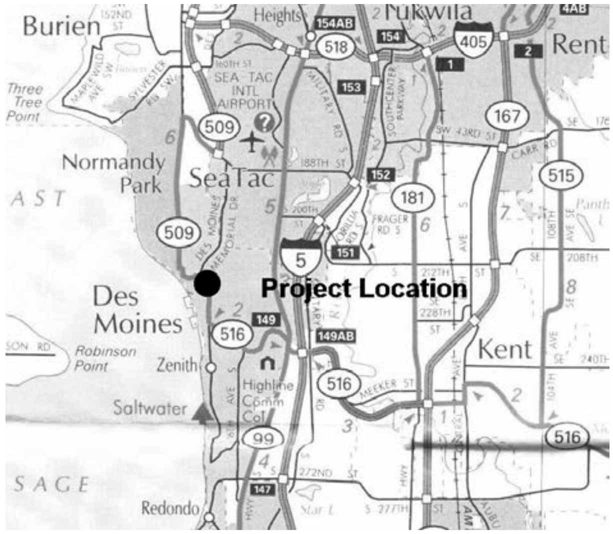
MGSFlood Version 4.38 - PROBLEM SUMMARY

Contents

Updated May 31, 2017

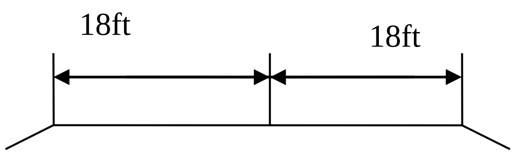
Work Session 1 - Automatic Detention Pond Design with Manual Adjustments

A section of highway near the city of Des Moines is to be improved with an additional lane in each direction.



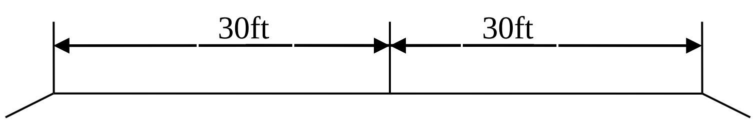
Project Location Map

The existing configuration consists of one 12-foot lane with a 6-foot shoulder in each direction. The area adjacent to the roadway is grass.



Existing Condition

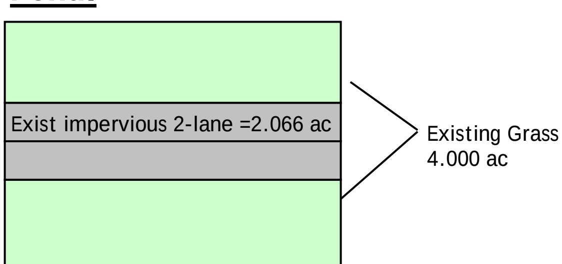
The project will add one 12-foot lane in each direction, while maintaining the current shoulder widths. Both lanes will be added on the outside of the existing lanes.



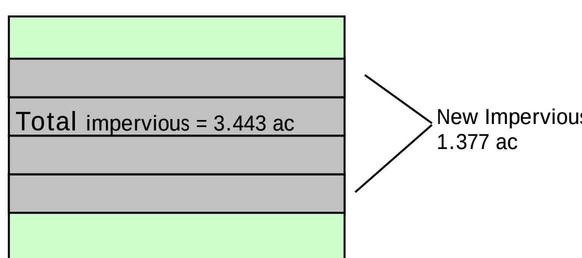
Proposed Condition

The project is located on Alderwood soils, which are classified as SCS Hydrologic Group C.

<u>Design a detention pond for this 2,500-foot section of roadway according to the HRM Equivalent Area Method. Use the *Automatic Pond Design F*eature in MGSFlood to Size the Pond.</u>



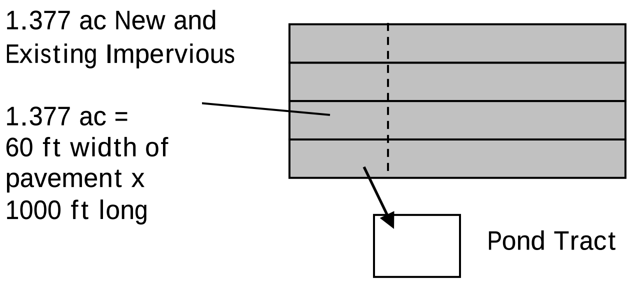
Existing



Proposed

Equivalent Area Representation:

- Design Pond to control runoff for new lane areas, conversion of 1.377 ac forest to 1.377 ac impervious.
- Direct 1.377 ac of new and existing impervious to the pond. (Note: We could also capture additional existing impervious surface up to 50% of the new impervious surface per the “50% Rule”, but for simplicity, we won’t do that now. We’ll go through the 50% Rule in Work Session 7).



MGSFlood Input Spreadsheet (Walk through this as a class):

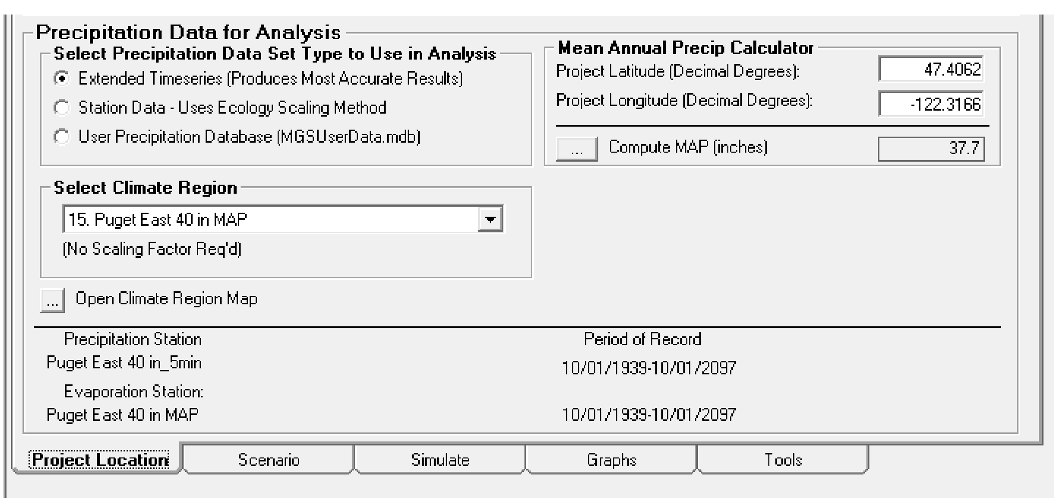
- The spreadsheet suggest 2 iterations for pond designs but only the second run needs to be documented.
- Input **all areas** in the TDA regardless of whether or not they will be impacted by the project. The spreadsheet will track all land cover conversions that need flow control and generate the MGSFlood model inputs. In the first iteration of the detention pond design, we are going to only account for the areas flowing to the pond but not account for the pond area yet.

Start Program, Save Project File (On your own)

1. Start program from Windows Start button
2. Start-All Apps-MGS Software-MGSFlood V4
3. Click File Save As, Enter “WS01_AutoSizeDetentionPond” for Project Title. Create project folder when prompted.

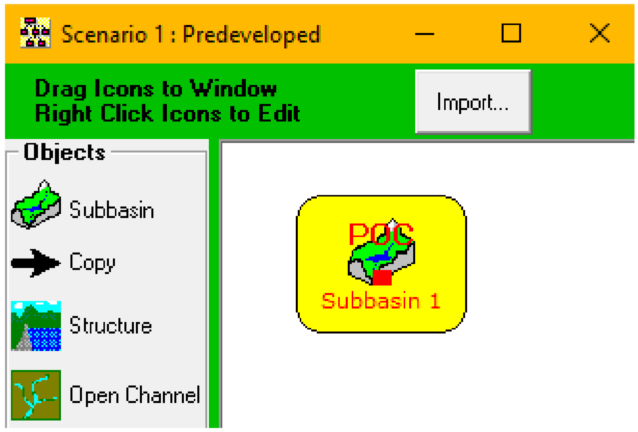
Project Location Tab

4. Enter project name, analysis title, and comments.
5. Check the Extended Precipitation Timeseries Option Button.
6. Click the *Map* button under Climate or refer to the printed copy of the map. Locate the project on the map. Note the Timeseries Region and the mean annual precipitation for the project. Close the Map window.
7. Select <u>Climate Region 15 Puget East 40</u> in MAP from the drop down list box.

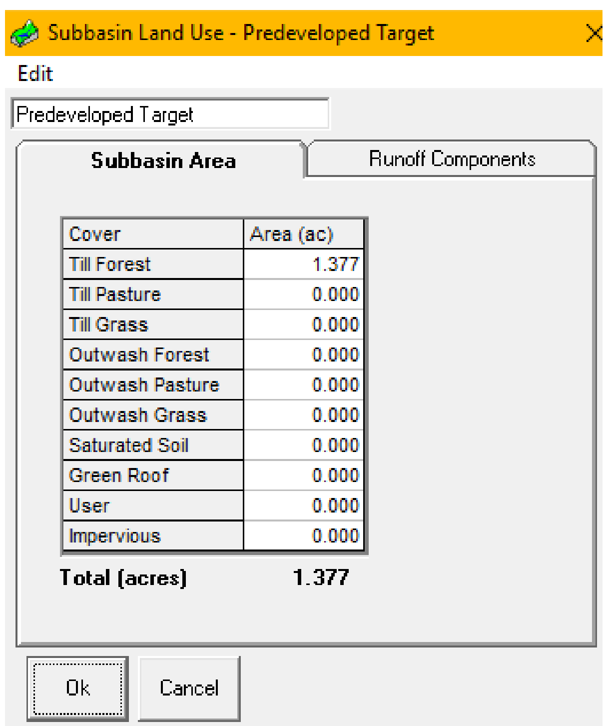


Scenario Tab

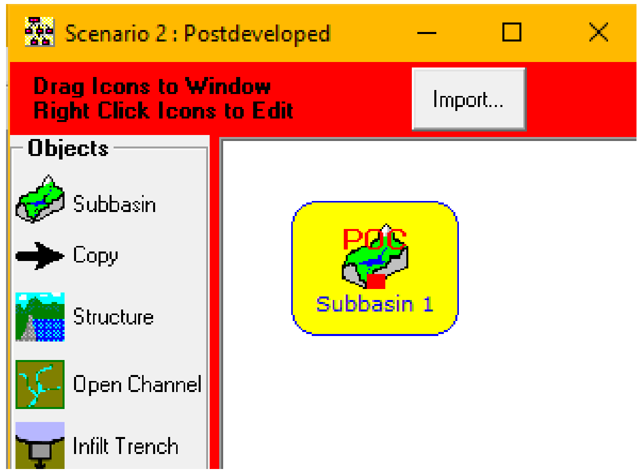
8. Click the Scenario Tab and then the Open Schematic button for the Predeveloped Scenario.
9. Click and drag a new Subbasin onto the Predeveloped input screen. Note that the subbasin is automatically set to the Point of Compliance (POC) noted by the POC label and the yellow color.



10. Right Click the Subbasin to Display the Menu and then Click Edit.
11. From the MGSFlood Inputs Spreadsheet, enter 1.377 acres of till forest for the predeveloped land use and enter “Predeveloped Target” as the subbasin Name. Click OK to close the Subbasin Land Use input screen.

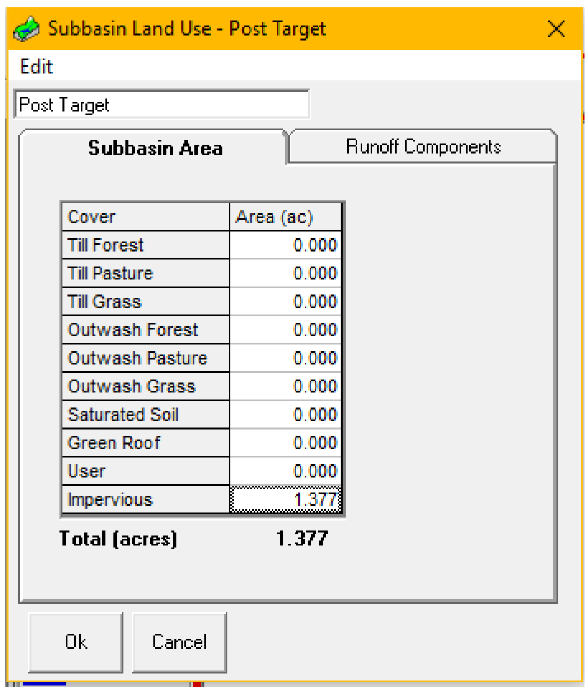


12. Click the Scenario Tab and then the post developed Scenario Button.
13. Click and drag a new subbasin onto the post developed input screen. Note that the one subbasin is automatically set to the Point of Compliance (POC) noted by the POC label and the yellow color.

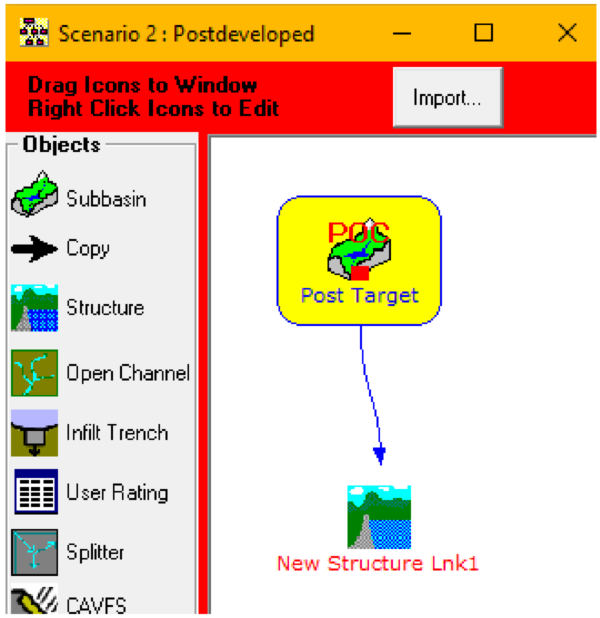


14. Right click Subbasin 1 and Select Edit.

15. From the MGSFlood Inputs Spreadsheet, enter the 1.377 acres of impervious surface for the post developed land use and enter "Post Target" as the subbasin Name. Click OK to close the Subbasin Land Use input screen.



16. Click and drag a new "Structure" onto the post developed input screen. The "Structure" element represents a detention BMP that could be a pond, vault, tank, or pipe. Right click the Post Target subbasin and selecting *Link Connection Primary*. Select the New Structure Lnk1. A line will appear connecting the Post Target subbasin to the "New Structure Lnk1".



17. Next, click the New Structure Lnk1 to select it and then right click and select Edit.

Hydraulic Structures input Screens

18. Click the *Optimization* Input tab

19. Enter the following general information about the pond:

   a. Select *Detention* option for type of pond

   b. Pond side slopes of 3H:1V

   c. Length to width ratio of 3 (typical)

   d. Bottom of Live Storage elevation = 250 ft. Note that 250 ft. is the elevation of the bottom of live storage. The actual pond bottom elevation during pond construction and grading would include the sediment storage, which is typically 0.5 ft deep. MGSFlood is only concerned with the elevation of the bottom of live storage. If the designer wanted to make the pond have a dead storage beneath the live storage, as in a combination wet/detention pond, the designer would still only input the elevation of the bottom of live storage for the pond floor elevation.

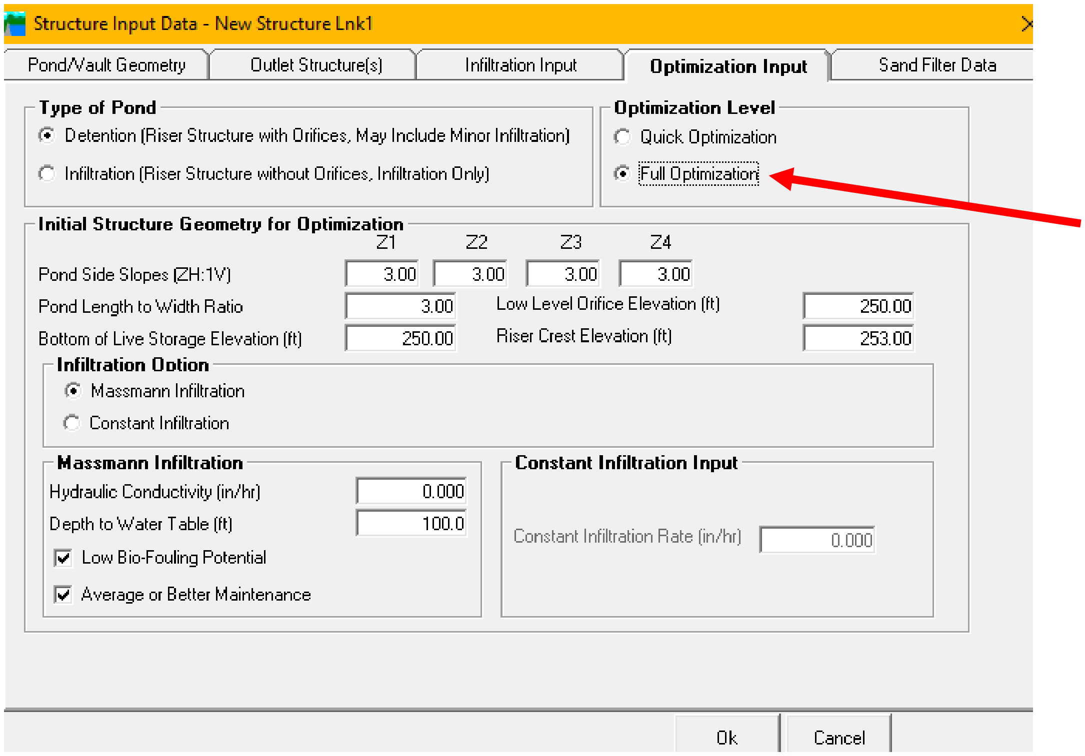
   e. Low Level Orifice elevation = 250 ft.

   f. Risers crest elevation = 253 ft.

   g. Soil Conductivity: 0 in/hr.

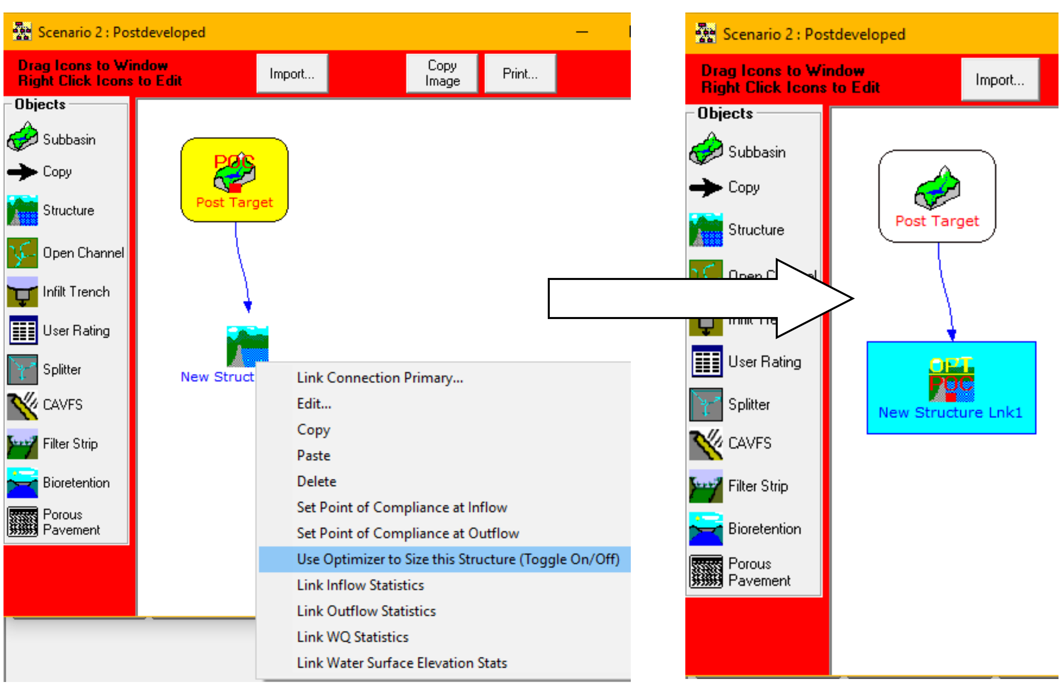
   h. Depth to Water Table: 100 ft

   i. Select Full Optimization. Quick Optimization will typically return an answer somewhat faster but may not match all duration criteria. Full Optimization takes a little longer, but does a more exhaustive search to minimize the pond size.



20. Click OK to close the structure input screen.

21. Next we must tell the program we want to optimize the pond. Right click on New Structure Lnk1 to display the menu and select "Use Optimizer". Note the structure icon changes color indicating it has been selected for optimization and the POC is automatically set at the outflow.



Simulate Tab

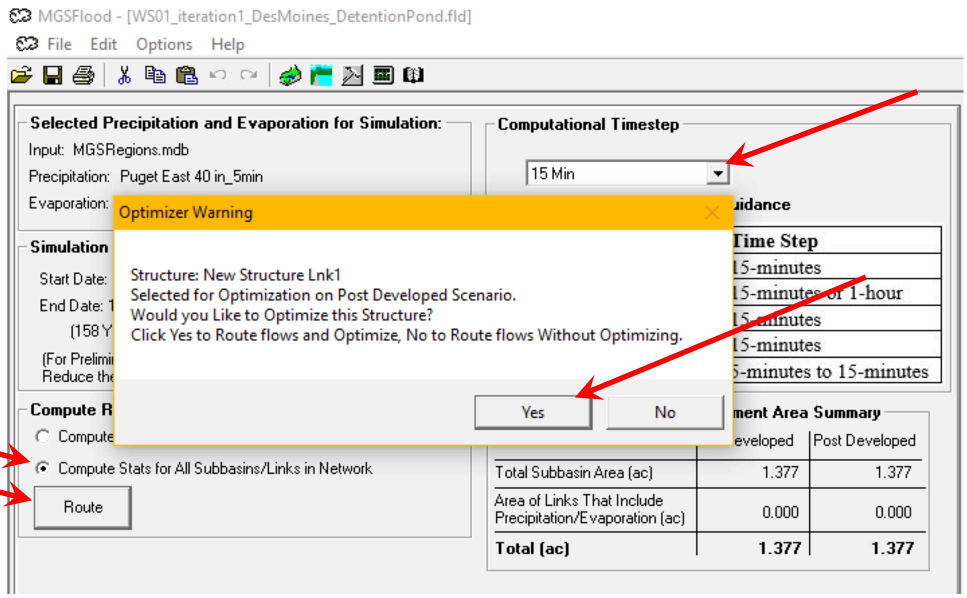
22. *The Simulation Time Span* is set to the full period of record of precipitation. No changes here.

23. We use 15-minute time steps for almost every type of calculation in MGSFlood. Make sure the 15-minute time step option is chosen.

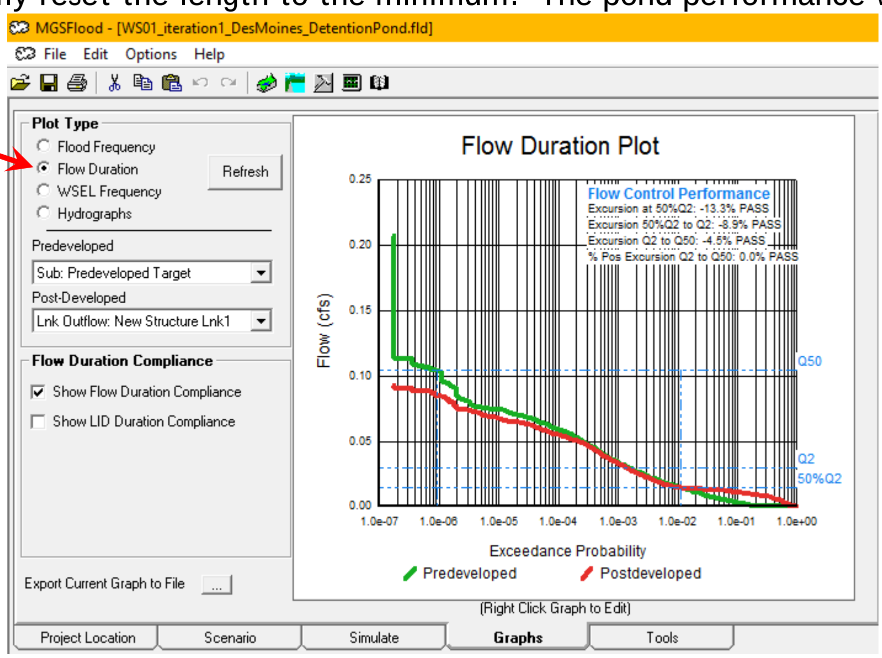
24. Check the Compute Stats for All Subbasins/Links in Network

25. Click the Route button to simulate runoff, route flows through the network, and automatically size the pond.

26. A Warning text box will be displayed. **Click "Yes".** Clicking Yes will optimize the design which will size the orifice riser structure and change the length, width, or height of the structure (pond, trench, etc.) being designed. Clicking "No" will only route flows through the structure with user defined dimensions. The riser structure size and structure dimensions will not change.

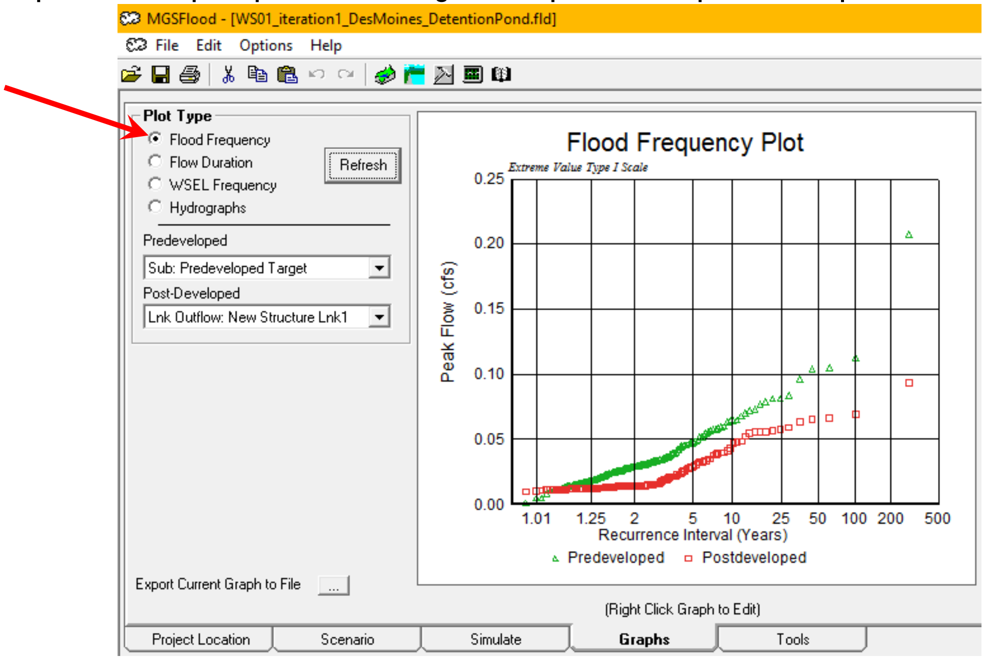


27. When the simulation is complete, MGSFlood will return a "Warning" message saying the outlet orifice structure No. 2 length is less than 0.25 inches. This is the vertical slot weir on the riser. We will manually reset the length to the minimum. The pond performance will be displayed.

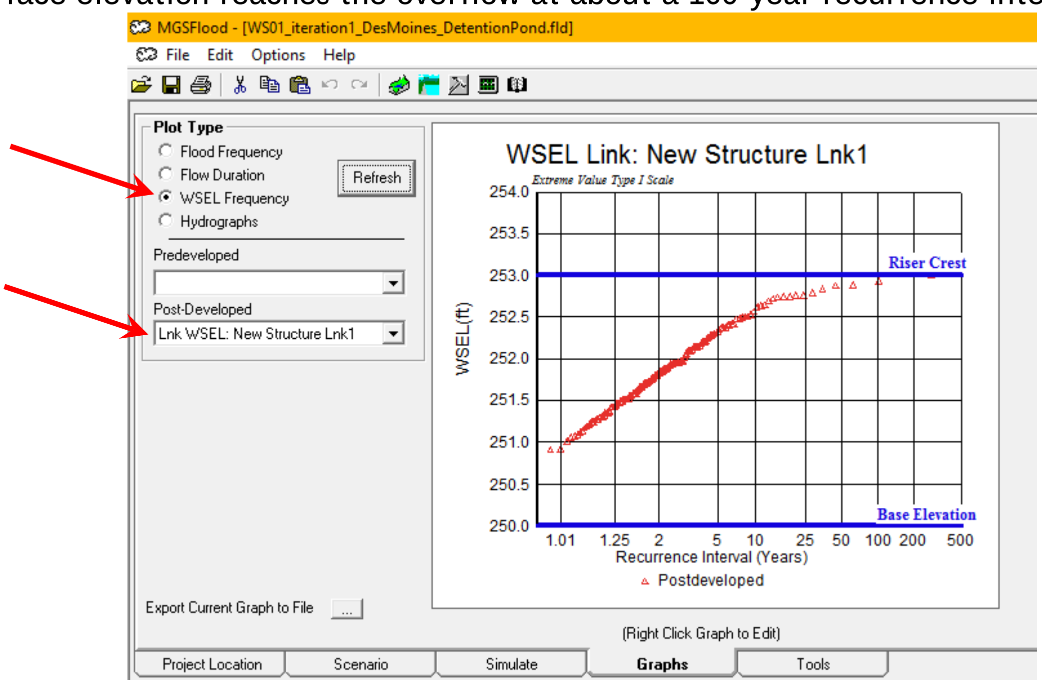


Note that the red postdeveloped duration curve is close to the green predeveloped curve. The goal is to get the red postdeveloped curve to lay right on top of the green predeveloped curve. Though the full optimizer did a good job and we get a "PASS" for all the duration criteria, there is still some extra volume left at the upper end of the duration curves since the green curve is above the red curve.

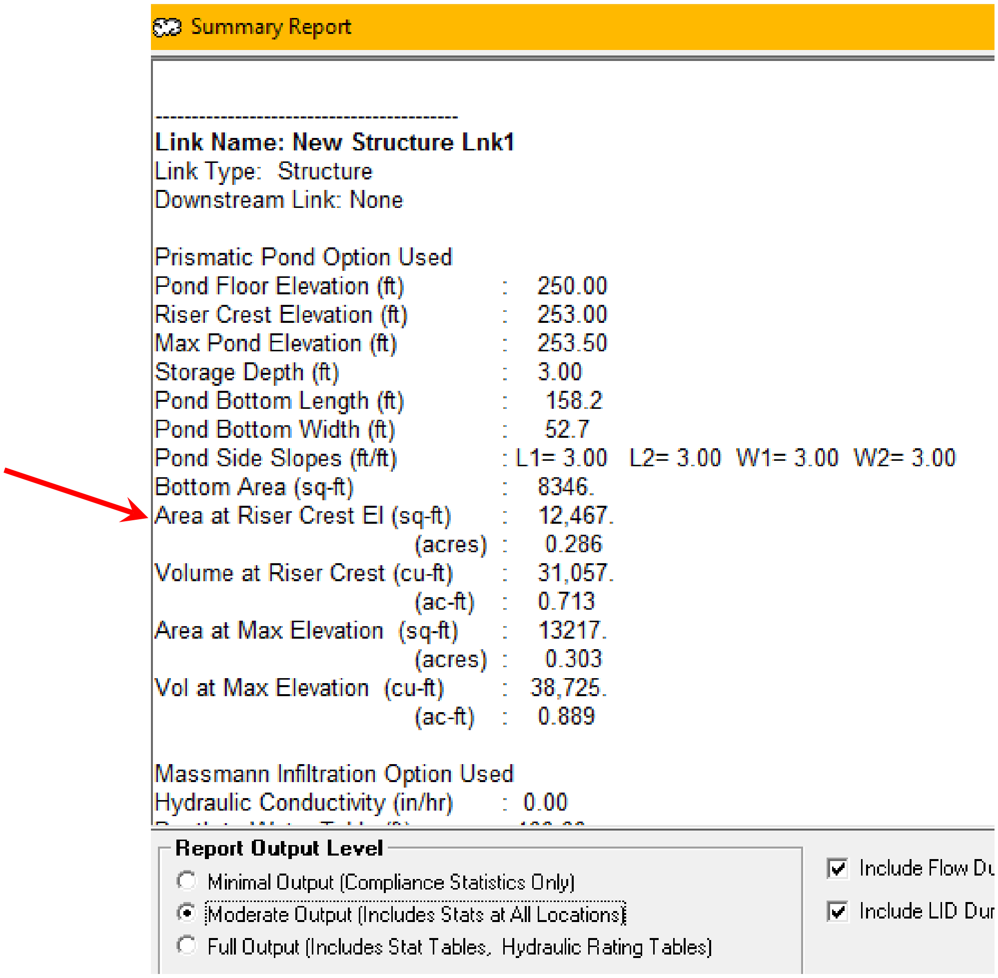
Select flood frequency and click "Refresh" to view flood-frequency plots. This shows how the pond outflow postdeveloped peak discharges compare with predeveloped conditions.



Next, click the WSEL Frequency button and then click "Refresh". Select "Lnk:WSEL: New Structure Lnk1" from the Post-Developed drop down menu. The pond water surface elevation-frequency data will be plotted along with the pond bottom and riser crest elevation. The pond water surface elevation reaches the overflow at about a 100-year recurrence interval.



28. Click on the "View Report" icon in the top middle of the screen. Scroll down to the "**Link Name: New Structure Lnk1**" information in the Summary Report. Find the "Area at Riser Crest Elevation."



29. Close the history report. Now that MGSFLood has given us an idea of the pond footprint (0.286 acres) needed to meet the flow duration standard, we can use this information to represent the pond footprint in MGSFlood and in the MGSFlood Input Spreadsheet. **Note that the area calculated by MGSFlood does not include outside pond cut/fill slopes for Right of Way decisions.** After figuring out the pond surface area, the designer should determine the final pond footprint which includes outside pond side slopes for Right of Way decisions. **Once you get to this point, STOP and we will restart again as a group.**

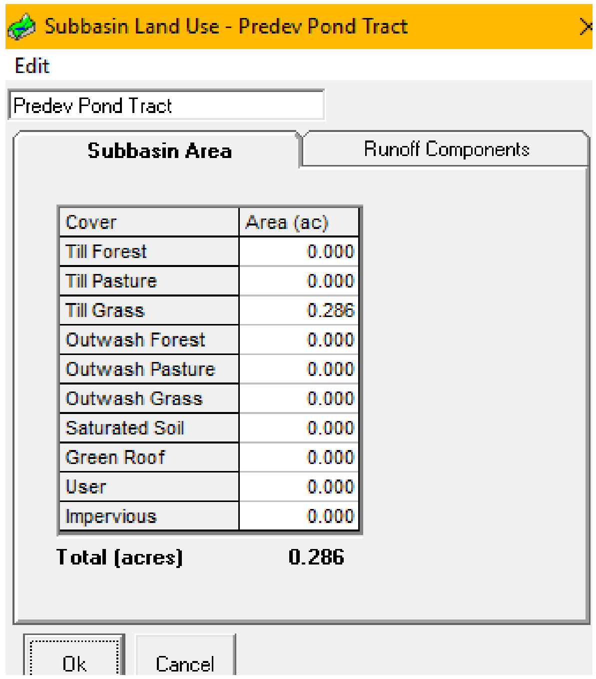
30. (Together as a class) Open up the MGSFLood Inputs Spreadsheet. We need to document Iteration #2. We need to show the pond land cover change associated with the 0.286 acres. The detention pond will be built over existing grass. Once we have the output from the MGSFlood Input Spreadsheet, we can now go back to MGSFlood with the basin input information.

31. Click the Scenario Tab and then the Open Schematic button for the Predeveloped Scenario.

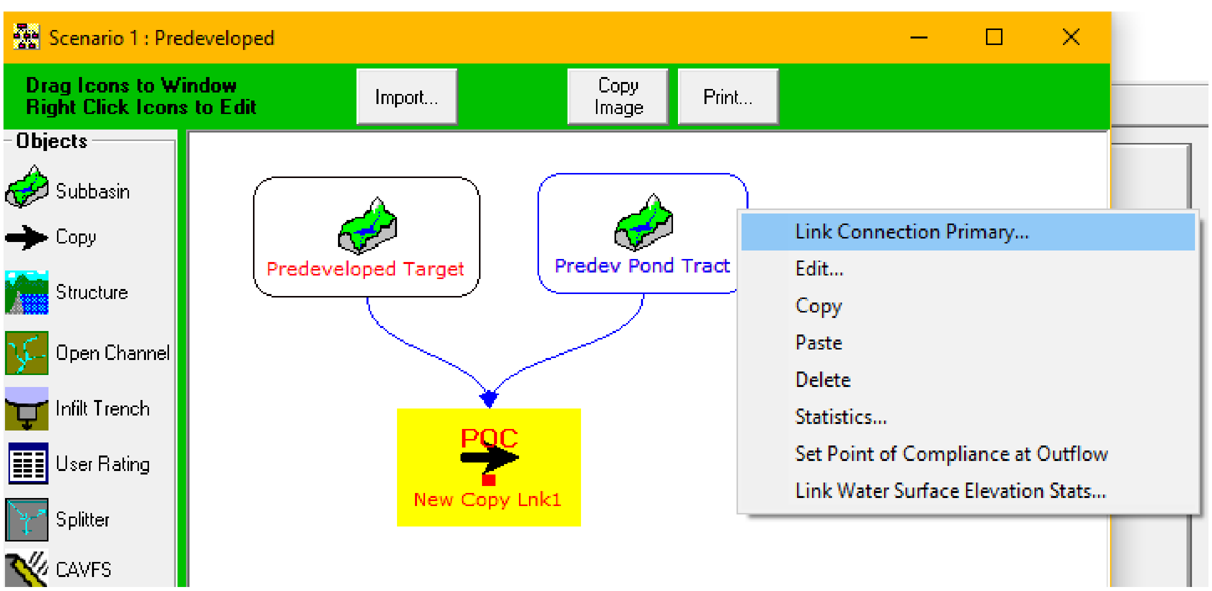
32. Click and drag a new Subbasin and a Copy object to the layout screen.

33. Right click the Subbasin 2 and click Edit.

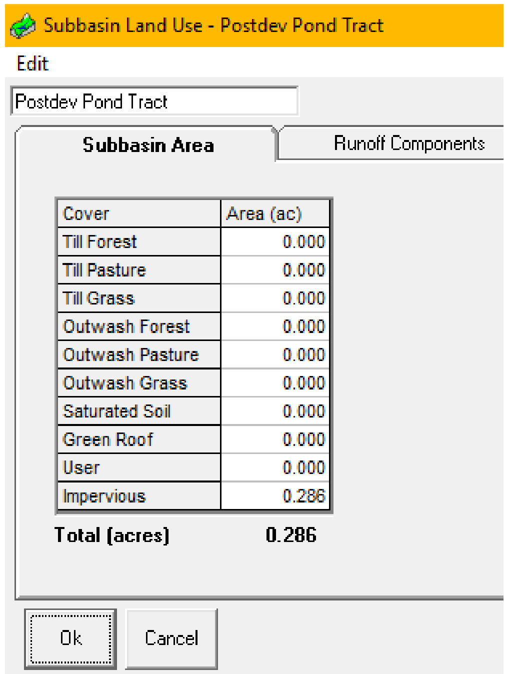
34. Enter 0.286 acres of till grass for the predeveloped land use and enter “Predeveloped Pond Tract” as the subbasin Name. Click OK to close the Subbasin Land Use input screen.



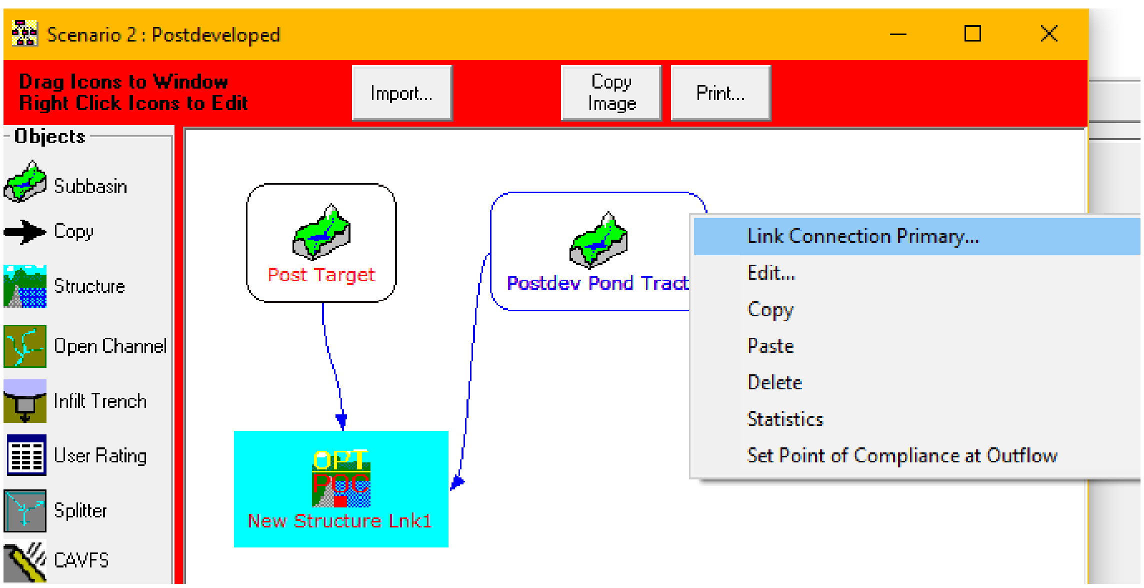
35. Next, we have to connect the Subbasins to the Copy link. Left click on the subbasin "Predeveloped Target" to make it active. Right click on the subbasin and select Link Connection Primary. A list of available structures to connect to the subbasin will appear in a drop down menu. Select the structure that you want to connect the subbasin to, in this case, "New Copy Lnk1". A line will appear connecting the subbasin to the link. Repeat this for the "Predev Pond Tract", connecting it to the "New Copy Lnk1"
36. Right click on the "New Copy Lnk1" and set the point of compliance at the outflow.



