

Use of Stormwater Best Management Practices for Runoff Volume Reduction

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Basis for Presentation/ Research

- Review of Existing and Emerging Regulations
- Provide Support to Quantify Impacts of BMPs on Runoff Reduction
- Begin to Quantify Utility of Various BMPs/Scenarios for Runoff Volume Reduction

Local Regulations Requiring Runoff Volume Reduction

- Six County area ordinances
- IEPA ILR10
- Wisconsin
 - NR151
- Emerging National Requirements

Existing Detention and Retention Based Regulations

- Quantifies release rate for 100-year 24 hour event and 2-year 24 hour event
- Hydrograph modification technique
- Designed to prevent increased downstream flooding and to limit the frequency of bank-full flow
- Separate water quality requirements

Runoff Reduction vs. Hydrograph Modification

Runoff Reduction

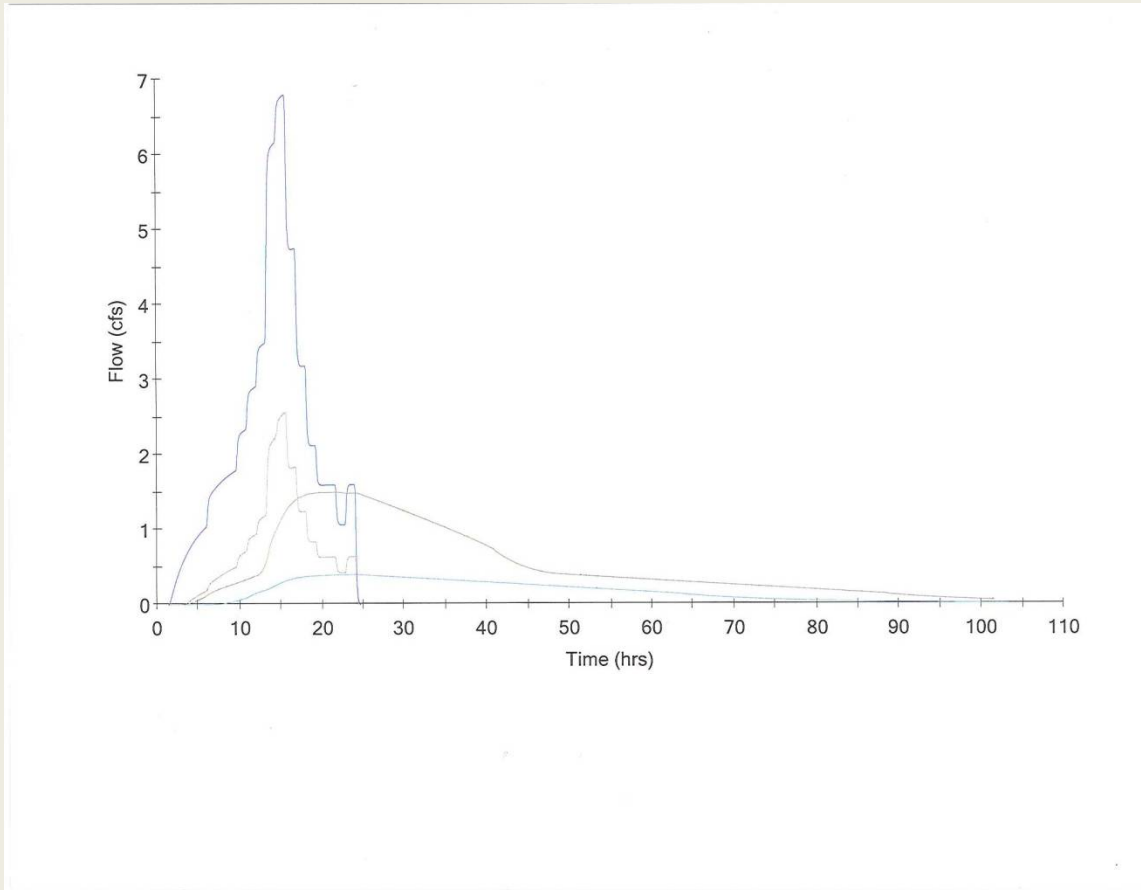
- Minimize impervious surfaces
- Route impervious to pervious
- Preserves or enhances infiltration
- Evapotranspiration

Hydrograph Modification

- Alters peak flow rates and times
- Modifies hydrograph shape
- Detention, Underdrained BMPs
- Does not necessarily reduce total runoff volume

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Runoff Reduction vs. Hydrograph Modification



