InRoads – Generating Stormwater Ponds Using Templates

Overview

InRoads provides a number of tools and processes to assist in the development of infiltration, detention, or Wet Pool BMPs (ponds). The process documented in this Tech Note uses InRoads commands to create geometry, templates and roadway corridors to model the surfaces, and volume and reporting tools to evaluate the design.

NOTE: While the hydraulic assumptions of the facility used in this document generally follow WSDOT Highway Runoff manual guidelines, some deviation from standards may occur in order to illustrate an InRoads concept.

Workflow

Horizontal and Vertical Geometry

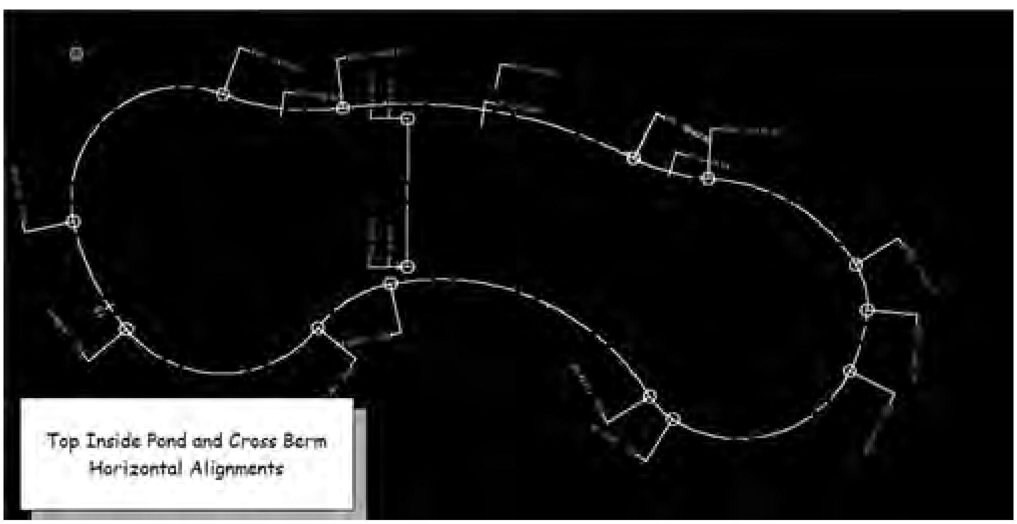
Begin by creating the top inside pond edge horizontal and vertical alignments. Additional geometry is necessary if a cross pond berm is needed to divide a large pond into two cells.

The various InRoads **Horizontal Element** tools work well in this situation, although importing MicroStation generated graphics will work as well. A combination of InRoads **Fixed Lines**, **Floating** and **Free Curves** and Cogo points are used here to create the horizontal alignments.

Pond design is an iterative process and much “tweaking” of the first design is needed to correctly size any pond for the given project specifics.

A good approximation of the horizontal and vertical dimensions should be in hand prior to this point. After the initial creation, editing the alignment elements to change length or radii, or moving parallel to enlarge or decrease the footprint are actions typically required.

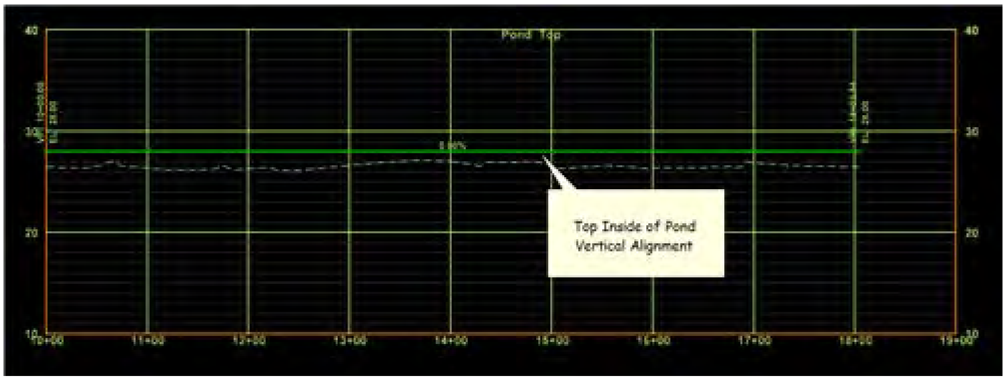
NOTE: Once the alignments are in InRoads and it is necessary to move the location, use the *Geometry* > *Utilities* > *Transform* command to shift the horizontal position. Update and review the profile against the existing ground at the new location.



