



Regulatory Review Webinar Series

Lesson 4 Hydraulics, Part 3

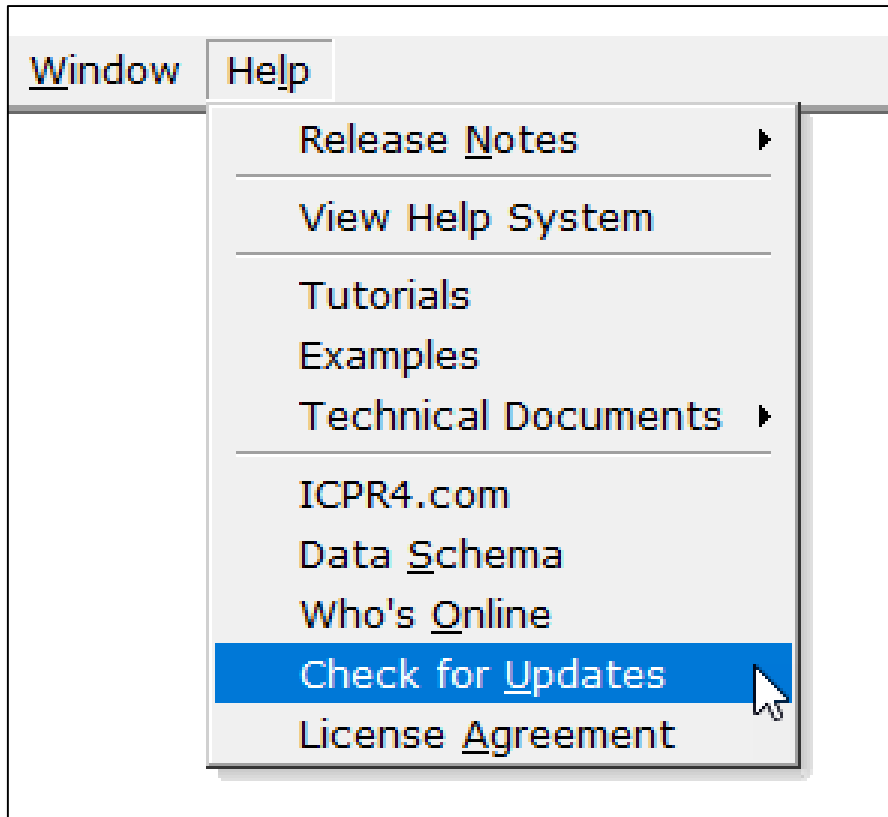
Peter J. Singhofen
Streamline Technologies, Inc.

Thursday – October 31, 2019

Next Webinar – Lesson 5: Typical Pre/Post Examples

Tuesday November 5, 2019

11:30 – 1:30 (EDT)



We will try to post a recording of this webinar and/or the presentation material as soon as we can.

To find them:

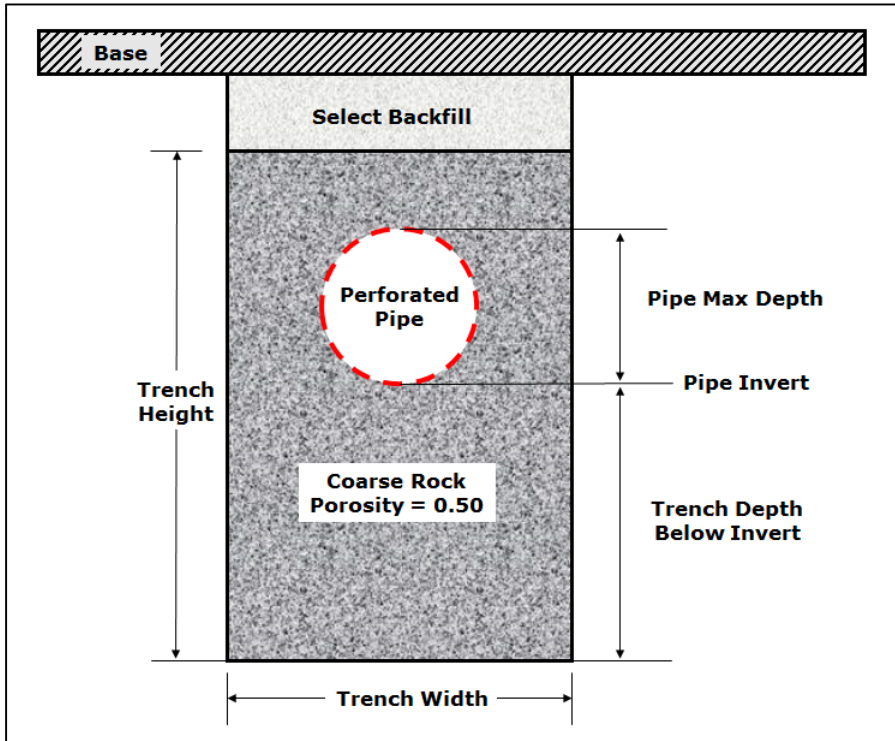
“Check for Updates”
sometime tomorrow.

support@icpr4.com

Lesson 4 Topics

- French Drain Links
- Percolation Links
- Examples

French Drain Links



Source: *An Overview of Urban Stormwater Management Practices in Miami-Dade County, Florida, 2004* →

French Drain Links

Includes:

- Storage in Trench & Pipe
- Pipe Hydraulics

Does Not Include:

- Percolation

French Drain Links

Provide treatment volume for 1" of runoff from a 1-ac site

$$V_{\text{treatment}} = 43,560 \text{ ft}^2 \times (1 \text{ in}) \times (1 \text{ ft}/12 \text{ in}) = 3,630 \text{ ft}^3$$

$$A_{\text{pipe}} = \pi r^2 = \pi$$

$$A_{\text{trench}} = [(W_{\text{trench}} \times D_{\text{treatment}}) - A_{\text{pipe}}] \times \text{Porosity}$$

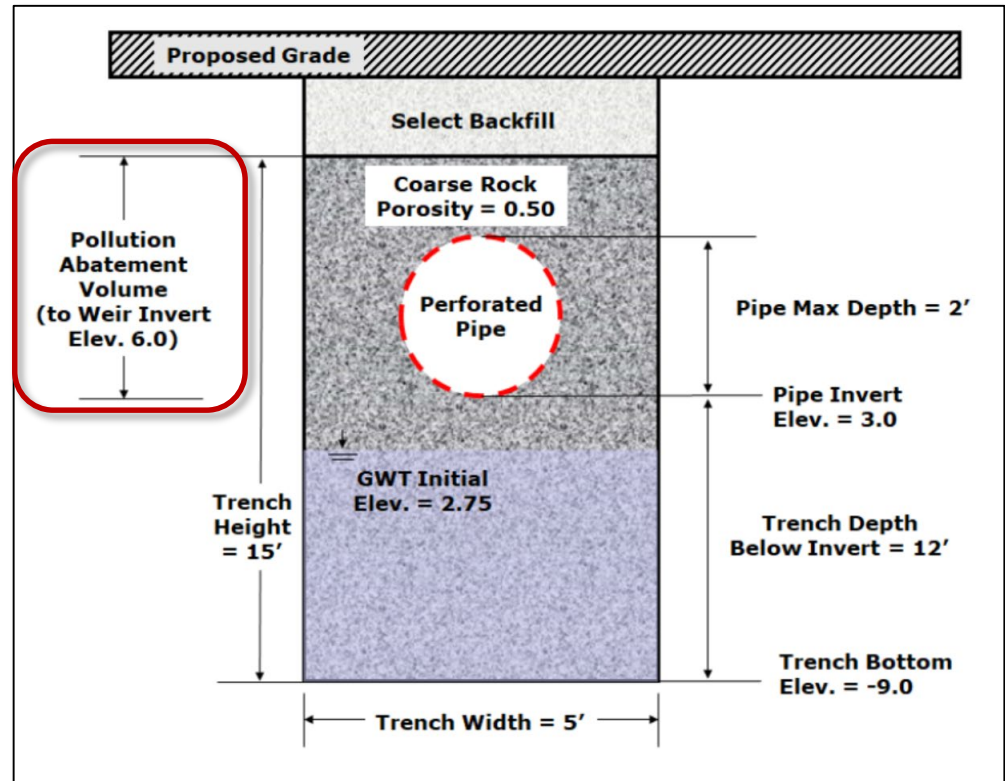
$$V_{\text{treatment}} / LF$$

$$= (1 \text{ ft})A_{\text{pipe}} + (1 \text{ ft})A_{\text{trench}}$$

$$= \pi + [(5' \times (6' - 3')) - \pi] \times 0.5$$

$$= 9.071 \text{ ft}^3 \text{ per ft}$$

$$L_{\text{FD}} = 3,630 / 9.071 = \underline{400 \text{ ft}}$$

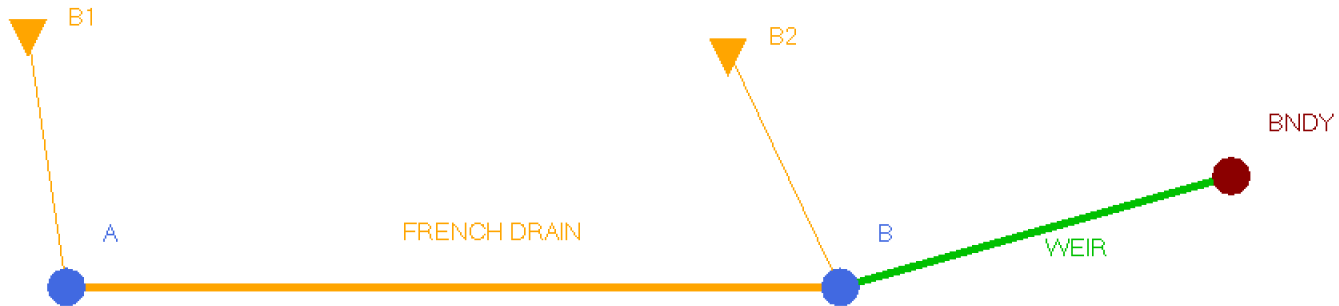


French Drain Links

Model Data

A = 0.5 ac
 CN = 100
 TC = 10 min

A = 0.5 ac
 CN = 100
 TC = 10 min



Trench

Length = 400'
 Width = 5'
 Height = 15'
 Depth Below Inv = 12'
 Gravel Porosity = 0.5

Pipe

Length = 416'
 Geometry = Circ
 Max Depth = 2'
 Invert Elev = 3'

Vertical Sharp Crested Weir

Geometry = Rect
 Max Depth = 1'
 Max Width = 4'
 Invert Elev = 6'

French Drain Links

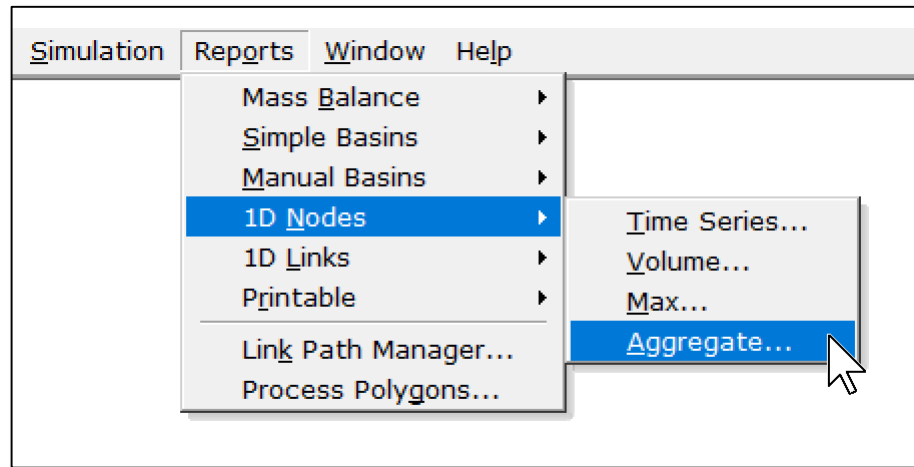
General Data	
Name	FRENCH DRAIN
Scenario	French Drain no Perc
From Node	A
To Node	B
Link Count	1
Flow Direction	Both
Trench Data	
Trench Length	400
Trench Width	5
Trench Height	15
Trench Depth Below Invert	12
Trench Gravel Porosity	0.5
Perforated Pipe Data	
Damping Threshold	0
FHWA Culvert Code	1
Entrance Loss Coefficient	0.5
Exit Loss Coefficient	0.1
Bend Loss Coefficient	0
Bend Location	0
Energy Switch	Energy
Pipe Length	416
Upstream Pipe Invert	3
Downstream Pipe Invert	3
Manning's N	0.012
Pipe Geometry	Circular
Pipe Max Depth	2
Comment	
Create	
Delete	

French Drain Links

French Drain Link: FRENCH DRAIN		Pipe Data	
Scenario:	French Drain no Perc	Damping:	0.0000 ft
From Node:	A	FHWA Code:	1
To Node:	B	Entr Loss Coef:	0.50
Link Count:	1	Exit Loss Coef:	0.10
Flow Direction:	Both	Bend Loss Coef:	0.00
		Bend Location:	0.00 ft
		Energy Switch:	Energy
		Pipe Length:	416.00 ft
Trench Length:	400.00 ft	Pipe Invert:	3.00 ft
Trench Width:	5.00 ft	Pipe Invert:	3.00 ft
Trench Height:	15.00 ft	Manning's N:	0.0120
Trench Depth Below Invert:	12.00 ft	Geometry Type:	Circular
Trench Gravel Porosity:	0.500	Pipe Max Depth:	2.00 ft
Comment:			

Input Report

French Drain Links



French Drain Links

Reports : 1D Nodes - Aggregate

Year Month Day Hour

Start Time 0 0 0 0

End Time 0 0 0 0

Report Chart

Type Superimpose params

X Parameter Absolute Time

Y Parameter Selection

- Total Inflow Rate
- Total Outflow Rate
- Base Inflow Volume
- Base Outflow Volume
- Basin Inflow Volume
- Basin Outflow Volume
- External Inflow Volume
- External Outflow Volume
- Link Inflow Volume
- Link Outflow Volume
- Stored Volume (Geometry Based)
- Stored Volume (Flow Based)
- Total Inflow Volume
- Total Outflow Volume

Simulation Selection

- Scenarios
 - French Drain no Perc
 - Simulations
 - 1inch_1HR
 - Scenario1
 - Scenario2

Item Selection

- A
- B
- BNDY

Units Volume - ft3 / m3

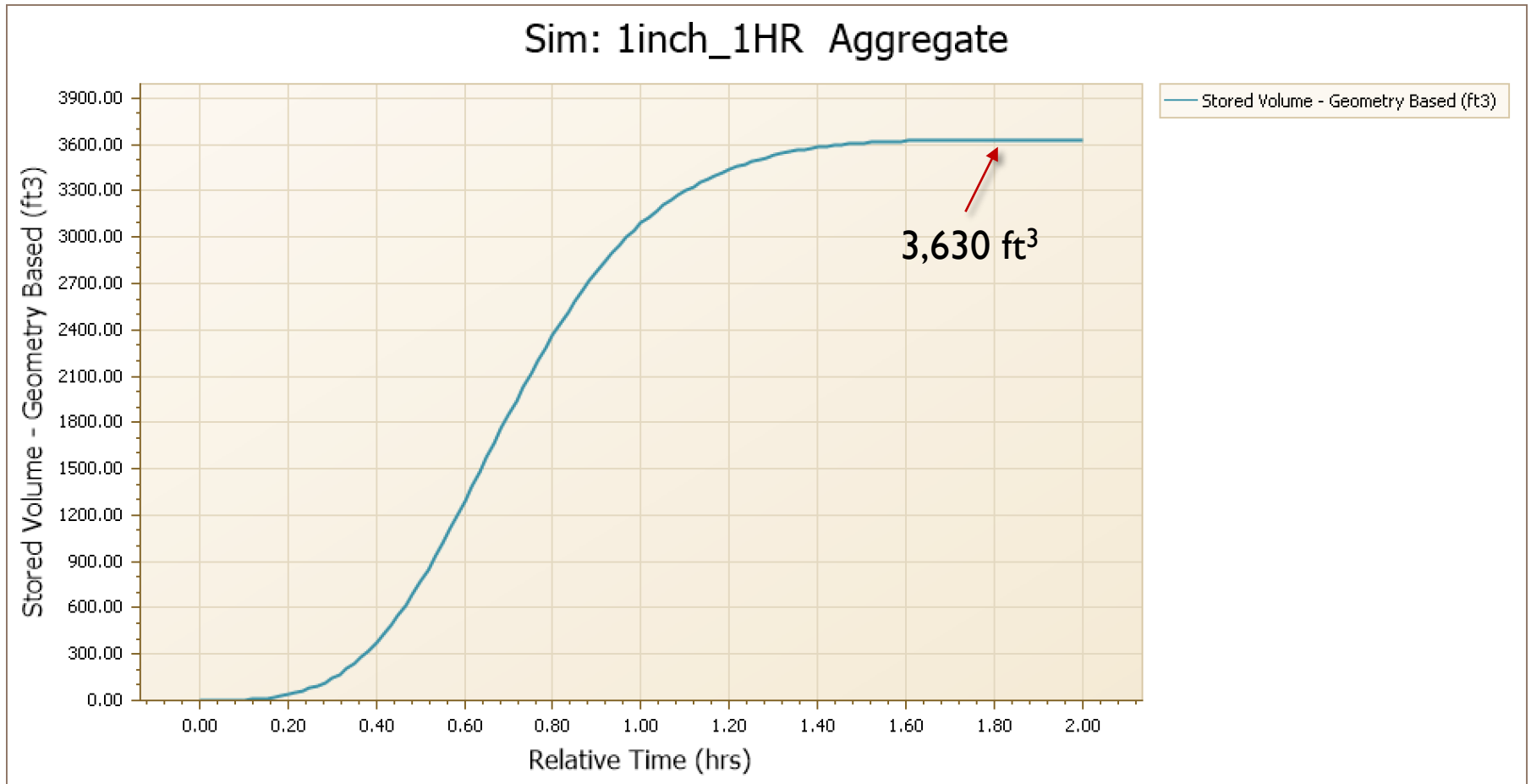
View Report View Chart Help

2 Selected Item(s) in Selected Simulation(s)

click here to see item list

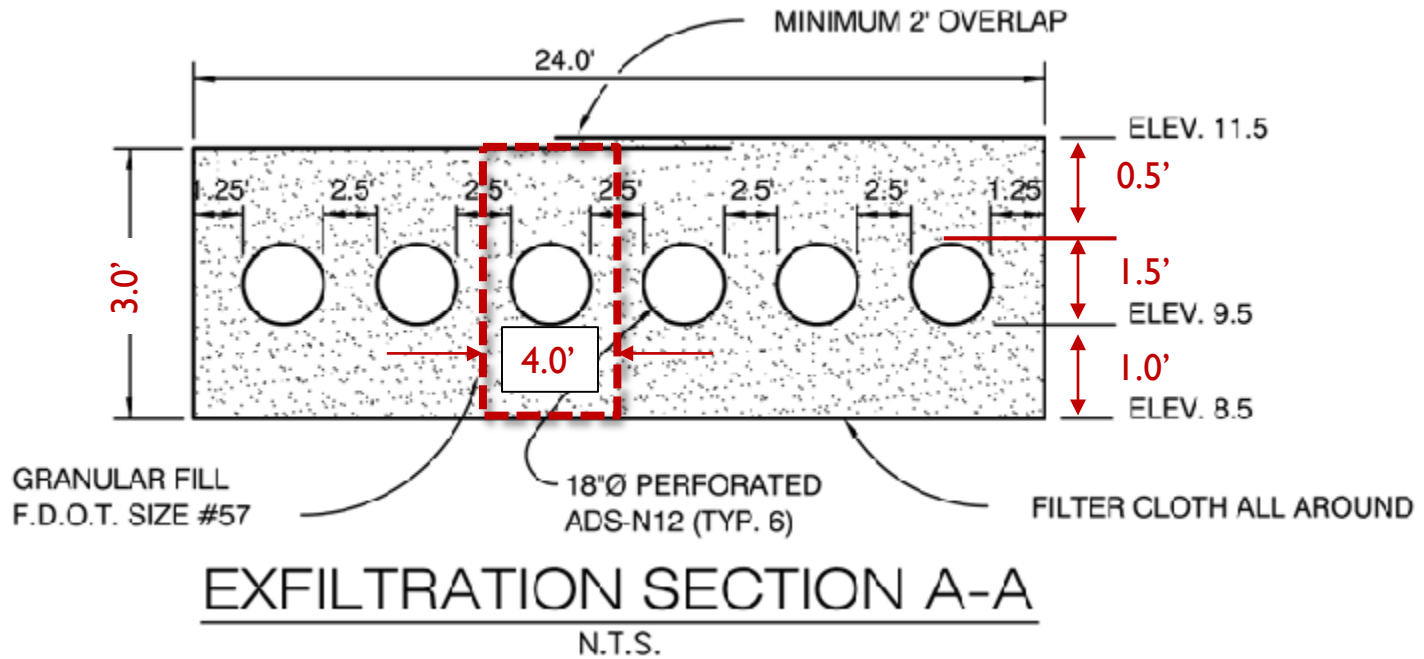
right click in this panel for options

French Drain Links



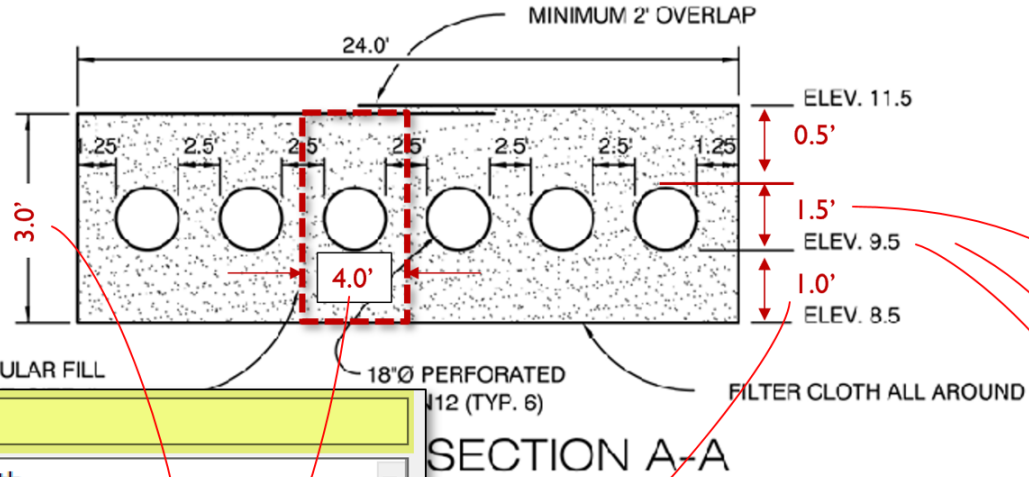
French Drain Links

Infiltration Gallery



French Drain Links

Infiltration Gallery

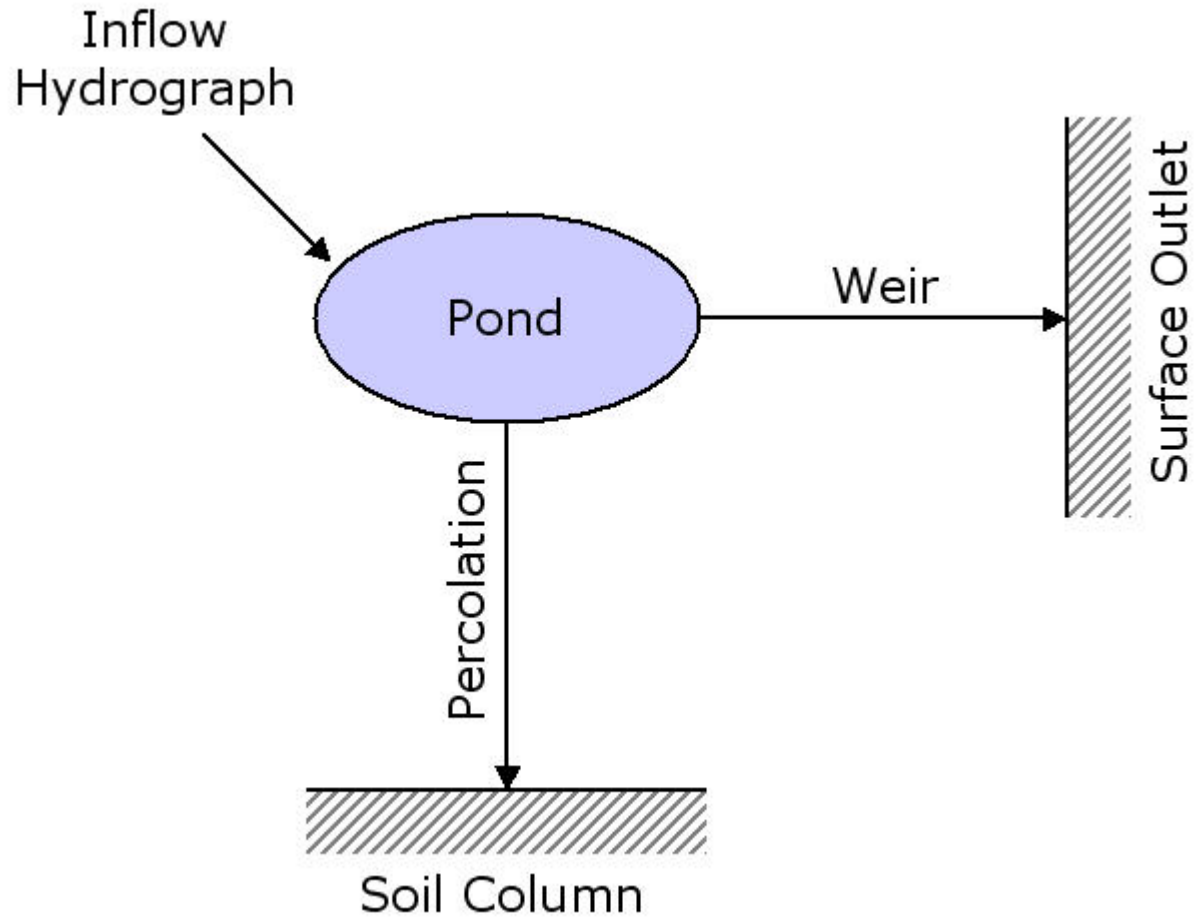


Link Count	6
Flow Direction	Both
Trench Length	0 TBD
Trench Width	4
Trench Height	3
Trench Depth Below Invert	1
Trench Gravel Porosity	0.5

Upstream Pipe Invert	9.5
Downstream Pipe Invert	9.5
Manning's N	0.024
Pipe Geometry	Circular
Pipe Max Depth	1.5

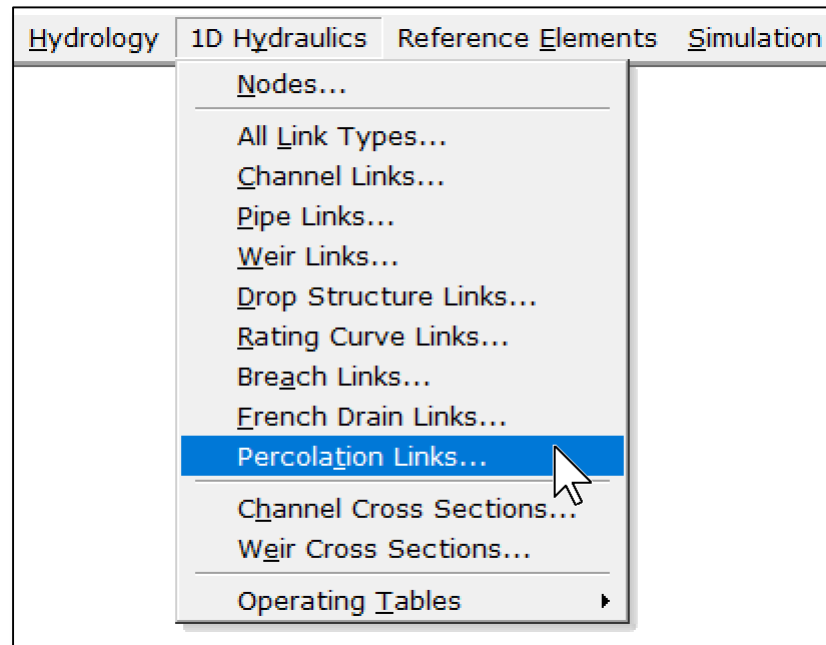
Percolation Links

Concepts



Percolation Links

Data Form



Percolation Links

Data Form

Name	<input type="text" value="PERC"/>	Surface Area Option	<input type="text" value="Vary Based on Stage/Area T..."/>
Scenario	<input type="text" value="French Drain with Perc"/>		
From Node	<input type="text" value="POND"/>		
To Node	<input type="text" value="GWT"/>	Vertical Flow Termination	<input type="text" value="Horizontal Flow Algorithm"/>
Link Count	<input type="text" value="1"/>	Perimeter 1	<input type="text" value="600"/>
Flow Direction	<input type="text" value="Both"/>	Perimeter 2	<input type="text" value="1228"/>
Aquifer Base Elevation	<input type="text" value="76"/>	Perimeter 3	<input type="text" value="3142"/>
Water Table Elevation	<input type="text" value="96"/>	Distance P1 to P2	<input type="text" value="100"/>
Annual Recharge Rate	<input type="text" value="0"/>	Distance P2 to P3	<input type="text" value="400"/>
Horizontal Conductivity	<input type="text" value="16"/>	# of Cells P1 to P2	<input type="text" value="20"/>
Vertical Conductivity	<input type="text" value="8"/>	# of Cells P2 to P3	<input type="text" value="40"/>
Fillable Porosity	<input type="text" value="0.3"/>		
Layer Thickness	<input type="text" value="99"/>		
Comment	<input type="text"/>		
	<input type="button" value="Create"/>	<input type="button" value="Delete"/>	

Percolation Links

Data Form

Name	PERC	Surface Area Option	Vary Based on Stage/Area T... ▾
Scenario	French Drain with Perc ▾	Connectivity	
From Node	POND	Vertical Flow Termination	Horizontal Flow Algorithm ▾
To Node	GWT	Perimeter 1	600
Link Count	1	Perimeter 2	1228
Flow Direction	Both ▾	Perimeter 3	3142
Aquifer Base Elevation	76	Distance P1 to P2	100
Water Table Elevation	96	Distance P2 to P3	400
Annual Recharge Rate	0	# of Cells P1 to P2	20
Horizontal Conductivity	16	# of Cells P2 to P3	40
Vertical Conductivity	8		
Fillable Porosity	0.3		
Layer Thickness	99		
Comment			
		Create	Delete

Percolation Links

Data Form

Name	<input type="text" value="PERC"/>
Scenario	<input type="text" value="French Drain with Perc"/>
From Node	<input type="text" value="POND"/>
To Node	<input type="text" value="GWT"/>
Link Count	<input type="text" value="1"/>
Flow Direction	<input type="text" value="Both"/>
Aquifer Base Elevation	<input type="text" value="76"/>
Water Table Elevation	<input type="text" value="96"/>
Annual Recharge Rate	<input type="text" value="0"/>
Horizontal Conductivity	<input type="text" value="16"/>
Vertical Conductivity	<input type="text" value="8"/>
Fillable Porosity	<input type="text" value="0.3"/>
Layer Thickness	<input type="text" value="99"/>
Comment	<input type="text"/>

Surface Area Option	<input type="text" value="Vary Based on Stage/Area T..."/>
Options	
Vertical Flow Termination	<input type="text" value="Horizontal Flow Algorithm"/>
Perimeter 1	<input type="text" value="600"/>
Perimeter 2	<input type="text" value="1228"/>
Perimeter 3	<input type="text" value="3142"/>
Distance P1 to P2	<input type="text" value="100"/>
Distance P2 to P3	<input type="text" value="400"/>
# of Cells P1 to P2	<input type="text" value="20"/>
# of Cells P2 to P3	<input type="text" value="40"/>

Percolation Links

Data Form

Name	PERC	Surface Area Option	Vary Based on Stage/Area T... ▾
Scenario	French Drain with Perc ▾		
From Node	POND		
To Node	GWT	Vertical Flow Termination	Horizontal Flow Algorithm ▾
Link Count	1	Perimeter 1	600
Flow Direction	Both ▾	Perimeter 2	1228
Aquifer Base Elevation	76	Perimeter 3	3142
Water Table Elevation	96	Distance P1 to P2	100
Annual Recharge Rate	0	Distance P2 to P3	400
Horizontal Conductivity	16	# of Cells P1 to P2	20
Vertical Conductivity	8	# of Cells P2 to P3	40
Fillable Porosity	0.3		
Layer Thickness	99		
Comment			

Aquifer Parameters

Create Delete

Percolation Links

Data Form

Name	<input type="text" value="PERC"/>	Surface Area Option	<input type="text" value="Vary Based on Stage/Area T..."/>
Scenario	<input type="text" value="French Drain with Perc"/>	Computational Grid Parameters	
From Node	<input type="text" value="POND"/>	Vertical Flow Termination	<input type="text" value="Horizontal Flow Algorithm"/>
To Node	<input type="text" value="GWT"/>	Perimeter 1	<input type="text" value="600"/>
Link Count	<input type="text" value="1"/>	Perimeter 2	<input type="text" value="1228"/>
Flow Direction	<input type="text" value="Both"/>	Perimeter 3	<input type="text" value="3142"/>
Aquifer Base Elevation	<input type="text" value="76"/>	Distance P1 to P2	<input type="text" value="100"/>
Water Table Elevation	<input type="text" value="96"/>	Distance P2 to P3	<input type="text" value="400"/>
Annual Recharge Rate	<input type="text" value="0"/>	# of Cells P1 to P2	<input type="text" value="20"/>
Horizontal Conductivity	<input type="text" value="16"/>	# of Cells P2 to P3	<input type="text" value="40"/>
Vertical Conductivity	<input type="text" value="8"/>		
Fillable Porosity	<input type="text" value="0.3"/>		
Layer Thickness	<input type="text" value="99"/>		
Comment	<input type="text"/>		
		<input type="button" value="Create"/>	<input type="button" value="Delete"/>

Percolation Links

Input Report

1

Percolation Link: PERC

Scenario:	French Drain with Perc	Surface Area Option:	Vary Based on Stage/Area Table
From Node:	POND	Vertical Flow Termination:	Horizontal Flow Algorithm
To Node:	GWT	Perimeter 1:	600.00 ft
Link Count:	1	Perimeter 2:	1228.00 ft
Flow Direction:	Both	Perimeter 3:	3142.00 ft
Aquifer Base Elevation:	76.00 ft	Distance P1 to P2:	100.00 ft
Water Table Elevation:	96.00 ft	Distance P2 to P3:	400.00 ft
Annual Recharge Rate:	0 ipy	# of Cells P1 to P2:	20
Horizontal Conductivity:	16.000 fpd	# of Cells P2 to P3:	40
Vertical Conductivity:	8.000 fpd		
Fillable Porosity:	0.300		
Layer Thickness:	99.00 ft		

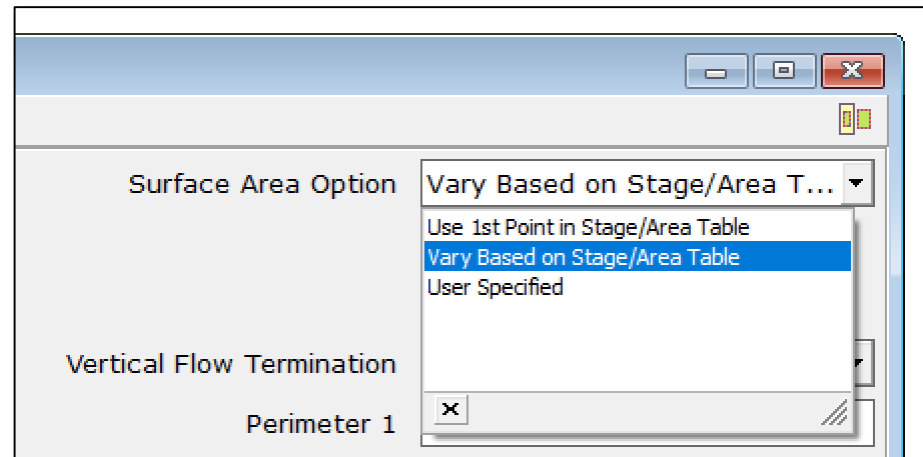
Comment:

Percolation Links

Unsaturated Vertical Flow

Surface Area Option

1. Use 1st Point in Stage/Area Table
2. Vary based on Stage/Area Table
3. User Specified

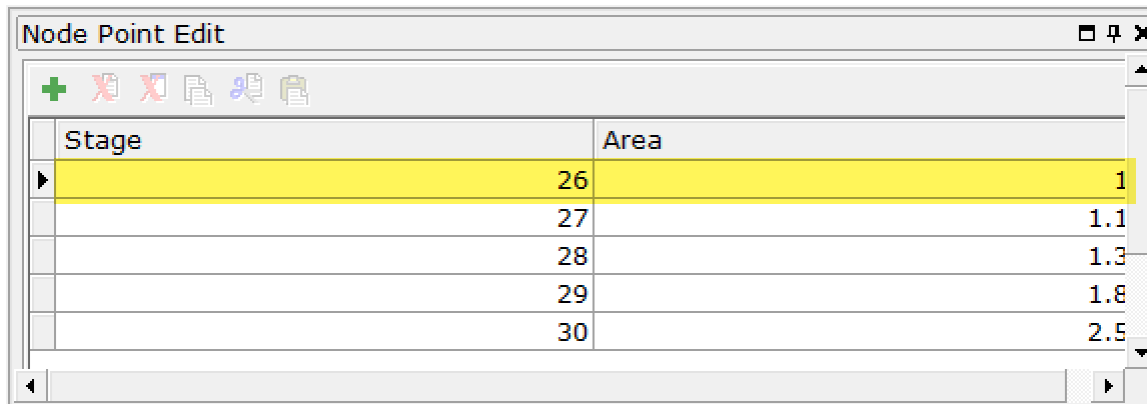


Percolation Links

Unsaturated Vertical Flow

Surface Area Option

1. Use 1st Point in Stage/Area Table
2. Vary based on Stage/Area Table
3. User Specified



Stage	Area
26	1
27	1.1
28	1.3
29	1.8
30	2.5

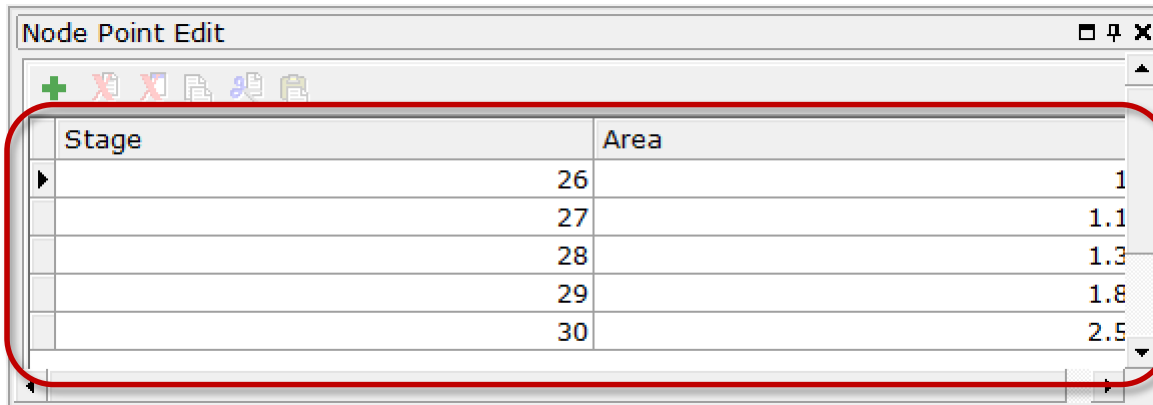
← Constant Surface Area Used

Percolation Links

Unsaturated Vertical Flow

Surface Area Option

1. Use 1st Point in Stage/Area Table
2. Vary based on Stage/Area Table
3. User Specified



Stage	Area
26	1
27	1.1
28	1.3
29	1.8
30	2.5

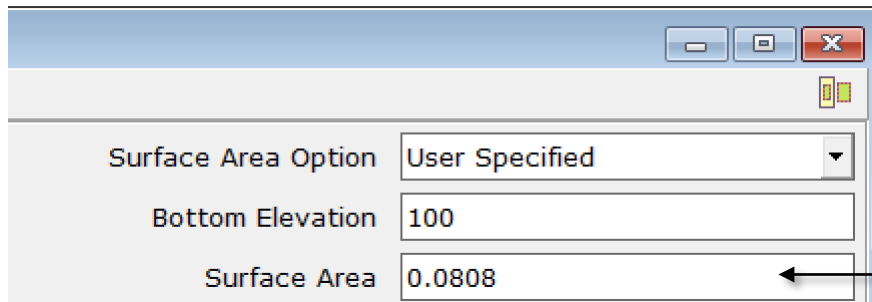
Variable Surface
Area Used

Percolation Links

Unsaturated Vertical Flow

Surface Area Option

1. Use 1st Point in Stage/Area Table
2. Vary based on Stage/Area Table
3. User Specified




Surface Area Option	User Specified
Bottom Elevation	100
Surface Area	0.0808

Constant Surface
Area Used

Percolation Links

Unsaturated Vertical Flow

- **Constant Surface Area**
- Variable Surface Area

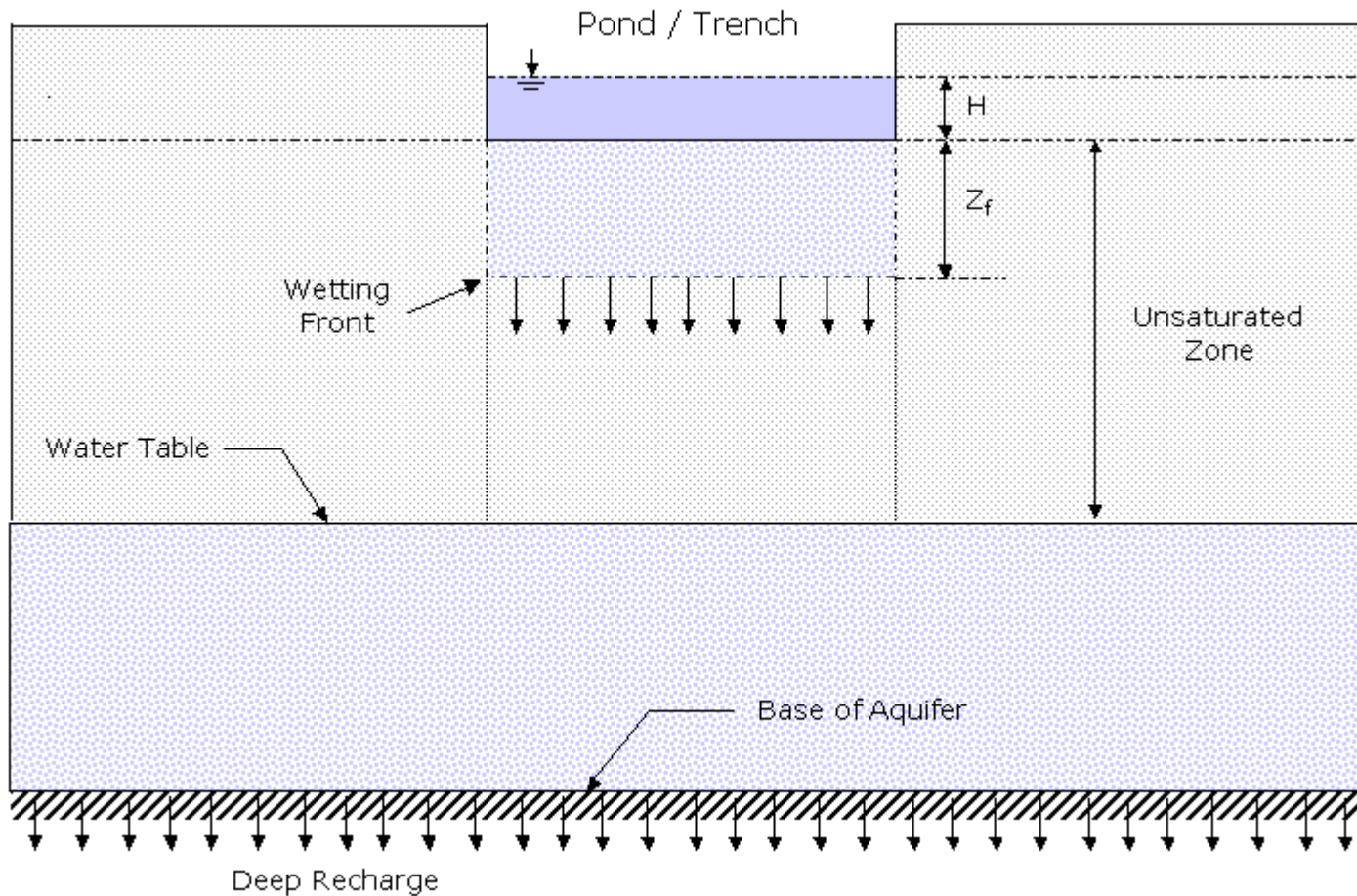


**Percolation Based on Modified
Green-Ampt Equation**
(driving head is considered)

Percolation Links

Unsaturated Vertical Flow

- constant surface area -



Percolation Links

Unsaturated Vertical Flow

- constant surface area -

$$q = K_v I \quad (\text{Darcy's Equation})$$

$$I = (H + Z_f) / Z_f \quad (\text{Gradient})$$

Modified Form of the Green-Ampt Equation

$$t_0 = (F H / K_y) [(Z_0 / H) - \ln(1 + Z_0 / H)]$$

Percolation Links

Unsaturated Vertical Flow

- constant surface area -

$$q = K_v I \quad (\text{Darcy's Equation})$$

$$I = (H + Z_f + \psi) / Z_f \quad (\text{Gradient})$$

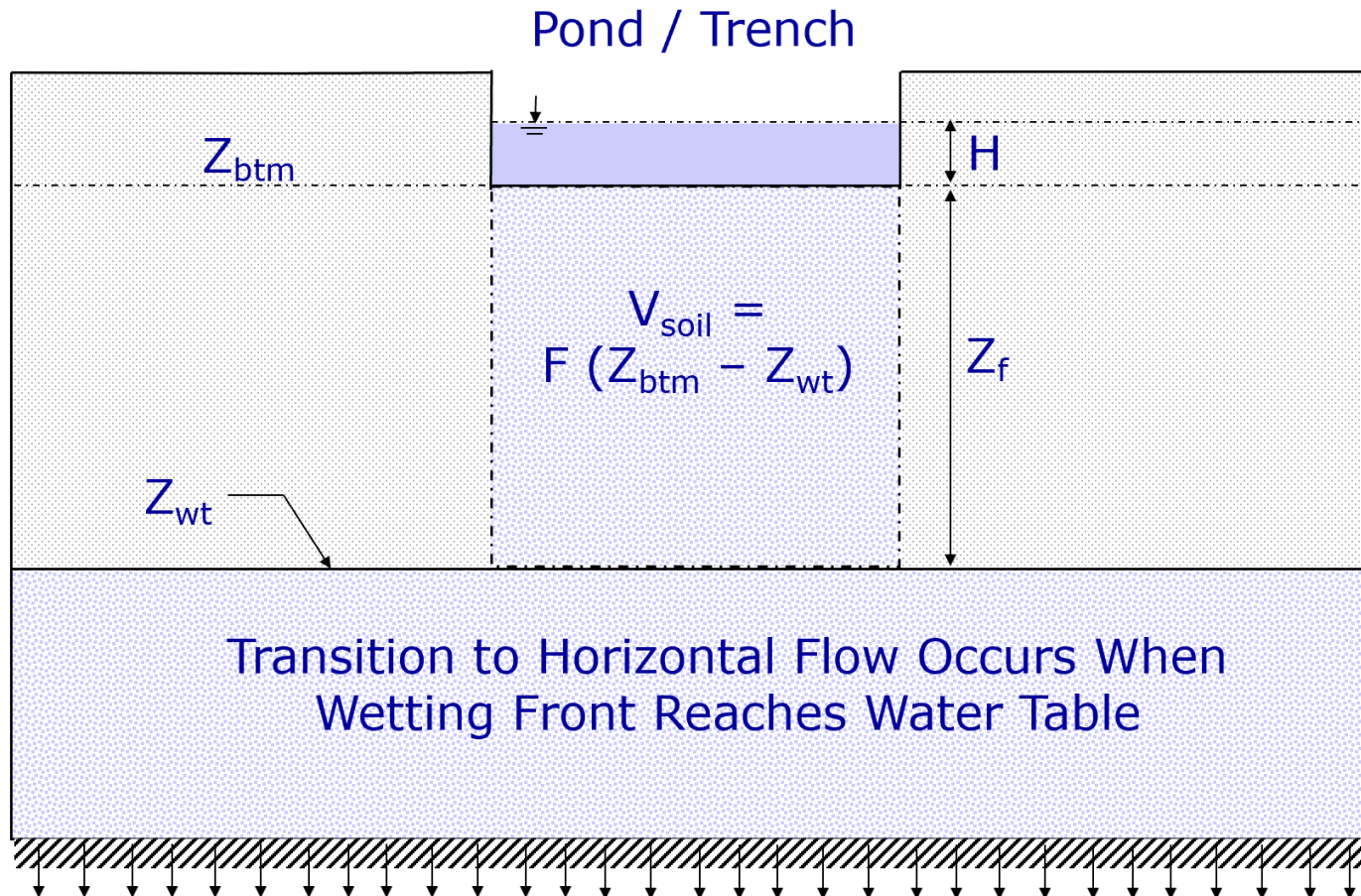
Modified Form of the Green-Ampt Equation

$$t_0 = (F H / K_v) [(Z_0 / H) - \ln(1 + Z_0 / H)]$$

Percolation Links

Unsaturated Vertical Flow

- constant surface area -




Percolation Links

Unsaturated Vertical Flow

- variable surface area -

- Constant Surface Area
- Variable Surface Area



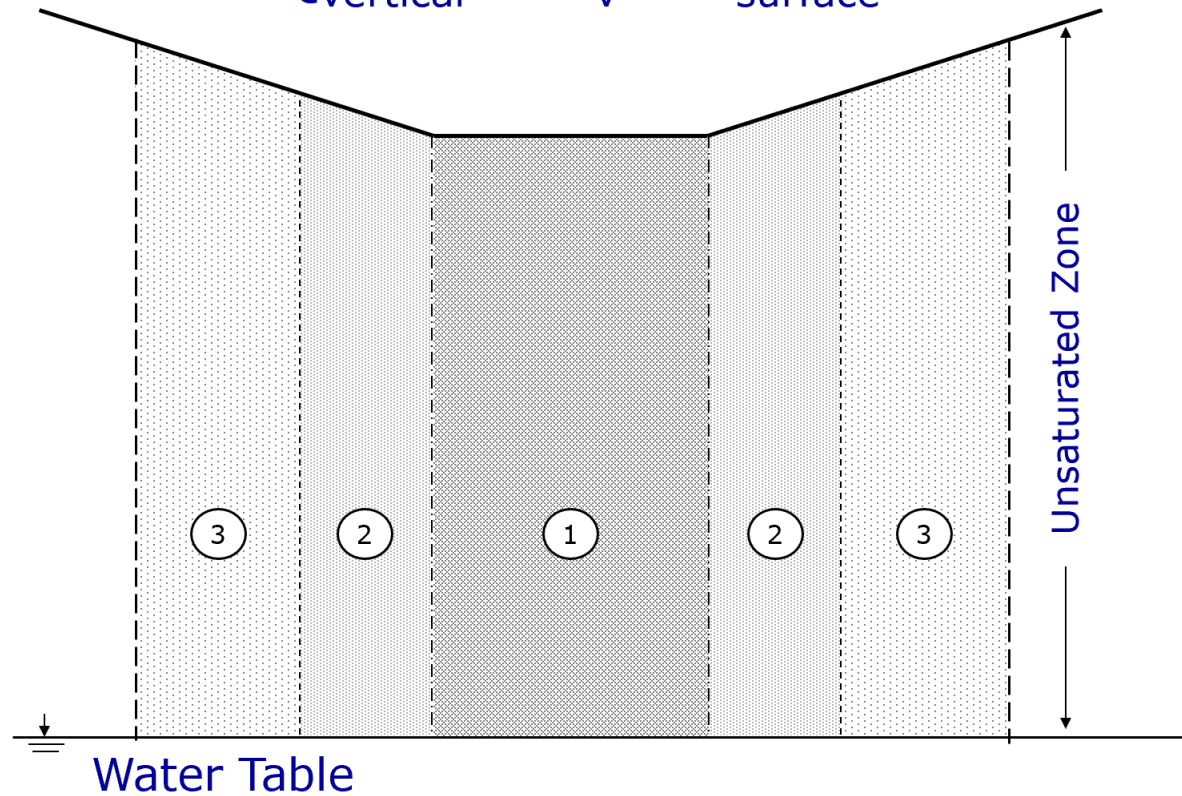
Percolation Based on Vertical
Conductivity Multiplied by
Wetted Surface Area
(driving head not considered)