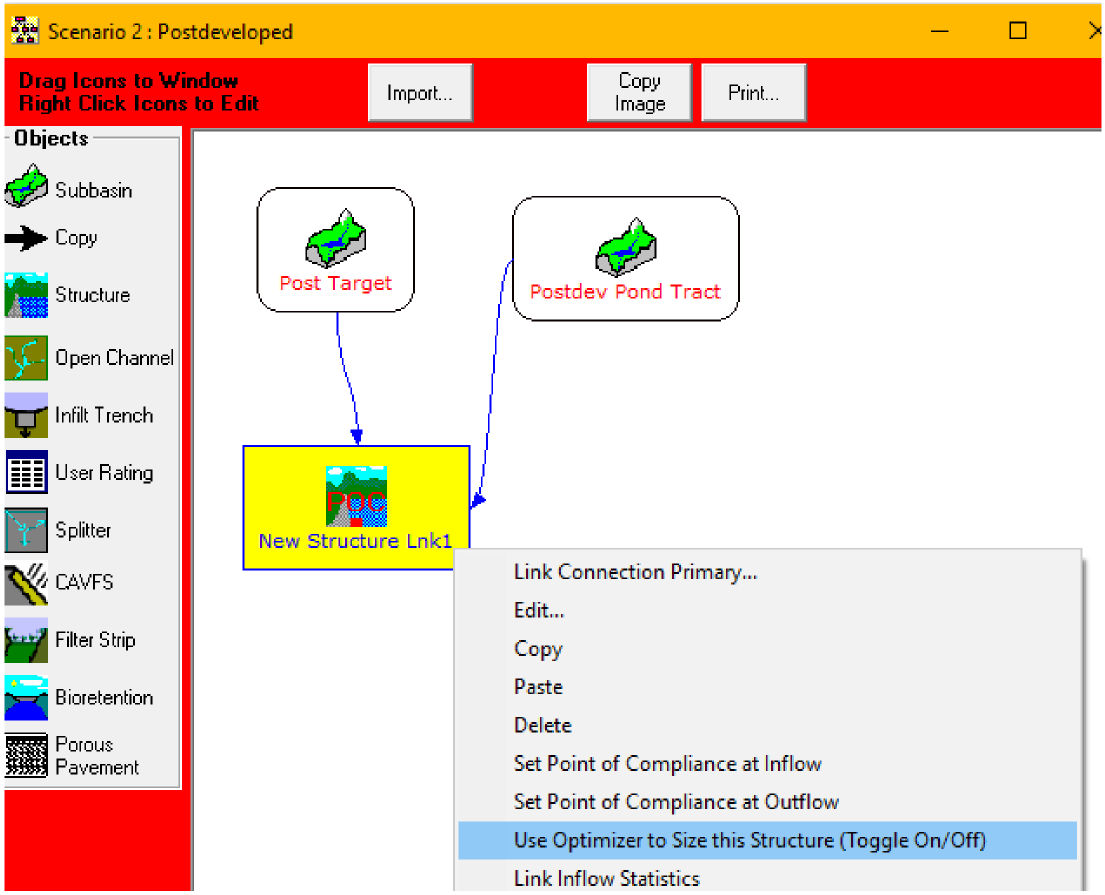
37. Click the Scenario Tab and then the Open Schematic button for the Postdeveloped Scenario.
38. Click and drag a new Subbasin to the layout screen.
39. Right click the Subbasin 2 and click Edit.
40. Enter 0.286 acres of impervious for the postdeveloped land use and enter "Postdeveloped Pond Tract" as the subbasin Name. Click OK to close the Subbasin Land Use input screen.



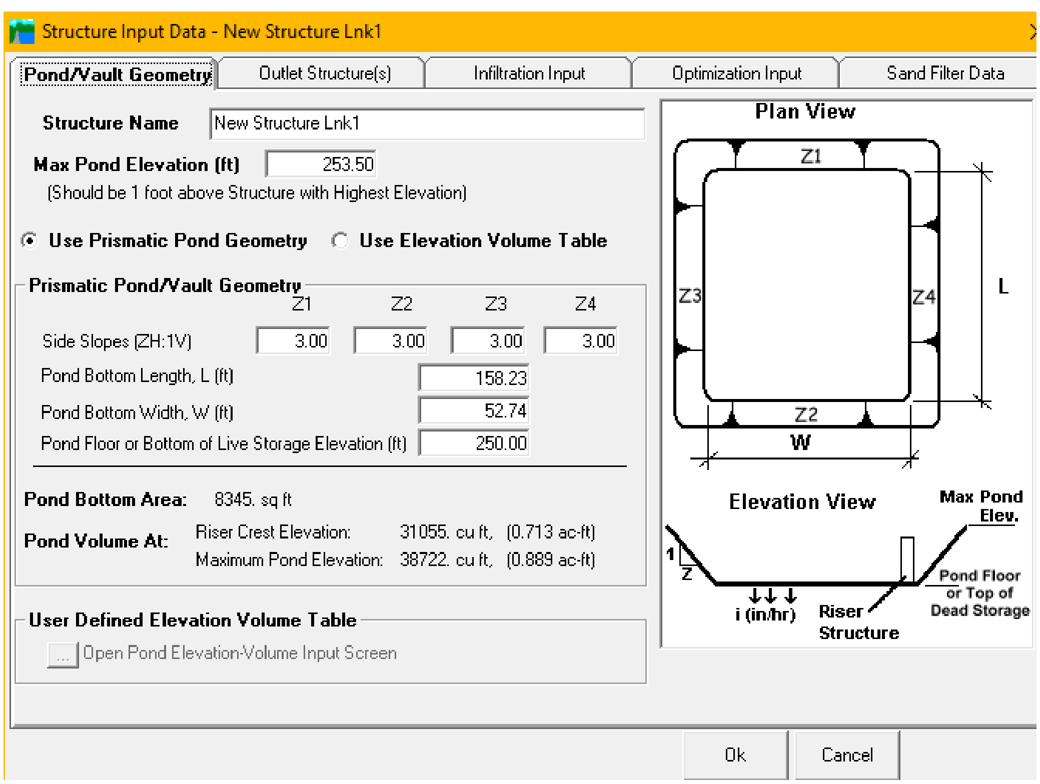
41. Next, we have to connect the Subbasins to the New Structure Lnk1. Left click on the subbasin "Post Target" to make it active. Right click on the subbasin and select Link Connection Primary. A list of available structures to connect to the subbasin will appear in a drop down menu. Select the structure that you want to connect the subbasin to, in this case, "New Structure Lnk1". A line will appear connecting the subbasin to the link. Repeat this for the "Postdev Pond Tract", connecting it to the "New Structure Lnk1".



42. **Turn off the pond optimizer** by right clicking New Structure Lnk1 and toggle the optimizer off. New Structure Lnk1 should turn yellow. The optimizer gave us a very good first guess at the pond size. We will do manual changes to the pond size and orifice sizes to see if we can make the pond footprint smaller while meeting the flow duration criteria.



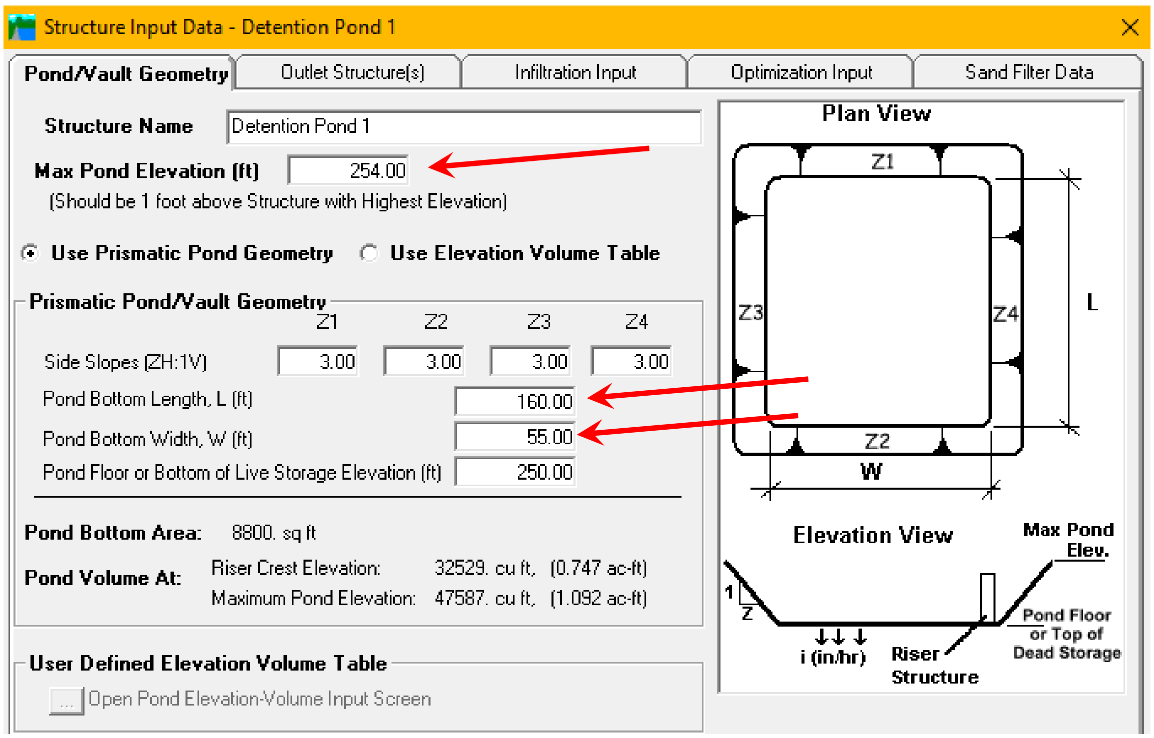
43. Open the Structure Input Data Screen by right clicking the New Structure Lnk 1 (your detention pond) and selecting Edit. The resulting pond geometry and discharge structure are displayed on the Pond/Vault Geometry and Outlet Structure tabs.



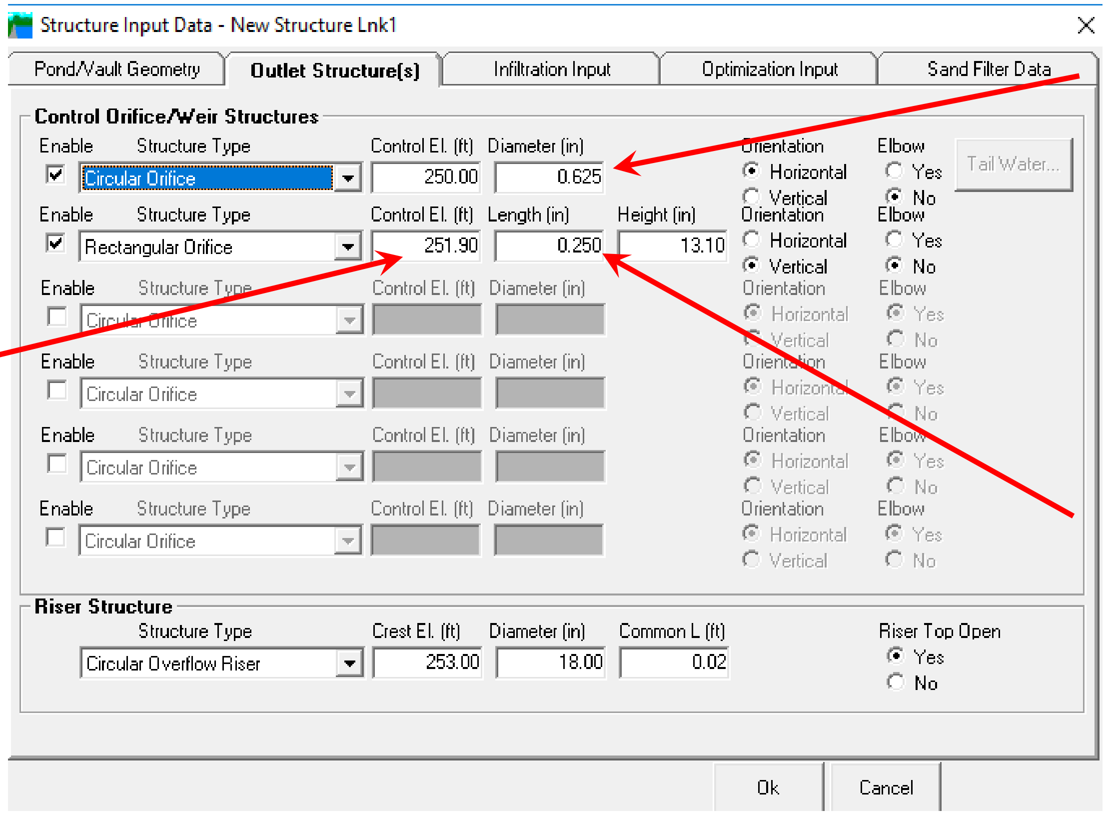
Our job is not done yet even though the full optimizer gave us a design that met the flow control duration standard. We still have many checks before a final pond design can be documented. We have to make sure:

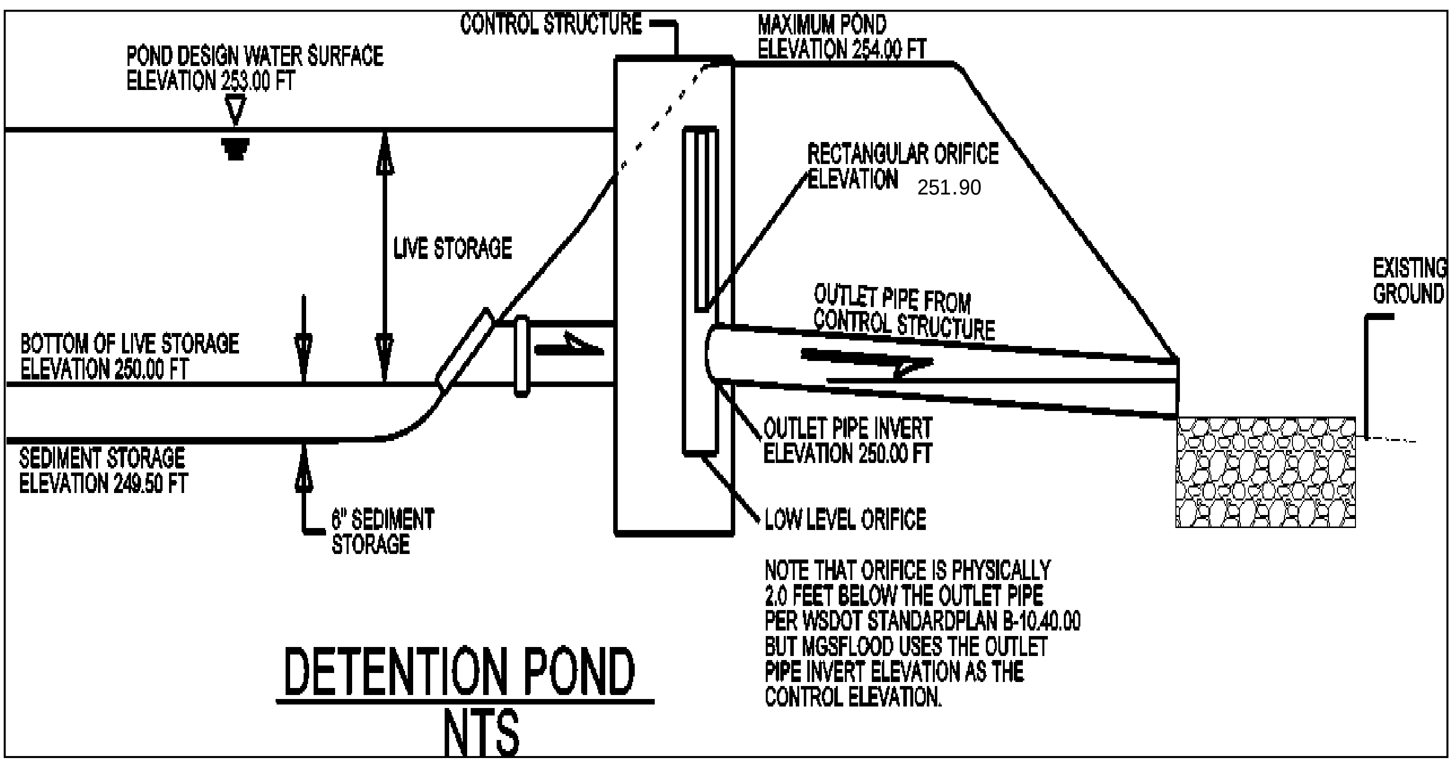
- the orifice sizes are nominal and constructible.
- the pond dimensions are nominal.
- a pond tract is represented in the model along with the land cover changes associated with constructing the detention pond.

44. Change the Structure Name to "Detention Pond 1". Change the Max Pond Elevation to 254.0 to account for the required 1 foot of freeboard. Change the length to 160 feet and width to 55 feet to make nice and round measurements. Since we are going to iterate this design a few times, we will revisit these numbers often.



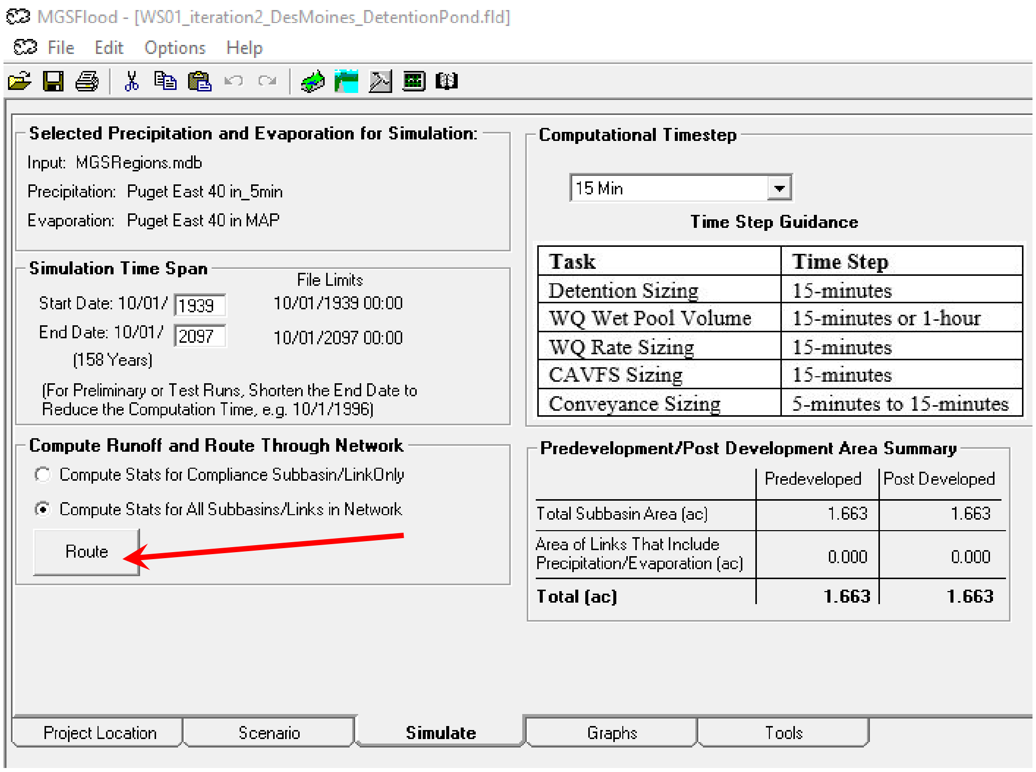
45. Click on the Outlet Structure(s) tab. Change the bottom orifice diameter to 0.625 inches for a constructible diameter. See http://en.wikipedia.org/wiki/Drill_and_tap_size_chart for a list of common drill bit sizes. Note the minimum bottom orifice diameter is 0.50 inches. If using a bottom orifice diameter that is less than 1 inch, a flow control orifice screen is recommended. See HRM Figure 5-54 for details on the flow control screen. Change the Rectangular Orifice Length to 0.250 inches (the minimum acceptable Length) to make it nominal. Change the control elevation for the Rectangular orifice to 251.90 feet. All other elevations look OK.



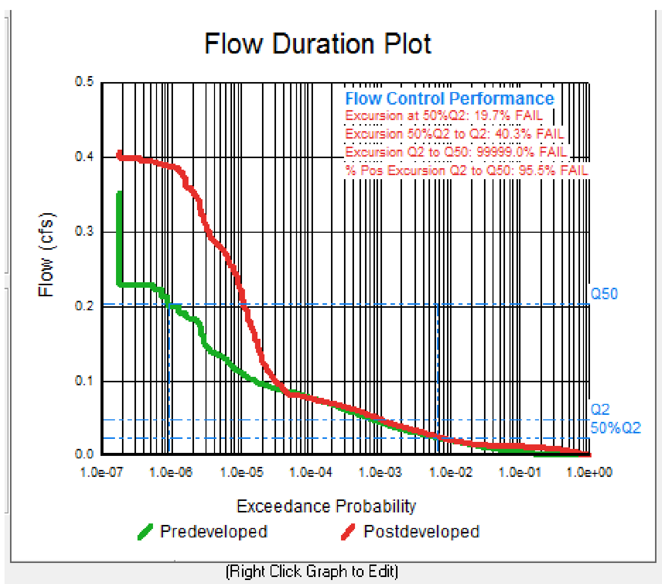


46. Click the OK button. **SAVE the project at this point.**

47. Click the Simulate Tab. Click the *Route* button with the Compute Stats for All Subbasins/Links in Network box checked. Since we turned off the optimizer in the previous steps, flows will be routed through the pond but the pond geometry and orifice sizes from the previous optimized design will not change.



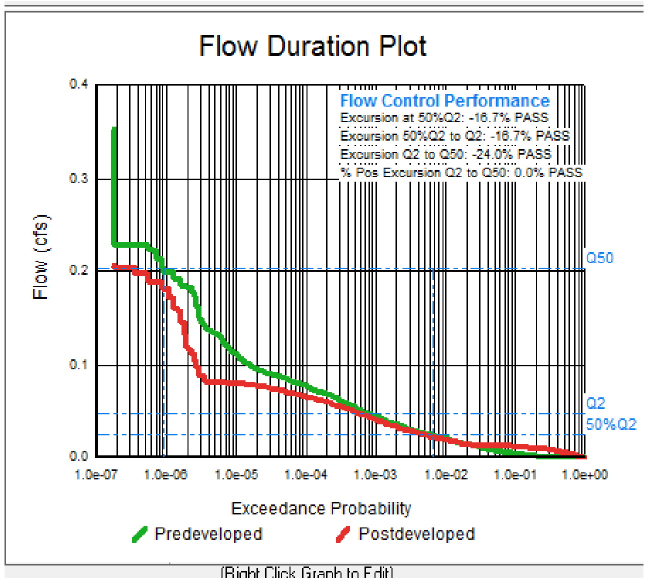
48. The resulting pond performance shows we did not pass any of the duration criteria because of the changes we just made. It is close on the right side of the graph but really separates on the left side. We will make some adjustments!



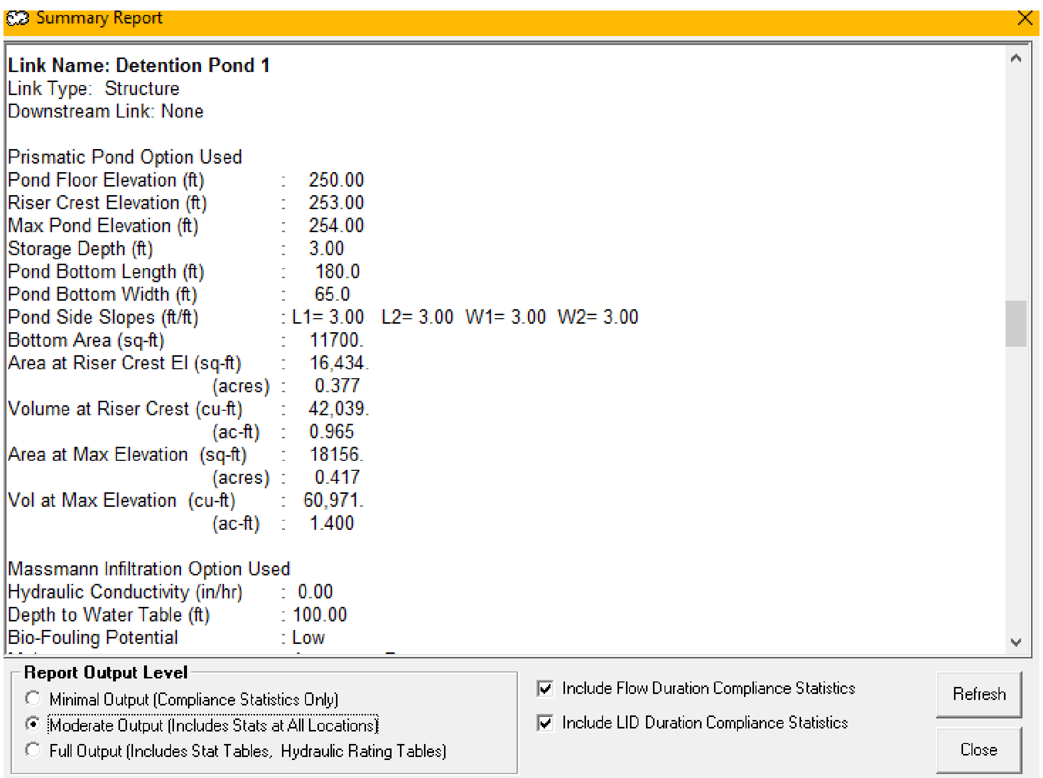
49. Now we'll go back and check to see if the detention pond meets the duration standard when trying to account for its own footprint area land cover conversions. Click the Scenario Tab, and then the Open Schematic button for the Postdeveloped Scenario to get to the detention pond. Right click the Detention Pond 1 and select Edit. Increase the Pond size to <u>180 ft. by 65 ft</u>. Click OK. In general, the simplest way to adjust a pond to meet the flow duration standard is to gradually increase the pond size until the flow duration standard is met. This may take several iterations to accomplish. We can also adjust the orifice sizes so long as we do not change the orifice elevations.

50. Save the project.

51. Click the Simulate tab and Click the *Route* button with the compute stats for all Subbasins/Links box checked. The pond now meets the required performance.



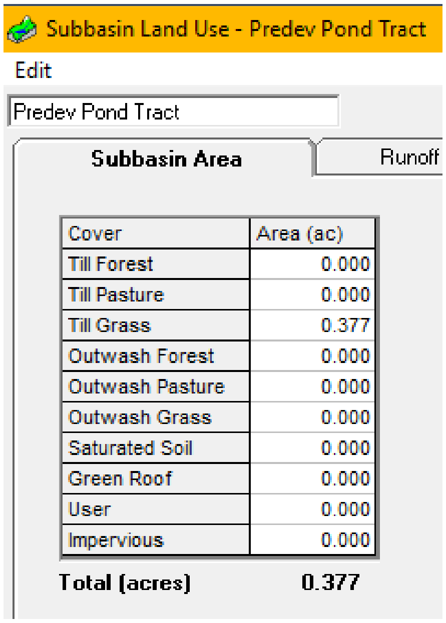
52. Next, we need to check the pond tract size. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file (in the project's specified file folder) with a word processor.



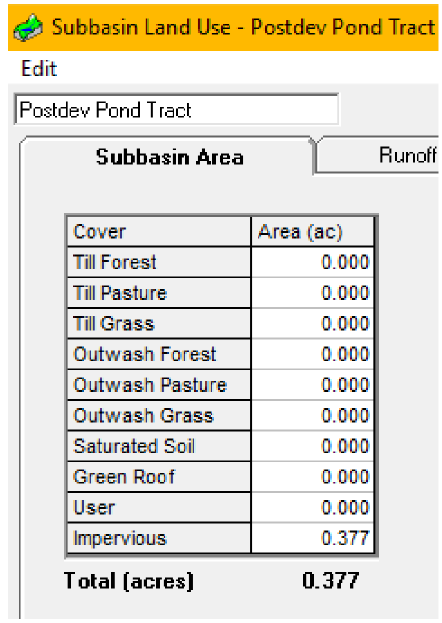
Initially, MGSFlood calculated a pond tract area of 12,467 square feet (0.268 acres). The pond area at the riser crest is shown to be 16,434 square feet (0.377 acres). <u>The designer must go back to the MGSFlood Inputs Spreadsheet and revise the pond footprint. This also checks the actual areas in the TDA to make sure enough area can be routed to the BMP. Once the spreadsheet is updated with the new pond tract area, the designer will have the inputs to go to the MGSFlood predeveloped and developed scenarios and update each basin (if needed) since the calculated pond area is larger than the initially guessed pond tract area.</u>

53. Open up the MGSFlood Inputs Spreadsheet. We need to show the land cover change associated with the 0.377 acres. The detention pond will be built over existing grass. Once we have the output from the MGSFlood Input Spreadsheet, we can now go back to MGSFlood with the basin input information.

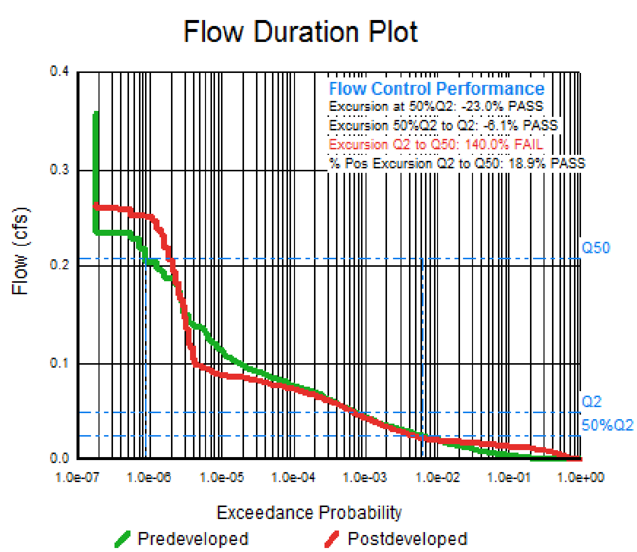
54. On the Scenario Tab, enter 0.377 acres for the pond tract area in the Predeveloped and Postdeveloped scenarios as shown below. Click OK and go to the Simulation Tab and route the design.



Cover	Area (ac)
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.377
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Saturated Soil	0.000
Green Roof	0.000
User	0.000
Impervious	0.000

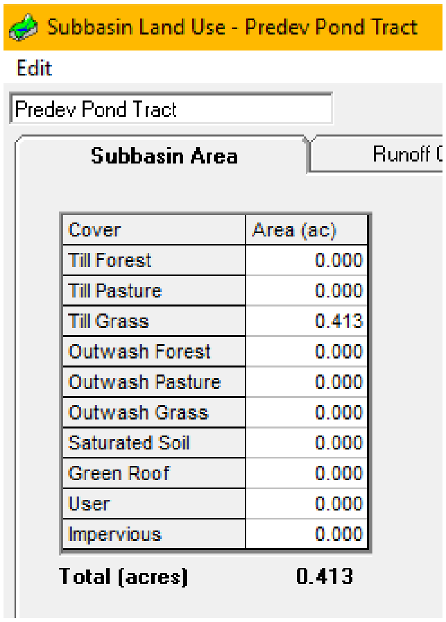


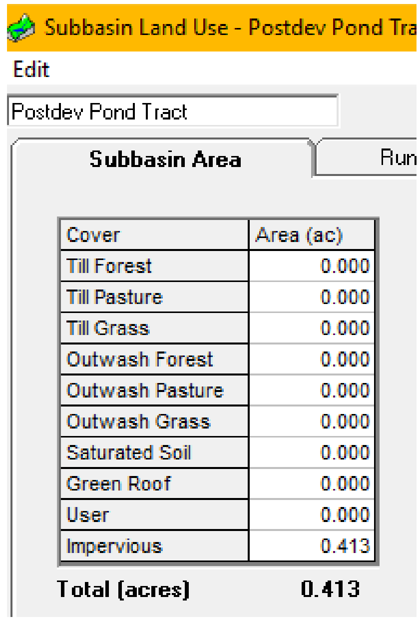
Cover	Area (ac)
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Saturated Soil	0.000
Green Roof	0.000
User	0.000
Impervious	0.377



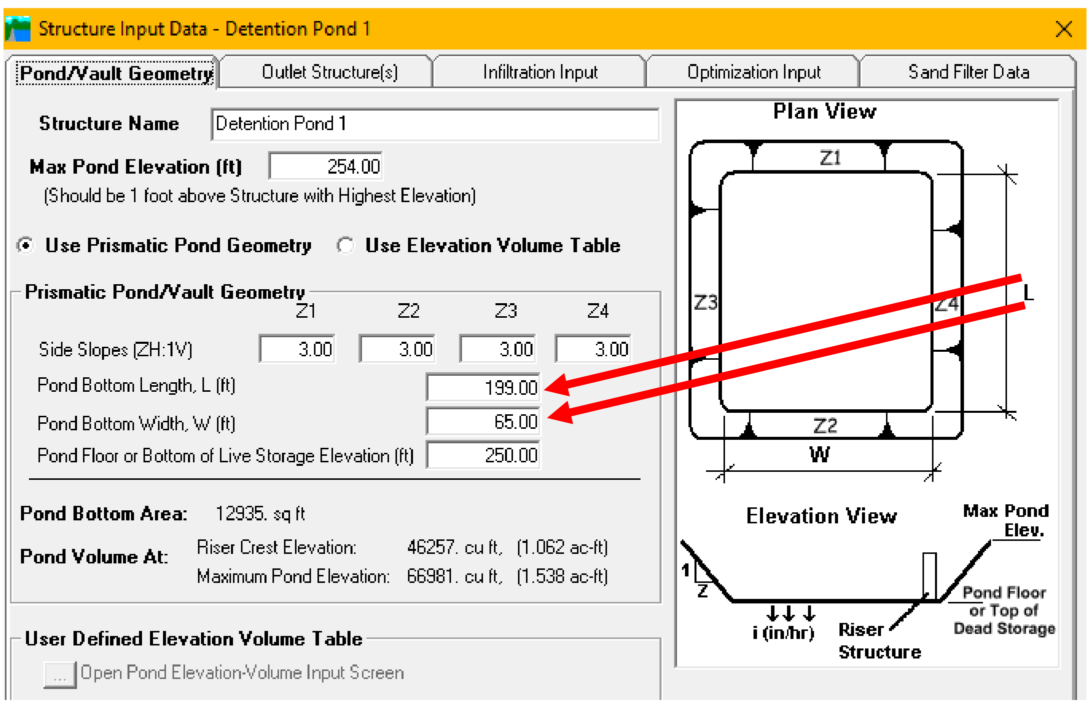
The pond does not meet the flow duration standard so we must increase the pond size and increase the pond tract size.

55. Repeat Steps 53 and 54 to iterate the design until a final size has been found. To save some time, we did a few iterations and found one size that works. On the Scenario Tab, enter 0.413 acres for the pond tract area in the Predeveloped and Postdeveloped scenarios as shown below.



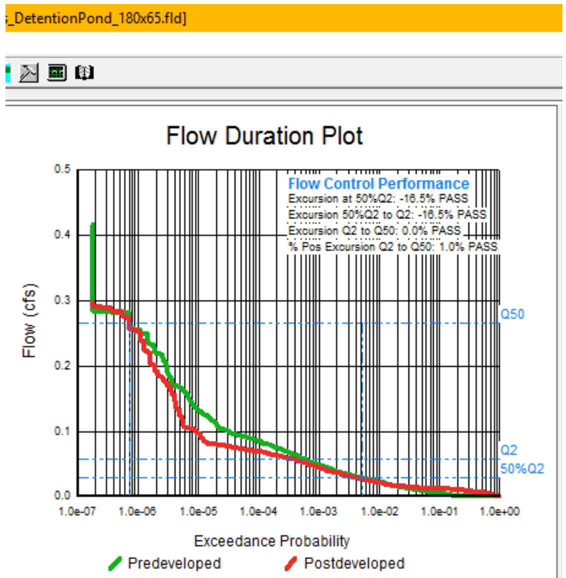


56. On the Postdeveloped scenario tab, right click Detention Pond 1 and select Edit. Change the pond dimensions to <u>199 feet x 65 feet.</u> Note that these new dimensions were found after a few iterations.

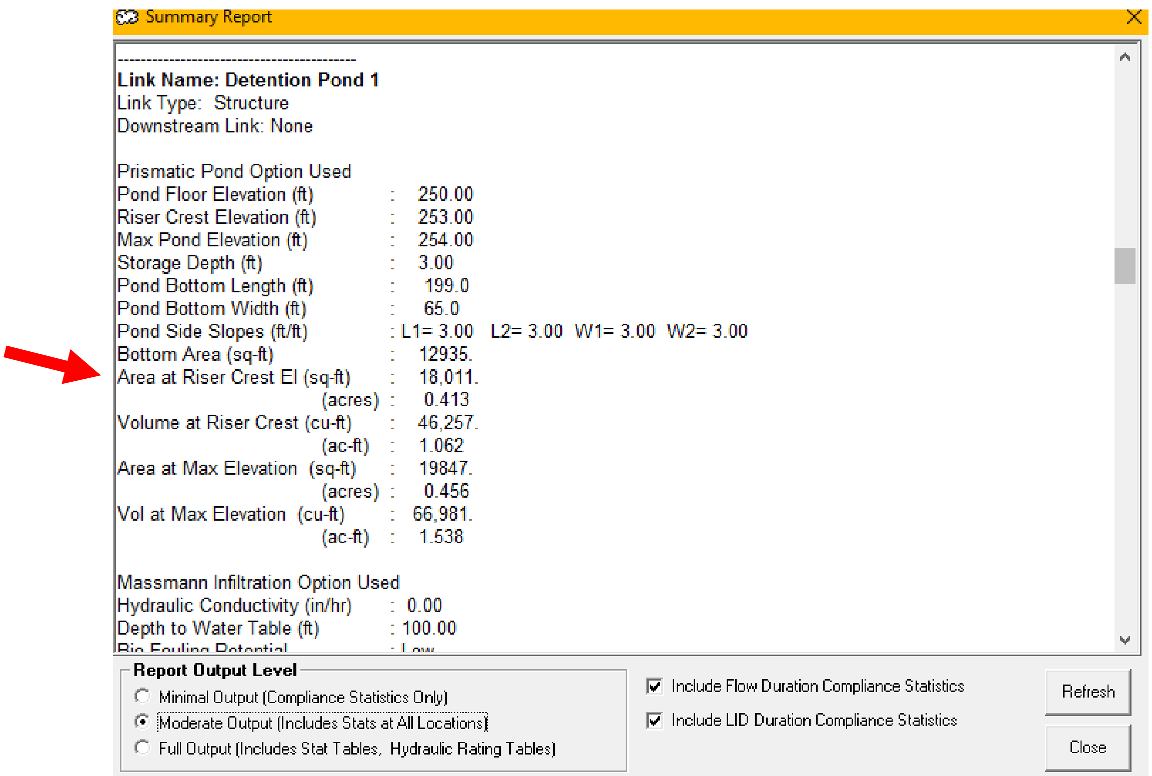


57. Save the Project.

58. On the Simulate Tab, click the Route button. The pond now meets the required performance.



59. Check the pond tract area assumption again. View the Project Report.



The pond tract was guessed to be 18,011 square feet (0.413 acres). The pond area at the riser crest is shown to be 18,011 square feet (0.413 acres). The calculated pond area fits into the pond tract that we guessed. <u>The final bottom pond dimensions are 199 feet x 65 feet that is 3 foot deep with a foot of freeboard. To finish off the detention pond design, the designer needs to design an emergency overflow spillway/structure as discussed in the HRM BMP FC.03 Detention Pond. This hand calculation is not discussed in these MGSFlood example problems.</u>

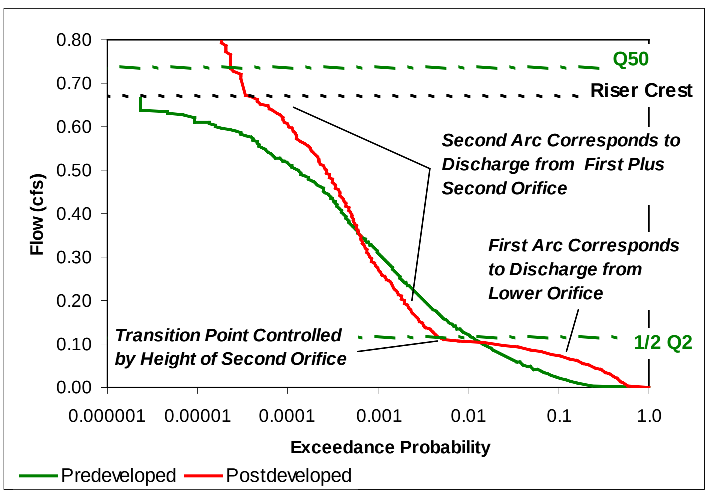
60. Advanced iterations – Having some free time, I played around with changing the lower orifice size. I increased the bottom orifice size from 0.625 to 0.6875. See

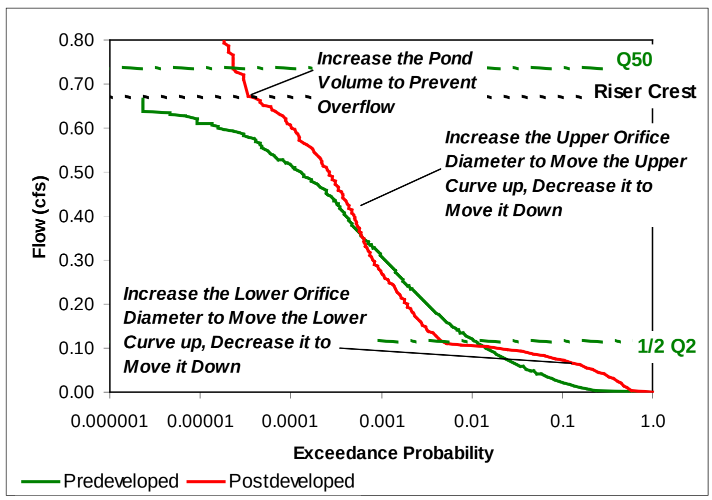
http://en.wikipedia.org/wiki/Drill_and_tap_size_chart for a list of common drill bit sizes. By increasing the lower orifice size, and following Steps 53, 54 and 55 above, I got a final pond footprint smaller than the one listed above in Step 59. The final bottom pond dimensions turned out to be 180 feet x 58 feet that is 3 foot deep with a foot of freeboard. It is about 16% smaller just by changing the bottom orifice size.