Pond Profile

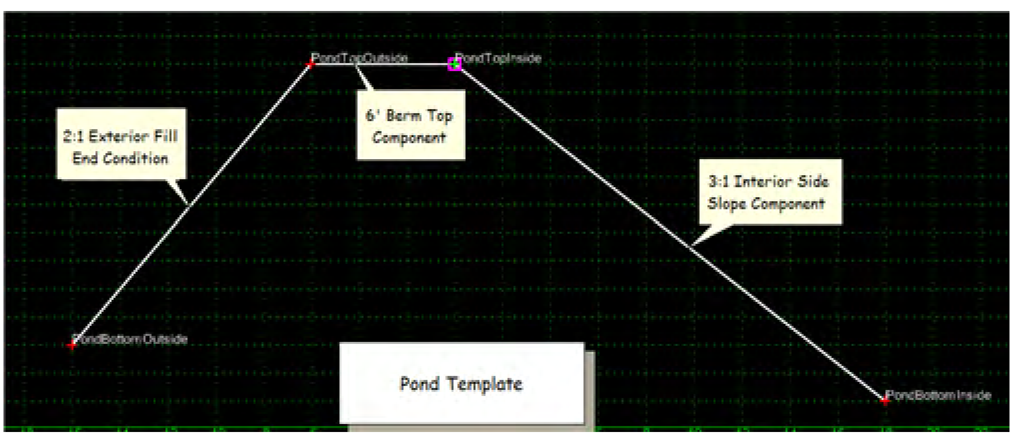
Create the pond top profile starting with the *Evaluation >Profile >Create Profile* command. Then the *Geometry >Vertical Element > Add Fixed Vertical Line* command can be employed which works by populating the dialog with the beginning and ending stations and elevations.

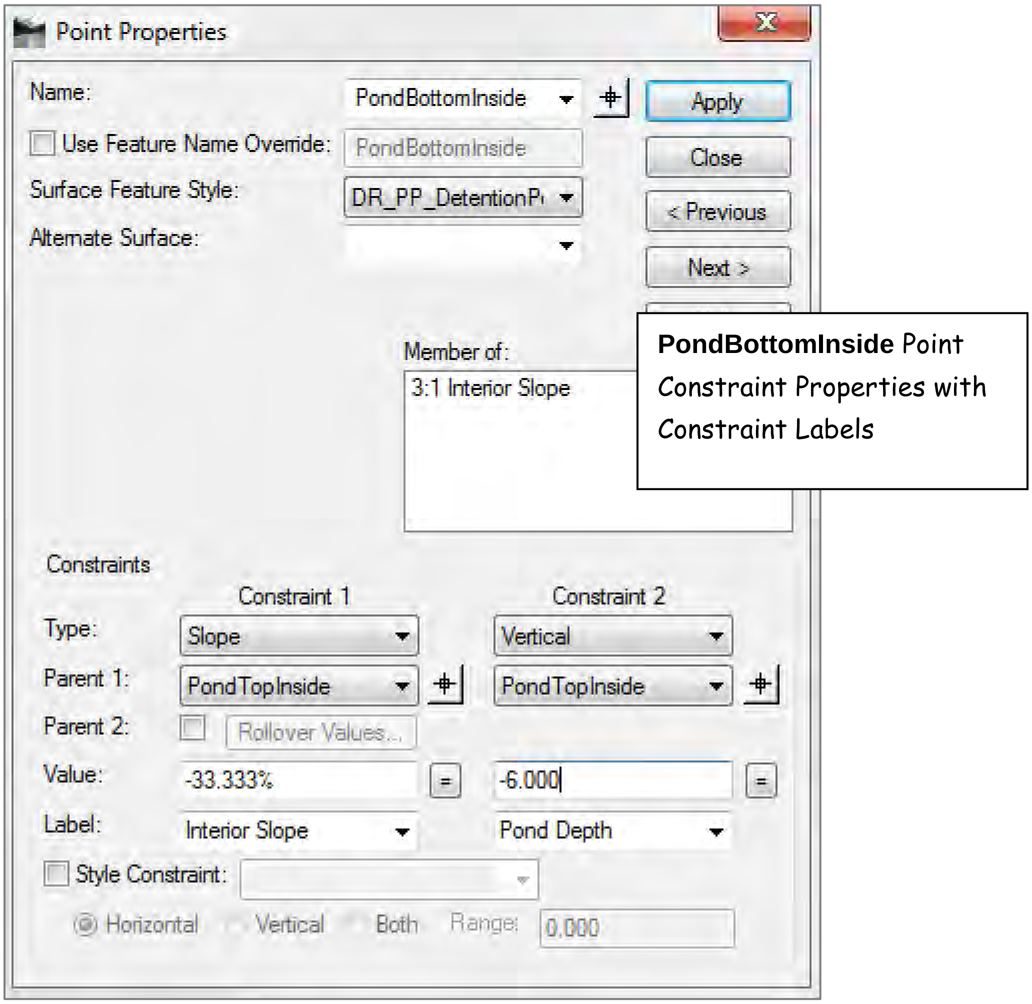
After an evaluation of the example existing surface an elevation of 28 feet is used. The berm top vertical is created the same way, but requires the main pond surface to be generated first. We will come back to this geometry later.