Percolation Links

Unsaturated Vertical Flow

- variable surface area -

$$Q_{\text{vertical}} = K_v \times A_{\text{surface}}$$

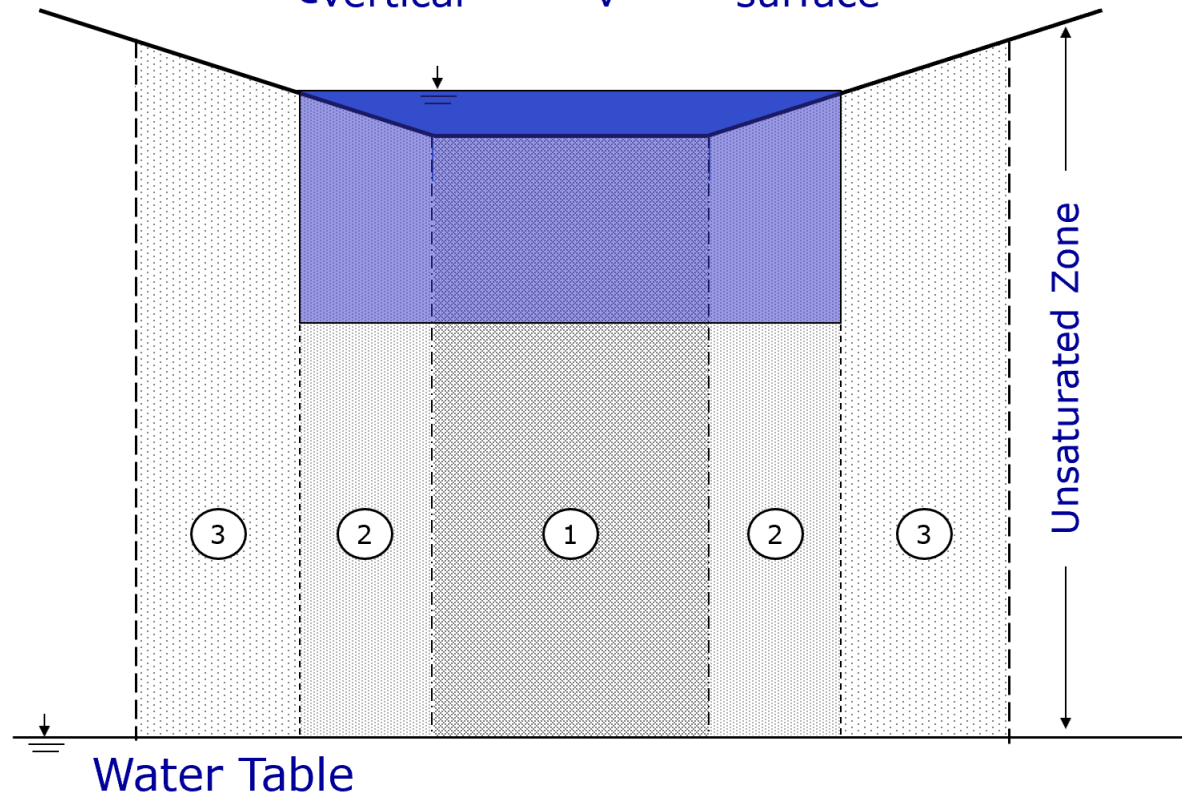


Percolation Links

Unsaturated Vertical Flow

- variable surface area -

$$Q_{\text{vertical}} = K_v \times A_{\text{surface}}$$

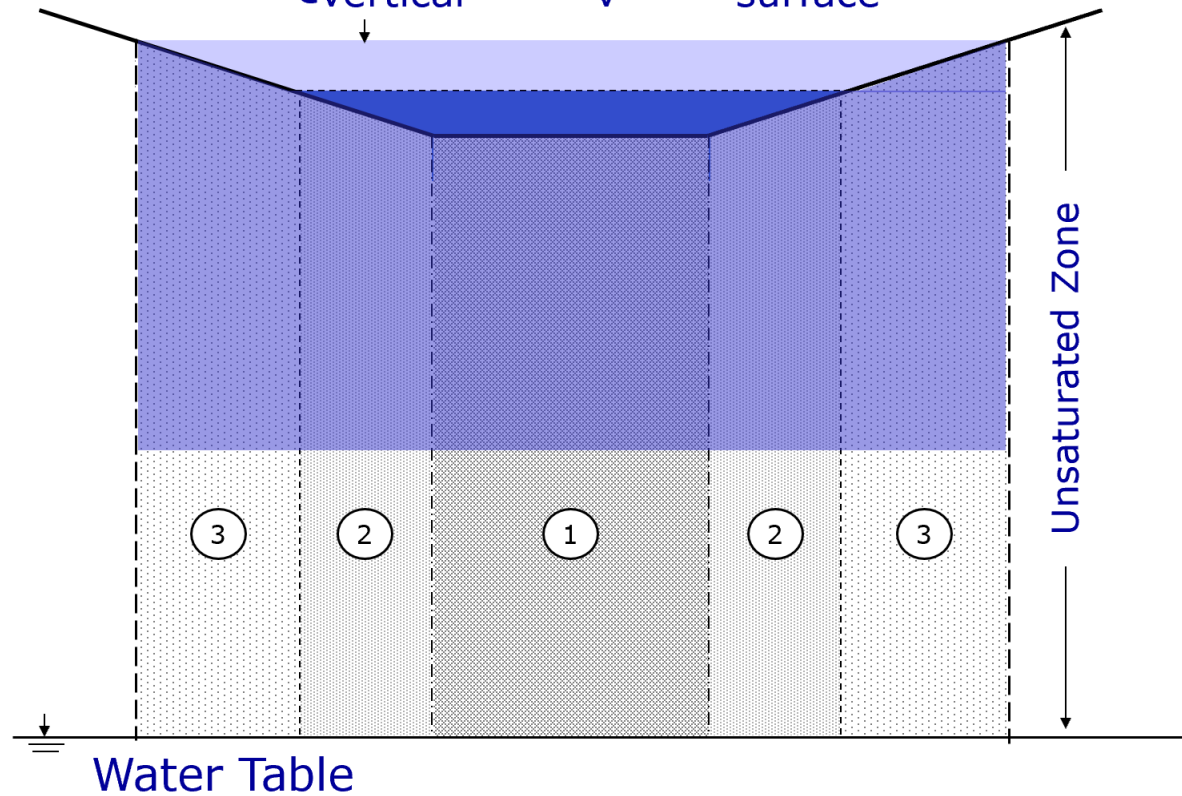


Percolation Links

Unsaturated Vertical Flow

- variable surface area -

$$Q_{\text{vertical}} = K_v \times A_{\text{surface}}$$

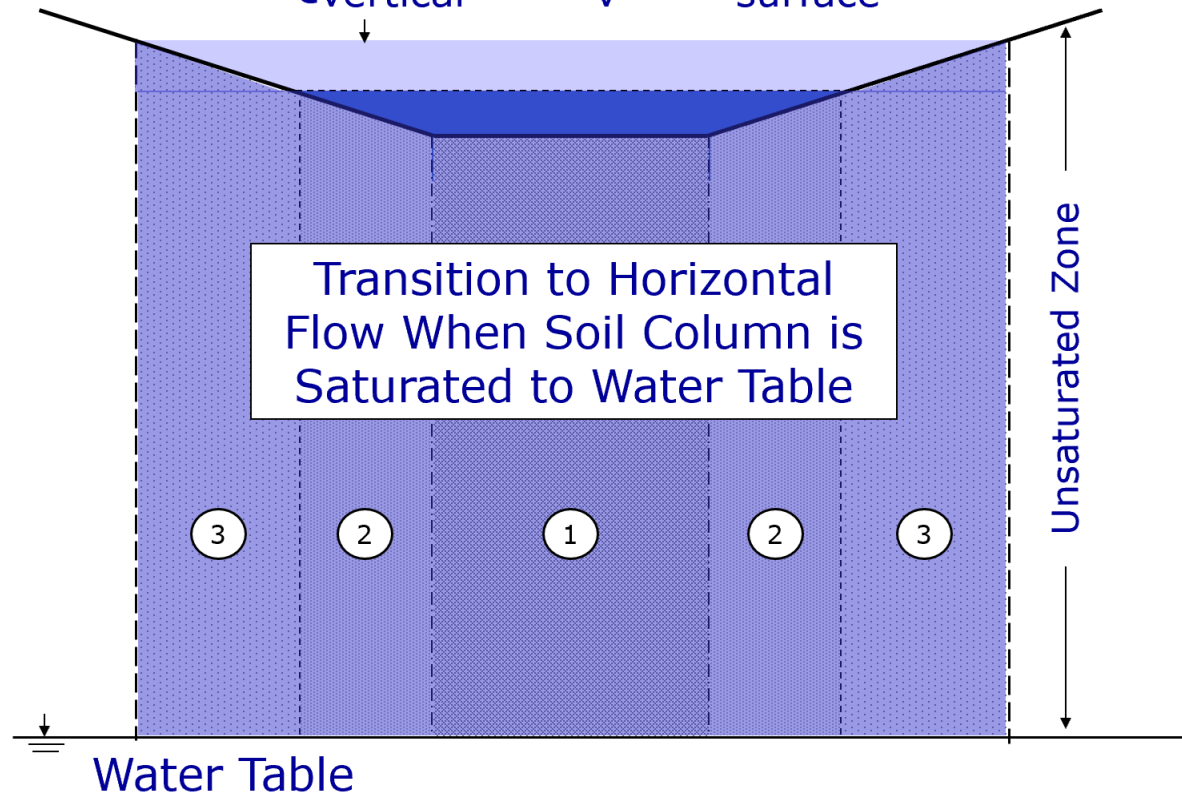


Percolation Links

Unsaturated Vertical Flow

- variable surface area -

$$Q_{\text{vertical}} = K_v \times A_{\text{surface}}$$



Percolation Links

Unsaturated Vertical Flow

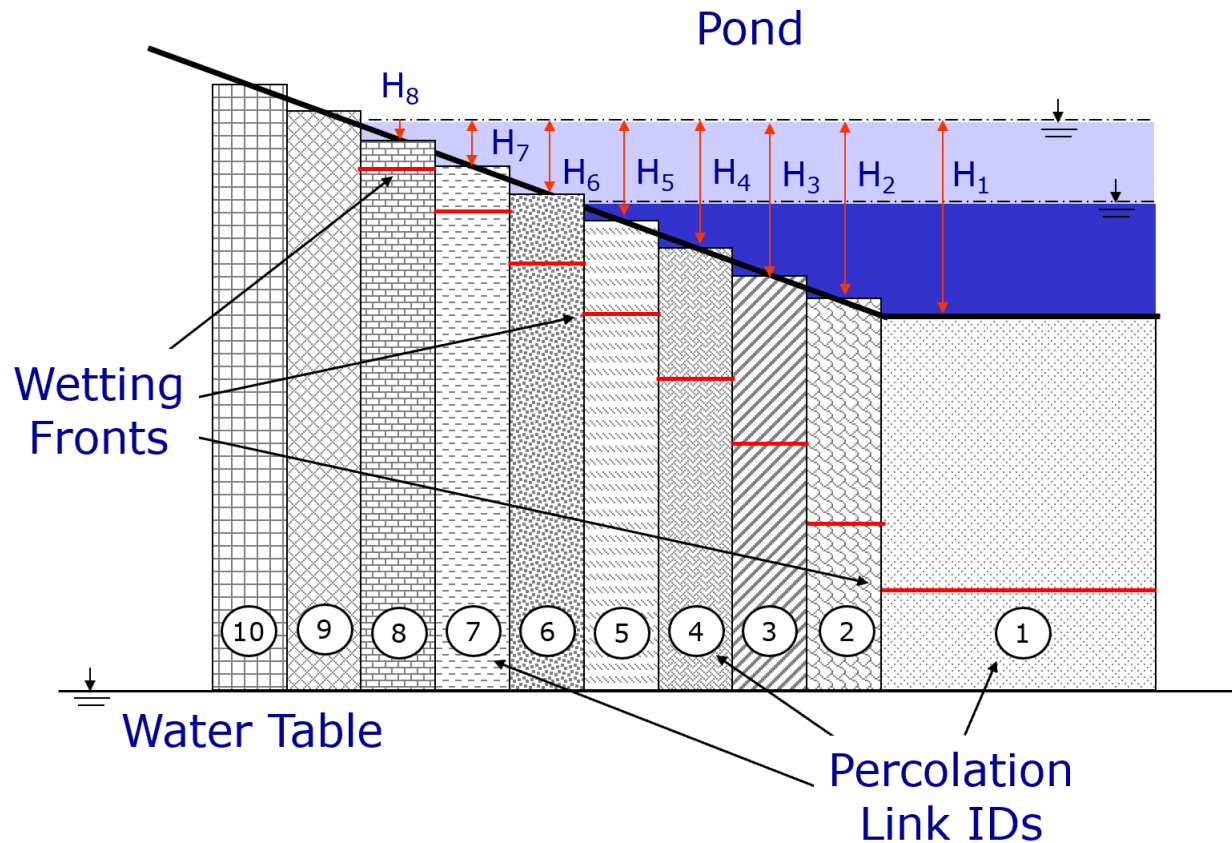
- stair stepping approach -

The advantages of the modified Green-Ampt equation can be combined with a variable surface area by “stair stepping” up the slope of the pond with multiple perc links.

Percolation Links

Unsaturated Vertical Flow

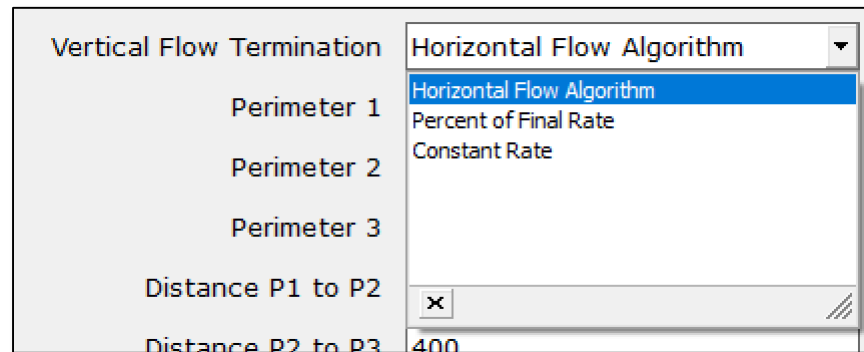
- stair stepping approach -



Percolation Links

Transition to Saturated Horizontal Flow - vertical flow termination option -

1. Horizontal Flow Algorithm
2. Percent of Final Rate
3. Constant Rate



Percolation Links

Transition to Saturated Horizontal Flow - vertical flow termination option -

1. Horizontal Flow Algorithm
2. Percent of Final Rate
3. Constant Rate

The screenshot shows a software window titled "Vertical Flow Termination". At the top right, there is a dropdown menu currently set to "Percent of Final Rate". At the bottom of the window, there is a text input field labeled "% of Final Rate" with the value "0" entered.

Percolation Links

Transition to Saturated Horizontal Flow - vertical flow termination option -

1. Horizontal Flow Algorithm
2. Percent of Final Rate
3. Constant Rate

The screenshot shows a software window titled "Vertical Flow Termination". At the top right, there is a dropdown menu currently set to "Constant Rate". At the bottom right, there is a text input field labeled "Constant Rate" containing the value "0".

Percolation Links

Transition to Saturated Horizontal Flow - vertical flow termination option -

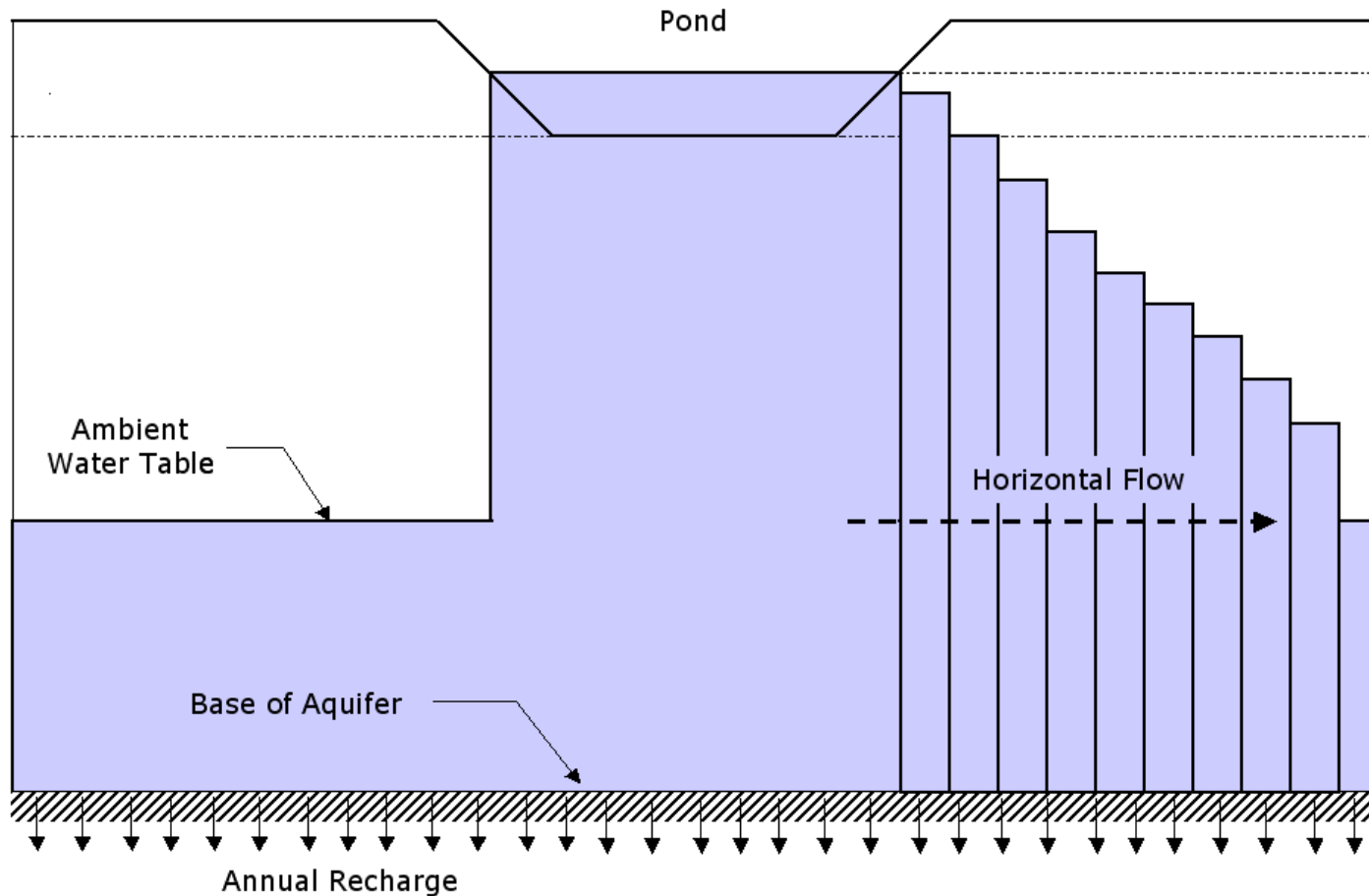
1. Horizontal Flow Algorithm
2. Percent of Final Rate
3. Constant Rate

Computational
Grid

Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	600
Perimeter 2	1228
Perimeter 3	3142
Distance P1 to P2	100
Distance P2 to P3	400
# of Cells P1 to P2	20
# of Cells P2 to P3	40

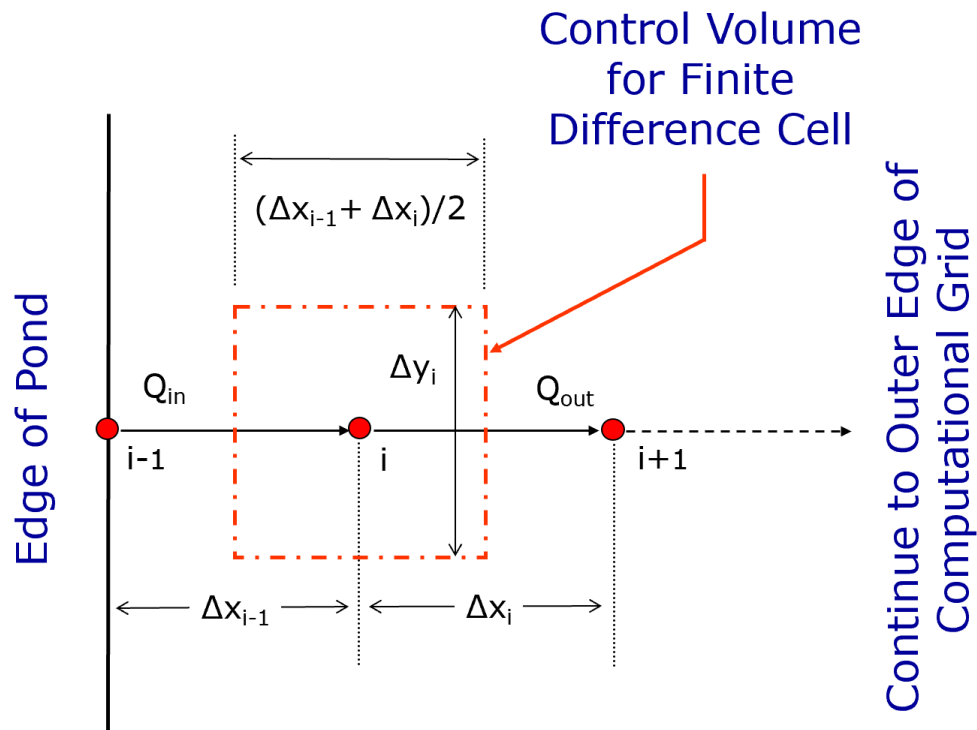
Percolation Links

Saturated Horizontal Flow



Percolation Links

Saturated Horizontal Flow



$$\begin{aligned} Q &= (K_h) \cdot (I) \cdot (A) \\ &= (K_h) \cdot (\Delta h / \Delta x) \cdot (h \Delta y) \end{aligned} \quad \text{(Darcy's Eq.)}$$

Percolation Links

Assumptions and Limitations of Perc Links

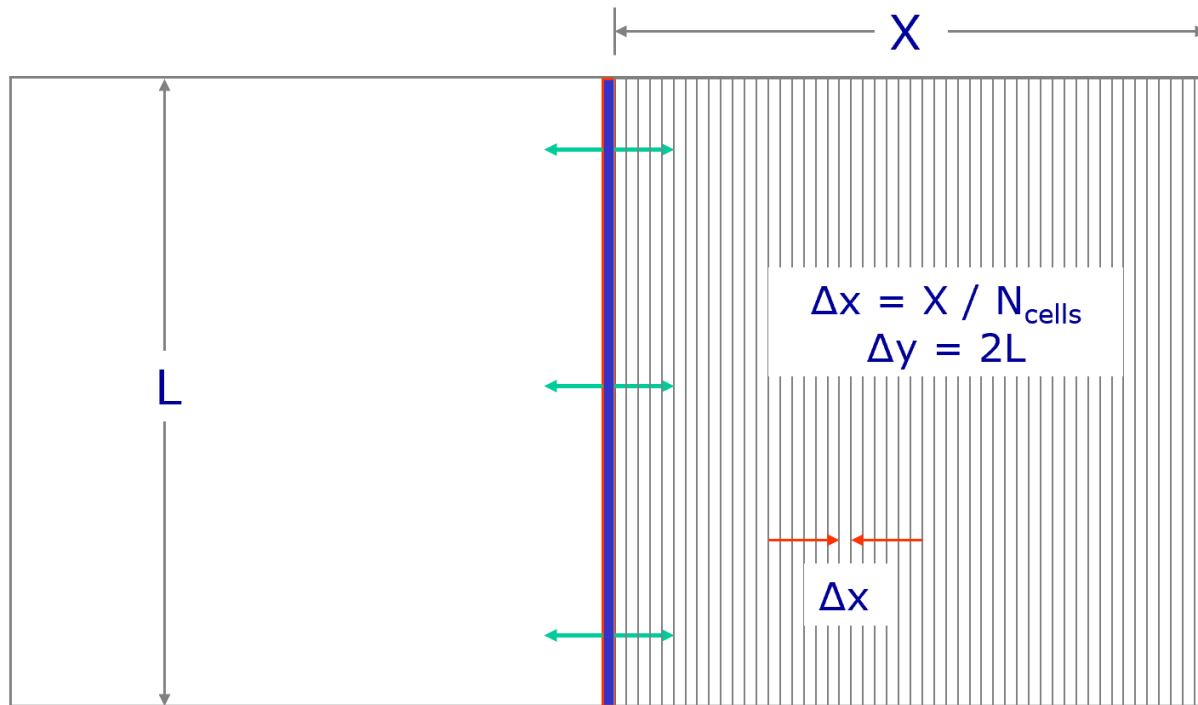
1. The aquifer base is assumed to be flat.
2. The ambient water table is assumed to be flat. Sloping water tables are not permitted.
3. Soil properties are homogeneous.
4. A physically-based rainfall-recharge mechanism is not included with percolation links.
5. Each percolation link is independent of other percolation links. Consequently, modeling ponds that are near one another or near other surface water bodies may require adjustments to the computational perimeters.

Percolation Links

Saturated Horizontal Flow

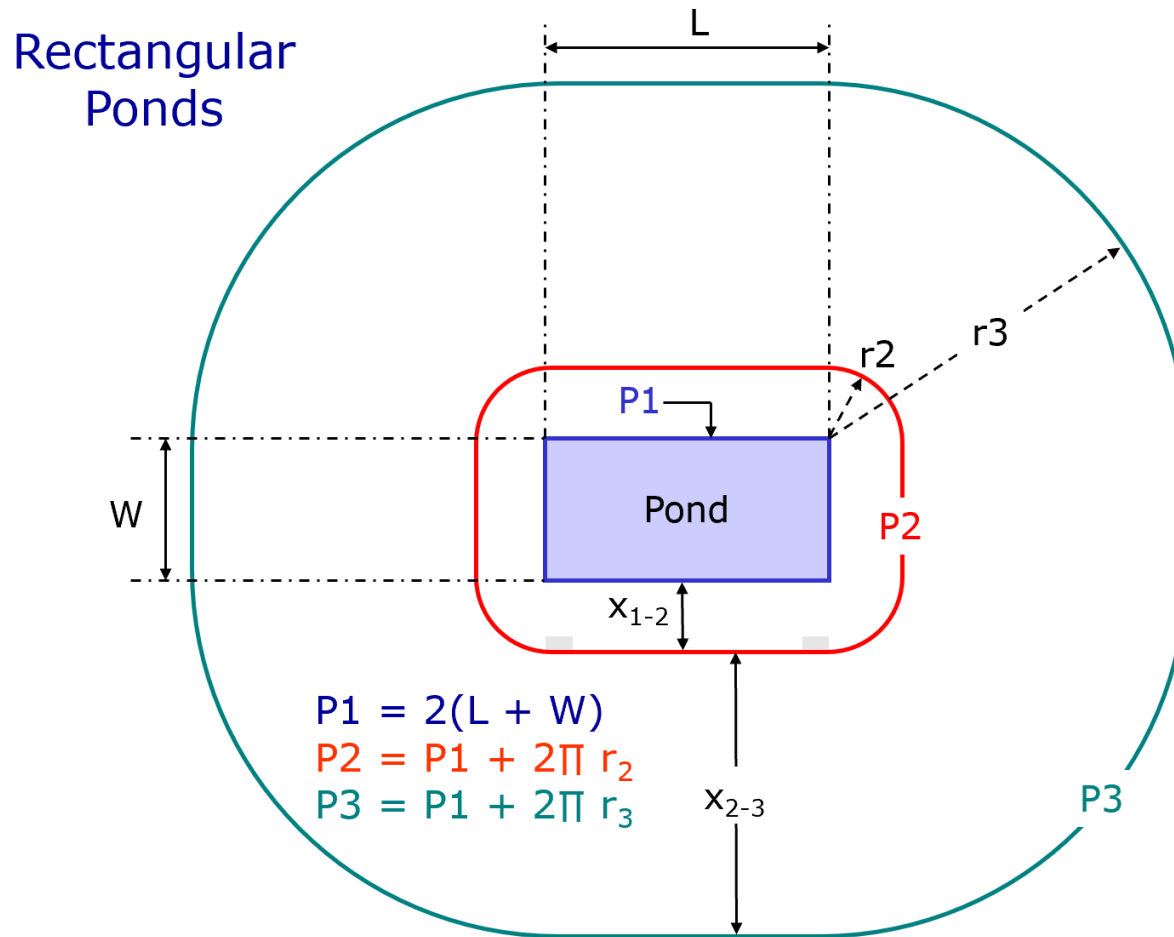
French Drain or Narrow Ditch

(groundwater flow occurs from both sides and is perpendicular to surface flow)



Percolation Links

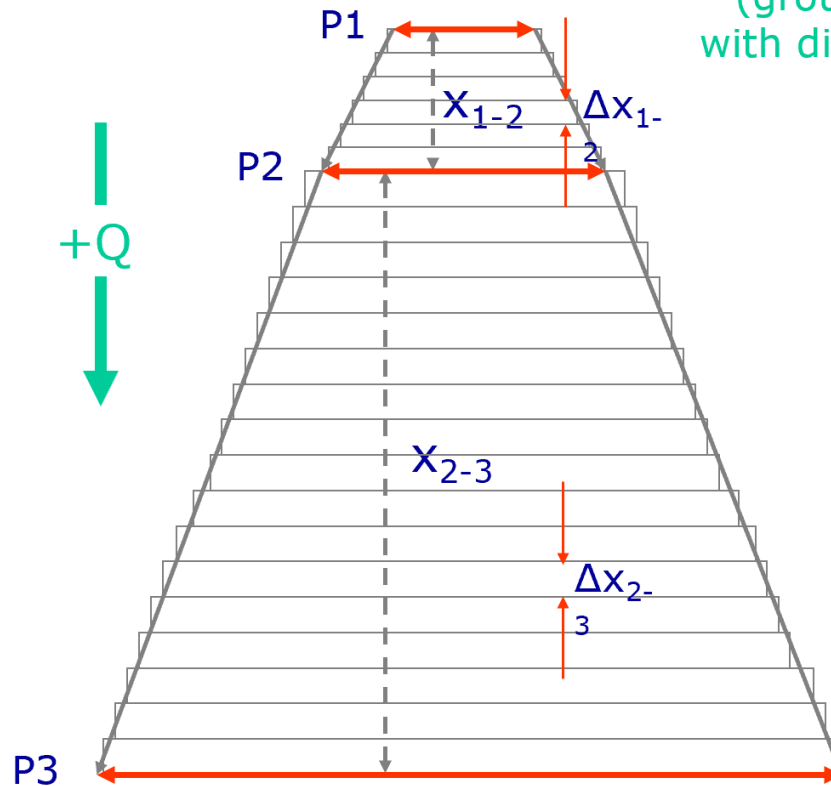
Saturated Horizontal Flow



Percolation Links

Saturated Horizontal Flow

“Unfurled” Rectangular
Computational Grid
(groundwater flow expands
with distance away from pond)



$$\Delta x_{1-2} = x_{1-2} / N_{1-2}$$
$$\Delta x_{2-3} = x_{2-3} / N_{2-3}$$

Δy varies

Percolation Links

Saturated Horizontal Flow

Circular Ponds

(groundwater flow expands radially outward from center)

$$P1 = 2\pi r_1$$

$$P2 = 2\pi r_2$$

$$X_{1-2} = r_2 - r_1$$

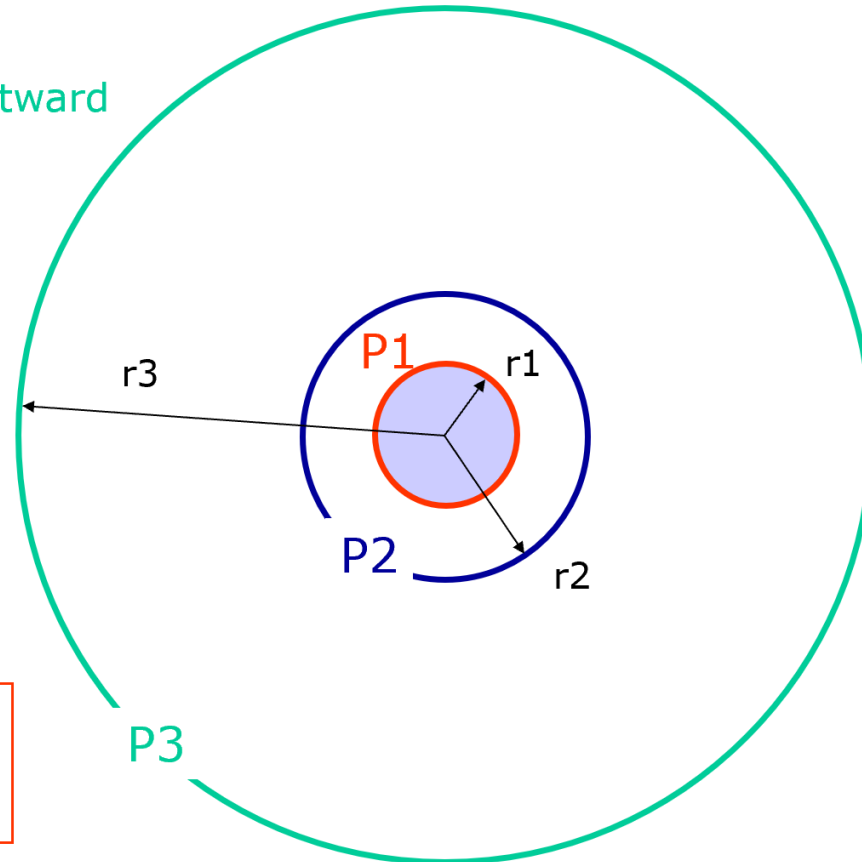
$$P3 = 2\pi r_3$$

$$X_{2-3} = r_3 - r_2$$

$$\Delta x_{1-2} = x_{1-2} / N_{1-2}$$

$$\Delta x_{2-3} = x_{2-3} / N_{2-3}$$

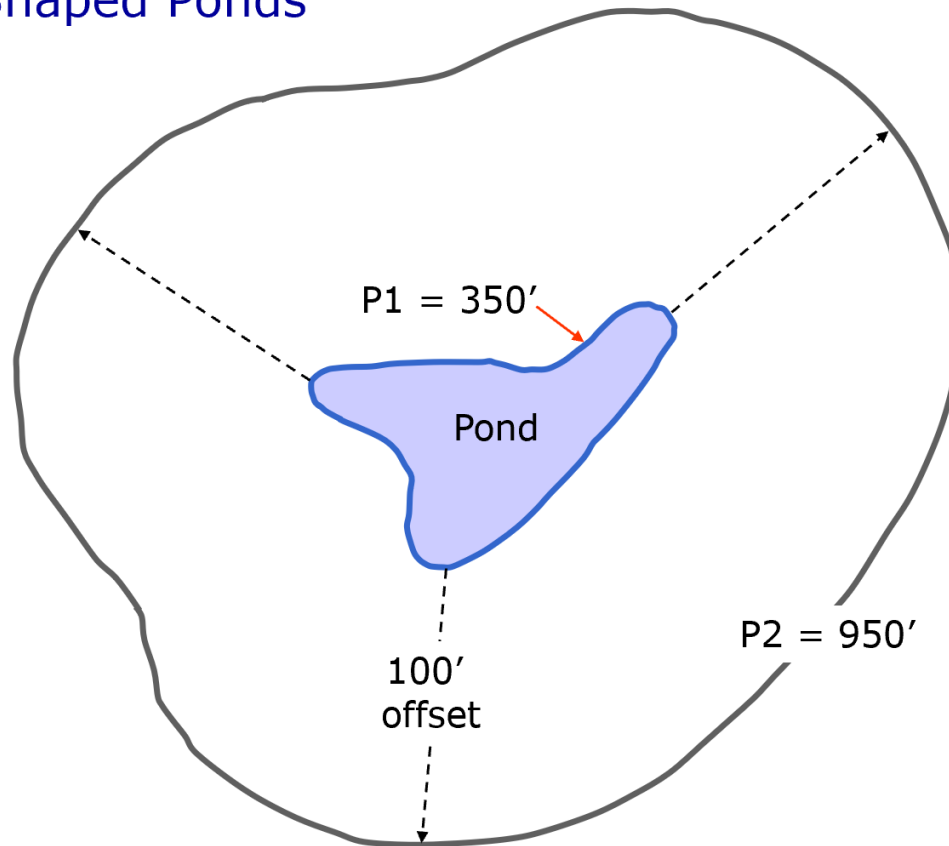
Δy varies



Percolation Links

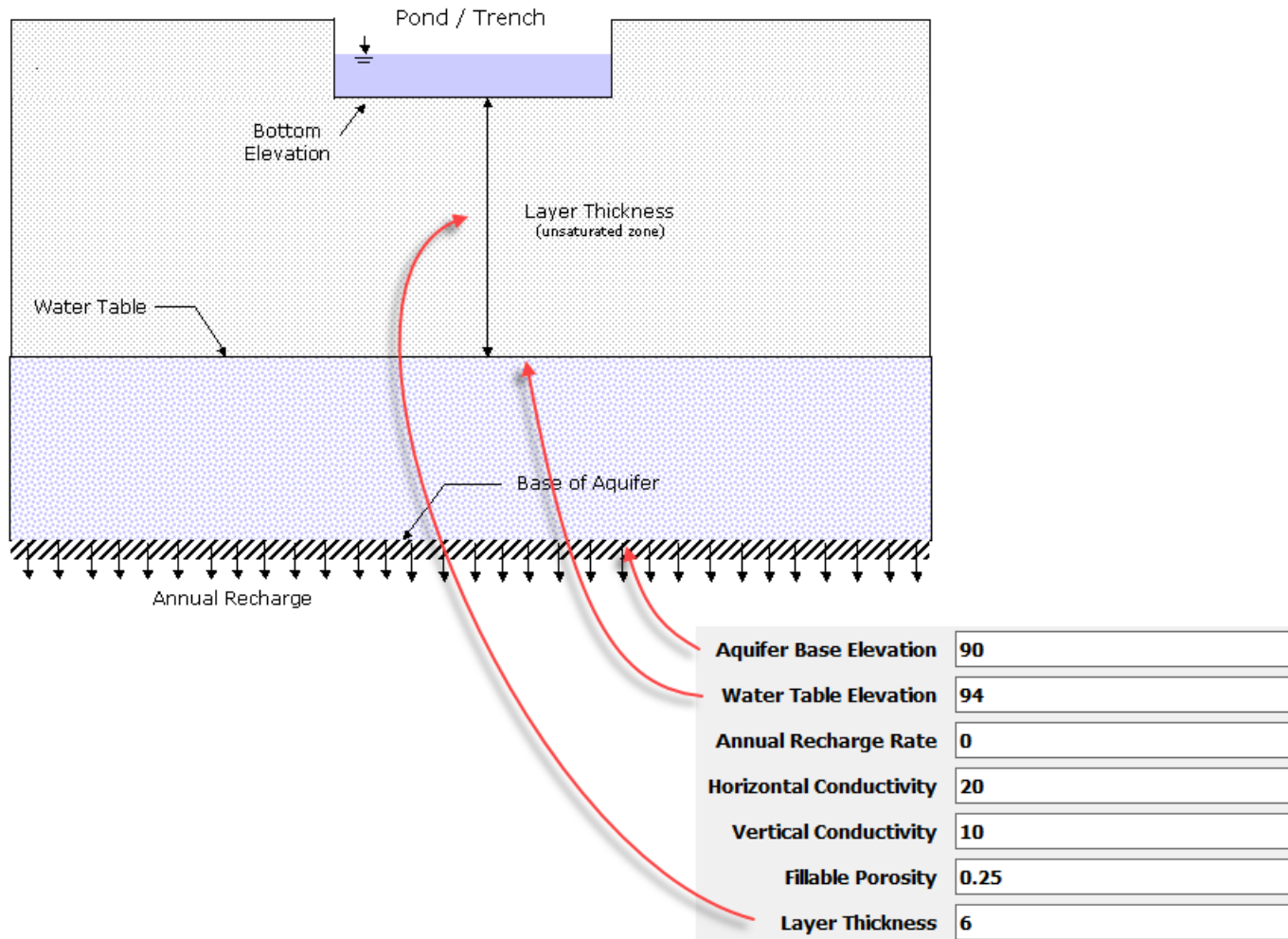
Saturated Horizontal Flow

Irregular Shaped Ponds



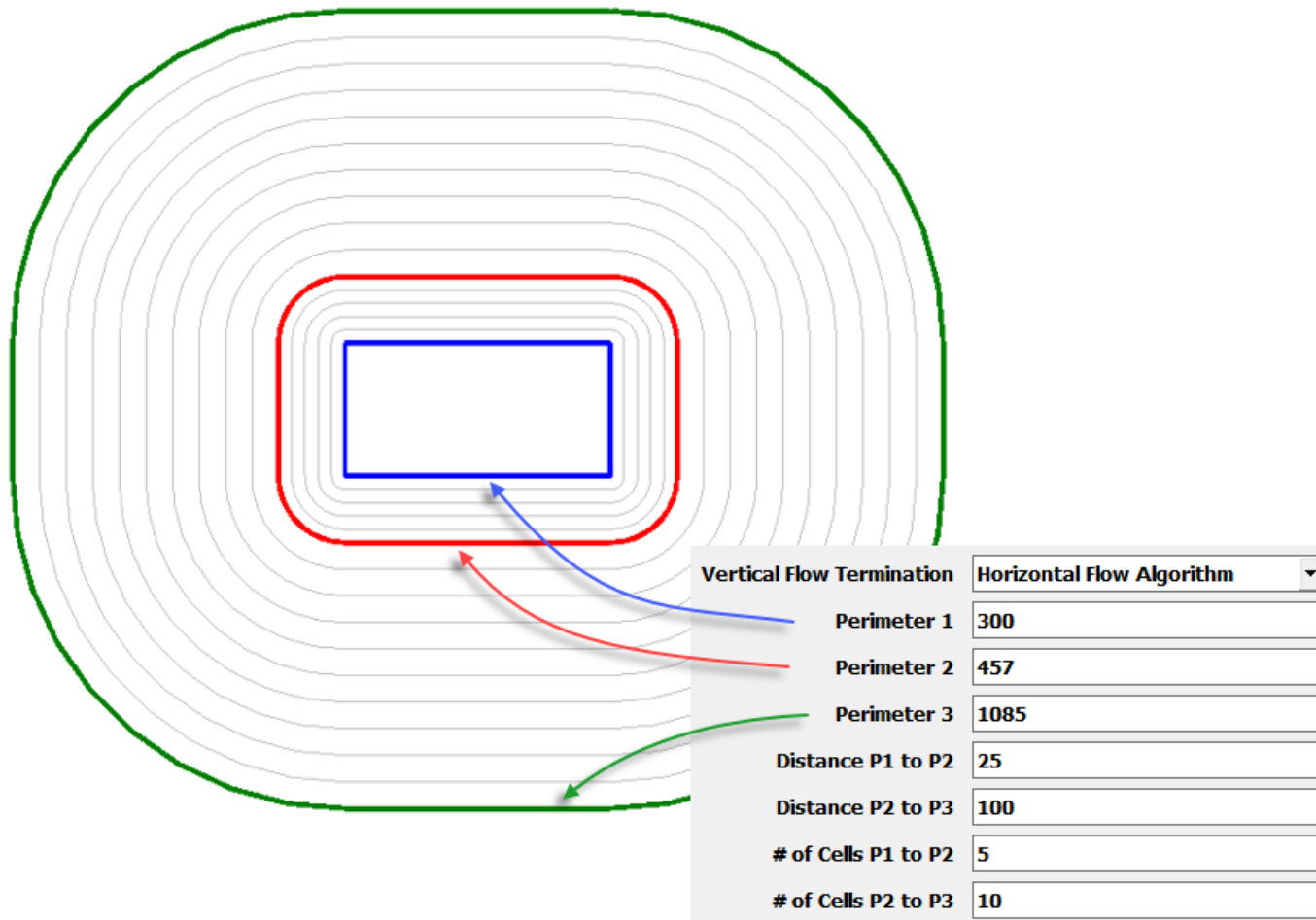
Percolation Links

Input Parameters: Aquifer



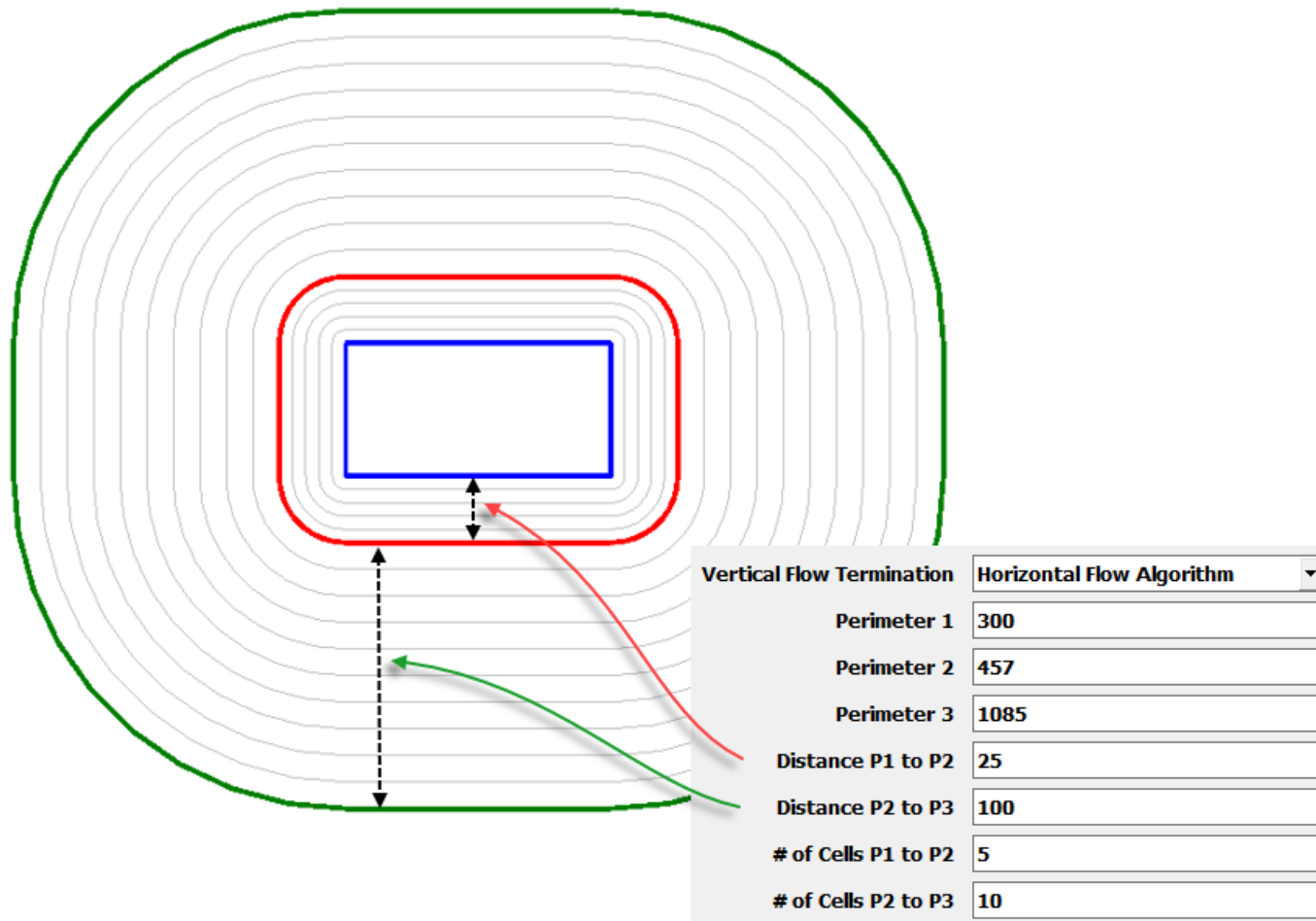
Percolation Links

Input Parameters: Computation Grid



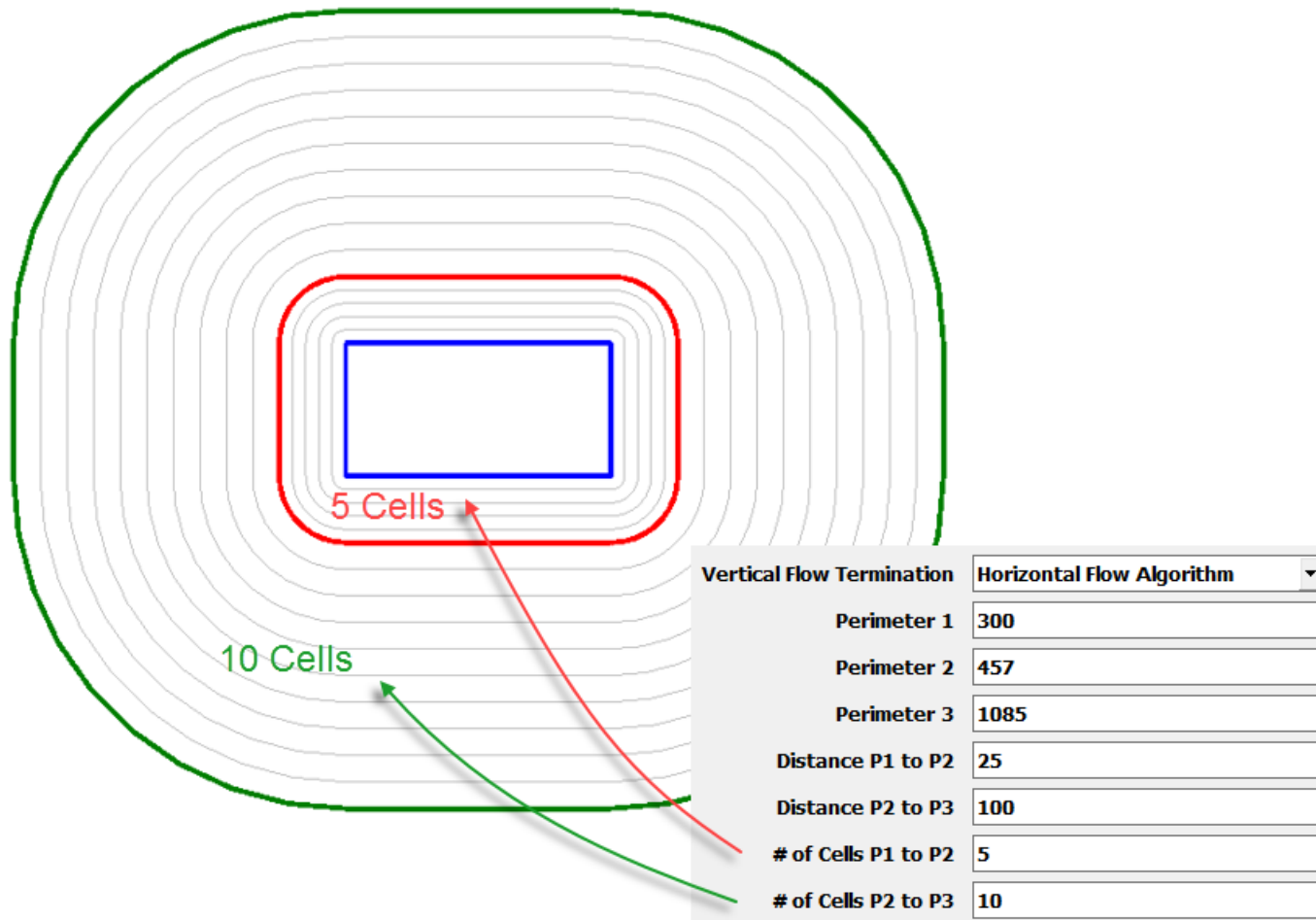
Percolation Links

Input Parameters: Computational Grid



Percolation Links

Input Parameters: Computational Grid



Percolation Links

Input Parameters: Initial Conditions

The water table (an input parameter) is used to initialize heads.