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BMP Types

Runoff Reduction

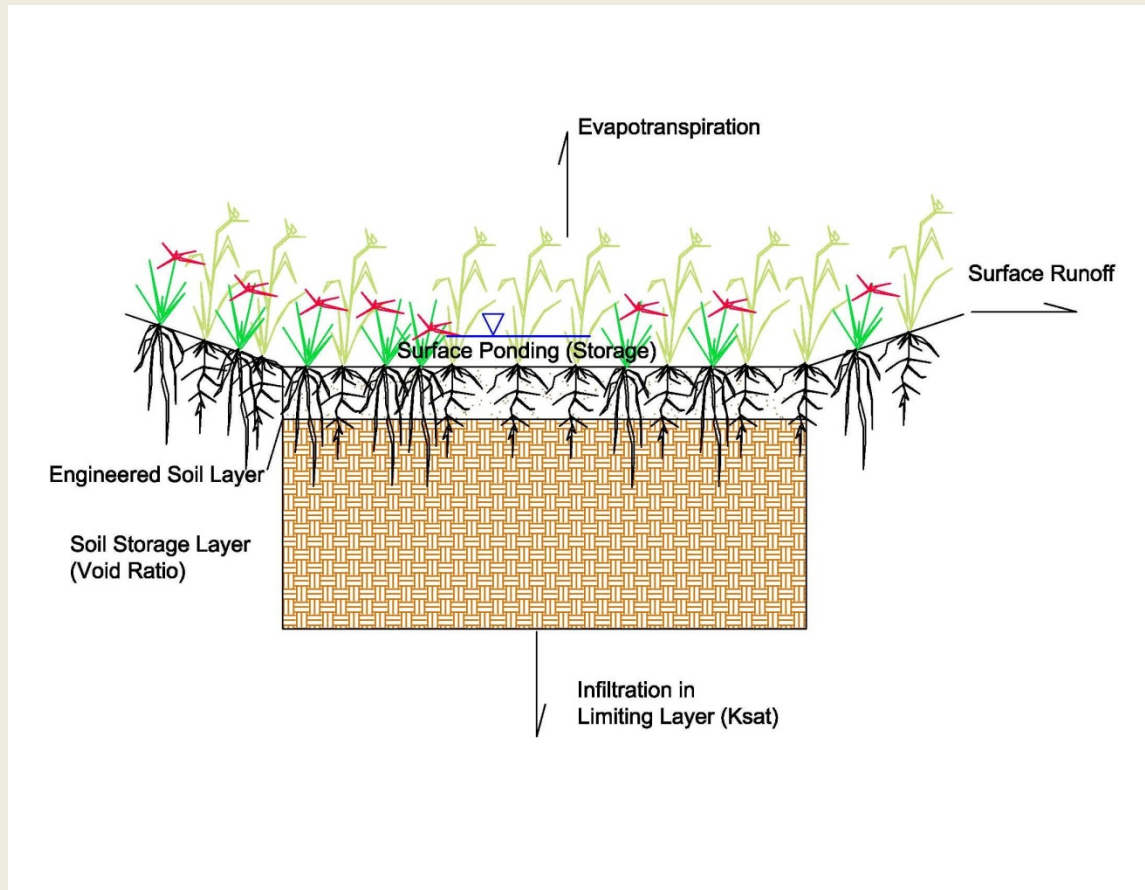
- Rain Barrels/ Cisterns
- Green roofs
- Permeable pavement
- Rain gardens
- Bioswales
- Infiltration facilities
- Retention

Hydrograph Modification

- Rain Barrels/ Cisterns
- Green roofs
- Permeable pavement
- Rain gardens
- Bioswales
- Detention
- Underdrained structures

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BMP Function



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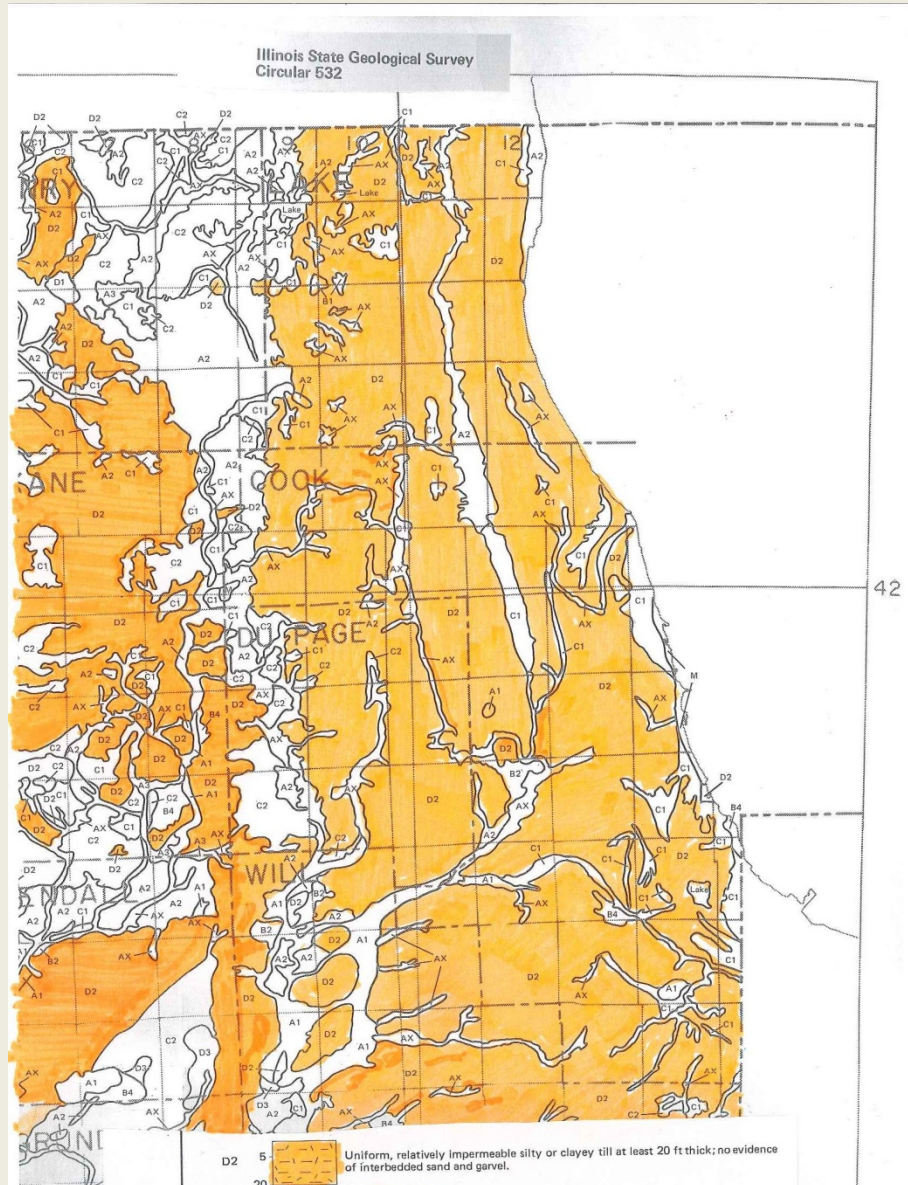
Benefits of BMPs

- Water quality treatment
- Routine runoff reduction
- Green space/Ecology

Limitations of BMPs

- Major (regulatory) storm hydrology
- Maintenance/long term function
- Limiting soil layer hydraulic conductivity (K_{sat})
- Groundwater
- Design and construction
- Cost