Template Design

A template run along the top of pond geometry generates the interior and exterior pond shape. A flat berm top extends from the origin with the exterior side slope generated by end conditions. The interior slope of the pond results from a regular component, not an end condition. The slope and/or elevation of this component can be controlled in the **Roadway Designer** more easily as a constrained component.





PondBottomInside Point Constraint Properties with Constraint Labels

A separate berm template creates an interior cross berm surface when a two-cell pond is desired. It is controlled by its own geometry and targets the pond surface, not the existing. It consists of a flat berm top centered on the alignment and end conditions at the desired slope targeting the main pond DTM.

Roadway Designer

Define a corridor for the pond controlled by the pond top geometry. Then assign the template the desired interval and process the design.

If a uniform depth is desired then this value should be defined in the template, usually by a Vertical constraint from the pond top. Often, a pond of varying depths is called for which can be accomplished in several ways. A vertical alignment can be used to control the bottom elevation. Since pond design requires many iterations to get the required volume, using a vertical alignment to define the pond bottom can be labor intensive as it is has to be revised over and over then re-modeled and volumes checked.

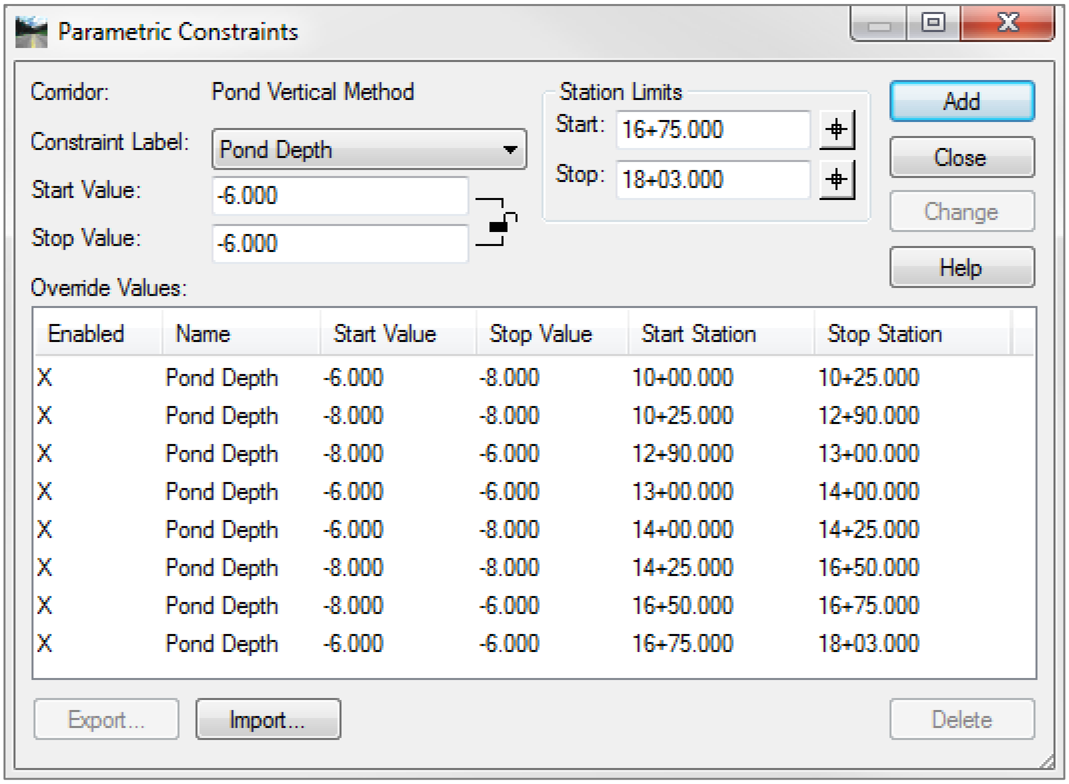
An easier way is to use the power of **Parametric Constraints** or **Point Controls.** Each one has advantages and both are presented here.

