Introduction to Bentley PondPack

CE 365K Hydraulic Engineering Design

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Contents

Goals of the Tutorial

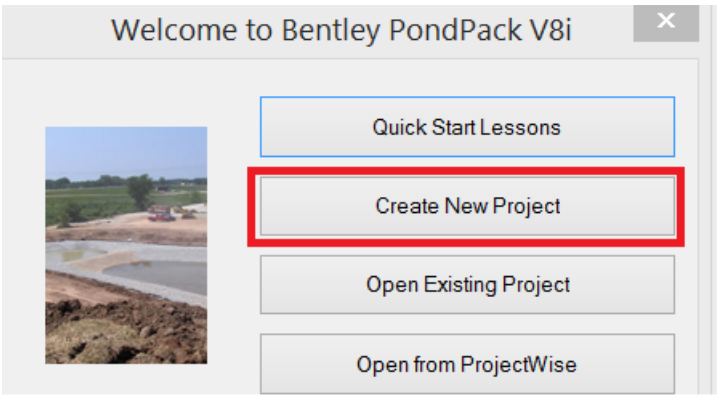
This tutorial will introduce you to the capabilities of Bentley PondPack. This includes creating a Detention Pond Network, routing a hydrograph through the system, and graphing results.

Procedure

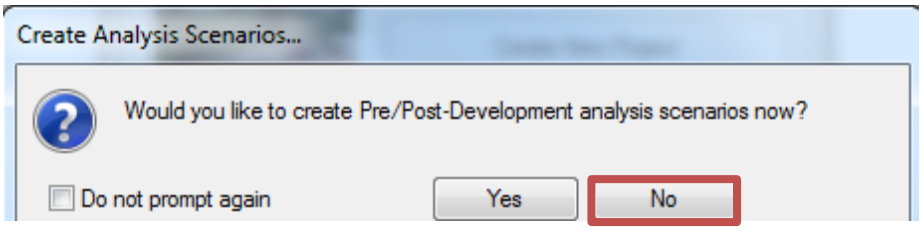
(1) Opening Bentley PondPack

Open the program by double-clicking the FlowMaster icon on your desktop, seen below, or click **Start > All Programs > Bentley > PondPack, and select PondPack**.

In the Welcome to Bentley PondPack dialog bog **select Create New Project**.

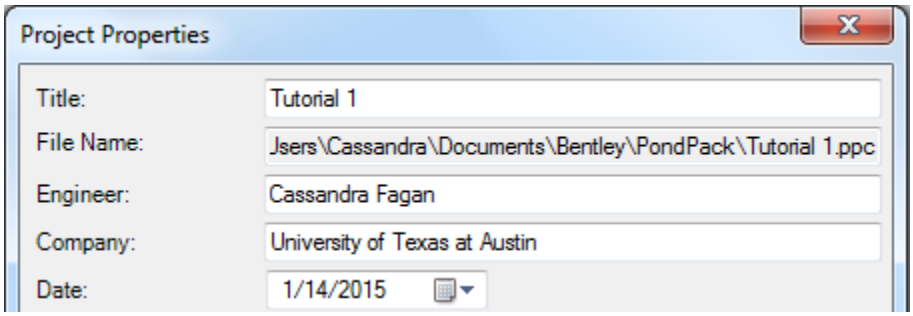


If a dialog box appears asking whether you would like to create Pre/Post-Development analysis scenarios now, **select No.**



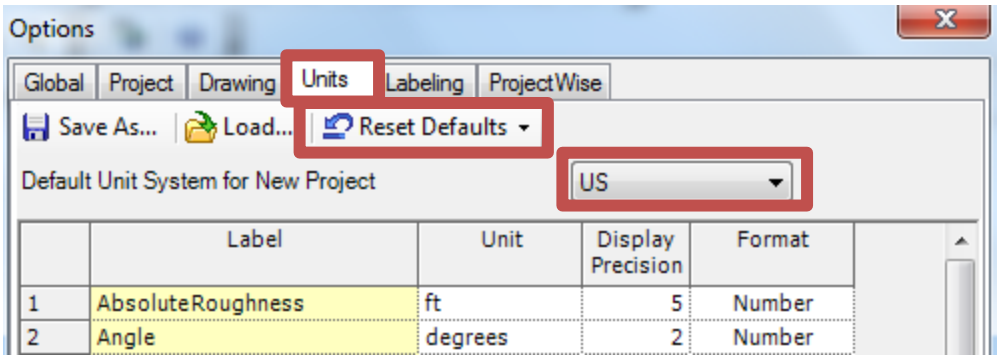
Save the project by **selecting File** > **Save As** from the menu bar. Navigate to the folder you will be using and **select Save**.