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Modeling for Study

- Weighed various models and techniques
 - Spreadsheet
 - Recarga
 - SCS Hydrology
 - SWMM
- XP-SWMM for ability to utilize SCS hydrology for consistency with regulatory requirements and model continuous simulation

Assumptions

- 10 acre site
- 1 acre detention facility (0.04 and 0.15 cfs/ac release rate)
- 50% Impervious area
- RCN 80 (Open Space Good HSG D) for pervious area
- Lake County, IL tabular rainfall for regulatory events
- 2007 O'Hare gauge for continuous simulation
- Evaporation data from Dekalb, IL pan data (yearly daily average)
- Variable infiltration rates (roughly till and HSG A-C)
- Variable BMP sizes

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Total Site Area

10 ac

Parameter	Scenario											
	1	2	3	4	5	6	7	8	9	10	11	12
BMP Area (%)	1.00%	5.00%	10.00%	1.00%	5.00%	10.00%	1.00%	5.00%	10.00%	1.00%	5.00%	10.00%
BMP Area (ac)	0.1	0.5	1	0.1	0.5	1	0.1	0.5	1	0.1	0.5	1
Det. Area (ac)	1	1	1	1	1	1	1	1	1	1	1	1
Pervious Percentage	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%
Open Space (Good D HSG) CN	80	80	80	80	80	80	80	80	80	80	80	80
Composite CN	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8
BMP Type	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf	Bio-Inf
Inf. Rate (in/hr)	0.002	0.002	0.002	0.2	0.2	0.2	0.6	0.6	0.6	6	6	6
Inf. Rate (cfs)	0.0002	0.0010	0.0020	0.0202	0.1008	0.2017	0.0605	0.3025	0.6050	0.6050	3.0250	6.0500
Evap. Rate (in/hr)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Evap. Rate (cfs)	0.0005	0.0025	0.0050	0.0005	0.0025	0.0050	0.0005	0.0025	0.0050	0.0005	0.0025	0.0050
Total EI (cfs)	0.0007	0.0035	0.0071	0.0207	0.1034	0.2067	0.0610	0.3050	0.6100	0.6055	3.0275	6.0550
Depth of BMP Storage (ft)	1	1	1	1	1	1	1	1	1	1	1	1
Surface Storage (ac-ft)	0.1	0.5	1	0.1	0.5	1	0.1	0.5	1	0.1	0.5	1
Depth of BMP Subsrface Storage (ft)	4	4	4	4	4	4	4	4	4	4	4	4
Subsurface Void Percentage	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Subsurface Storage (ac-ft)	0.1	0.5	1	0.1	0.5	1	0.1	0.5	1	0.1	0.5	1
Total Storage (ac-ft)	0.2	1	2	0.2	1	2	0.2	1	2	0.2	1	2

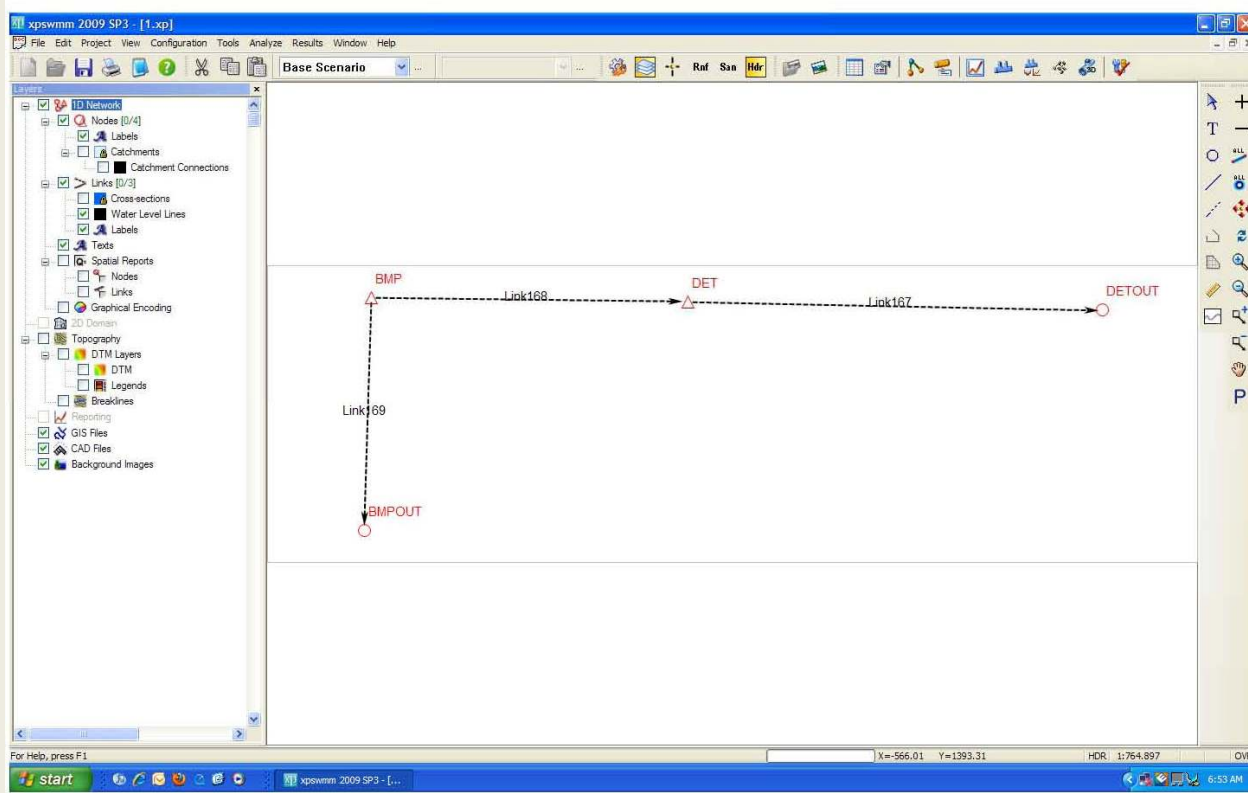
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Evapotranspiration