61. Graphs may be exported to .jpg files by clicking the button on the Graphs tab and specifying a file name.

General Guidance for Adjusting Pond Duration Performance

- Analyze the duration curve from bottom to top, and adjust orifices from bottom to top.
- The bottom arc corresponds with the discharge from the bottom orifice. Reducing the bottom orifice discharge lowers and shortens the bottom arc while increasing the bottom orifice raises and lengthens the bottom arc.
- Inflection points in the outflow duration curve occur when additional structures (orifices, notches, overflows) become active.
- Lowering the upper orifice moves the transition right on the lower arc and raising the upper orifice moves the breakpoint left of the lower arc.
- The upper arc represents the combined discharge of both orifices. Adjustments are made to the second orifice similar to the bottom orifice.
- Increasing the facility volume moves the entire curve down and to the left. This is done to control riser overflow conditions. Decreasing facility volume moves the entire curve up and to the right.

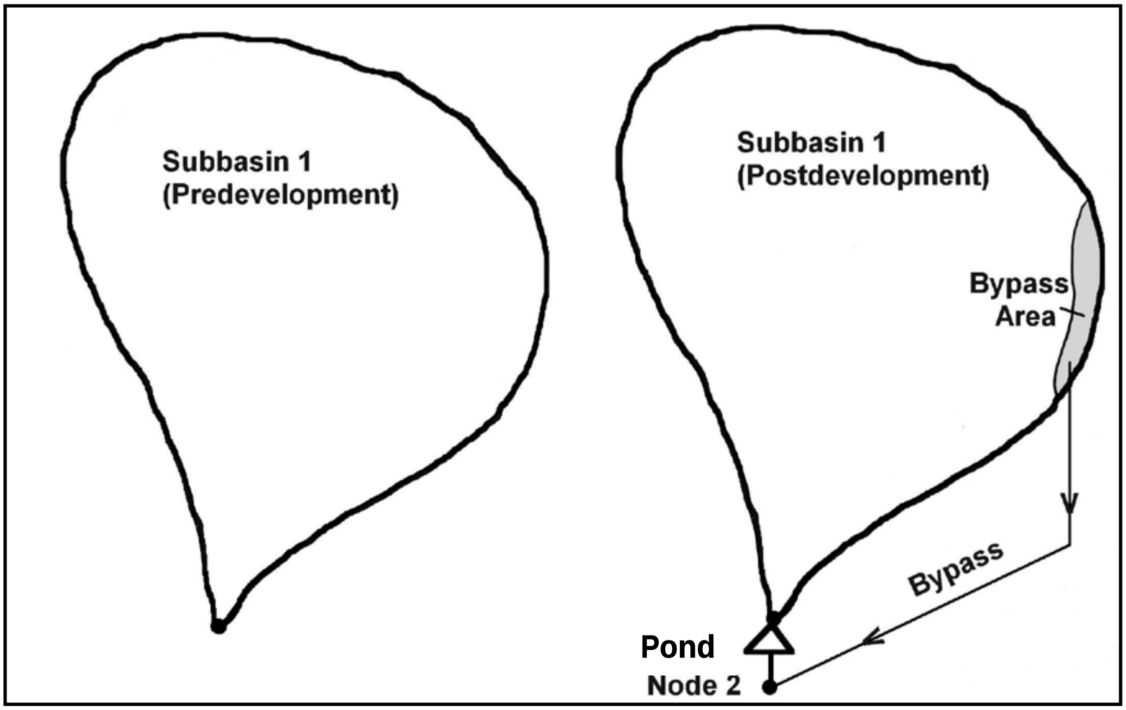




Work Session 2 – Detention Pond Design with Bypass.

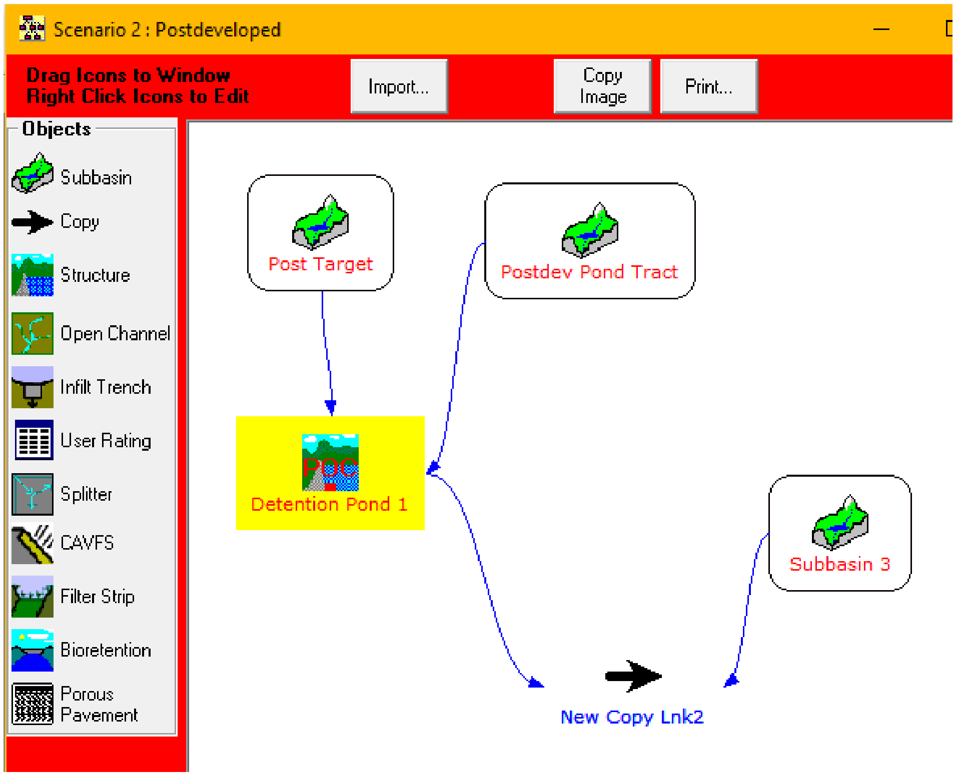
Local topographic constraints often make it impractical to direct all runoff from developed areas that need flow control to a detention facility. If a portion of the developed subbasin bypasses the pond, then we can model the net effect of flow at a point downstream where the bypass area and the area going to the detention facility meet. We will "over-detain" the area and reduce flows to offset the increase in flow from the bypass area.

Using the file created under Work Session 1, redesign the pond assuming that 0.20 acres of pavement that we need to capture will bypass the detention pond.



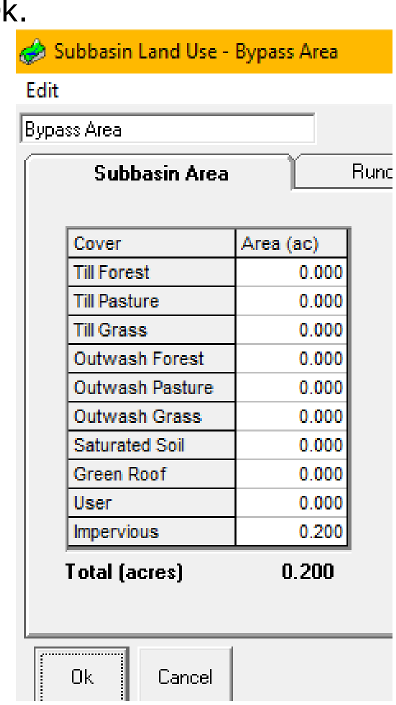
Node 2 is the Point of Compliance where flows join.

1. Open up the MGSFlood Inputs Spreadsheet to tab WorkSession2. We need to represent the 0.2 acres of area that bypasses the detention pond. We show this by reducing the "Area Physically Transported to Detention Facility" (Step 5 of the MGSFlood Inputs Spreadsheet) by 0.2 acres from 1.79 acres to 1.59 acres. Step 6 of the spreadsheet now shows the 0.2 acres of bypass. The MGSFlood model inputs are shown in Step 9 of the spreadsheet. We can now go back to MGSFlood with the basin input information.
2. Open the file called, "WS02_BypassDetentionPond_A_Start.fld".
3. Open the Postdeveloped Scenario Window. Note the Predeveloped Scenario does not change from that defined in the Work Session 1 example.
4. Drag another Subbasin onto the screen. This subbasin will represent the bypass area.
5. Drag a Copy Link onto the Screen.
6. Configure the Postdeveloped as shown below.

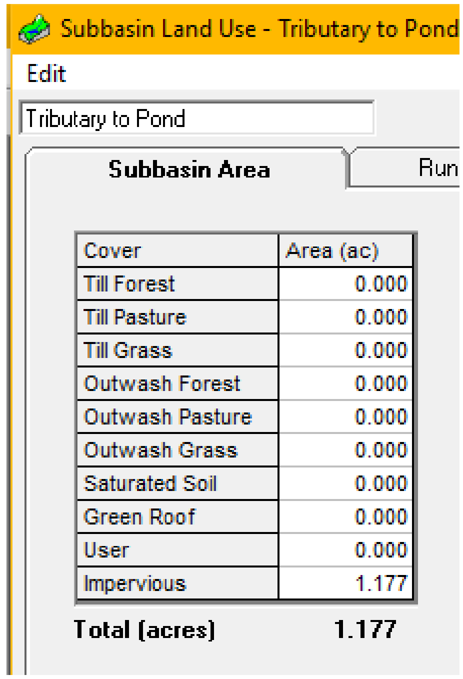


Configuration for Bypass

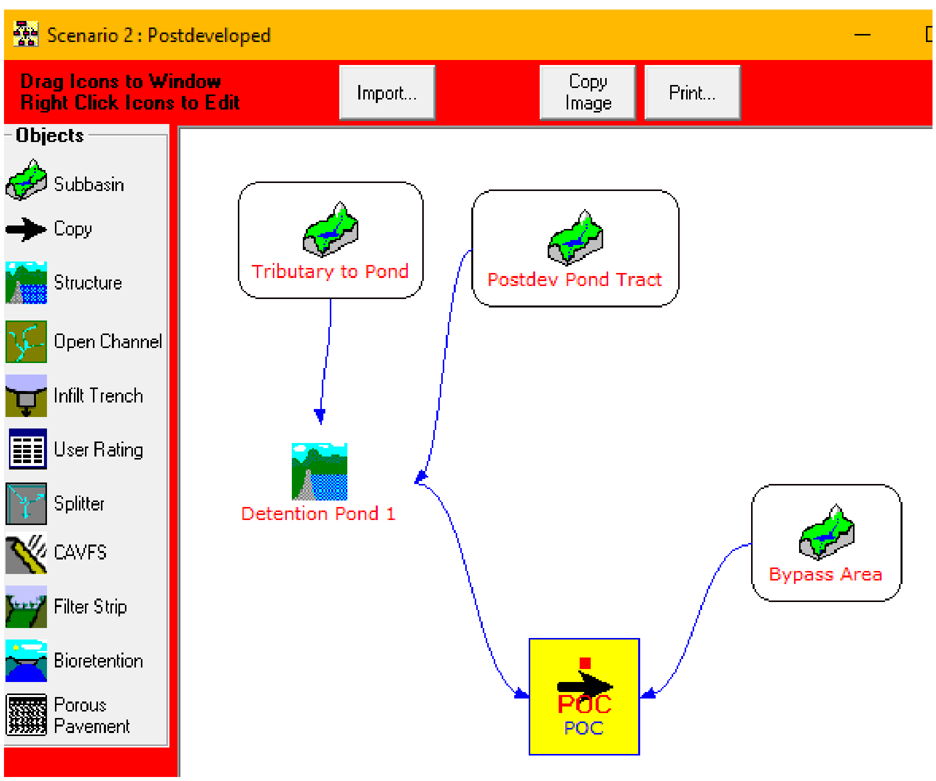
7. Click on Subbasin 3 to Select it. Right Click to display the menu and then select Edit. Change the subbasin name to Bypass Area and enter 0.200 acres for the bypass impervious area. Click Ok.



8. Right click the Post Target Subbasin to edit it. Change the subbasin name to Tributary to Pond. Subtract 0.200 acres from the impervious surface to make a total of 1.177 acres of impervious area for the subbasin. Click Ok.

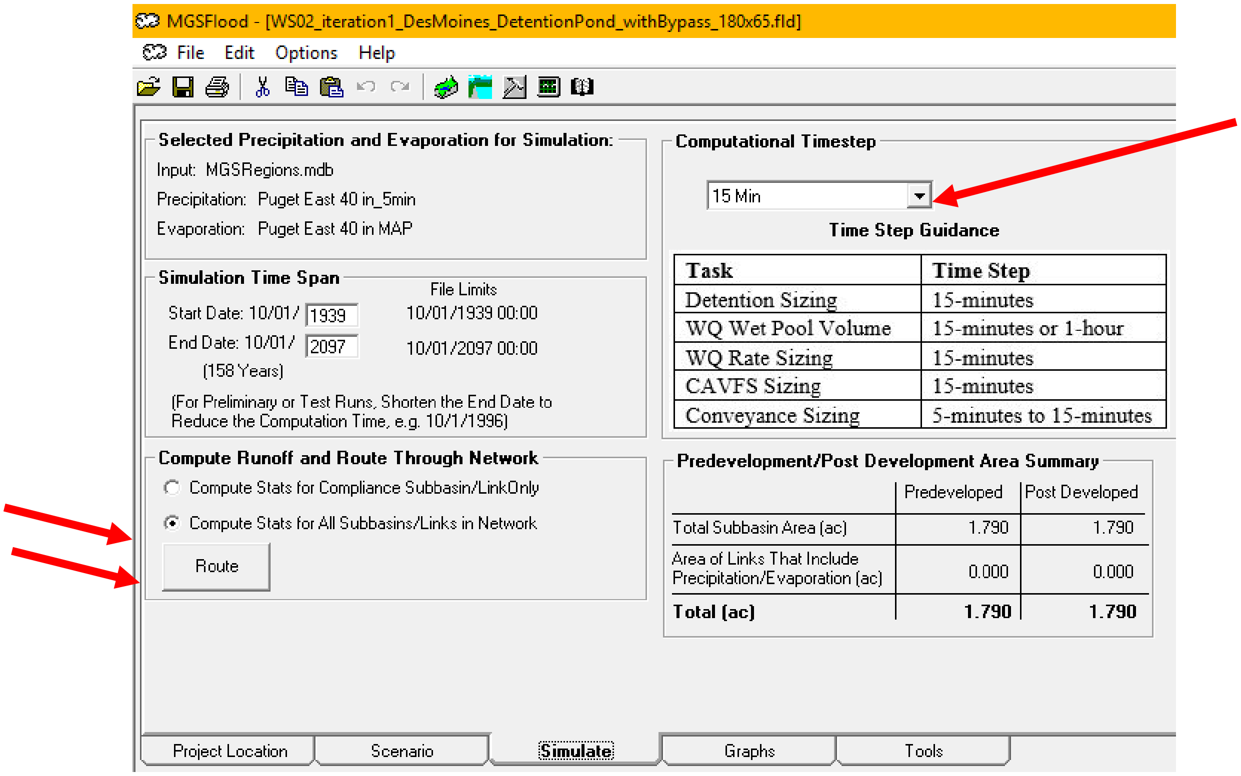


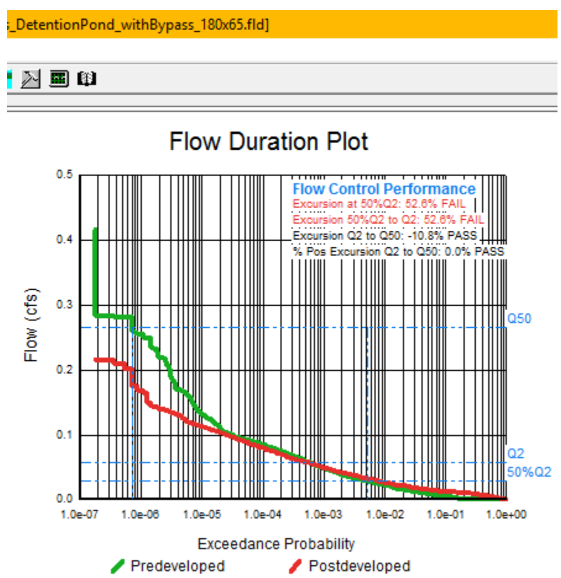
9. Right click the Copy Link and select edit. Enter POC for the Link Name. Click OK.
10. Right click POC again. Select Set Point of Compliance at Inflow. The Postdeveloped scenario configuration should look like the below drawing. The program will combine the pond outflow with the bypass area and size the pond to meet the duration standard.



11. Click File Save As and enter “WS02_iteration1_DesMoines_DetentionPond_withBypass”. Click “No” when prompted to create a new subdirectory.
12. Click the Simulate Tab. Click the Route Button

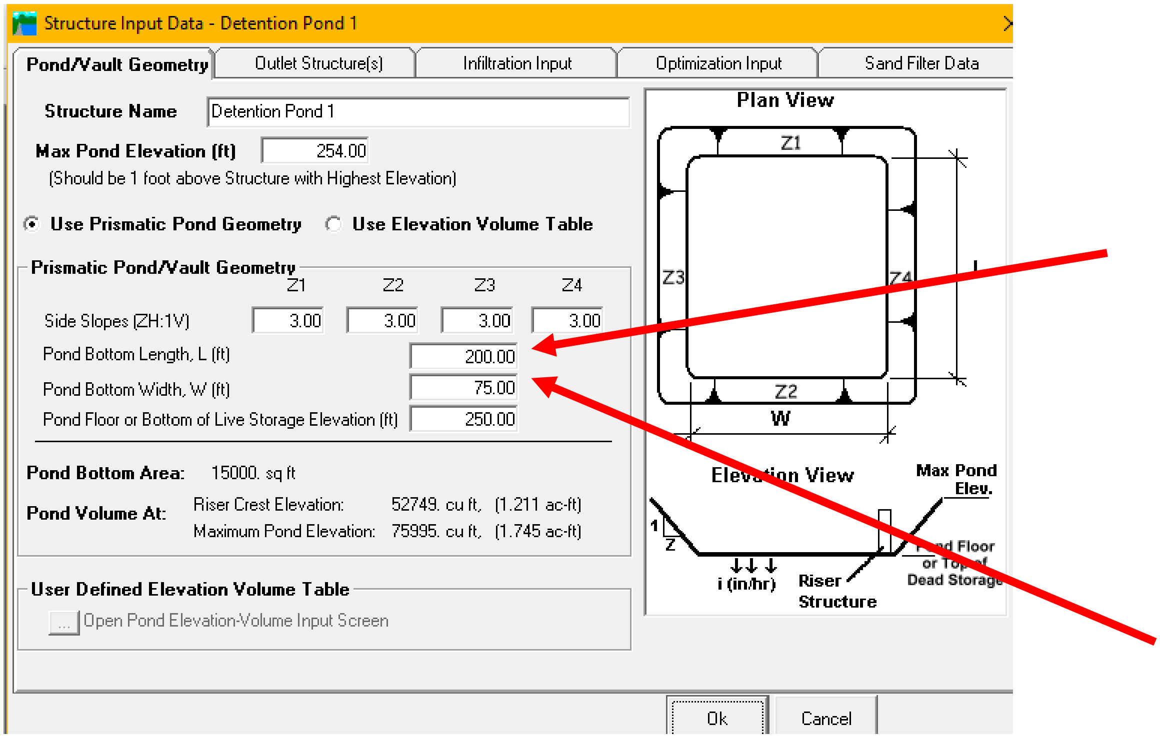
13. Click Route so MGSFlood will run the runoff through the existing pond dimensions and control orifice/weir structure dimensions to see what effect the bypass area has on the duration analysis.





Simulation Results are shown above for the bypass configuration. Since the pond does not meet the duration standard due to the 0.2 acres of bypass impervious area, we'll need to go back do some modifications to the pond size and possibly the orifice sizes. We'll also make sure anything we change is constructible as well as make sure the pond design fits inside the guessed pond tract area.

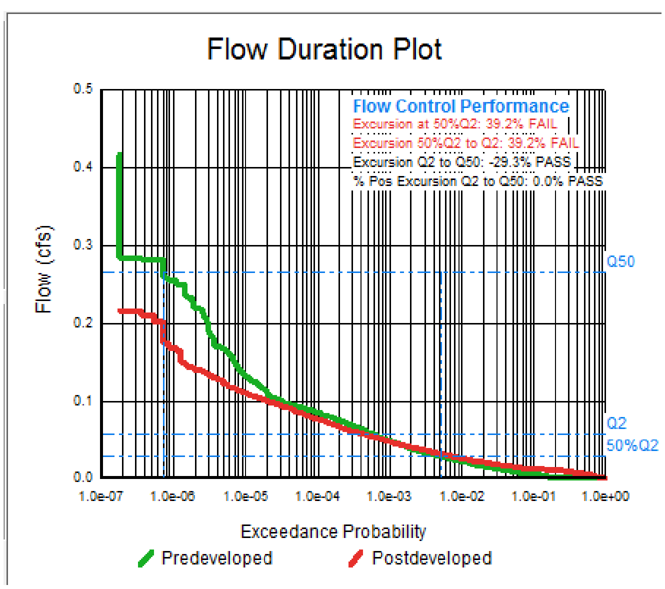
14. On the Postdeveloped Scenario, right click Detention Pond 1 and select Edit. Increase the pond length to 200 feet and width to 75 feet. Click OK.



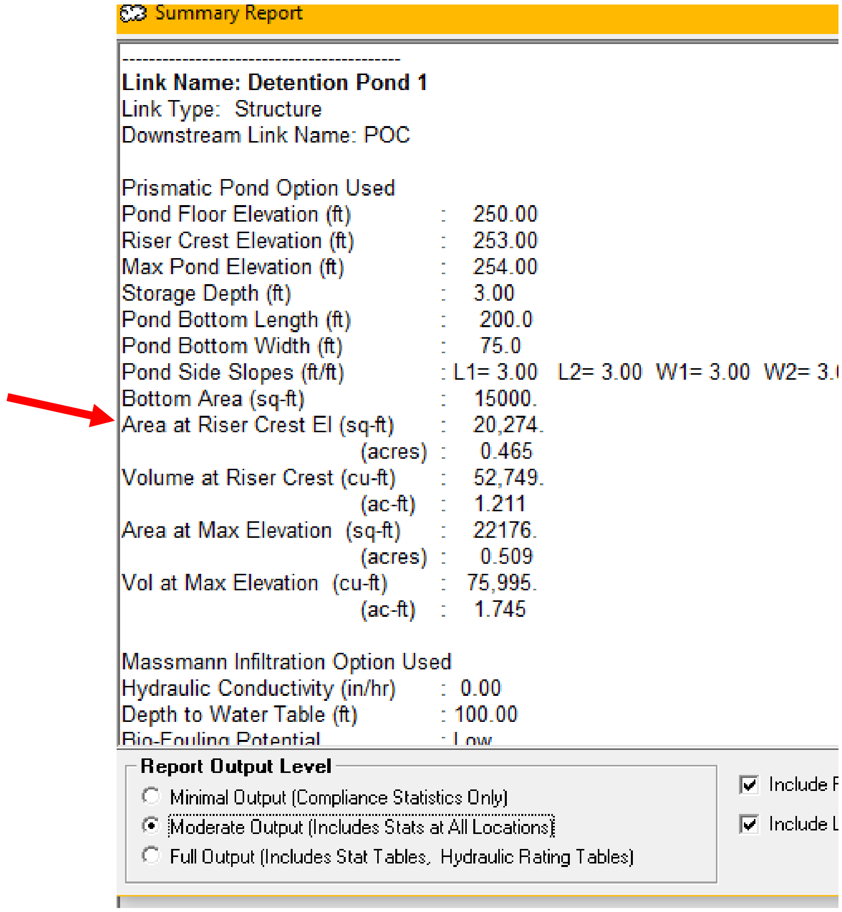
15. Click the Outlet Structures tab. Let's leave the orifice sizes as is. The Pond Tract size is still set at 0.413 acres from the previous problem.

16. Click the OK button. **SAVE the project at this point.**

17. Click the Simulate Tab. Click the Route Button so that MGSFlood will route flows through the newly revised pond but will not change the pond dimensions and control orifice/weir structure dimensions. The result shows that the pond with modified length and width does not meets the flow duration standard. It is close and needs some more fine tuning.

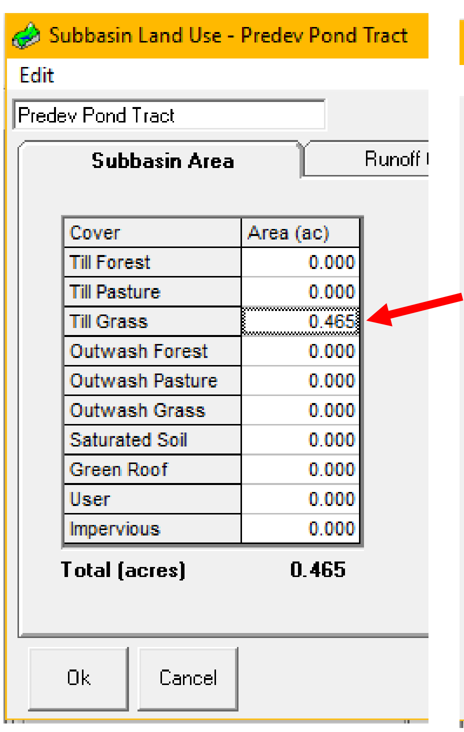


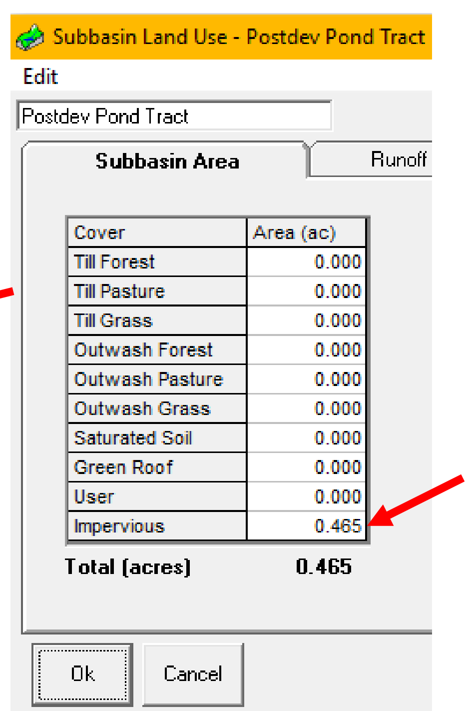
18. Next, check that the calculated pond footprint fits in the guessed pond tract area. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



We guessed the pond tract to be 0.413 acres. The pond area at the riser crest is 0.465 acres. <u>The designer must go back to the predeveloped and developed scenarios and change the pond tract size. Consider setting the pond tract at 0.465 acres.</u>

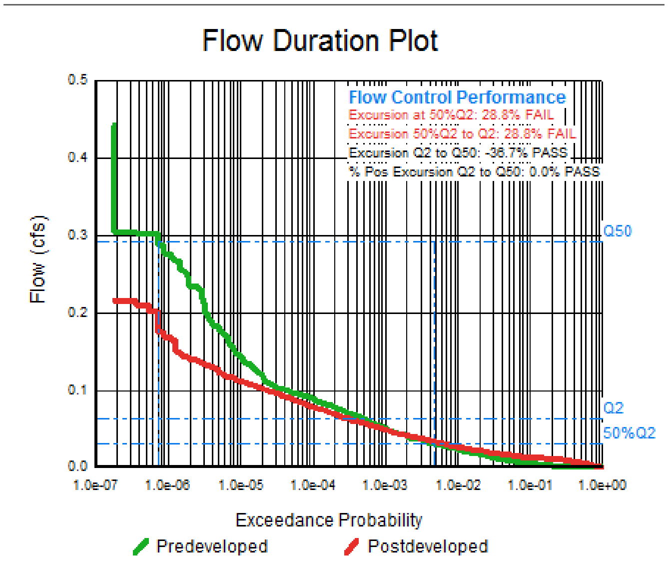
19. On the Scenario Tab, enter 0.465 acres for the pond tract area in the Predeveloped and Postdeveloped scenarios as shown below.





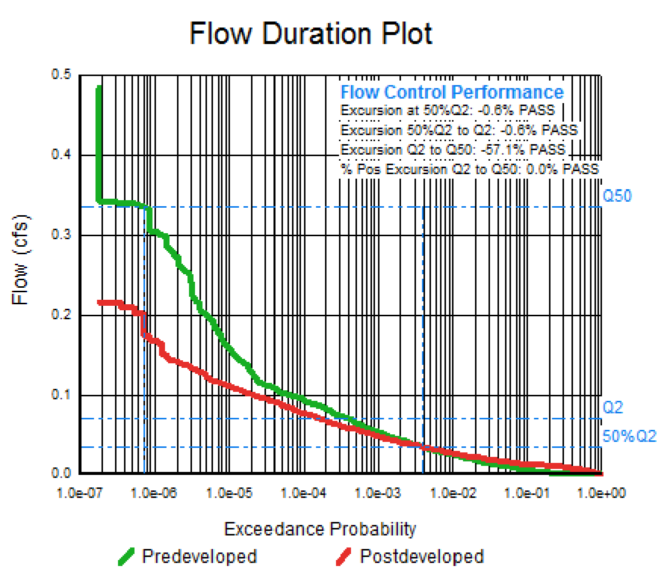
20. Click OK. **SAVE the project at this point.**

21. Click the Simulate Tab. Click the Route Button. The pond now meets the required performance.

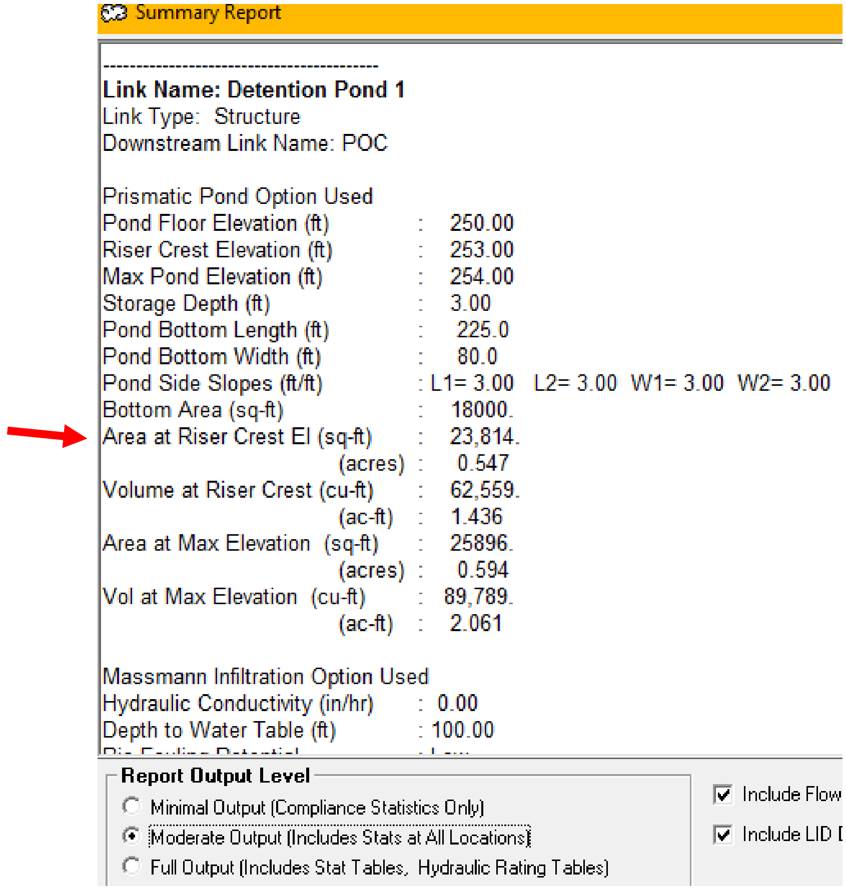


22. Since the pond still doesn't meet the flow duration standard, we have to modify the detention pond size again. After a few iterations in the MGSFlood Inputs spreadsheet and MGSFlood itself, the following dimensions were found. On the Postdeveloped Scenario, right click Detention Pond 1 and select Edit. Increase the pond length to 225 feet and width to 80 feet. In the Predeveloped and Postdeveloped scenarios, change the Pond Tract to 0.547 acres.

23. Click the Simulate Tab. Click the Route Button. The pond now meets the required performance.



24. Check the pond tract area assumption again. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



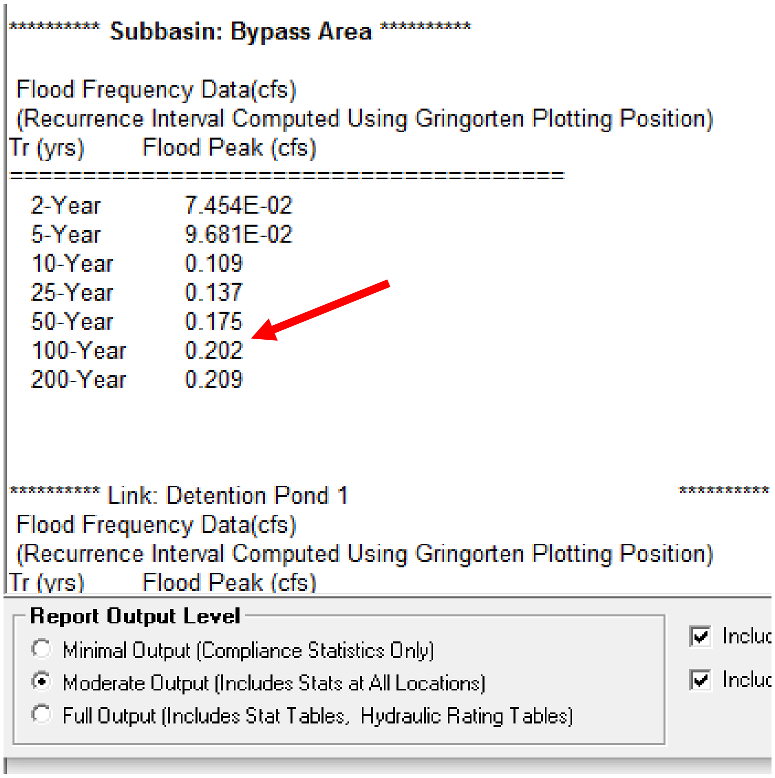
The pond tract was guessed to be 0.547 acres. The pond area at the riser crest is 0.547 acres. <u>The calculated pond area fits into the guessed pond tract area.</u> Need to update MGSFlood Inputs spreadsheet.

25. For a Point of Compliance (Bypass) flow control design, per the HRM 4-3.5.1 Option 3, there is a maximum flow rate that the bypass area needs to be less than if they bypass area is conveyed to the point of compliance via overland flow.

"If the bypass area flows to the point of compliance via overland flow, the 100-year developed peak flow rate from the bypass area will not exceed 0.4 cfs. If the bypass area flows through a constructed conveyance channel or pipe, then the 0.4 cfs criteria does not apply."

For this example, let's assume the bypass flow from the 0.2 acres is conveyed to the point of compliance via overland flow. We will check the 100-year developed flow to make sure it is less than 0.4 cfs. To do this, open the history file and scroll down to the "Subbasin: Bypass Area" in the POSTDEVELOPED condition.

Based on the history file for the Bypass Area in the POSTDEVELOPED condition, the 100-year flow is 0.202 cfs which is less than 0.4 cfs. The Point of Compliance design meets the maximum flow rate criterion.



26. To finish off the pond design, the designer needs to size the overflow and emergency overflow spillways/structures as discussed in the HRM BMP FC.03 Detention Pond. These hand calculations are not discussed in these MGSFlood example problems.

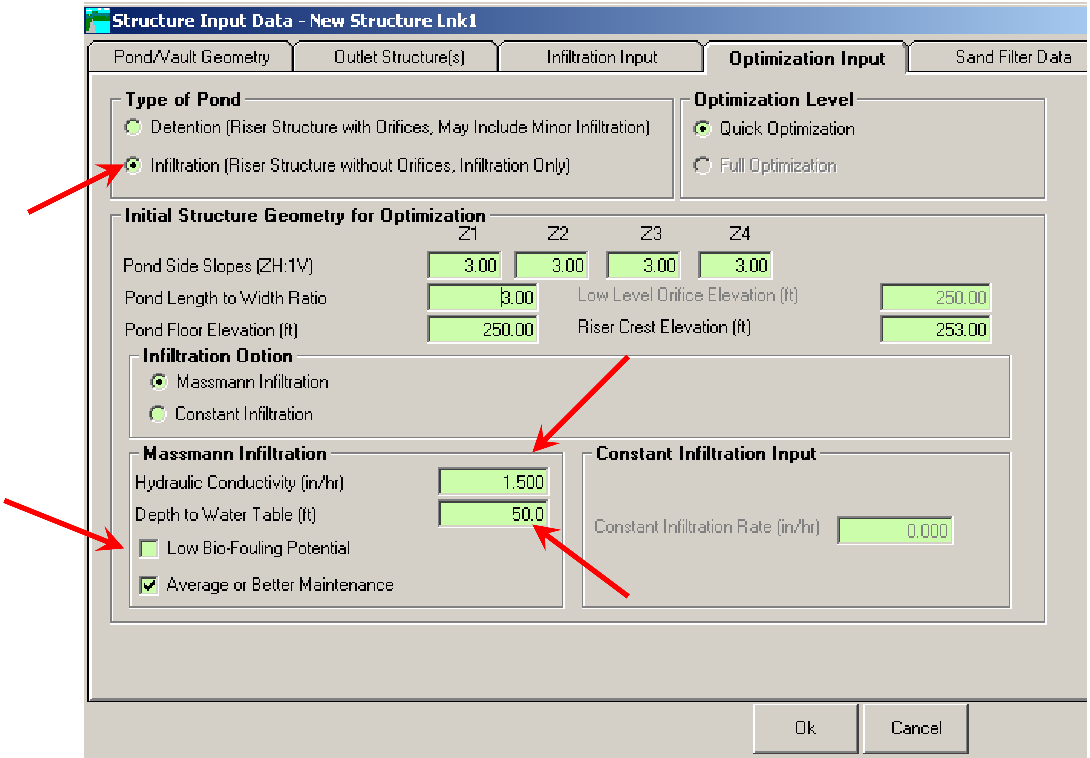
27. **Extra Discussion:** Comparing Work Session 1 and Work Session 2, the only difference was that there was 0.2 acres of pavement that we could not capture in the detention pond. That 0.2 acres bypassed the pond and we tried to make the pond over-detain the area that we could capture to compensate. Theoretically, a point downstream at the point of compliance should feel the net benefit. For the 0.2 acres that we could not capture, the detention pond went from an area of 199 feet x 65 feet (0.413 acres) to 225 feet x 80 feet (0.547 acres). This was an increase of about 32% in size.