Enter the project information by **selecting File > Project Properties** under the File menu.

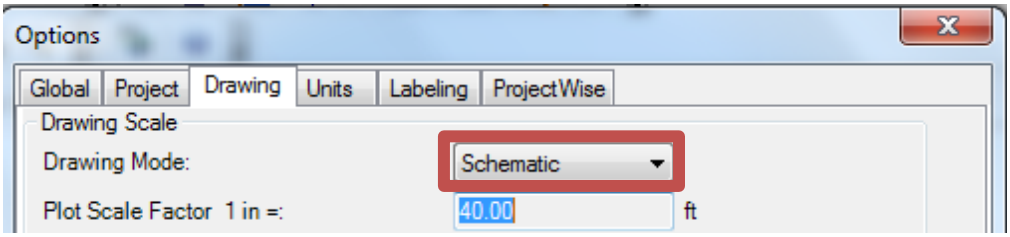


Before beginning a project, you should configure the units and drawing settings.

Select Tools > Options in the menu bar. **Select the Units tab**, and **change the Default Unit System for New Project to US**. Then **click** the **Reset Defaults tab** and **select US Customary**.



Next, **select the Drawing tab** in the Options Window. **Click** the drop-down arrow next to the **Drawing Mode tab**, and **select Schematic**. This allows you to draw a schematic of the detention pond network without worrying about sizes and node lengths.

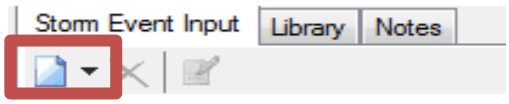


Click OK to close out of the Options Window.

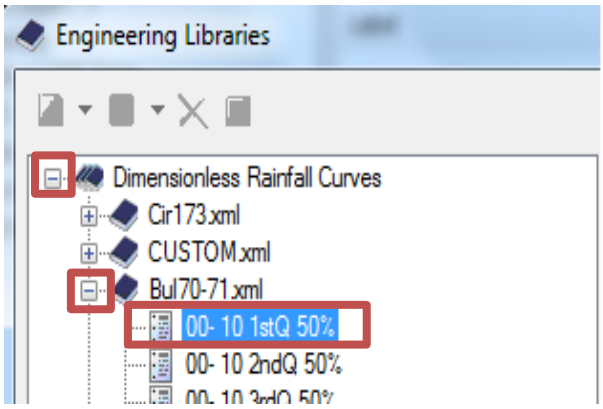
(2) Entering Storm Data

For this tutorial, water from a storm event, modeled as an inflow hydrograph, will be routed through a detention pond and outlet. To begin, you will need to specify the Storm Event. A 10-year, 2-hour storm event with a fall depth of 4.5 inches, with synthetic distribution data from the Illinois State Water Survey Bulletin 70/71 will be used in this analysis.