- Assumed to be 1 times pan data value
- Large component of total loss for low hydraulic conductivity soils
- Difficult to measure and quantify
- Highly variable
- Difficult to regulate

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Model Schematic



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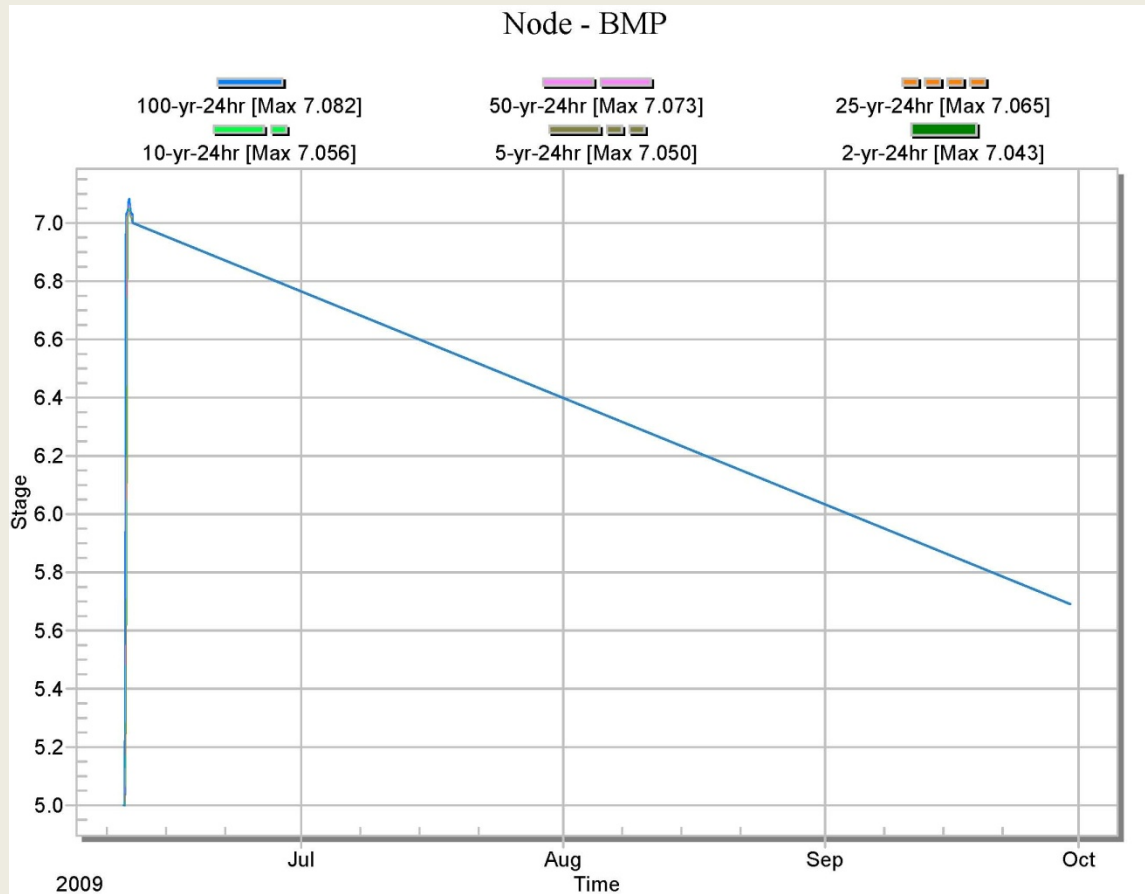
Results

Scenario	100-Year		50-Year		25-Year		10-Year		5-Year		2-Year	
	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume
1	0.01	0.3%	0.01	0.4%	0.01	0.5%	0.01	0.6%	0.01	0.7%	0.01	0.9%
2	0.07	1.6%	0.07	1.9%	0.07	2.3%	0.07	2.9%	0.07	3.5%	0.07	4.5%
3	0.14	3.1%	0.14	3.8%	0.14	4.6%	0.14	5.9%	0.14	7.0%	0.14	9.2%
4	0.27	6.2%	0.27	7.6%	0.27	9.0%	0.27	11.7%	0.27	13.9%	0.27	18.2%
5	1.35	30.7%	1.35	37.3%	1.34	44.6%	1.34	57.6%	1.33	68.6%	1.32	89.4%
7	0.35	7.8%	0.34	9.5%	0.34	11.3%	0.34	14.6%	0.34	17.3%	0.33	22.4%
8	1.71	38.8%	1.69	46.9%	1.68	55.7%	1.65	71.2%	0.16	8.4%	1.48	99.8%
10	1.29	29.4%	1.26	35.0%	1.23	40.8%	1.18	50.7%	1.14	58.7%	1.05	70.7%
Total Volume	4.4 acre-feet		3.61 acre-feet		3.01 acre-feet		2.32 acre-feet		1.94 acre-feet		1.48 acre-feet	

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Limiting Till Layer



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One Percent of Site Area

Scenario	100-Year		50-Year		25-Year		10-Year		5-Year		2-Year	
	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume
1	0.01	0.3%	0.01	0.4%	0.01	0.5%	0.01	0.6%	0.01	0.7%	0.01	0.9%
4	0.27	6.2%	0.27	7.6%	0.27	9.0%	0.27	11.7%	0.27	13.9%	0.27	18.2%
7	0.35	7.8%	0.34	9.5%	0.34	11.3%	0.34	14.6%	0.34	17.3%	0.33	22.4%
10	1.29	29.4%	1.26	35.0%	1.23	40.8%	1.18	50.7%	1.14	58.7%	1.05	70.7%

Total Volume 4.4 acre-feet 3.61 acre-feet 3.01 acre-feet 2.32 acre-feet 1.94 acre-feet 1.48 acre-feet

