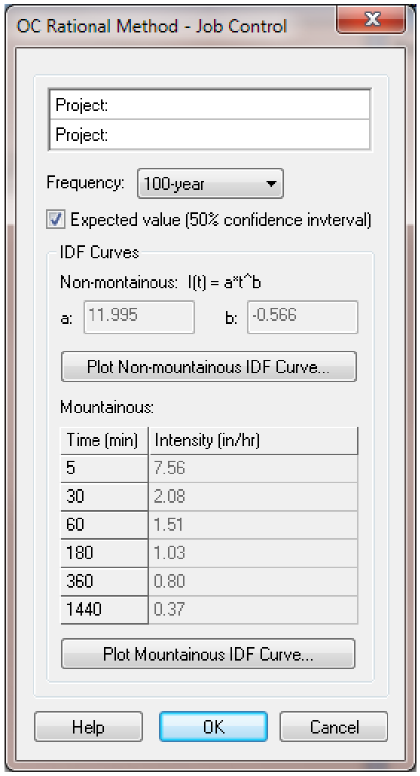


Figure 2 Job Control dialog

4. In the *OC Rational Method – Job Control* dialog, change the *Frequency* to "100-year".
5. Toggle on *Expected value*. The *Job Control* windows should now look identical to Figure 2.
6. Select **OK**.

4 Sub-area Parameters

A model is now ready to be set up and run. By double-clicking a sub-area symbol , or a concentration point symbol , the *Orange County Rational Method – Edit Parameters* dialog will appear, allowing for the editing of the sub-area/concentration point attributes.

4.1 Initial sub-area parameters

1. Use the **Zoom** tool to zoom in to the area shown in the upper right corner of Figure 3

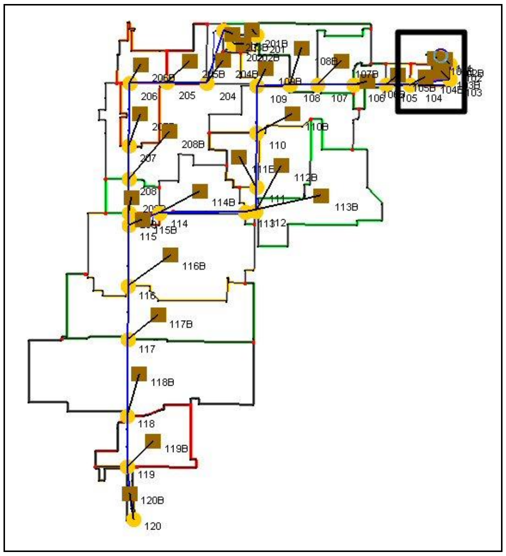


Figure 3 Zoom to first initial sub-area

2. Use to **Select Basin** tool to double-click on the sub-area labeled 101B.

The *Orange County Rational Method - Edit Parameters* dialog, will open.

3. Click the **Compute** button in the *Initial sub-area* section of the dialog. This calculates the time of concentration for the initial sub-area.
4. The *Initial Sub-area Tc* dialog will appear. Change *Land use type* to "Multi Family: Condos".
5. Verify that the *% impervious* value is "65".

Once the percent impervious value is selected, the corresponding K value will be automatically updated. The K value is a coefficient that depends on the land use type and percent impervious.

6. For *L* enter "234.0".
7. For *H* enter "0.5".
8. Select **OK**.

The intensity value will automatically be calculated using the new time of concentration and the value contained in the *Mountain fraction* edit field. This field, located just below the area data, allows entering in the decimal fraction of the area which is above 2000 ft. The **Compute** button, located next to this data, calculates this value using digital terrain data, if it exists. The intensity value is updated as these values are changed.

9. Select **Done**.
10. Select the **Frame** macro.
11. Use the **Zoom** tool to zoom in to the area shown in the upper middle portion of Figure 4.