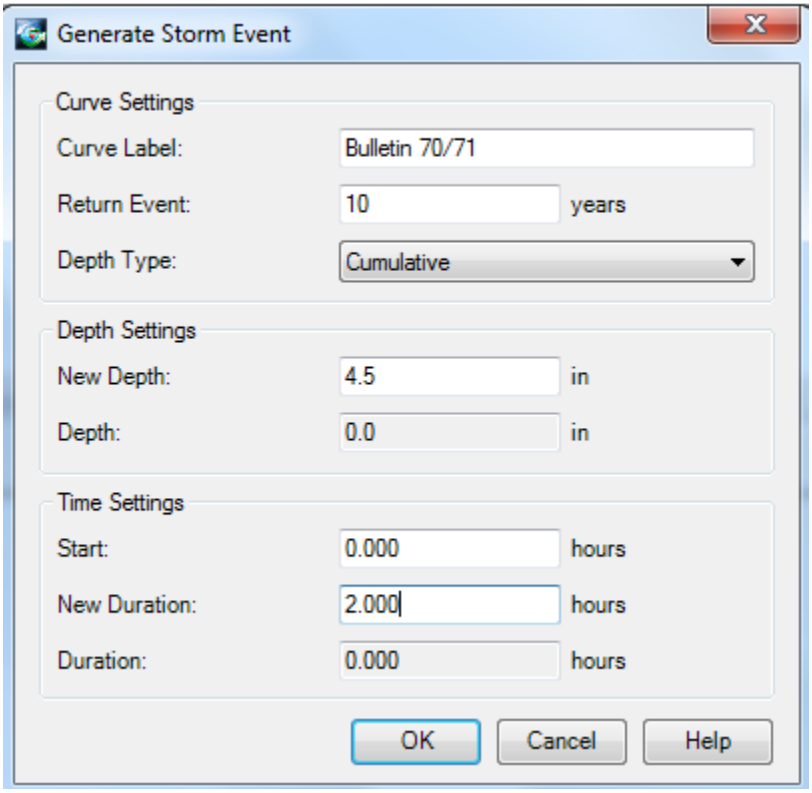
To specify this storm event, **navigate** to **Components > Storm Data** in the menu bar, and in the Storm Data window **select** the **New** button,  and **click Time-Depth.** Under the Storm Event Input seen in the central window, select the new button, seen below, and **select Add Return Event from Dimensionless Curve.**



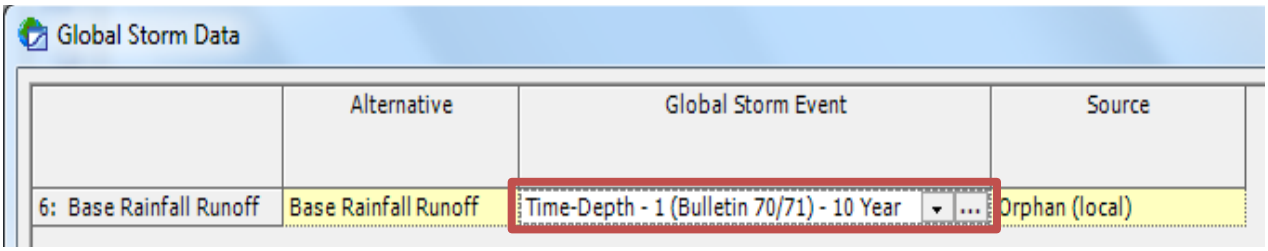
The Engineering Libraries window will appear on the screen. E**xpand** the **Dimensionless Rainfall Curves** tab and **expand** the **Bul70-71.xml** tab. **Select** the **00-10 1stQ 50%** option, and **click Select**, pictured below. This design storm will use first-quartile statistics from storm events with return intervals of 10 years or less.



A Generate Storm Event Window will appear on the screen, pictured below. **Enter Bulletin 70/71** as the **Curve Label**, **enter 10 years** for **Return Event**, **select Cumulative** in the **Depth Type** drop-down menu. **Enter 4.5 inches** as the **New Depth**, **2.0 Hours** as the **New Duration**, and **select OK.** In the Storm Data window **select Close.**



In the top menu bar **select Components > Global Storm Data** in the menu bar. In the Global Storm Data Window, click the drop down menu under the Global Storm Even tab, and **select Time-Depth- 1 (Bulletin 70/71)- 10 Year**. **Click Close** to close the Global Storm Data window.



(3) Laying out the Detention Pond Network

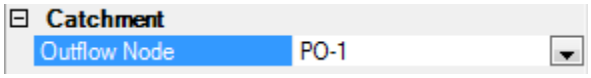
The Detention Pond Network will consist of a drainage area contributing a detention pond and draining to a detention pond outlet. To draw this schematic, begin by **selecting** the **Catchment** button on the vertical toolbar. In the upper left corner of the workspace draw a catchment by left-clicking to draw vertices. Finish by right-clicking and **selecting Done**. A catchment labeled CM-1 should appear in the workspace.

