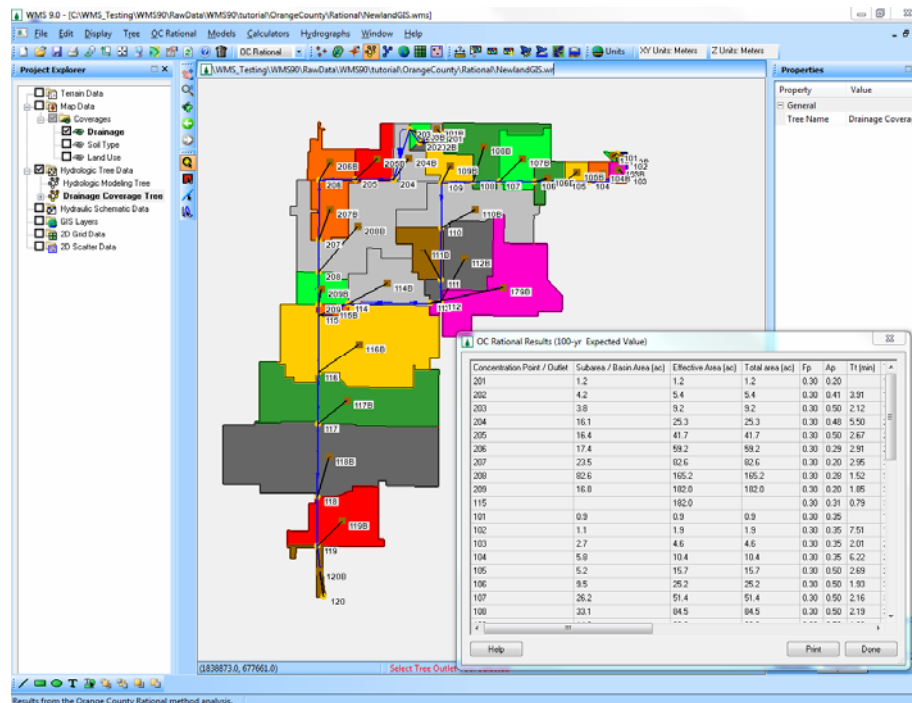


WMS 9.0 Tutorial

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 you 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

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2 Introduction

WMS has many features and tools that will help you to 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*)

3 GIS Data

3.1 Open Project File

1. Close all instances of WMS
2. Open WMS
3. Select **File / Open...** 
4. Locate the **OrangeCounty\Rational** folder in your tutorial files. If you have used default installation settings in WMS, the tutorial files will be located in **|My documents|WMS 9.0|Tutorials|**.
5. Open “**NewlandGIS.wms**”
6. Toggle off the Land Use and Soil Type coverages in the Project Explorer

7. 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 3-1 shows the drainage coverage and the area calculated for each sub-area.