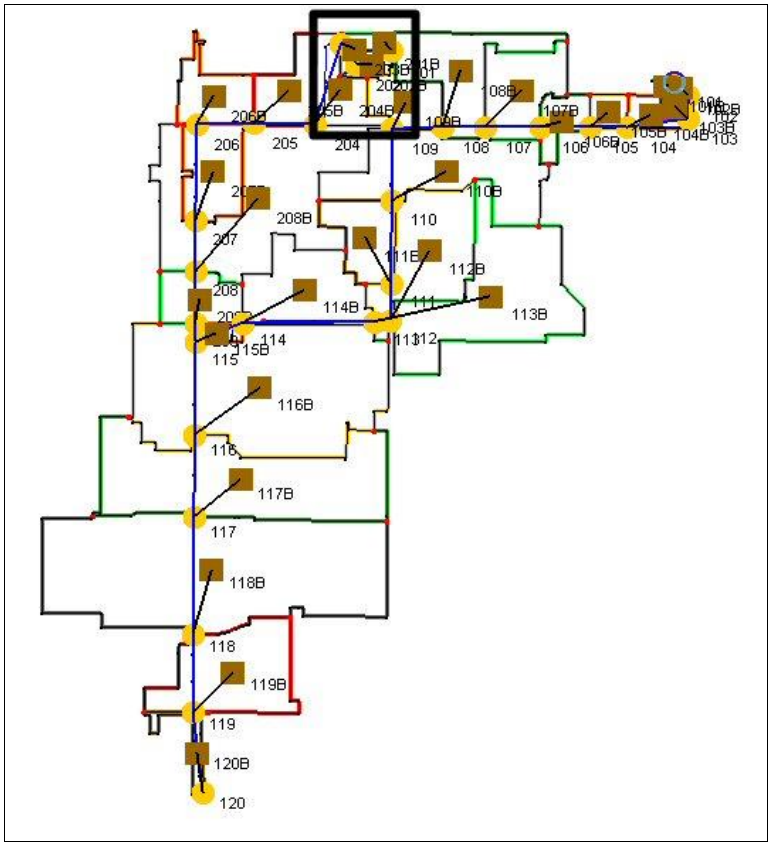


Figure 4 Zoom to second initial sub-area

12. Use to **Select Basin** tool to double-click on the sub-area labeled 201B.
13. The *Orange County Rational Method – Edit Paramters* dialog will reappear. Click on the **Compute** button in the *Initial sub-area* section of the dialog.
14. In the *Initial Sub-area Tc* dialog, change *Land use type* to "Single Family: > 10 dwell/acre".
15. For *L* enter "245.0".
16. For *H* enter "0.3".
17. Select **OK**.

4.2 Compute Losses

Notice that there are two buttons in the Losses section of the dialog, one labeled **Compute** and the other one labeled **Compute – GIS**.

The **Compute** button will allow for the computation of composite loss values by multiplying all ap (pervious area fraction) values with their corresponding Fp (maximum effective pervious area loss rate) values for the specified areas.

The **Compute – GIS** button will allow for the computation of composite loss value by using the Soil Type and Land Use data in the *Compute GIS Attributes calculator*. The computer automatically calculates composite ap and Fp values for each of the sub-basins as well as the corresponding Fm values.

1. Click on the **Compute – GIS** button in the *Losses* section of the *Edit Parameters* dialog.

2. The *Compute GIS Attributes* dialog will appear. 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.
3. Click on the **Import** button.
4. In the *Open* dialog locate the file “ocland.txt” and click **Open**.
5. Select **OK** to compute loss parameters for all basins.
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 loss rates by overlaying the soil type and land use coverages with the drainage coverage and using the Fp values associated with each soil type and percent impervious values in the land use mapping table to compute composite Fm loss values.

The composite loss values are calculated and displayed in the *Edit Parameters* dialog. (Figure 5)

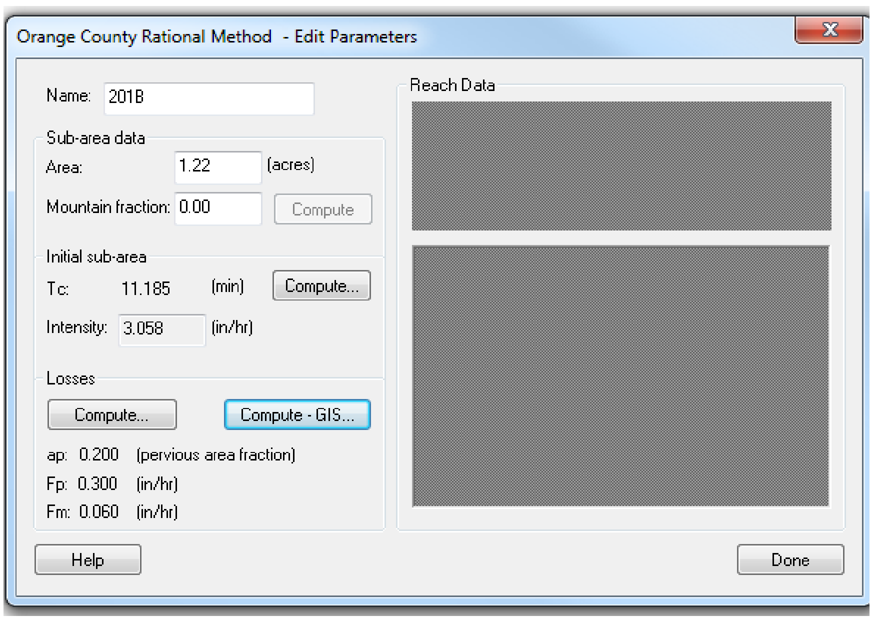
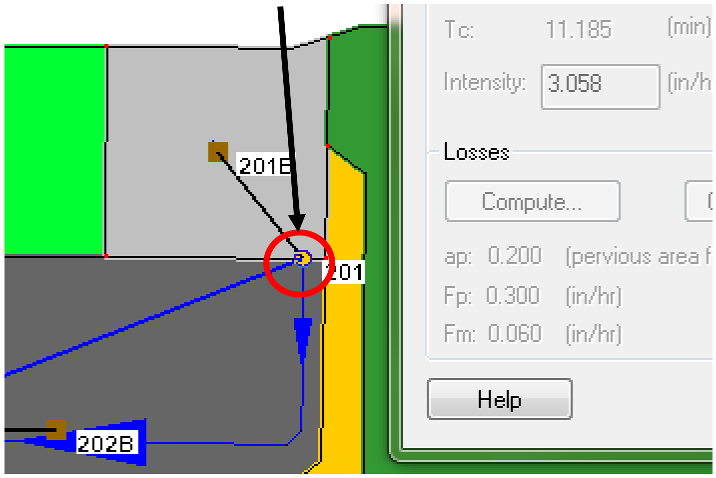


