

Waukesha County 2023 Stormwater Conference
April, 2023

WinSLAMM v 10.5 Update – Biofiltration (Mostly)

Using WinSLAMM v10.5.1 to Meet Urban Stormwater Management Goals

John Voorhees

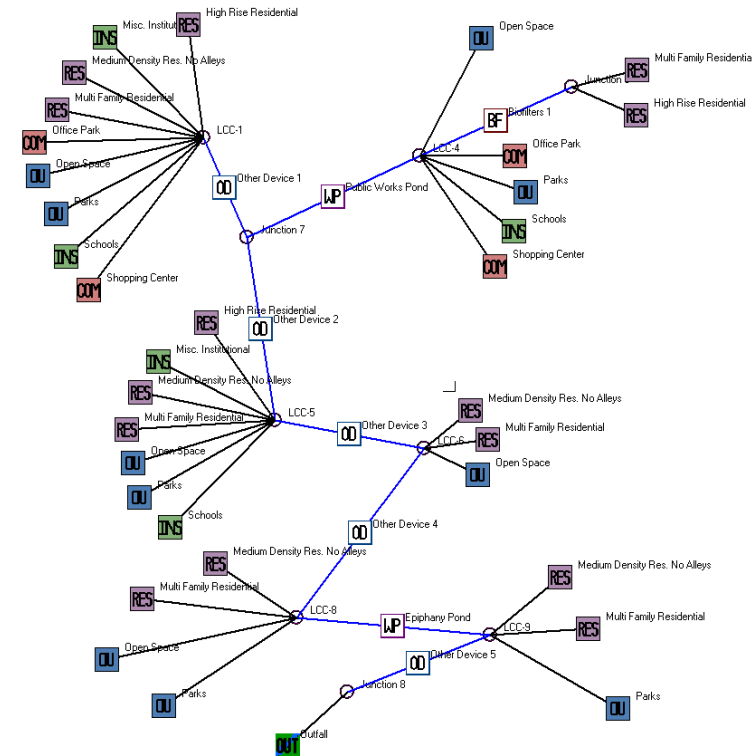
AECOM

Middleton, WI



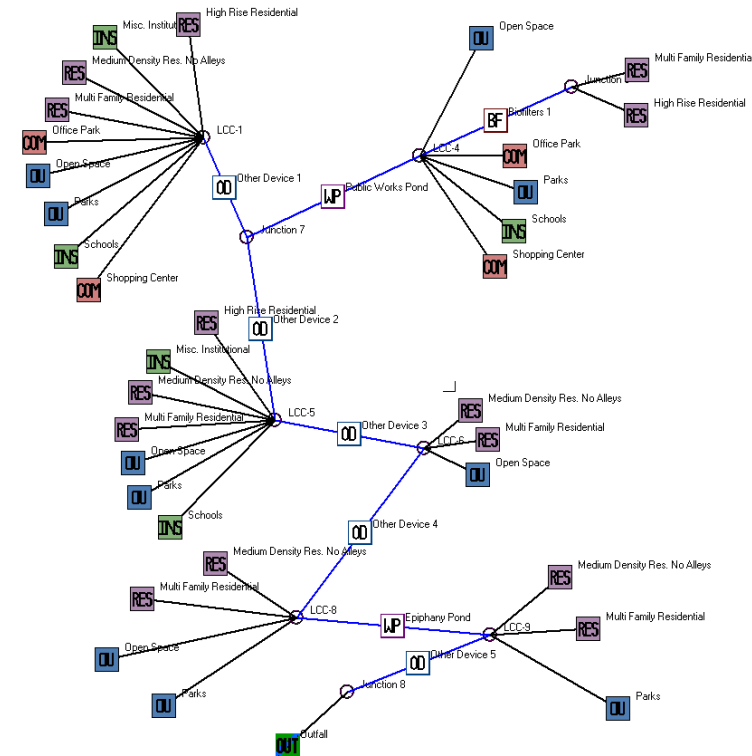
We will cover . . .

1. v 10.5 updates and changes
2. Biofilter Changes
3. Street Source Area Parameter Data Entry



We will cover . . .