Select the P**ond** button from the vertical menu bar and in the center of the workspace area draw a pond by left-clicking to draw corners. Right-click and **select Done** to finish the pond. A pond labeled PO-1 should appear in the workspace.

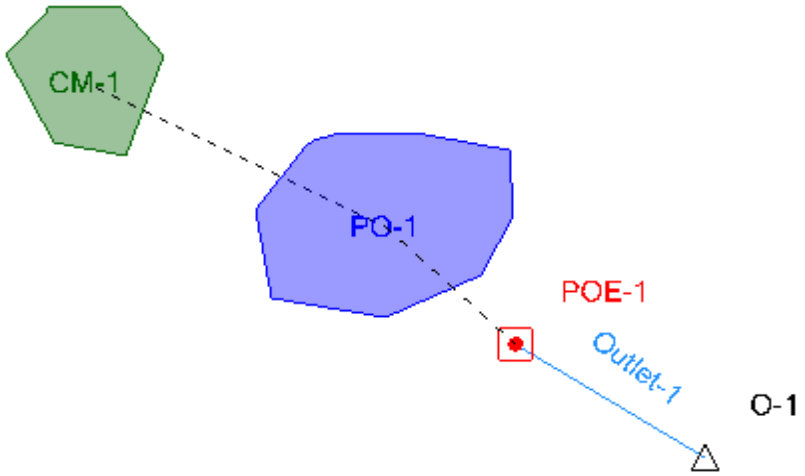
Select the **Layout** button and select **Pond Outlet** from the drop-down menu. On the Right-Side of the Pond, PO-1, left-click to create a pond outlet entrance, POE-1. Move the cursor away from the pond, **right-click**, **select Outfall…,** and **left-click** to create the Outfall, **O-1**.

Click select to exit layout mode.

Double click on the Catchment, CM-1, and the **Properties** window will appear on the screen. Next to Outflow Node, select the drop-down menu and **click Select Outflow Node**. In the schematic click on the pond, PO-1, and PO-1 will appear as the Outflow Node in the Properties window.



Double-click on the pond outlet entrance, POE-1, to open the Properties window. **Select** the drop-down arrow next to **Upstream Pond**, and **click Select Upstream Pond**, and in the schematic **select PO-1**. Close the Properties window. The pond network schematic is pictured below.



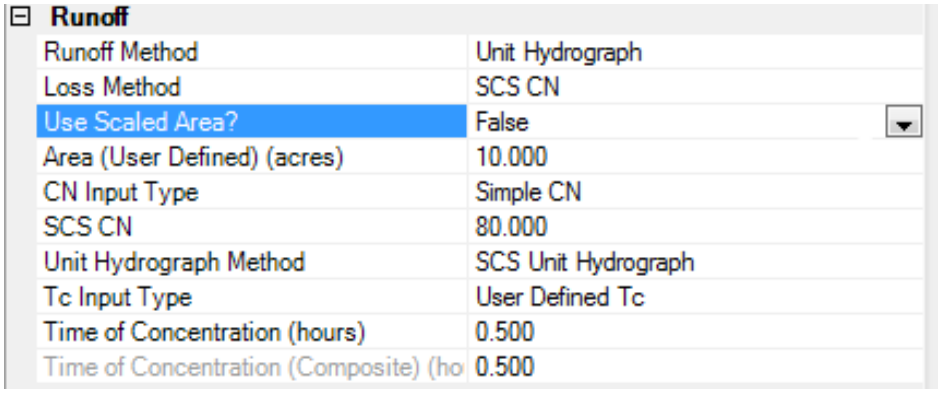
(4) Entering Watershed Data

To enter watershed data, **double-click on** the catchment, **CM-1**, in the schematic to open the Properties window. The **catchment** has an **area** of **10 acres**, a **runoff curve number** of **80** and a **time of concentration** of **30 minutes**.

Under the **Rainfall** section of the Properties window **click** the **drop-down arrow** next to **Use Local Rainfall?** and **select True.** A line below it should appear, and next to **Local Storm Event, select Time-Depth- 1 (Bulletin 70/71)- 10 Year** in the drop-down menu. The Rainfall section is pictured below.