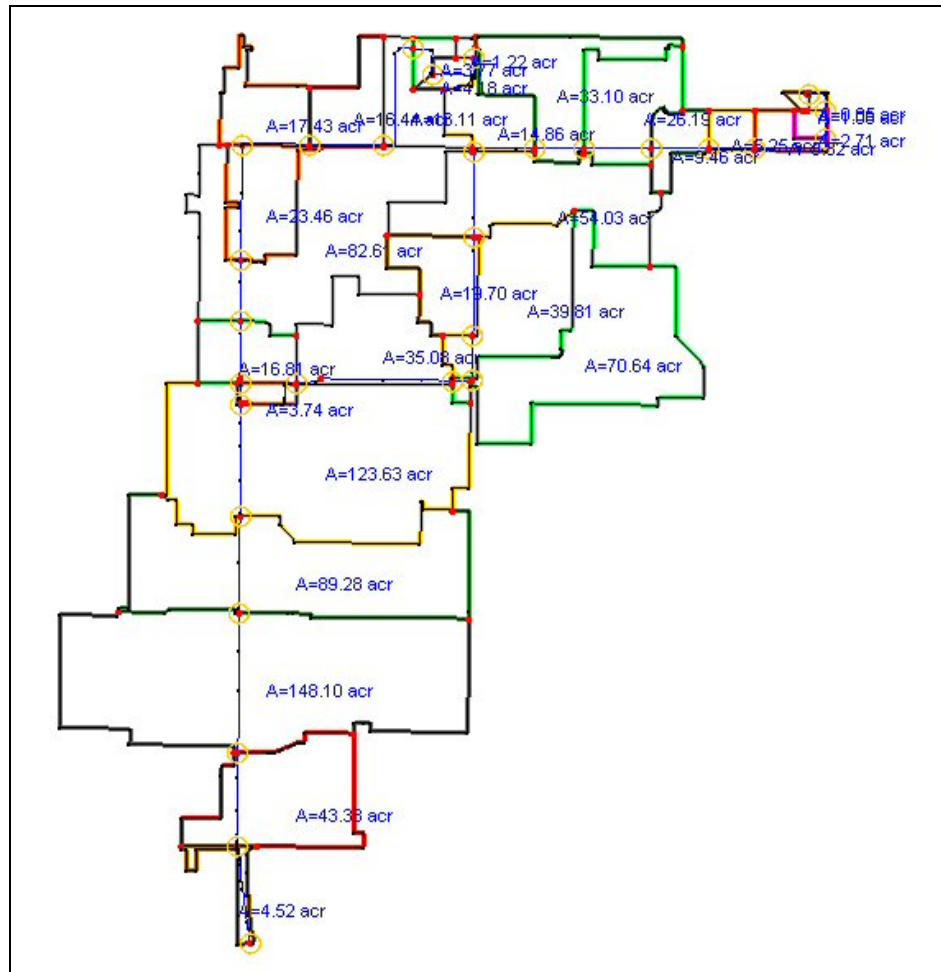




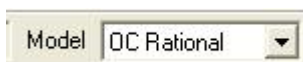
Figure 3-1: Newland drainage coverage

1. Select **Display / Display Options...** 
2. Select Drainage Data and toggle off Basin Areas
3. Select OK

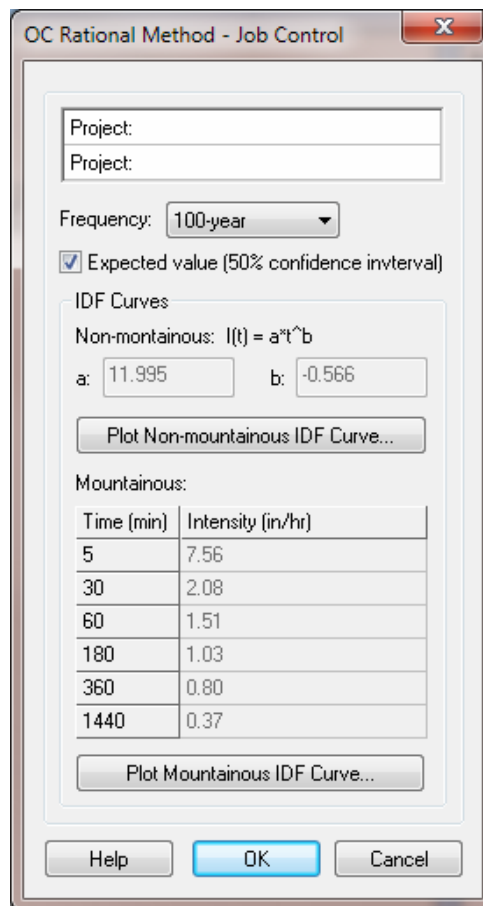
4 Global Job Control Parameters

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 4-1).

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...**



The dialog box is titled "OC Rational Method - Job Control". It contains the following fields and controls:



- Two "Project:" text input fields.
- A "Frequency:" dropdown menu set to "100-year".
- A checked checkbox for "Expected value (50% confidence interval)".
- A section for "IDF Curves" with the formula $I(t) = a \cdot t^b$.
- Input fields for "a:" (11.995) and "b:" (-0.566).
- A button "Plot Non-mountainous IDF Curve...".
- A section for "Mountainous:" with a table of Time (min) vs Intensity (in/hr).
- A button "Plot Mountainous IDF Curve...".
- Buttons for "Help", "OK", and "Cancel" at the bottom.