Figure 5 OC Rational Method – Edit Parameters dialog

Losses are computed for all sub-areas when losses using GIS attributes are calculated, but other loss values can be entered and computed for a new Fm for individual sub-areas.

5 Concentration Point (Reach) Data

1. Select the concentration point labeled 201 (the *Orange County Rational Method – Edit Parameters* dialog may need to be moved in order to view and select the concentration point)



Notice that only the Reach Data section of the dialog (Figure 6) is accessible.

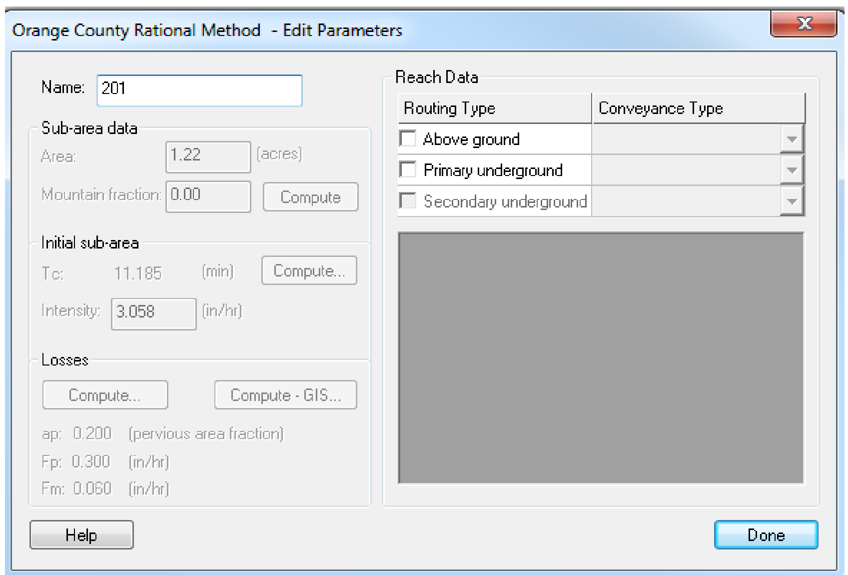


Figure 6 OC Rational Method – Edit Parameters dialog

2. Toggle on the checkbox next to *Primary underground*.
3. Change *Conveyance Type* to "Circular channel".

The different variables associated with the channel type will be displayed in a spreadsheet-type edit box and can be edited if necessary in the appropriate fields. There is also a checkbox which allows specifying whether the flow is on one side of the street or not.

4. For *Up elevation* enter "40.79".
5. For *Down elevation* enter "39.4".
6. For *Pipe diameter* enter "18.0".
7. For *Manning's n* enter "0.013".
8. For *Minor loss energy factor* enter "0.9".
9. Continue to edit reach data by selecting each of the concentration points and entering parameters using Table 1. For point *120* there is no need to input any parameters since it is the most downstream node and there won't be any routing that point further.

It may be necessary to move the *Orange County Rational Method – Edit Parameters* dialog around and/or use the zoom and pan tools (middle scroll button on mouse) in order to select other concentration points.