Whatever the method of controlling the pond bottom, first determine bottom of pond elevations related to station ranges and other key stations defining elevation transitions.

Variable exterior side slopes – if desired – can be generated by defining **End Condition Exceptions** and variable interior side slopes can be generated through the use of **Parametric Constraints**.

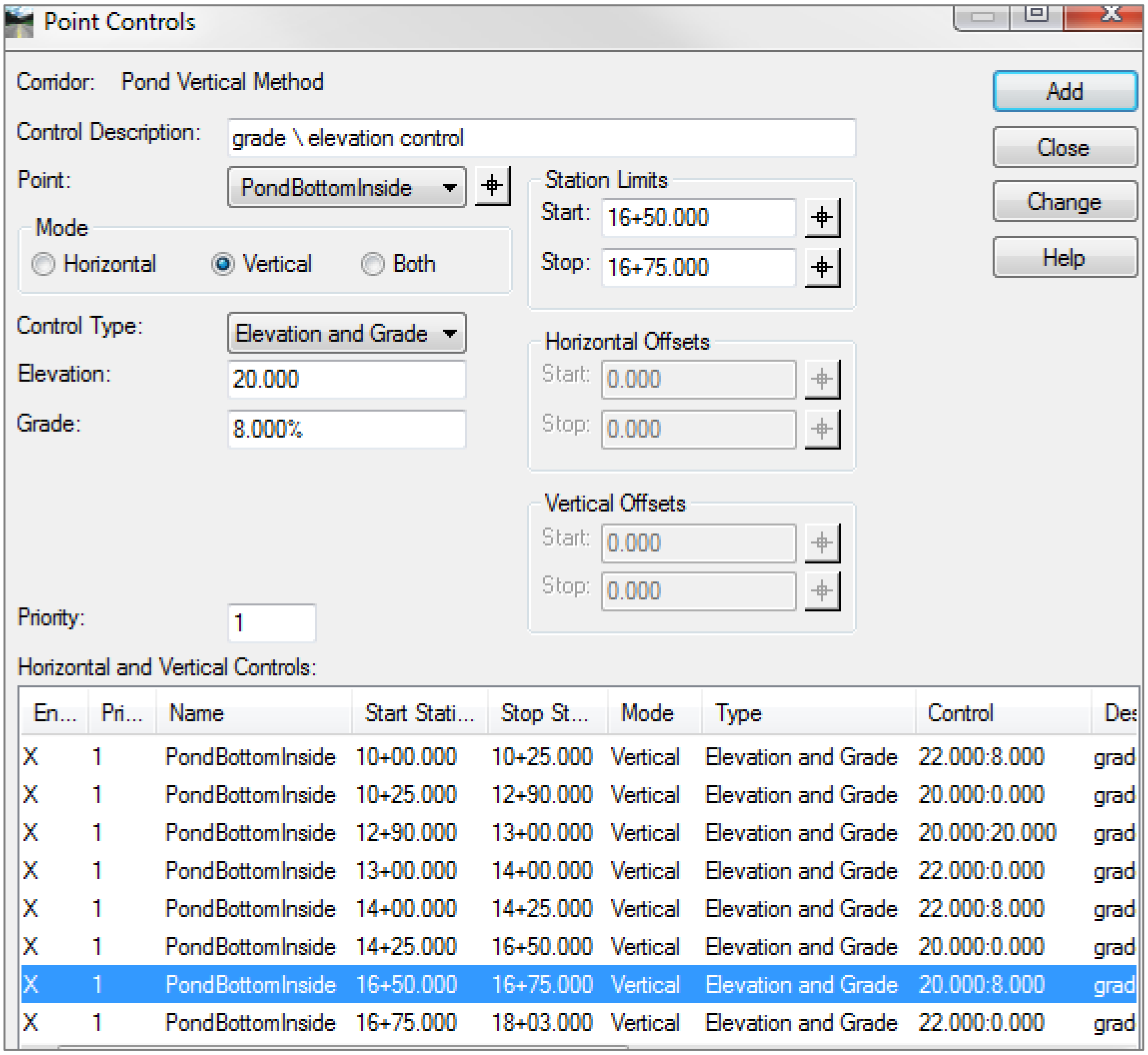
Parametric Constraints

Open the Roadway Designer *Tools >Parametric Constraints* command. Select the *Label* assigned to the vertical constraint and enter values and station limits for the entire alignment.