    Having bypass areas will mean large increases in detention pond size.

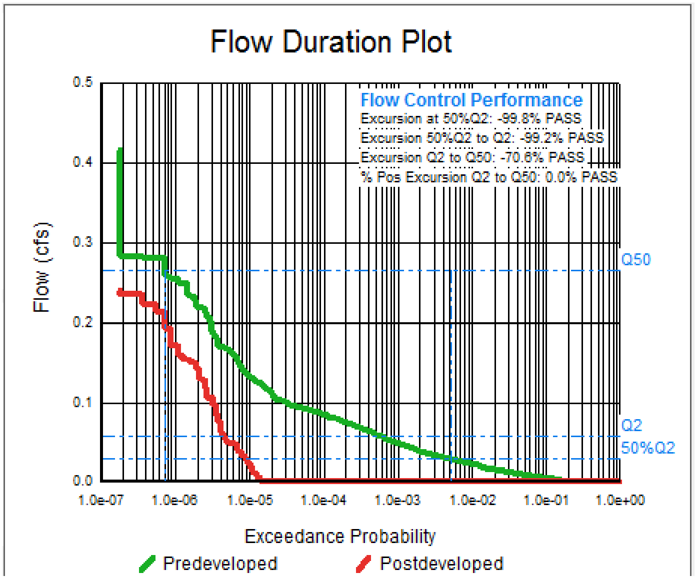
Work Session 3 - Roadway Widening Problem, Infiltration Pond Design

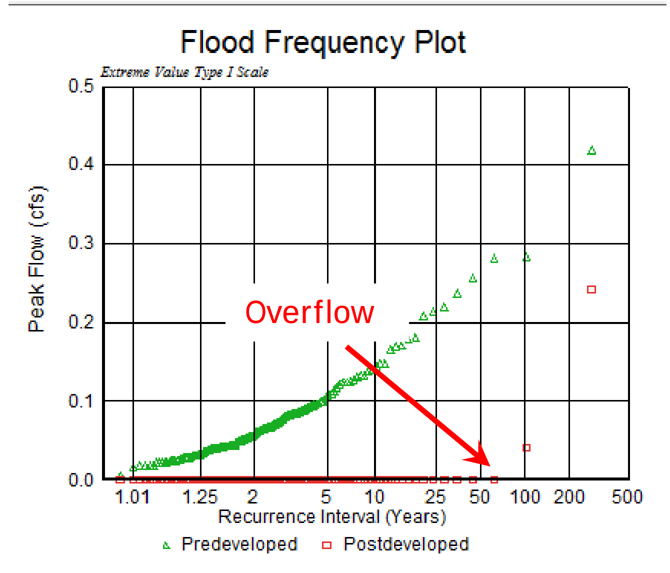
Using the file created under Work Session 1, replace the detention pond with an infiltration pond. Use the Massmann Infiltration Option with a conductivity of 1.5 in/hr, depth to water table of 50 feet, Low Bio-Fouling unchecked, and Average or Better Maintenance checked. Use the Optimization routine to size the pond.

1. Open the file called, "WS03_Infilpond_A_Start.fld".
2. Click the Scenario Tab and select the Proposed Condition Scenario.
3. Right click the Detention Pond 1 and select Edit to display the structure input screens.



4. Click the Optimization tab. Click Infiltration Pond for the Type of Pond. Note that full optimization is no longer an option when sizing an infiltration pond. This is because infiltration ponds are much less complex than a detention pond. Enter 1.500 in/hr for the Hydraulic Conductivity and 50.0 feet for the Depth to Water Table. Make sure the Low Bio-Fouling Potential button is unchecked. This represents the fact that the infiltration pond may become clogged with leaves or ground cover. Typically, we would check both items but in this problem, we are unchecking the Low bio-Fouling Potential. Click OK to close the input screen.
5. Right click the "Detention Pond 1" (the infiltration pond) and set it to optimize. It should turn blue. Save the file.
6. Click the Simulate tab. Make sure the time step is 15 minutes. Click the Route button. Click Yes on the Warning text box so that MGSFlood optimizes the infiltration pond design.
7. When the simulation has finished, the flow duration and peak discharge graphs look like the following:

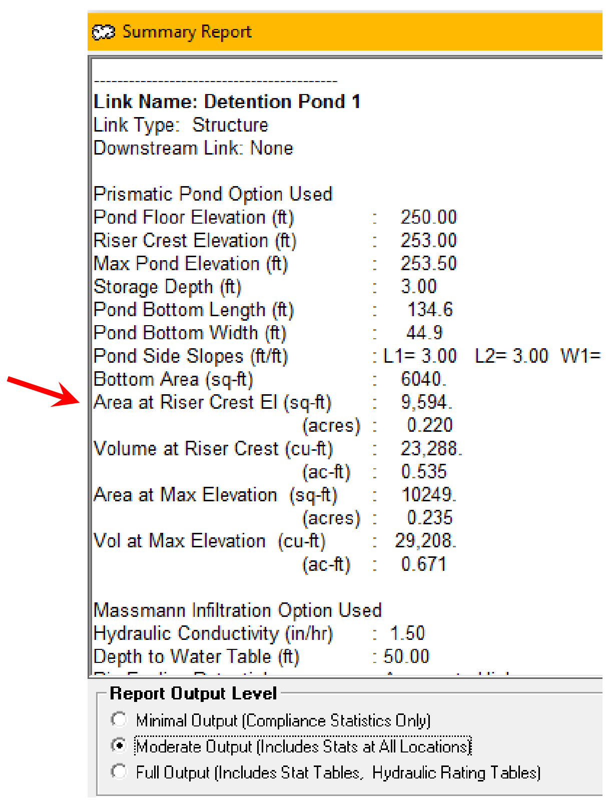




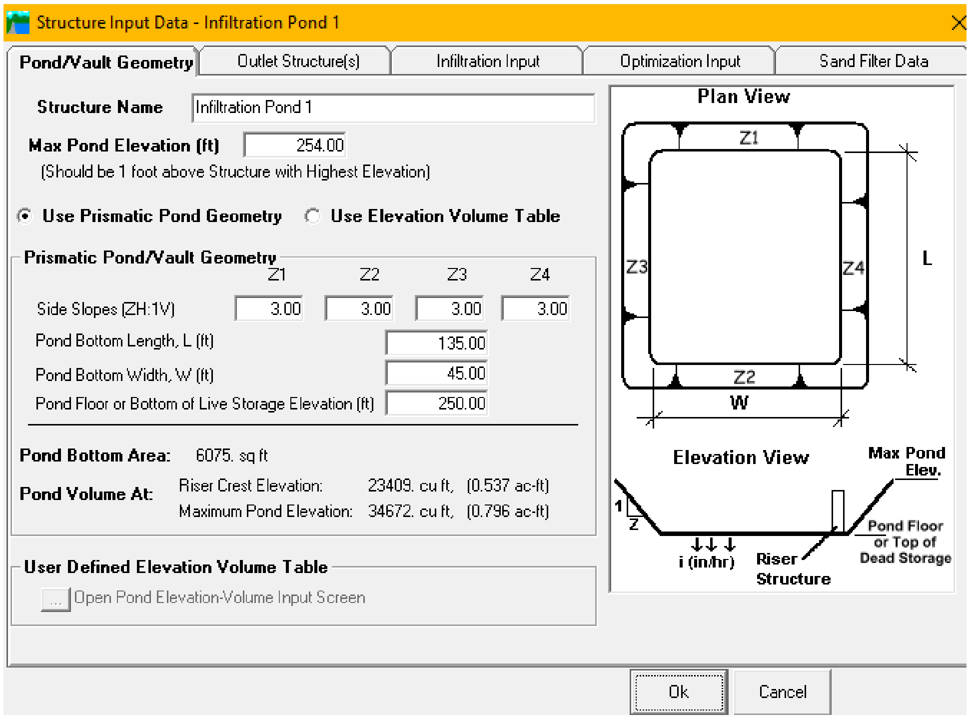
Note that the post development duration and frequency statistics plot well below the predeveloped. This is because an infiltration pond is designed to infiltrate all runoff up to the 50-year recurrence interval. Floods larger than the 50-year recurrence interval discharge through the overflow structure and contribute to downstream runoff.

8. Click on the Post Developed Scenario Screen and then open the link definition for the pond. Note the Pond Volume determined by the optimizer (approximately 0.535 ac-ft at the riser crest elevation).

9. Check to make sure the calculated pond area fits in the assumed pond tract area. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



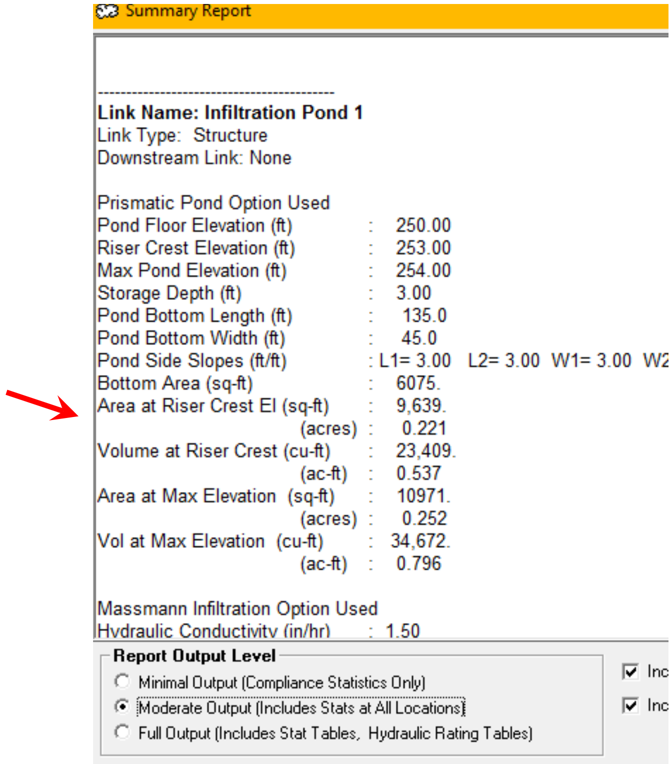
10. On the Scenario Tab, right click the New Structure Lnk1 (infiltration pond) and click Edit. Change the name to Infiltration Pond 1. Change the maximum pond elevation to 254.00. Also, round off the length to 135.00 ft. and width to 45 ft. Click OK to close. Save the project.



11. Right click on the Infiltration Pond 1 icon and toggle the optimizer off.

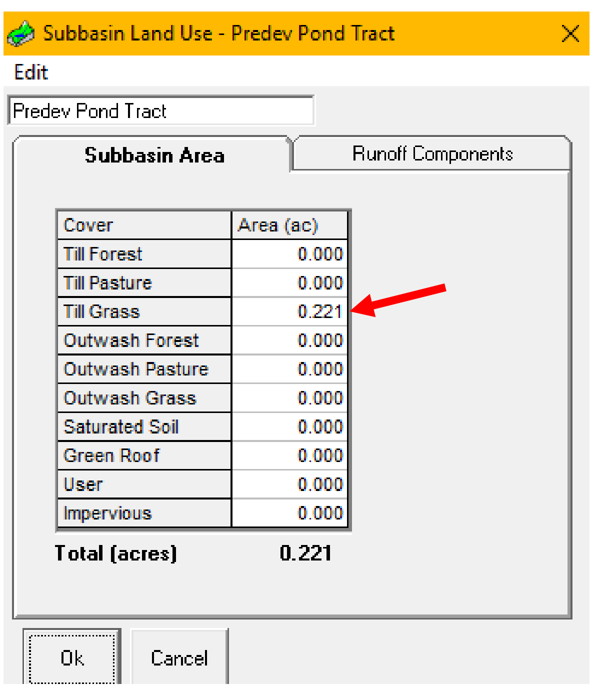
12. Click the Simulate tab and click Route. The pond should still meet the duration standard.

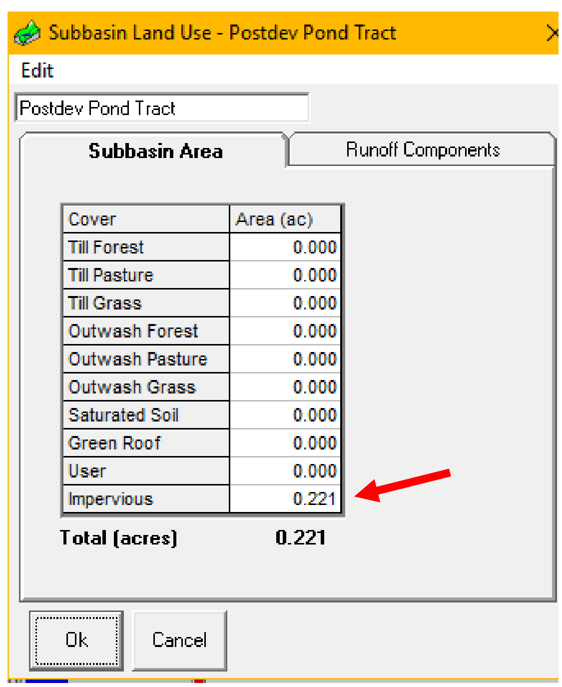
13. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



Initially, the pond tract was guessed to be 0.413 acres. The pond area is 0.221 acres. The proposed pond fits into the pond tract that was guessed. The designer should try to reduce the size of the assumed pond tract to become closer in size with the calculated pond area. Consider setting the pond tract at 0.221 acres.

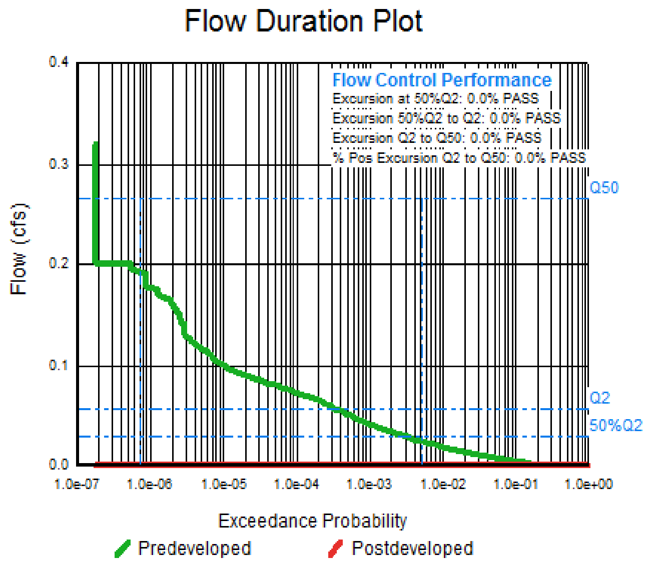
14. On the Scenario Tab, enter 0.221 acres for the pond tract area in the Predeveloped and Postdeveloped scenarios as shown below. Click OK and SAVE.



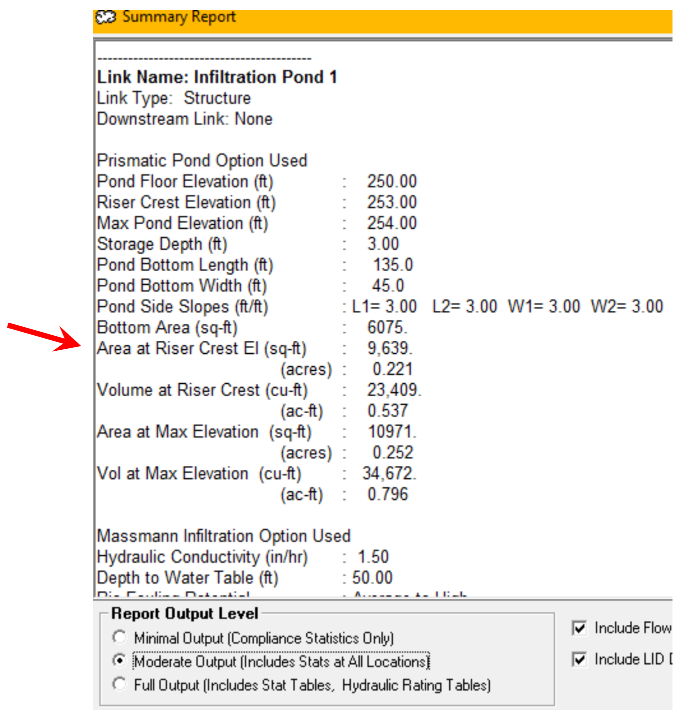


15. Click the Simulate Tab. Click the Route Button.

16. The pond still meets the required performance.



13. Check to make sure the calculated pond area fits in the assumed pond tract area. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.


Summary Report

Link Name: Infiltration Pond 1
Link Type: Structure
Downstream Link: None

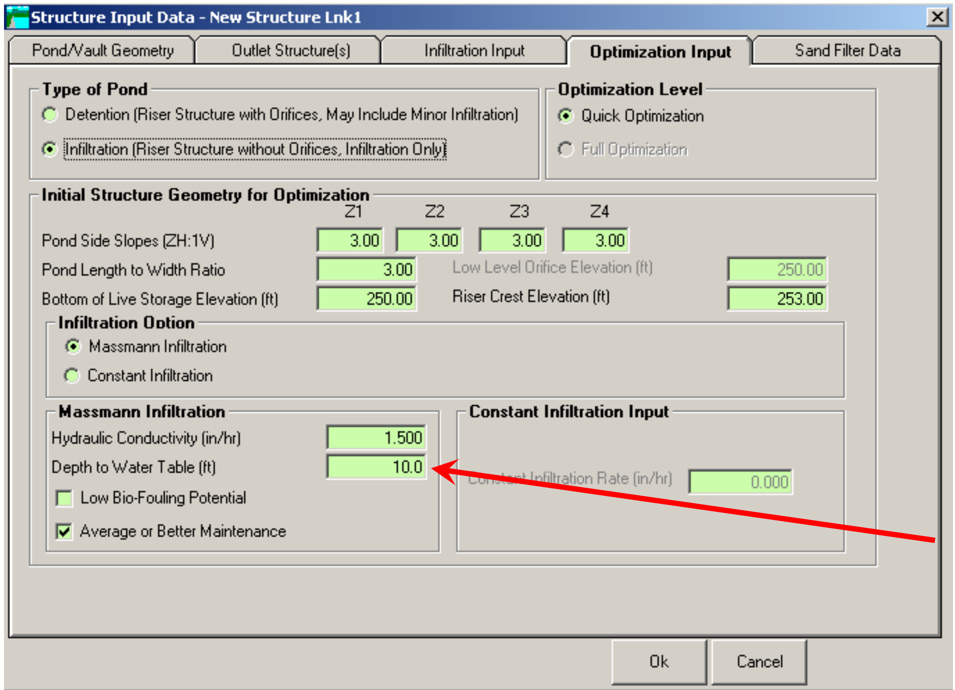
Prismatic Pond Option Used
Pond Floor Elevation (ft) : 250.00
Riser Crest Elevation (ft) : 253.00
Max Pond Elevation (ft) : 254.00
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 135.0
Pond Bottom Width (ft) : 45.0
Pond Side Slopes (ft/ft) : L1= 3.00 L2= 3.00 W1= 3.00 W2= 3.00
Bottom Area (sq-ft) : 6075.
Area at Riser Crest El (sq-ft) : 9,639.
(acres) : 0.221
Volume at Riser Crest (cu-ft) : 23,409.
(ac-ft) : 0.537
Area at Max Elevation (sq-ft) : 10971.
(acres) : 0.252
Vol at Max Elevation (cu-ft) : 34,672.
(ac-ft) : 0.796

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 1.50
Depth to Water Table (ft) : 50.00

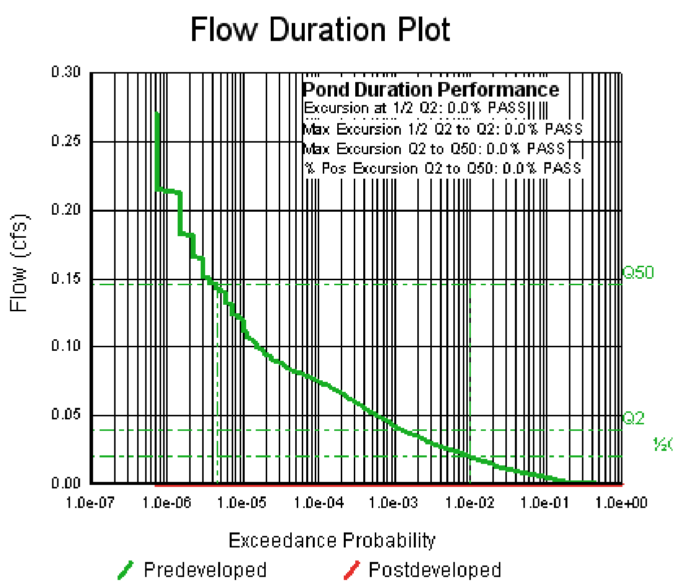
We guessed the pond tract to be 0.221 acres. The pond area is 0.221 acres at the riser crest elevation. <u>The calculated pond fits into the guessed pond tract area. To finish off the pond design, the designer needs to size the overflow and emergency overflow spillways/structures as discussed in the HRM BMP IN.02 Infiltration Pond. These hand calculations are not discussed in these MGSFlood example problems.</u>

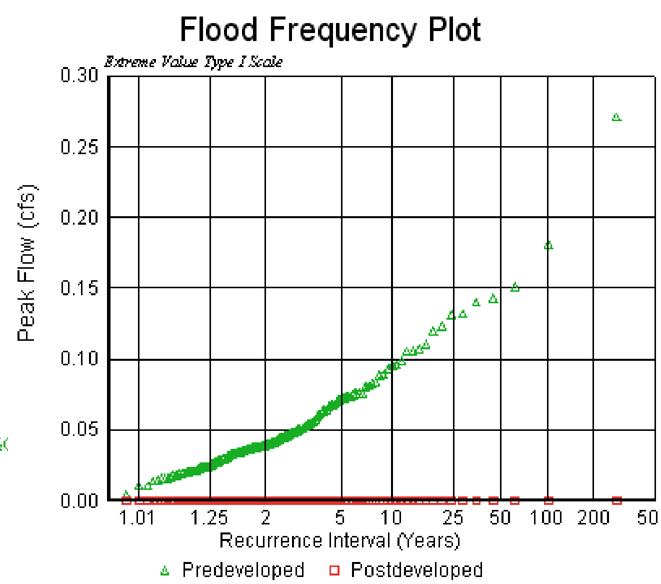
Let's see how a shallow groundwater table influences the performance of an infiltration facility. Previously, the depth to groundwater was set to 50 feet. We will look at a depth to ground water of 10 feet. Again, use the final Work Session 1 file and change the detention pond to an infiltration pond. Use the Optimizer to size a pond with a depth to groundwater of 10 feet.

1. Click the Optimization tab and change the depth to water table to 10 feet.

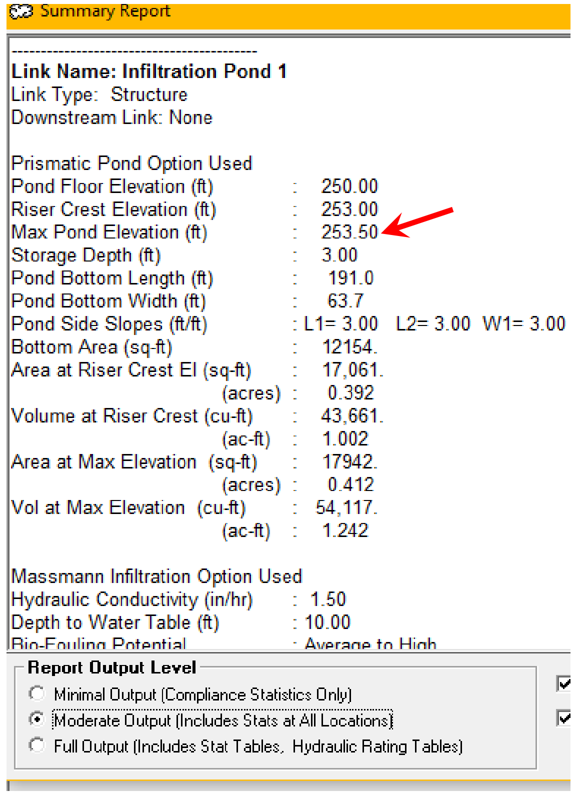


2. Right click on the Infiltration Pond 1 icon and toggle the optimizer on. It should turn blue.
3. Click Ok and then Click the Simulate tab. Click the Route button. Click Yes on the Warning text box to optimize the infiltration pond design.
4. When the simulation has finished, the flow duration and peak discharge graphs look like the following:



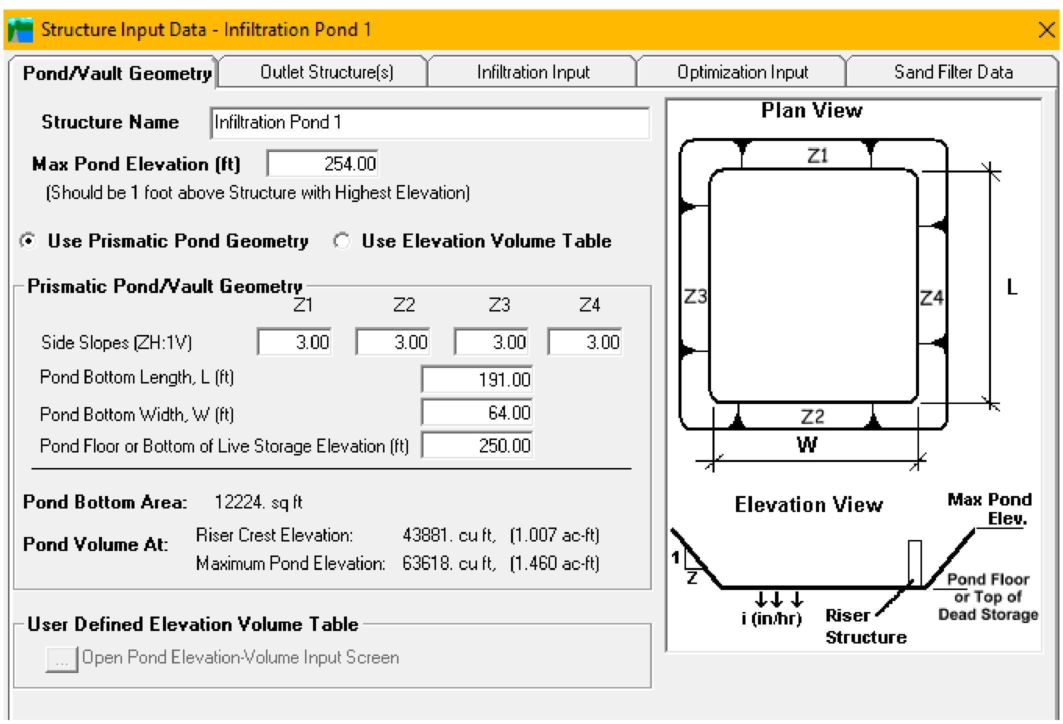


5. Check to make sure the calculated pond area fits in the assumed pond tract area. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



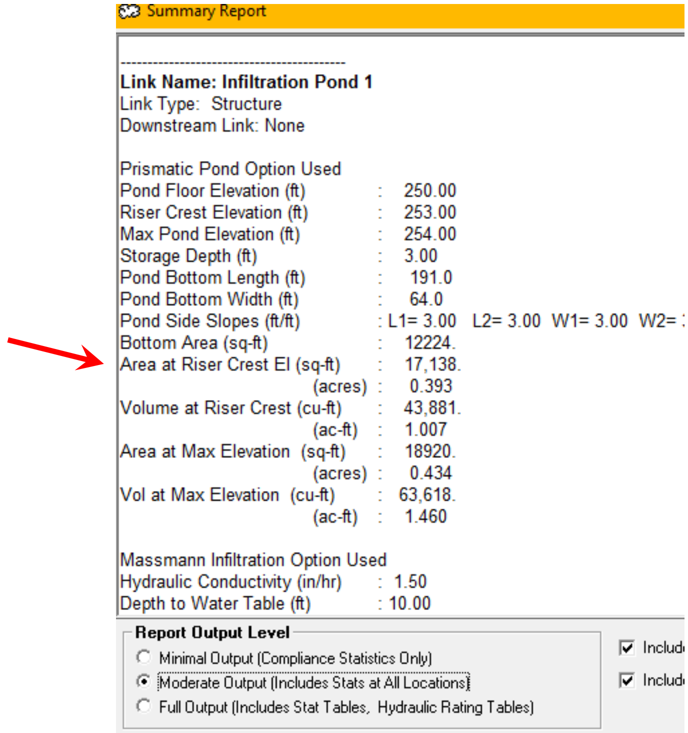
The designer needs to go back and set the maximum pond elevation at 254.00 to account for the 1 foot of freeboard requirement.

6. On the Scenario Tab, right click the Detention Pond 1 (infiltration pond) and click Edit. Change the maximum pond elevation to 254.00. Also, round off the length to 191.00 ft. and width to 64.00 ft. Also, change the name to Infiltration Pond 1. Click OK to close. Save the project



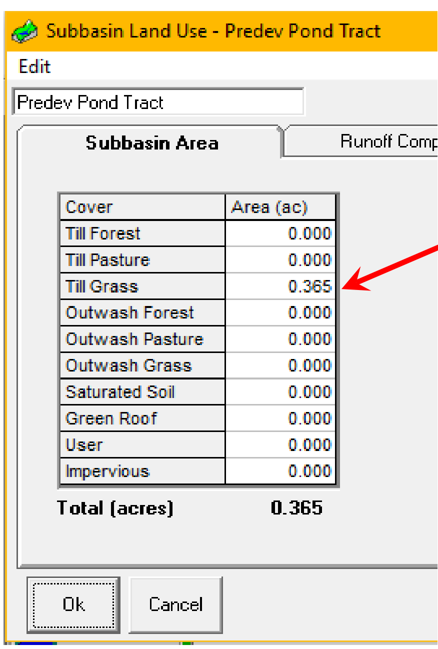
7. Right click on the Infiltration Pond 1 icon and toggle the optimizer off. It should turn yellow.
8. Click the Simulate tab. Make sure the time step is 15 minutes. Click the Route button. The pond should still meet the duration standard.

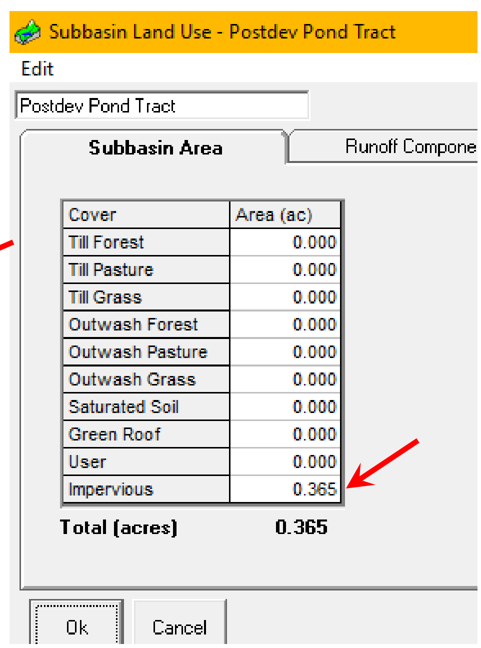
9. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



Initially, the pond tract was guessed to be 0.413 acres. The pond area at the riser crest is 0.393 acres. <u>The designer should go back to the predeveloped and developed scenarios and change the guessed pond tract since there is room to make the pond tract smaller. Consider setting the pond tract at 0.365 acres and reducing the pond dimensions to 200 feet x 55 feet. This was found after several iterations.</u>

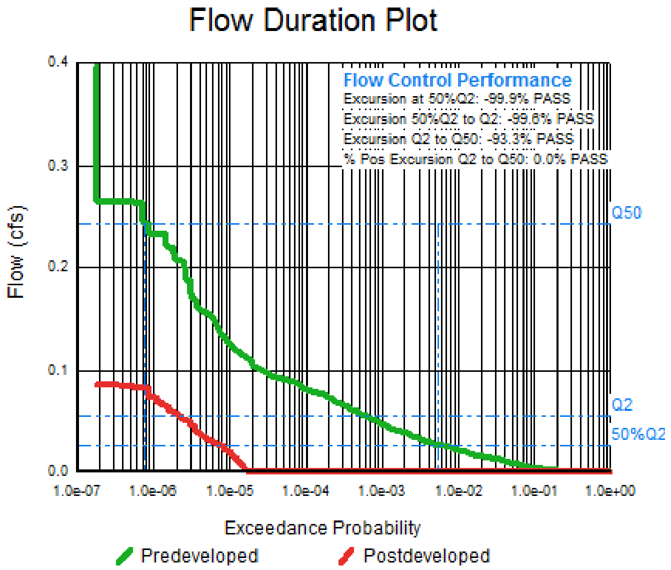
10. On the Scenario Tab, enter 0.365 acres for the pond tract area in the Predeveloped and Postdeveloped scenarios as shown below.

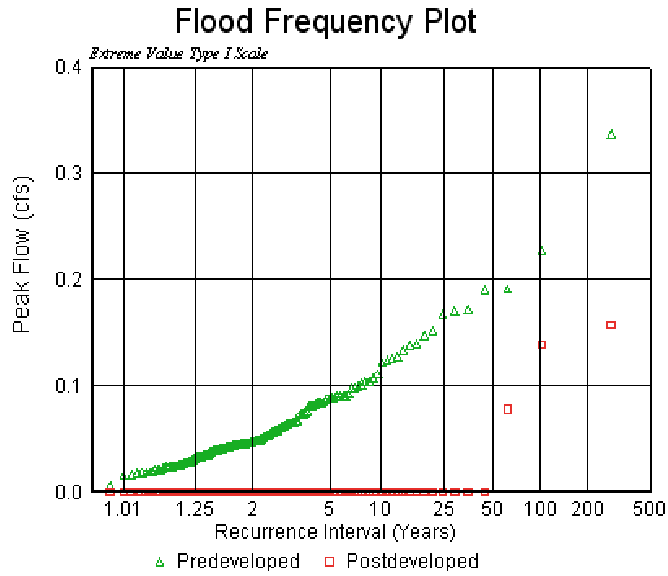




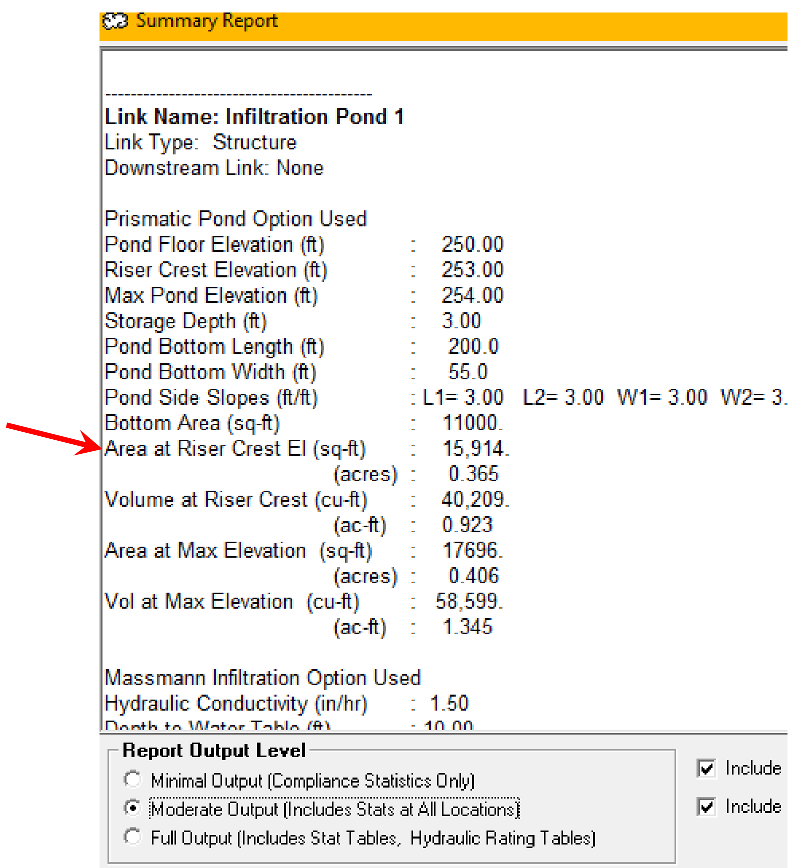
11. Click the Simulate tab. Click the Route button.

12. When the simulation has finished, the design meets the flow duration standard. The flow duration and peak discharge graphs look like the following:





13. Check to make sure the calculated pond area fits in the assumed pond tract area. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor.



The pond tract was guessed to be 0.365 acres. The pond area at the riser crest 0.365 acres. <u>The calculated pond fits into the guessed pond tract area. To finish off the pond design, the designer</u>

needs to size the overflow and emergency overflow spillways/structures as discussed in the HRM BMP IN.02 Infiltration Pond. These hand calculations are not discussed in these MGSFlood example problems.

COMPARISON OF RESULTS

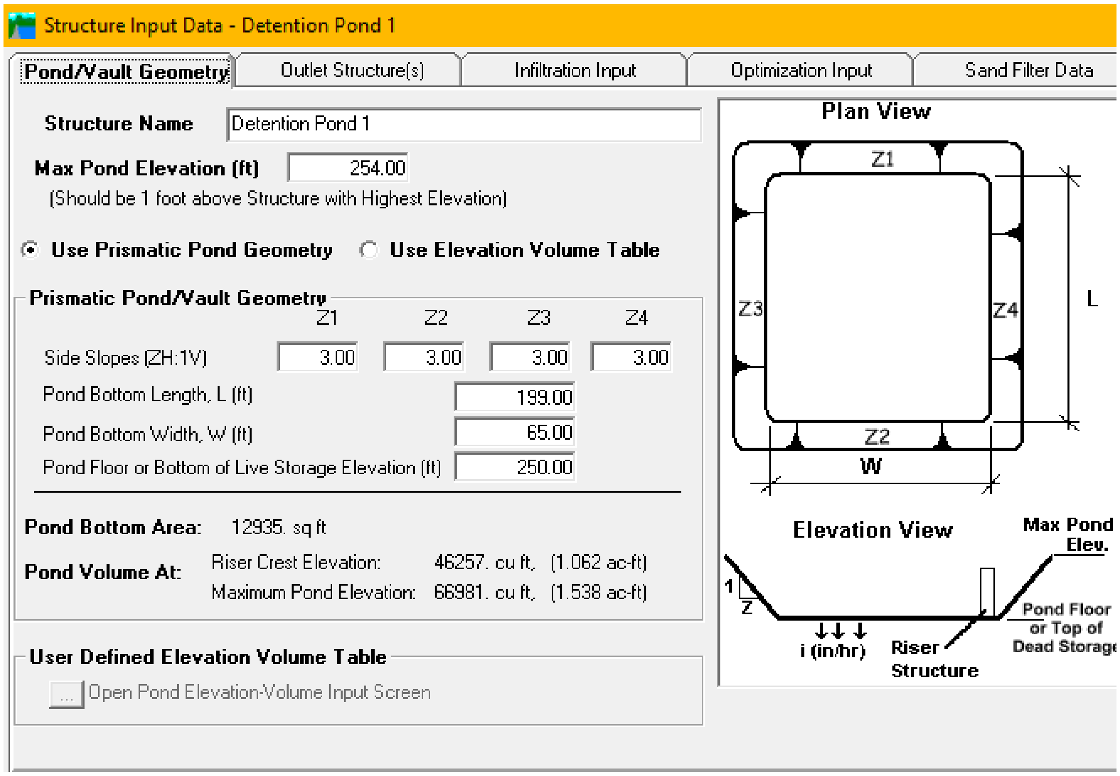
The first simulation in Work Session 3 where the ground water was 50 feet below the infiltration pond gave a pond surface area of 0.221 acres. When the ground water was only 10 feet below the infiltration pond, the resultant necessary infiltration pond surface area of 0.365 acres at the maximum pond elevation. The higher groundwater table causes a groundwater mound to form quickly beneath the pond and reduces the effective infiltration rate. **The necessary infiltration pond area (and volume) increased with the shallower ground water table. In this example it increased by about 65%.**

Take Away Message: When you have a high ground water table, you have less infiltration capacity and you BMP volume and area will be very large!