Aquifer Base Elevation	76
Water Table Elevation	96
Annual Recharge Rate	0
Horizontal Conductivity	16
Vertical Conductivity	8
Fillable Porosity	0.3
Layer Thickness	99

Percolation Links

Input Parameters: Boundary Condition at Outer Edge (P3)

- For “Annual Recharge” = Zero, use “Fixed Head” = Water Table
- Otherwise, use “Zero Flow” and let Head fluctuate as needed

Aquifer Base Elevation	76
Water Table Elevation	96
Annual Recharge Rate	0
Horizontal Conductivity	16
Vertical Conductivity	8
Fillable Porosity	0.3
Layer Thickness	99

Aquifer Base Elevation	76
Water Table Elevation	96
Annual Recharge Rate	0.0001
Horizontal Conductivity	16
Vertical Conductivity	8
Fillable Porosity	0.3
Layer Thickness	99

Percolation Links

Input Parameters: Boundary Condition at Pond (PI)

Use “Variable Head” = Pond Elevation

unless, $Q_{\text{vertical}} < Q_{\text{horizontal}}$

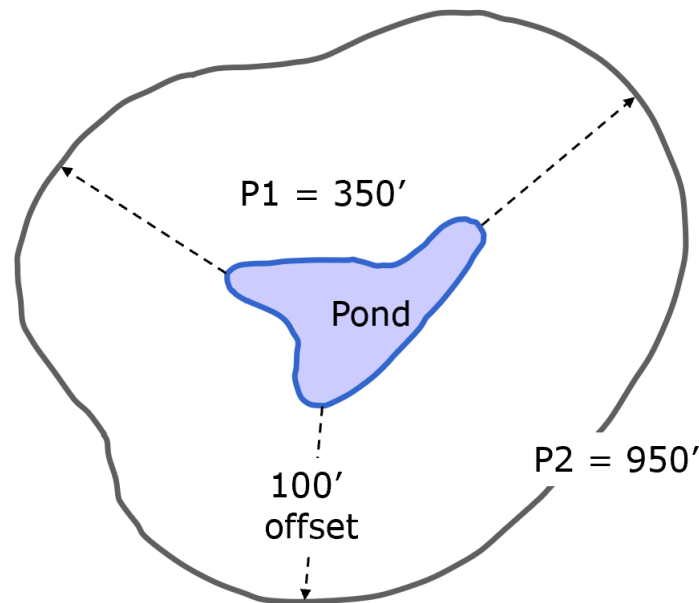
in which case,

set $Q_{\text{horizontal}} = Q_{\text{vertical}}$

Percolation Links

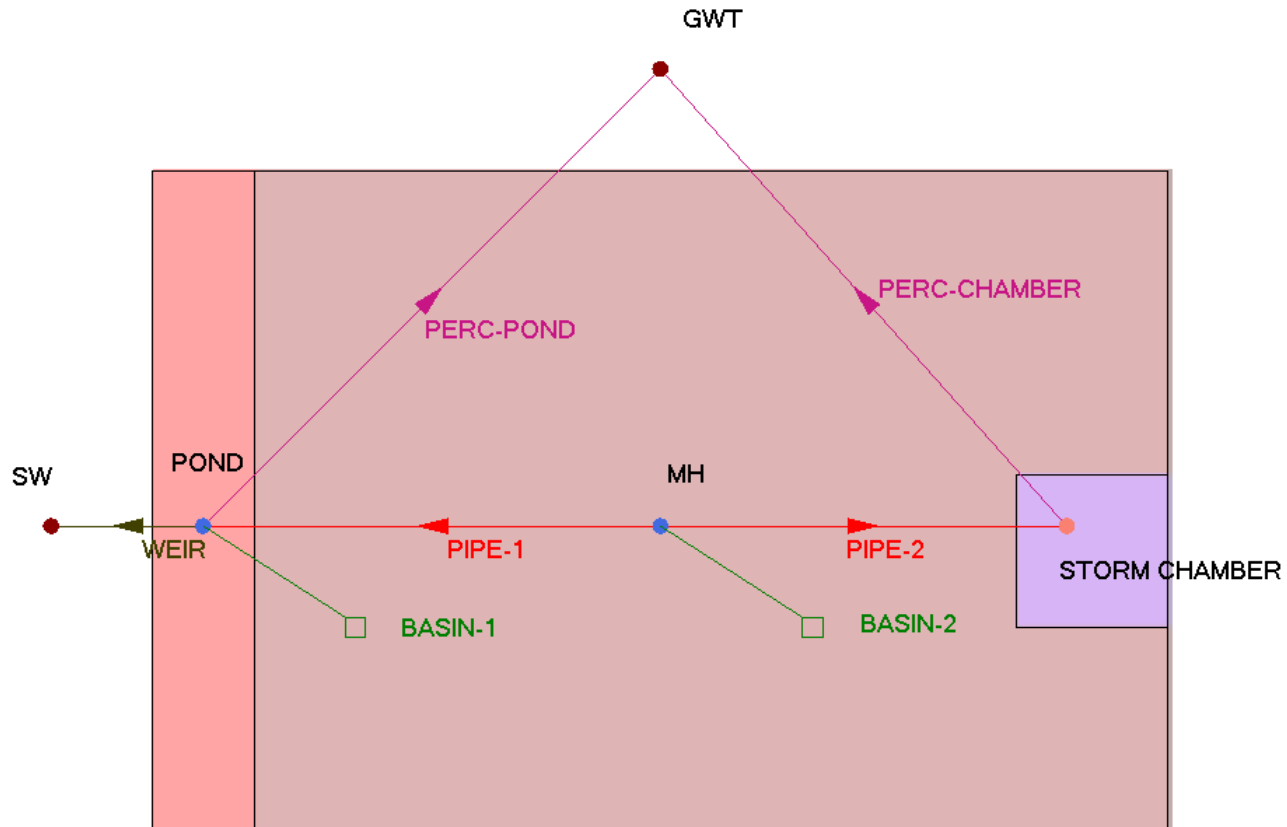
Input Parameters: Final Perc Rate for Pond

The flux (horizontal flow) across the innermost computational ring becomes the percolation rate for the pond or trench.



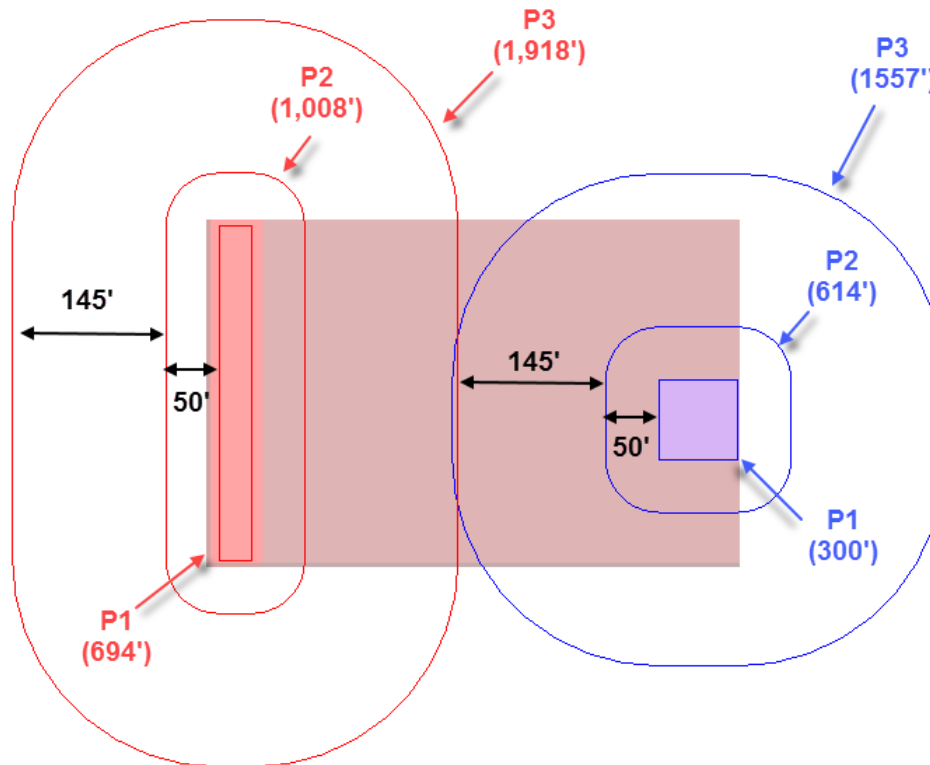
Percolation Links

Setup Example: Storm Chamber & Pond



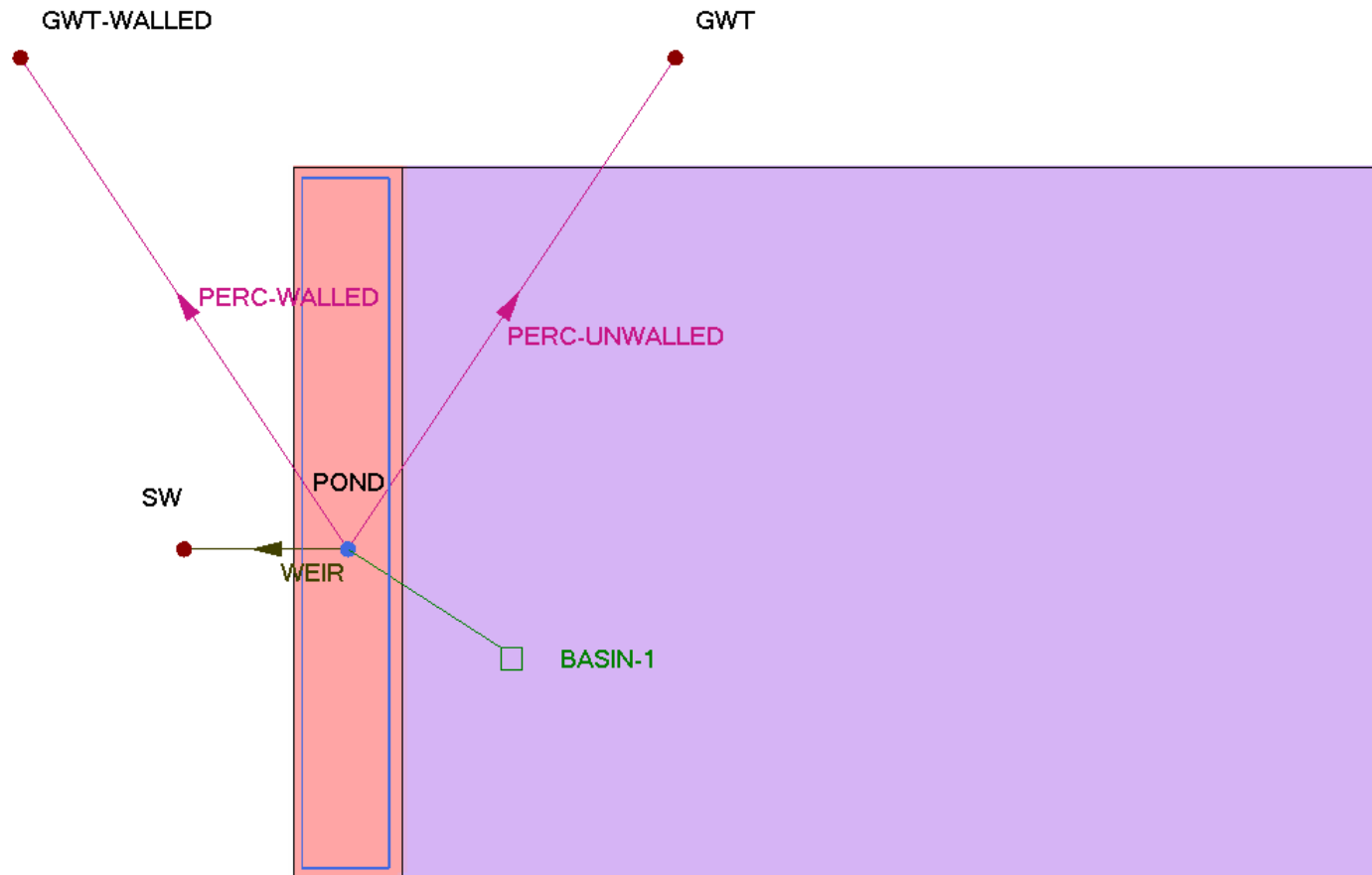
Percolation Links

Setup Example: Storm Chamber & Pond



Percolation Links

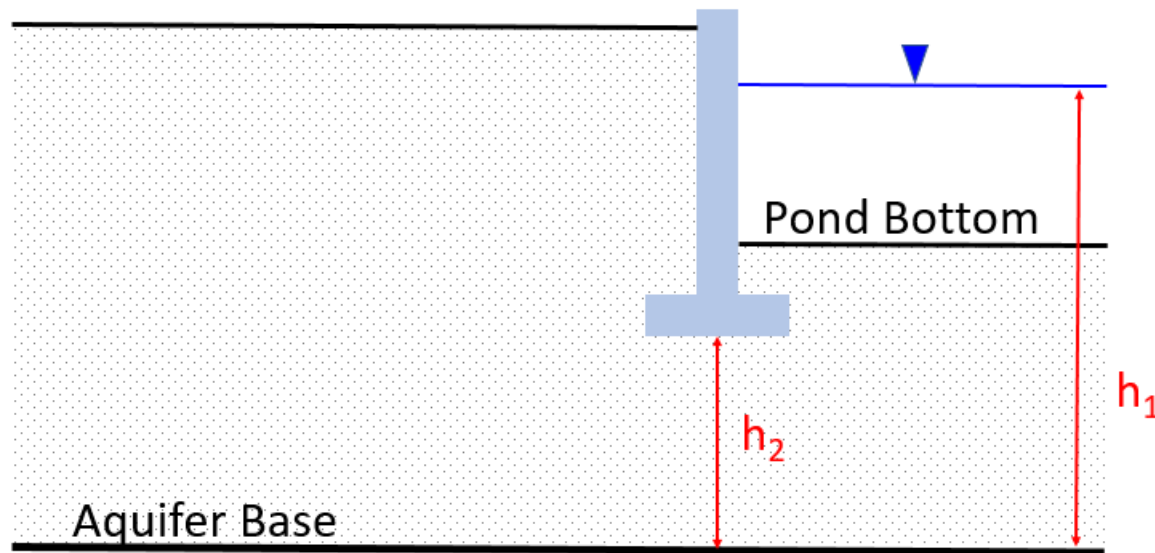
Setup Example: Pond with Retaining Wall



Percolation Links

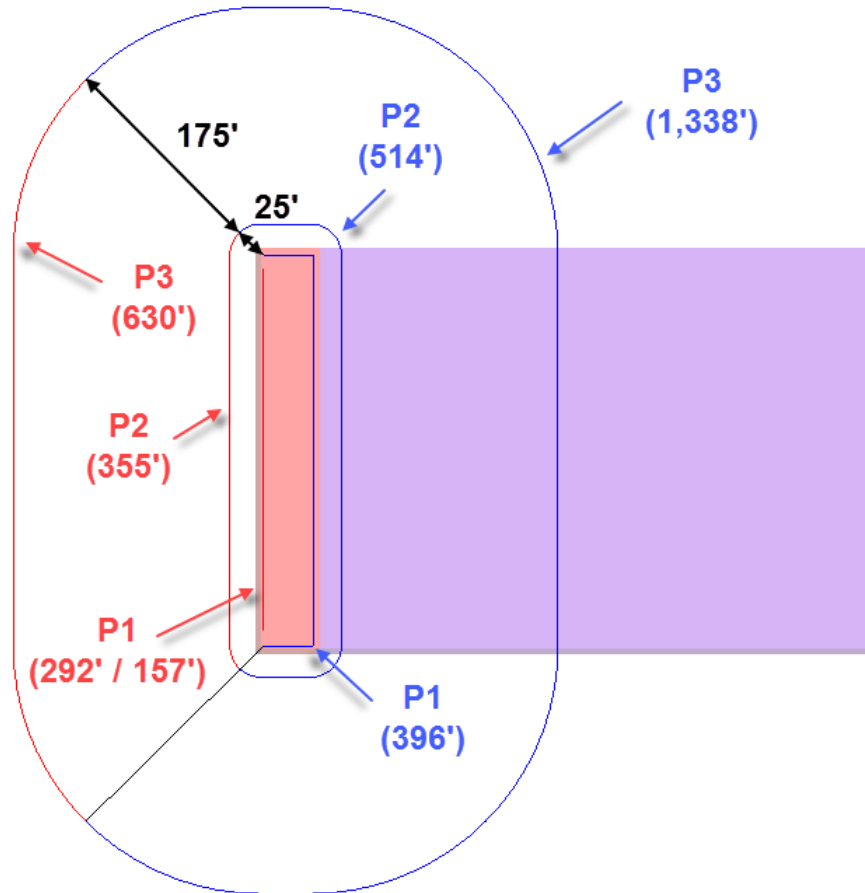
Setup Example: Pond with Retaining Wall

$$P_1^* = P_1 \times (h_2 / h_1)$$



Percolation Links

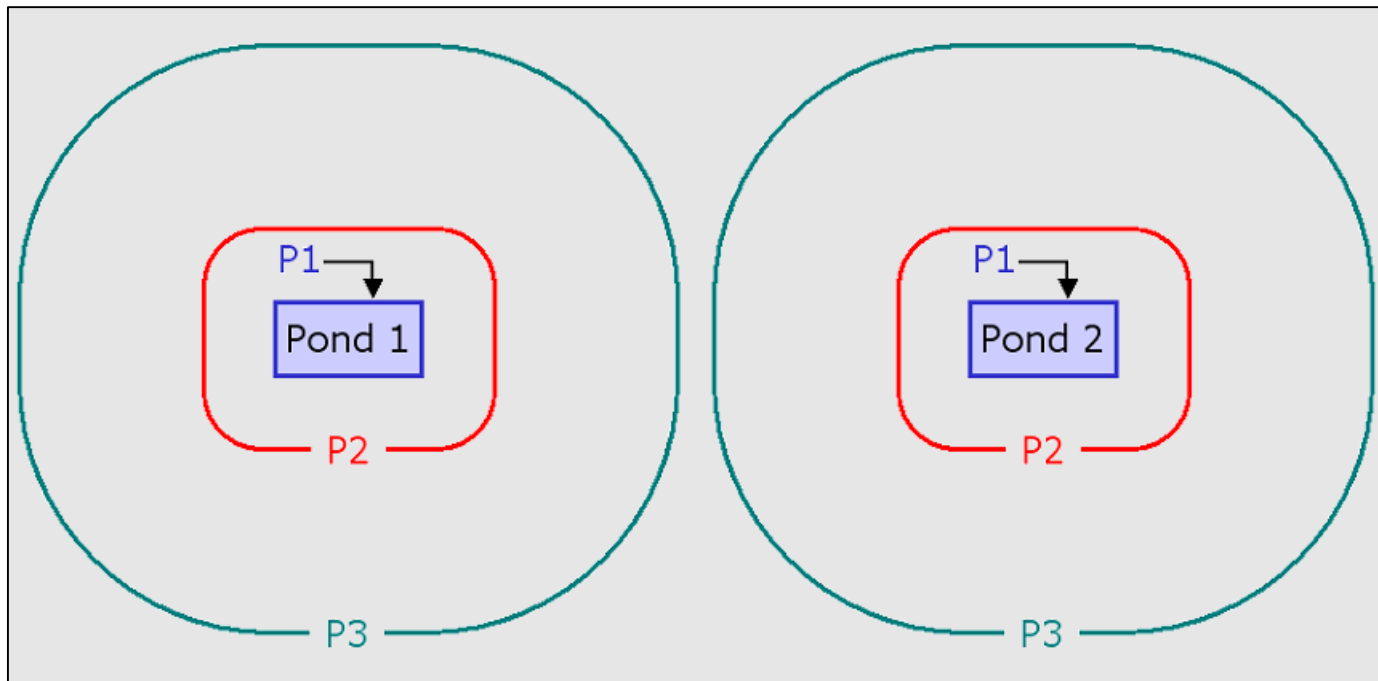
Setup Example: Pond with Retaining Wall



Percolation Links

Setup Example: Dual Ponds in Close Proximity

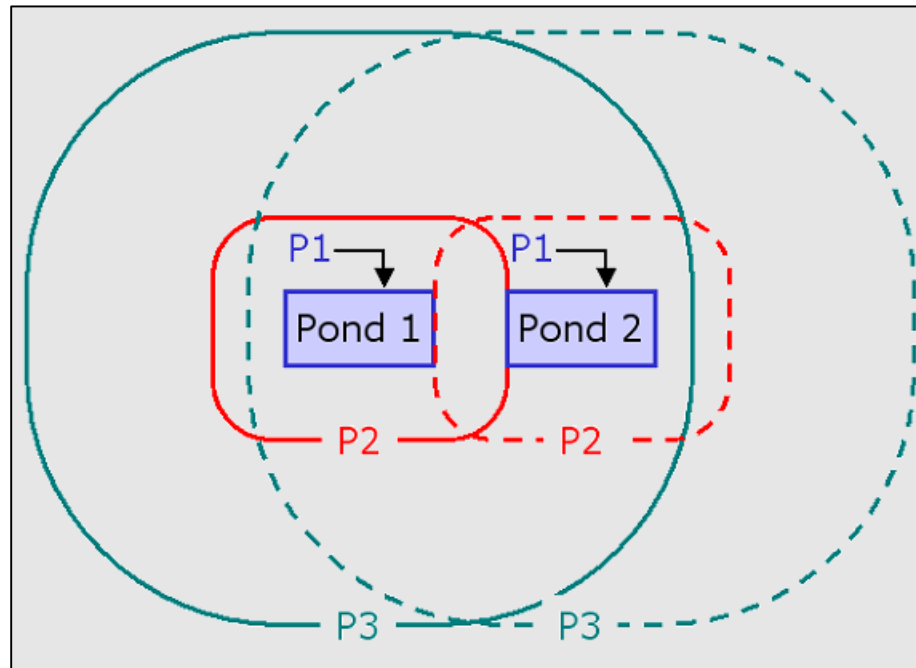
If the computational rings for adjacent ponds do not intersect, then the ponds are independent and no adjustments to the perimeters are required.



Percolation Links

Setup Example: Dual Ponds in Close Proximity

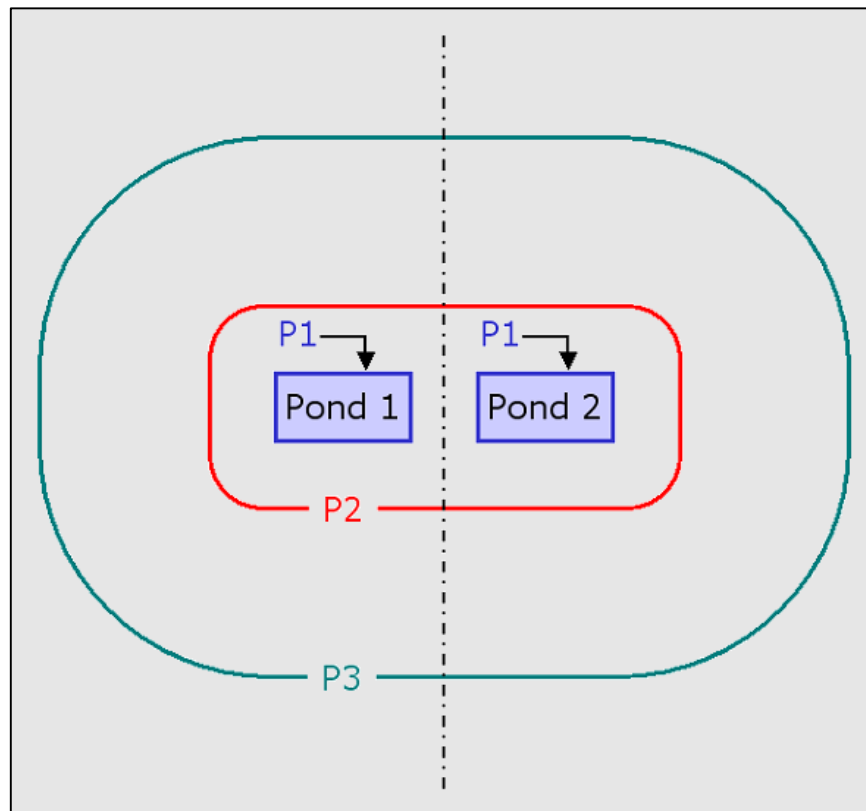
If the computational rings do intersect, then an adjustment to the perimeters is required.



Percolation Links

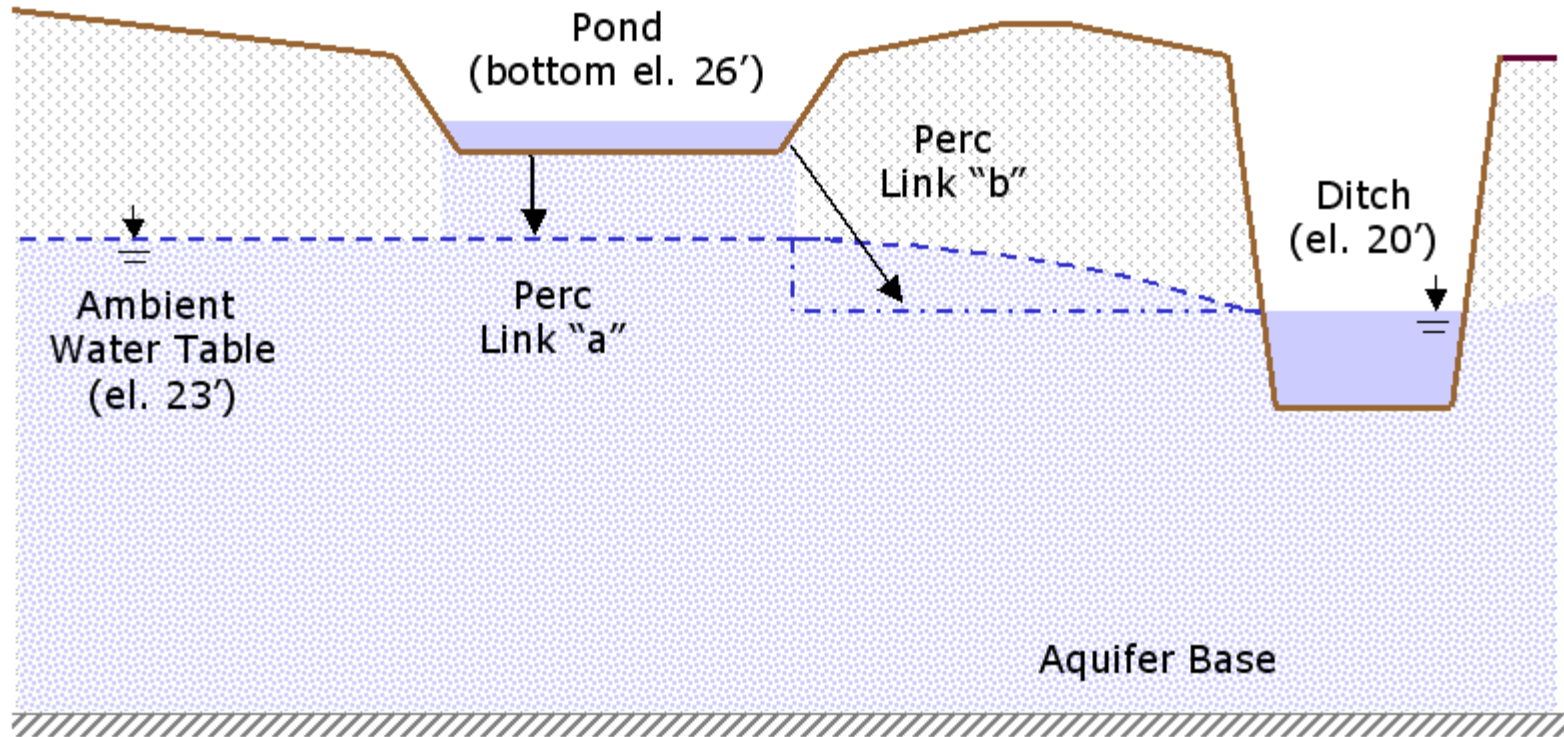
Setup Example: Dual Ponds in Close Proximity

The computational rings must be blended together and then proportioned between the two ponds.



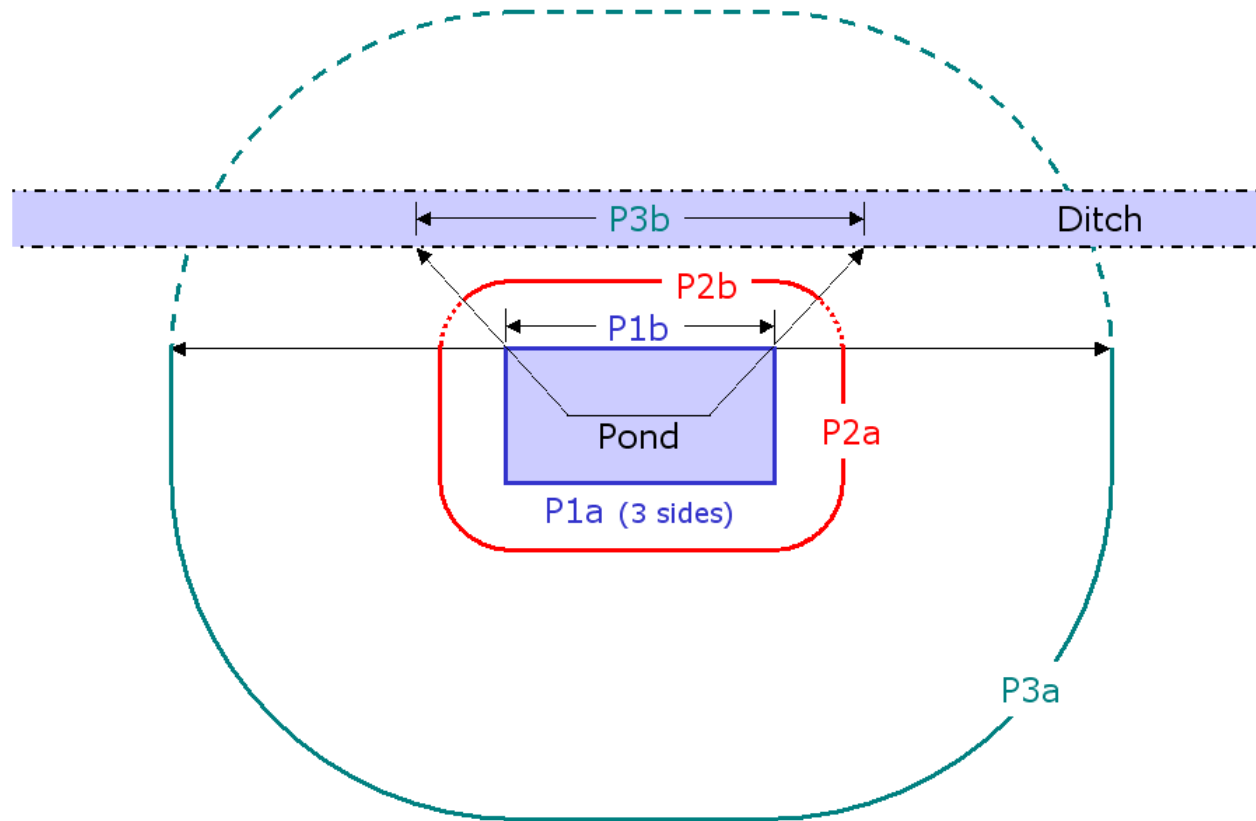
Percolation Links

Setup Example: Ponds in Close Proximity to Canal



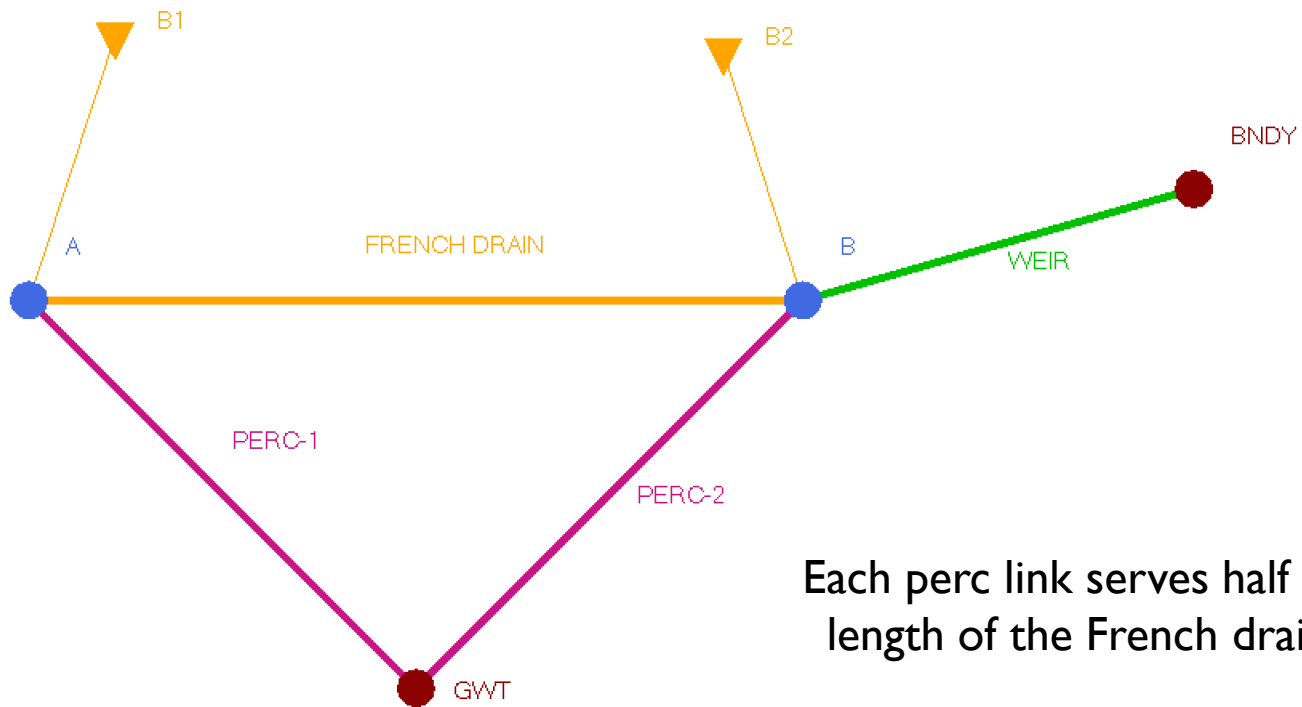
Percolation Links

Setup Example: Ponds in Close Proximity to Canal



Example #1 – French Drain with Percolation

Nodal Network



Example #1 – French Drain with Percolation

Name	<input type="text" value="FRENCH DRAIN"/>	Damping Threshold	<input type="text" value="0"/>
Scenario	<input type="text" value="French Drain with Perc"/>	FHWA Culvert Code	<input type="text" value="1"/>
From Node	<input type="text" value="A"/>	Entrance Loss Coefficient	<input type="text" value="0.5"/>
To Node	<input type="text" value="B"/>	Exit Loss Coefficient	<input type="text" value="0.1"/>
Link Count	<input type="text" value="1"/>	Bend Loss Coefficient	<input type="text" value="0"/>
Flow Direction	<input type="text" value="Both"/>	Bend Location	<input type="text" value="0"/>
		Energy Switch	<input type="text" value="Energy"/>
		Pipe Length	<input type="text" value="416"/>
		Upstream Pipe Invert	<input type="text" value="3"/>
Trench Length	<input type="text" value="400"/>	Downstream Pipe Invert	<input type="text" value="3"/>
Trench Width	<input type="text" value="5"/>	Manning's N	<input type="text" value="0.012"/>
Trench Height	<input type="text" value="15"/>	Pipe Geometry	<input type="text" value="Circular"/>
Trench Depth Below Invert	<input type="text" value="12"/>	Pipe Max Depth	<input type="text" value="2"/>
Trench Gravel Porosity	<input type="text" value="0.5"/>		
Comment	<input type="text"/>		
	<input type="button" value="Create"/>	<input type="button" value="Delete"/>	

Example #1 – French Drain with Percolation

- Water will percolate from both sides of the trench.
- Each perc link serves $\frac{1}{2}$ of the French drain.

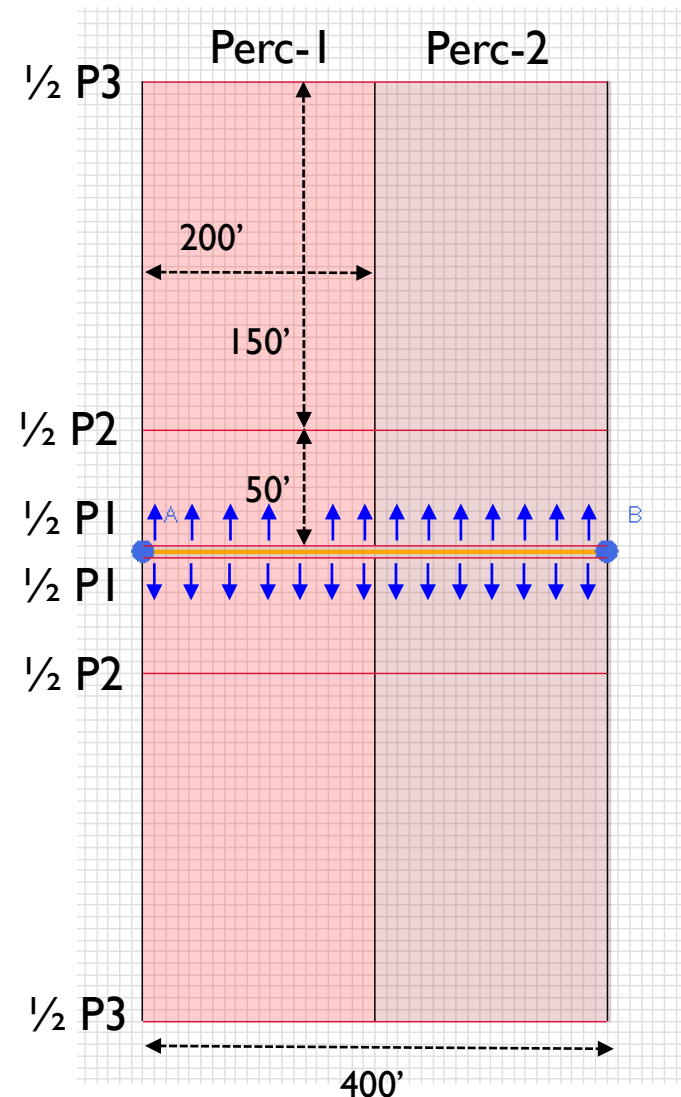
Therefore:

$$P1 = 2 \times \frac{1}{2} L = 2 \times (\frac{1}{2} \times 400') = 400'$$

$$P1 = P2 = P3$$

$$\text{Distance } P1 \text{ to } P2 = 50'$$

$$\text{Distance } P2 \text{ to } P3 = 150'$$



Example #1 – French Drain with Percolation

Nodal Network

Soil Conductivity: Saturated horizontal conductivity for projects in South Florida are calculated from field tests at 10-foot and 15-foot depths (and sometimes to 20-feet). A weighted average conductivity is needed for ICPR4.

$$K_{10} = 3.7 \times 10^{-4} \text{ cfs per sqft per foot of head (fps per foot of head)}$$

(from 0-ft to 10-ft depth)

$$K_{15} = 6.1 \times 10^{-4} \text{ cfs per sqft per foot of head (fps per foot of head)}$$

(from 10-ft to 15-ft depth)

Weighted average:

$$K = 4.5 \times 10^{-4} \text{ cfs per sqft per foot of head (fps per foot of head)}$$

Assuming 1-ft of head*:

$$K_{icpr4} = (4.5 \times 10^{-4}) \times (24 \times 3600) = 38.9 \text{ fpd (19.45 fpd, F.O.S. = 2.0)}$$

* Perc links in ICPR4 automatically include head and hydraulic gradient components.