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Five Percent of Site Area

Scenario	100-Year		50-Year		25-Year		10-Year		5-Year		2-Year	
	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume	Volume Lost (ac-ft)	Percentage of Total Volume
2	0.07	1.6%	0.07	1.9%	0.07	2.3%	0.07	2.9%	0.07	3.5%	0.07	4.5%
5	1.35	30.7%	1.35	37.3%	1.34	44.6%	1.34	57.6%	1.33	68.6%	1.32	89.4%
8	1.71	38.8%	1.69	46.9%	1.68	55.7%	1.65	71.2%	1.55	79.9%	1.48	99.8%
Total Volume	4.4 acre-feet		3.61 acre-feet		3.01 acre-feet		2.32 acre-feet		1.94 acre-feet		1.48 acre-feet	

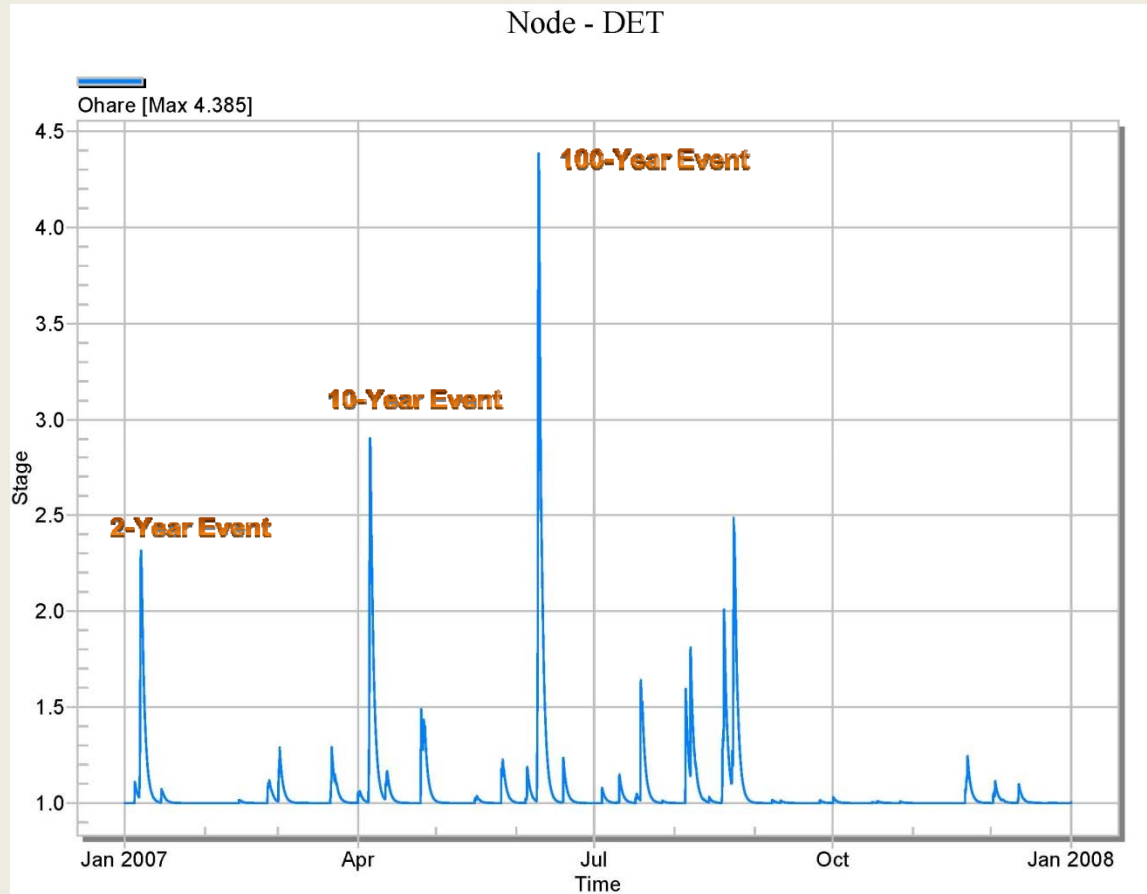
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Continuous Simulation

- 2007 O'Hare hourly rainfall record
- 2-year, 10-year, 100-year 24 hour Lake County Huff Distribution storms built in to record
- Demonstrates that stormwater BMPs effective for routine hydrology

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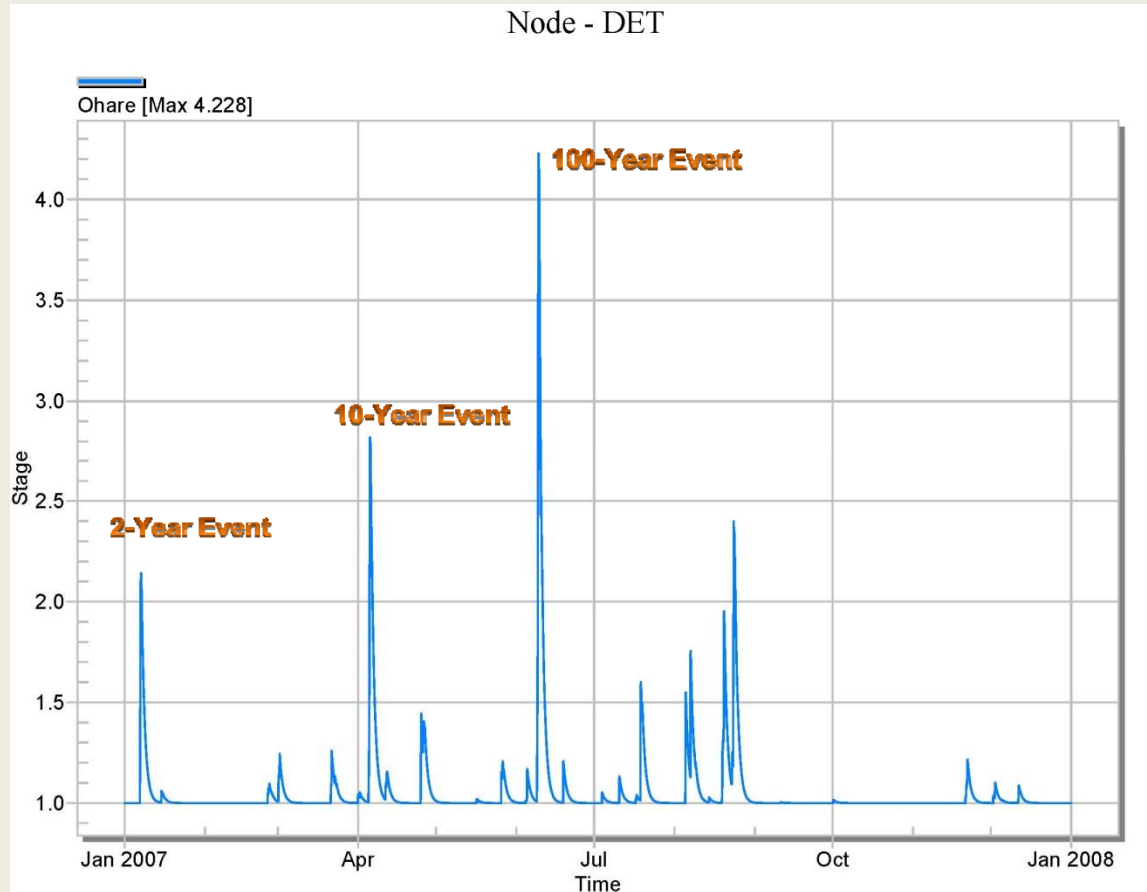
Standard Detention