Rainfall	
Use Local Rainfall?	True
Local Storm Event	Time-Depth - 1 (Bulletin 70/71) - 10 Year

In the Runoff section, next to Runoff Method **select Unit Hydrograph** from the drop-down menu. Set the **Loss Method** to **SCN CN** in the drop down menu. Next to **Use Scaled Area? select False,** and enter **80** acres as the **Area (User Defined).** Set the **CN Input Type** to **Simple CN** and next to **SCS CN enter** a value of **80**. Set the Unit Hydrograph method to **SCS Unit Hydrograph**, the **Tc Input Type** should be set to **User Defined Tc**, and **enter 0.5 hours** as the **Time of Concentration**. The runoff section of the catchment properties window is pictured below. Once this information is entered, **close** the **CM-1** Properties window.

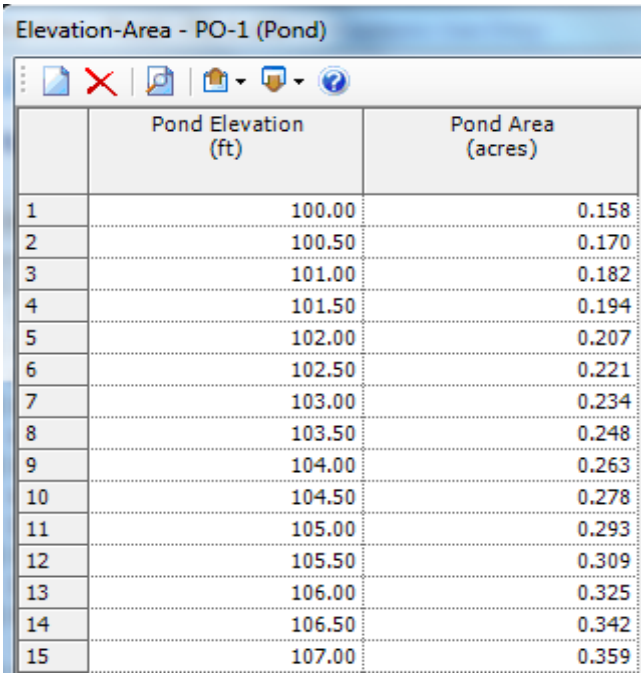


(5) Entering Stage-Area data for the Detention Pond

Elevation-Area Data for Detention Pond

Elevation (ft)	Area (ac)	Elevation (ft)	Area (ac)
100	0.158	104	0.263
100.5	0.170	104.5	0.278
101	0.182	105	0.293
101.5	0.194	105.5	0.309
102	0.207	106	0.325
102.5	0.221	106.5	0.342
103	0.234	107	0.359
103.5	0.248		

Double click on the detention pond PO-1 to open the Properties window. Under the Volume section, **set** the **Pond Type** to **Elevation-Area**. Next to Elevation-Area, **click** the **ellipsis** button. In the Elevation-Area window, **enter** the pond **Elevation-Area data** found in the table above. When you complete entering the data, **close** out of the **Elevation-Area window**, and **close** out of the **PO-1 properties window**.



	Pond Elevation (ft)	Pond Area (acres)
1	100.00	0.158
2	100.50	0.170
3	101.00	0.182
4	101.50	0.194
5	102.00	0.207
6	102.50	0.221
7	103.00	0.234
8	103.50	0.248
9	104.00	0.263
10	104.50	0.278
11	105.00	0.293
12	105.50	0.309
13	106.00	0.325
14	106.50	0.342
15	107.00	0.359

Right-click on **PO-1**, and **select Pond Volume Results Table** to view a graph of the detention pond's Elevation versus Volume curve. Select the Data Table tab to view the data for the curve. Close out of the Volume Results Table window.

(6) Entering Outlet Data and Creating an Outlet Discharge Rating Curve

The pond outlet, Outlet 1, has **two outlets** operating in parallel. One outlet is a **rectangular, contracted weir** with a **weir coefficient** of **2.6**. The weir structure is **15 feet wide**, and has an **elevation of 105.0 feet**. The second outlet consists of a **6-inch diameter orifice** plate at an **elevation of 100.0 feet** and an **orifice coefficient** of **0.6**. Both outlets operate under **free outfall** conditions.