Example #1 – French Drain with Percolation

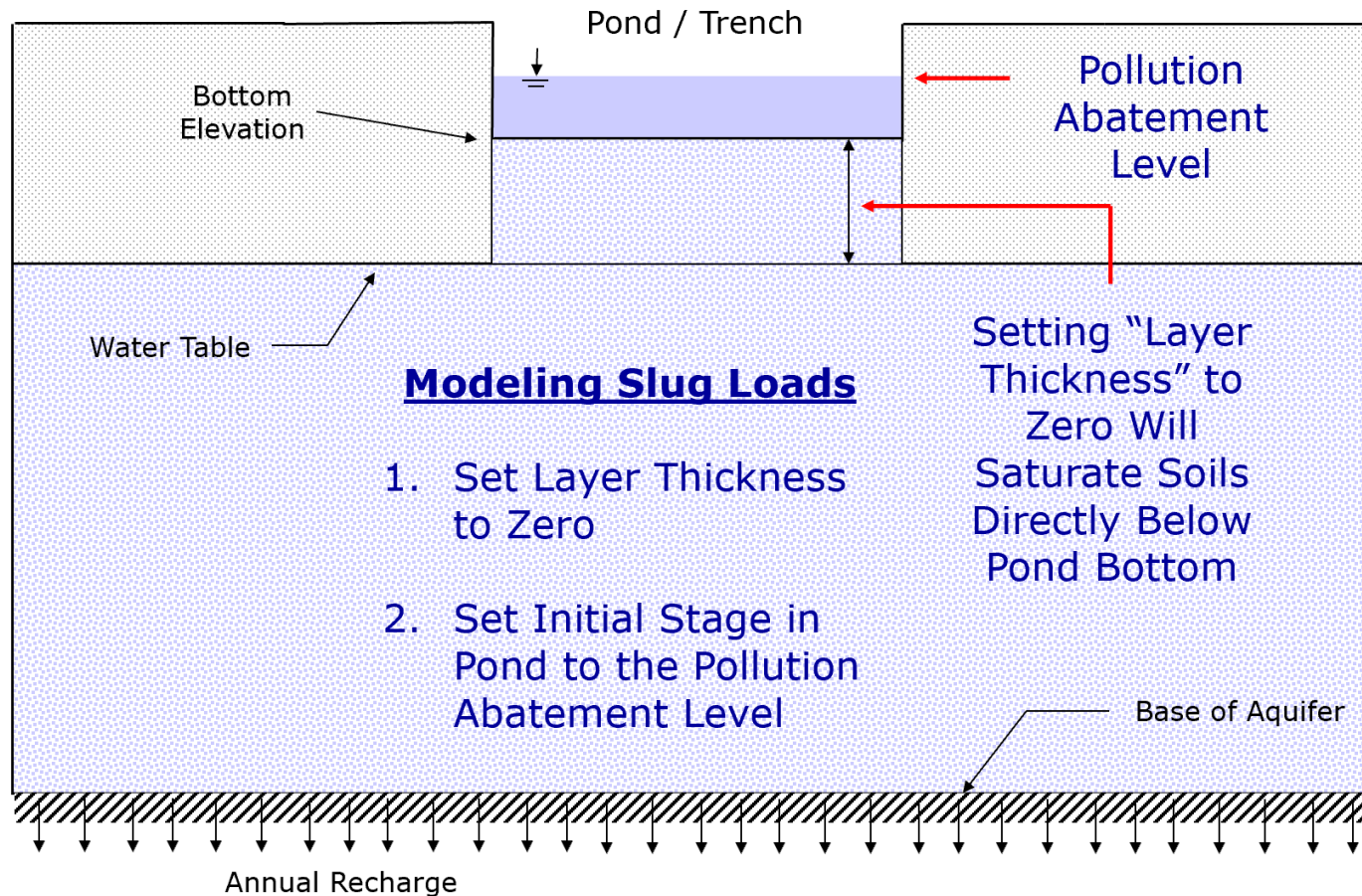
Perc Link Data Form

Flow Direction	Both
Aquifer Base Elevation	-9.1
Water Table Elevation	2.75
Annual Recharge Rate	0
Horizontal Conductivity	19.45
Vertical Conductivity	9.73 $K_v = 1/2 K_h$
Fillable Porosity	0.25
Layer Thickness	0 GWT > BTM of Trench

Surface Area Option	User Specified
Bottom Elevation	-9 bottom of trench
Surface Area	0.02296 = $(5 \times 200) / 43560$
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	400
Perimeter 2	400 $P1 = P2 = P3 = 2(1/2)L$
Perimeter 3	400
Distance P1 to P2	50
Distance P2 to P3	150
# of Cells P1 to P2	10
# of Cells P2 to P3	15

Example #1 – French Drain with Percolation

Slug Load



Example #1 – French Drain with Percolation

Slug Load

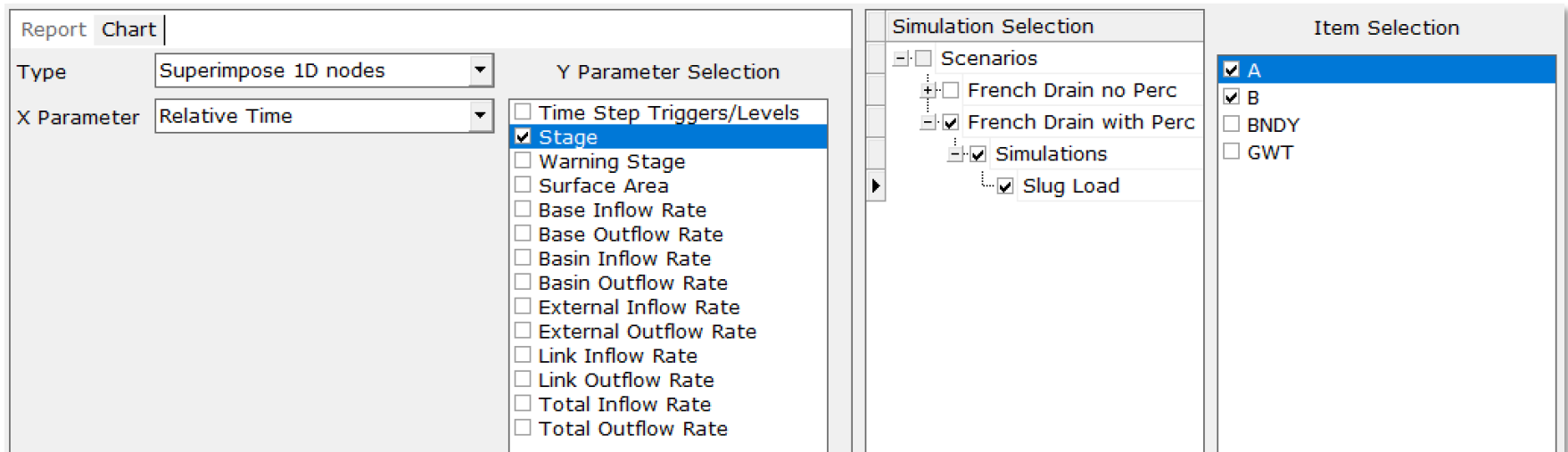
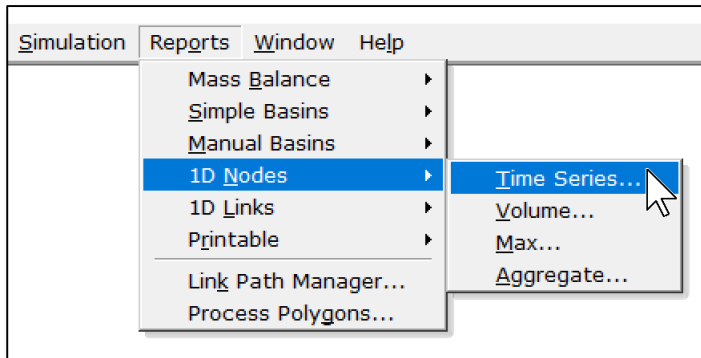
- Initial stage at the weir overflow elevation of 6' (pollution abatement volume)
- No rainfall
- Recovery to elevation 3' must occur by hour 72

Name	A
Scenario	French Drain with Perc
Type	Stage/Area
Base Flow	0
Initial Stage	6
Warning Stage	7.5

Name	B
Scenario	French Drain with Perc
Type	Stage/Area
Base Flow	0
Initial Stage	6
Warning Stage	7.5

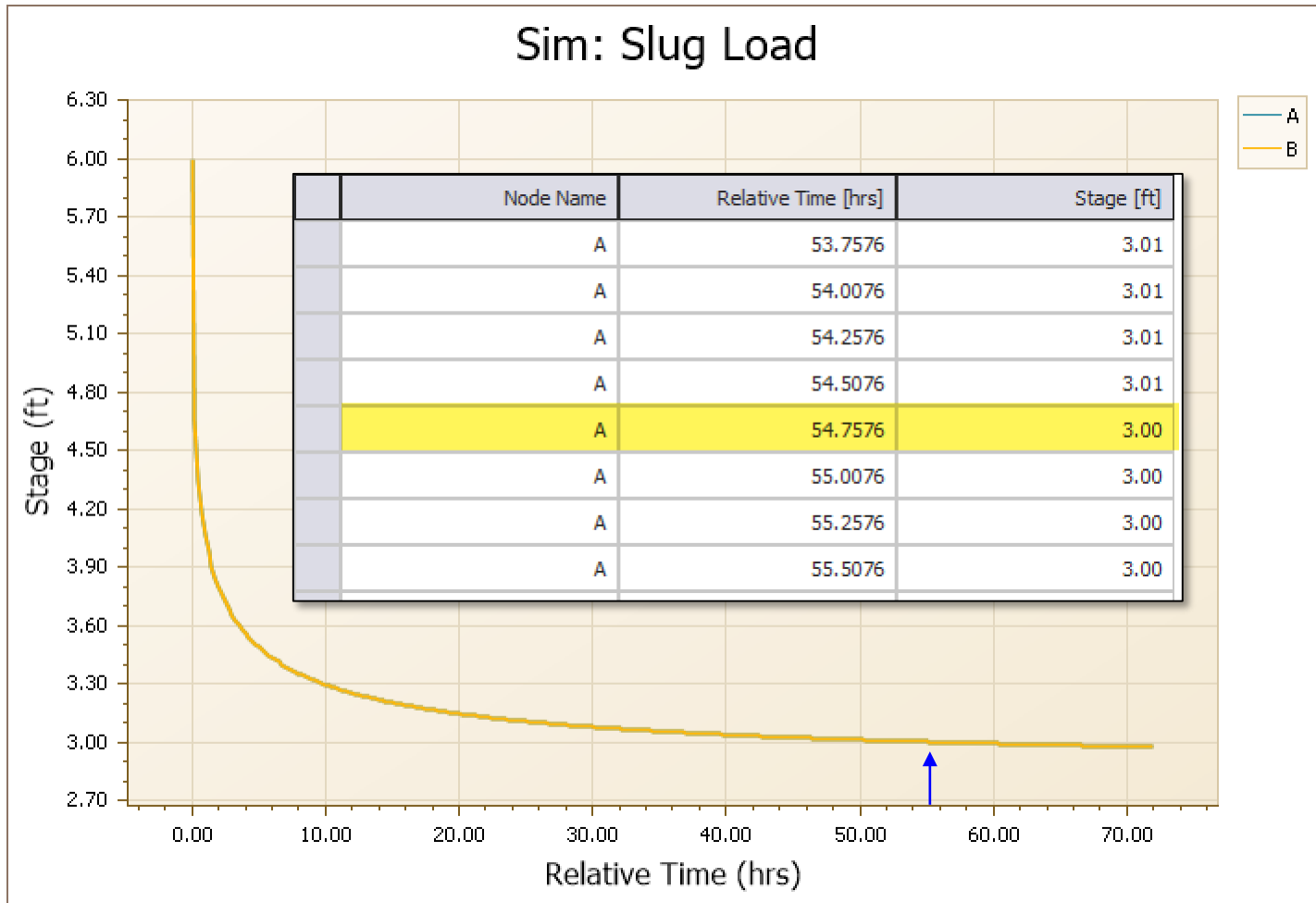
Example #1 – French Drain with Percolation

Slug Load



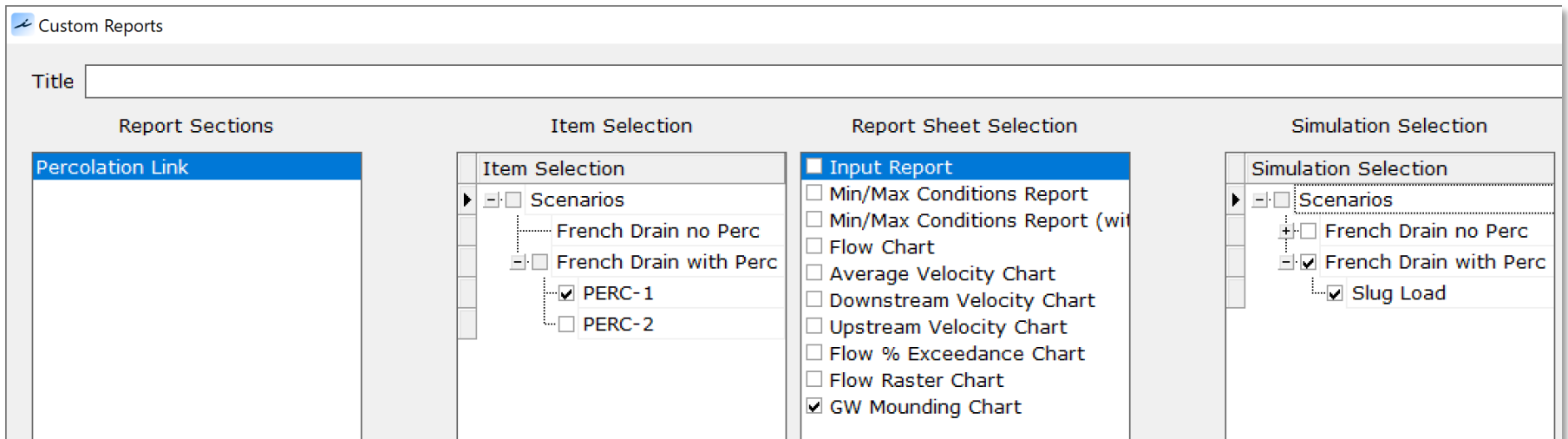
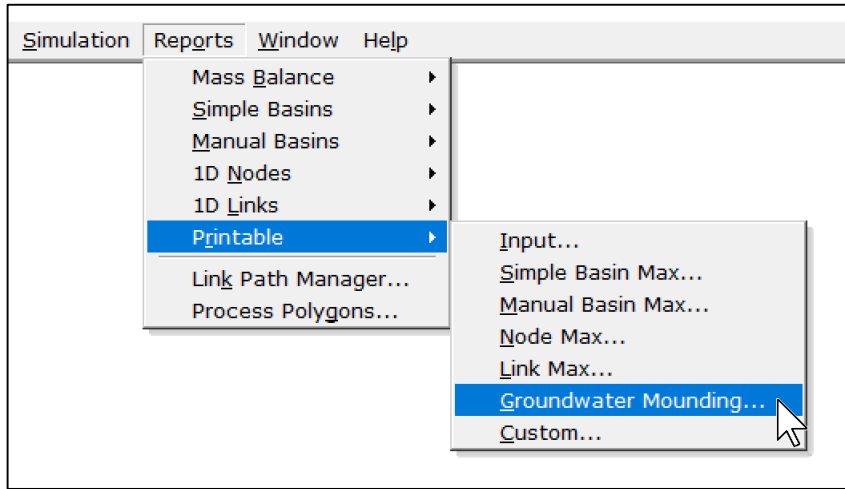
Example #1 – French Drain with Percolation

Slug Load



Example #1 – French Drain with Percolation

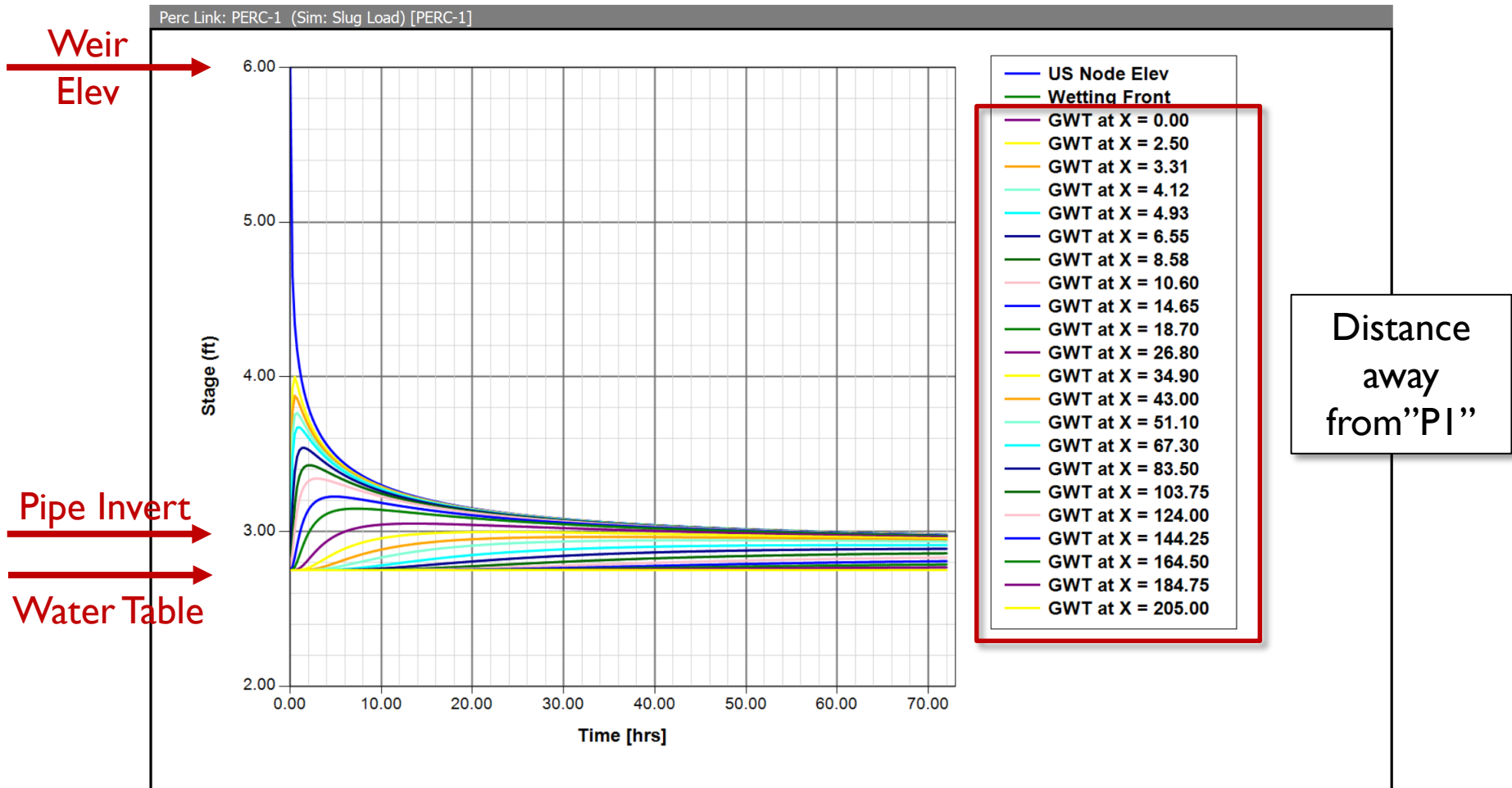
Slug Load



Example #1 – French Drain with Percolation

Slug Load

1



Example #1 – French Drain with Percolation

8.5” Storm

- Initial stage at the pipe invert elevation of 3’
- 8.5” rainfall in 24 hours (FLMOD distribution)

Name	A
Scenario	French Drain with Perc
Type	Stage/Area
Base Flow	0
Initial Stage	3
Warning Stage	7.5

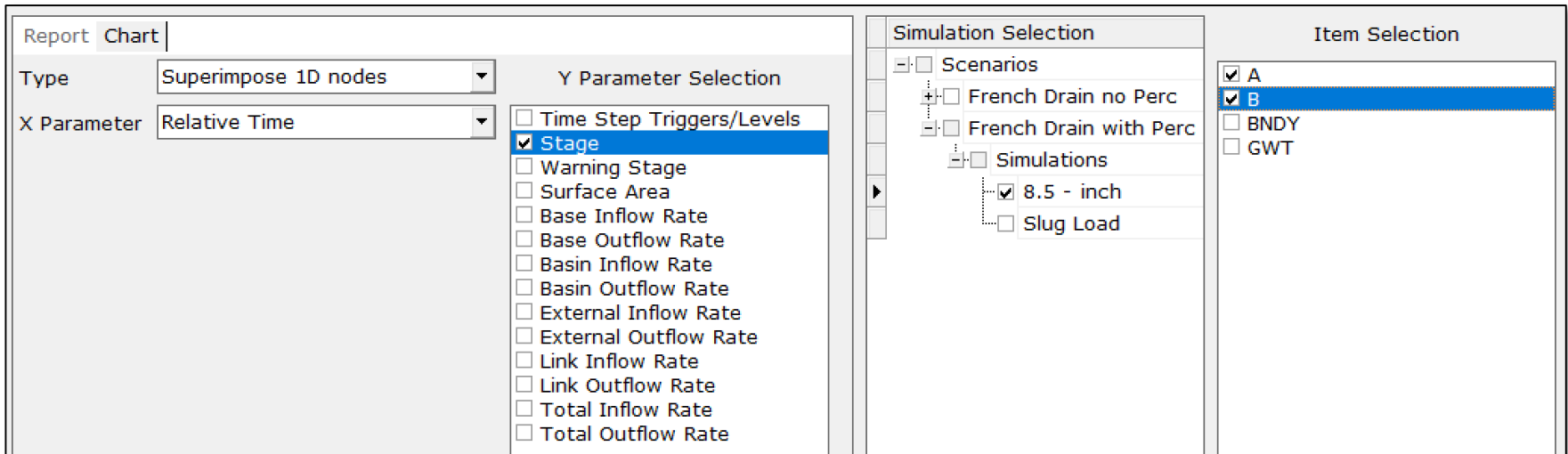
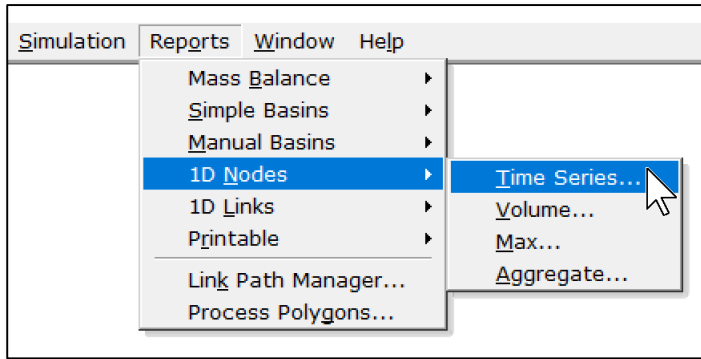
Node Data Form

Simple / Manual Basin Rainfall Opt.	Global
Rainfall Name	~FLMOD
Rainfall Amount	8.5
Storm Duration	24

Simulation Manager

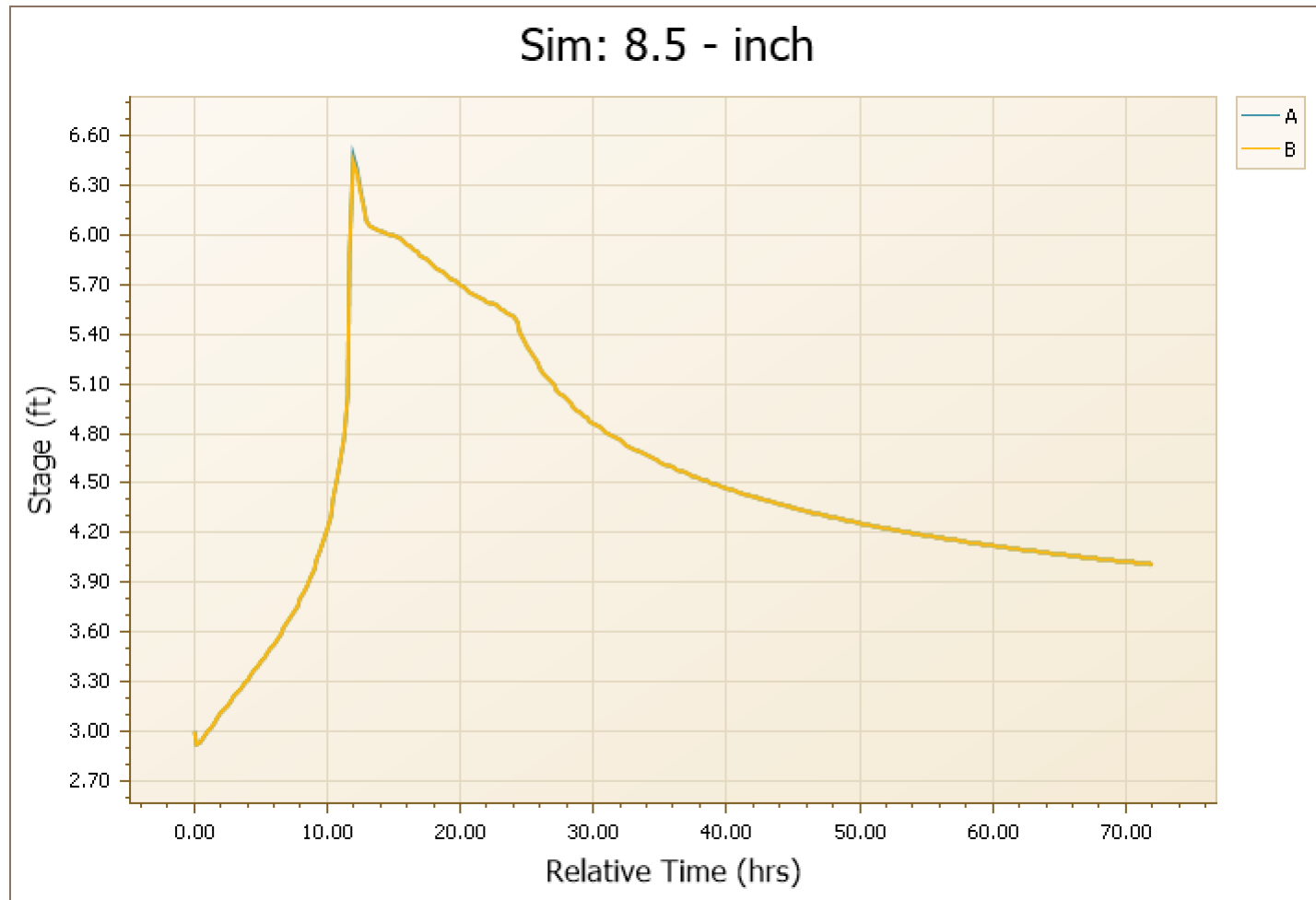
Example #1 – French Drain with Percolation

8.5” Storm



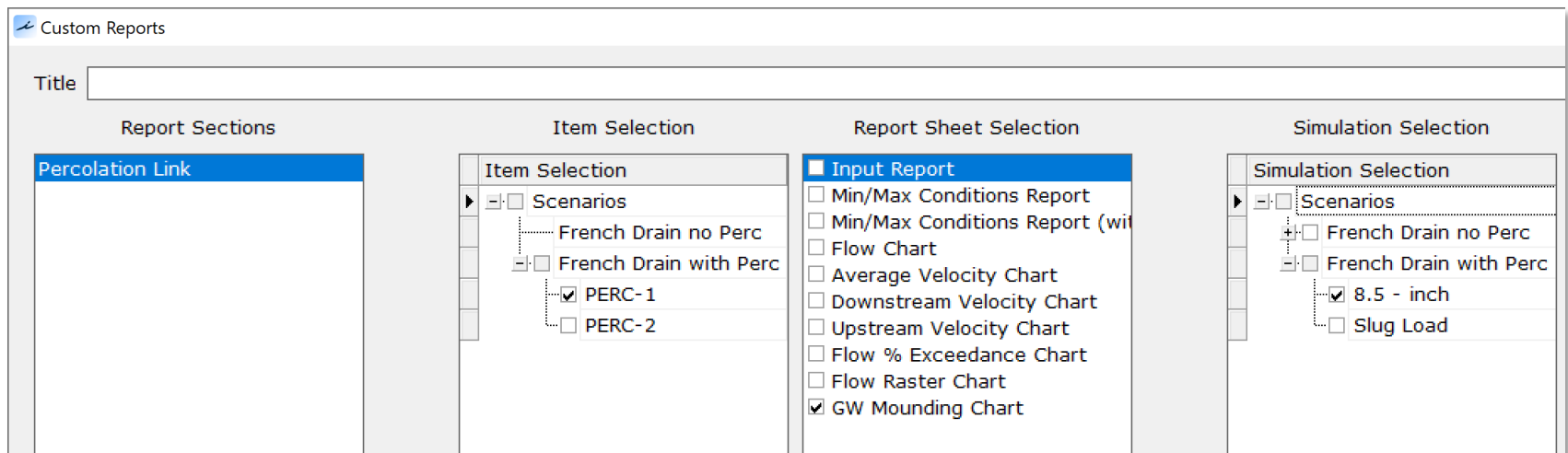
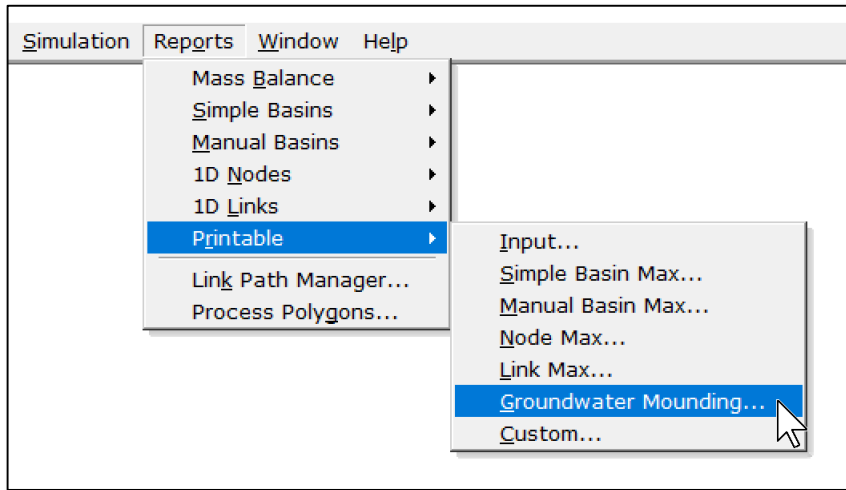
Example #1 – French Drain with Percolation

8.5” Storm



Example #1 – French Drain with Percolation

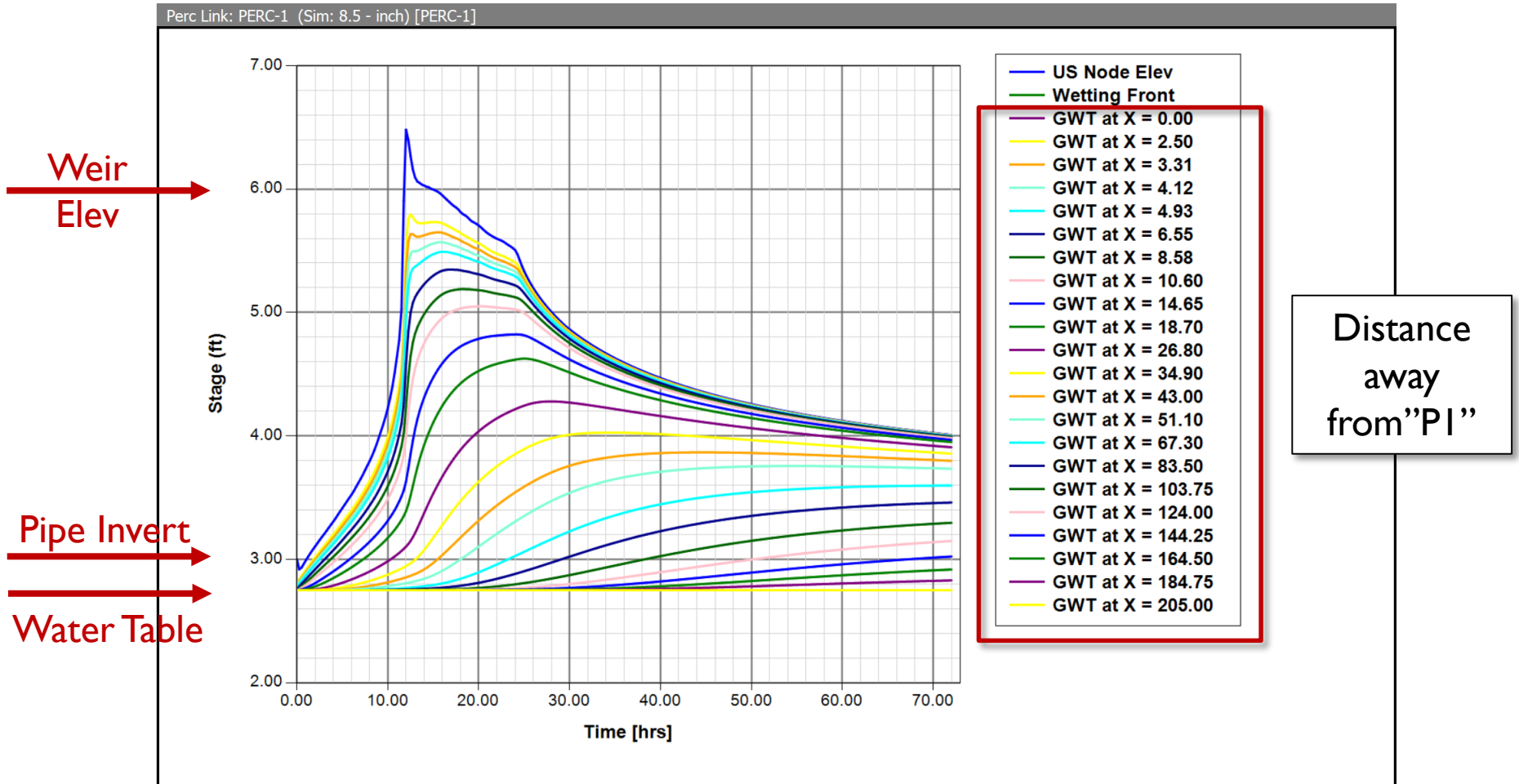
8.5” Storm



Example #1 – French Drain with Percolation

8.5" Storm

1



Example #1 – French Drain with Percolation

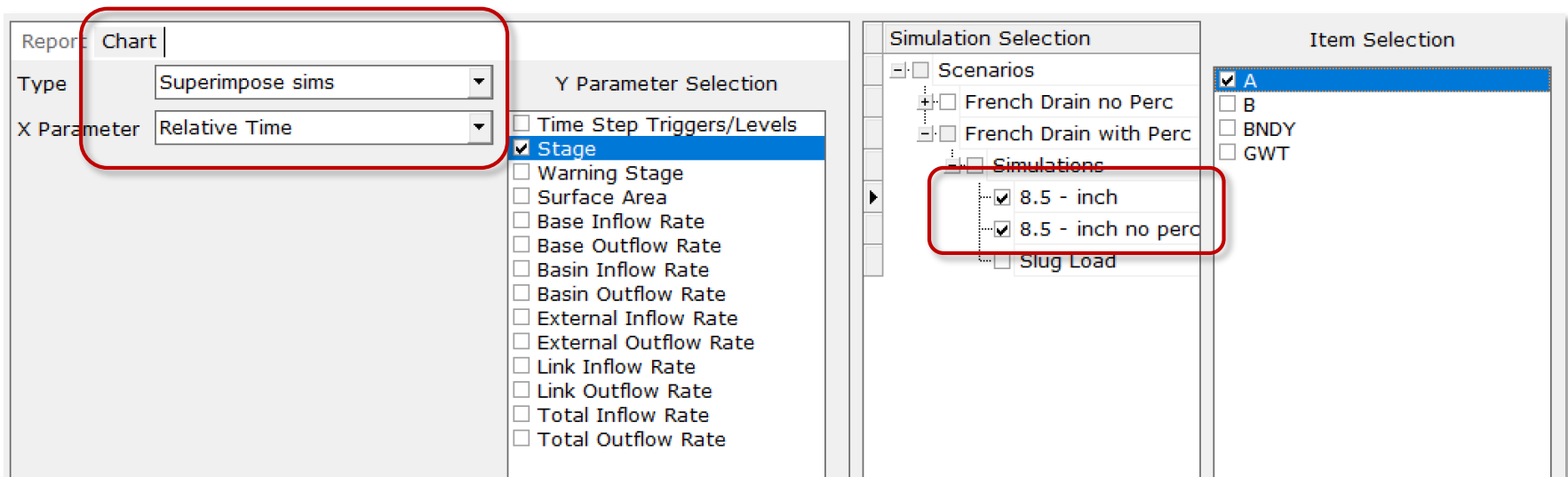
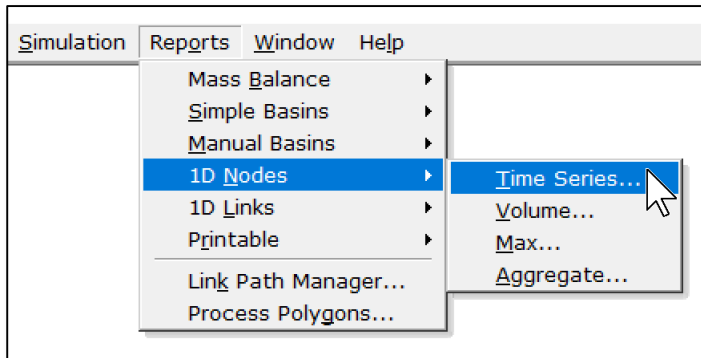
8.5” Storm

- Turn perc links off and rerun the 8.5” storm

Name	PERC-1
Scenario	French Drain with Perc ▼
From Node	A
To Node	GWT
Link Count	1
Flow Direction	None ▼
Aquifer Base Elevation	-9.1
Water Table Elevation	2.75

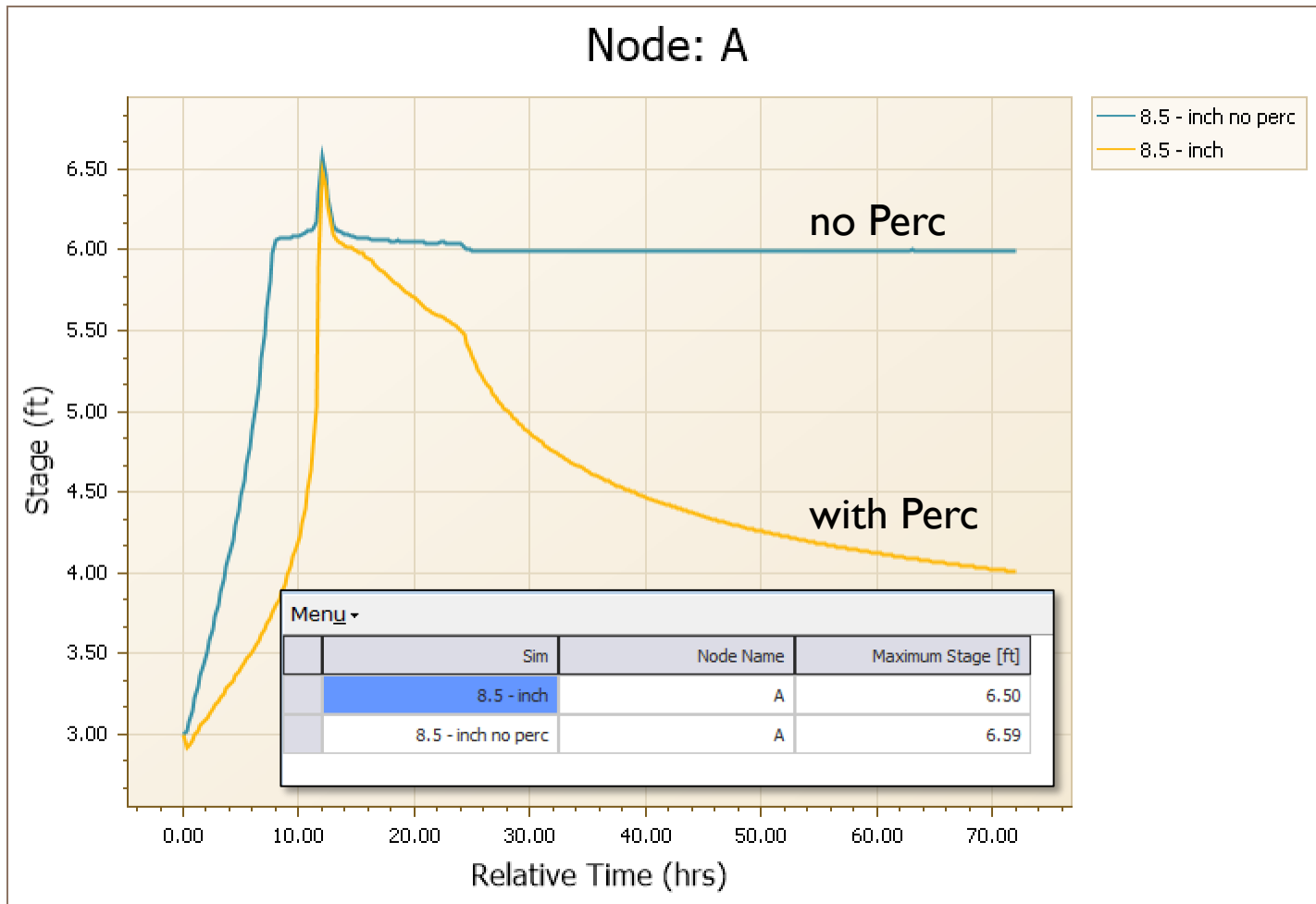
Example #1 – French Drain with Percolation

8.5” Storm



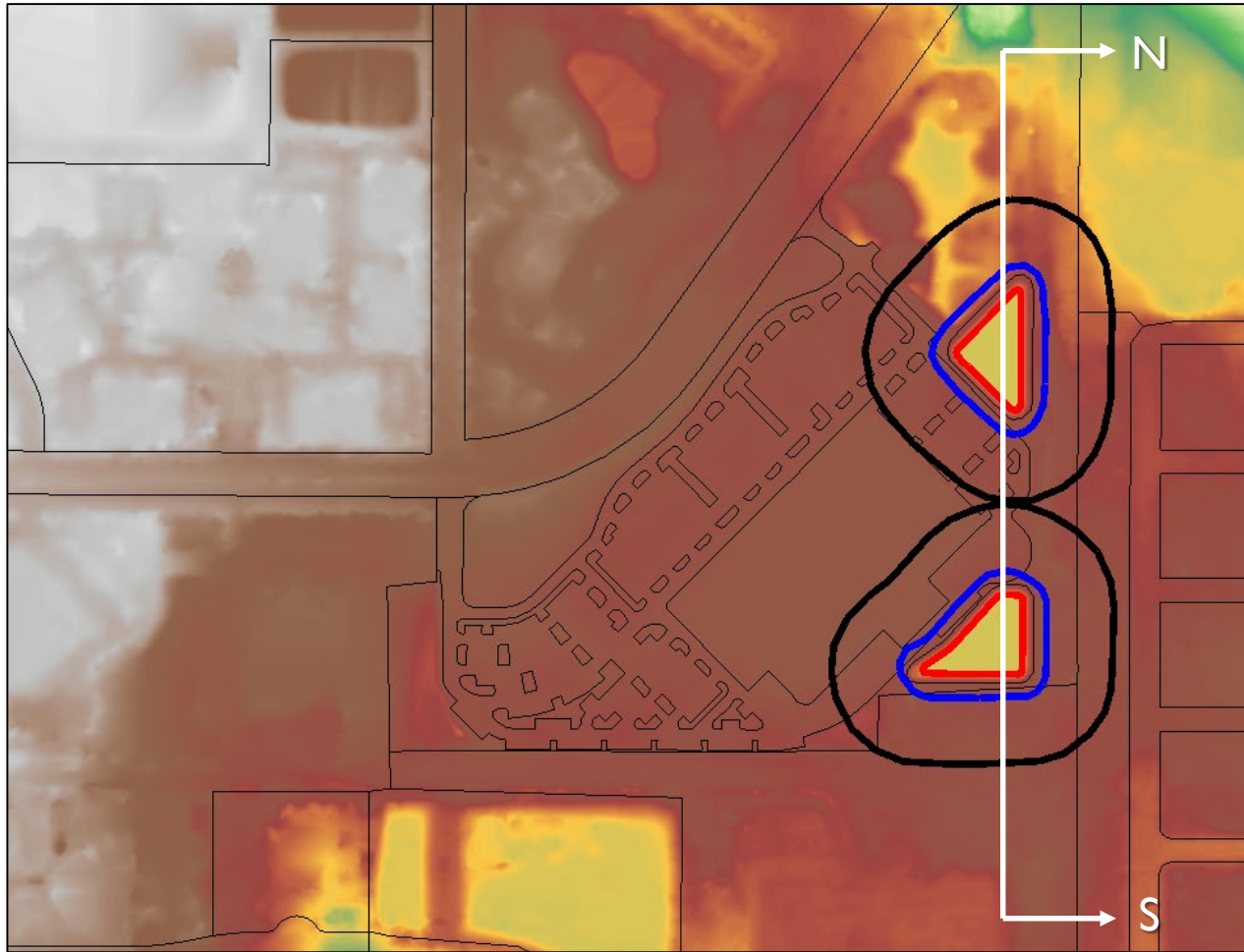
Example #1 – French Drain with Percolation

8.5” Storm



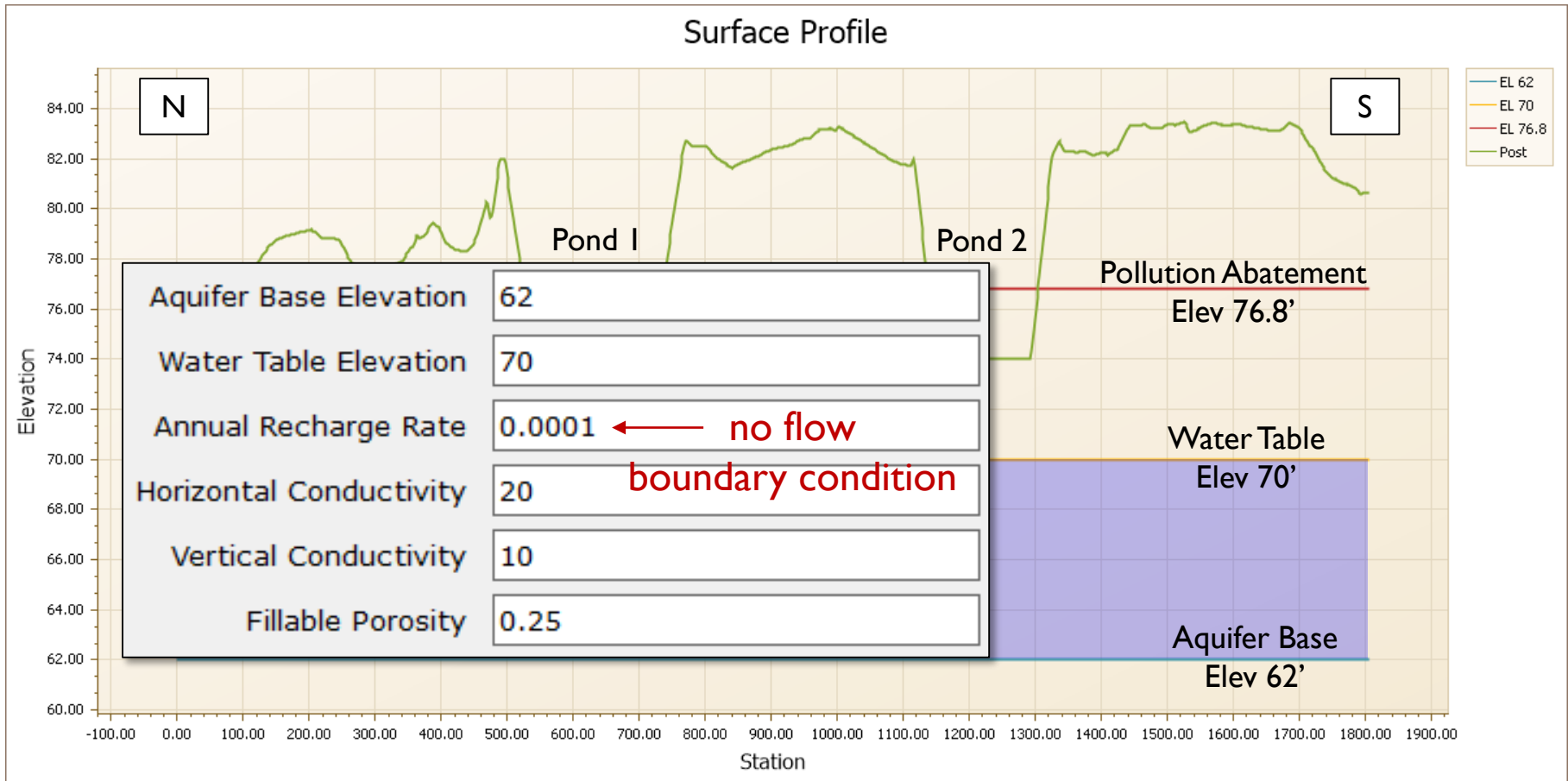
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190')



Example #2 – Dual Ponds in Close Proximity

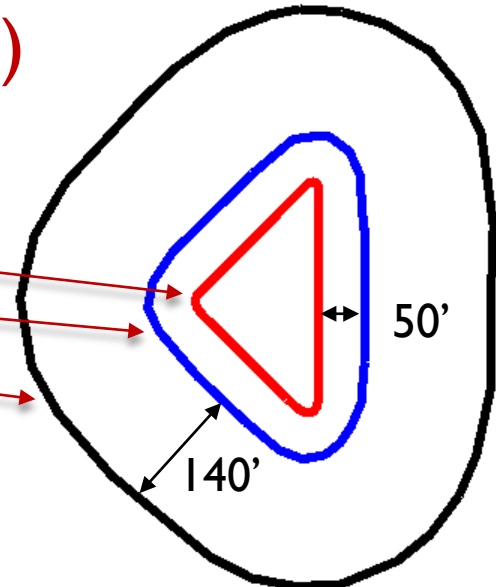
Layout I (P3@190') No Flow at P3



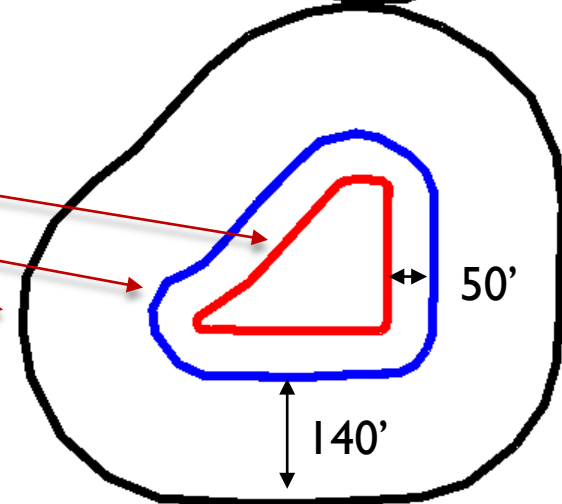
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190')

Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	623.4
Perimeter 2	931.9
Perimeter 3	1807.7
Distance P1 to P2	50
Distance P2 to P3	140
# of Cells P1 to P2	10
# of Cells P2 to P3	28



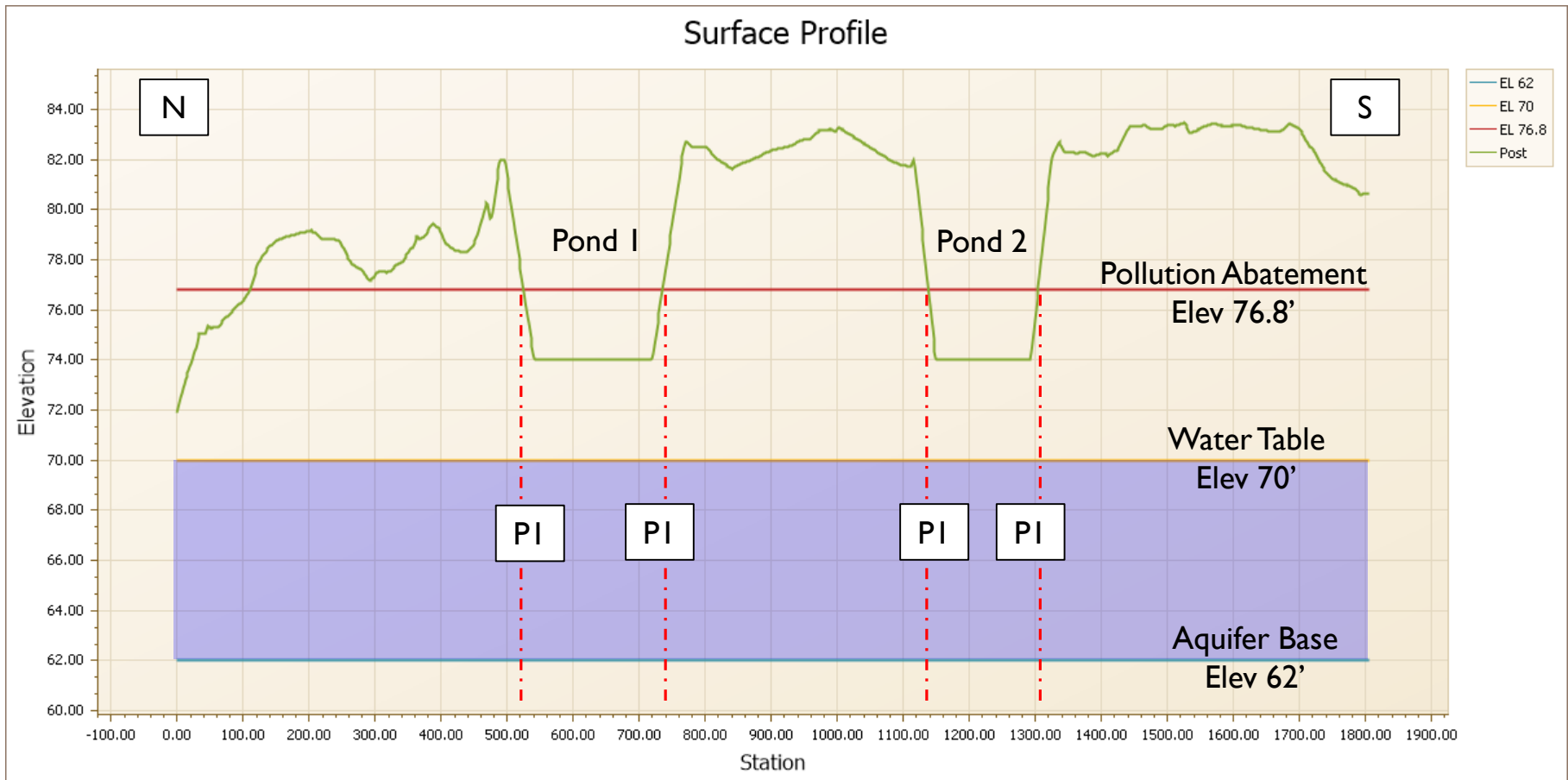
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	645.6
Perimeter 2	944.9
Perimeter 3	1828.1
Distance P1 to P2	50
Distance P2 to P3	140
# of Cells P1 to P2	10
# of Cells P2 to P3	28