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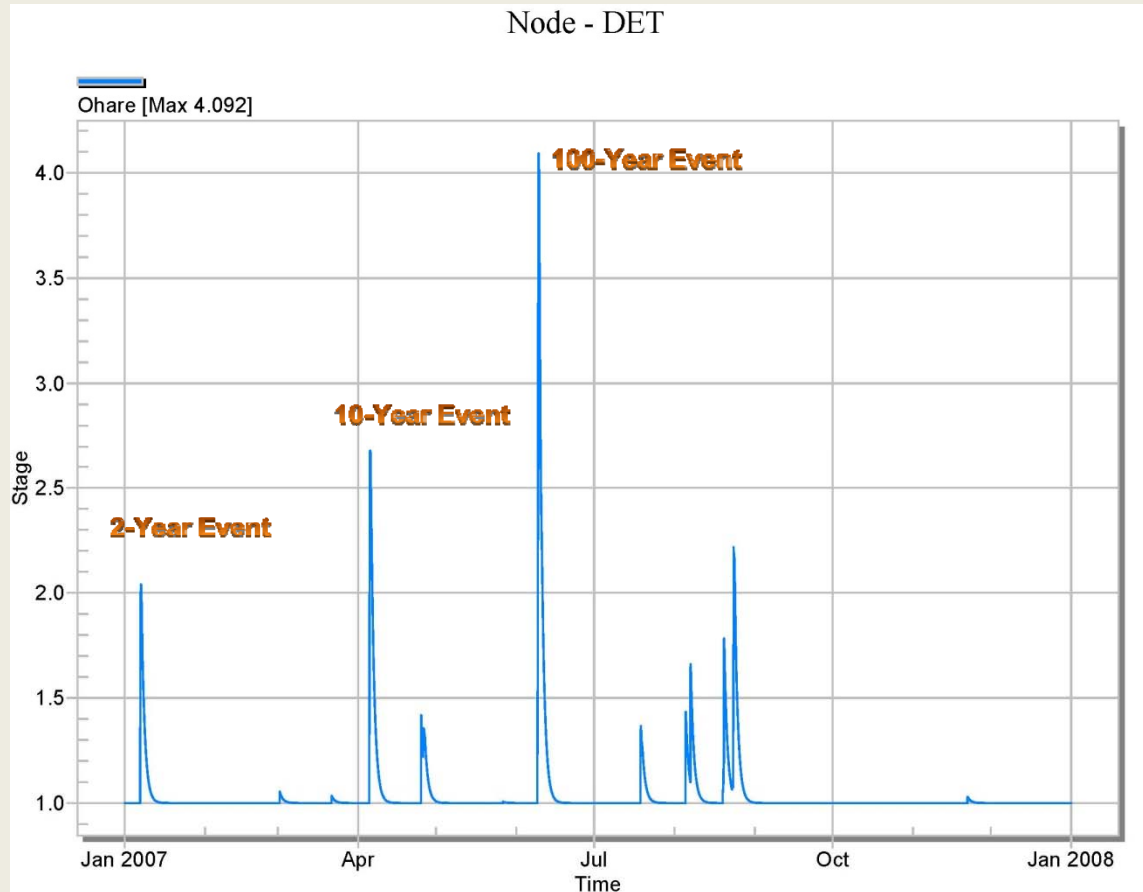
Scenario 1 (1% Area, 0.002 in/hr)