Table 1: Concentration point (reach) parameters

Conc. point	Description	Up elev	Down elev	Other parameters
101	Above ground Industrial local	57.1	56.8	Half width = 30.0; Gradebreak = 20.0 Toggle on Flow on one side
102	Primary underground Circular channel	50.8	50.3	Diameter = 18.0; Manning's n = .013 Minor loss energy factor = 0.9
103	Primary underground Circular channel	50.3	49.6	Diameter = 30.0; Manning's n = .013 Minor loss energy factor = 0.9
104	Primary underground Circular channel	49.6	49.1	Diameter = 36.0; Manning's n = .013 Minor loss energy factor = 0.9
105	Primary underground Circular channel	49.1	46.5	Diameter = 30.0; Manning's n = .013 Minor loss energy factor = 0.9
106	Primary underground Circular channel	46.5	44.0	Diameter = 36.0; Manning's n = .013 Minor loss energy factor = 0.9
107	Primary underground Circular channel	44.0	43.5	Diameter = 60.0; Manning's n = .013 Minor loss energy factor = 0.9
108	Primary underground Circular channel	43.5	42.3	Diameter = 63.0; Manning's n = .013 Minor loss energy factor = 0.9
109	Primary underground Circular channel	42.3	39.7	Diameter = 60.0; Manning's n = .013 Minor loss energy factor = 0.9
110	Primary underground Circular channel	39.7	36.1	Diameter = 69.0; Manning's n = .013 Minor loss energy factor = 0.9
111	Primary underground Circular channel	36.1	35.2	Diameter = 78.0; Manning's n = .013 Minor loss energy factor = 0.9
112	Primary underground Circular channel	35.2	34.5	Diameter = 78.0; Manning's n = .013 Minor loss energy factor = 0.9
113	Primary underground Circular channel	34.5	29.6	Diameter = 87.0; Manning's n = .013 Minor loss energy factor = 0.9
114	Primary underground Circular channel	29.6	26.1	Diameter = 84.0; Manning's n = .013 Minor loss energy factor = 0.9
115	Above ground Trapezoidal channel	26.1	23.7	b = 9.0; h = 10.0 Manning's n = 0.014
116	Above ground Trapezoidal channel	23.7	22.3	b = 11.0; h = 12.0 Manning's n = 0.014
117	Above ground Trapezoidal channel	22.3	21.3	b = 12.0; h = 12.0 Manning's n = 0.014
118	Above ground Trapezoidal channel	21.3	20.0	b = 11.0; h = 12.0 Manning's n = 0.014
119	Above ground Trapezoidal channel	20.0	18.9	b = 12.0; h = 13.0 Manning's n = 0.014
201	Primary underground Circular channel	40.8	39.4	Diameter = 18.0; Manning's n = .013 Minor loss energy factor = 0.9
202	Primary underground Circular channel	39.4	38.4	Diameter = 27.0; Manning's n = .013 Minor loss energy factor = 0.9
203	Primary underground	38.4	35.7	Diameter = 33.0; Manning's n = .013

Conc. point	Description	Up elev	Down elev	Other parameters
	Circular channel			Minor loss energy factor = 0.9
204	Primary underground Circular channel	35.7	34.0	Diameter = 42.0; Manning's n = .013 Minor loss energy factor = 0.9
205	Primary underground Circular channel	34.0	33.2	Diameter = 57.0; Manning's n = .013 Minor loss energy factor = 0.9
206	Primary underground Circular channel	33.2	29.2	Diameter = 54.0; Manning's n = .013 Minor loss energy factor = 0.9
207	Primary underground Circular channel	29.2	27.1	Diameter = 57.0; Manning's n = .013 Minor loss energy factor = 0.9
208	Primary underground Circular channel	27.1	26.3	Diameter = 90.0; Manning's n = .013 Minor loss energy factor = 0.9
209	Primary underground Box culvert	26.3	26.1	b = 7.0; h = 8.0; Manning's n = 0.014 Minor loss energy factor = 0.9

10. Select **Done**.

6 Running the Simulation

1. Select *OC Rational* **| Tree Mapping…**
2. The *Orange County Rational Method – Tree Mapping* dialog will open up. Select Concentration point 114.
3. Select Sub-area 115B.
4. Click on the map () button.
5. Select **OK**.
6. Select *OC Rational* **| Run Simulation…**
7. The *Select Orange County Rational details output filename* dialog will appear. Enter a file name for the detailed output and click **Save**.
8. The *OC Rational Results (100-yr Expected Value)* dialog will appear displaying the results. When done viewing the results, click **Done**.

7 Conclusion

This exercise shows how to use GIS data to automate rational and unit hydrograph analyses. How to compute Orange County loss rates (Fm and Ybar) with soil type and land use GIS data was also demonstrated.