1. v 10.5 updates and changes
2. Biofilter Changes
3. Street Source Area Parameter Data Entry



Version 10.5 Updates and Changes

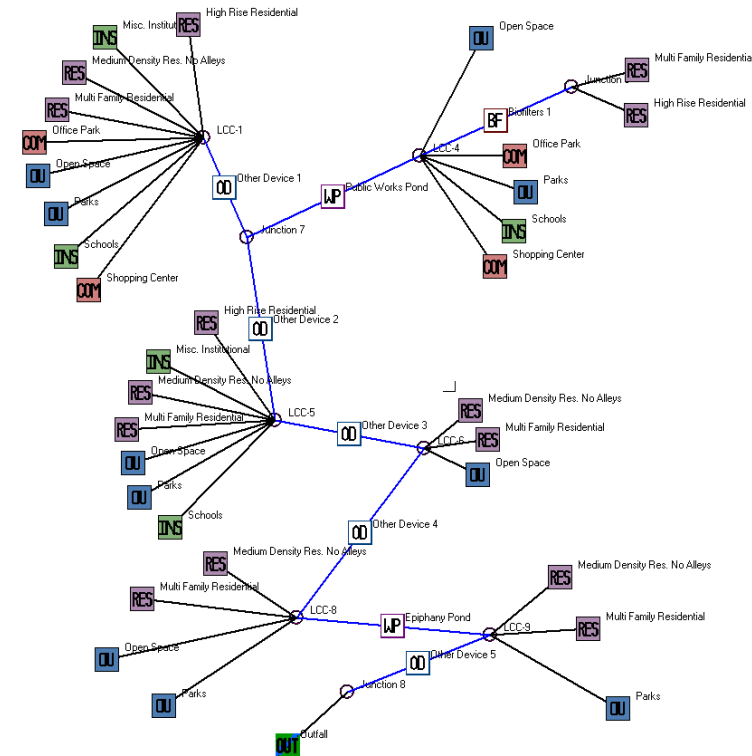
1. Tree Canopy source area adjustments
2. Biofilter Media Table update
3. Linking Files
4. Detention Pond area calcs
5. Control Practice database
6. Minor Isolator Row updates
7. Street Parameter presentation
8. Orifice Discharge Equations (v 10.5.1)
9. Rainfall file creator updates
10. Pollutant Strength Calculation Option (v 10.5.2)

Will Not Affect Output

Will Affect Output

We will cover . . .

1. v 10.5 updates and changes
2. **Biofilter Changes**
3. **Street Source Area Parameter Data Entry**



2. Biofilter Media

The new Data Components for Biofilter Media Types Include:

- Filterable Pollutant Retention by Ion Exchange and Media Sorption
- Particulate (TSS) Retention by Particle Size Group
- Influent and Effluent Pollutant Concentration Regression Equations for Filterable Pollutants
- Data from Full Depth Column Tests and Field Tests
- Media Clogging
- Breakthrough Time (in upcoming release)

This New Data has Significantly Expanded the Data Table

Update Biofilter Media Data

Version 10.4 Biofilter Media Table

Detailed Media Characteristics

Soil Type Texture	Saturation Water Content % (Porosity)	Field Capacity (Percent)	Permanent Wilting Point (Percent)	Infiltration Rate (in/hr)	Fraction of Soil Type Texture in Engineered Soil (0-1)
<input type="checkbox"/> User-Defined Soil Type	0.0	0.0	0.0	0.000	0.000
Gravel	32	4	0	40	0.000
Sands	38	8	2.5	13	0.000
Loamy Sands	39	13.5	4.5	2.5	0.000
Sandy Loams	40	19.5	6.5	1	0.000
Fine Sandy Loams	42	26.5	10.5	0.5	0.000
Loams & Silt Loams	43	34	14	0.15	0.000
Clay Loams/Silty Clay Loams	50	34.5	17	0.1	0.000
Silty Clays & Clays	55	33.5	18	0.015	0.000
Peat as Amendment	78	59	5	3	0.000
Compost as Amendment	61	55	5	3	0.000
Composite Soil Mixture Properties	0.0	0.0	0.0	0.000	0.000

Apply Soil Mixture Values as a User Defined Soil Mixture

Apply Porosity Apply Field Capacity Apply Wilting Point Apply Infiltration Rate Apply All Values

Soil Texture Fraction in last column Less Than 1

Old Data Table

2. Biofilter Media

The new Data Table works the same way as the v 10.4 table, but with more media options