Point Controls

A *Vertical Mode* and a *Control Type* of **Elevation and Grade** will provide the same results. The *Elevation* value is the elevation at the *Start Station* and the *Grade* value generates the elevation at the *Stop* station.



Process All and **Create Surface**. Any exterior boundary feature generated using this method will probably cause the resulting surface to have a "hole" where the pond bottom should be. The modeler generated exterior feature runs around both the inside bottom and the outside perimeter. The recommendation is to <u>not</u> create the boundary during the modeling phase, but to manually import the perimeter into the surface later as an **Exterior** feature after deleting any extraneous exterior triangles.

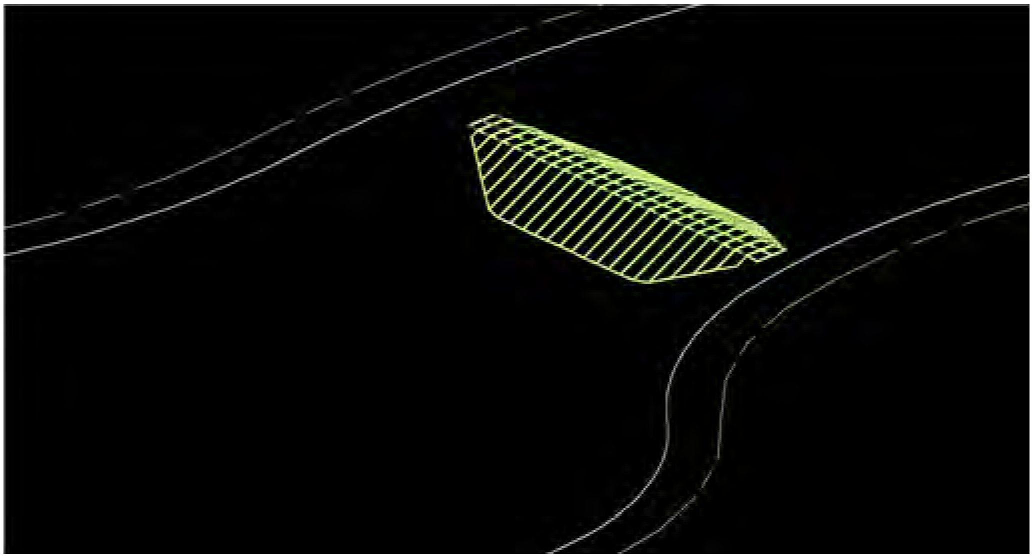
Review the new surface by checking properties, cutting sections and re-model as needed.
If a two cell pond is called for then a Cross Berm must be developed. The berm divides the pond so that the first cell is 25%-30% of the overall pond volume.

The Cross Berm Geometry

Create a perpendicular horizontal alignment at the chosen location. There are many ways to do this, but the design elevation of the berm top and the interior slope controls the overall length of the berm.

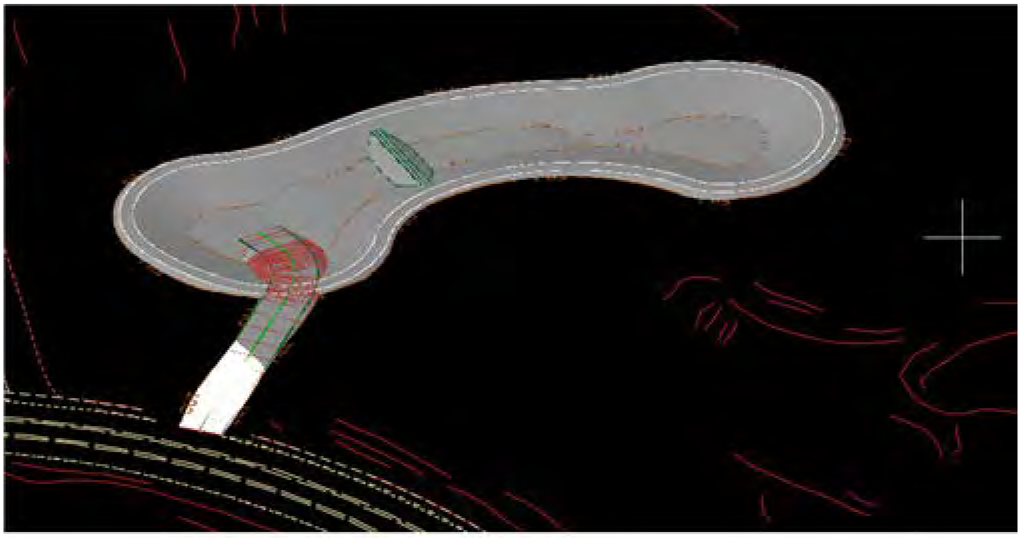
The vertical alignment is created the same way as the pond with the elevations matching the pond sides.