5' cell size

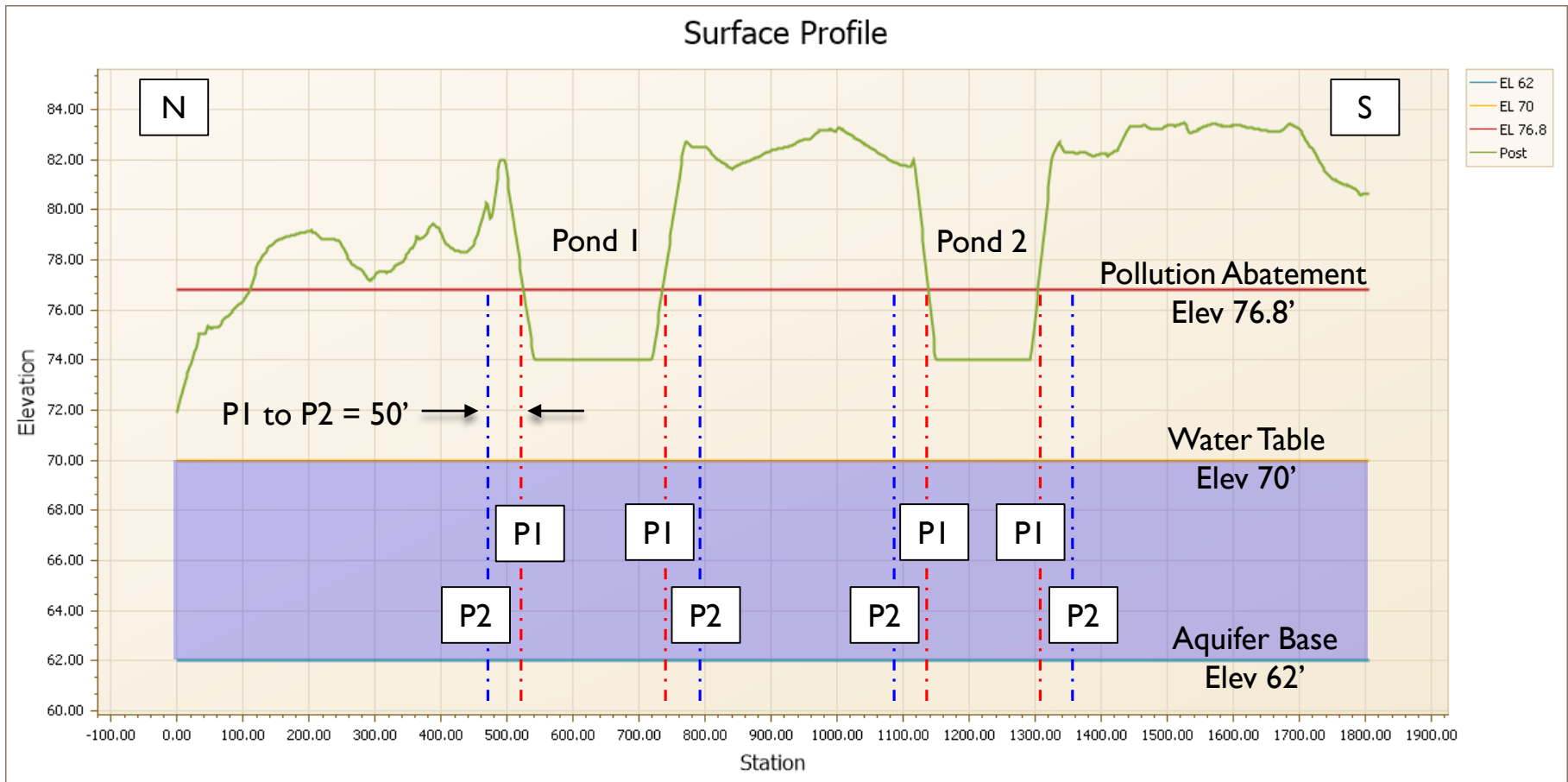
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190')



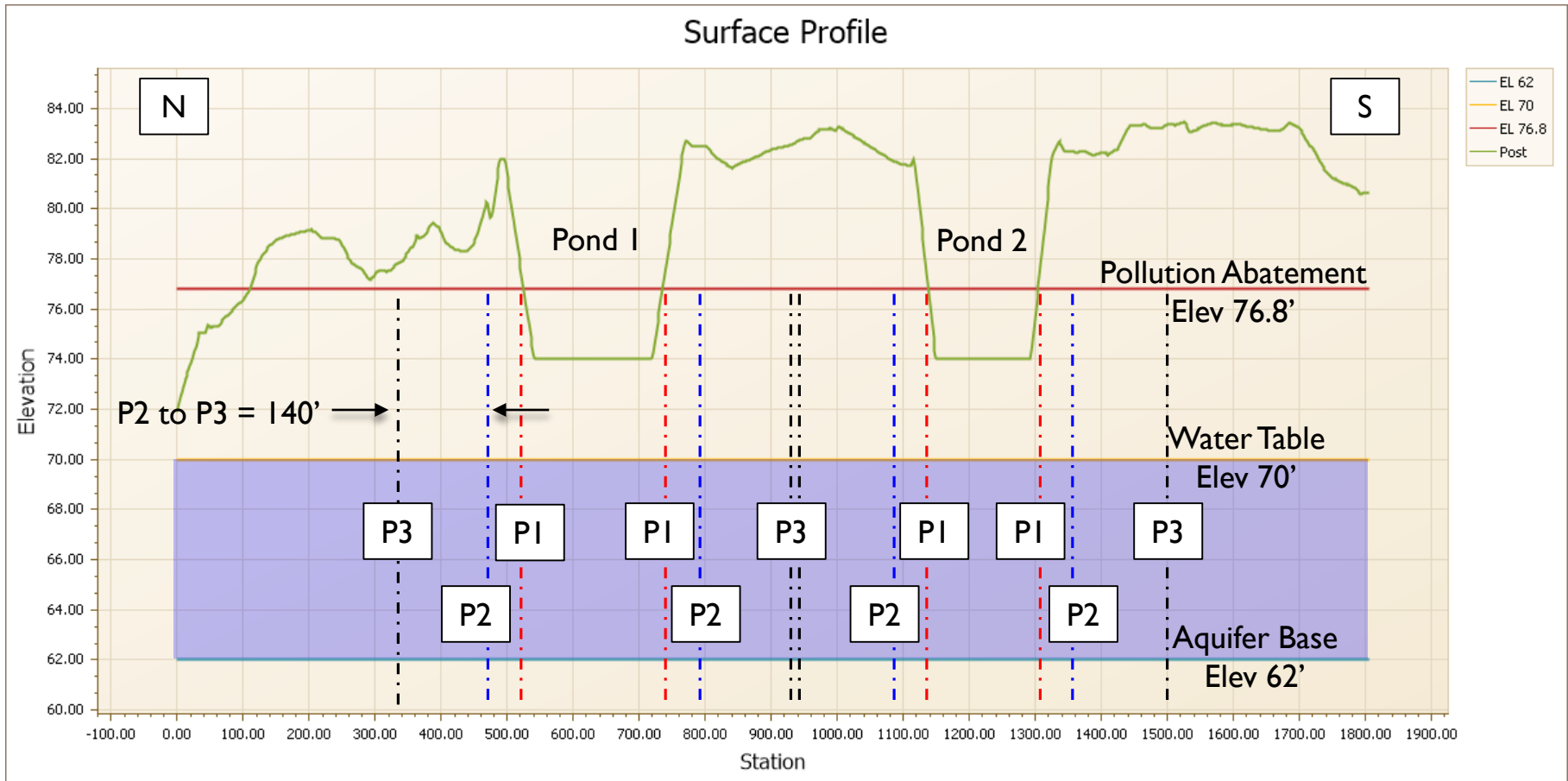
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190')



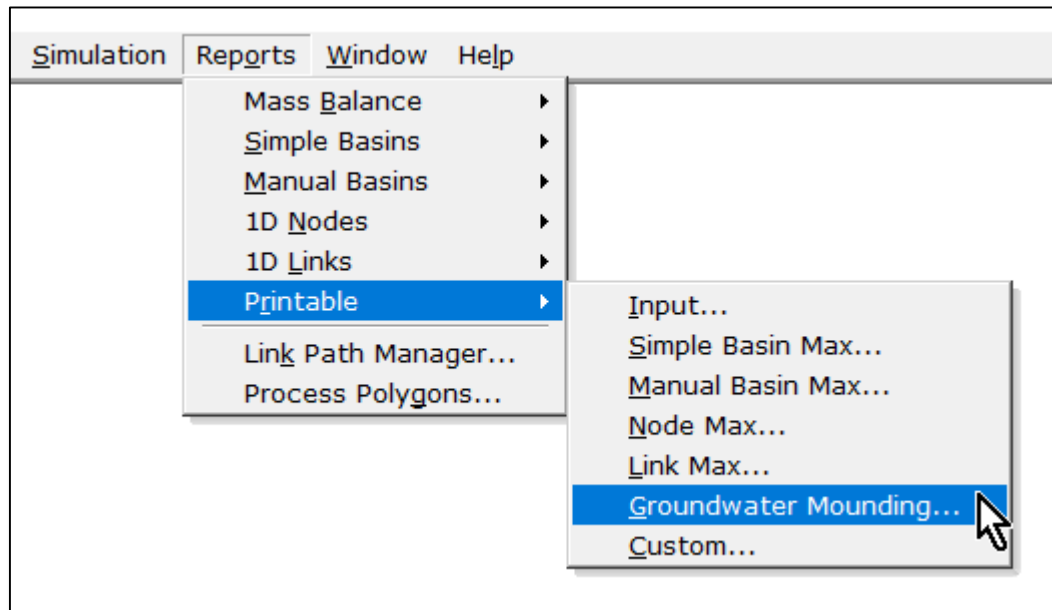
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190')



Example #2 – Dual Ponds in Close Proximity

Layout 1 (P3@190') No Flow at P3



Example #2 – Dual Ponds in Close Proximity

Layout 1 (P3@190') No Flow at P3

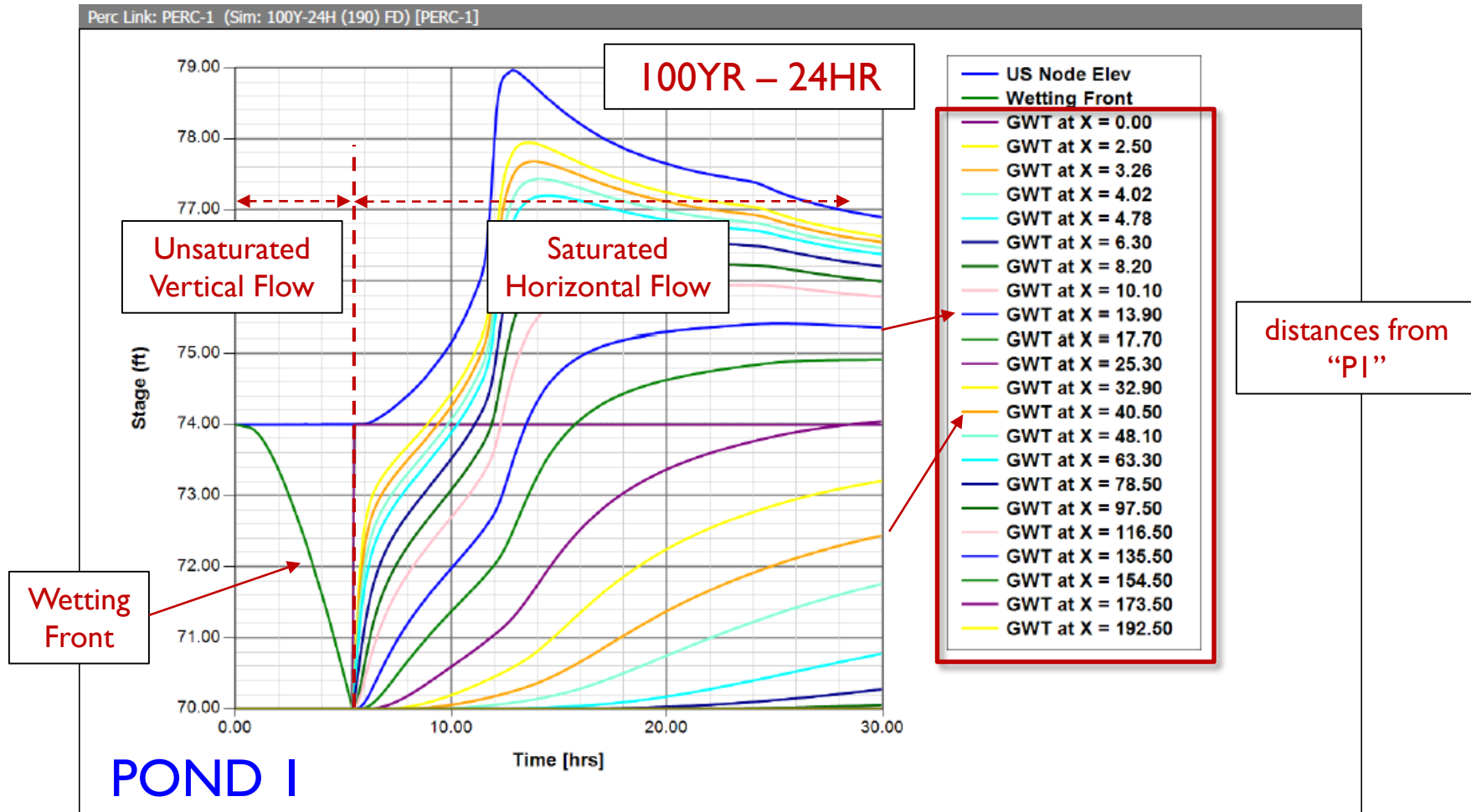
The screenshot displays the 'Custom Reports' configuration window. It is divided into four main sections: Report Sections, Item Selection, Report Sheet Selection, and Simulation Selection.

- Report Sections:** A list containing 'Percolation Link'. Below the list are 'Add', 'Remove', and 'Remove All' buttons.
- Item Selection:** A tree view showing 'Scenarios' with two sub-items: 'SS - Ponds & Perc (190)' (checked) and 'SS - Ponds & Perc (500)'. Under 'SS - Ponds & Perc (190)', 'PERC-1' and 'PERC-2' are checked. Under 'SS - Ponds & Perc (500)', 'PERC-1' and 'PERC-2' are unchecked.
- Report Sheet Selection:** A list of report types. 'Input Report' is selected. Other options include 'Min/Max Conditions Report', 'Flow Chart', 'Average Velocity Chart', 'Downstream Velocity Chart', 'Upstream Velocity Chart', 'Flow % Exceedance Chart', 'Flow Raster Chart', and 'GW Mounding Chart' (checked).
- Simulation Selection:** A tree view showing 'Scenarios' with two sub-items: 'SS - Ponds & Perc (190)' and 'SS - Ponds & Perc (500)'. Under 'SS - Ponds & Perc (190)', '010Y_03H (190)', '010Y_03H (190) FD', '025Y-24H (190)', '025Y-24H (190) FD', and '100Y-24H (190)' are unchecked. '100Y-24H (190) FD' is checked. Under 'SS - Ponds & Perc (500)', no items are checked.

At the bottom, there is a 'Page Break Rule' dropdown menu set to 'Join'.

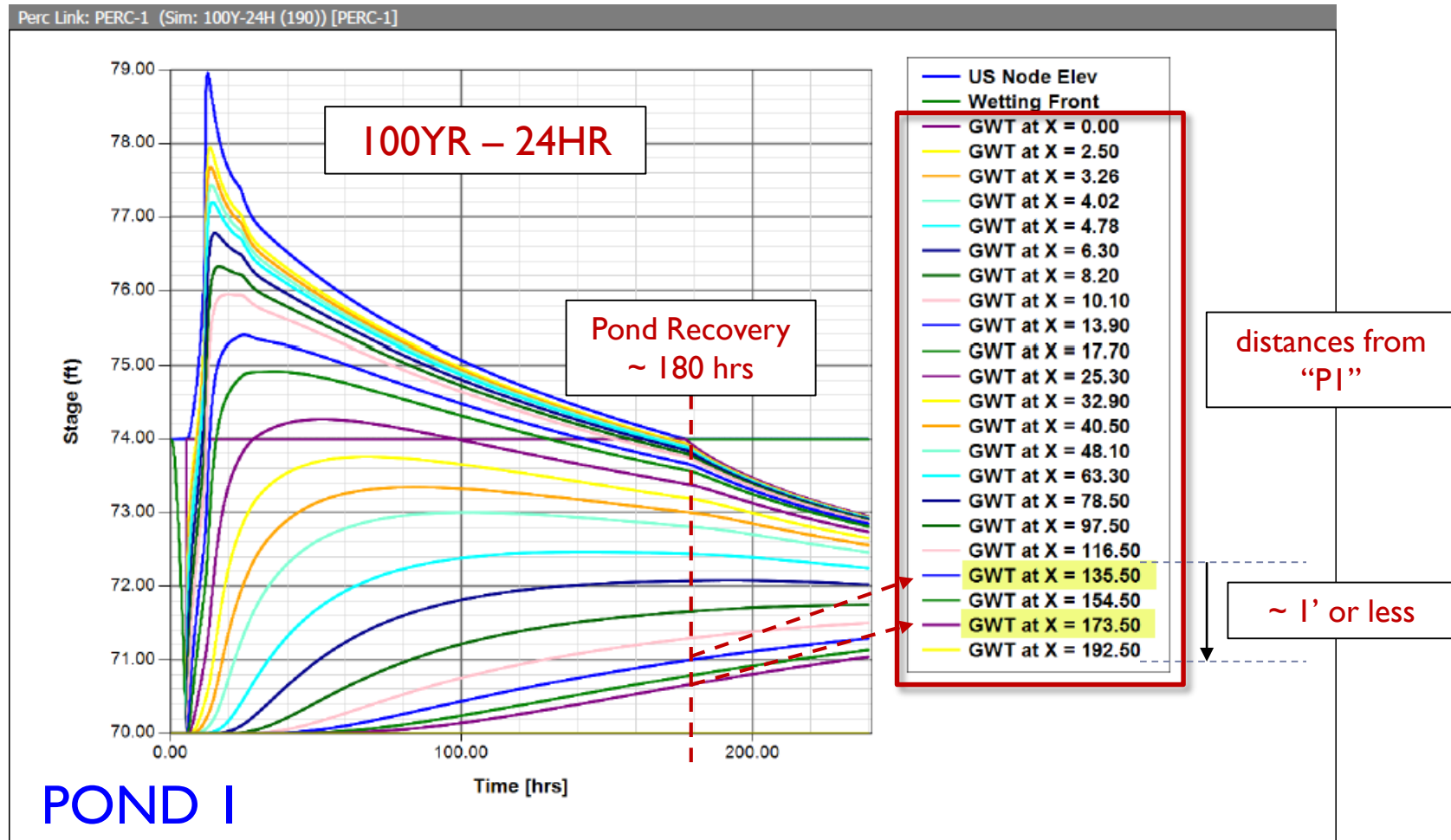
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190') No Flow at P3



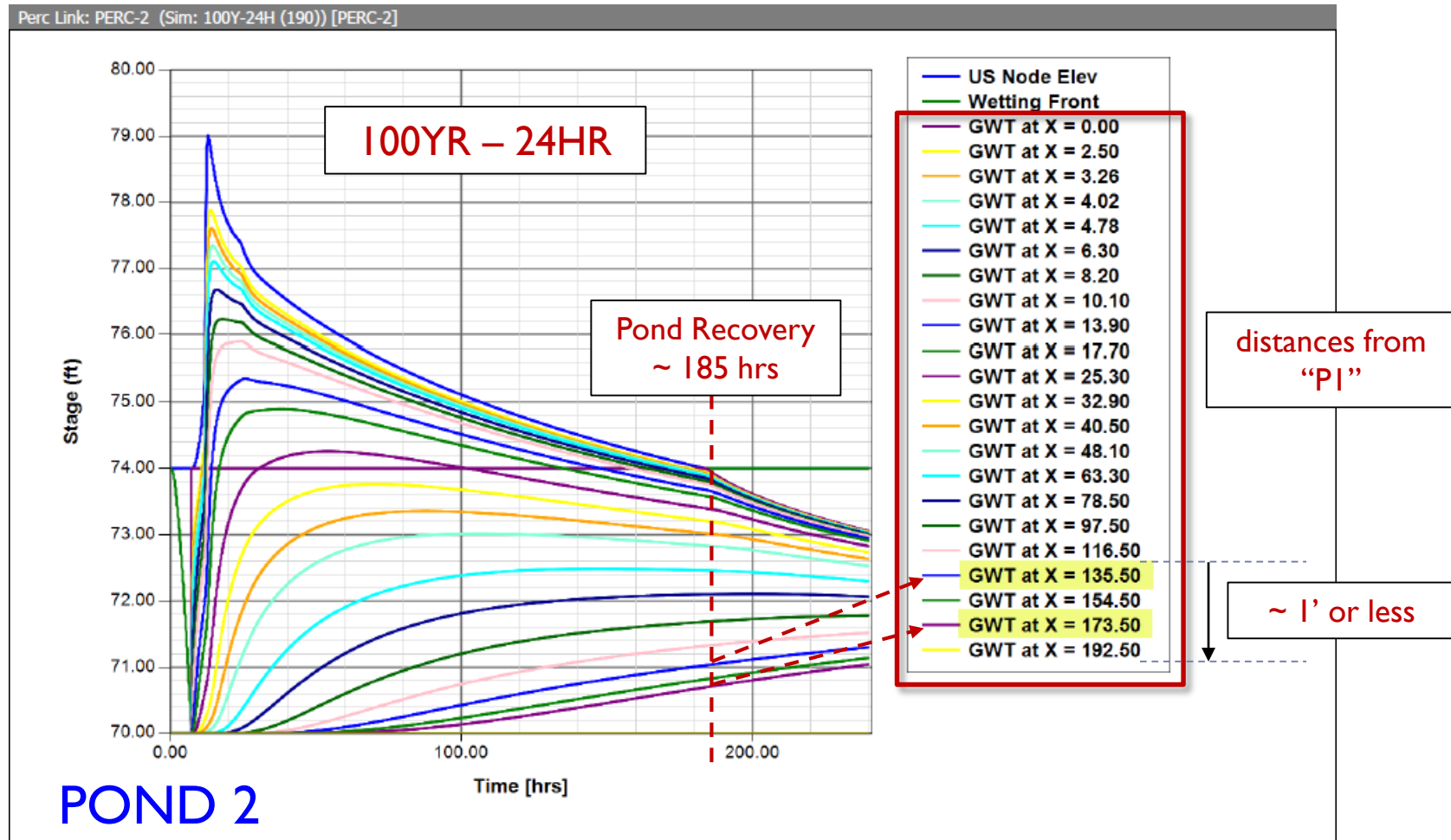
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190') No Flow at P3



Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190') No Flow at P3



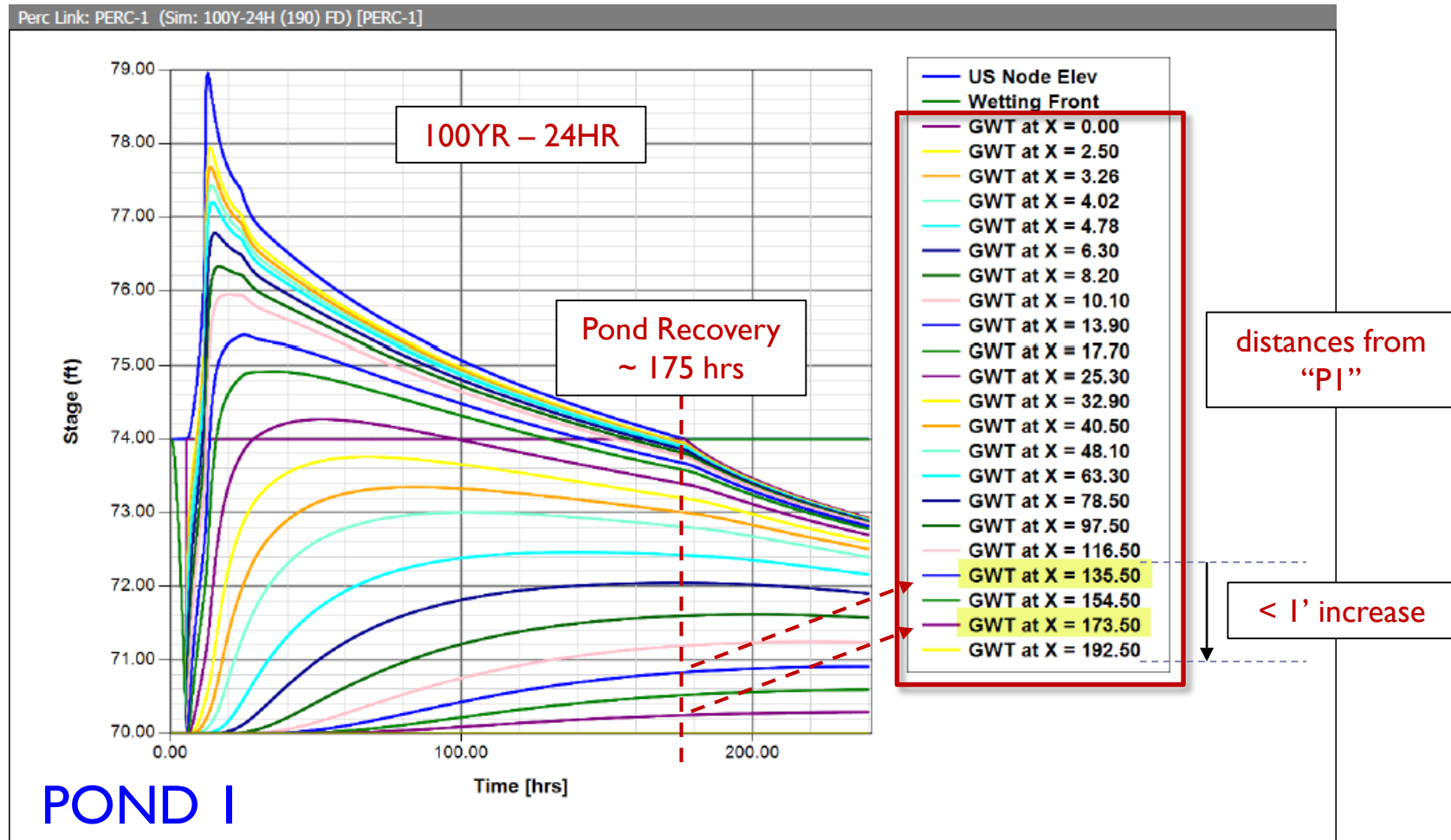
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190') P3 = WT Elev

Aquifer Base Elevation	62
Water Table Elevation	70
Annual Recharge Rate	0 ← P3 = WT Elev
Horizontal Conductivity	20
Vertical Conductivity	10
Fillable Porosity	0.25
Layer Thickness	4

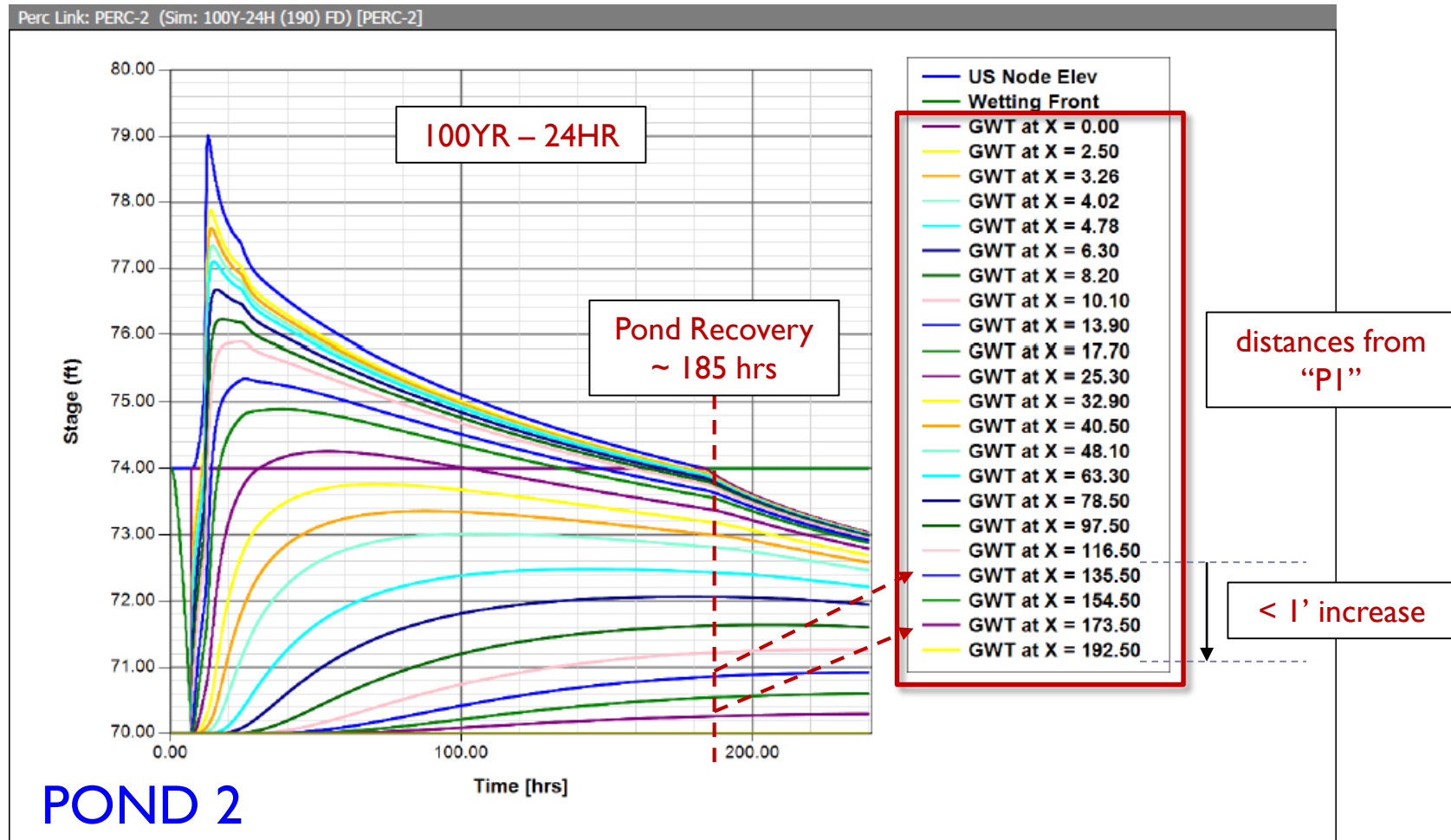
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190') P3 = WT Elev



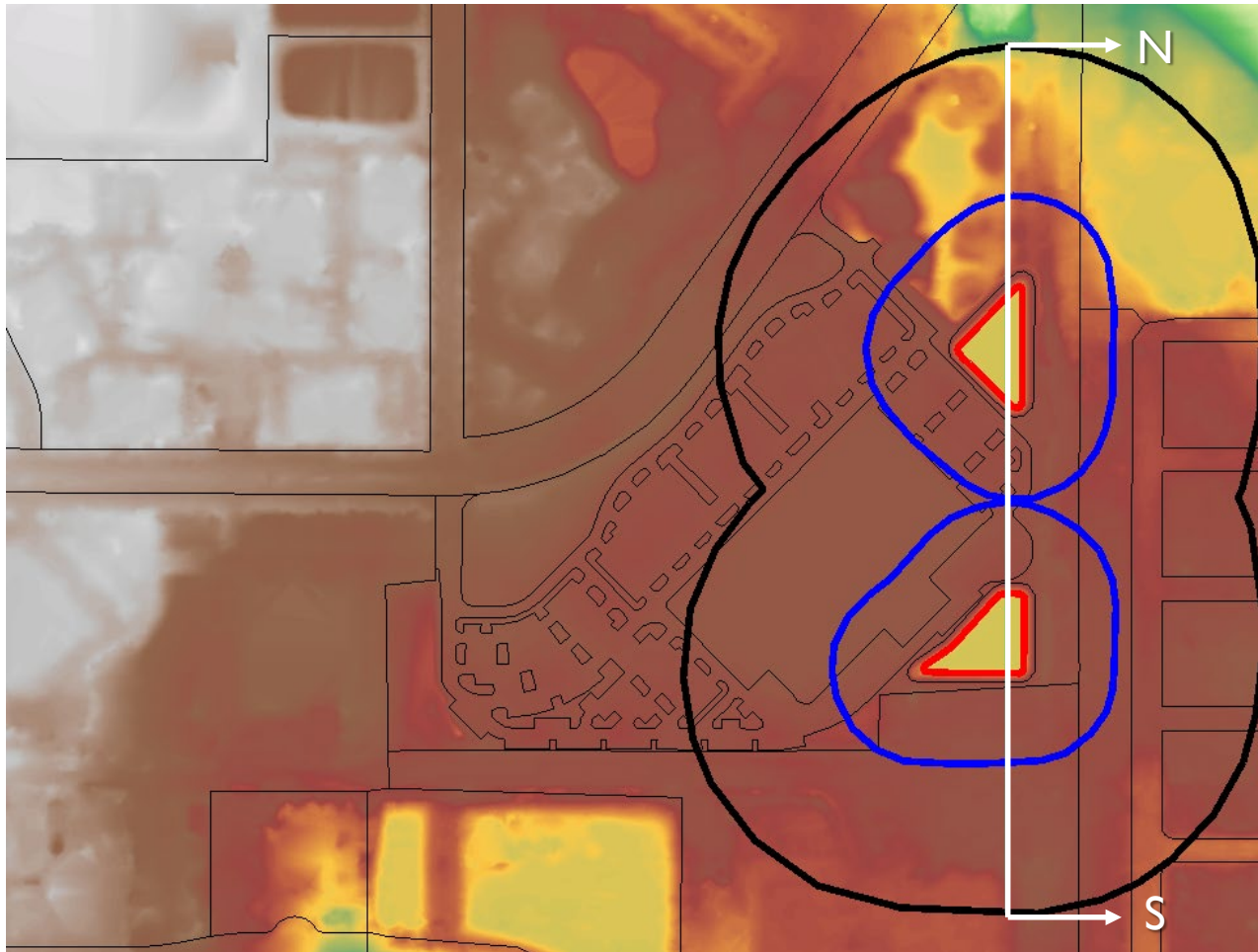
Example #2 – Dual Ponds in Close Proximity

Layout I (P3@190') P3 = WT Elev



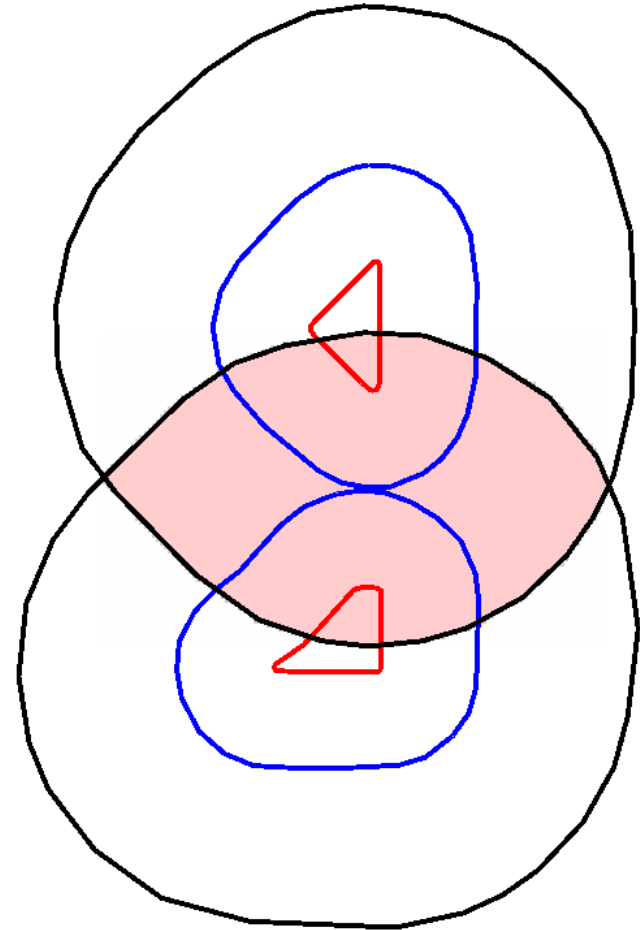
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500')



Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500')



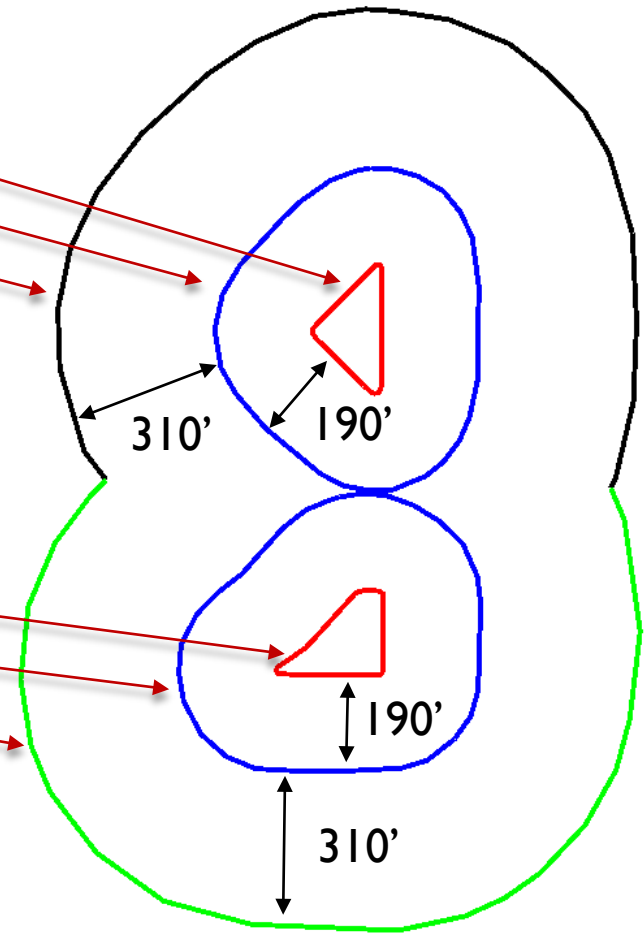
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500')

Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	623.4
Perimeter 2	1807.7
Perimeter 3	2514
Distance P1 to P2	190
Distance P2 to P3	310
# of Cells P1 to P2	38
# of Cells P2 to P3	62

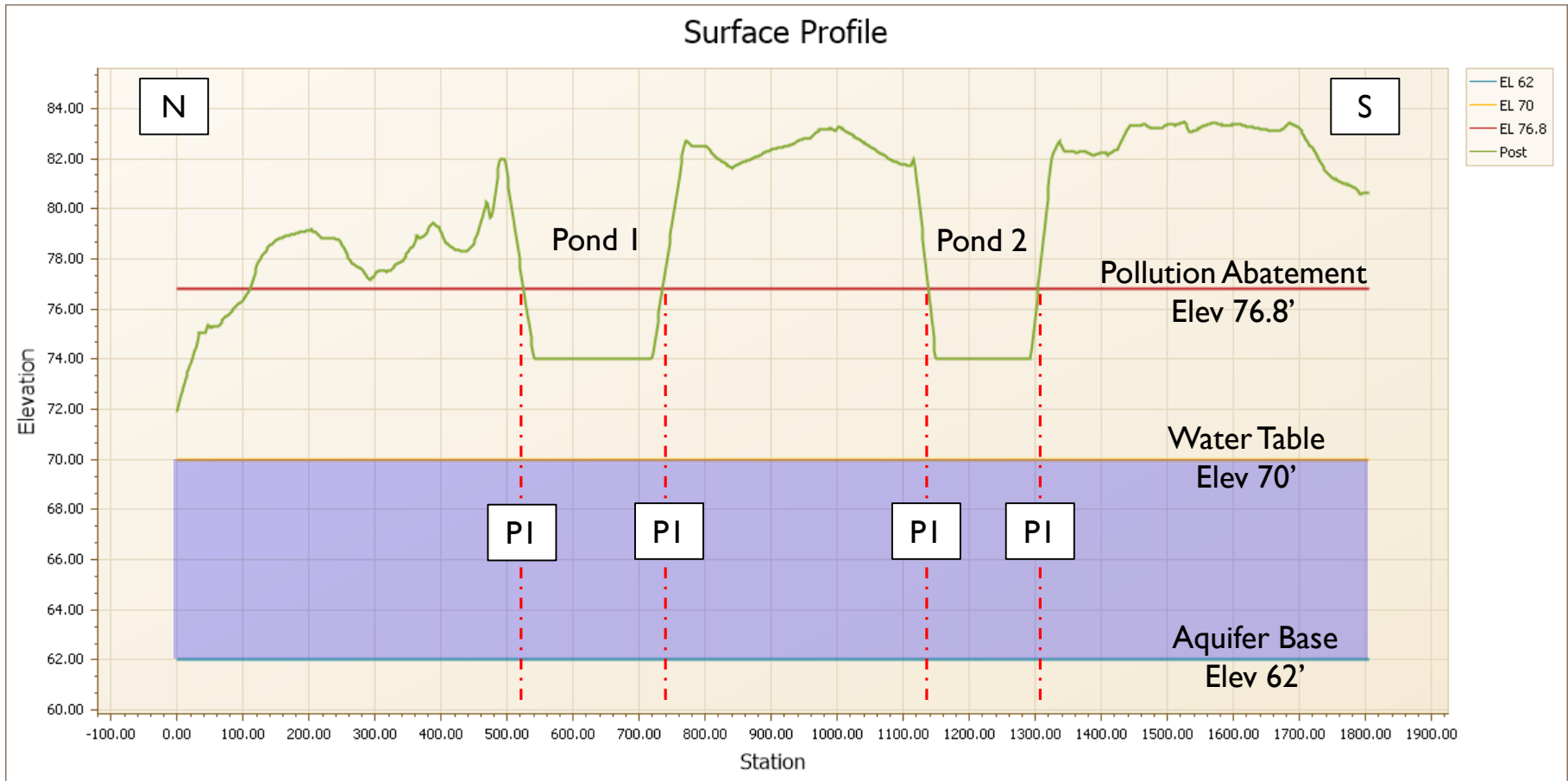
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	645.6
Perimeter 2	1828.1
Perimeter 3	2569
Distance P1 to P2	190
Distance P2 to P3	310
# of Cells P1 to P2	38
# of Cells P2 to P3	62

5' cell size



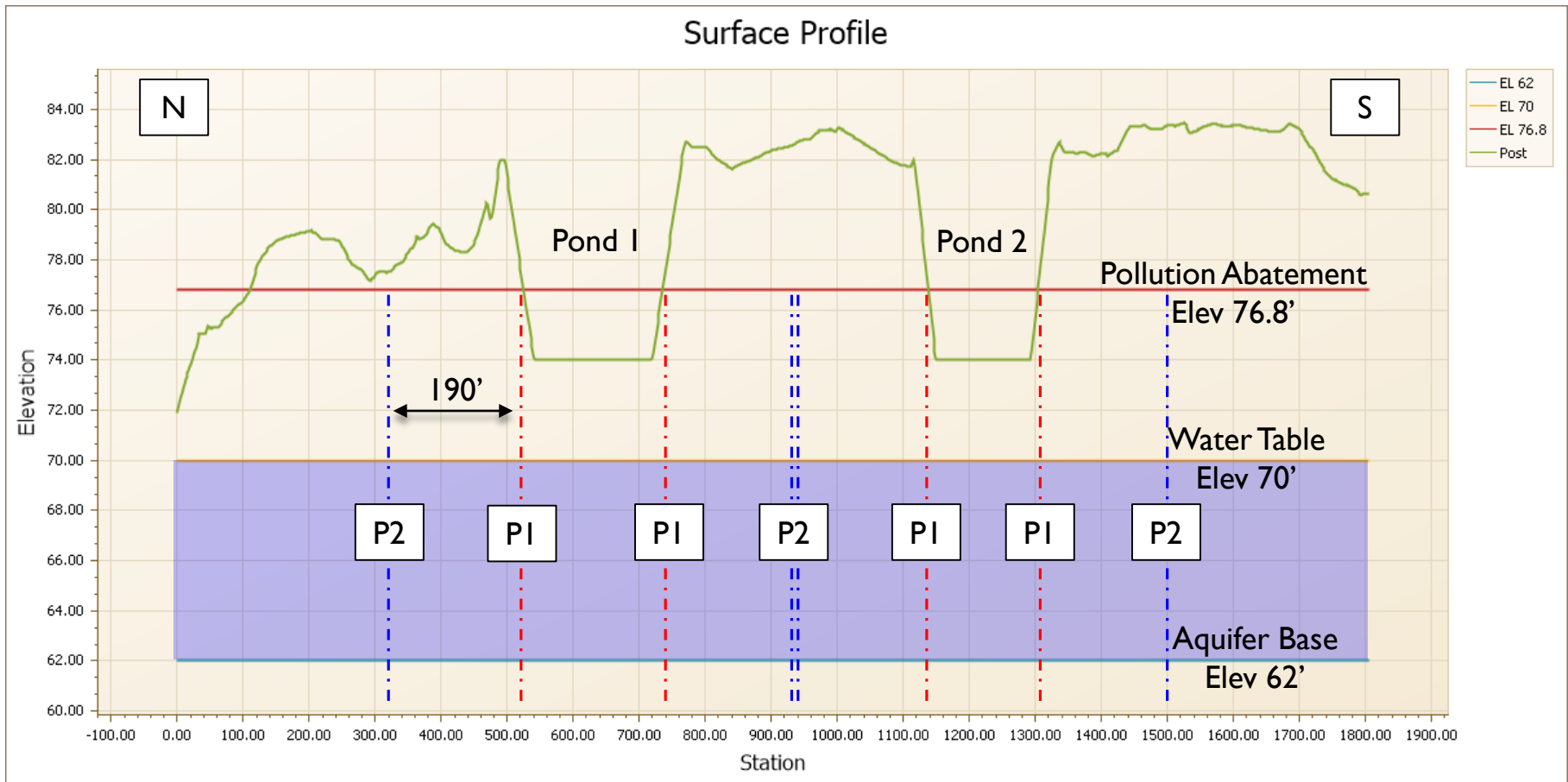
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500')