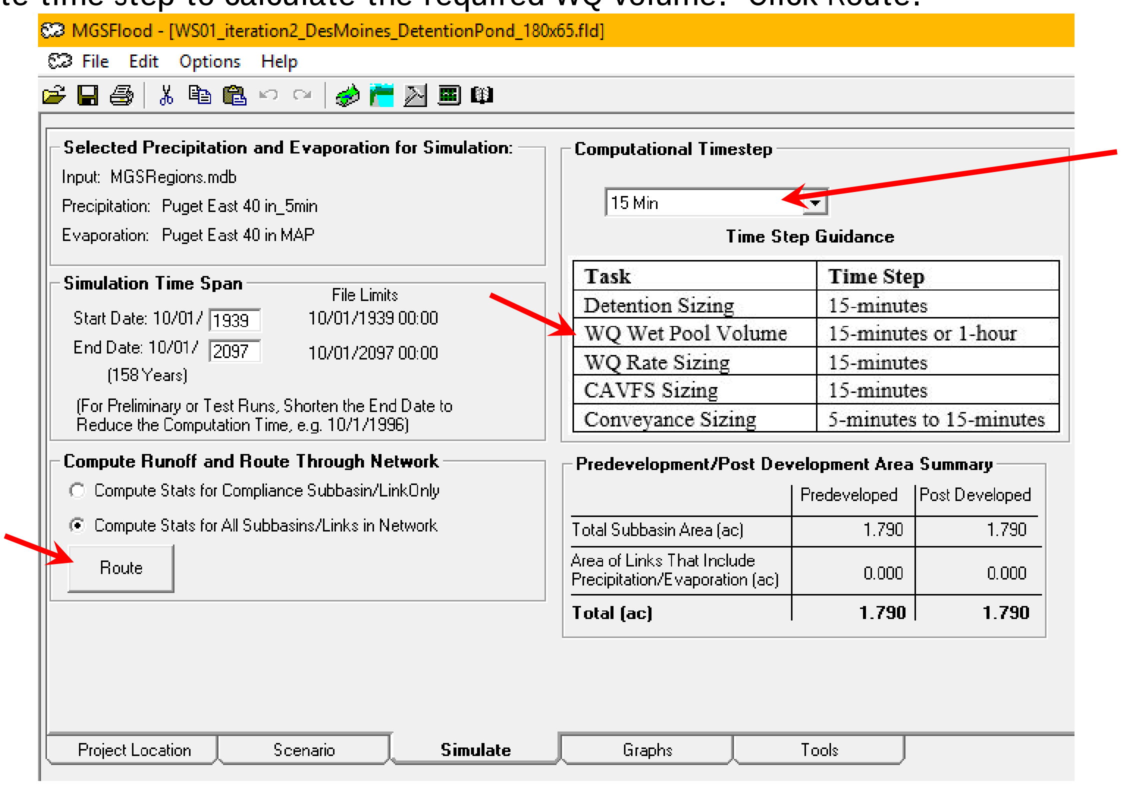
Work Session 4 – Water Quality Design – Wet Pool Volume

Determine a "Large" wet pond volume required for the <u>Work Session 1</u> roadway widening example.

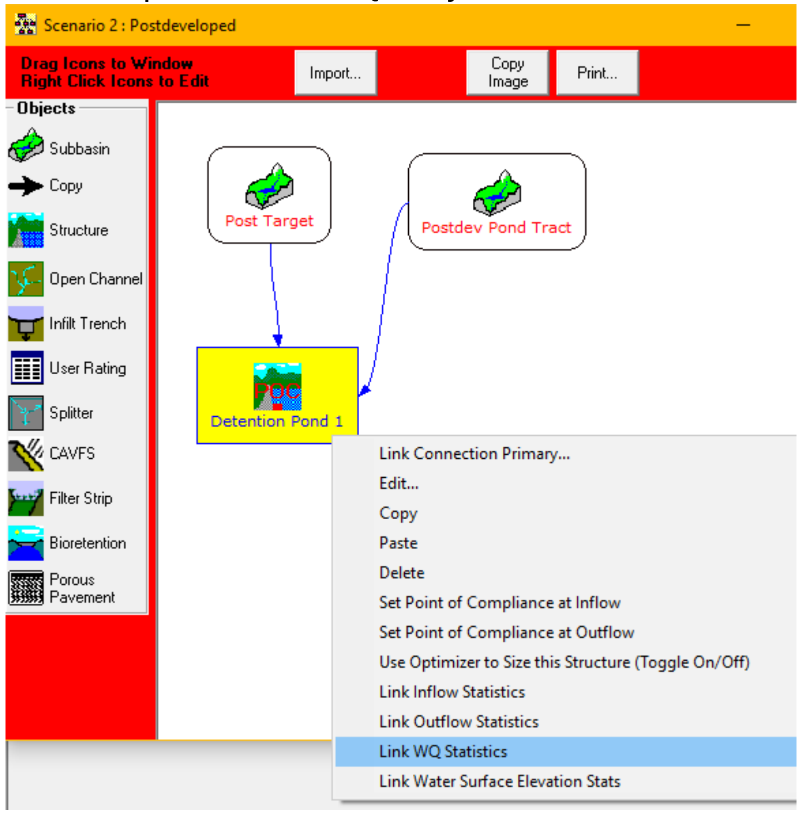
1. Open the file called, "WS04_WQDesign_START.fld". The file should have a detention pond with dimensions of:



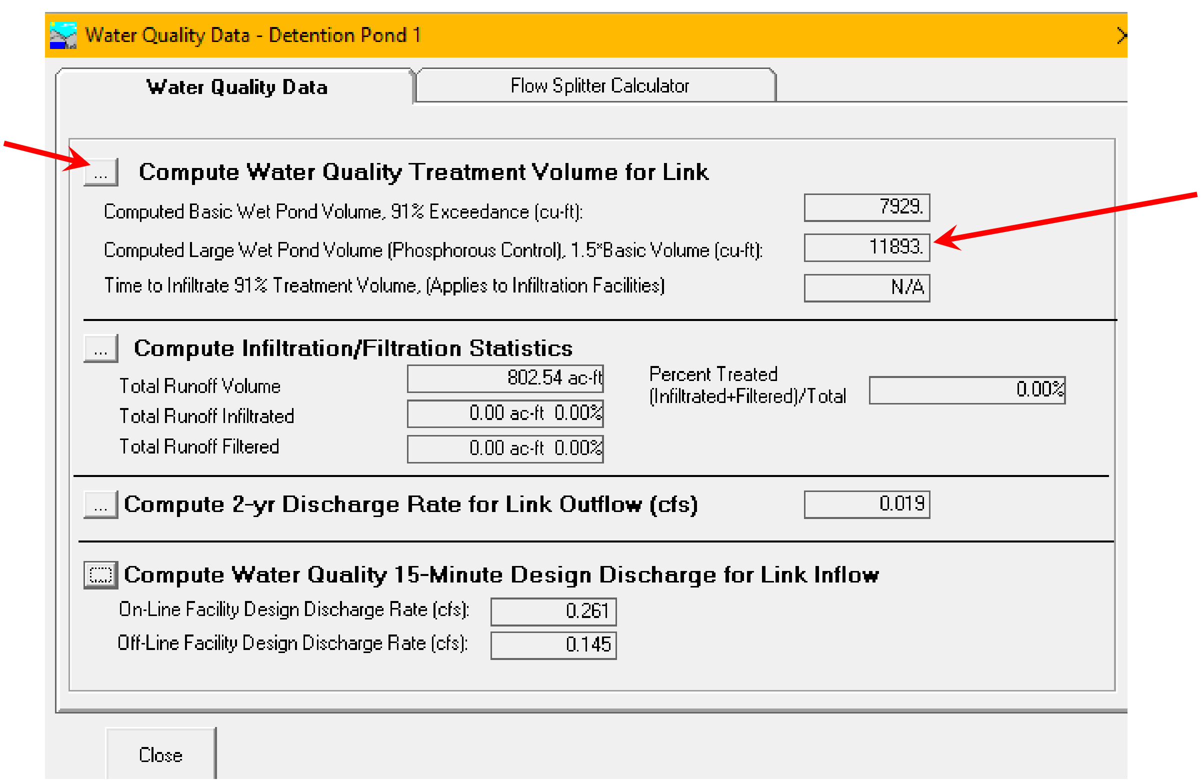
2. Click the Simulate tab. For Water Quality Wet Pool Volume based BMPs, WSDOT uses the 15-minute time step to calculate the required WQ volume. Click Route.



3. Click the Scenario Tab and Open the Post Developed Scenario Window.
4. Click the Detention Pond 1 to select it and then right click to show the menu. Select Link WQ Statistics. This will open the Water Quality statistics window for the link.



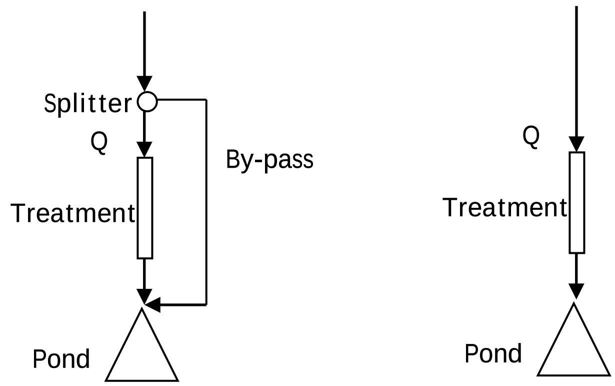
The basic wet pond volume is calculated using the Link Inflow Statistics. Click the Compute Water Quality Treatment Volume button. The results will be displayed on the form. The "Large" wet pond volume is also provided, which is the basic volume multiplied by 1.5.



Work Session 5 – Water Quality Design for a Biofiltration Swale

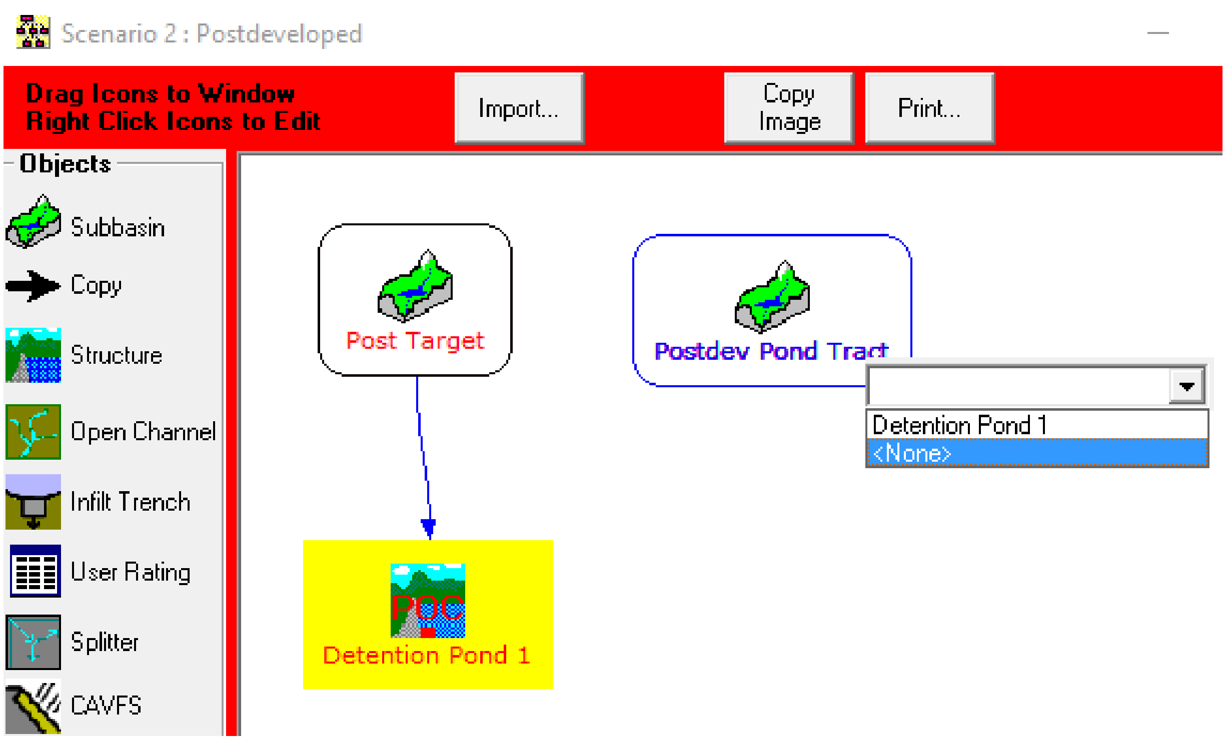
Determine the water quality flow rate to a biofiltration swale that is just upstream of the detention pond in the Work Session 1 roadway widening example. This is referred to as Qwq when using the WSDOT bioswale design spreadsheets.

Bioswales are sized using the water quality design discharge rate. For treatment upstream of the pond, the "on-line" or "off-line" design discharge rate is used. For treatment downstream of the pond, the 2-year discharge rate is used. For the project above, determine the "on-line" and "off-line" design discharge rates.

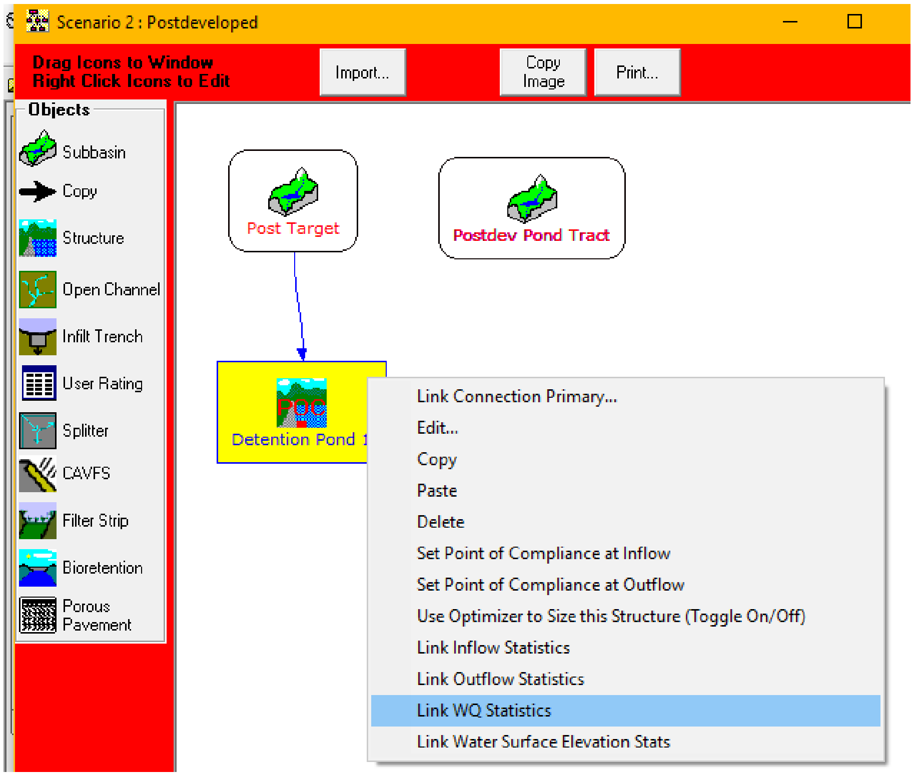


Upstream of Detention Facility, Off-Line | **Upstream of Detention Facility, On-Line**

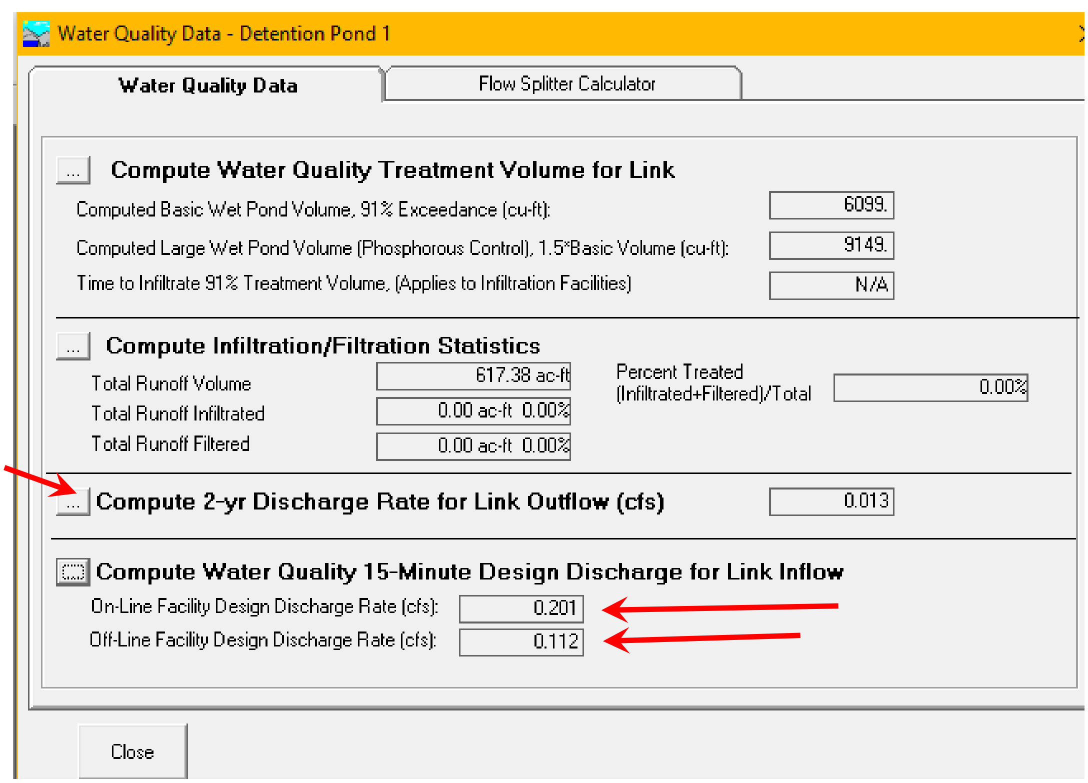
1. Open the file called, "WS05_Bioswale_START.fld".
2. In the postdeveloped scenario, select the Developed Pond Tract basin and disconnect it from going to the Detention Pond 1. We are only interested in the flows from the postdeveloped basin. The bioswale is upstream of the detention pond so the area from the Pond Tract should not be included in the flows to be calculated for Qwq for the bioswale design.



3. Click the Simulate tab. Click the Route button.
4. Once done routing, click the Scenario Tab and Open the Post Developed Scenario Window.
5. Click the Detention Pond 1to select it and then right click to show the menu. Select Link WQ Statistics. This will open the Water Quality statistics window for the link.



6. The Water Quality Data Tab will show the water quality flow rates and volumes once the radial buttons are pushed. In this case, for a bioswale that is online and upstream of the detention pond, Qwq = 0.201 cfs while an offline bioswale has Qwq = 0.112 cfs.

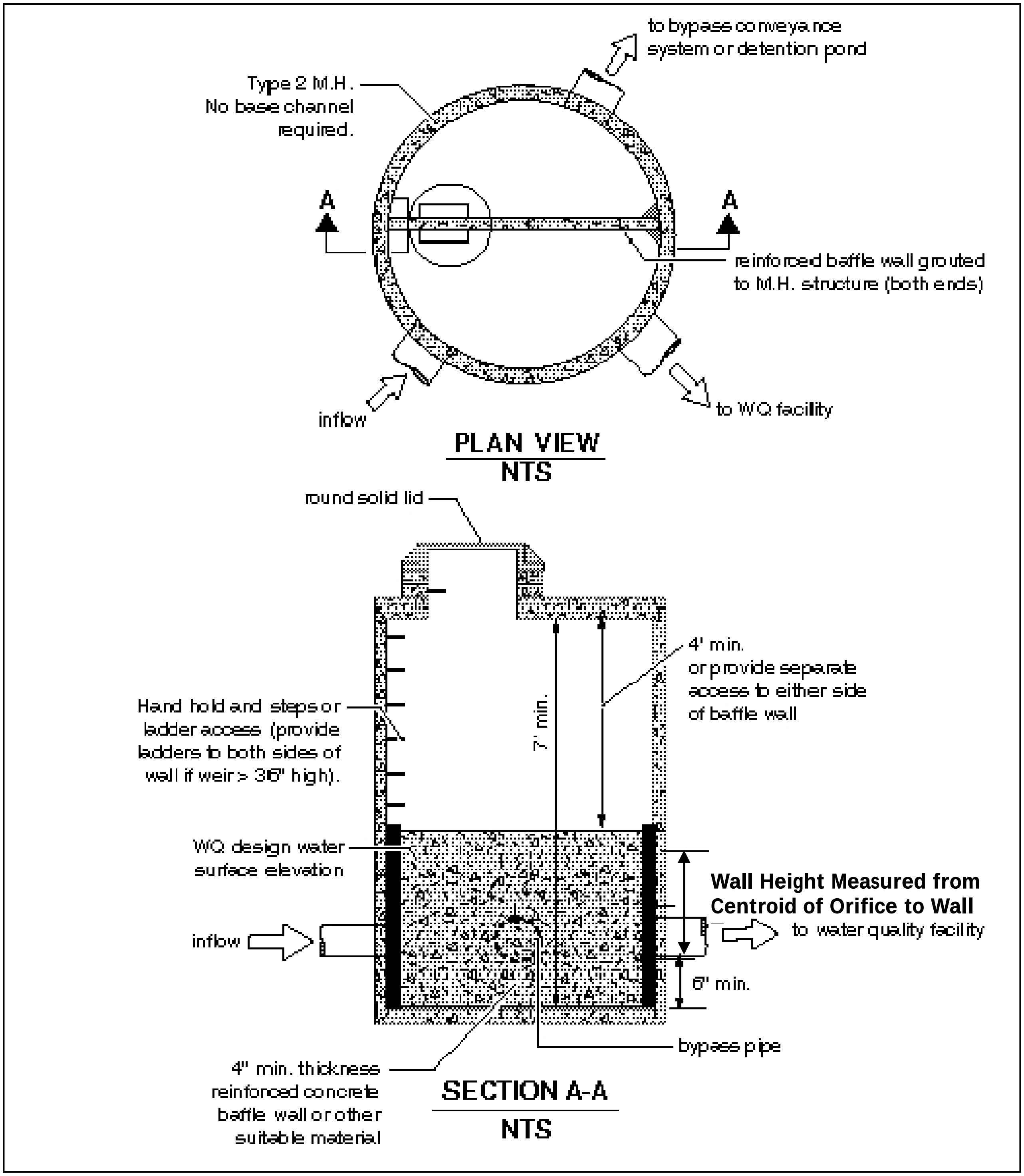


Determine the geometry of the "off-line" Flow Splitter Structure that will fit in a 48" diameter manhole.

When an *off-line* treatment approach is used, a flow-splitter is needed for bypassing flows that exceed the design flow rate. The splitter structure includes an orifice and on overflow weir (see figure below), and the design guidelines are listed below.

- The maximum head on the overflow weir must be minimized for flow in excess of the water quality design flow. Specifically, flow to the water quality facility at the 100-year water surface must not increase the design water quality flow by more than 10-percent.
- The splitter structure requires an orifice plate upstream of the discharge pipe that leads to the water quality treatment facility. The design water surface should be set to provide a minimum headwater/diameter ratio of 2.0.

The splitter design is a trial and error procedure whereby the orifice diameter is selected by the user. The program then computes the height of the baffle wall, the length of the overflow weir, and the ratio of the baffle wall height to orifice diameter. There is not a unique solution and the user should select an orifice size that produces a baffle wall height and overflow length that will conveniently fit in a standard manhole (or other structure) and meets the required headwater/diameter ratio of 2.0.



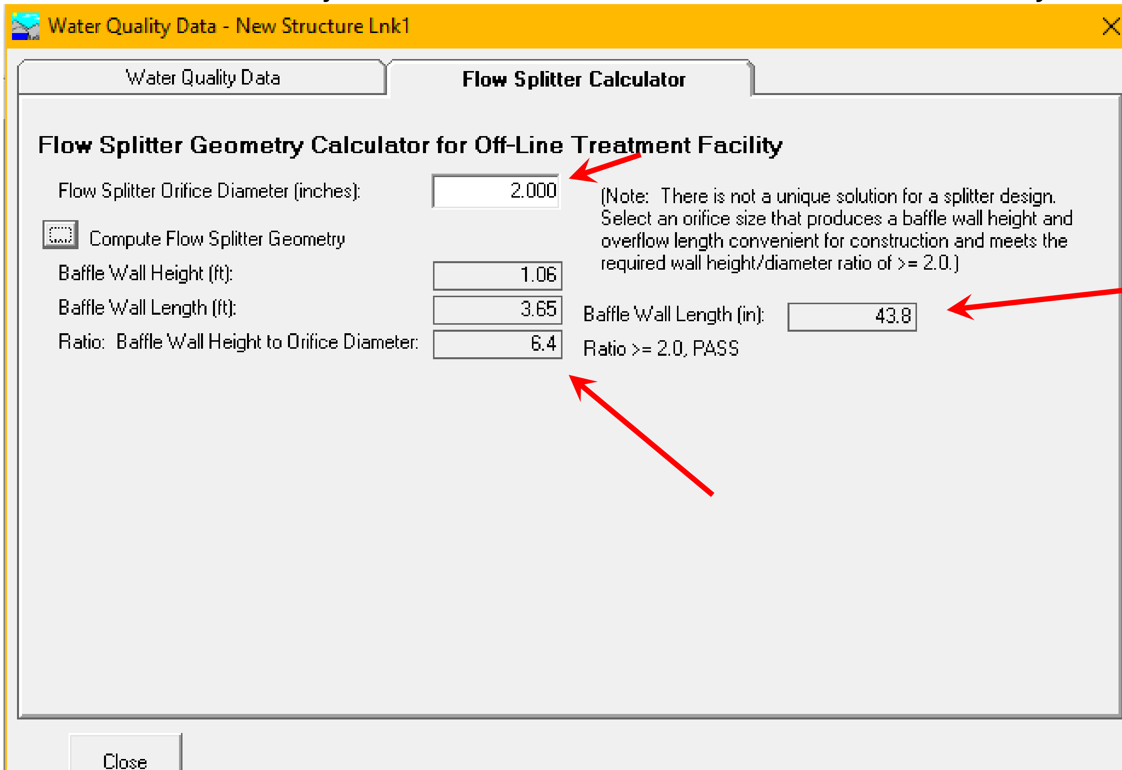
Flow Splitter Geometry (per Ecology Stormwater Management Manual)

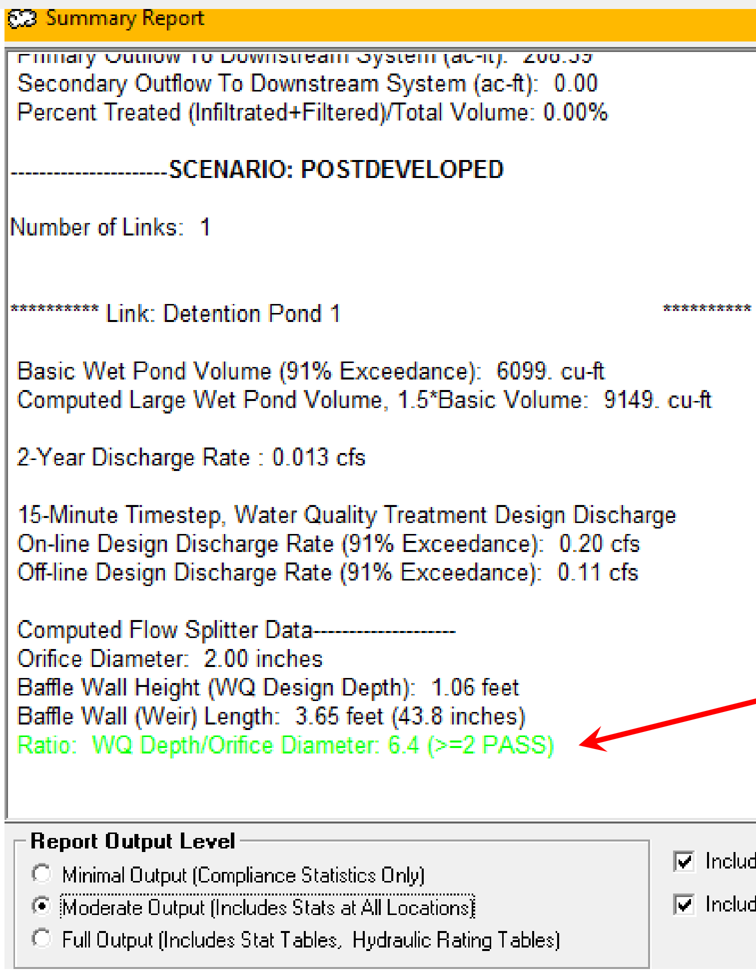
Flow Splitter Example

The project has the subbasin set up in Work Session 5. The project wants to utilize an off-line bioswale for runoff treatment. The designer needs to figure out the flow splitter design. Assume the flow splitter will be in a 48" diameter manhole. Using Work Session 5,

1. Click the Flow Splitter Calculator Tab. Enter an orifice size of 6", Click the Compute Flow Splitter Geometry button. Repeat the process until the Baffle Wall Length just fits in the manhole (48") and the ratio criteria are met
2. Try an orifice size of 4".

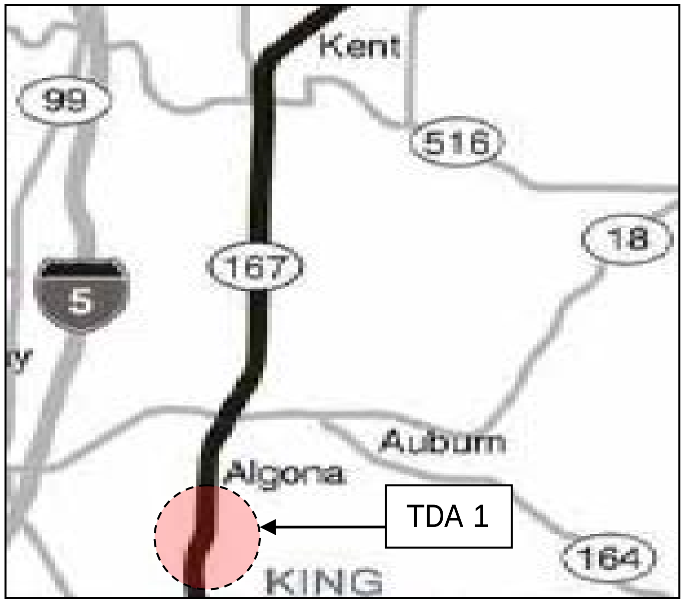
3. An orifice size of 2.0” will just fit inside the 48” manhole and satisfies the hydraulic criteria.





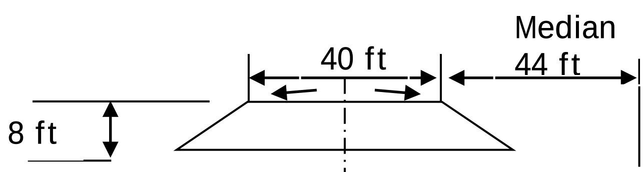
Work Session 6 - Design of CAVFS for Water Quality Treatment

A section of SR-167 near Auburn is to be improved with the addition of a carpool lane for the southbound direction of travel.



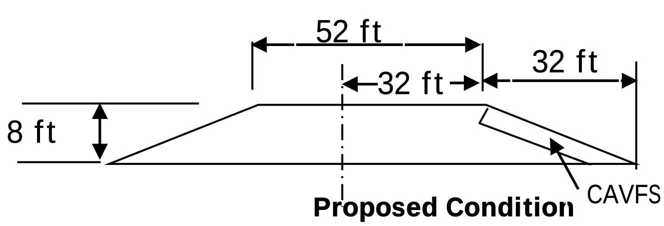
Project Location Map

The existing configuration consists of two 12-foot lanes with 8-foot shoulders. The existing lanes are crowned so that ½ of the runoff drains toward the median.



Existing Condition, South Bound Lanes

The project will add one 12-foot car pool lane while maintaining the current shoulder widths. The roadway widening will extend into the freeway median to accommodate the new lane. The area of roadway draining to the median will be the existing lane (12') plus the new carpool lane (12') plus the shoulder (8') for a total of 32'. The project is in one TDA.



Proposed Condition

The project is located on Alderwood soils, which are classified as SCS Hydrologic Group C. **Design a CAVFS to treat runoff from the impervious surfaces that drain to the median for this 1200-foot-long section of roadway. The CAVFS data are as follows:**

CAVFS Depth: 1 foot
CAVFS Porosity: 20%
CAVFS Hydraulic Conductivity: 1.95 in/hr
CAVFS Length: 1200 feet

CAVFS Width: This is what we are trying to figure out
Underlying Soil Infiltration Rate: 0.01 in/hr
CAVFS Slope: 4H:1V
Gravel Spreader Width: 2 ft
Gravel Spreader Porosity: 30%
Gravel Spreader Hydraulic Conductivity: 2 in/hr

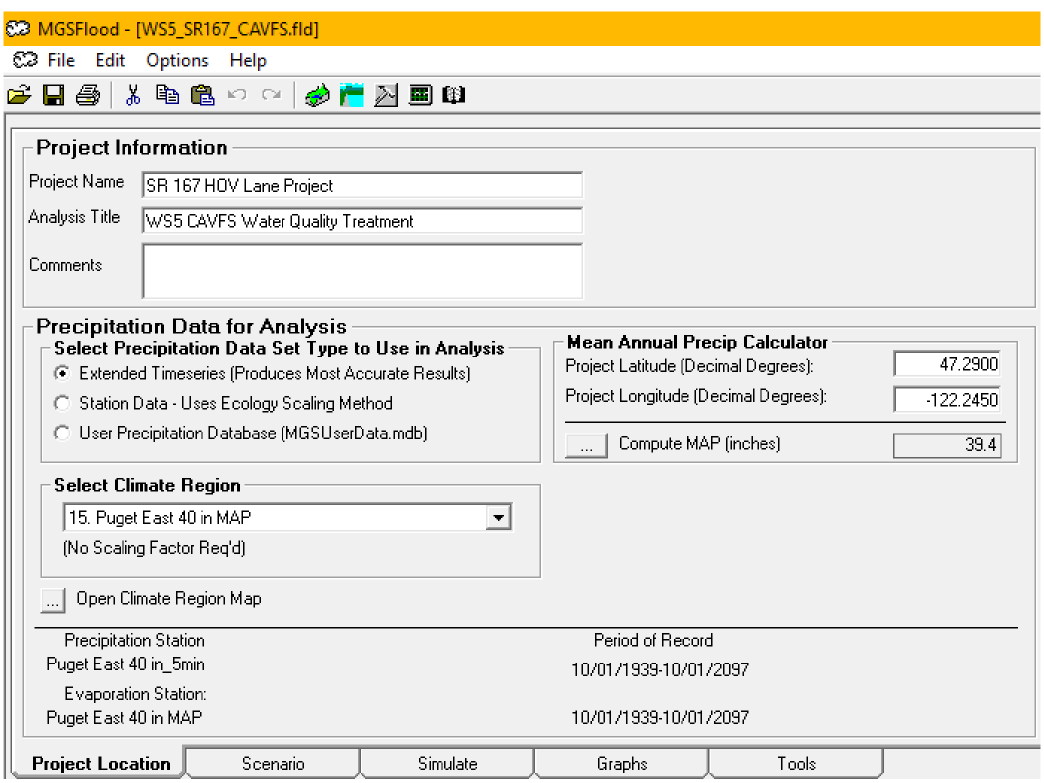
Note designing the CAVFS is a trial and error procedure. We'll input the CAVFS width, run the model, and check the percentage of runoff treated. This process will be repeated until we achieve the 91% volume treatment criteria shown in the history file. The values for the CAVFS input above are for this problem only and should not be used as default values for another design. **The designer should consult a geotechnical engineer to establish project site specific values for the all of the above CAVFS input.** Since this is a WQ design problem, the MGSFlood Inputs Spreadsheet is not needed.

Start Program, Save Project File

1. Start program from Windows Start button
   Start-All Apps-MGS Software-MGSFlood V4
2. Click File Save as, Enter "WS06_CAVFS" for file name. Create project folder when prompted

Project Location Tab

3. Enter project name, analysis title, and comments.
4. Check the Extended Precipitation Timeseries Option Button.
5. Compute the mean annual precipitation using the calculator,
   From Google or the WSDOT Environmental Workbench, Lat=47.29 deg, Long=122.245 deg
6. Select Climate Region 15 Puget East 40 in MAP from the drop down list box.



Land Use Input

7. Enter Pre- and postdeveloped area. For SCS Type C soil, use Till. Note, we're only entering the area that drains to the CAVFS including a guess of what the CAVFS area is in the predeveloped condition.

Predeveloped:

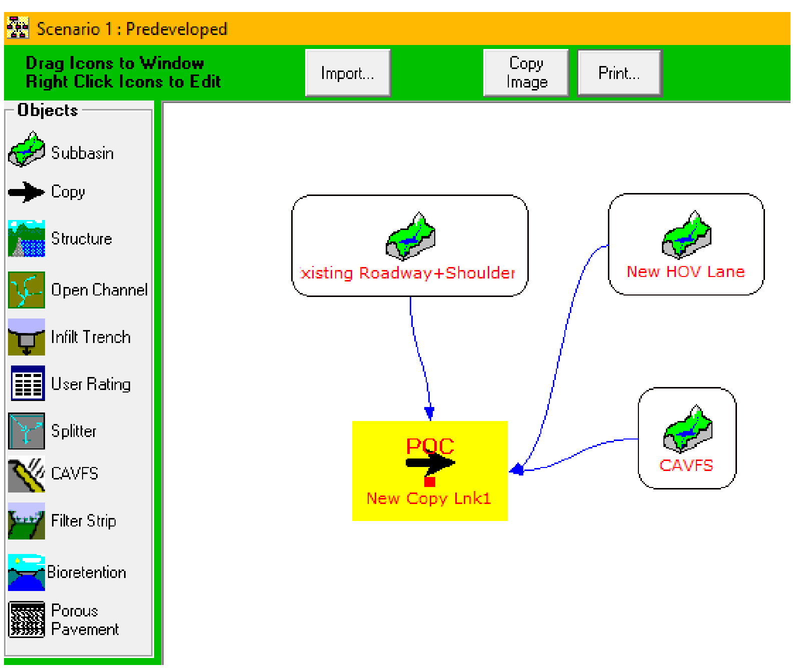
Till Forest:
Existing median that will become new HOV lane:
12' x 1,200' = 14,400/43560 = 0.331 ac
Till Grass:
Existing median that will become a CAVFS = guess a width = 8' x 1200' = 9,600/43,560= 0.220 ac
Existing Impervious:
Impervious roadway from the road crown towards the median:
(12'+8') x 1,200' = 24,000/43,560= 0.551 ac
Total predevelopment Area: 1.102 ac

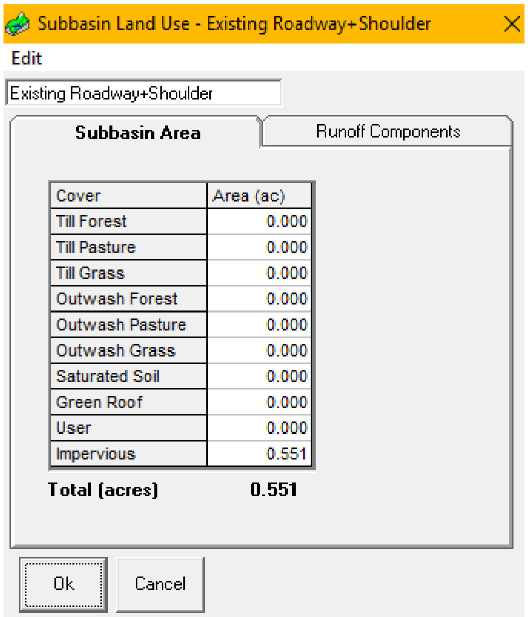
Postdeveloped:

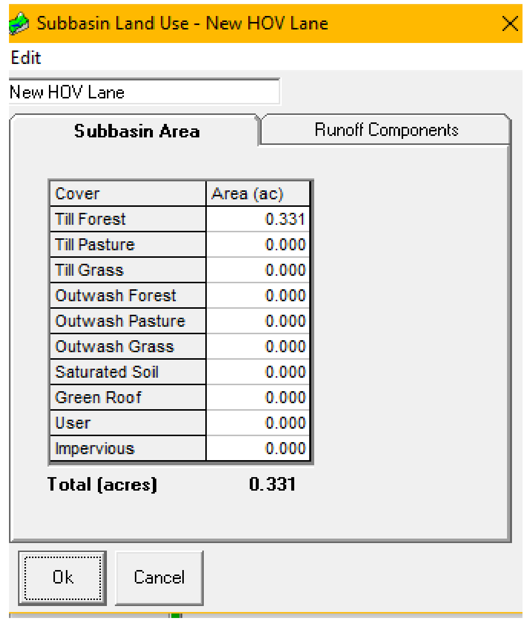
Precipitation will be simulated on the CAVFS by the CAVFS routine, therefore we don't need to specify this area on the Land Use tab.