Time (min)	Intensity (in/hr)
5	7.56
30	2.08
60	1.51
180	1.03
360	0.80
1440	0.37


Figure 4-1: Job Control dialog

4. Change the Frequency to 100-year
5. Toggle on Expected value
6. Select OK

5 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.

5.1 Initial sub-area parameters

1. Use the *Zoom* tool  to zoom in to the area shown in the upper right corner of Figure 5-1

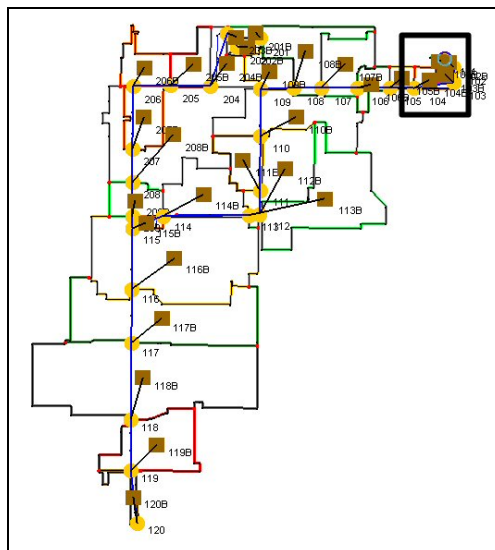



Figure 5-1: Zoom to first initial sub-area

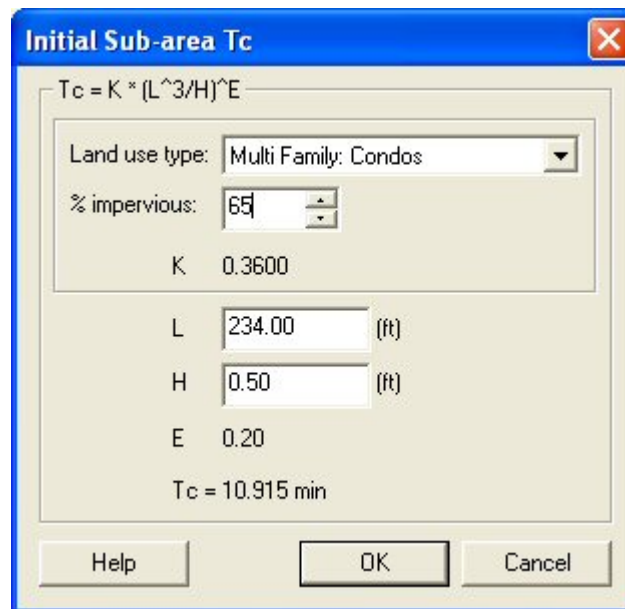
2. Use the *Select Basin* tool  to double-click on the sub-area labeled 101B

The Orange County Rational Method - Edit Parameters dialog, shown in Figure 5-2, will open.

Figure 5-2: Orange County Rational Method - Edit Parameters dialog

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.

The Initial Sub-area Tc dialog (Figure 5-3) will appear.



The dialog box is titled "Initial Sub-area Tc" and features a close button (X) in the top right corner. It contains a formula $T_c = K * (L^3/H)^E$ at the top. Below the formula, there is a section with a "Land use type:" dropdown menu set to "Multi Family: Condos" and a "% impervious:" spinner box set to "65". This section is followed by a "K" value of "0.3600". Below this, there are input fields for "L" (set to "234.00" with "(ft)" next to it) and "H" (set to "0.50" with "(ft)" next to it). Below these is an "E" value of "0.20". At the bottom of the input section, it displays "Tc = 10.915 min". At the very bottom of the dialog are three buttons: "Help", "OK", and "Cancel".