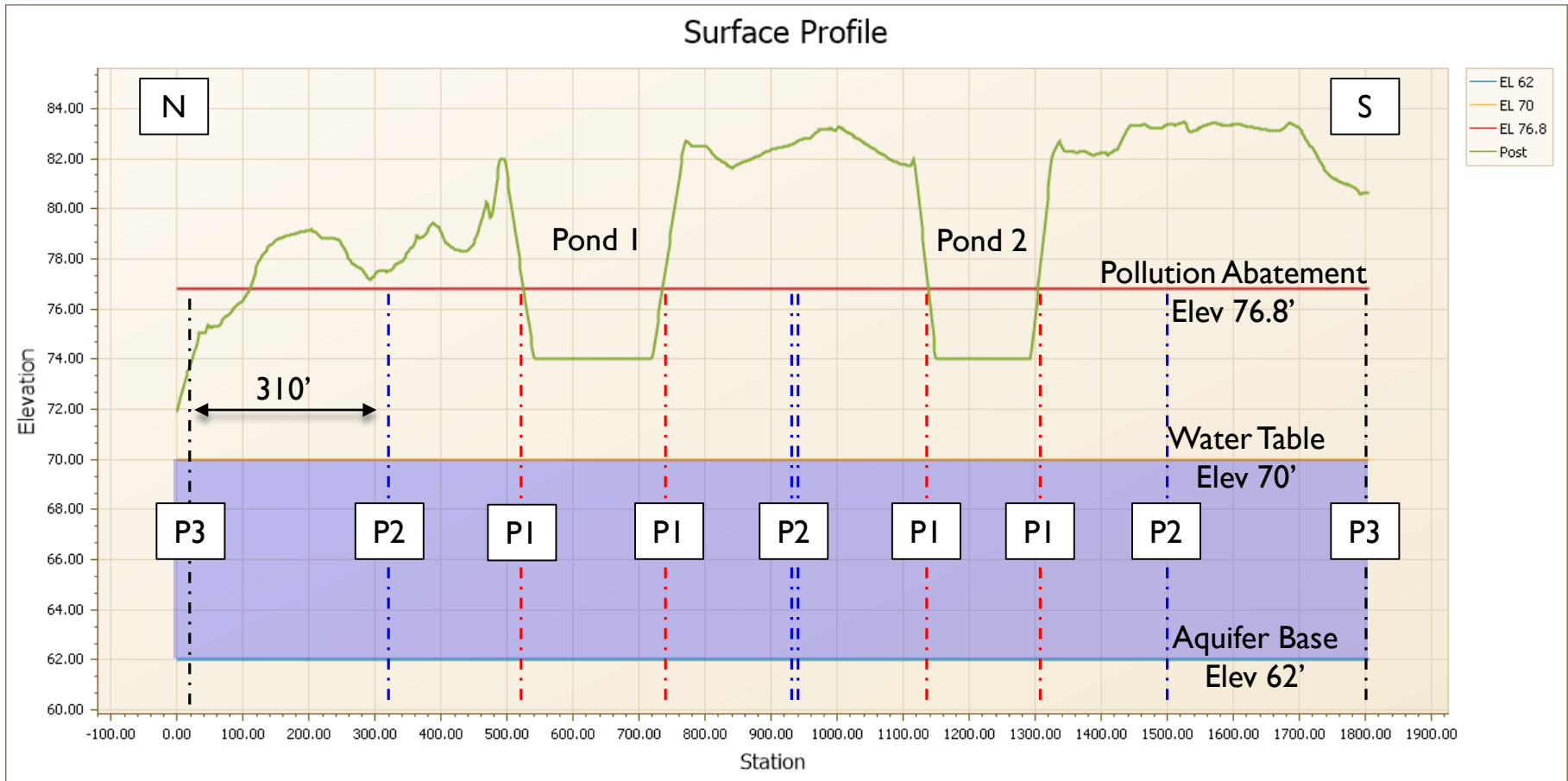
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500')



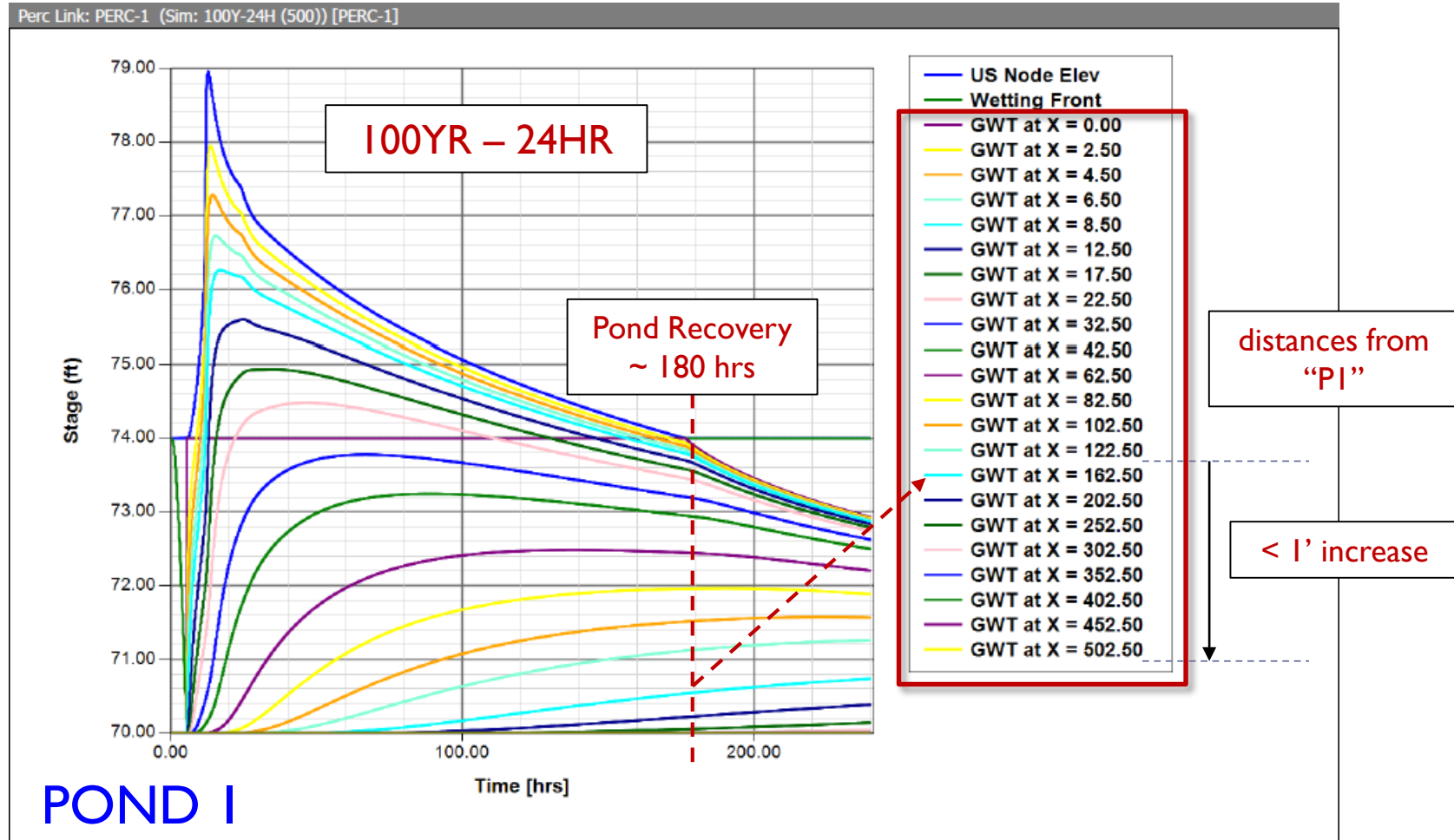
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500')



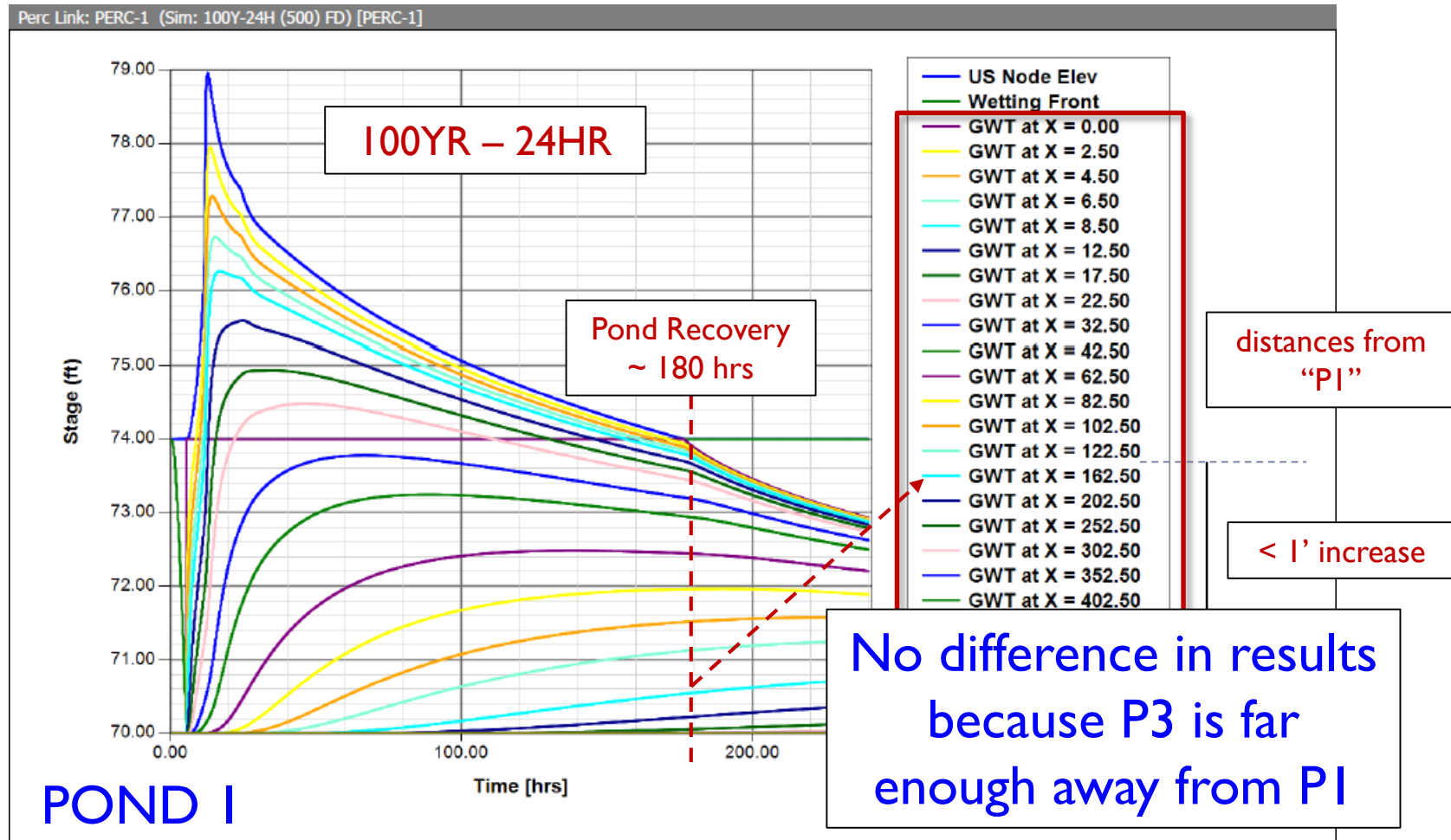
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500') No Flow at P3



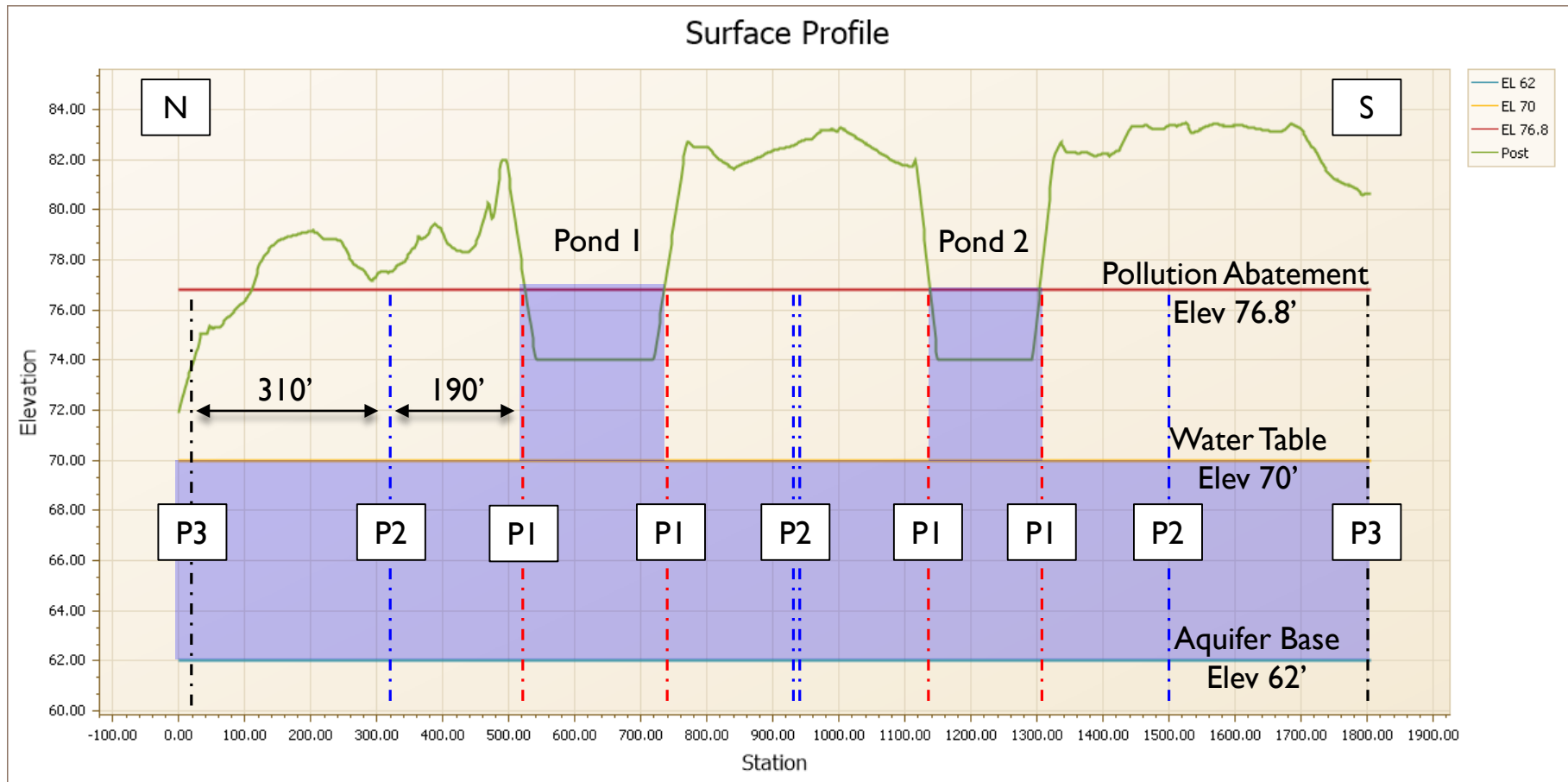
Example #2 – Dual Ponds in Close Proximity

Layout 2 (P3@500') P3 = WT Elev



Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3



Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3

Aquifer Base Elevation	62
Water Table Elevation	70
Annual Recharge Rate	0.0001
Horizontal Conductivity	20
Vertical Conductivity	10
Fillable Porosity	0.25
Layer Thickness	0

Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3

Name	Scenario	Node Type	Base Flow	Initial Stage	Warning Stage
North_Boundary	Slug Recovery (500)	Time/Stage	0	0	0
Pond 1	Slug Recovery (500)	Stage/Area	0	76.8	80.5
Pond 2	Slug Recovery (500)	Stage/Area	0	76.8	80.5
S-22	Slug Recovery (500)	Stage/Area	0	79	83.5
S-33	Slug Recovery (500)	Stage/Area	0	76.8	81.7
S-35	Slug Recovery (500)	Stage/Area	0	79	83.5
S-37	Slug Recovery (500)	Stage/Area	0	76.8	81.6
S-41	Slug Recovery (500)	Stage/Area	0	78.35	83.5
S-45	Slug Recovery (500)	Stage/Area	0	76.8	82.9
S-48	Slug Recovery (500)	Stage/Area	0	77	82.4
S-50	Slug Recovery (500)	Stage/Area	0	79	83.2
S-52	Slug Recovery (500)	Stage/Area	0	77.5	81.4
S-30	Slug Recovery (500)	Stage/Area	0	78.25	82
S-28	Slug Recovery (500)	Stage/Area	0	77.75	82
S-26	Slug Recovery (500)	Stage/Area	0	77.15	82
S-24	Slug Recovery (500)	Stage/Area	0	76.8	82
S-20	Slug Recovery (500)	Stage/Area	0	76.8	81.7
GWT-1	Slug Recovery (500)	Time/Stage	0	0	0
GWT-2	Slug Recovery (500)	Time/Stage	0	0	0

Set initial stages to elevation 76.8' (pollution abatement) or higher, including the storm sewer system

Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3

Name: SLUG RECOVERY (500) FD Scenario: Slug Recovery (500)

General | Output Time Increments | Resources & Lookup Tables | Tolerances & Options

Run Mode: Normal

	Year	Month	Day	Hour
Start Time	0	0	0	0
End Time	0	0	0	96

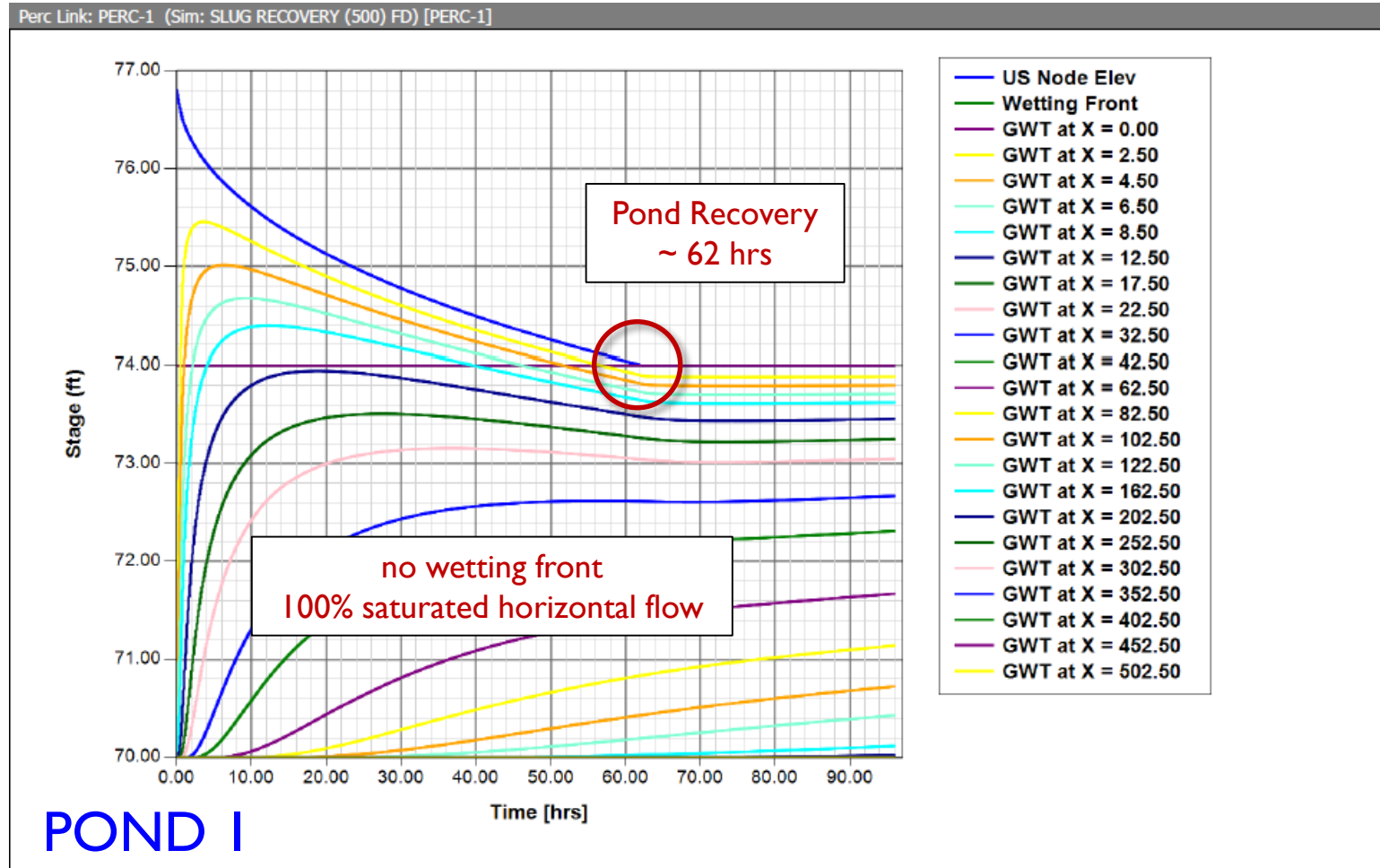
Name: SLUG RECOVERY (500) FD Scenario: Slug Recovery (500)

General | Output Time Increments | Resources & Lookup Tables | Tolerances & Options

Time Marching	SAOR	Initial Abstraction Recovery Time	24
Maximum Iterations	6		
Over-Relaxation Weighting Factor	0.5		
dZ Tolerance	0.001	Simple / Manual Basin Rainfall Opt.	No Rainfall
Maximum dZ	1		
Link Optimizer Tolerance	0.0001		

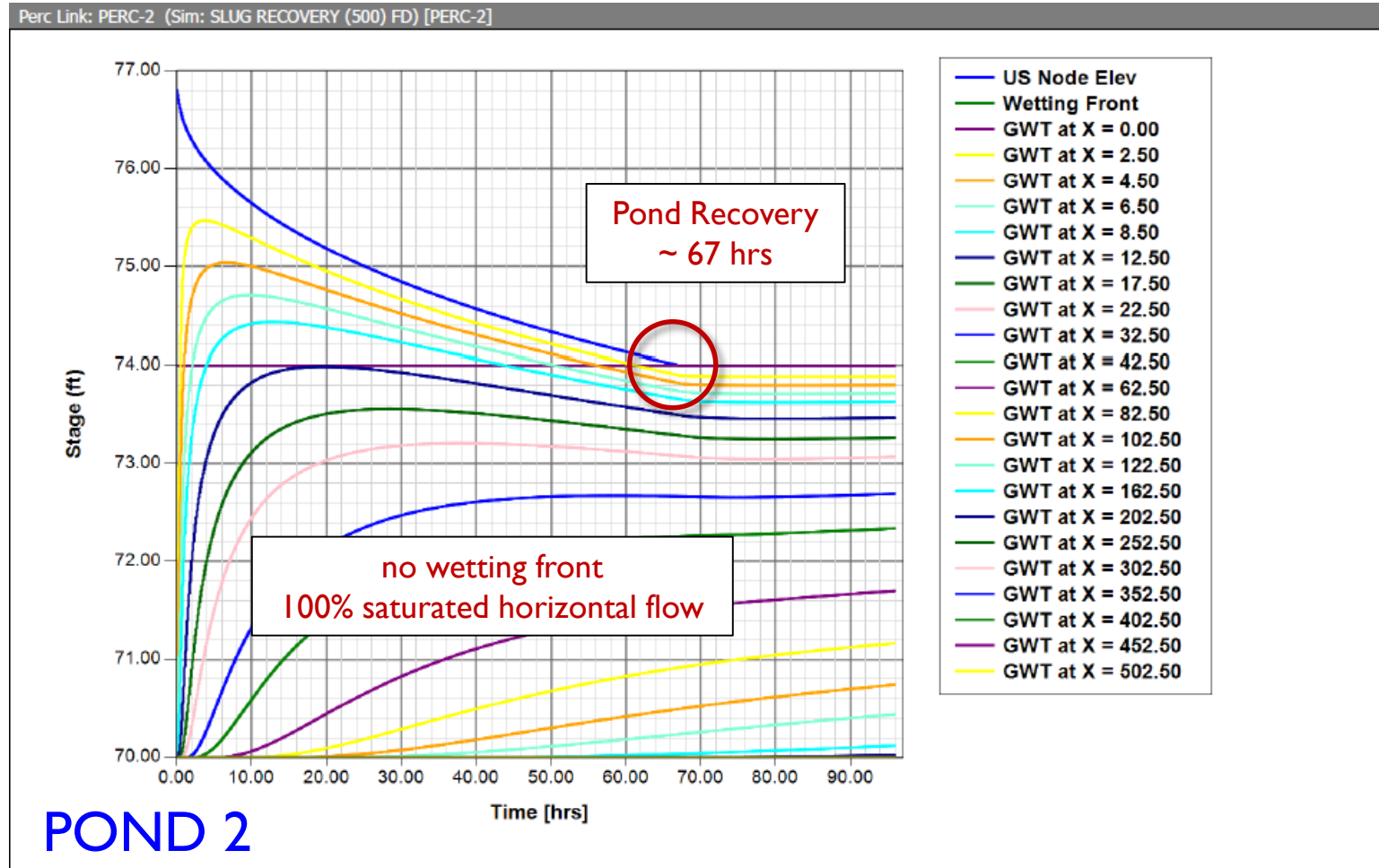
Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3



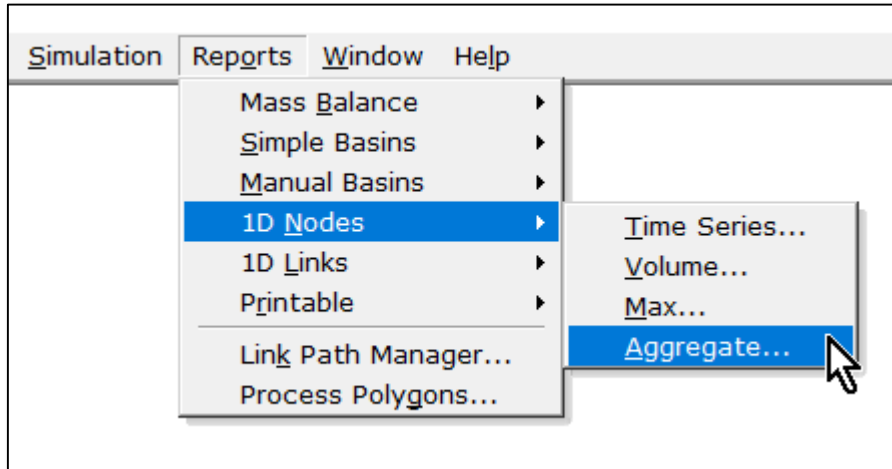
Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3

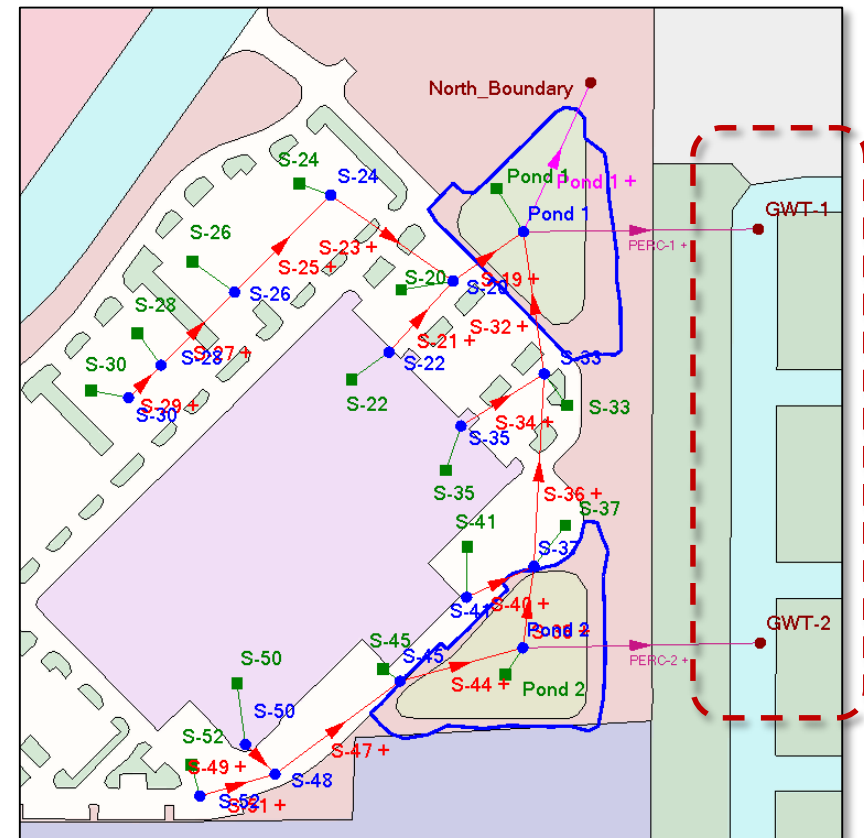


Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3



“Aggregate” to add node volumes



Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3

Reports : 1D Nodes - Aggregate

Year Month Day Hour

Start Time 0 0 0 0

End Time 0 0 0 0

Report Chart

Type Superimpose sims

X Parameter Relative Time

Y Parameter Selection

- Total Inflow Rate
- Total Outflow Rate
- Base Inflow Volume
- Base Outflow Volume
- Basin Inflow Volume
- Basin Outflow Volume
- External Inflow Volume
- External Outflow Volume
- Link Inflow Volume
- Link Outflow Volume
- Stored Volume (Geometry Based)
- Stored Volume (Flow Based)
- Total Inflow Volume
- Total Outflow Volume

Simulation Selection

- Scenarios
 - SS - Ponds & Perc (100)
 - SS - Ponds & Perc (500)
 - Slug Recovery (500)
 - Simulations
 - SLUG RECOVERY (

Item Selection

- D Pond 1~N
 - GWT-1
 - GWT-2
- North_Boundary
- Pond 1
- Pond 2
- S-20
- S-22
- S-24
- S-26
- S-28
- S-30
- S-33
- S-35
- S-37

click here to see item selection list

right click in this panel for options

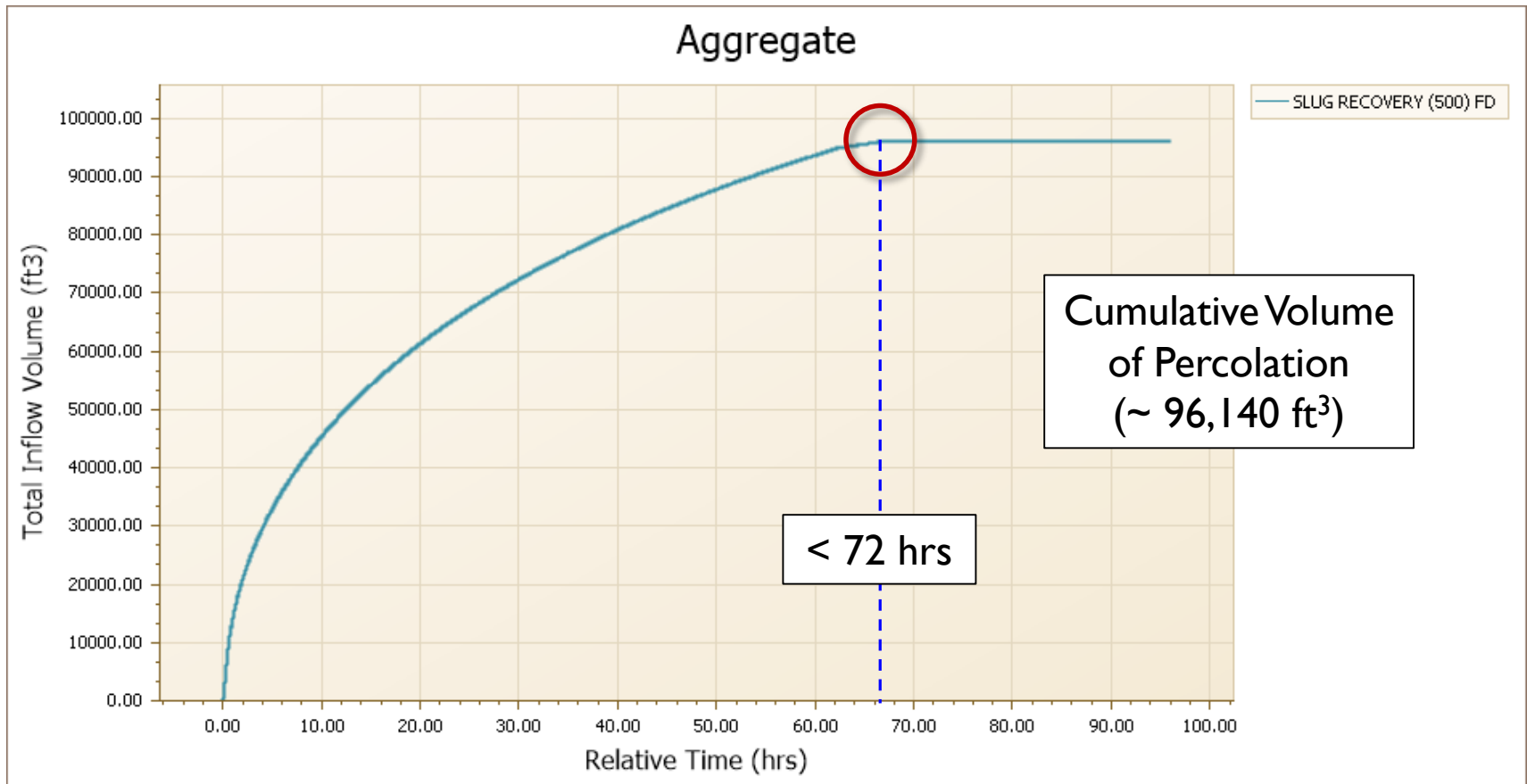
Units Volume - ft3 / m3

View Report View Chart Help

Enter 'Units' 2 Selected Item(s) in Selected Simulation(s)

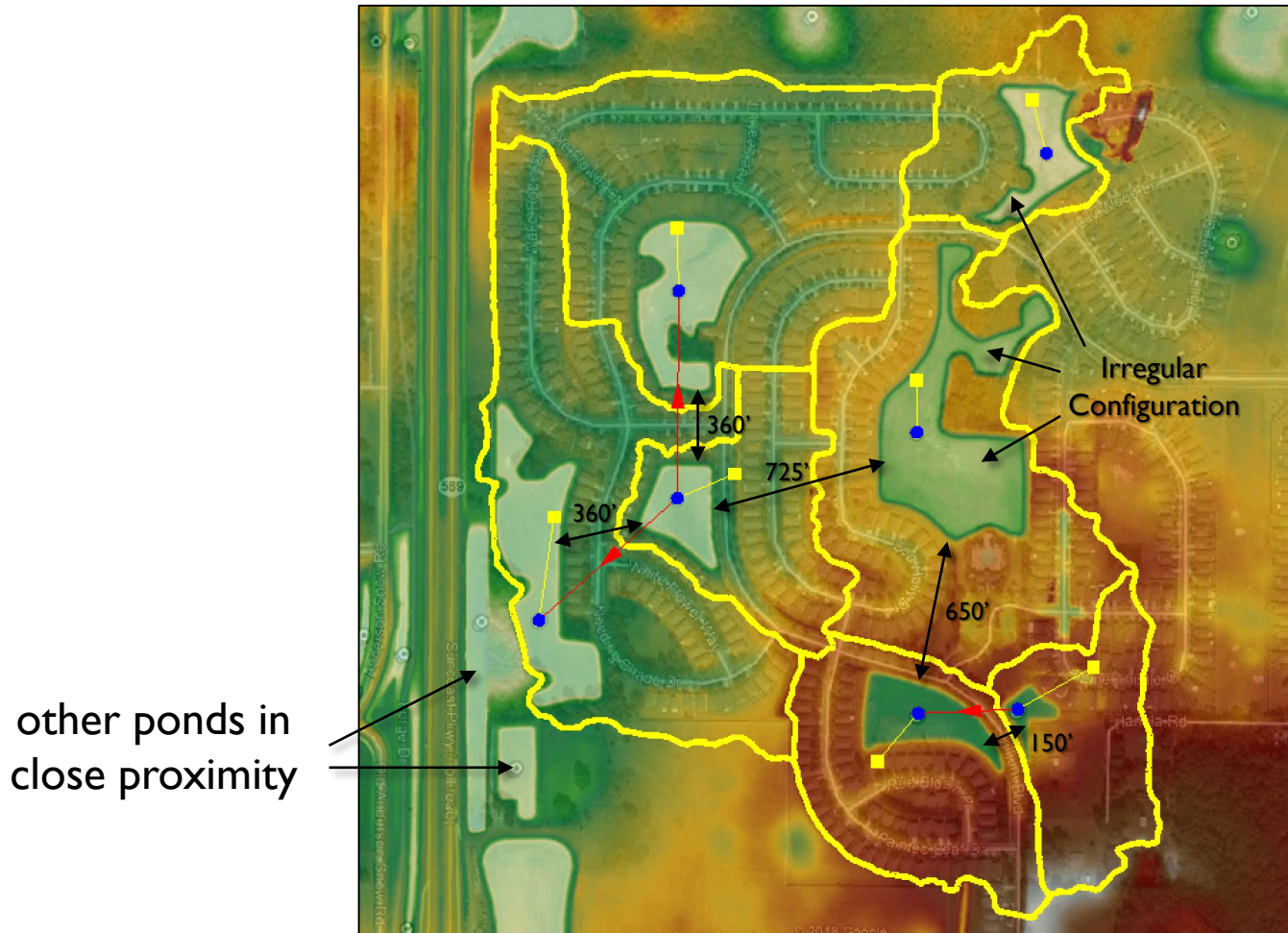
Example #2 – Dual Ponds in Close Proximity

Slug Load Recovery, Layout 2 (P3@500') No Flow at P3



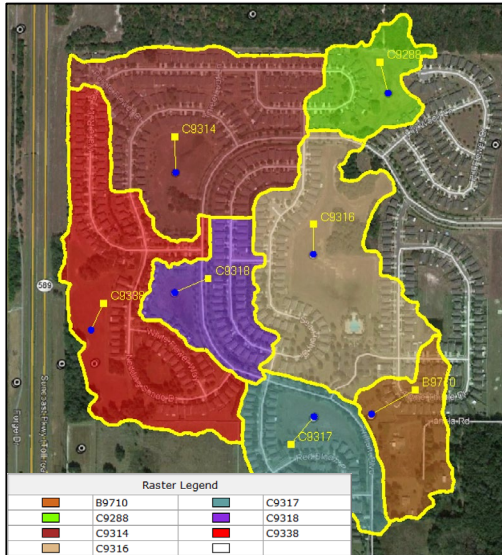
Example #3 – Multiple Land-Locked Ponds

Dry Ponds in Close Proximity

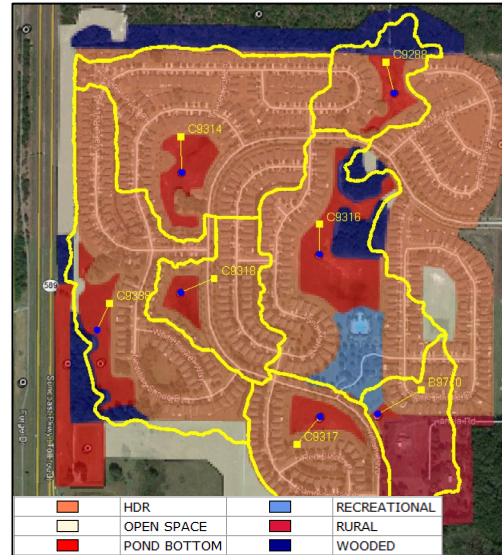


Example #3 – Multiple Land-Locked Ponds

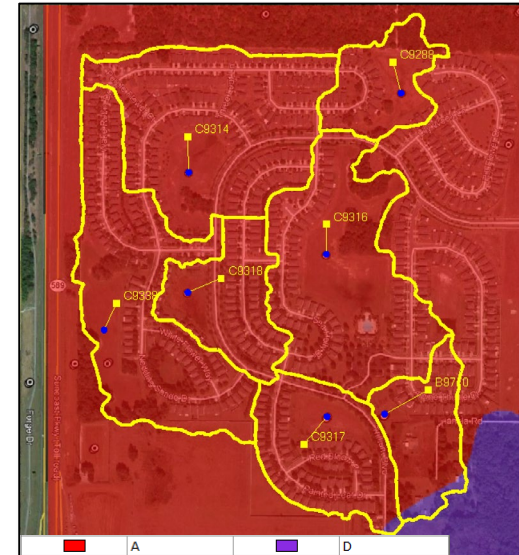
Dry Ponds in Close Proximity



Basins



Land Use



Soil Hydrologic Group

Example #3 – Multiple Land-Locked Ponds

Dry Ponds in Close Proximity

right click

- Hydraulic Network
 - Node Types
 - Link Types
 - Simple Basin
 - Manual Basin
 - Cross Section Type
 - Reference Elements
- Map Layers
- Background Images

Process Basin Polygons

Basin Map Layer: L4-BASINS

Land Cover Zone Map Layer: L4-LU

Manual Basin Sub-Basin Edit

Area	Land Cover Zone	Soil Zone	Rainfall Name
18.876492	HDR	A	
4.740955	RECREATIONAL	A	
0.539325	OPEN SPACE	A	
6.848072	POND BOTTOM	A	
3.725826	WOODED	A	

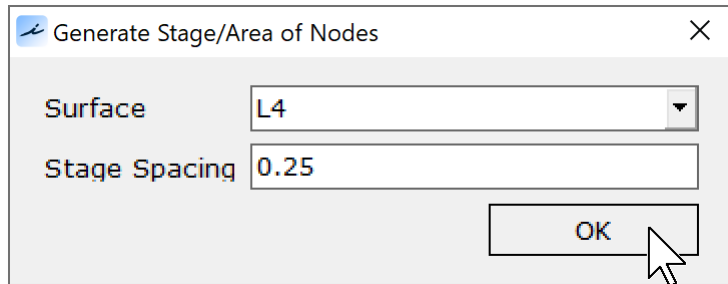
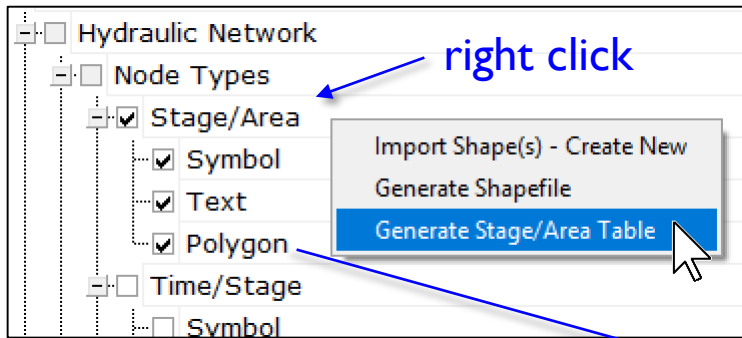
Basin Properties:

- Name: C9316
- Scenario: L4
- Node: NC9316
- Hydrograph Method: NRCS Unit Hydrograph
- Infiltration Method: Curve Number
- Time of Concentration: 15
- Max Allowable Q: 0
- Time Shift: 0
- Unit Hydrograph: UH256
- Peaking Factor: 256
- Comment:

Buttons: Create, Delete

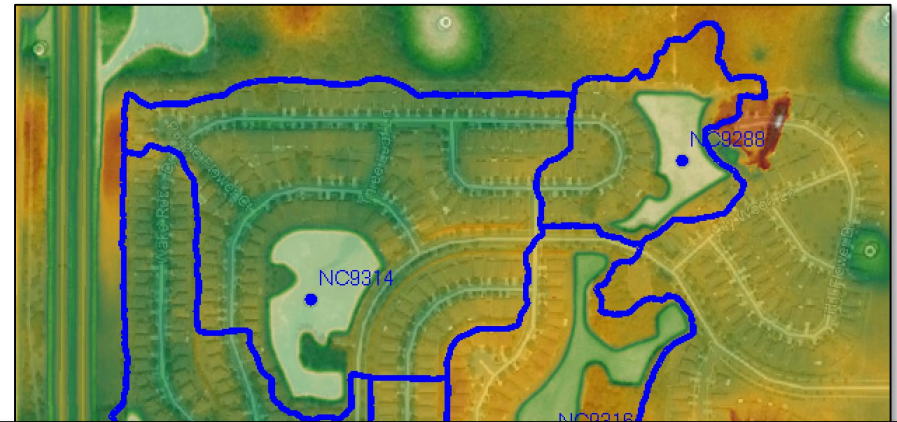
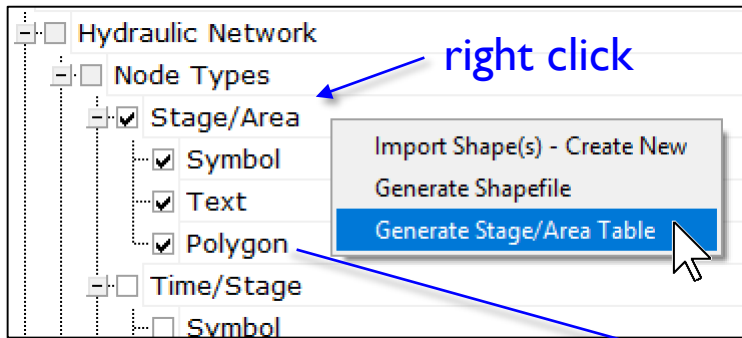
Example #3 – Multiple Land-Locked Ponds

Dry Ponds in Close Proximity



Example #3 – Multiple Land-Locked Ponds

Dry Ponds in Close Proximity



Name	NC9316
Scenario	L4
Type	Stage/Area
Base Flow	0
Initial Stage	57.25
Warning Stage	63.3
Comment	P1 Area (acres): 6.8471

Stage	Area
57.25	0.908517
57.5	3.110078
57.75	4.946051
58	6.029614
58.25	6.67298
58.5	6.982897
58.75	7.164256
59	7.283058
59.25	7.415634
59.5	7.539601
59.75	7.652663

Example #3 – Multiple Land-Locked Ponds

Dry Ponds in Close Proximity

The screenshot shows the 'Impervious Set Data' dialog box with the following data:

Land Cover Zone	% Impervious	% DCIA	% Direct	Ia Impervious	Ia Pervious
HDR	65	45	0	0	0
OPEN SPACE	0	0	0	0	0
POND BOTTOM	0	0	100	0	0
RECREATIONAL	50	25	0	0	0
RURAL	10	0	0	0	0
WOODED	0	0	0	0	0

Buttons: Extract, Set Impervious

Status: 1 Impervious Set(s)

Example #3 – Multiple Land-Locked Ponds

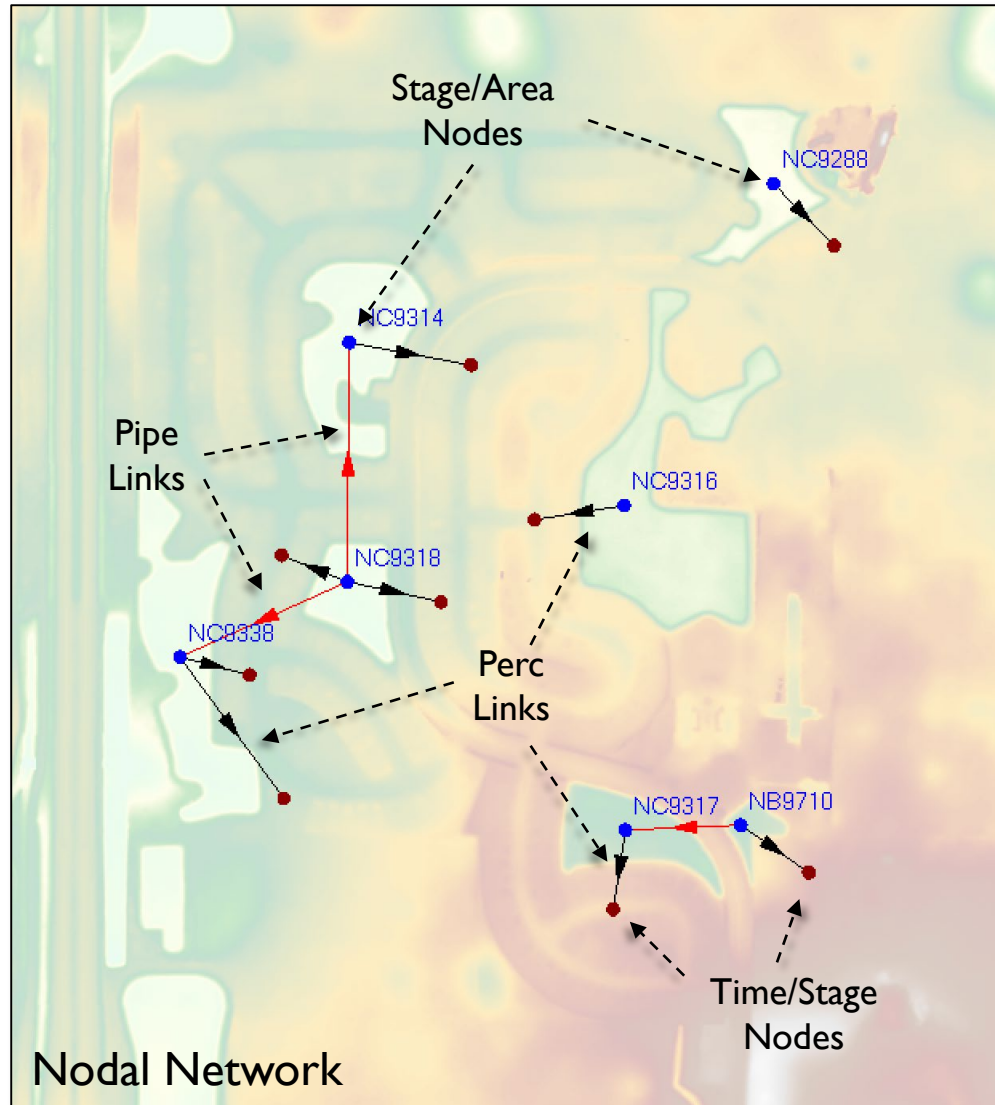
Dry Ponds in Close Proximity

The screenshot shows the 'Curve Number Set Data' dialog box. The table contains the following data:

Land Cover Zone	Soil Zone	Curve Number
HDR	A	39
HDR	D	80
OPEN SPACE	A	39
OPEN SPACE	D	80
POND BOTTOM	A	39
POND BOTTOM	D	80
RECREATIONAL	A	39
RECREATIONAL	D	80
RURAL	A	39
RURAL	D	80
WOODED	A	30
WOODED	D	77

A callout box with the text "CNs are for pervious areas only" is positioned over the Curve Number column. The "Set Curve Number" button at the bottom is highlighted with a red box. The status bar at the bottom right indicates "1 Curve Number Set(s)".

Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds

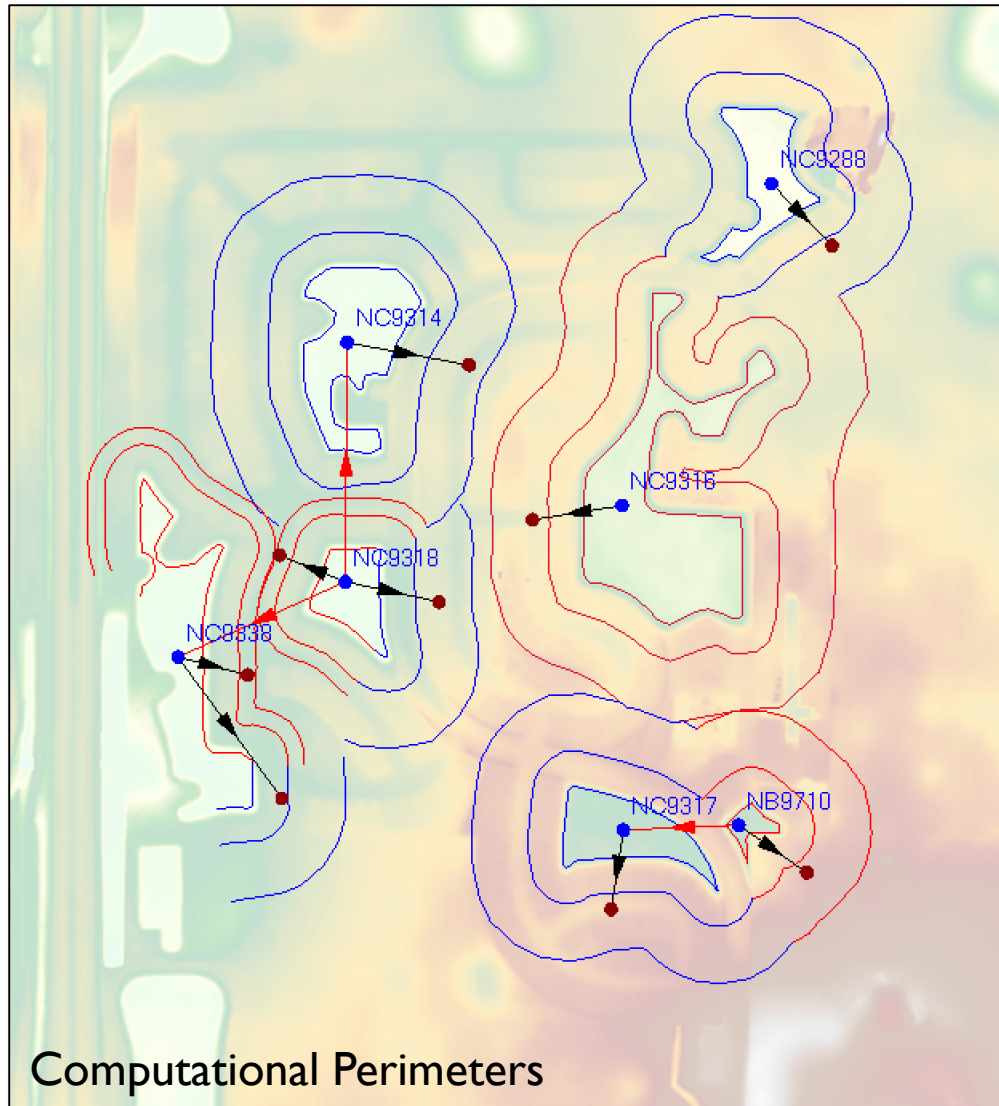
Typical Aquifer Parameters

Aquifer Base Elevation	24.5
Water Table Elevation	48.3
Annual Recharge Rate	0.0001
Horizontal Conductivity	18.7
Vertical Conductivity	12.5
Fillable Porosity	0.2
Layer Thickness	5.2

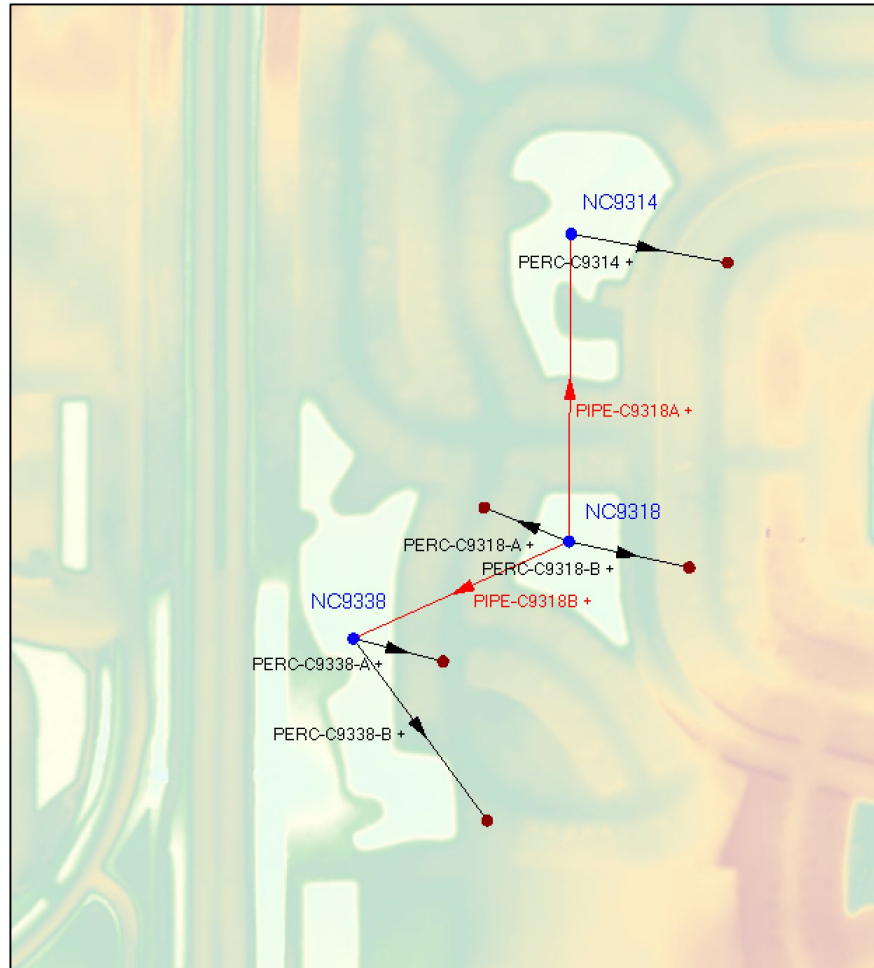
This setting creates a “no flow” boundary condition at perimeter P3, a typical setting for ponds in close proximity to other ponds.

all parameters except “Annual Recharge Rate” vary for each perc link

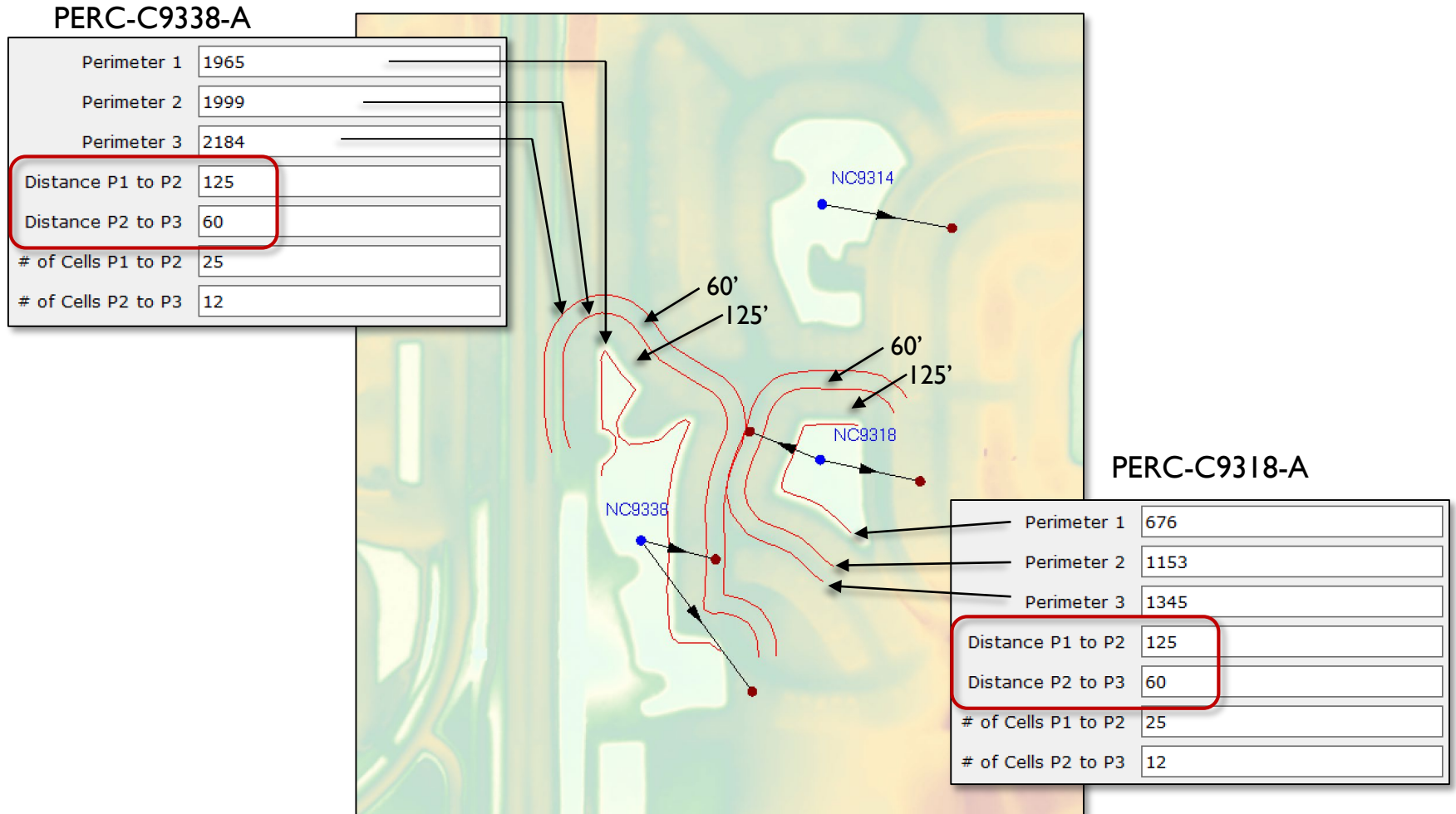
Example #3 – Multiple Land-Locked Ponds



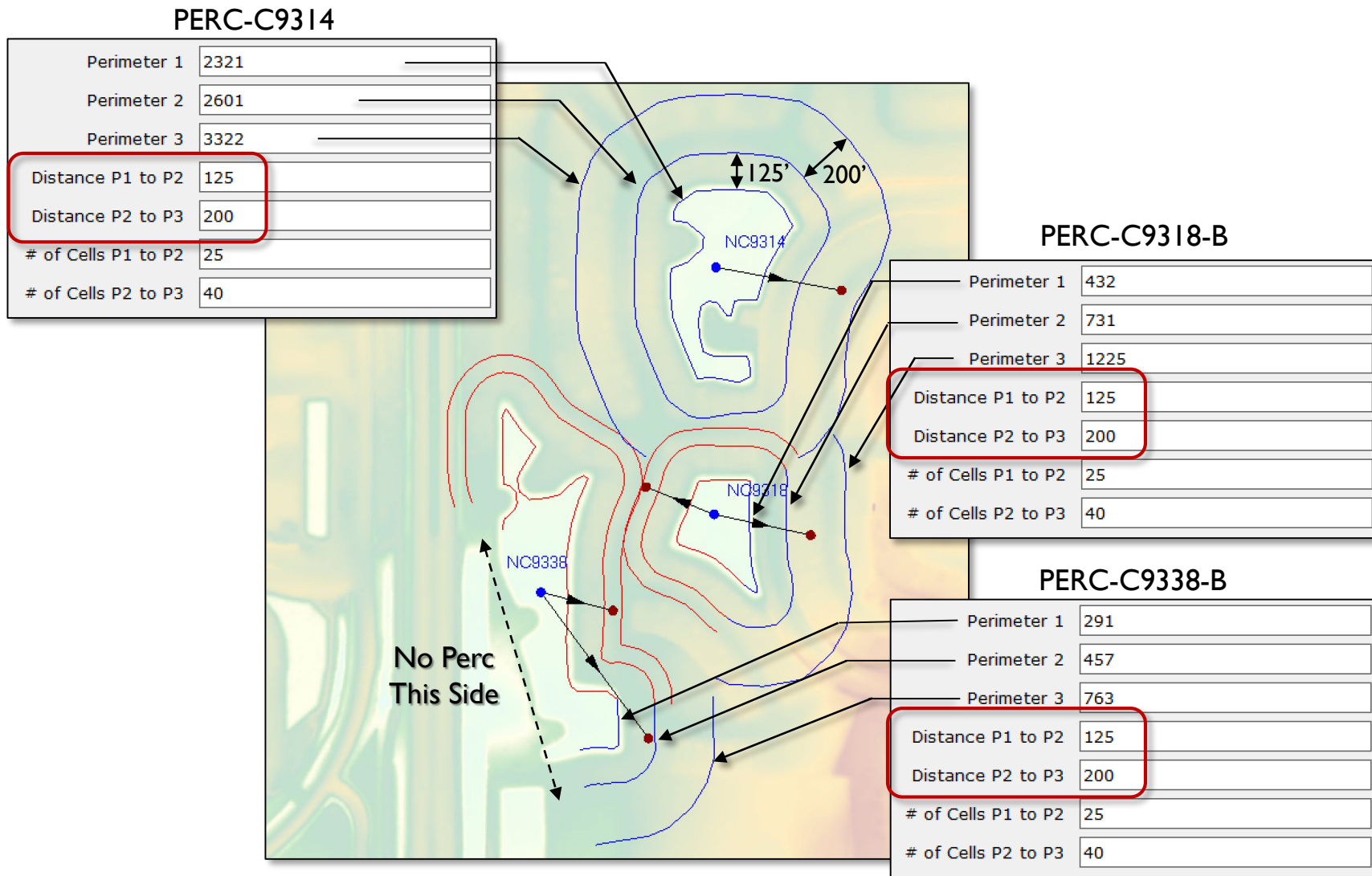
Example #3 – Multiple Land-Locked Ponds



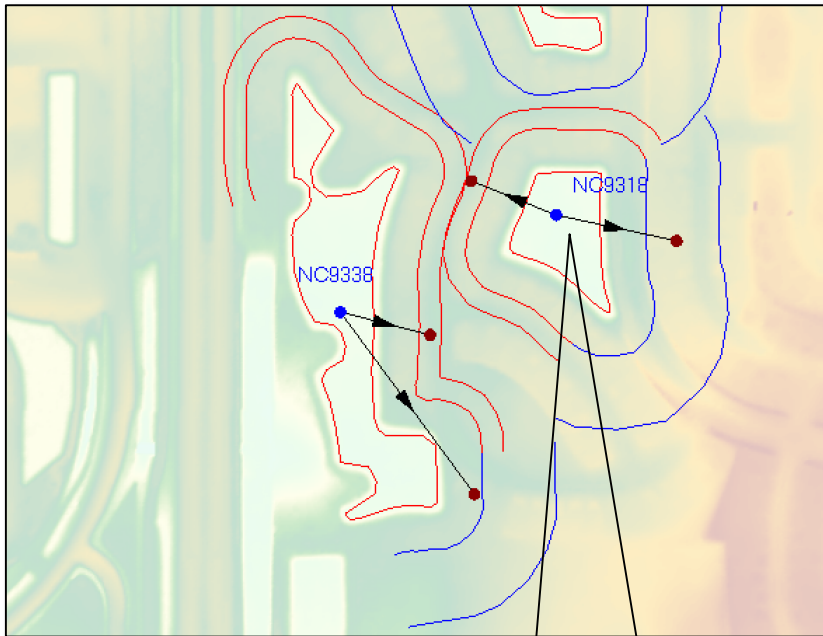
Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds



$PI = 1,108 \text{ ft}$
 $PI_{\text{area}} = 1.45\text{ac}$

PERC-C9318-A

Surface Area Option	User Specified
Bottom Elevation	53.75
Surface Area	0.88
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	676

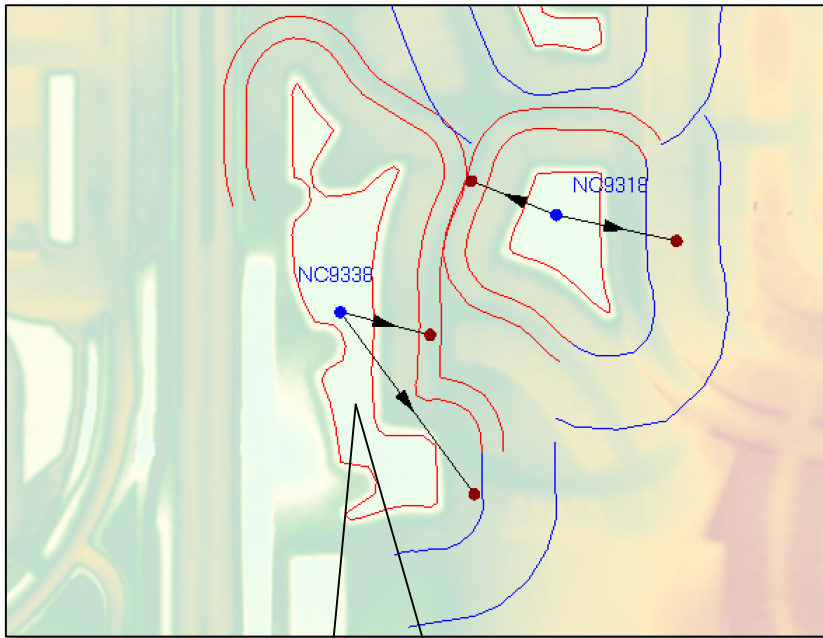
$$\begin{aligned}
 PI-A_{\text{area}} &= PI_{\text{area}} \times (PI-A / PI) \\
 &= 1.45 \times (676 / 1,108) = 0.88 \text{ ac}
 \end{aligned}$$

$$\begin{aligned}
 PI-B_{\text{area}} &= PI_{\text{area}} \times (PI-B / PI) \\
 &= 1.45 \times (432 / 1,108) = 0.57 \text{ ac}
 \end{aligned}$$

Surface Area Option	User Specified
Bottom Elevation	53.75
Surface Area	0.57
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	432

PERC-C9318-B

Example #3 – Multiple Land-Locked Ponds



$PI = 2,256 \text{ ft}$
 $PI_{\text{area}} = 3.98 \text{ ac}$

PERC-C9338-A

Surface Area Option	User Specified
Bottom Elevation	53.5
Surface Area	3.47
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	1965

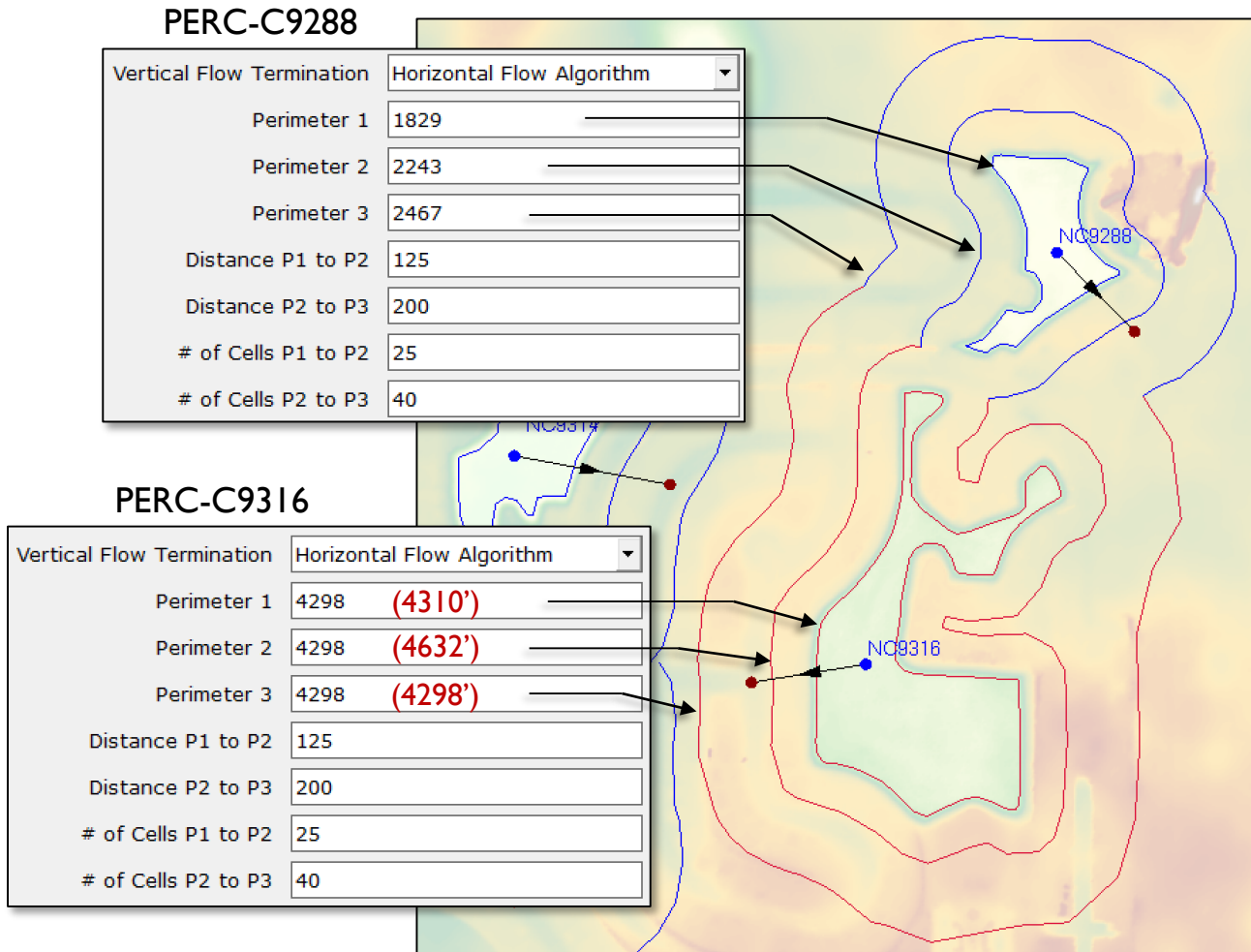
$$\begin{aligned}
 PI-A_{\text{area}} &= PI_{\text{area}} \times (PI-A / PI) \\
 &= 3.98 \times (1,965 / 2,256) = 3.47 \text{ ac}
 \end{aligned}$$

$$\begin{aligned}
 PI-B_{\text{area}} &= PI_{\text{area}} \times (PI-B / PI) \\
 &= 3.98 \times (291 / 2,256) = 0.51 \text{ ac}
 \end{aligned}$$

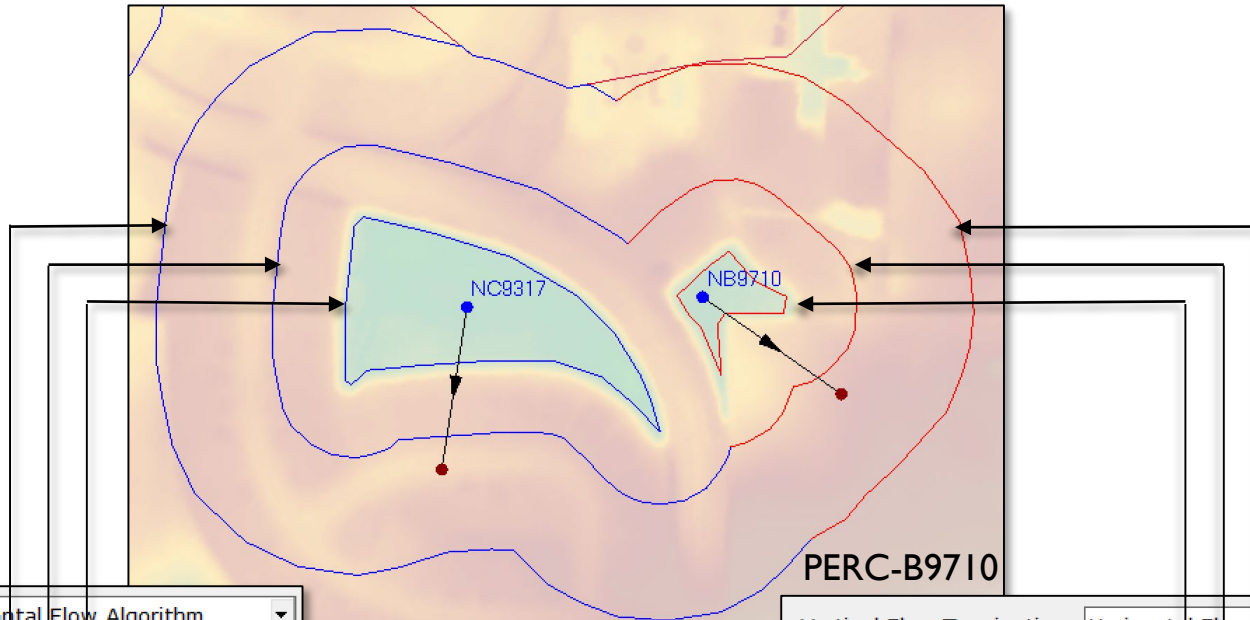
Surface Area Option	User Specified
Bottom Elevation	53.5
Surface Area	0.51
Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	291

PERC-C9338-B

Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds



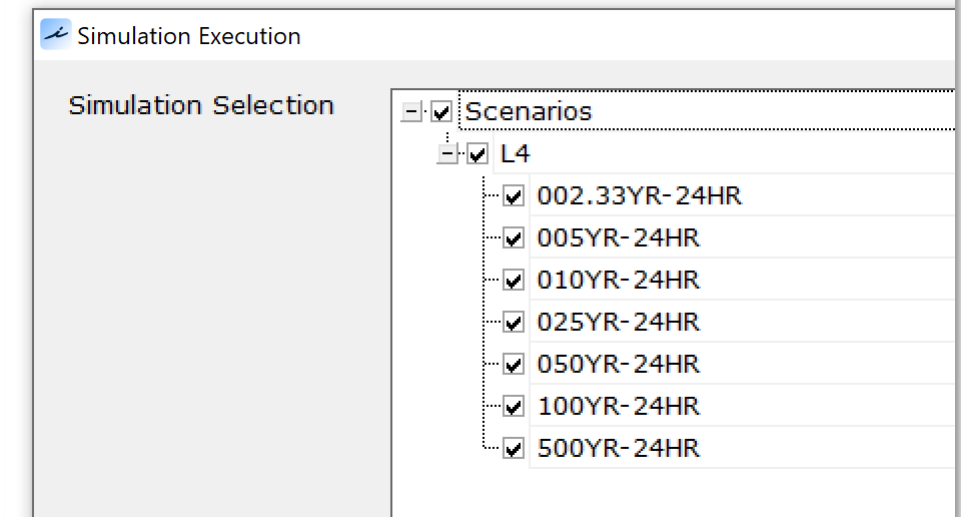
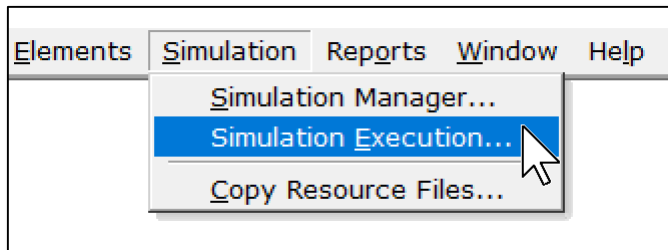
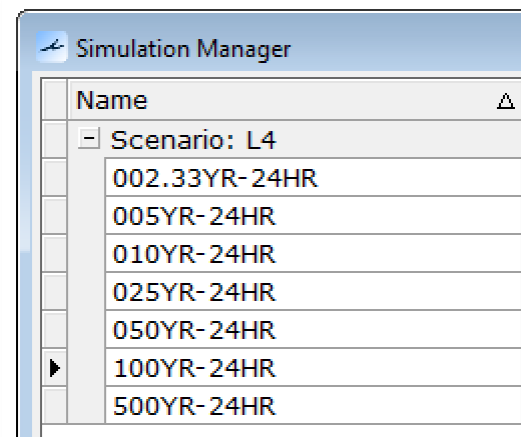
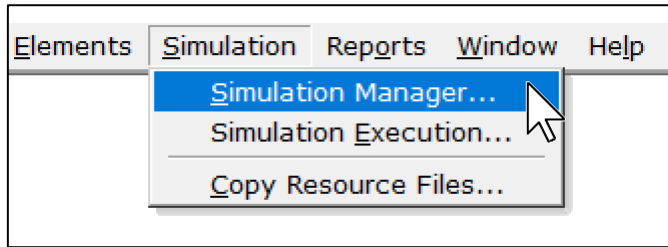
PERC-C9317

Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	1565
Perimeter 2	1937
Perimeter 3	2672
Distance P1 to P2	125
Distance P2 to P3	200
# of Cells P1 to P2	25
# of Cells P2 to P3	40

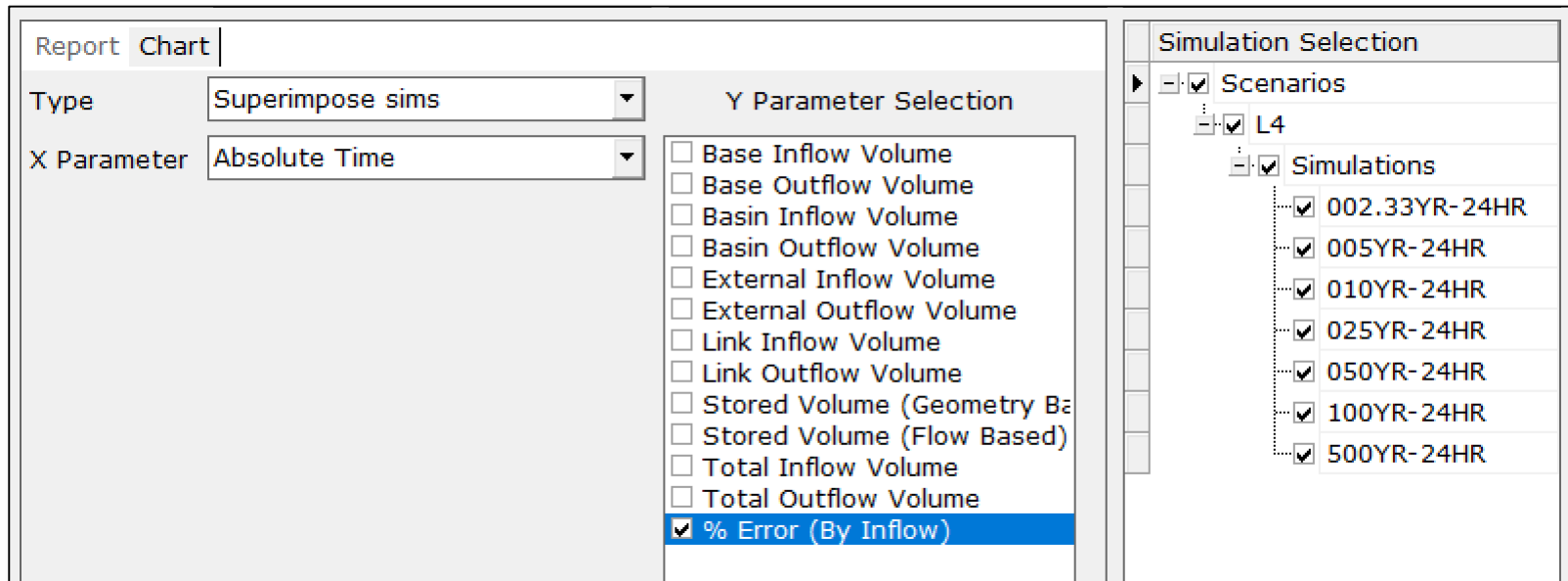
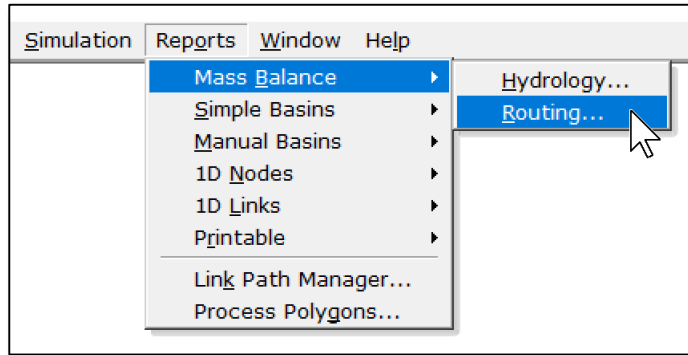
PERC-B9710

Vertical Flow Termination	Horizontal Flow Algorithm
Perimeter 1	648
Perimeter 2	903
Perimeter 3	1375
Distance P1 to P2	125
Distance P2 to P3	200
# of Cells P1 to P2	25
# of Cells P2 to P3	40

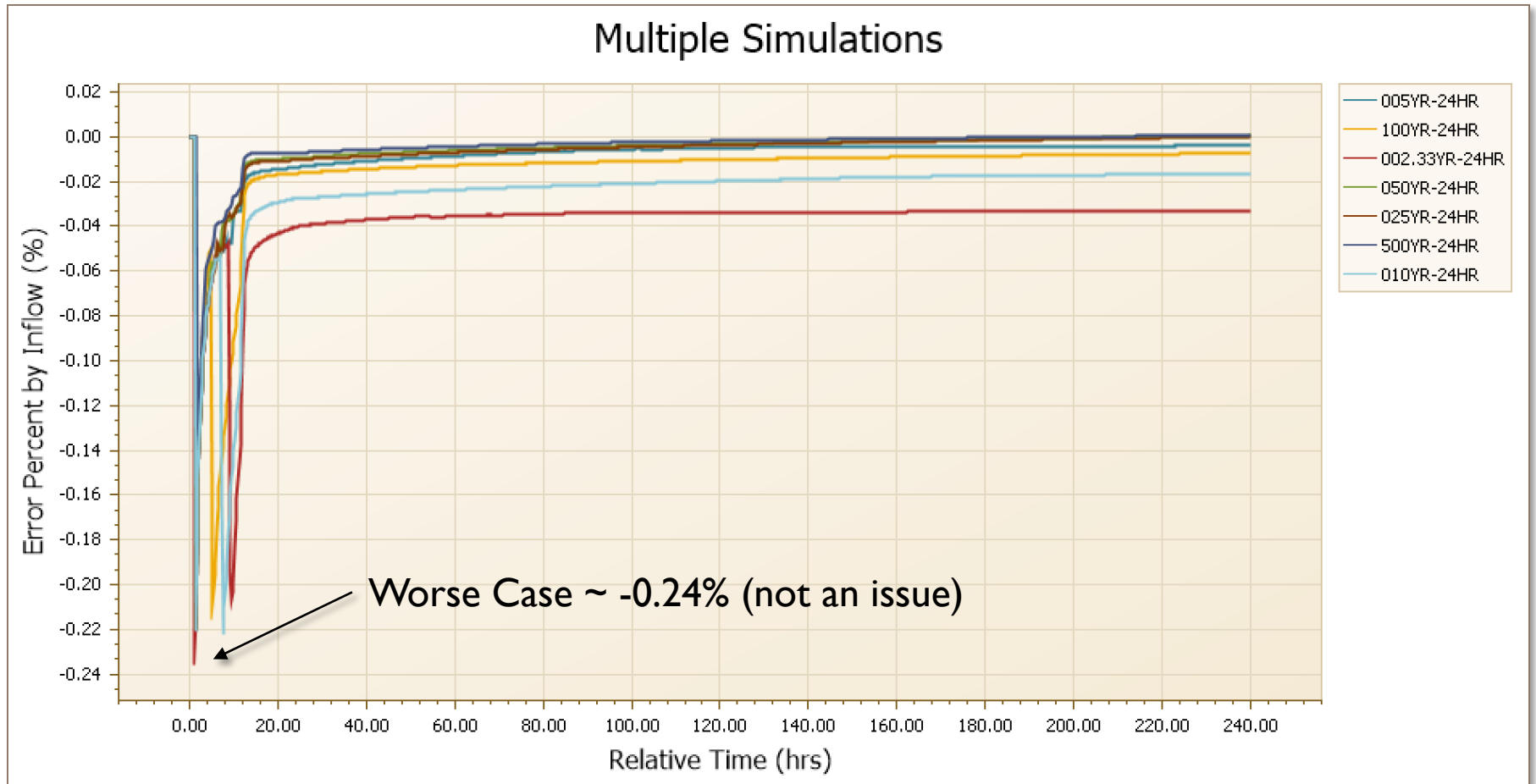
Example #3 – Multiple Land-Locked Ponds



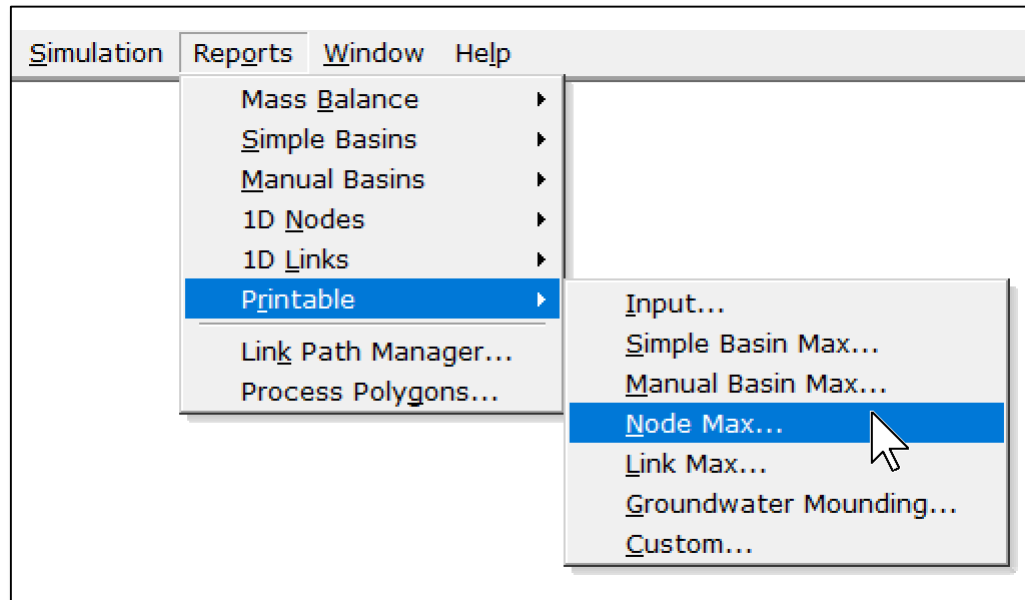
Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds

The screenshot displays a software interface for configuring reports. At the top, a menu bar includes 'Simulation', 'Reports', 'Window', and 'Help'. The 'Reports' menu is open, showing options for 'Mass Balance', 'Simple Basins', and 'Manual Basins'. Below the menu bar, the interface is divided into four main sections:

- Report Sections:** A panel on the left with a 'Node (Multi)' header and a list area. It includes 'Add', 'Remove', and 'Remove All' buttons.
- Item Selection:** A tree view showing a hierarchy of 'Scenarios' and 'L4' items. Selected items include NB9710, NC9288, NC9314, NC9316, NC9317, and NC9318.
- Report Sheet Selection:** A list of report sheets. The first item, 'Max Conditions Report (sim, na)', is selected and highlighted in blue. A red arrow points to this item, and the text 'Group by Simulation' is overlaid in red.
- Simulation Selection:** A tree view showing a hierarchy of 'Scenarios' and 'L4' items. Selected items include 002.33YR-24HR, 005YR-24HR, 010YR-24HR, 025YR-24HR, 050YR-24HR, 100YR-24HR, and 500YR-24HR.

At the bottom of the interface, there is a 'Page Break Rule' dropdown menu set to 'Join'.

Node Max Conditions [L4]

Node Name	Sim Name	Warning Stage [ft]	Max Stage [ft]	Min/Max Delta Stage [ft]	Max Total Inflow [cfs]	Max Total Outflow [cfs]	Max Surface Area [ft2]
NB9710	002.33YR-24HR	66.20	62.11	0.0010	8.75	4.61	17792
NC9288	002.33YR-24HR	61.90	56.39	0.0010	15.82	7.96	55054
NC9314	002.33YR-24HR	60.10	55.50	0.0010	53.68	7.78	155673
NC9316	002.33YR-24HR	63.30	58.39	0.0010	52.79	2.17	298407
NC9317	002.33YR-24HR	66.20	62.02	0.0010	28.08	2.84	98775
NC9318	002.33YR-24HR	60.30	55.09	0.0010	22.35	9.96	68821
NC9338	002.33YR-24HR	60.30	54.90	0.0010	48.83	25.17	188017
NB9710	005YR-24HR	66.20	62.49	0.0010	11.62	6.70	19141
NC9288	005YR-24HR	61.90	56.51	0.0010	19.18	8.96	63754
NC9314	005YR-24HR	60.10	55.78	0.0010	66.09	9.94	158902
NC9316	005YR-24HR	63.30	58.62	0.0010	64.28	2.32	307848
NC9317	005YR-24HR	66.20	62.48	0.0010	34.92	2.61	102577
NC9318	005YR-24HR	60.30	55.36	0.0010	27.73	9.75	70462
NC9338	005YR-24HR	60.30	55.36	0.0010	59.90	25.59	199453
NB9710	010YR-24HR	66.20	63.24	0.0010	17.07	10.46	21807
NC9288	010YR-24HR	61.90	56.77	0.0010	24.72	9.44	76169
NC9314	010YR-24HR	60.10	56.22	0.0010	87.05	14.10	163751
NC9316	010YR-24HR	63.30	58.98	0.0010	83.43	2.60	316776
NC9317	010YR-24HR	66.20	63.24	0.0010	46.85	2.44	107304
NC9318	010YR-24HR	60.30	56.03	0.0010	36.99	11.30	73693
NC9338	010YR-24HR	60.30	56.03	0.0010	78.97	26.13	210416
NB9710	025YR-24HR	66.20	64.05	0.0010	23.80	14.72	24381
NC9288	025YR-24HR	61.90	57.08	0.0010	30.97	9.24	82114
NC9314	025YR-24HR	60.10	56.76	0.0010	110.99	17.87	168949
NC9316	025YR-24HR	63.30	59.38	0.0010	105.21	2.94	325821
NC9317	025YR-24HR	66.20	64.05	0.0010	60.95	2.65	112397
NC9318	025YR-24HR	60.30	56.76	0.0010	47.89	15.07	77269
NC9338	025YR-24HR	60.30	56.76	0.0010	101.45	25.31	220696
NB9710	050YR-24HR	66.20	64.65	0.0010	29.16	17.64	27984
NC9288	050YR-24HR	61.90	57.32	0.0010	35.83	8.62	84734
NC9314	050YR-24HR	60.10	57.30	0.0010	129.22	20.35	174318
NC9316	050YR-24HR	63.30	59.68	0.0010	121.95	3.21	331983

Node Name	Sim Name	Warning Stage [ft]	Max Stage [ft]	Min/Max Delta Stage [ft]	Max Total Inflow [cfs]	Max Total Outflow [cfs]	Max Surface Area [ft ²]
NC9317	050YR-24HR	66.20	64.65	0.0010	72.34	2.87	116588
NC9318	050YR-24HR	60.30	57.29	0.0010	56.66	17.32	79052
NC9338	050YR-24HR	60.30	57.29	0.0010	119.29	23.71	228635
NB9710	100YR-24HR	66.20	65.89	0.0010	41.75	22.33	43715
NC9288	100YR-24HR	61.90	57.89	0.0010	47.16	6.85	90165
NC9314	100YR-24HR	60.10	58.45	0.0010	170.46	23.14	185742
NC9316	100YR-24HR	63.30	60.35	0.0010	160.37	3.88	344091
NC9317	100YR-24HR	66.20	65.89	0.0010	98.88	3.36	125336
NC9318	100YR-24HR	60.30	58.45	0.0010	76.93	19.44	84969
NC9338	100YR-24HR	60.30	58.45	0.0010	161.43	25.18	245172
NB9710	500YR-24HR	66.20	66.91	0.0010	56.37	23.86	91619
NC9288	500YR-24HR	61.90	58.57	0.0010	60.25	5.14	95956
NC9314	500YR-24HR	60.10	59.66	0.0010	216.81	23.90	198872
NC9316	500YR-24HR	63.30	61.08	0.0010	204.15	4.64	357156
NC9317	500YR-24HR	66.20	66.91	0.0010	125.91	3.89	222995
NC9318	500YR-24HR	60.30	59.65	0.0010	98.04	20.36	91928
NC9338	500YR-24HR	60.30	59.65	0.0010	210.06	22.11	270417

Example #3 – Multiple Land-Locked Ponds

Custom Reports

Title

Report Sections

- Node (Multi)

Item Selection

- NC9288-GW
- NC9314
- NC9314-GW
- NC9316
- NC9316-GW
- NC9317
- NC9317-GW
- NC9318
- NC9318-GW-A
- NC9318-GW-B
- NC9338
- NC9338-GW-A
- NC9338-GW-B

Report Sheet Selection

- Max Conditions Report (sim, na
- Max Conditions Report (name,
- Max Conditions Report (with Ti
- Max Conditions Report (with Ti

Simulation Selection

- Scenarios
 - L4
 - 002.33YR-24HR
 - 005YR-24HR
 - 010YR-24HR
 - 025YR-24HR
 - 050YR-24HR
 - 100YR-24HR
 - 500YR-24HR

Simulation Add Remove Remove All

Page Break Rule Join

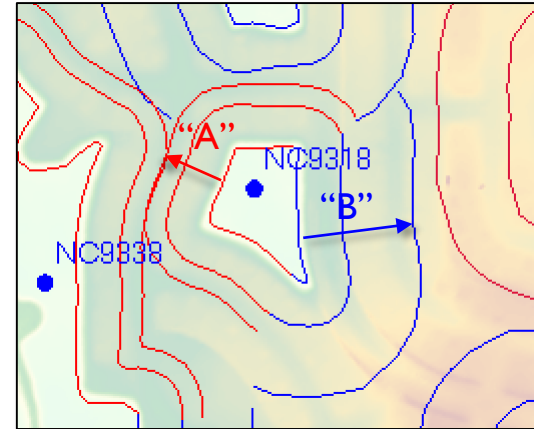
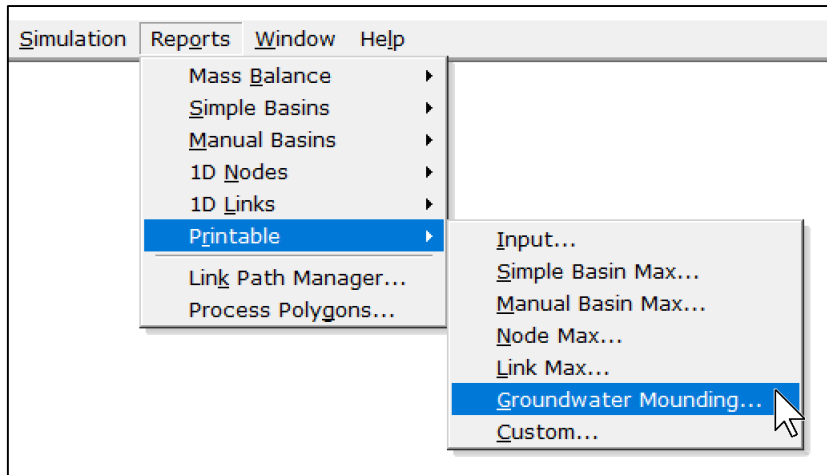
Group by Node Name

Node Max Conditions [L4]

Node Name	Sim Name	Warning Stage [ft]	Max Stage [ft]	Min/Max Delta Stage [ft]	Max Total Inflow [cfs]	Max Total Outflow [cfs]	Max Surface Area [ft2]
NB9710	002.33YR-24HR	66.20	62.11	0.0010	8.75	4.61	17792
NB9710	005YR-24HR	66.20	62.49	0.0010	11.62	6.70	19141
NB9710	010YR-24HR	66.20	63.24	0.0010	17.07	10.46	21807
NB9710	025YR-24HR	66.20	64.05	0.0010	23.80	14.72	24381
NB9710	050YR-24HR	66.20	64.65	0.0010	29.16	17.64	27984
NB9710	100YR-24HR	66.20	65.89	0.0010	41.75	22.33	43715
NB9710	500YR-24HR	66.20	66.91	0.0010	56.37	23.86	91619
NC9288	002.33YR-24HR	61.90	56.39	0.0010	15.82	7.96	55054
NC9288	005YR-24HR	61.90	56.51	0.0010	19.18	8.96	63754
NC9288	010YR-24HR	61.90	56.77	0.0010	24.72	9.44	76169
NC9288	025YR-24HR	61.90	57.08	0.0010	30.97	9.24	82114
NC9288	050YR-24HR	61.90	57.32	0.0010	35.83	8.62	84734
NC9288	100YR-24HR	61.90	57.89	0.0010	47.16	6.85	90165
NC9288	500YR-24HR	61.90	58.57	0.0010	60.25	5.14	95956
NC9314	002.33YR-24HR	60.10	55.50	0.0010	53.68	7.78	155673
NC9314	005YR-24HR	60.10	55.78	0.0010	66.09	9.94	158902
NC9314	010YR-24HR	60.10	56.22	0.0010	87.05	14.10	163751
NC9314	025YR-24HR	60.10	56.76	0.0010	110.99	17.87	168949
NC9314	050YR-24HR	60.10	57.30	0.0010	129.22	20.35	174318
NC9314	100YR-24HR	60.10	58.45	0.0010	170.46	23.14	185742
NC9314	500YR-24HR	60.10	59.66	0.0010	216.81	23.90	198872
NC9316	002.33YR-24HR	63.30	58.39	0.0010	52.79	2.17	298407
NC9316	005YR-24HR	63.30	58.62	0.0010	64.28	2.32	307848
NC9316	010YR-24HR	63.30	58.98	0.0010	83.43	2.60	316776
NC9316	025YR-24HR	63.30	59.38	0.0010	105.21	2.94	325821
NC9316	050YR-24HR	63.30	59.68	0.0010	121.95	3.21	331983
NC9316	100YR-24HR	63.30	60.35	0.0010	160.37	3.88	344091
NC9316	500YR-24HR	63.30	61.08	0.0010	204.15	4.64	357156
NC9317	002.33YR-24HR	66.20	62.02	0.0010	28.08	2.84	98775
NC9317	005YR-24HR	66.20	62.48	0.0010	34.92	2.61	102577
NC9317	010YR-24HR	66.20	63.24	0.0010	46.85	2.44	107304
NC9317	025YR-24HR	66.20	64.05	0.0010	60.95	2.65	112397