Double click Outlet-1, to open the properties window. In the **Pond Outlet** section, next to **Has Control Structure? select Yes.** On the Composite Outlet Structure line, **click the drop-down arrow** and **select Edit**. A Composite Outlet Structures window will appear on the screen. In the upper-left corner of the window, **click** the **New** button and **select Composite Outlet Structure**. A composite Outlet Structures window will come up on the screen. In the Headwater section, **click** next to **Pond** and **click Select from Drawing** from the drop-down menu**. Select** the detention pond, **PO-1**, in the main window.

In the upper-left corner of the Composite Outlet Structure window, **click** the **New** button and **select Weir** from the drop-down menu**. Enter 105.0 fee**t as the **Elevation** in the Outlet Structure section. **Select Forward Flow Only** as the **Flow Direction** in the Outlet Structure (IDs and Direction) section.

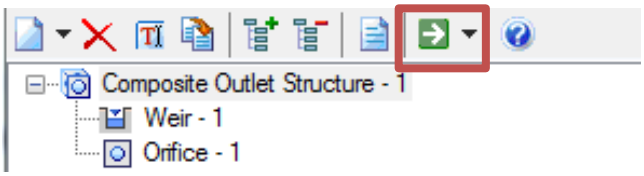
In the Outlet Structure section, next to Weir **select Rectangular Weir**. **Set** the **Weir Coefficient** to **2.6**, **set Rectangular Wei**r to **Suppressed**, and **set** the **Weir Length** to **15 feet**. The Weir properties are pictured below.

Outlet Structure	
Outlet Structure Type	Weir
Outlet Structure (Common)	
Elevation (ft)	105.00
Outlet Structure (IDs and Direction)	
Outlet ID	Weir - 1
Flow Direction	Forward Flow Only
Downstream ID	Tailwater
Notes	
Outlet Structure (Weir)	
Weir	Rectangular Weir
Vary Coefficient with Depth	False
Weir Coefficient ((ft^0.5)/s)	2.60
Rectangular Weir	Suppressed
Weir Length (ft)	15.00

In the upper-left corner **click** the **New** button  , and **select Orifice**. In the Outlet Structure (Common) section, **enter 100 feet** for the **Elevation (ft)**. In the Outlet Structure (IDs and Direction) section, **set** the **Flow Direction** to **Forward Flow Only**. Under the Outlet Structure (Orifice) section **set** the **Orifice** to **Circular Orifice**. **Set** the **Orifice Coefficient** to **0.6**, and **set** the **Orifice Diameter** to **6.0 inches**. The orifice window is pictured below.

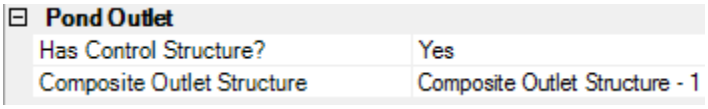
Outlet Structure	
Outlet Structure Type	Orifice
Outlet Structure (Common)	
Elevation (ft)	100.00
Outlet Structure (IDs and Direction)	
Outlet ID	Orifice - 1
Flow Direction	Forward Flow Only
Downstream ID	Tailwater
Notes	
Outlet Structure (Advanced)	
Elevation (On) (ft)	0.00
Elevation (Off) (ft)	0.00
Outlet Structure (Orifice)	
Orifice	Circular Orifice
Number of Openings	1
Orifice Coefficient	0.600
Orifice Diameter (in)	6.0

In the top of the Composite Outlet Structures Window **highlight Composite Outlet Structure-1** and **select** the **Compute** button  .



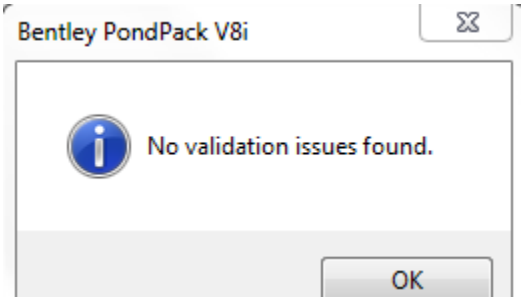
A Rating Curve plotting Pond Water Surface Elevation versus Flow will appear on the right side of the Composite Outlet Structures window. **Close** the **Composite Outlet Structures window**.