Figure 5-3: Initial Sub-area Tc dialog

4. 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 the user to enter 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 5-4

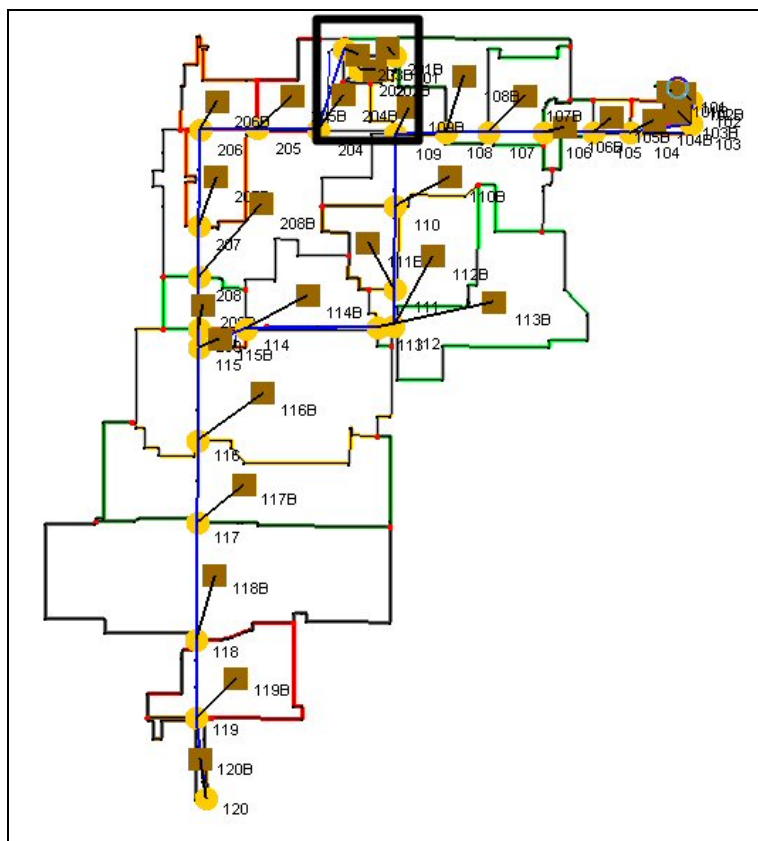



Figure 5-4: Zoom to second initial sub-area

12. Use the *Select Basin* tool  to double-click on the sub-area labeled 201B
13. Click on the *Compute* button in the Initial sub-area section of the dialog
14. 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

5.2 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 dialog

2. 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. Open “ocland.tbl”
5. Select OK to compute loss parameters for all basins
6. 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 5-5)

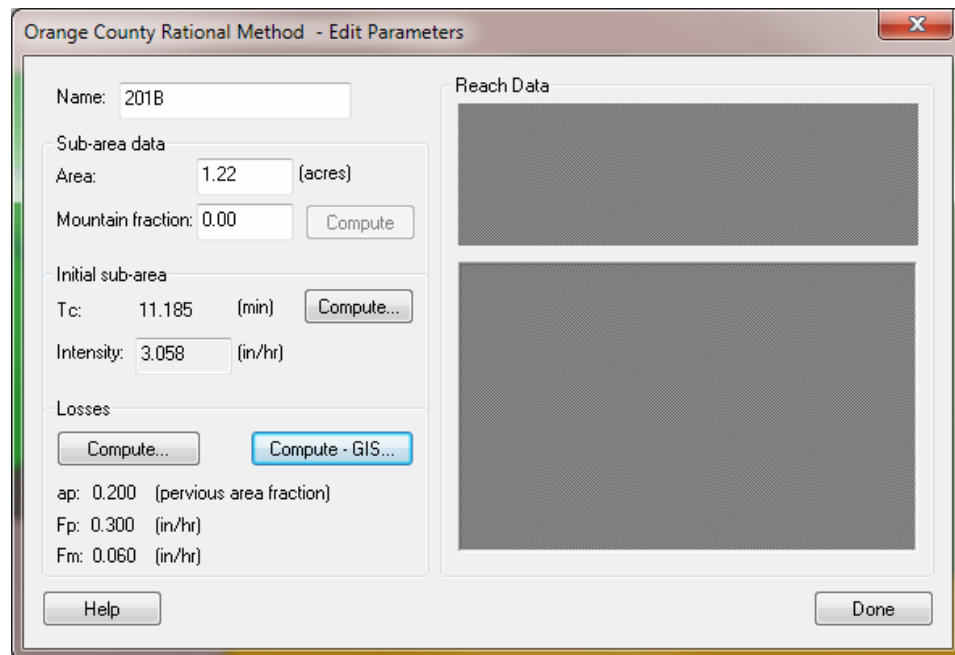
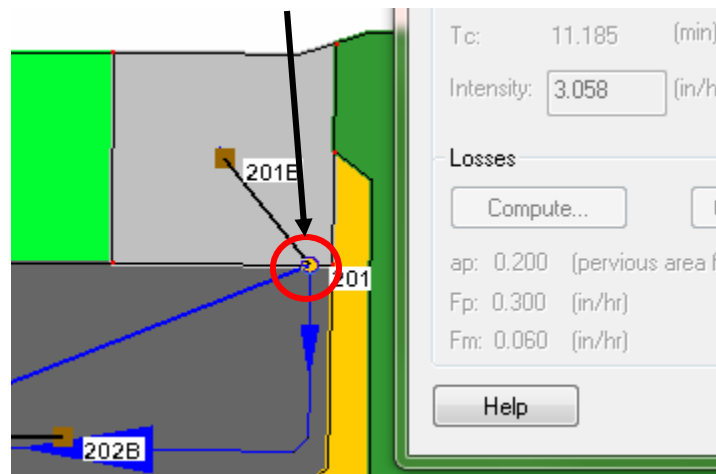