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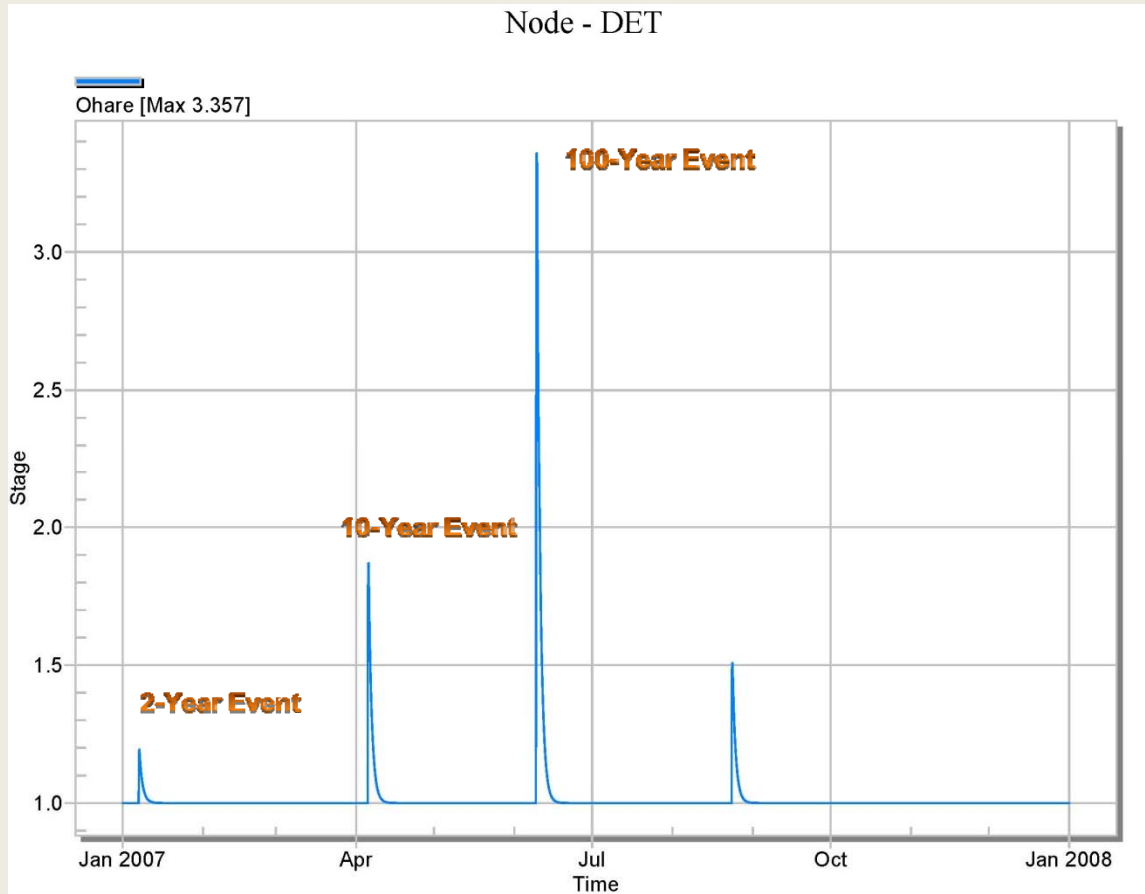
Scenario 4 (5% Area, 0.2 in/hr)



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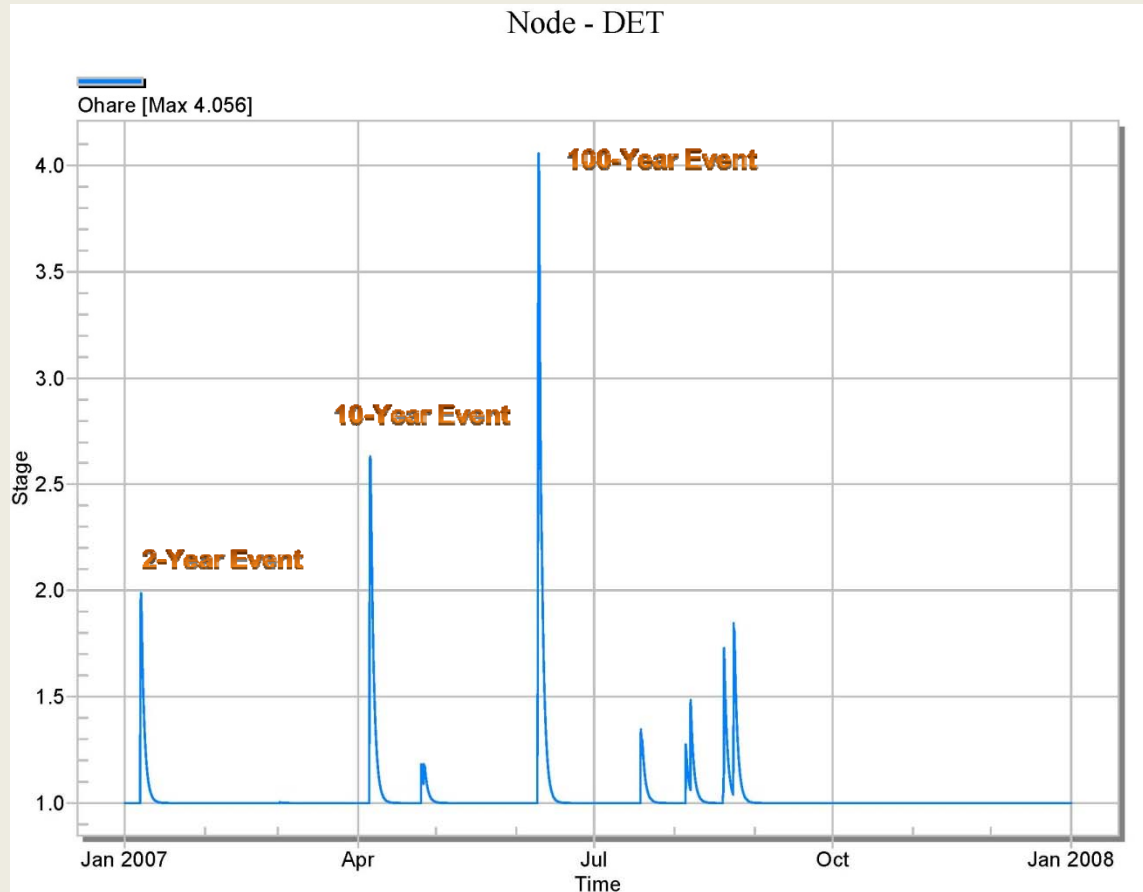
Scenario 5 (10% Area, 0.2 in/hr)