In the Pond Outlet Properties window, Pond Outlet section **set** the **Composite Outlet Structure** to **Composite Outlet Structure- 1** using the drop-down menu. **Close** out of the **Properties window**.



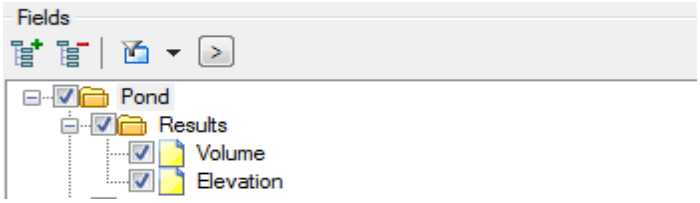
(7) Routing the Hydrograph through the Detention Pond

The Detention Pond model is now ready for the hydrograph routing. **Select** the **Validate** button to check for any errors in the model. If no validation issues are found, **select OK** in the window pictured below.



Select the **Compute** button . The model will run to completion, and a Scenario Calculation Summary window will appear on the screen. Review the summary and **select close**. In the menu bar, **select Analysis > User Notifications** to see if there would any errors during the model run.

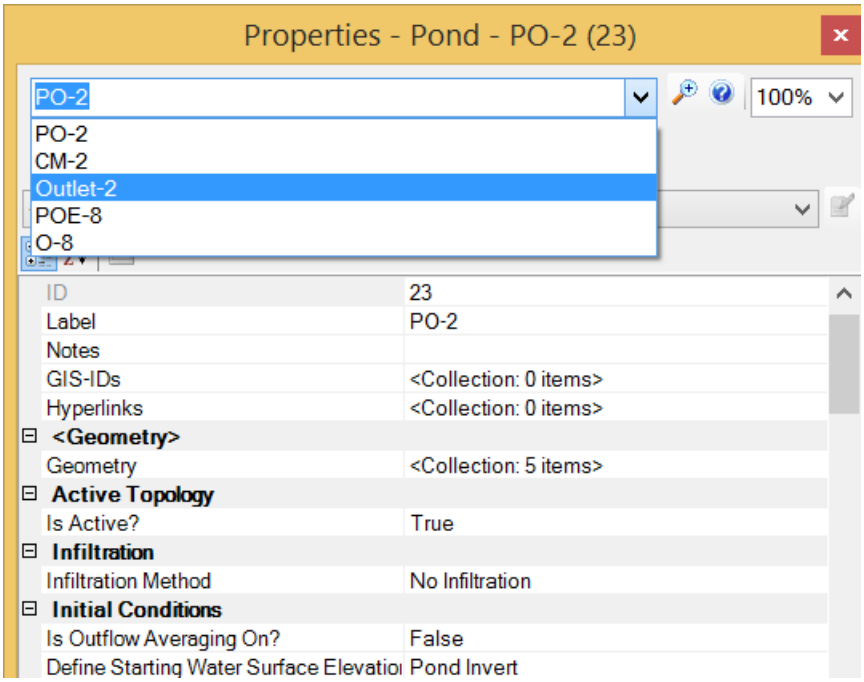
Right click on the detention pond, **PO-1**, and **select Graph.** In the Graph Series Options window there are three sections, Scenarios, Elements, and Fields. In the **Fields** panel, **select Volume** and **Elevation** and **select OK**. Note the many variables that can be plotted.



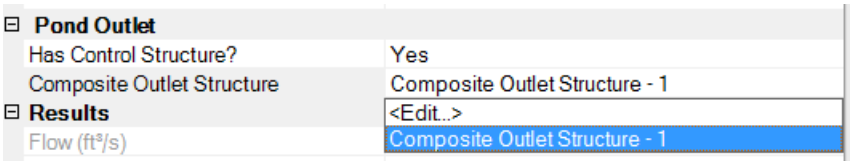
A Graph will appear on the screen plotting Volume and Elevation versus Time. To view the data used to create the chart **select** the **Data** tab.