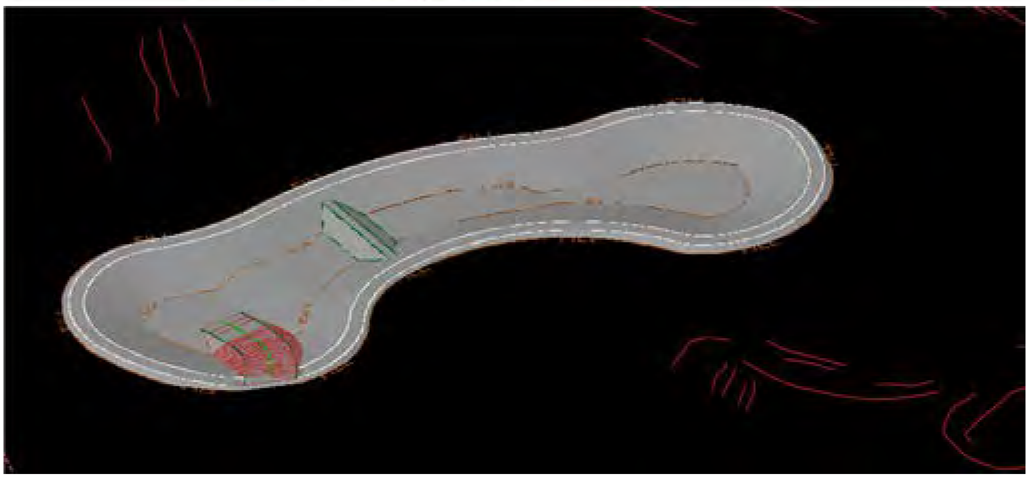
Create a template defining the berm top and end conditions targeting the Pond surface. Then create a corridor definition and model.



An access road to the first cell is a required design element and the process steps are similar to the cross berm design: create geometry, template, and model the Merge Pond, Berm, and Access Road surfaces to produce the final DTM.

An alternate method is to model all the corridors together into a single final surface. **Target Aliases** and **Clipping Options** are used to accomplish this.