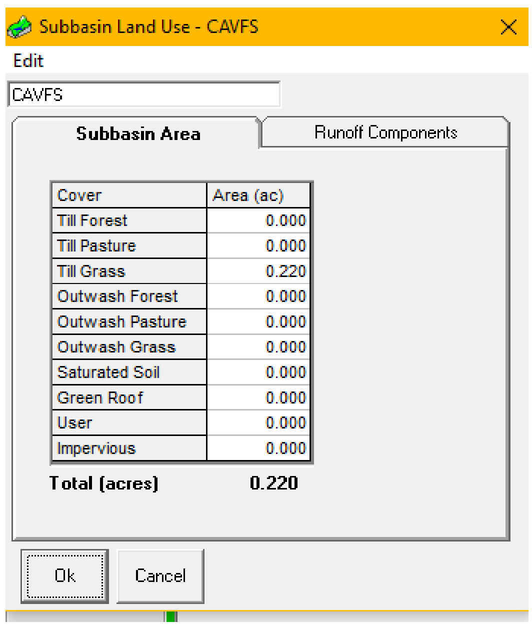
Existing Impervious:
Impervious roadway from the road crown towards the median:
(12'+8') x 1,200' = 24,000/43,560= 0.551 ac
New Impervious:
Existing median that will become new HOV lane:
12' x 1,200' = 14,400/43560 = 0.331 ac

8. Click the Scenario tab and Open the Predeveloped Scenario. Drag three subbasins into the window. Drag a copy link into the window. Connect the three subbasins to the copy link. Right click the copy link and make it the point of compliance at the outflow. Right click each subbasin and input the below information. Enter the land use as follows: (Note: We're only interested in the Post developed runoff for this step for water quality treatment design. It's somewhat irrelevant what land use we put in for the existing condition.)

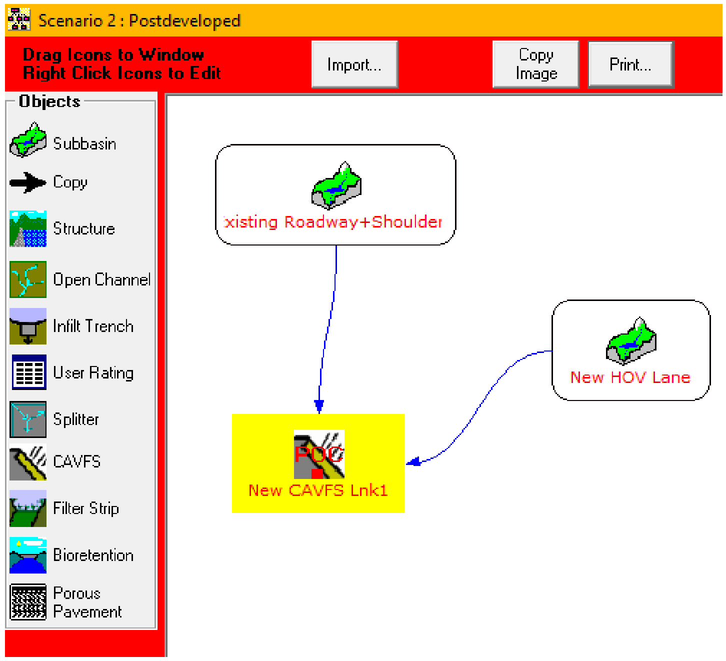


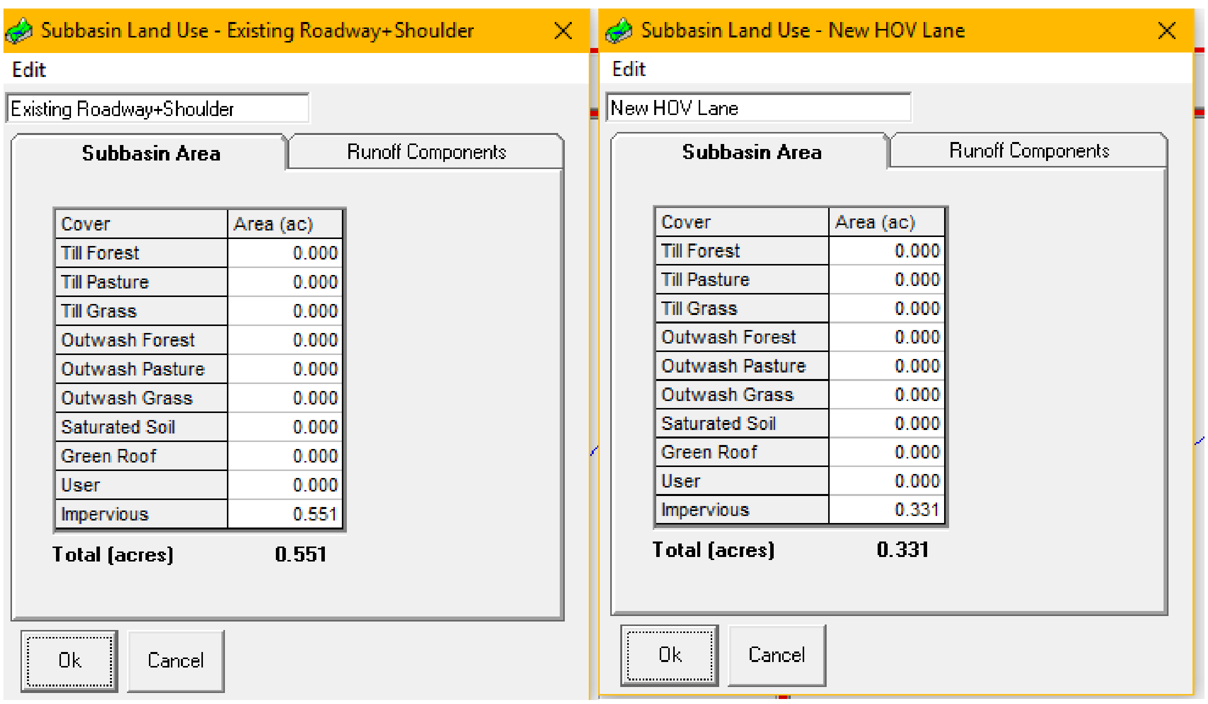




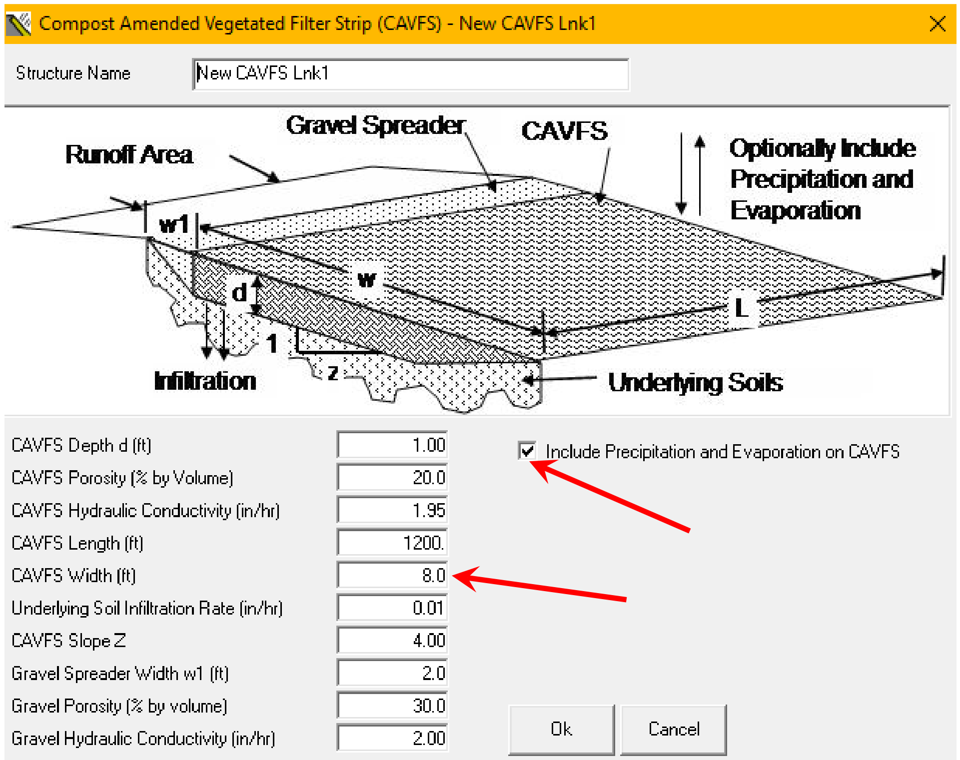


9. Open the Post Developed Scenario. Drag two subbasins and a CAVFS link into the window. Connect the subbasins to the CAVFS by right clicking each subbasin and selecting Link Connection Primary and choose the New CAVFS Lnk1. Right click each subbasin and select edit. Enter the land use as follows and click OK:





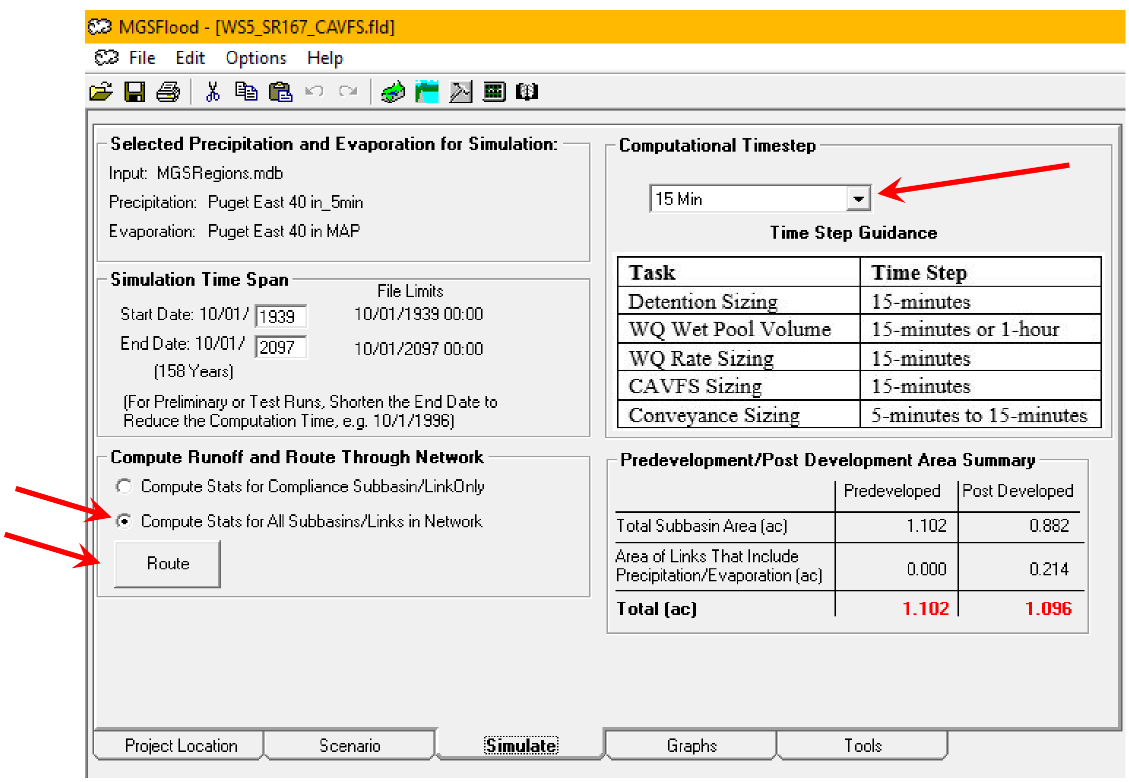
10. Click the CAVFS Link to Select it. Click Edit and enter the following data for the CAVFS geometry. We guessed an 8-foot width in the predeveloped condition to establish the CAVFS area. Check the option box to include precipitation and evaporation on the CAVFS. Enter the remainder CAVFS information as follows:



11. Click OK, save your input, and click the Simulate tab.

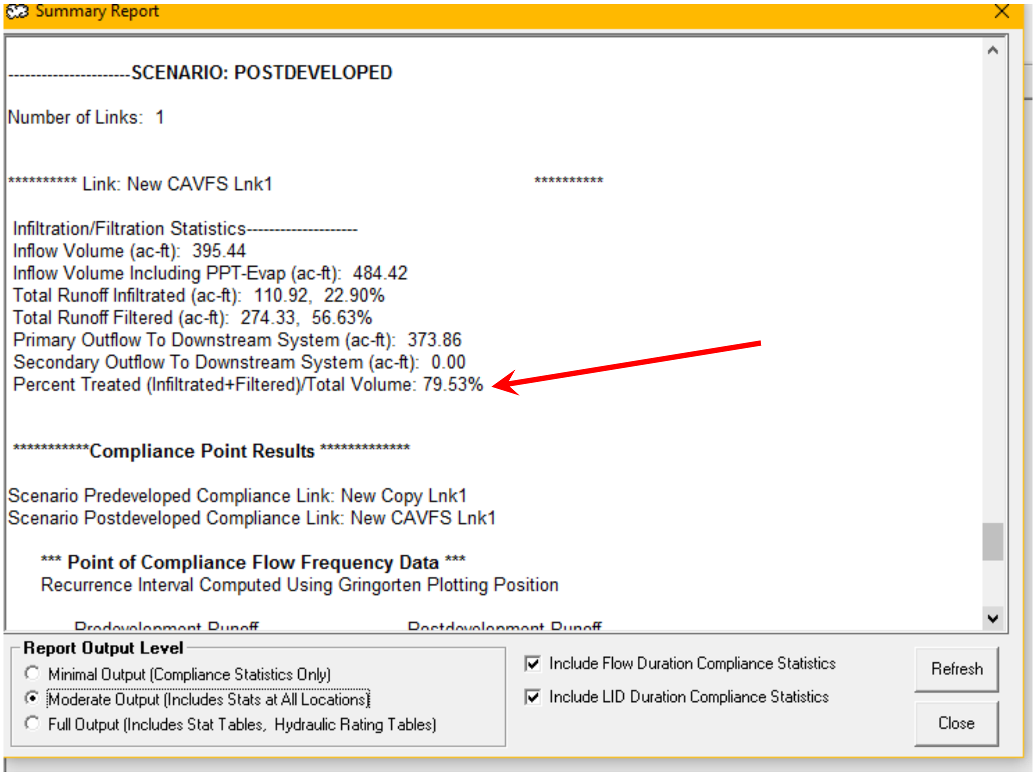
Simulate Tab

12. Select a time step of 15-minutes.

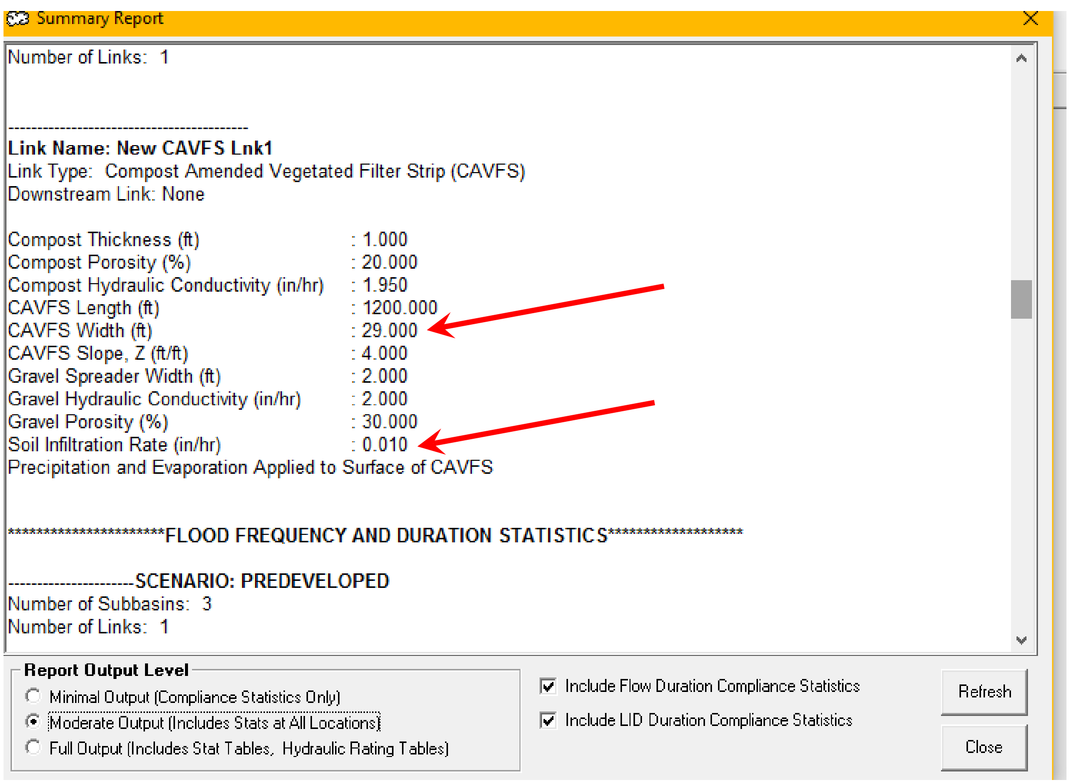


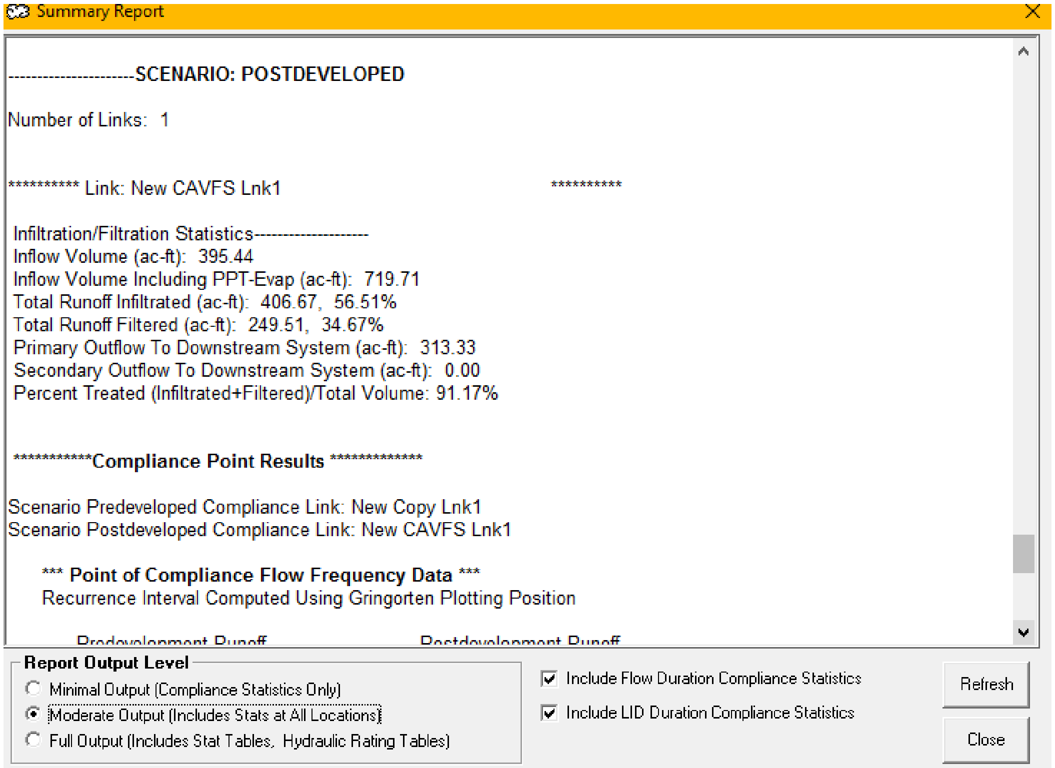
13. Click the *Route* button. When the simulation is complete, the duration performance will be displayed. We will ignore the duration performance now because we are sizing the CAVFS for water quality treatment only. We'll add a pond later to meet the flow control criteria.

14. Click the project report button and scroll down to the CAVFS treatment statistics. Our goal here is to treat 91% of the runoff. Note the treatment for the 8 foot wide CAVFS is 79.53% < 91.00%, therefore we need a wider CAVFS.



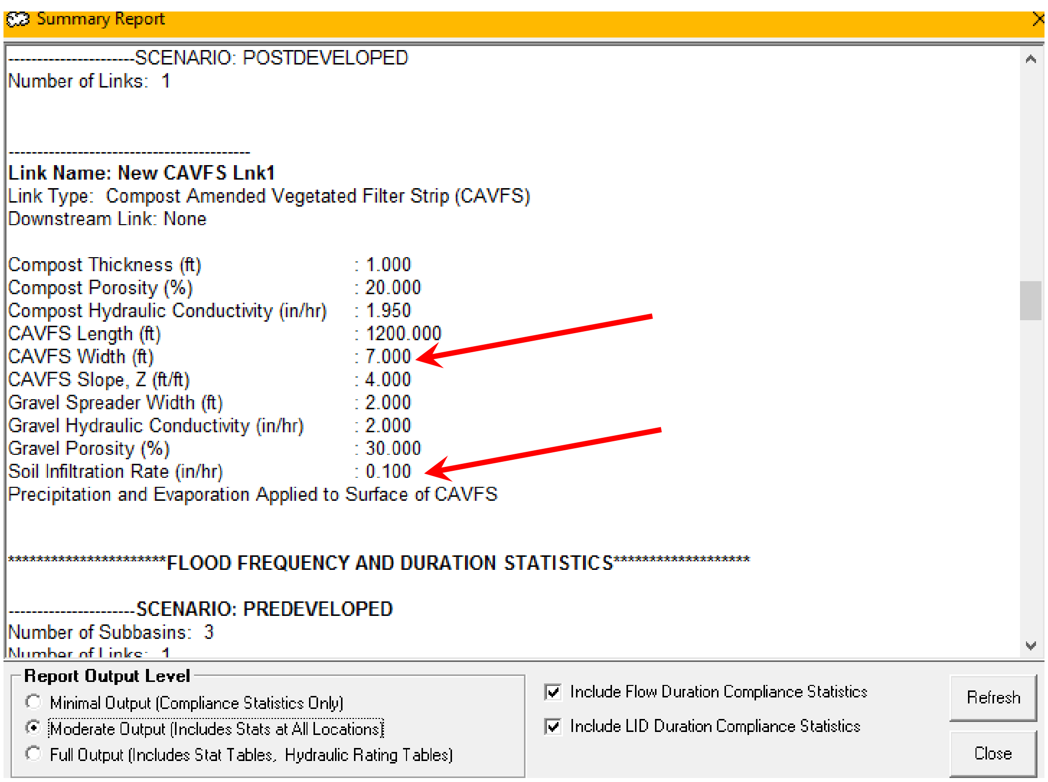
15. Repeat the process above starting at Step 7 in this problem. Let's guess a CAVFS width of 29 feet (I got this after several iterations). This will result in a (%infiltrated+%filtered)/total volume of: 91.17%

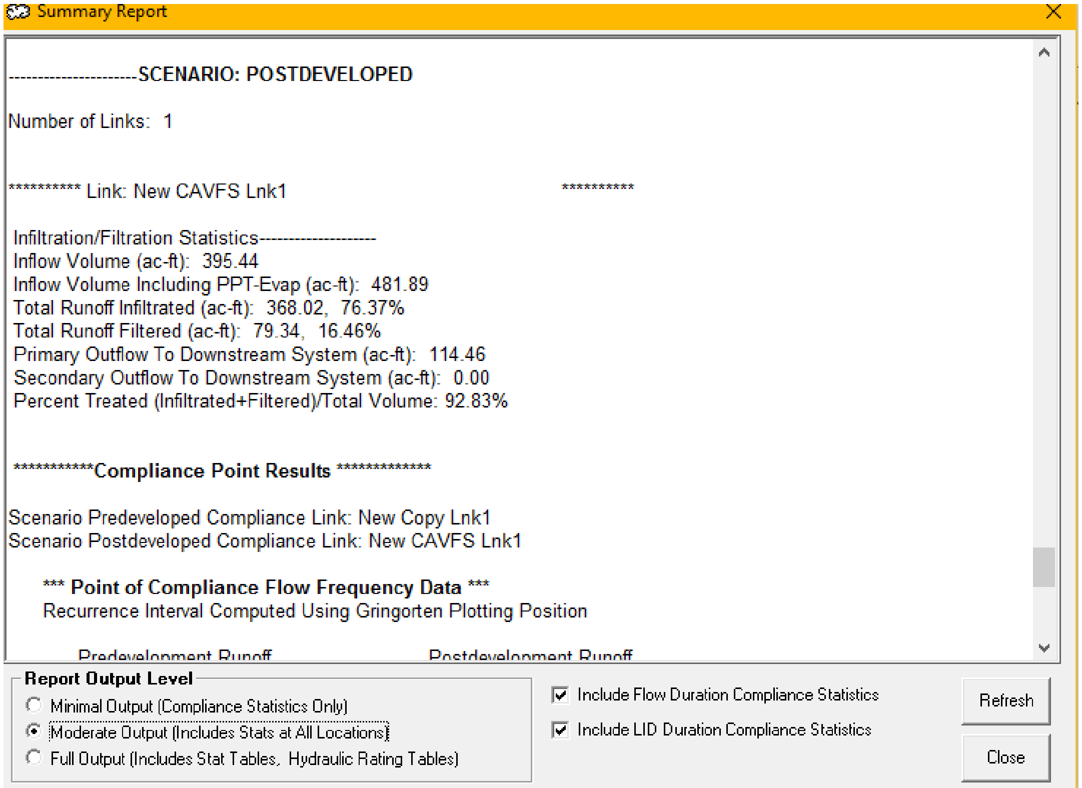




This CAVFS design now meets the runoff treatment requirements.

For the same conditions, what width of CAVFS is needed if the underlying soils rate is 0.1 in/hr instead of 0.01 in/hr?





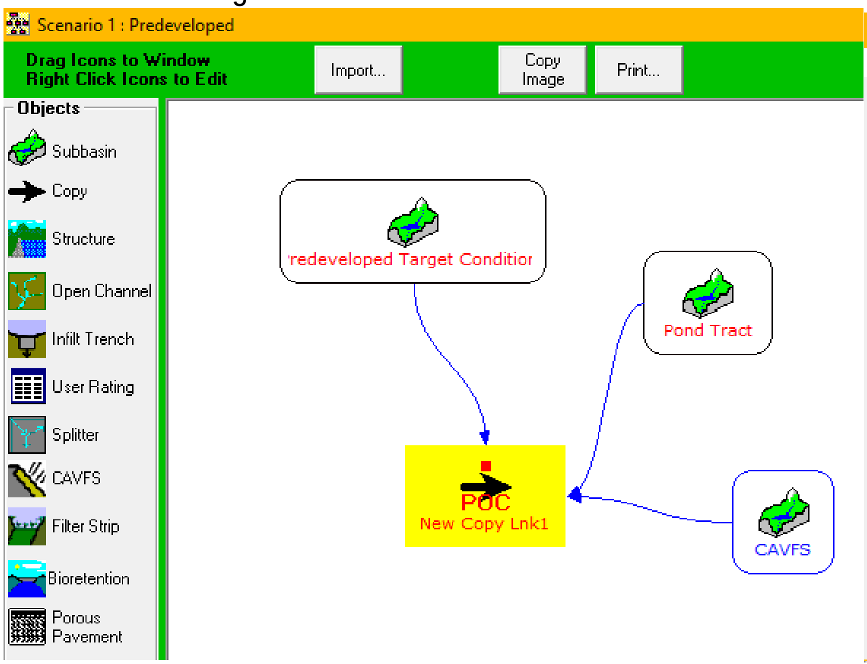
So by going from 0.01 inch/hr to 0.1 inch/hr for the underlying soils rate, the CAVFS width went from 29 feet to 7 feet.

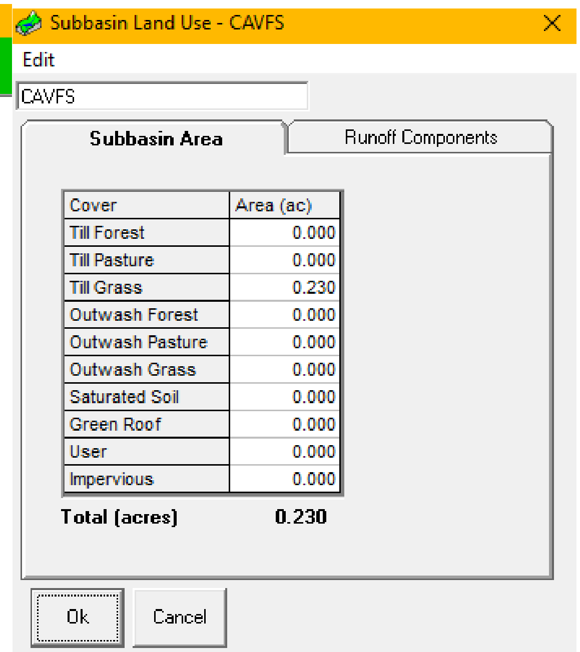
It is very important to verify the underlying soils infiltration rate!

Work Session 7 - Design Stormwater Pond with Upstream CAVFS

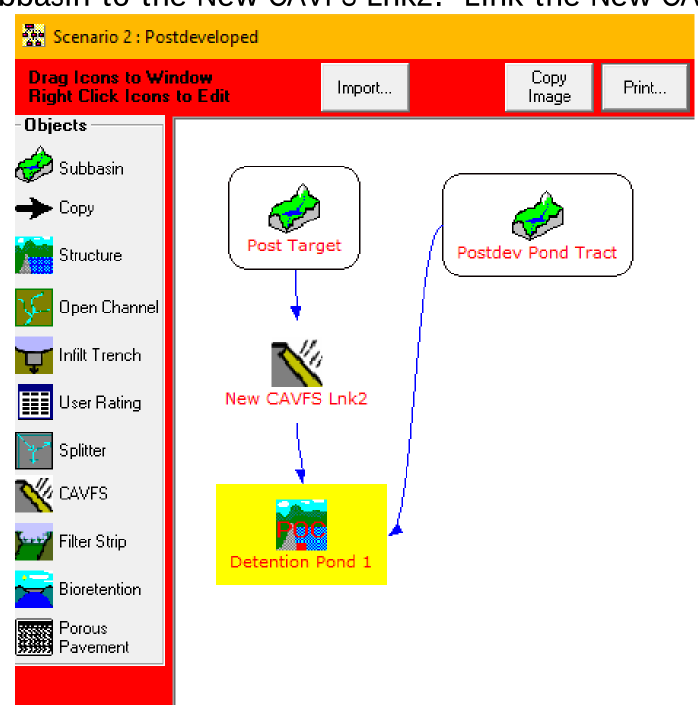
Using the finished pond from Work Session 1 Des Moines Pond, let's install a CAVFS upstream of the detention pond to see the flow control benefits of the CAVFS. The CAVFS length is 1000 feet based on our equivalent area design in Work Session 1. We will design a CAVFS to treat the runoff from the impervious area and also see what flow benefits we get.

1. Open up the file called "WS07_CAVFS_Upstream_DetentionPond_A_Start.fld".
2. Open up the predeveloped scenario and add a basin called "CAVFS". The length is 1000 feet and the width is something we will guess. Let's try 10 feet. So the area is 10,000 ft2 = 0.230 acres of Till grass. Link the CAVFS basin to the POC.

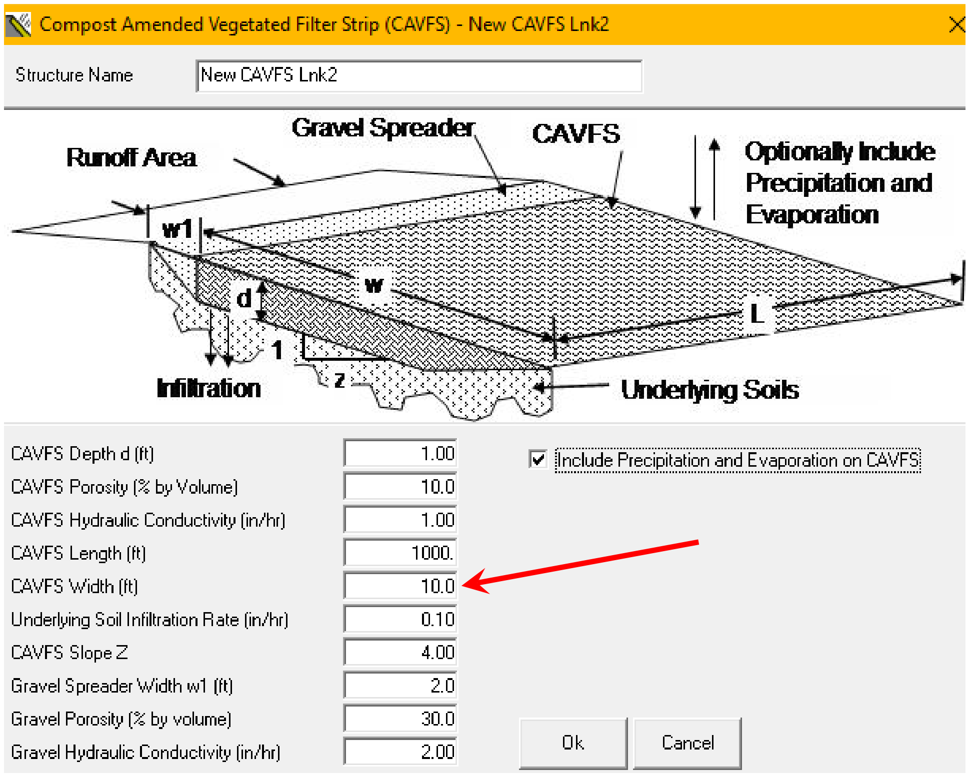




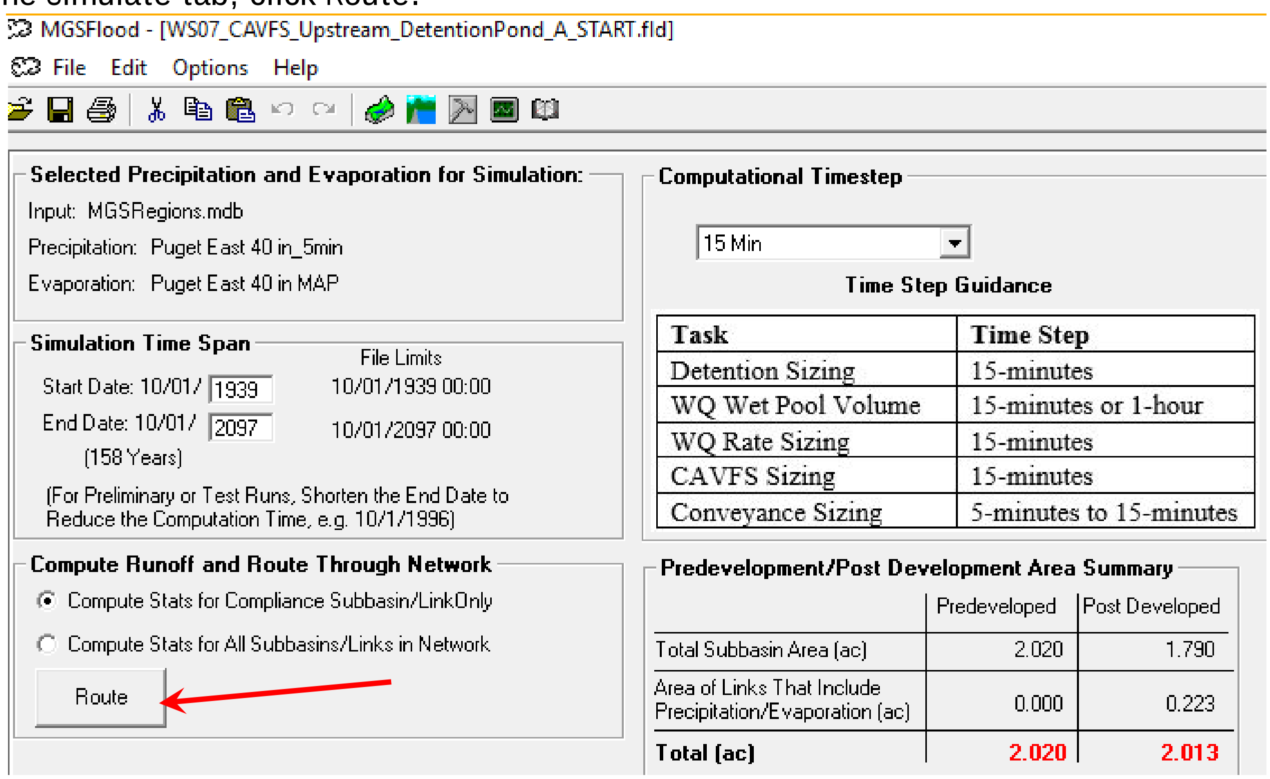
3. Open the Postdeveloped scenario. Add a CAVFS to the scenario and link the Post Target subbasin to the New CAVFS Lnk2. Link the New CAVFS Lnk2 to the Detention Pond1.



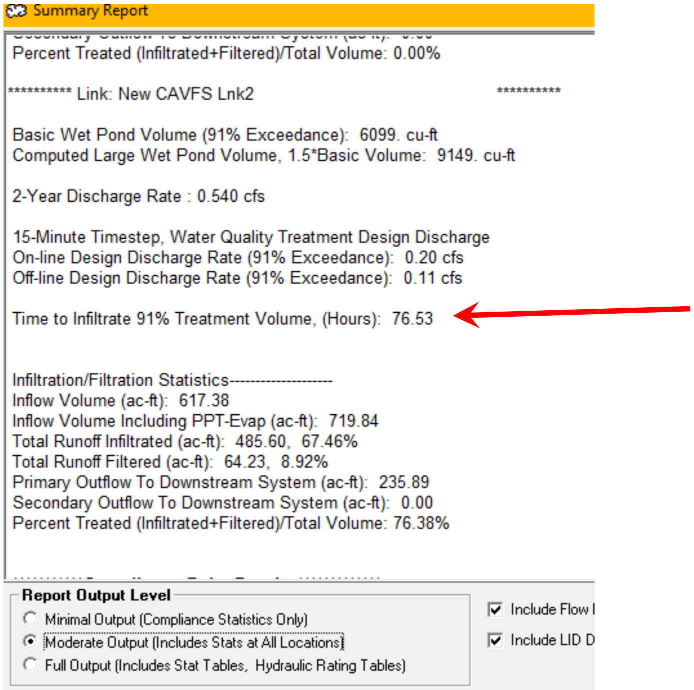
4. Open the New CAVFS Lnk2 and input the below information. Remember we are guessing a CAVFS width of 10 feet.



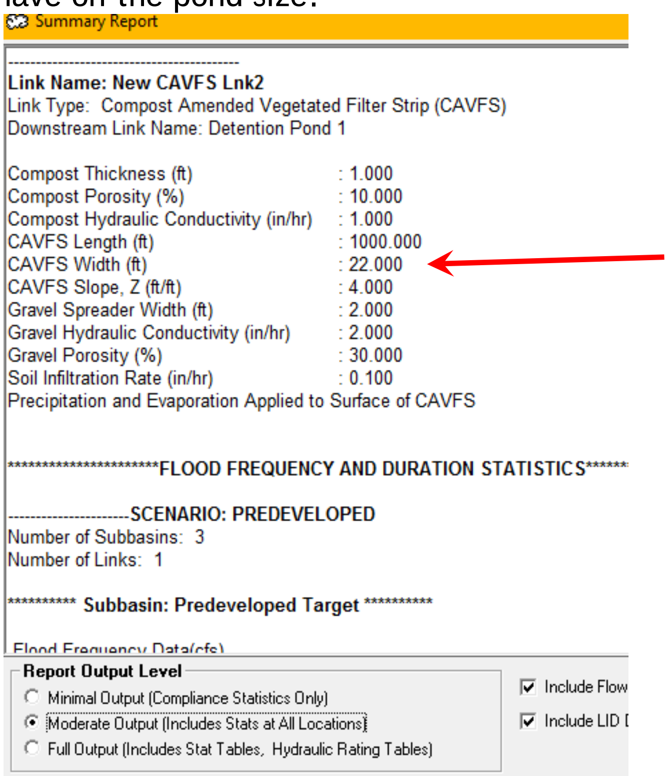
5. Save the project.
6. On the Simulate tab, click Route.

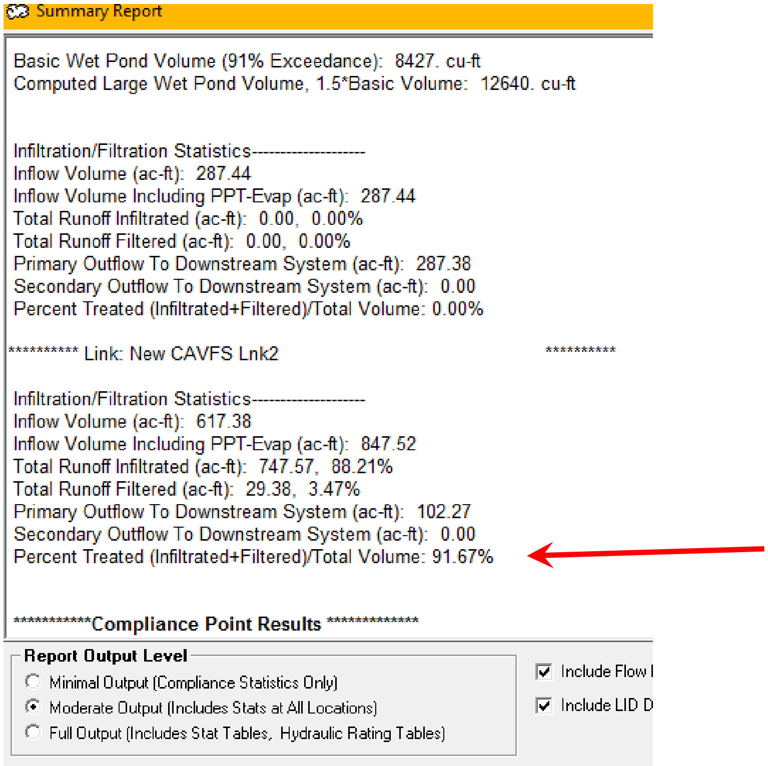


7. After routing, we need to check to see if the CAVFS provided the 91% treatment for the pavement area. Open up the history file Summary Report and scroll down to the Postdeveloped scenario New CAVFS Lnk2 statistics. They show the CAVFS provided 76.53% which is close. We need to make it a little wider to meet runoff treatment requirements of 91%.