(8) Editing the Outlet Structure Properties

Double click on the Pond Element in the Drawing, and in the Pond Properties, select the Outlet

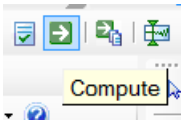


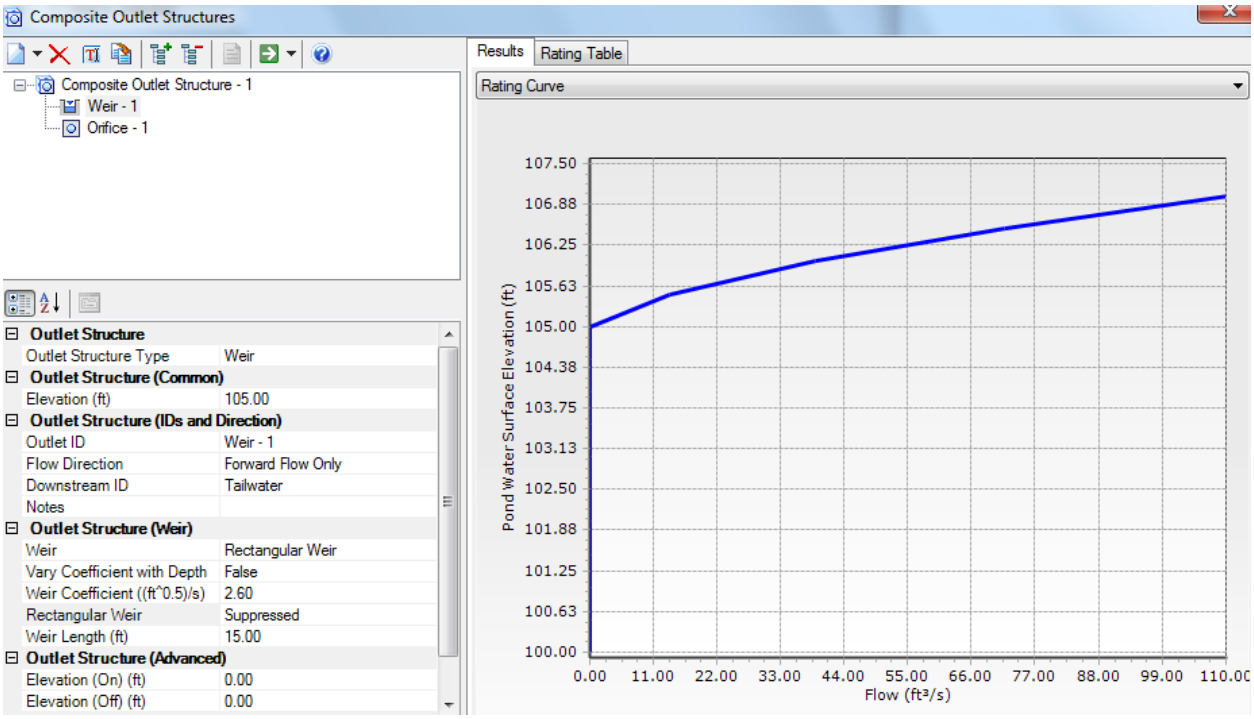
Double Click on the Composite Outlet Structure and select <Edit>



Select the Weir (or Orifice), change its properties, and recompute the Rating Table using the  compute button in the display.

Go back to the main Pond Pack window and recompute the flow through the system.




Composite Outlet Structures
Composite Outlet Structure - 1
Weir - 1
Orifice - 1
Outlet Structure
Outlet Structure Type Weir
Outlet Structure (Common)
Elevation (ft) 105.00
Outlet Structure (IDs and Direction)
Outlet ID Weir - 1
Flow Direction Forward Flow Only
Downstream ID Tailwater
Notes
Outlet Structure (Weir)
Weir Rectangular Weir
Vary Coefficient with Depth False
Weir Coefficient ((ft^0.5)/s) 2.60
Rectangular Weir Suppressed
Weir Length (ft) 15.00
Outlet Structure (Advanced)
Elevation (On) (ft) 0.00
Elevation (Off) (ft) 0.00
Results
Rating Table
Rating Curve
Pond Water Surface Elevation (ft)
107.50
106.88
106.25
105.63
105.00
104.38
103.75
103.13
102.50
101.88
101.25
100.63
100.00
0.00
11.00
22.00
33.00
44.00
55.00
66.00
77.00
88.00
99.00
110.00
Flow (ft³/s)