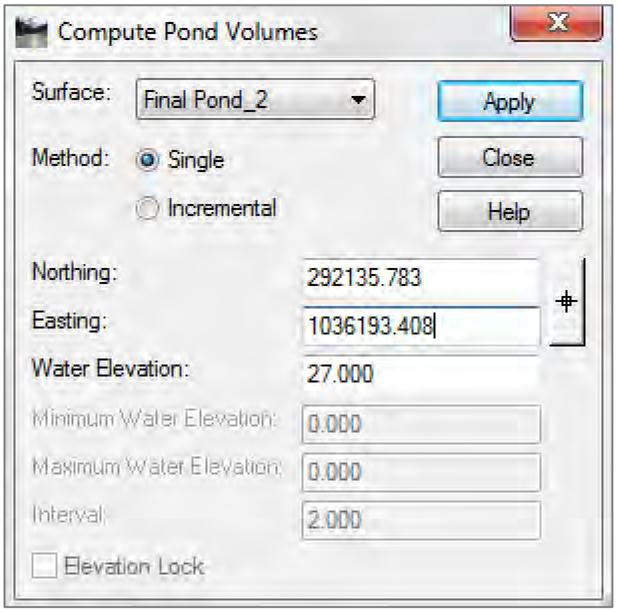


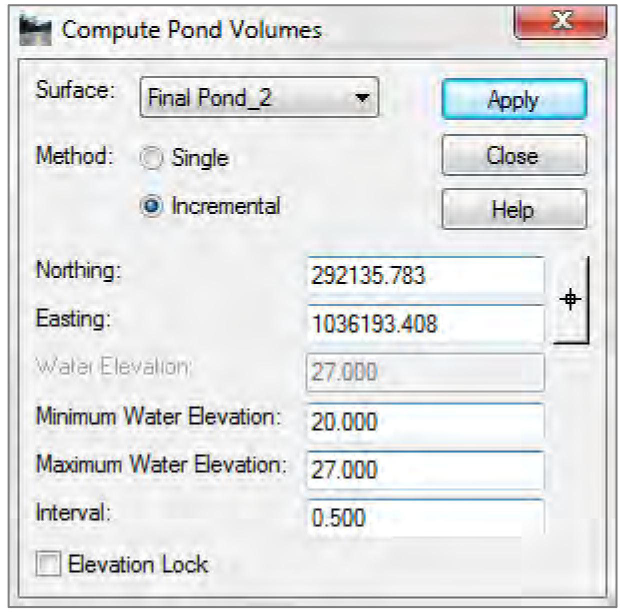
Calculating Volumes

The overall and first cell volumes need to be calculated to determine if the design requirements are met. In addition to the overall volume, separate dead and live storage quantities may also be required. There are several ways to do this:

Evaluation >Hydrology and Hydraulics >Compute Pond Volumes Command

The **Hydrology and Hydraulics** menu will appear when it is checked on as an **Application Add-In**.



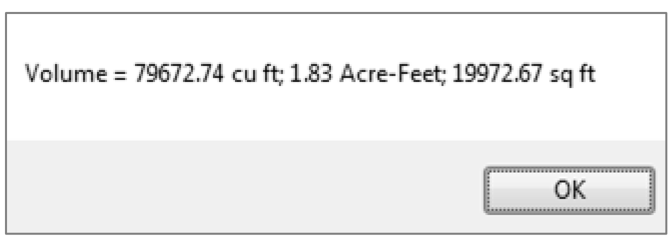


This tool generates volumes via two methods: (1) Single, and (2) Incremental. The **Single** method returns a single volume quantity up to a user defined elevation. The **Incremental** method computes volumes at different elevation increments.

Calculating Total Pond Volume

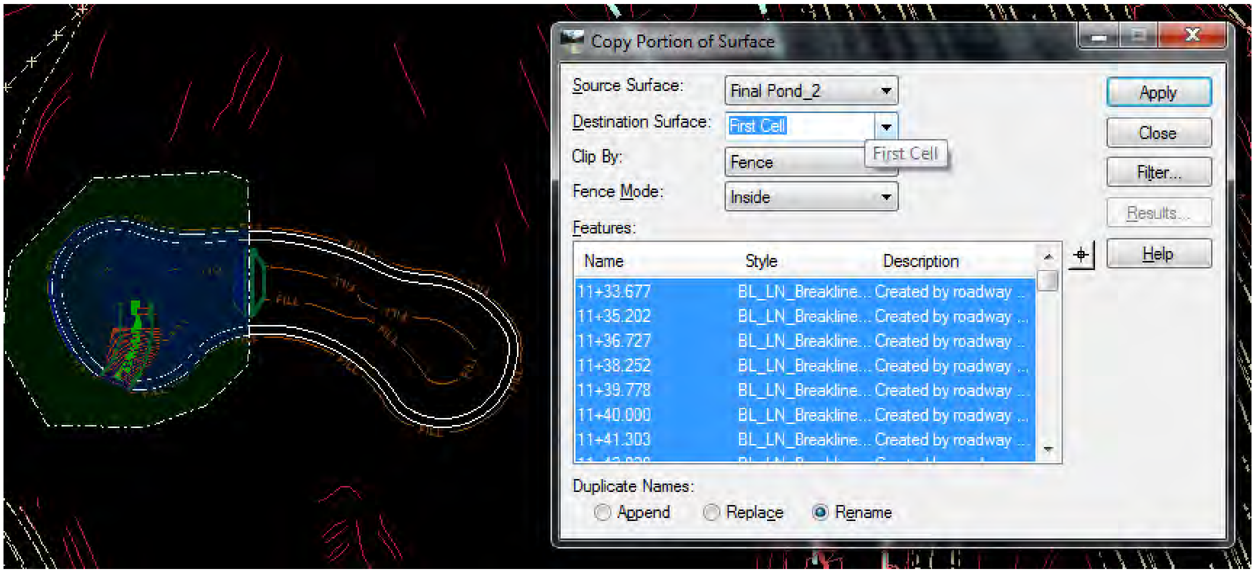
Select the *Pond Volume* command – Single method. Key in or target coordinate values for the location of your pond. It is much easier to graphically select the location using the target button. The location chosen must be at an elevation which is lower than the entered Water Elevation. The design elevation in this example is one foot below the top of the pond.