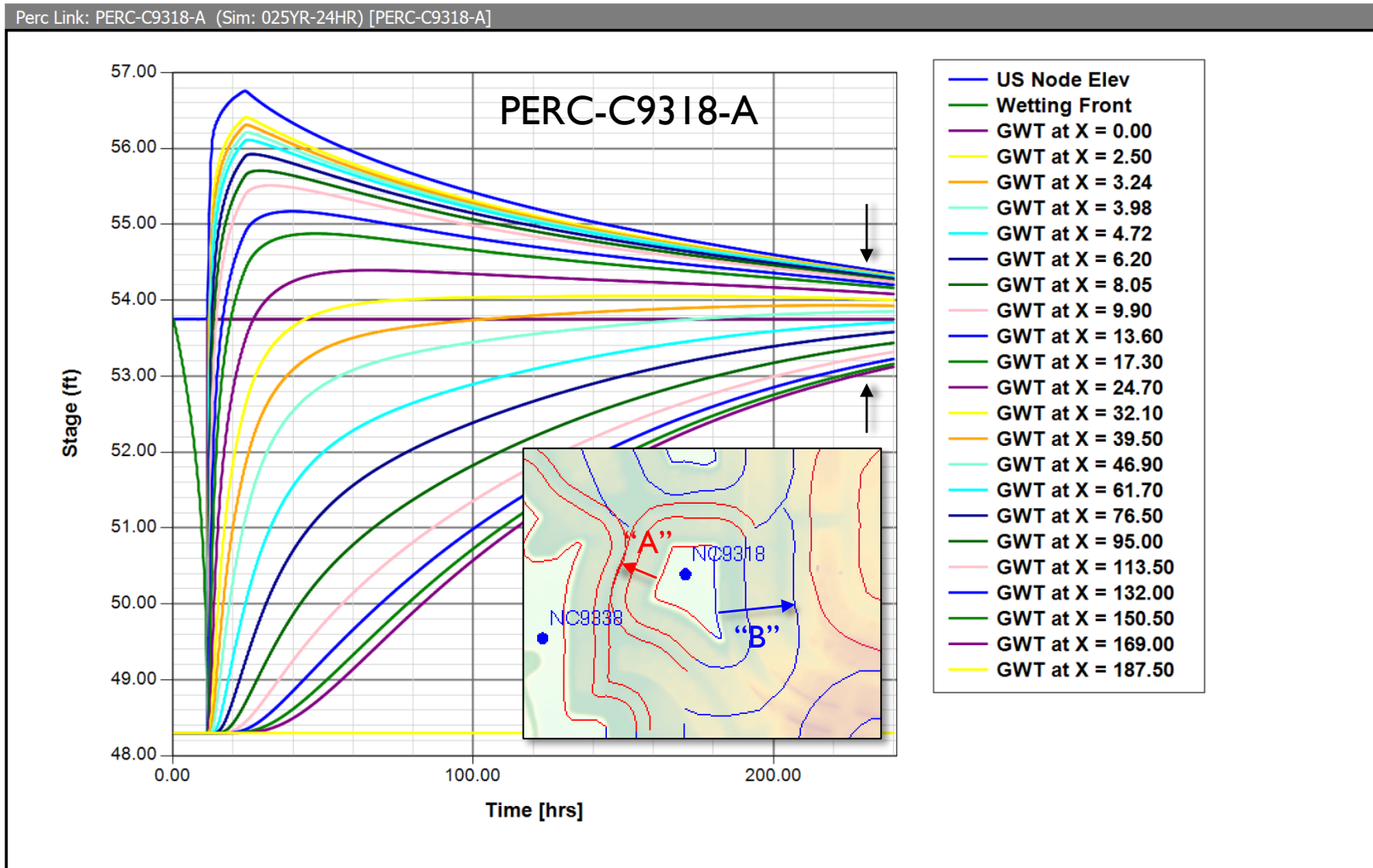
Node Name	Sim Name	Warning Stage [ft]	Max Stage [ft]	Min/Max Delta Stage [ft]	Max Total Inflow [cfs]	Max Total Outflow [cfs]	Max Surface Area [ft2]
NC9317	050YR-24HR	66.20	64.65	0.0010	72.34	2.87	116588
NC9317	100YR-24HR	66.20	65.89	0.0010	98.88	3.36	125336
NC9317	500YR-24HR	66.20	66.91	0.0010	125.91	3.89	222995
NC9318	002.33YR-24HR	60.30	55.09	0.0010	22.35	9.96	68821
NC9318	005YR-24HR	60.30	55.36	0.0010	27.73	9.75	70462
NC9318	010YR-24HR	60.30	56.03	0.0010	36.99	11.30	73693
NC9318	025YR-24HR	60.30	56.76	0.0010	47.89	15.07	77269
NC9318	050YR-24HR	60.30	57.29	0.0010	56.66	17.32	79052
NC9318	100YR-24HR	60.30	58.45	0.0010	76.93	19.44	84969
NC9318	500YR-24HR	60.30	59.65	0.0010	98.04	20.36	91928
NC9338	002.33YR-24HR	60.30	54.90	0.0010	48.83	25.17	188017
NC9338	005YR-24HR	60.30	55.36	0.0010	59.90	25.59	199453
NC9338	010YR-24HR	60.30	56.03	0.0010	78.97	26.13	210416
NC9338	025YR-24HR	60.30	56.76	0.0010	101.45	25.31	220696
NC9338	050YR-24HR	60.30	57.29	0.0010	119.29	23.71	228635
NC9338	100YR-24HR	60.30	58.45	0.0010	161.43	25.18	245172
NC9338	500YR-24HR	60.30	59.65	0.0010	210.06	22.11	270417

Example #3 – Multiple Land-Locked Ponds

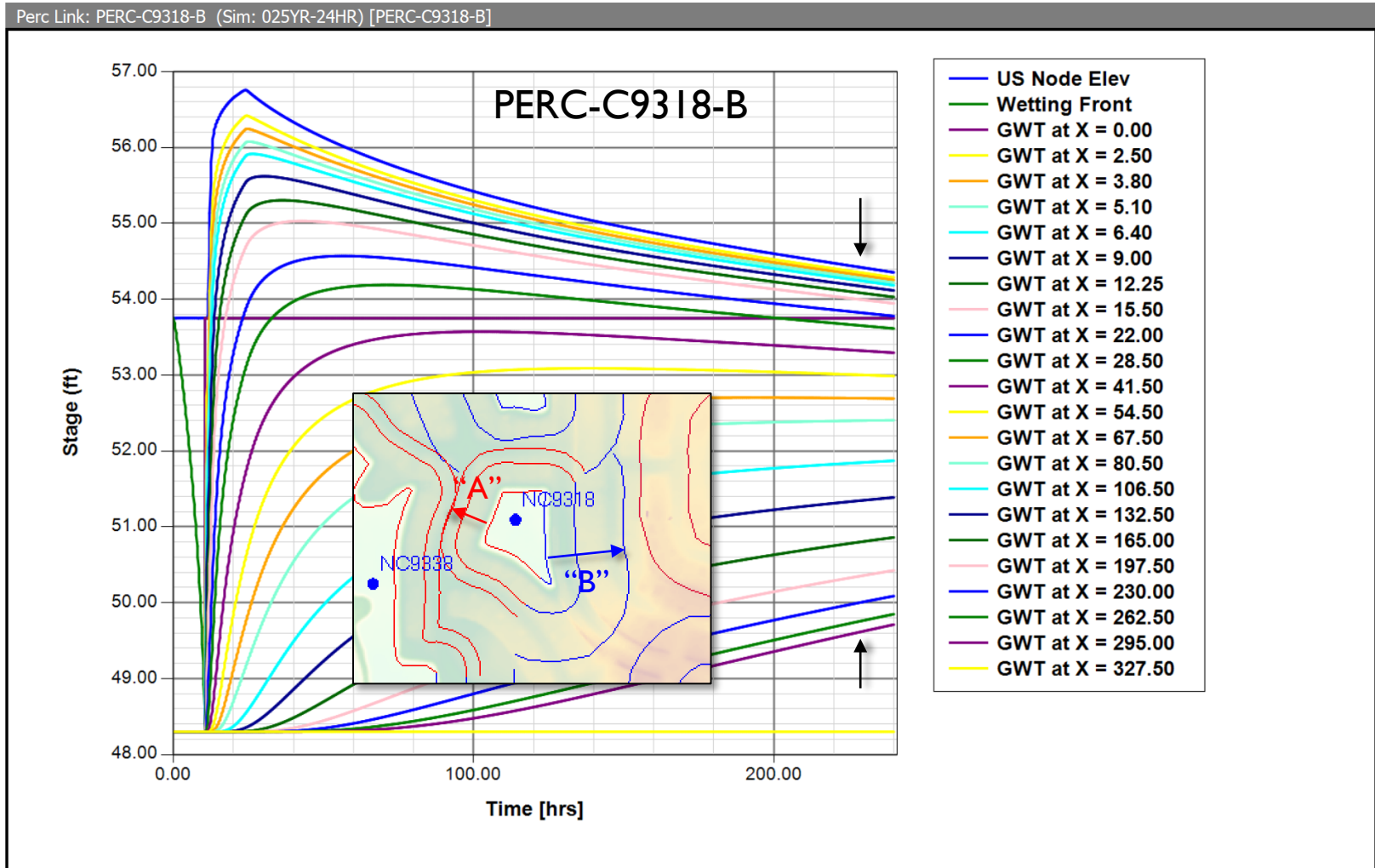


Report Sections	Item Selection	Report Sheet Selection	Simulation Selection
Percolation Link	<p>Item Selection</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scenarios <ul style="list-style-type: none"> <input type="checkbox"/> L4 <ul style="list-style-type: none"> <input type="checkbox"/> PERC-B9710 <input type="checkbox"/> PERC-C9288 <input type="checkbox"/> PERC-C9314 <input type="checkbox"/> PERC-C9317 <input checked="" type="checkbox"/> PERC-C9318-A <input checked="" type="checkbox"/> PERC-C9318-B <input type="checkbox"/> PERC-C9338-A <input type="checkbox"/> PERC-C9338-B <input type="checkbox"/> PERC-NC9316 	<p>Report Sheet Selection</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Input Report <input type="checkbox"/> Min/Max Conditions Report <input type="checkbox"/> Min/Max Conditions Report (with ...) <input type="checkbox"/> Flow Chart <input type="checkbox"/> Average Velocity Chart <input type="checkbox"/> Downstream Velocity Chart <input type="checkbox"/> Upstream Velocity Chart <input type="checkbox"/> Flow % Exceedance Chart <input type="checkbox"/> Flow Raster Chart <input checked="" type="checkbox"/> GW Mounding Chart 	<p>Simulation Selection</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scenarios <ul style="list-style-type: none"> <input type="checkbox"/> L4 <ul style="list-style-type: none"> <input type="checkbox"/> 002.33YR-24HR <input type="checkbox"/> 005YR-24HR <input type="checkbox"/> 010YR-24HR <input checked="" type="checkbox"/> 025YR-24HR <input type="checkbox"/> 050YR-24HR <input type="checkbox"/> 100YR-24HR <input type="checkbox"/> 500YR-24HR

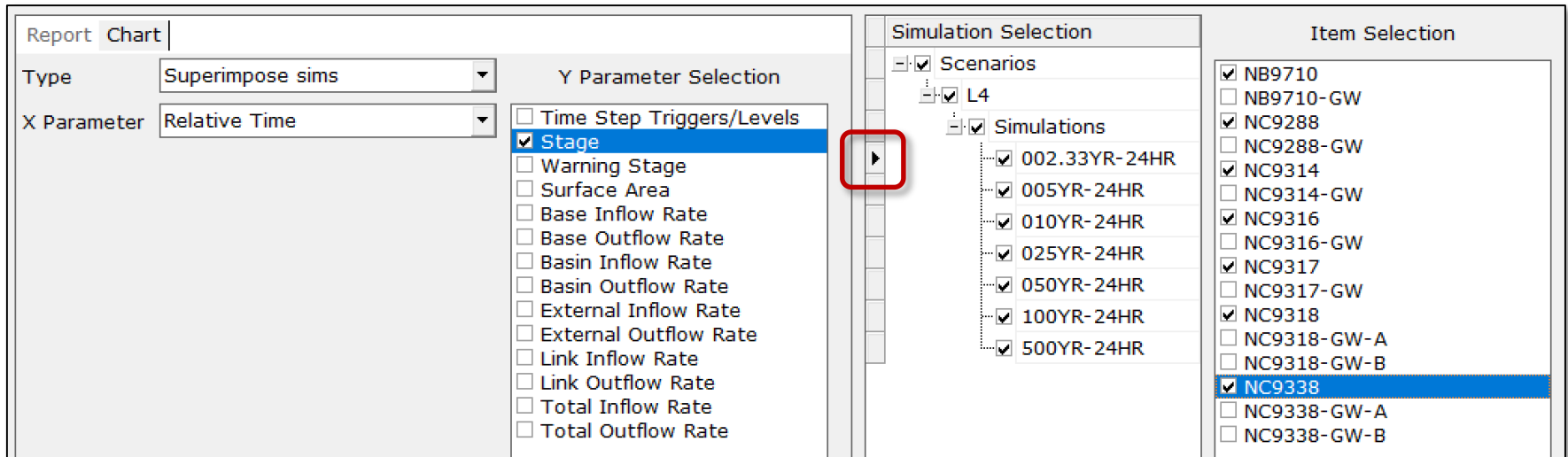
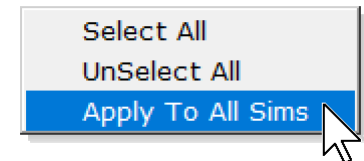
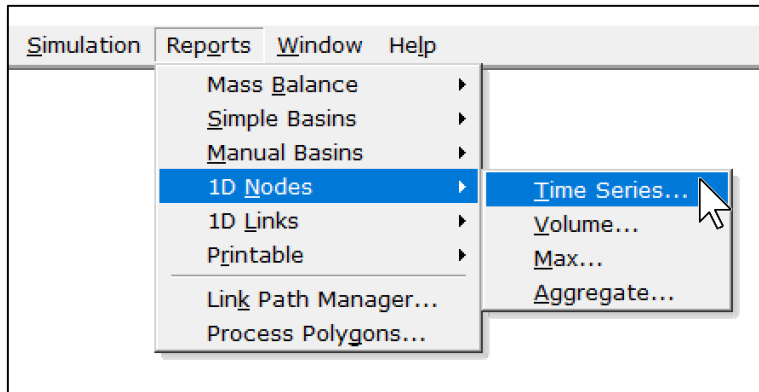
Example #3 – Multiple Land-Locked Ponds



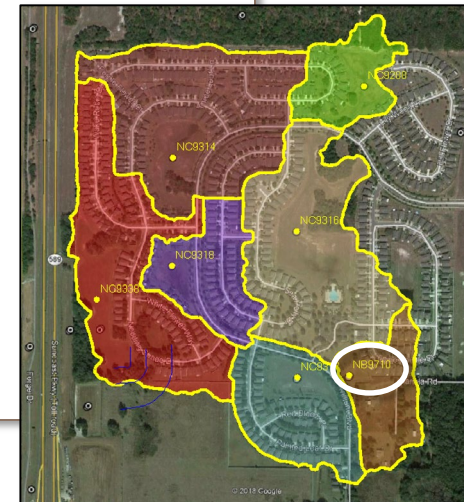
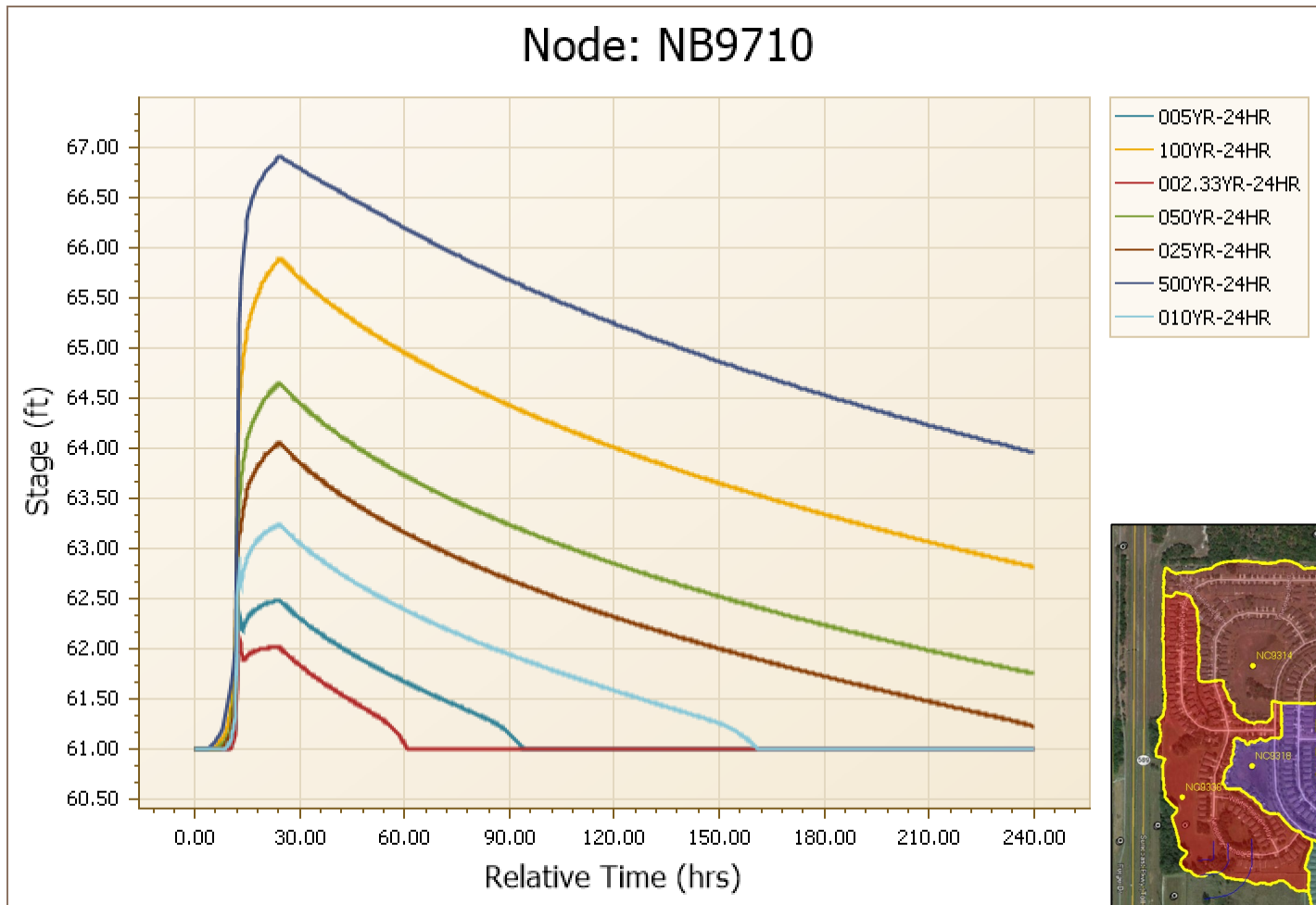
Example #3 – Multiple Land-Locked Ponds



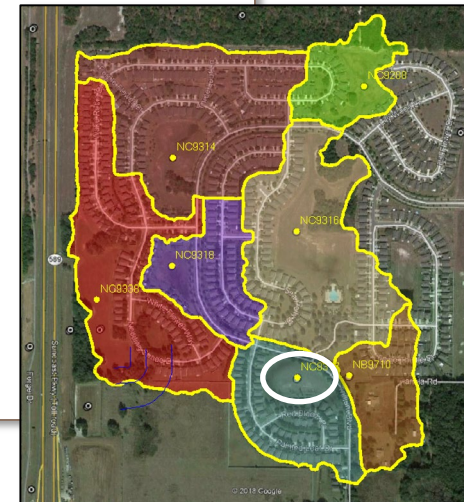
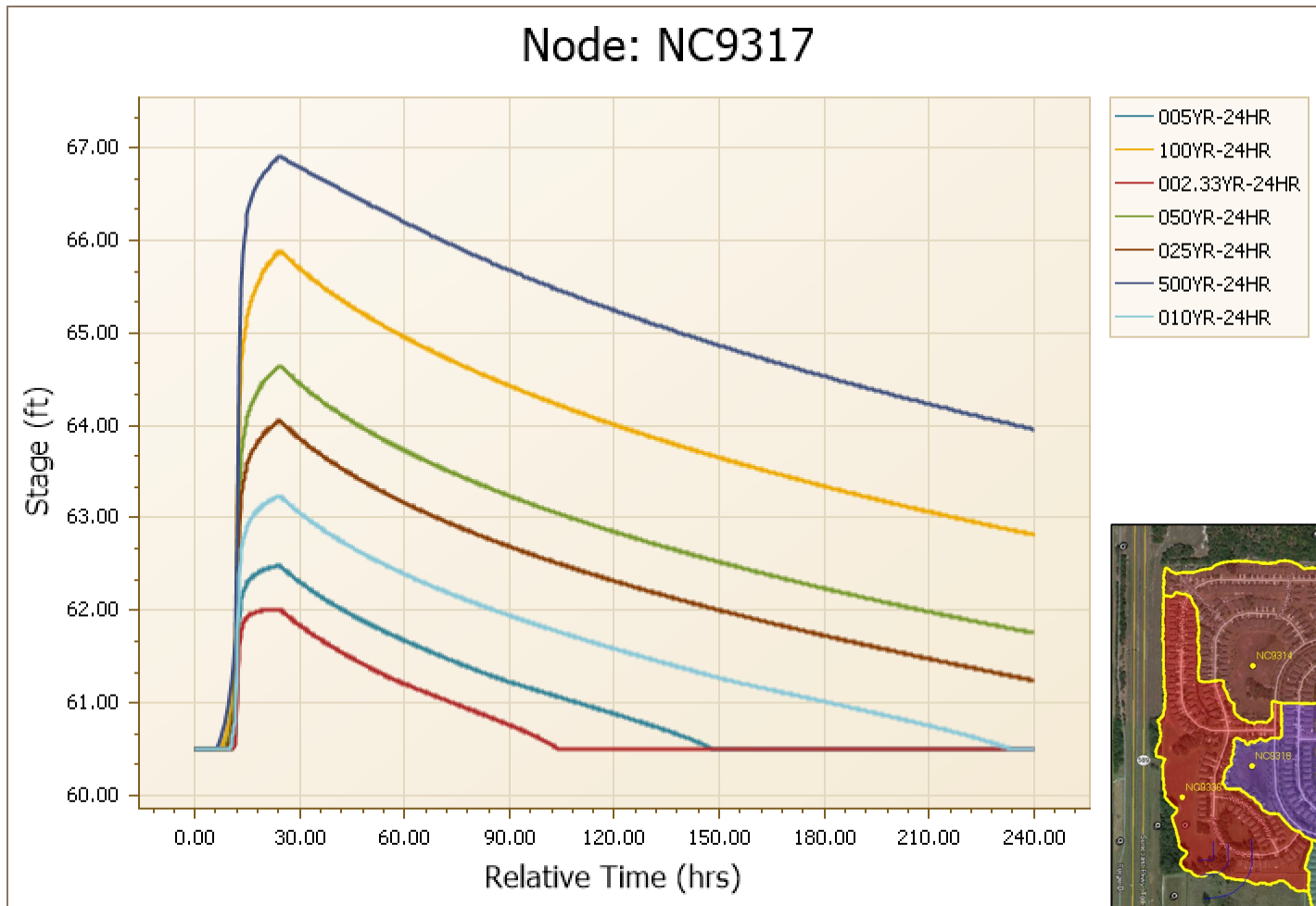
Example #3 – Multiple Land-Locked Ponds



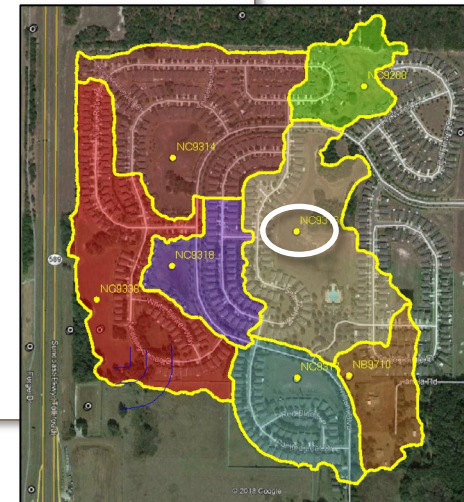
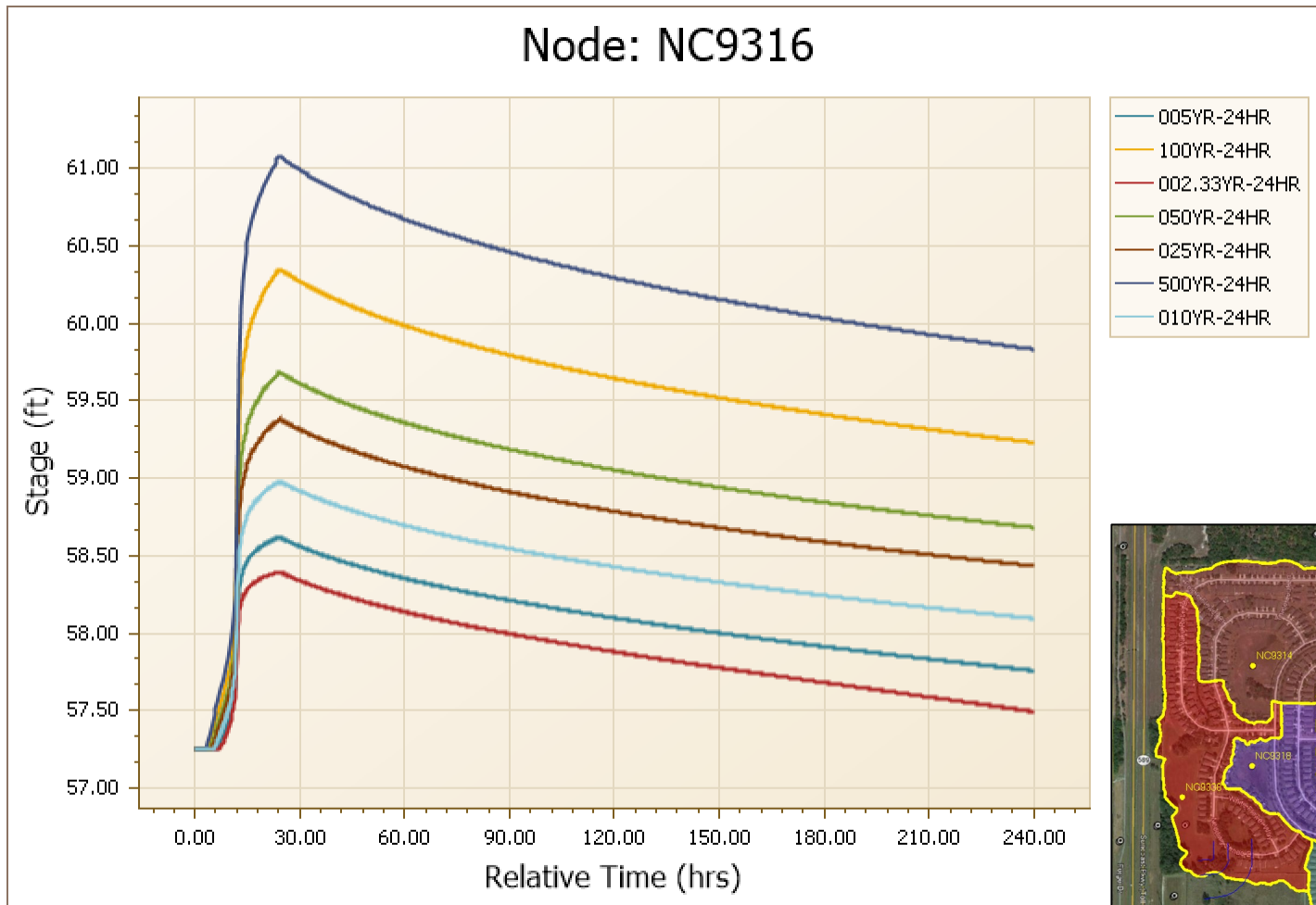
Example #3 – Multiple Land-Locked Ponds



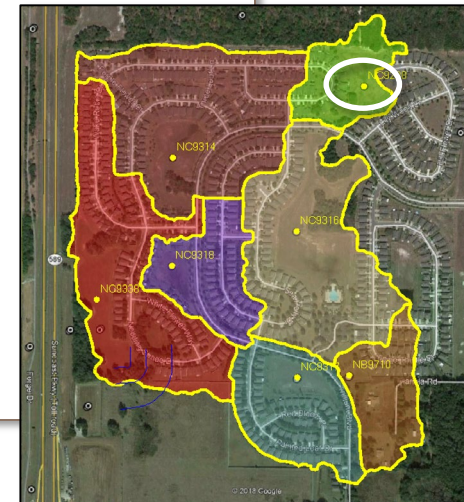
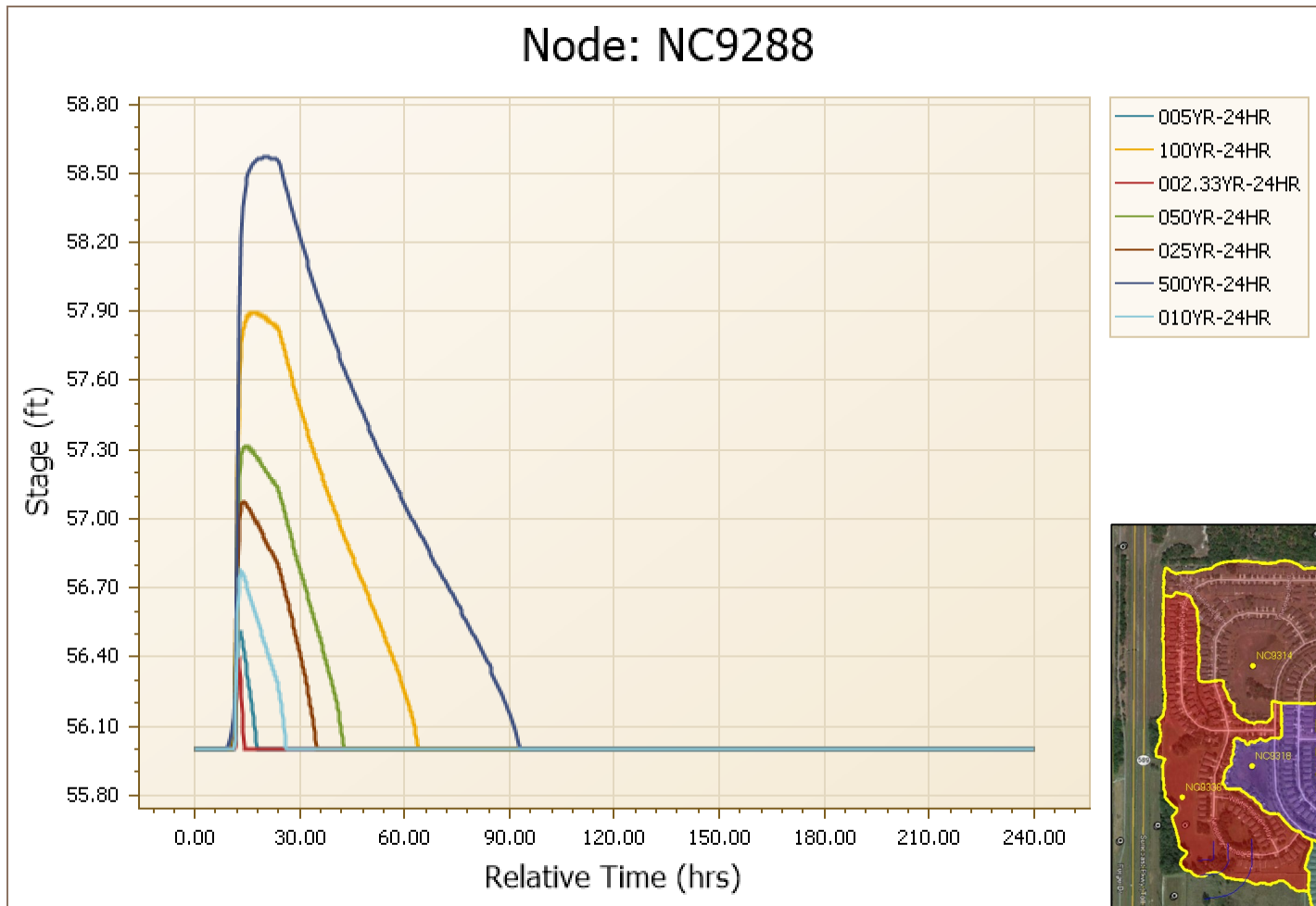
Example #3 – Multiple Land-Locked Ponds



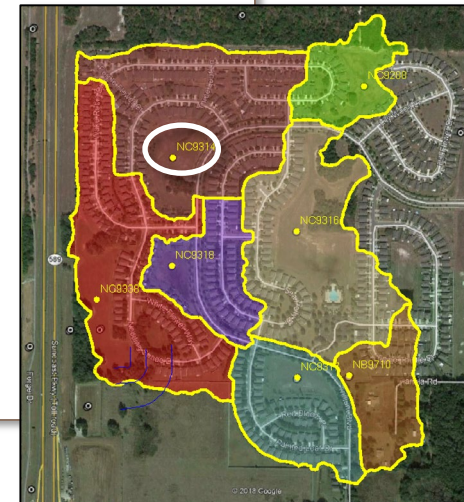
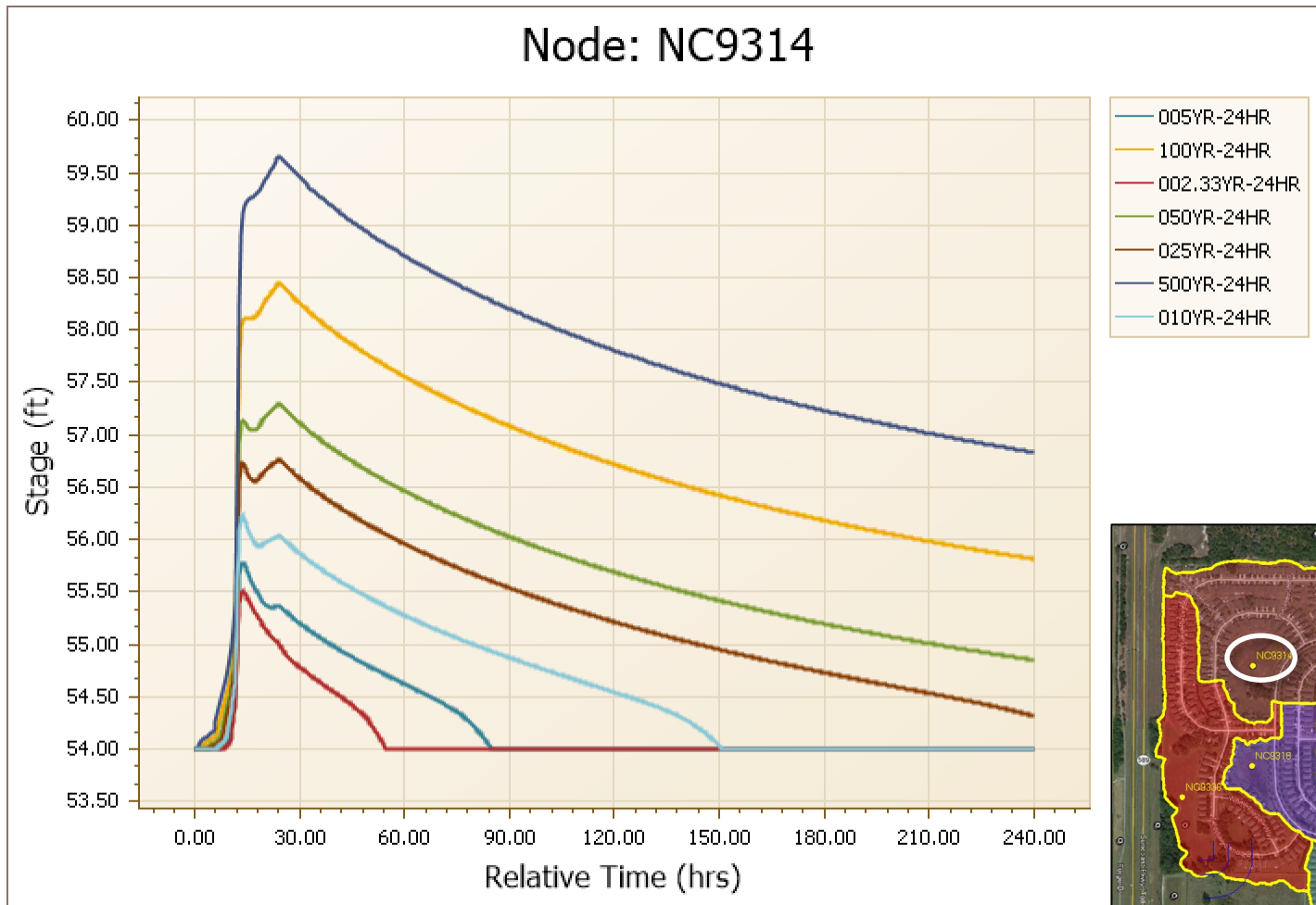
Example #3 – Multiple Land-Locked Ponds



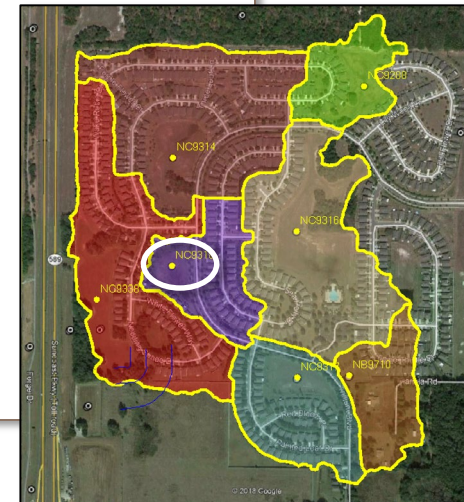
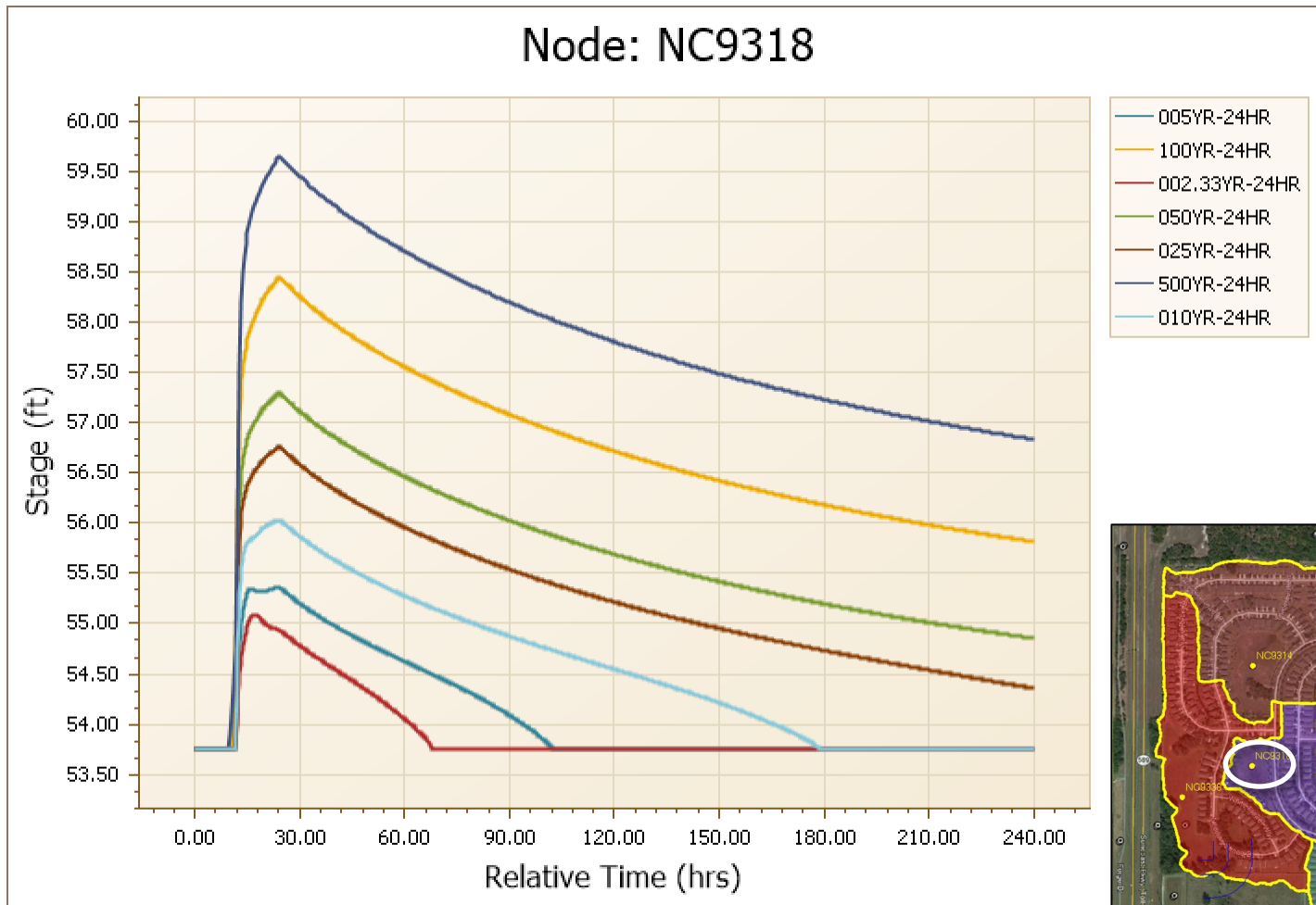
Example #3 – Multiple Land-Locked Ponds



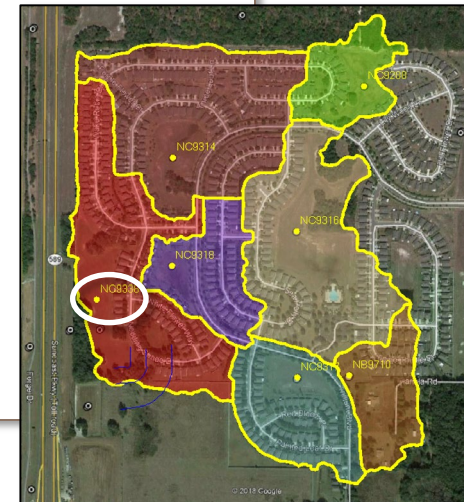
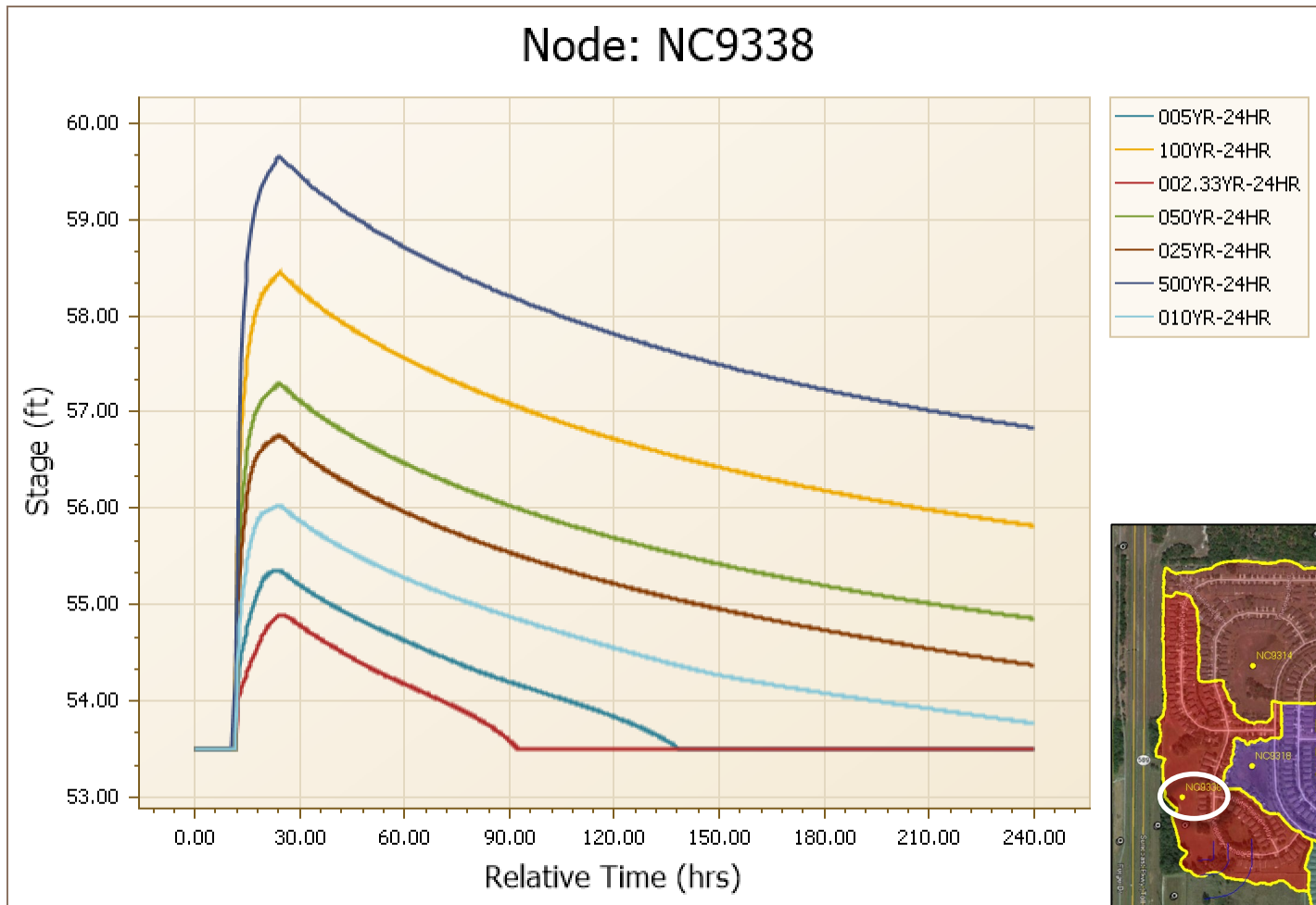
Example #3 – Multiple Land-Locked Ponds



Example #3 – Multiple Land-Locked Ponds



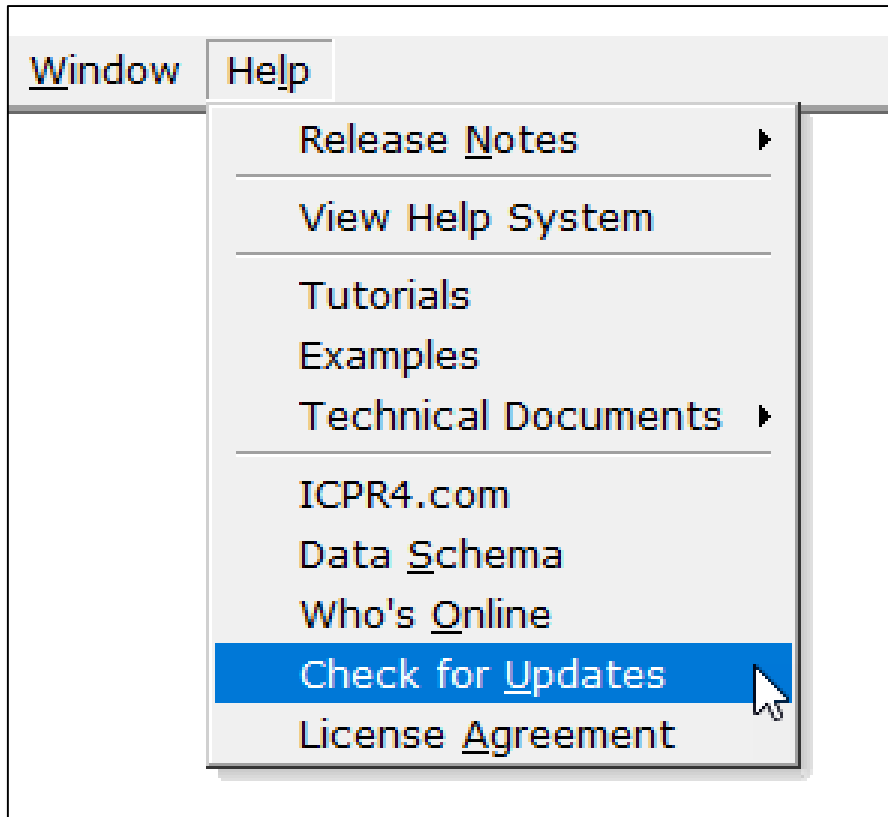
Example #3 – Multiple Land-Locked Ponds



Next Webinar – Lesson 5: Typical Pre/Post Examples

Tuesday November 5, 2019

11:30 – 1:30 (EDT)



We will try to post a recording of this webinar and/or the presentation material as soon as we can.

To find them:

“Check for Updates”
sometime tomorrow.

support@icpr4.com