Soil – Typical soil types, not much different from previous version

Rhyolite Sand – Porous volcanic sand

Green Roof Light Media – Expanded slate, other light and porous materials

Zeolite – lightweight volcanic mineral that attracts heavy metals

Compost and Peat – Infiltration rate varies based on percent of organic matter

Wisconsin users should comply with DNR Infiltration Standard requirements

Soil, Media Mixtures and Components Table

Soil Type Texture	Saturation Water Content % (Porosity)	Field Capacity (Percent)	Permanent Wilting Point (Percent)	Infiltration Rate (in/hr)	Fraction of Soil Type Texture in Treatment Soil (0-1)	
User-Defined Media Type						
Soil						
Well Graded Sand	38	8	2.5	13		
Loamy Sand	39	13.5	4.5	2.5		
Sandy Loam	40	19.5	6.5	1		
Loam	43	34	14	0.15		
Silt Loam	43	34	14	0.15		
Silt	42	30	12	0.3		
Sandy Clay Loam	42	26.5	10.5	0.5		
Clay Loam	50	34.5	17	0.1		
Silty Clay Loam	50	34.5	17	0.1		
Sandy Clay	40	34	17	0.05		
Silty Clay	55	33.5	18	0.015		
Clay	55	33.5	18	0.015		
Other Media						
Fine Rhyolite Sand	38	8	2.5	13		
Fine Sand	38	8	2.5	13		
Filter Sand	38	8	2.5	13		
Coarse Sand	32	4	0	40		
Gravel	32	4	0	40		
Light Media for Green Roofs	50	20	5	13		
Chemically Active Amendments						
Activated Carbon	32	4	0	40		
Fine Zeolite (SMZ)	32	4	0	40		
Coarse Zeolite	32	4	0	40		
Compost	61	55	5	Varies		
Peat Moss	78	59	5	Varies		
User Defined Amendments						
'BF Other Media Data Loamy Sand Inde	39	13.5	4.5	2.5		
Pre-Defined Media Mixtures						
Composite Media Mixture Properties						
	0.0	0.0	0.0	0.000	0.000	
Apply Soil Mixture Values as a User Defined Soil Mixture	<input type="checkbox"/>	Apply Porosity <input type="checkbox"/>	Apply Field Capacity <input type="checkbox"/>	Apply Wilting Point <input type="checkbox"/>	Apply Infiltration Rate <input type="checkbox"/>	Apply All Values <input type="checkbox"/>
Soil Texture Fraction in last column Less Than 1						
					Cancel	Continue

2. Biofilter Media

Media Mixtures

These mixtures require that you enter a 1.0 as the fraction

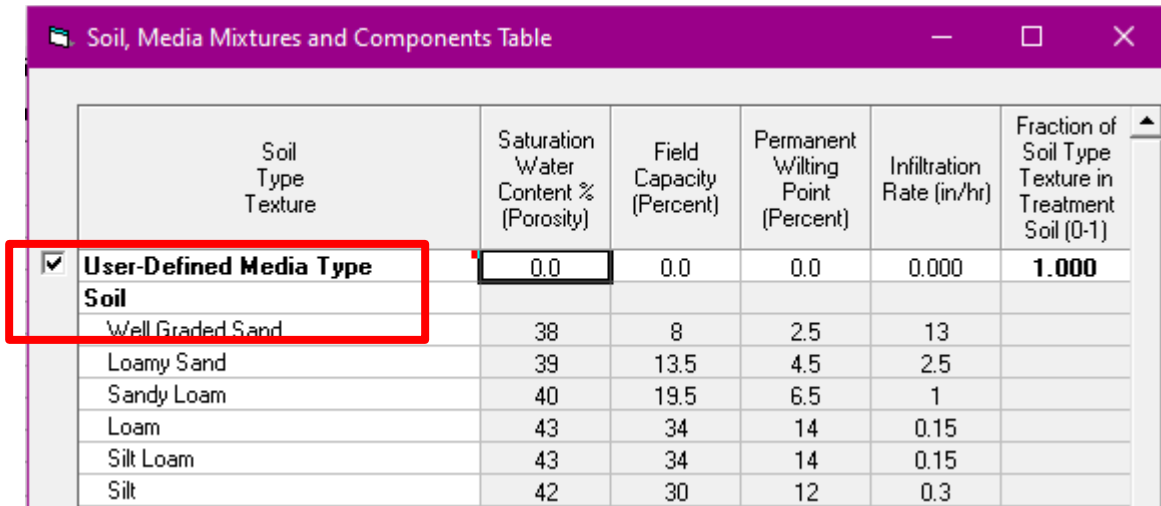
To activate red square info, click on the cell with the square and hover over the red square

User defined data will be activated with a text file that allows the user to define all variables associated with pollutant removal.