Apply the command, and the volume is displayed in a pop-up dialog.



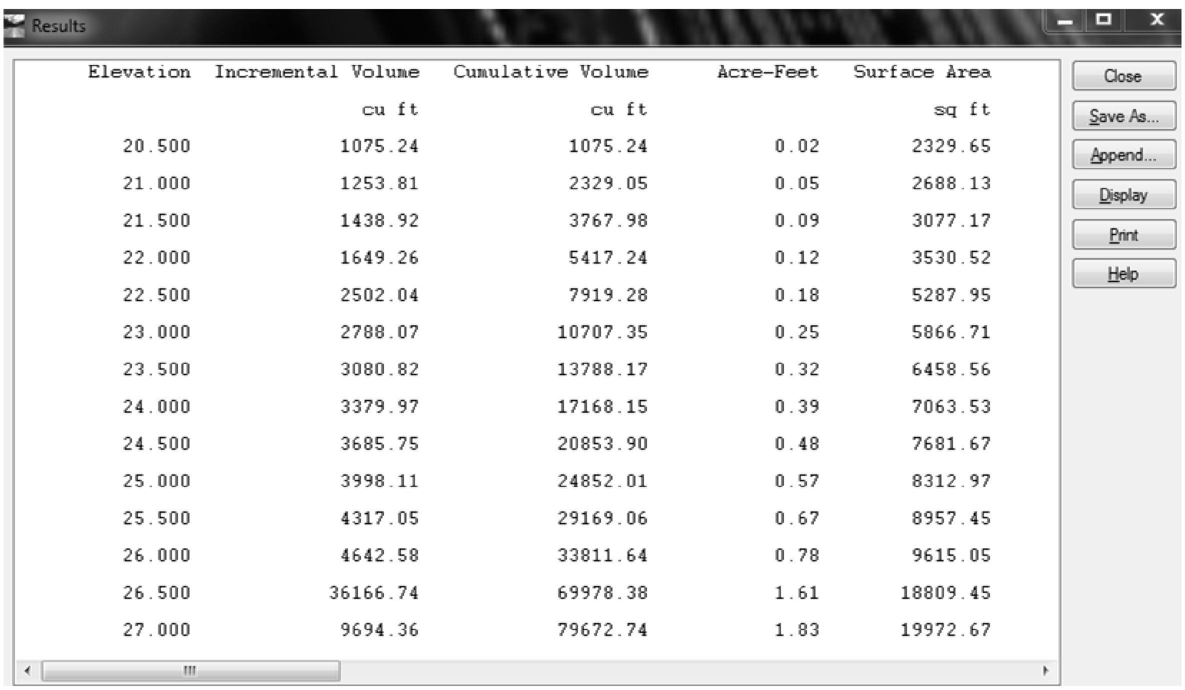
Calculating the First Cell Volume

Perhaps the easiest method to compute the quantity cell one is to use the *Surface > Edit Surface > Copy Portion of Surface* command and copy just the first cell portion of the **Final Pond** surface and use that to compute the volume. Use a fence and a clip mode. Use either of the volume methods.



Calculating Dead/Live Storage Volumes

The **Incremental** method is a "stage storage" way of viewing pond volume. The resultant report will only show values at elevations which are higher than the targeted coordinates. So a location at the lowest elevation is required in order to see the entire volume.



Elevation	Incremental Volume	Cumulative Volume	Acre-Feet	Surface Area
	cu ft	cu ft		sq ft
20.500	1075.24	1075.24	0.02	2329.65
21.000	1253.81	2329.05	0.05	2688.13
21.500	1438.92	3767.98	0.09	3077.17
22.000	1649.26	5417.24	0.12	3530.52
22.500	2502.04	7919.28	0.18	5287.95
23.000	2788.07	10707.35	0.25	5866.71
23.500	3080.82	13788.17	0.32	6458.56
24.000	3379.97	17168.15	0.39	7063.53
24.500	3685.75	20853.90	0.48	7681.67
25.000	3998.11	24852.01	0.57	8312.97
25.500	4317.05	29169.06	0.67	8957.45
26.000	4642.58	33811.64	0.78	9615.05
26.500	36166.74	69978.38	1.61	18809.45
27.000	9694.36	79672.74	1.83	19972.67

For questions or comments on this tech note, contact your regional CAE Support Coordinator or the WSDOT CAE Help Desk at (360) 709-**8013**.