Figure 5-5: OC Rational Method - Edit Parameters dialog

Losses are computed for all sub-areas when you calculate losses using GIS attributes, but you can always enter other loss values and compute a new Fm for individual sub-areas.

6 Concentration Point (Reach) Data

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



Notice that only the Reach Data section of the dialog (Figure 6-1) is accessible.

Conveyance Parameters	Value	Units
Reach length	661.19	ft
Up elevation	40.79	ft
Down elevation	39.40	ft
Slope	0.002100	ft/ft
Compute pipe size		
Pipe diameter	18.00	in
Full pipe flow	0.82*D	
Manning's n	0.01300	
Minor loss energy factor	0.90	

Figure 6-1: 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 the user to specify 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 6-1. For point 120 there is no need to input any parameters since it is the most downstream node and we are not doing any routing that point further.

You may need 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 6-1: Concentration point (reach) parameters

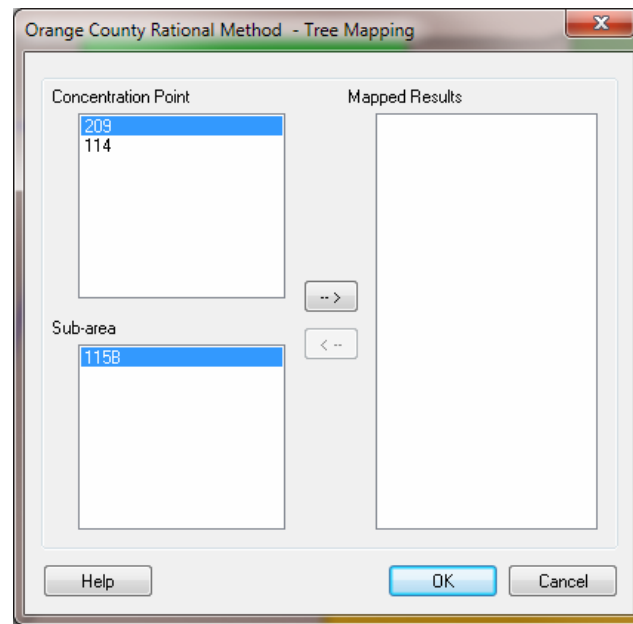
Conc. point	Description	Up elev	Down elev	Other parameters
101	Above ground Industrial local	57.1	56.8	Half width = 30.0; Gradebreak = 20.0 Toggle on Flow on one side
102	Primary underground Circular channel	50.8	50.3	Diameter = 18.0; Manning's n = .013 Minor loss energy factor = 0.9
103	Primary underground 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


Conc. point	Description	Up elev	Down elev	Other parameters
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 Circular channel	38.4	35.7	Diameter = 33.0; Manning's n = .013 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

7 Running the Simulation

1. Select *OC Rational / Tree Mapping...*
2. 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. Enter the file name for the detailed output and click Save