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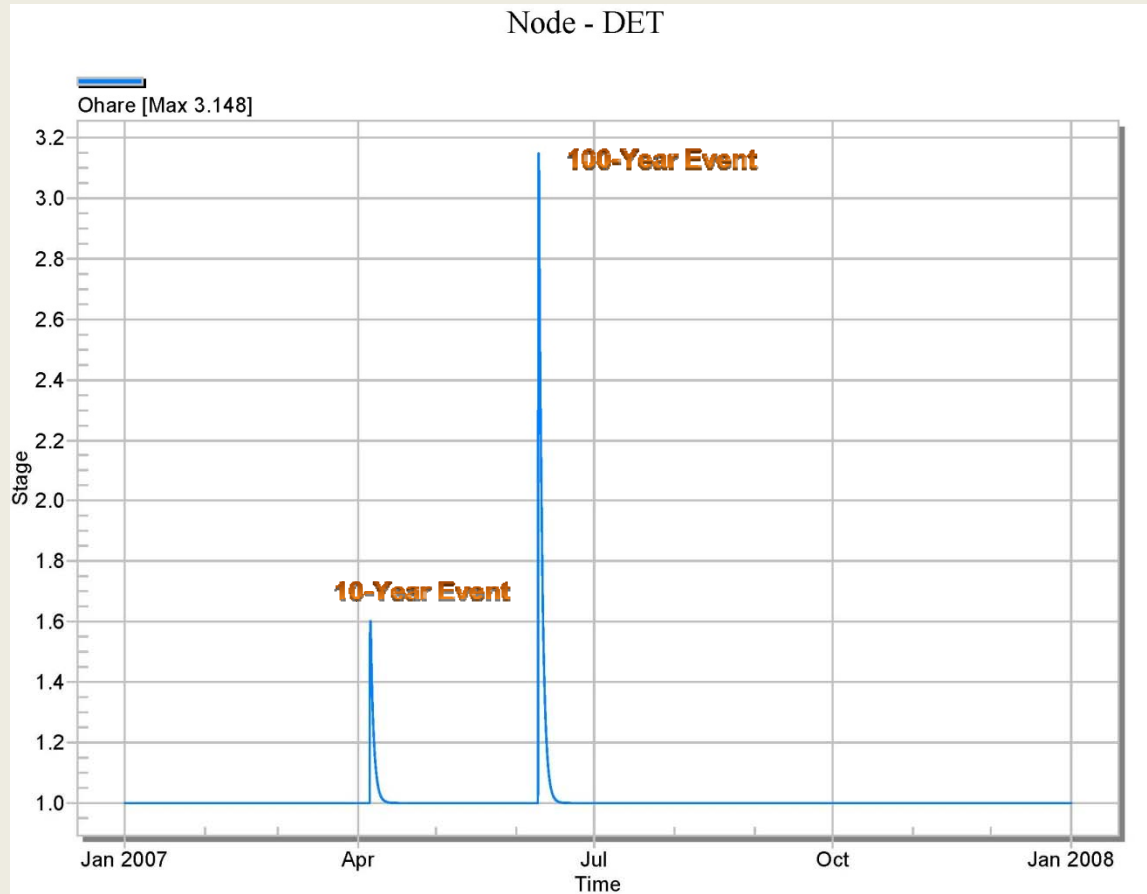
Scenario 7 (5% Area, 0.6 in/hr)



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Scenario 8 (10% Area, 0.6 in/hr)

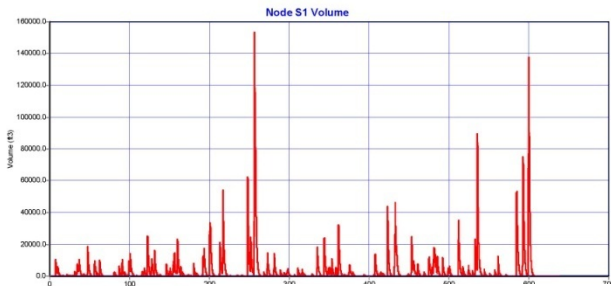


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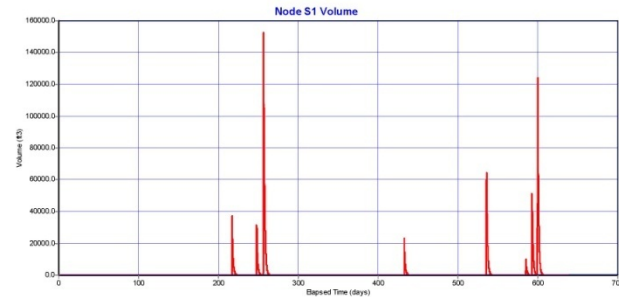
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EPA SWMM (5% Area)

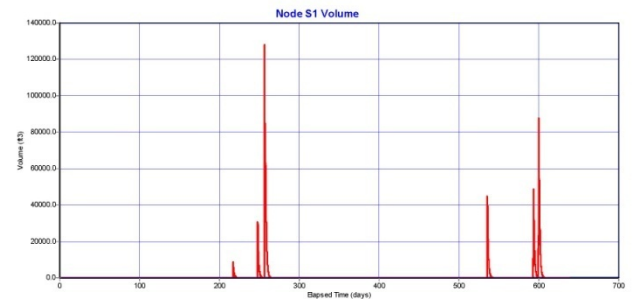
Detention



Scenario 5

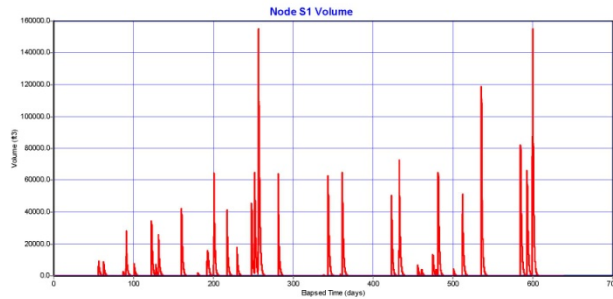


Scenario 8



Scenario 2

SWMM 5



SWMM 5

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Conclusions

- BMP runoff reduction function highly dependent upon site soil conditions and limiting layer
- Importance of documentation of site conditions
- Difficulty in assuring ongoing function in design
- Benefits from volume provided
- Beneficial for routine hydrology
- Cannot mitigate increases in impervious area for regulatory storms over low hydraulic conductivity soils

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Questions?

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