8. Starting at Step 2, repeat the process for a CAVFS width of 22 feet. 22' x 1000' = 22,000/43560 = 0.505 acres. MGSFlood tells us that the 22-foot-wide CAVFS will provide a 91.7% treated which meets the runoff treatment requirement. Now we get to see what affect the CAVFS will have on the pond size.





Summary Report

Basic Wet Pond Volume (91% Exceedance): 8427. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 12640. cu-ft

Infiltration/Filtration Statistics--------------------
Inflow Volume (ac-ft): 287.44
Inflow Volume Including PPT-Evap (ac-ft): 287.44
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 287.38
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 0.00%

********** Link: New CAVFS Lnk2 **********

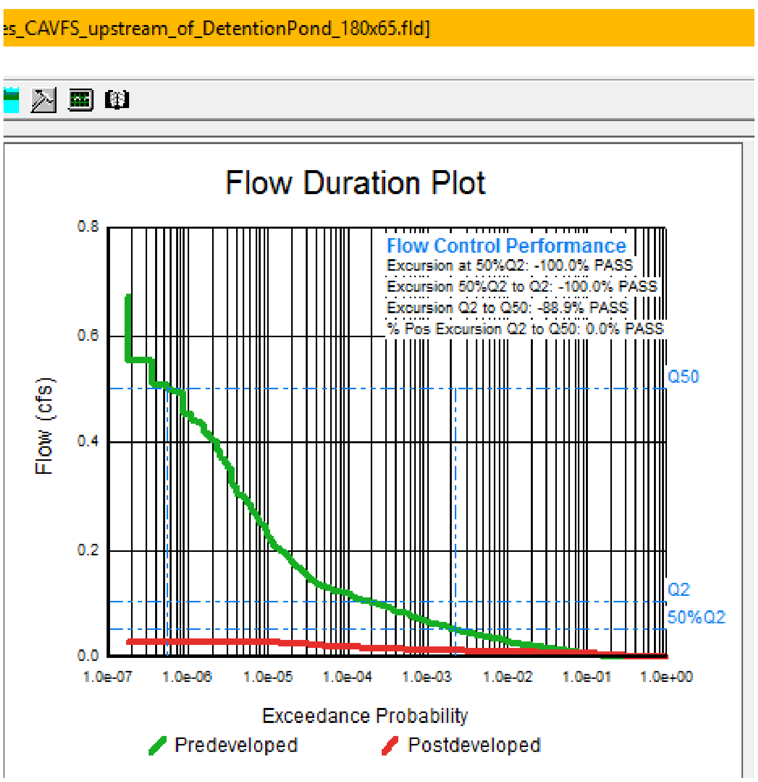
Infiltration/Filtration Statistics--------------------
Inflow Volume (ac-ft): 617.38
Inflow Volume Including PPT-Evap (ac-ft): 847.52
Total Runoff Infiltrated (ac-ft): 747.57, 88.21%
Total Runoff Filtered (ac-ft): 29.38, 3.47%
Primary Outflow To Downstream System (ac-ft): 102.27
Secondary Outflow To Downstream System (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered)/Total Volume: 91.67%

***********Compliance Point Results *************

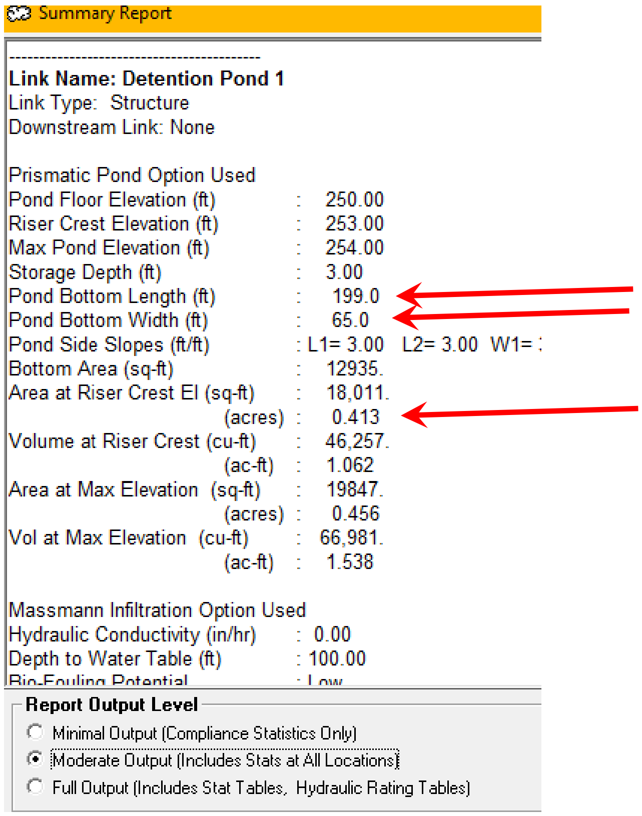
Report Output Level
Minimal Output (Compliance Statistics Only)
Moderate Output (Includes Stats at All Locations)
Full Output (Includes Stat Tables, Hydraulic Rating Tables)

Include Flow I
Include LID D

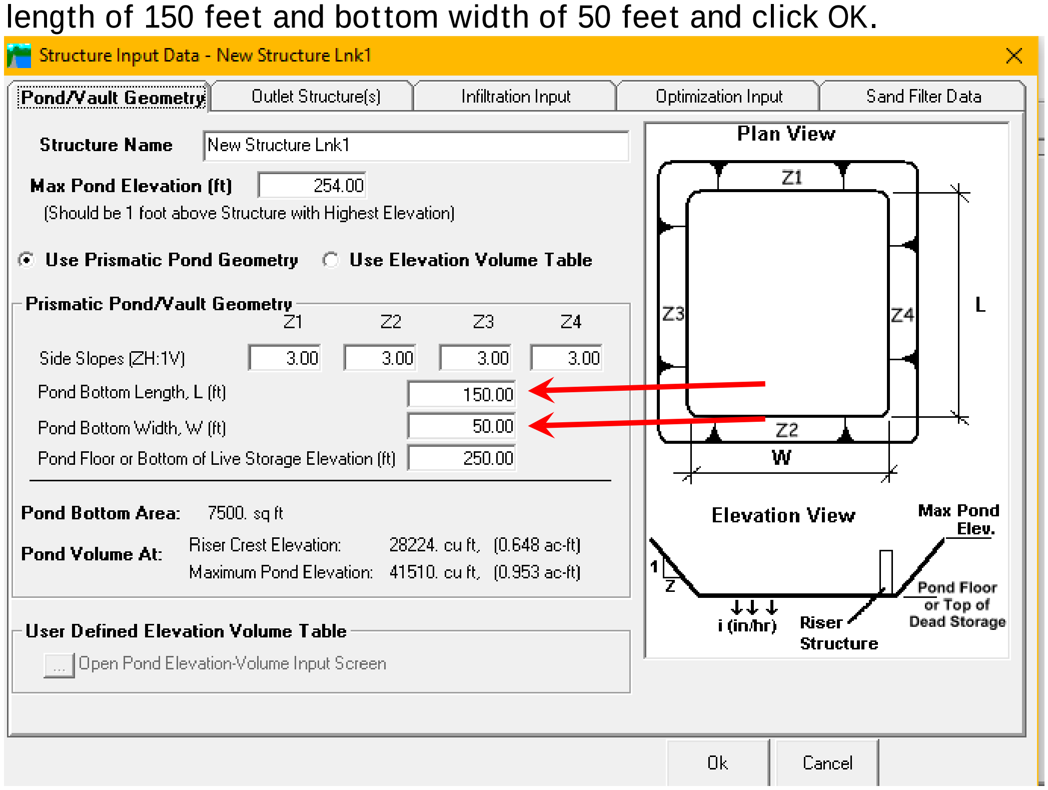
9. The resulting Flow Duration Plot shows that the detention pond may be oversized.



10. Here is where things get tricky. If we go back through the analysis and change the pond size, we have to go into the predeveloped scenario and eventually change the pond tract size. That may alter the CAVFS analysis. As long as we keep track of the changes we make, we should be able to make the pond smaller to show the benefits of the CAVFS. Currently, the detention pond is shown below. It is 199’ x 65’ with an area at the riser crest of 0.413 acres.

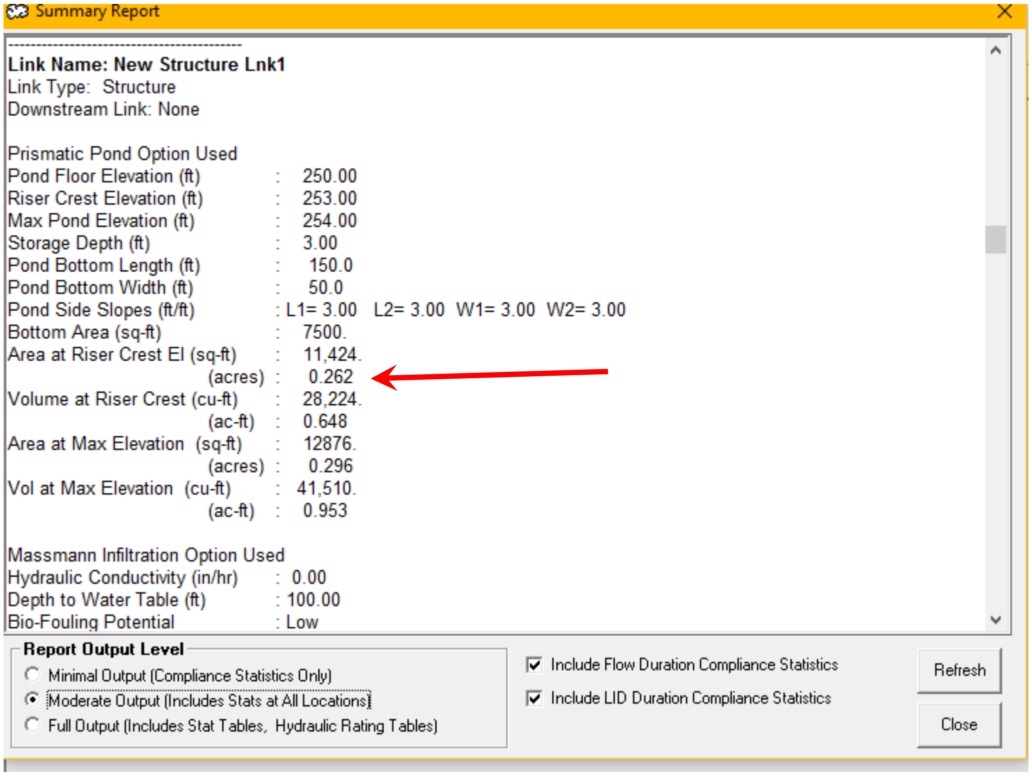


11. Open up the Postdeveloped Scenario and edit Detention Pond 1. Let's input a new pond bottom length of 150 feet and bottom width of 50 feet and click OK.

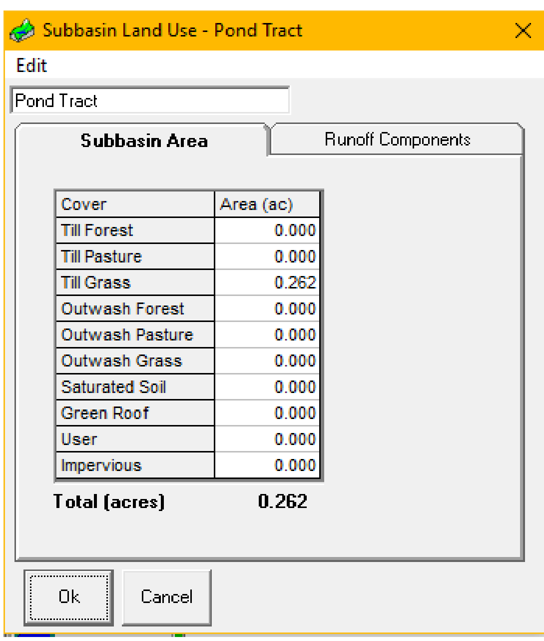


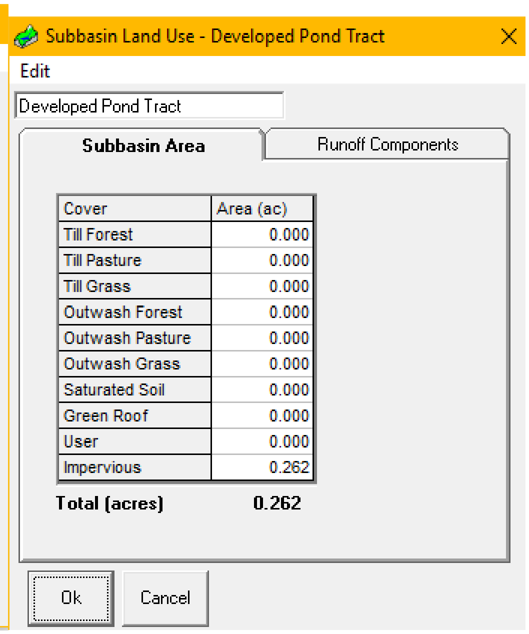
12. Open up the history file. It will show in red text that changes have been made to the MGSFlood file but it has not yet been Routed. This is fine since we are interested in finding out the new pond area at the riser crest. MGSFlood automatically calculates the pond areas and volumes

based on the new 150' x 50' pond bottom length and width. The new pond area at the riser crest is 0.262 acres

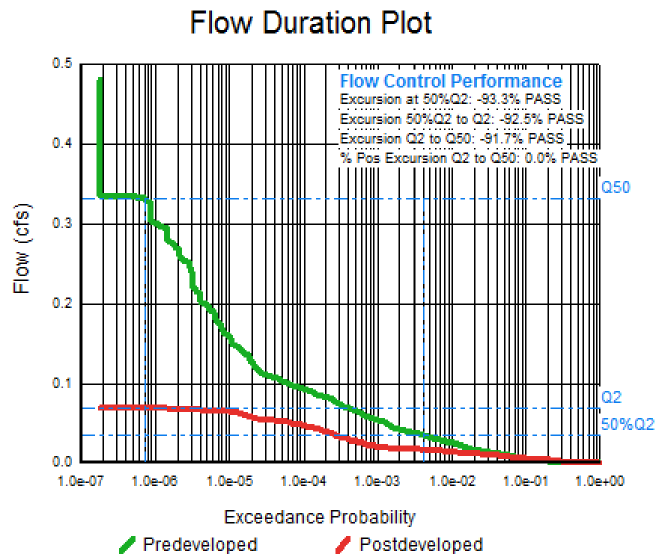


13. Open the Predeveloped and Postdeveloped scenarios and change the Pond Tract size to 0.262 acres.

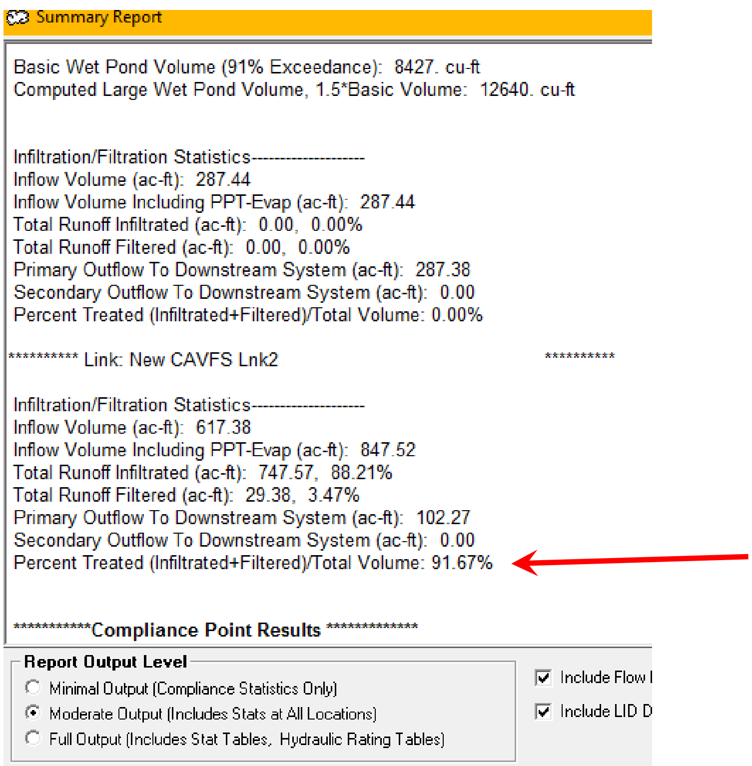




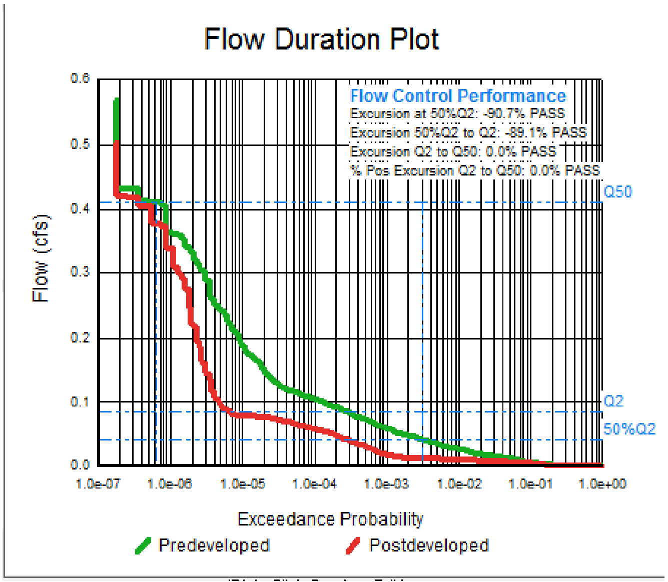
14. On the Simulate Tab, click Route.
15. MGSFlood shows the new (and smaller) detention pond size meets the duration standard. Also, we need to make sure the CAVFS design still meets the 91% treated criteria.

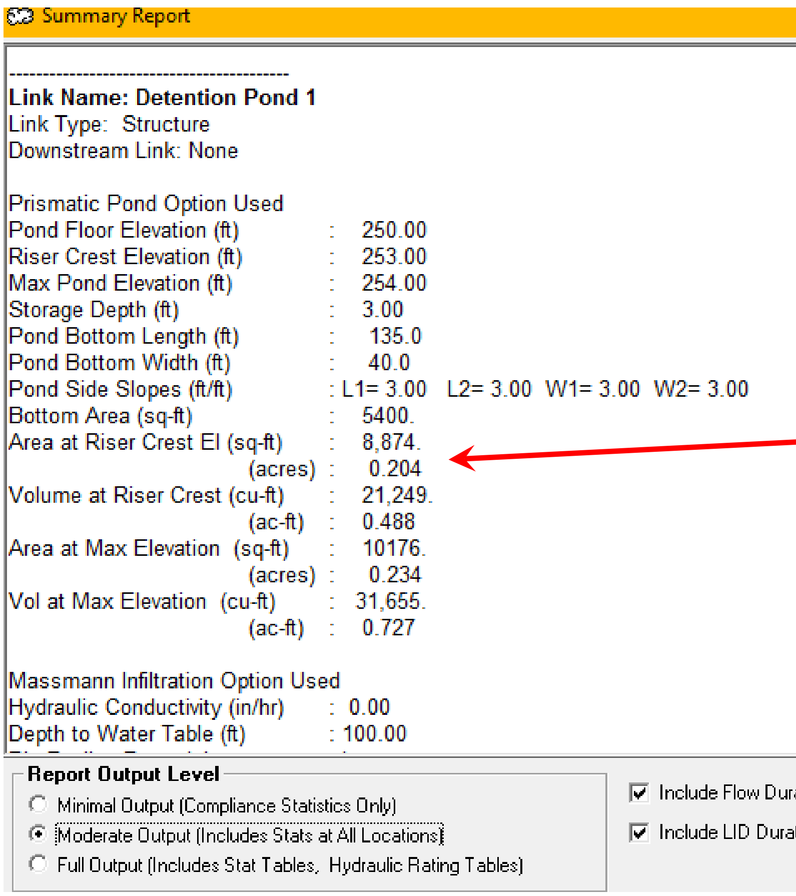


16. Open the history file and check the CAVFS performance. It shows a 91.7% treated so the CAVFS design meets requirements.



17. So to summarize, we initially started out with a detention pond that was 199' x 65' with an area at the riser crest of 0.413 acres. After adding a CAVFS that is 1000' long by 22' wide, we get a smaller detention pond that is 150' x 50' with an area and volume at the riser crest of 0.262 acres. I did some more refinements and got an even smaller detention pond!





Summary Report

Link Name: Detention Pond 1
Link Type: Structure
Downstream Link: None

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 250.00
Riser Crest Elevation (ft) : 253.00
Max Pond Elevation (ft) : 254.00
Storage Depth (ft) : 3.00
Pond Bottom Length (ft) : 135.0
Pond Bottom Width (ft) : 40.0
Pond Side Slopes (ft/ft) : L1= 3.00 L2= 3.00 W1= 3.00 W2= 3.00
Bottom Area (sq-ft) : 5400.
Area at Riser Crest El (sq-ft) : 8,874.
(acres) : 0.204
Volume at Riser Crest (cu-ft) : 21,249.
(ac-ft) : 0.488
Area at Max Elevation (sq-ft) : 10176.
(acres) : 0.234
Vol at Max Elevation (cu-ft) : 31,655.
(ac-ft) : 0.727

Massmann Infiltration Option Used
Hydraulic Conductivity (in/hr) : 0.00
Depth to Water Table (ft) : 100.00

Report Output Level
Minimal Output (Compliance Statistics Only)
Moderate Output (Includes Stats at All Locations)
Full Output (Includes Stat Tables, Hydraulic Rating Tables)

Include Flow Dura
Include LID Durat

18. After more simulations, I get a more optimized pond size of 135' x 40' with an area of 0.204 acres at the riser crest.

By adding the CAVFS (1000' x 22'), we reduced the detention pond area by:

(0.413 – 0.204)/0.413 = 51% reduction in area

Work Session 8 – Flow Control Design and the 50% Rule

Using the Work Session 1 Des Moines Pond, we will demonstrate the 50% Rule. In stormwater modeling, sometimes areas that do not receive flow control are allowed to pass through the detention facility. This area is referred to as "flow through" area. The Department of Ecology says that there is a limit to how much "flow through" area can be allowed in detention facilities. This limit is referred to as the 50% Rule.

"50% Rule"

***50% Rule**: Existing Areas may be allowed to flow through the Detention Pond without flow control if: The 100-year peak flow rate from the existing areas (not subject to flow control) is less than or equal to 50% of the 100-year developed undetained peak flow rate of the areas subject to flow control.*

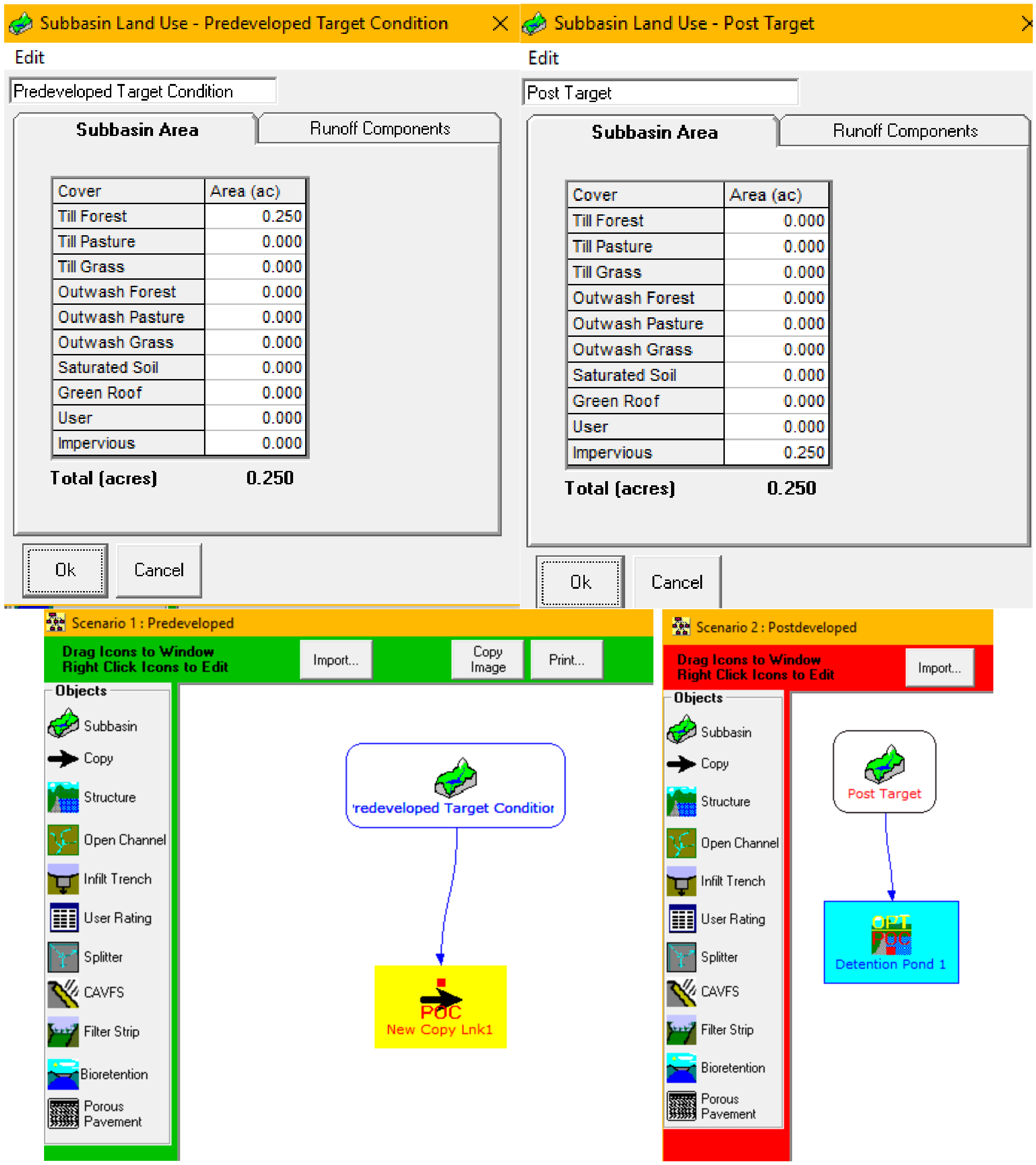
Another way to say this is:

It's OK to route "existing areas" through the detention pond without any flow control applied to these existing areas if:

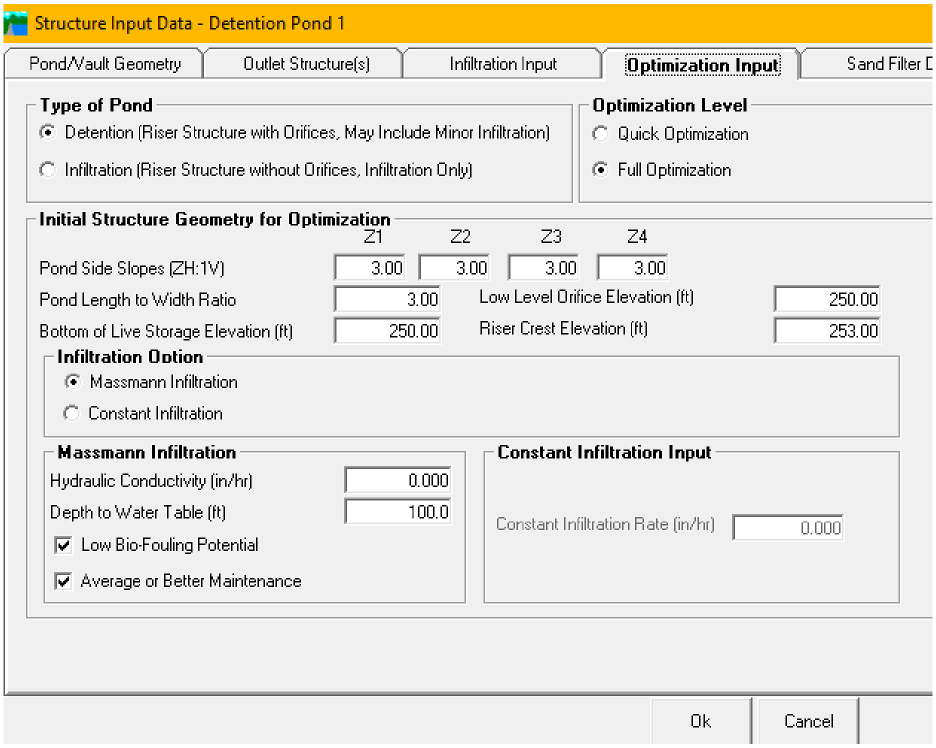
100-year peak flow rate From the "Existing Areas" Not receiving flow control	< or =	50% of the 100-year undetained peak flow rate from Areas subject to flow control in the detention pond

The 50% Rule allows some existing pervious and impervious surfaces to be routed through the detention facility without any flow control. These areas are referred to as "flow through" areas.

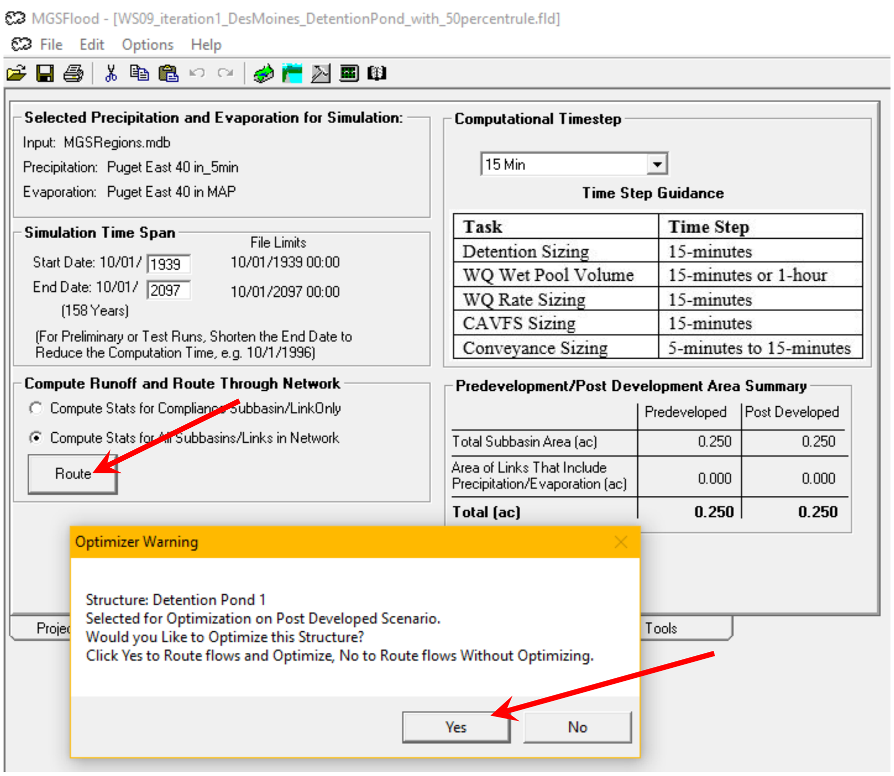
1. For Work Session 8, we are going to use the completed file from Work Session 1 but change the new impervious to 0.25 acres.
2. Open the MGSFlood Inputs Spreadsheet to the tab called WS8_Iteration#1. Using the same TDA information as Work Session 1, the new impervious has changed from 1.377 acres to 0.25 acres. Please update Iteration #1 with this information assuming that you can also physically route 0.25 acres to the detention pond. We have not yet designed the detention pond so it does not show up in the land cover conversions in Step 2 of the spreadsheet. Step 7-9 gives the inputs for the predeveloped and postdeveloped scenarios.
3. Open up the file called, "WS08_50percent_DetentionPond_A_START.fld".
4. Open the Predeveloped and Postdeveloped scenarios and delete the Pond Tract in each scenario. Modify each subbasin per the below screen pictures. We are going to provide flow control for 0.25 acres of new impervious surface, which is just over 10,000 square feet.



5. Right Click on Detention Pond and set toggle it to Optimize. We want MGSFlood to redo the pond dimensions based on our new basin of 0.25 acres. Right click the Detention Pond 1 and edit the Optimization Tab. Use the inputs shown below. When done, click OK.

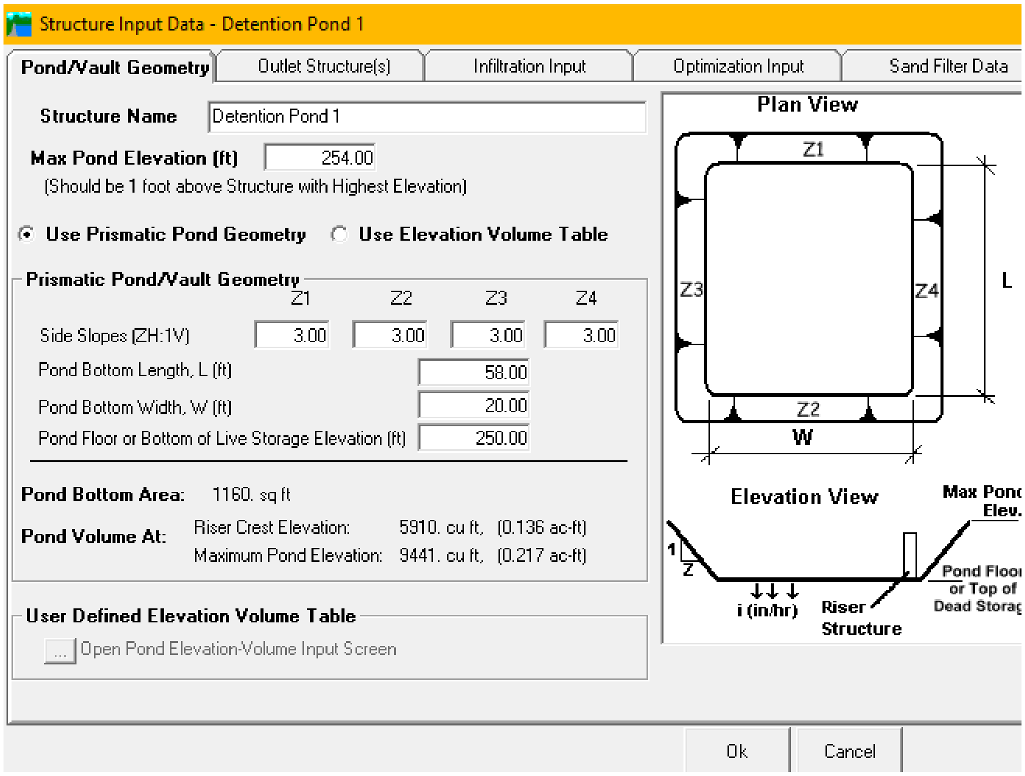


6. Click Route on the Simulations Tab. Click Yes when prompted to Optimize.

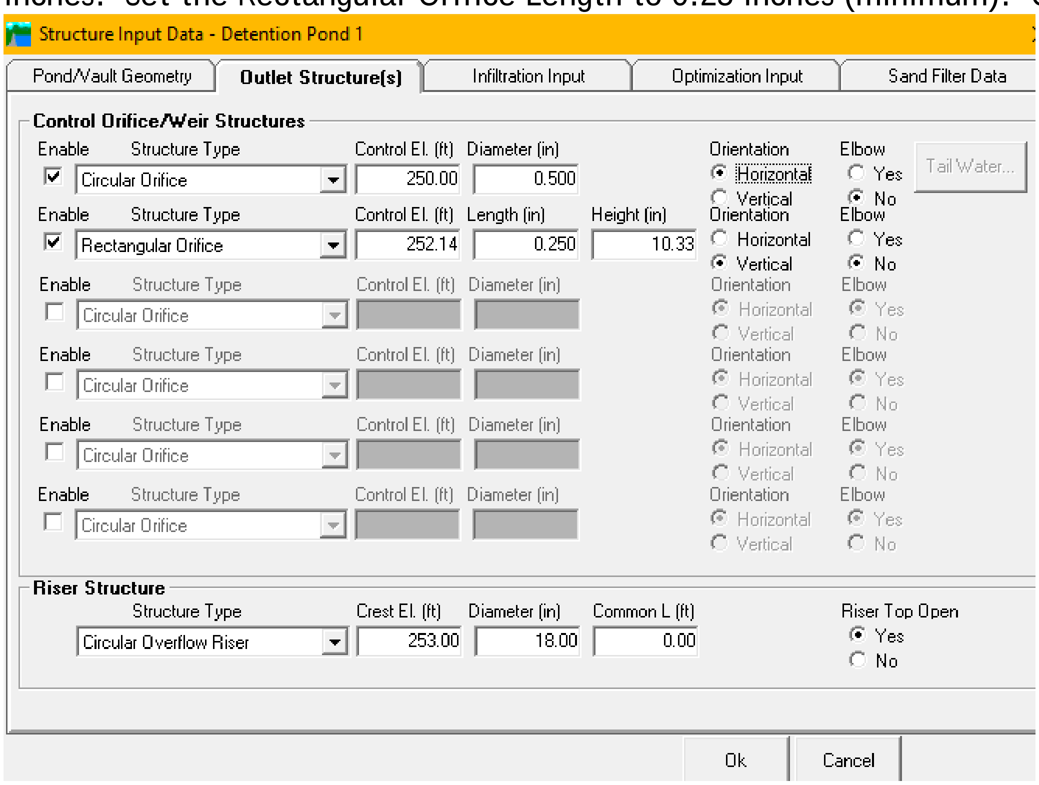


7. MGSFlood will return a Warning saying that the lower orifice #1 and rectangular orifice #2 are smaller than the minimum sizes. Click OK.
8. MGSFlood returns a design that seems to pass the duration standard but remember the orifice sizes are too small and the pond dimensions are probably not nominal. We need to revise the pond size and orifice sizes. We also haven't yet added the pond area into the predeveloped and developed scenarios. Click on the Detention Pond in the Postdeveloped scenario, toggle the optimizer off, and click edit.

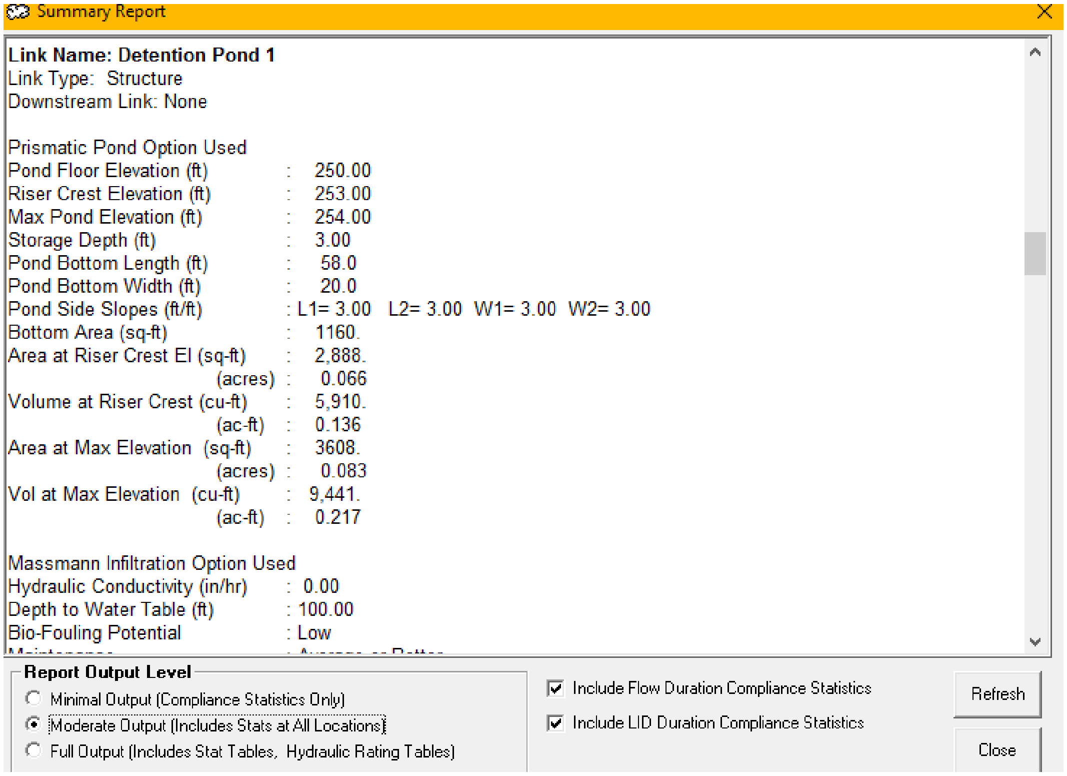
9. Change the Pond Bottom Length to 58 feet and Pond Bottom Width to 20 feet. Change the Max Pond Elevation to 254.0 feet for the 1 foot of freeboard.



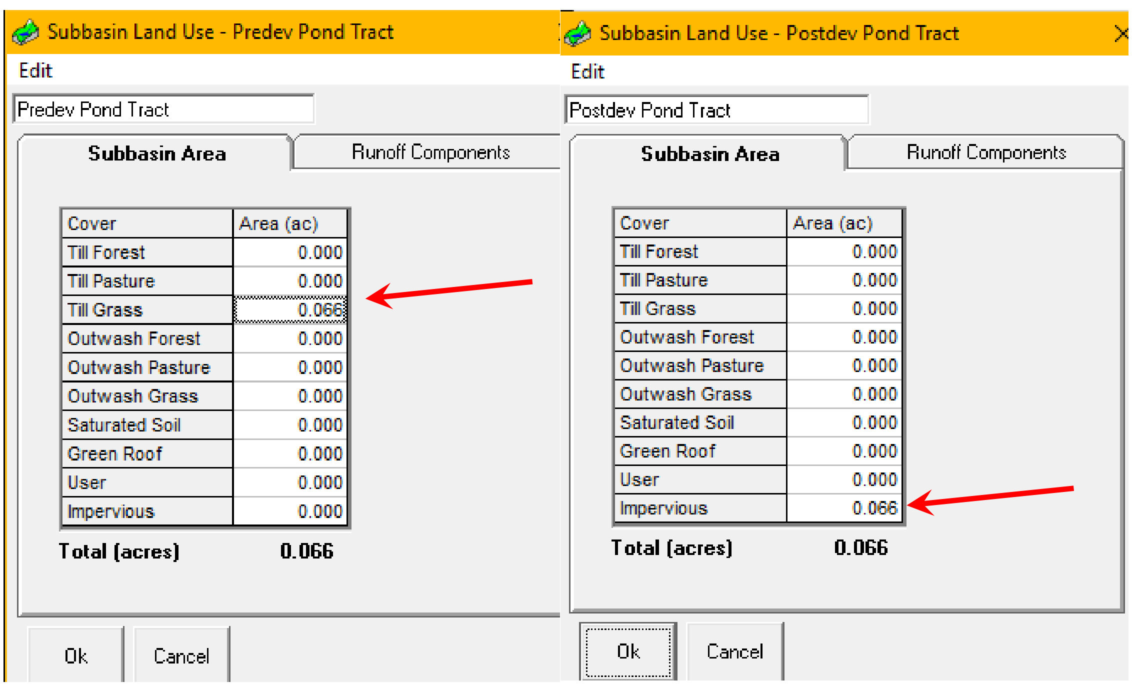
10. Click on the Outlet Structures Tab and set the Circular Orifice diameter to the minimum of 0.5 inches. Set the Rectangular Orifice Length to 0.25 inches (minimum). Click OK when done.



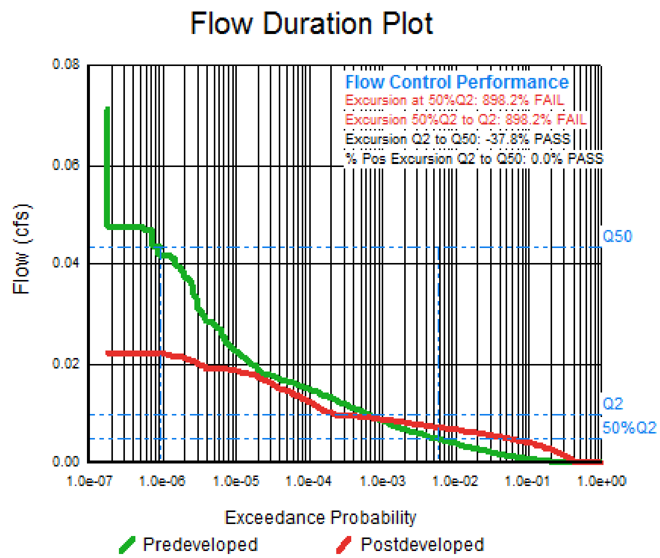
11. Open up the history file and find the new pond area at the riser crest. The area is 0.066 acres. Use this area to make a guess at the pond tract size in the Predeveloped and Postdeveloped scenarios.
12. In the MGSFlood Inputs spreadsheet, update the numbers to show a pond tract of 0.066 acres from grass to impervious.



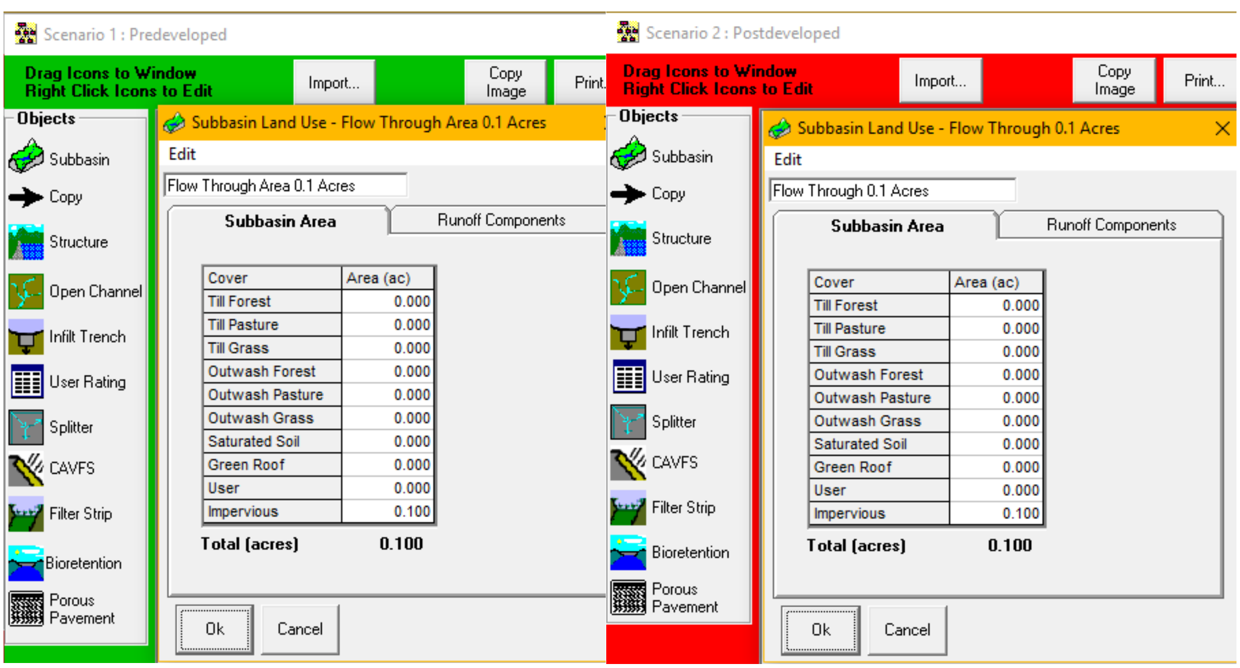
13. Add the Pond Tract to the predeveloped and postdeveloped scenarios. Make the Pond Tract size equal to 0.066 acres as shown below and link them to the point of compliance.

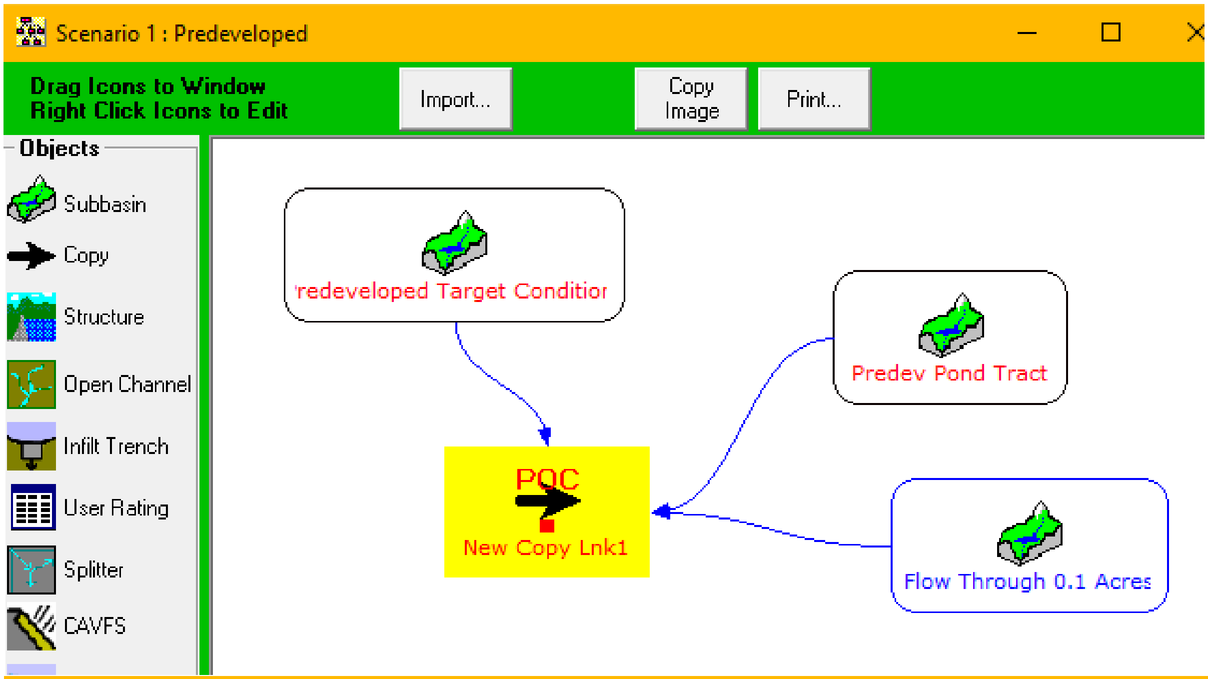


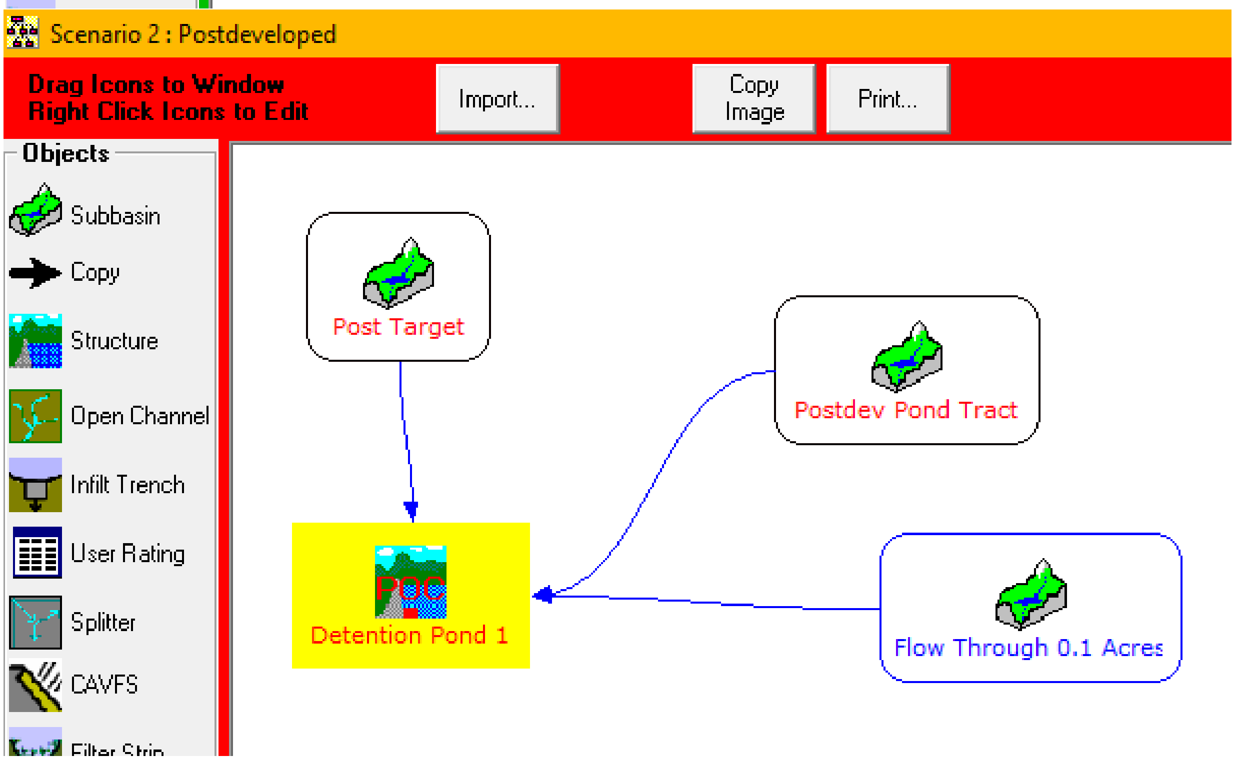
14. Now that we have the pond tract represented in both scenarios, click the Simulate Tab and Route the file. The resulting Flow Duration Plots shows the following:



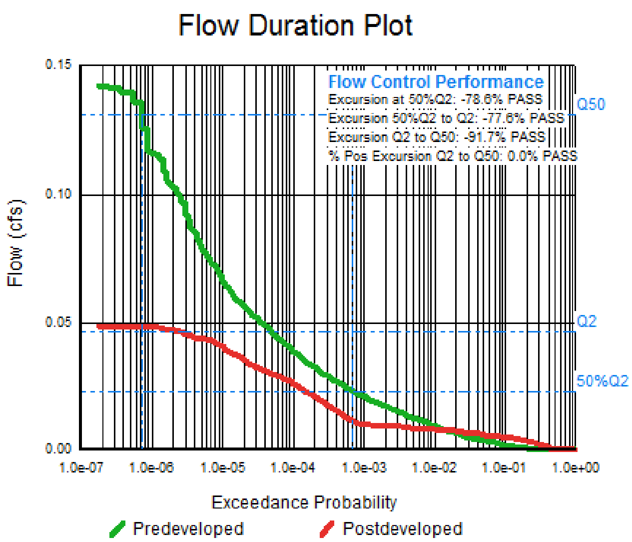
15. The detention pond is not in compliance with the flow duration standard. We could try to increase the pond size but we will add some flow through area instead. We are going to use the flow through area to increase the predeveloped flow rates so that the pond can better handle and detain higher predeveloped flows.
16. In the MGSFlood Inputs spreadsheet, update the numbers in Step 5 to show 0.416 acres (0.316 acres of pavement + 0.1 acres of additional flow through pavement) Use the information in Step 9 of the MGSFlood Inputs spreadsheet to continue to the next step.
17. In the Predeveloped and Postdeveloped scenarios, add a subbasin in each with 0.1 acres of impervious surface as shown below.







18. MGSFlood will return a Flow Duration Plot that shows the detention pond now meets the duration standard.



19. By adding the flow through area, we increased the predeveloped flow rates which helped the pond control structure better handle the higher flow rates. We still have to check the 50% rule to make sure the flow through area meets the maximum flow requirements.

100-year peak flow rate From the "Flow Through"	< or =	50% of the 100-year undetained peak flow rate from Areas subject to flow control in the detention Area

The history file shows the 100-year peak flow rate for the flow through area = 0.101 cfs. The 100-year undetained peak flow rate from area receiving flow control (Post Target subbasin + Pond Tract in this example) = 0.252 + 0.067 = 0.319 cfs.

So 0.101 < (0.5 x 0.319) -----→ 0.101 cfs < 0.160 so yes, the flow through area is OK to use in this analysis.

Summary Report

********** **Subbasin: Flow Through 0.1 Acres** **********

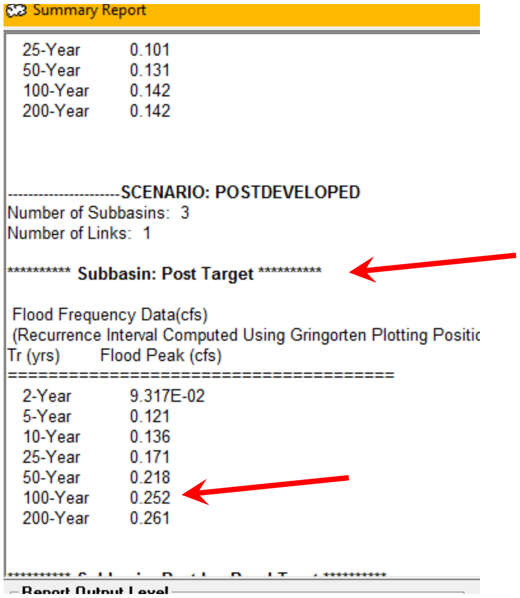
Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	3.727E-02
5-Year	4.841E-02
10-Year	5.446E-02
25-Year	6.855E-02
50-Year	8.725E-02
100-Year	0.101
200-Year	0.105

********** Link: Detention Pond 1 ******

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.155
5-Year	0.201



Summary Report

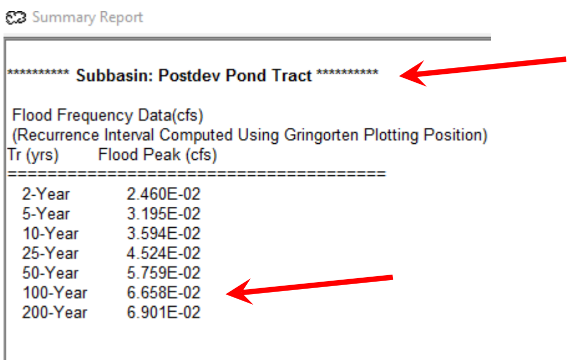
25-Year	0.101
50-Year	0.131
100-Year	0.142
200-Year	0.142

----------------------SCENARIO: POSTDEVELOPED
Number of Subbasins: 3
Number of Links: 1

********** Subbasin: Post Target **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Positic

Tr (yrs)	Flood Peak (cfs)
2-Year	9.317E-02
5-Year	0.121
10-Year	0.136
25-Year	0.171
50-Year	0.218
100-Year	0.252
200-Year	0.261



Summary Report

********** Subbasin: Postdev Pond Tract **********

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	2.460E-02
5-Year	3.195E-02
10-Year	3.594E-02
25-Year	4.524E-02
50-Year	5.759E-02
100-Year	6.658E-02
200-Year	6.901E-02

20. The overflow and emergency overflow designs need to be completed per the FC.03 BMP description in the Highway Runoff Manual. This example problem will not cover these hand calculations.

Work Session 9 – Irregular Shape Pond Design.

Using the final pond design from Work Session 1 Des Moines, we want to check the designed pond against the real life condition that the pond is irregularly shaped. It is not rectangular as designed in MGSFlood. We have the irregular shaped pond stage-area-volume relationship from our InRoads/CAD information. We need to check to see if the irregular pond volume and irregular pond area meets the duration standard set in Work Session 1.

We are going to use the Work Session 1 modeling output that shows the pond stage-volume needed to meet the duration standard. We will use the Excel spreadsheet ElevVol.xls to compare the real irregular shaped pond stage-volume information to the Work Session 1 designed pond stage-volume information to determine if the duration standard is met.

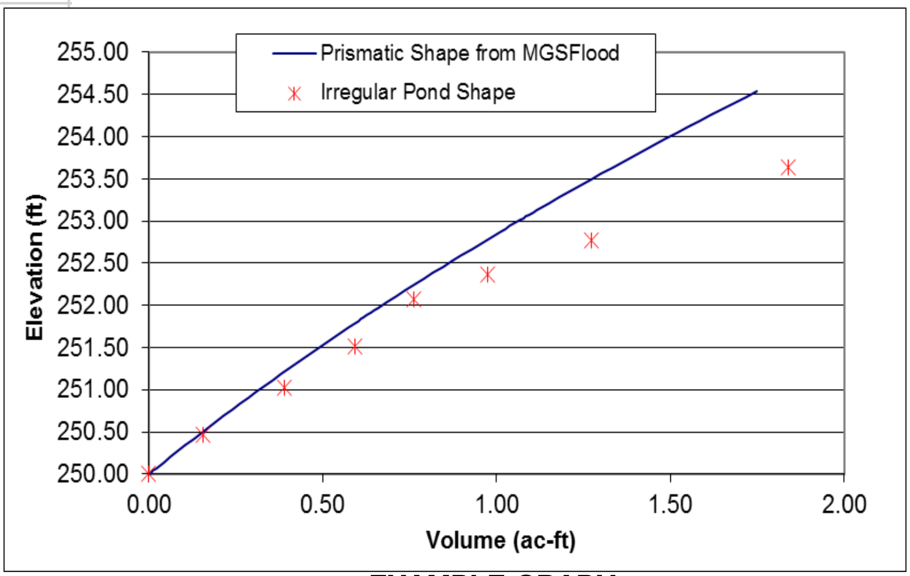
We have found the irregular shaped pond stage volume information using InRoads or CAD. The information is listed in the table below.

Rating Table from CAD program			
Copy Blue Cells to MGSFlood			
	Surf Area	Volume	Volume
Elev	sq ft	cu-ft	ac-ft
250.00	0	0	0.000
250.47	10000	6800	0.156
251.02	12000	17000	0.390
251.52	14000	25800	0.592
252.07	16000	33120	0.760
252.36	18000	42480	0.975
252.77	20000	55400	1.272
253.64	22000	80080	1.838
254.00	24000	96000	2.204

The Goal of the Analysis

If the irregular pond (red) data points plot on or to the right of the MGSFlood pond data (blue line), then the irregular pond will meet the duration criteria.

How to Read The Graph
"At elevation 253.00 ft, I need 1.10 ac-ft of storage based on my MGSFlood calculations (blue line). At elevation 253.00 ft, I have 1.35 ac-ft from my stage storage information (red x - irregular pond shape)."

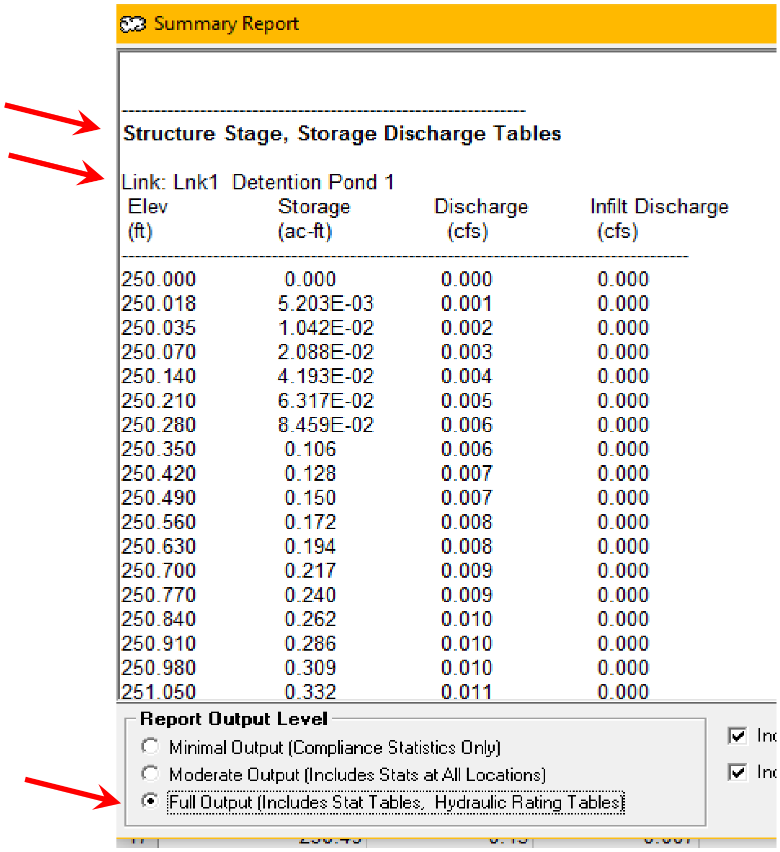


EXAMPLE GRAPH

KEEP THE RED POINTS (X's) ON OR TO THE RIGHT OF THE BLUE LINE FOR A SUCCESSFUL DESIGN!

1. Open the file called, "WS09_IrregularPond_A_START.fld".

2. View the Project Report either from the *File-Print* menu, from the icon on the tool bar, or by opening the .rtf file with a word processor. Specifically, copy the entire Detention Pond 1 stage-storage-discharge table shown below.

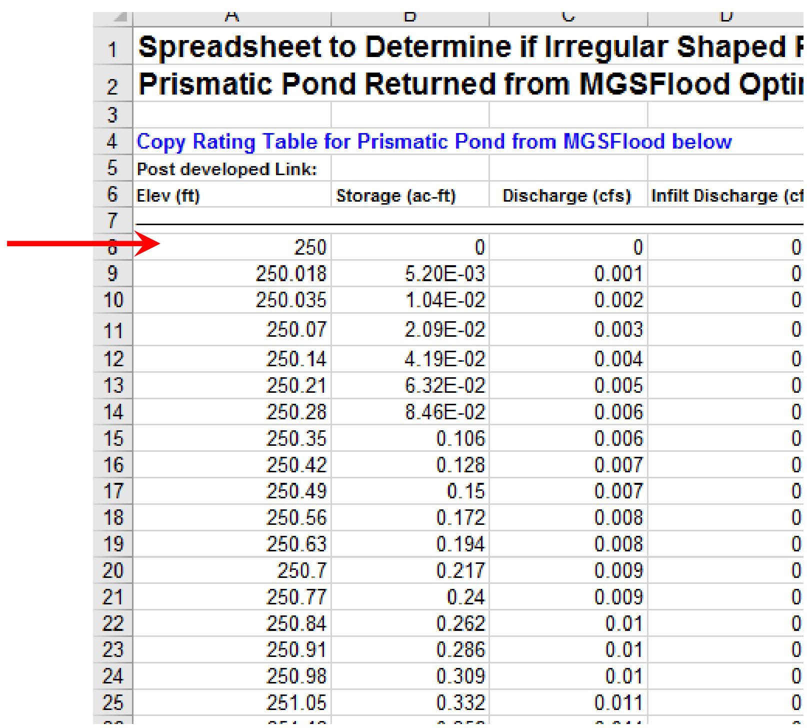


Structure Stage, Storage Discharge Tables

Link: Lnk1 Detention Pond 1

Elev (ft)	Storage (ac-ft)	Discharge (cfs)	Infilt Discharge (cfs)
250.000	0.000	0.000	0.000
250.018	5.203E-03	0.001	0.000
250.035	1.042E-02	0.002	0.000
250.070	2.088E-02	0.003	0.000
250.140	4.193E-02	0.004	0.000
250.210	6.317E-02	0.005	0.000
250.280	8.459E-02	0.006	0.000
250.350	0.106	0.006	0.000
250.420	0.128	0.007	0.000
250.490	0.150	0.007	0.000
250.560	0.172	0.008	0.000
250.630	0.194	0.008	0.000
250.700	0.217	0.009	0.000
250.770	0.240	0.009	0.000
250.840	0.262	0.010	0.000
250.910	0.286	0.010	0.000
250.980	0.309	0.010	0.000
251.050	0.332	0.011	0.000

3. Open the Excel file called ElevVol.xls and paste the copied stage-storage-discharge information into the table as shown below. Some formatting of the pond stage-storage-discharge information is needed before pasting into the Excel spreadsheet.



Spreadsheet to Determine if Irregular Shaped P
Prismatic Pond Returned from MGSFlood Optim

Copy Rating Table for Prismatic Pond from MGSFlood below

Post developed Link:

Elev (ft)	Storage (ac-ft)	Discharge (cfs)	Infilt Discharge (cf
250	0	0	0
250.018	5.20E-03	0.001	0
250.035	1.04E-02	0.002	0
250.07	2.09E-02	0.003	0
250.14	4.19E-02	0.004	0
250.21	6.32E-02	0.005	0
250.28	8.46E-02	0.006	0
250.35	0.106	0.006	0
250.42	0.128	0.007	0
250.49	0.15	0.007	0
250.56	0.172	0.008	0
250.63	0.194	0.008	0
250.7	0.217	0.009	0
250.77	0.24	0.009	0
250.84	0.262	0.01	0
250.91	0.286	0.01	0
250.98	0.309	0.01	0
251.05	0.332	0.011	0

4. Input into the spreadsheet the elevation-volume table information for the irregularly shaped pond. You generate this table from InRoads or your roadway design software.

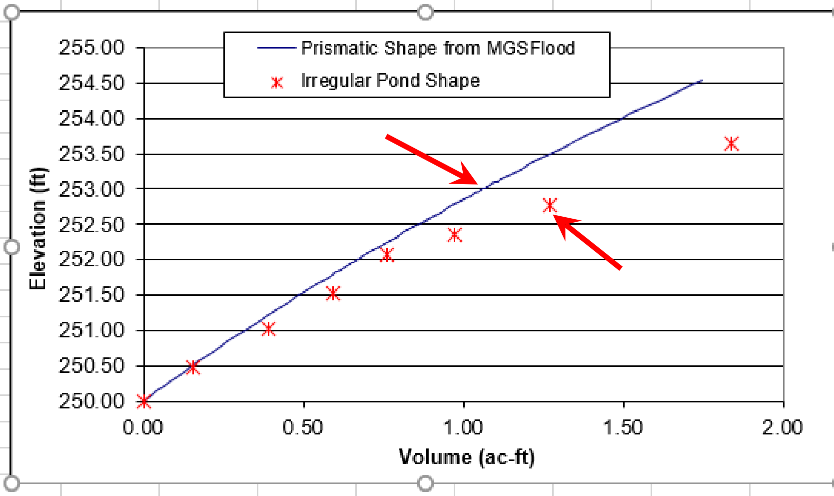
ɔstituted for

MGS Software LLC

Rating Table from CAD program

Copy Blue Cells to MGSFlood

Elev	Surf Area sq ft	Volume cu-ft	Volume ac-ft
250.00	0	0	0.000
250.47	10000	6800	0.156
251.02	12000	17000	0.390
251.52	14000	25800	0.592
252.07	16000	33120	0.760
252.36	18000	42480	0.975
252.77	20000	55400	1.272
253.64	22000	80080	1.838
254.00	24000	96000	2.204



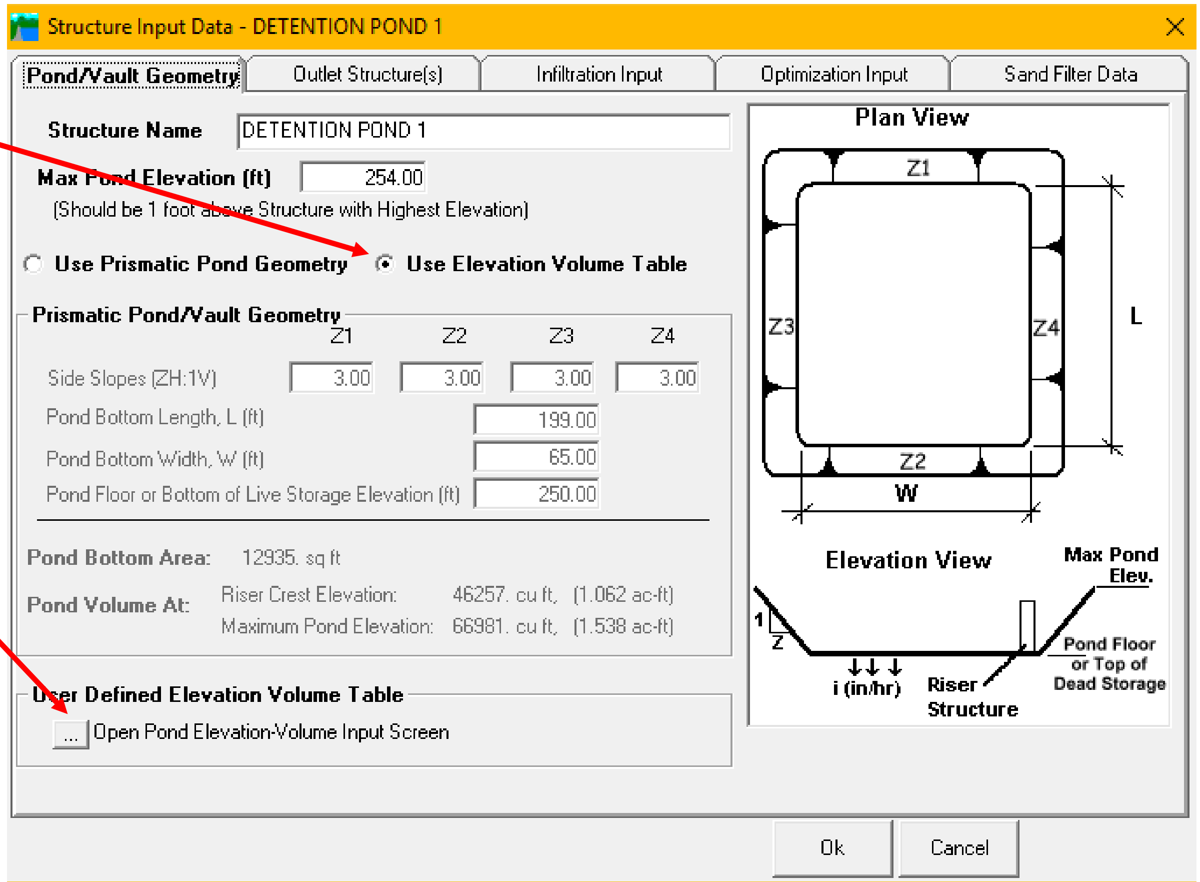
Compare Rating Table from MGSFlood Optimizer with Data points obtained from survey/CAD. If CAD points plot to the right of the MGSFlood volume, then the irregular shape pond will meet the duration criteria too.

5. If the RED data points for the irregularly shaped pond plot to the right of the BLUE prismatic pond line, then the irregular shaped pond will work. For this irregular shaped pond, it appears that all the red data points are to the right of the blue line so this pond should meet the duration standard.

6. Next, the designer needs to enter the stage-volume table directly into MGSFlood to see if the irregular shaped pond meets the duration standard. The designer also has the ability to determine if the irregular pond can be made smaller so long as it meets the duration standard.

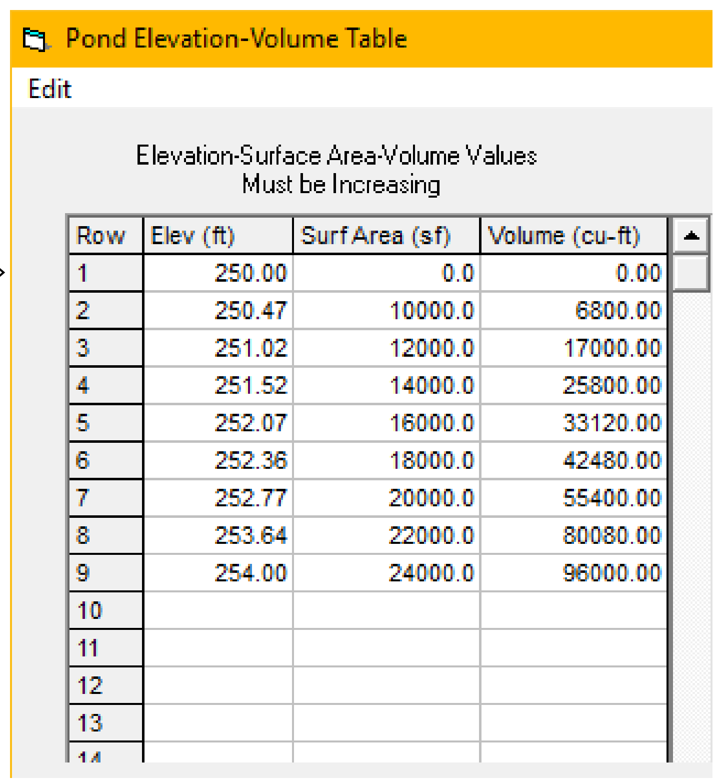
Scenario Tab

7. In MGSFlood, open the Postdeveloped Scenario Screen. Right click the Detention Pond 1 and select Edit. Click the User Defined Elevation Volume Option Table button on the bottom of the Pond/Vault Geometry Tab to open the Elevation volume table.



8. Copy the elevation volume information for the irregularly shaped pond into MGSFlood. Click OK to close the window and OK again to close the structure window.

Rating Table from CAD prograr		
Copy Blue Cells to MGSFl		
	Surf Area	Volume
Elev	sq ft	cu-ft
250.00	0	0
250.47	10000	6800
251.02	12000	17000
251.52	14000	25800
252.07	16000	33120
252.36	18000	42480
252.77	20000	55400
253.64	22000	80080
254.00	24000	96000


Pond Elevation-Volume Table

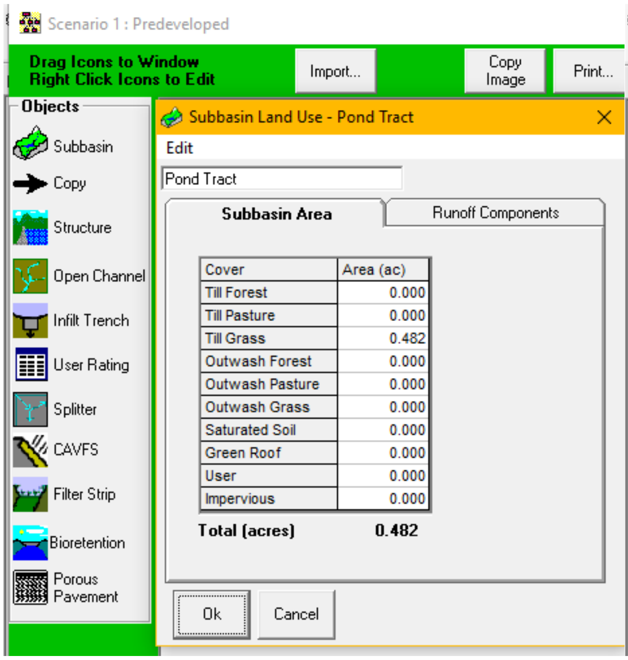
Edit

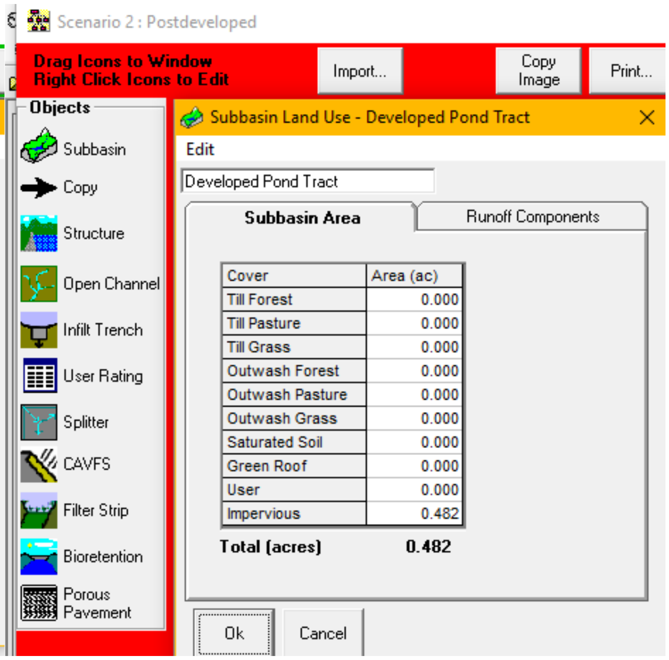
Elevation-Surface Area-Volume Values
Must be Increasing

Row	Elev (ft)	Surf Area (sf)	Volume (cu-ft)
1	250.00	0.0	0.00
2	250.47	10000.0	6800.00
3	251.02	12000.0	17000.00
4	251.52	14000.0	25800.00
5	252.07	16000.0	33120.00
6	252.36	18000.0	42480.00
7	252.77	20000.0	55400.00
8	253.64	22000.0	80080.00
9	254.00	24000.0	96000.00
10			
11			
12			
13			
14			

Note that the given information has the pond tract area increased to about 21,000 sq. ft. (0.482 acres) at elevation 253.00. In the previous Work Session 1, the pond tract area was calculated to be 0.431 acres. We need to revise the pond tract areas in the Predeveloped and Postdeveloped subbasins.

9. On the Scenario Tab, enter 0.482 acres for the pond tract area in the Predeveloped and Postdeveloped scenarios as shown below. Click OK to close





10. Click the Simulate Tab and then the Route Button. This will confirm that the final design with the irregular pond shape meets the detention criteria.