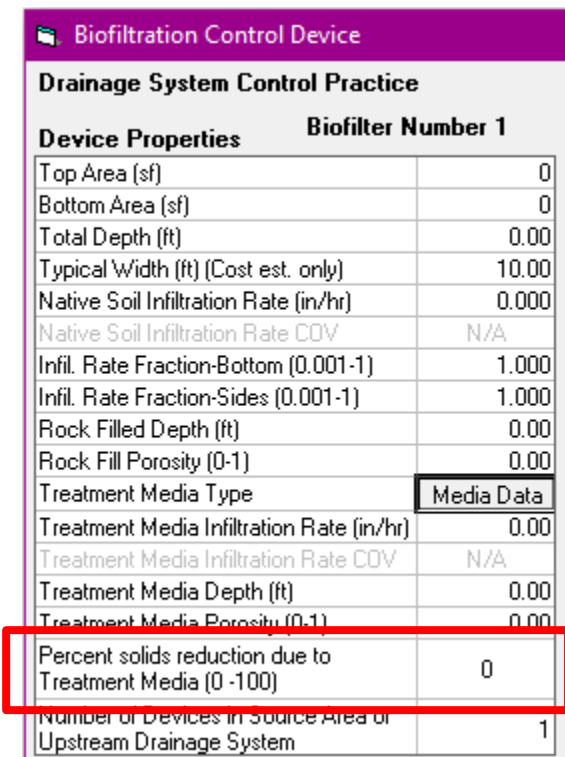
Soil Type Texture	Saturation Water Content % (Porosity)	Field Capacity (Percent)	Permanent Wilting Point (Percent)	Infiltration Rate (in/hr)	Fraction of Soil Type Texture in Treatment Soil (0-1)
Sandy Clay Loam	42	26.5	10.5	0.5	
Clay Loam	50	34.5	17	0.1	
Silty Clay Loam	50	34.5	17	0.1	
Sandy Clay	40	34	17	0.05	
Silty Clay	55	33.5	18	0.015	
Clay	55	33.5	18	0.015	
Other Media					
Fine Rhyolite Sand	38	8	2.5	13	
Fine Sand	38	8	2.5	13	
Filter Sand	38	8	2.5	13	
Coarse Sand	32	4	0	40	
Gravel	32	4	0	40	
Light Media for Green Roofs	50	20	5	13	
Chemically Active Amendments					
Activated Carbon	32	4	0	40	
Fine Zeolite (SMZ)	32	4	0	40	
Coarse Zeolite	32	4	0	40	
Compost	61	55	5	Varies	
Peat Moss	78	59	5	Varies	
User Defined Amendments					
DF-Other Media Data Loamy Sand Ind	39	13.5	4.5	2.5	
Pre-Defined Media Mixtures					
Rhyolite Sand - SMZ	43	4	0	25	
Rhyolite Sand - SMZ-GAC	41	4	0	25	
Rhyolite Sand - SMZ-GAC-PM	43	10	0.5	25	
Iron Fillings (5%) / Sand	38	8	2.5	13	
Biofilter Media Mixtures					
Kansas City	40	12	10	.55	
Neenah 2	40	10	5	20.5	
North Carolina	40	7	5	18.7	
Composite Media Mixture Properties 0.0 0.0 0.0 0.000 0.000					
Apply Soil Mixture Values as a User Defined Soil Mixture	<input type="checkbox"/> Apply Porosity	<input type="checkbox"/> Apply Field Capacity	<input type="checkbox"/> Apply Wilting Point	<input type="checkbox"/> Apply Infiltration Rate	<input type="checkbox"/> Apply All Values
Soil Texture Fraction in last column Less Than 1					Cancel Continue

Two User Defined Media Options

1. Select the **User Defined Media Type** checkbox to enter the Percent Solids Reduction due to Treatment Media value as allowed by WDNR standards



Soil Type Texture	Saturation Water Content % (Porosity)	Field Capacity (Percent)	Permanent Wilting Point (Percent)	Infiltration Rate (in/hr)	Fraction of Soil Type Texture in Treatment Soil (0-1)
<input checked="" type="checkbox"/> User-Defined Media Type	0.0	0.0	0.0	0.000	1.000
Soil					
Well Graded Sand	38	8	2.5	13	
Loamy Sand	39	13.5	4.5	2.5	
Sandy Loam	40	19.5	6.5	1	
Loam	43	34	14	0.15	
Silt Loam	43	34	14	0.15	
Silt	42	30	12	0.3	



Biofiltration Control Device	
Drainage System Control Practice	
Biofilter Number 1	
Device Properties	
Top Area (sf)	0
Bottom Area (sf)	0
Total Depth (ft)	0.00
Typical Width (ft) (Cost est. only)	10.00
Native Soil Infiltration Rate (in/hr)	0.000
Native Soil Infiltration Rate COV	N/A
Infil. Rate Fraction-Bottom (0.001-1)	1.000
Infil. Rate Fraction-Sides (0.001-1)	1.000
Rock Filled Depth (ft)	0.00
Rock Fill Porosity (0-1)	0.00
Treatment Media Type	Media Data
Treatment Media Infiltration Rate (in/hr)	0.00
Treatment Media Infiltration Rate COV	N/A
Treatment Media Depth (ft)	0.00
Treatment Media Porosity (0-1)	0.00
Percent solids reduction due to Treatment Media (0-100)	0
Number of Devices in Source Area or Upstream Drainage System	1

The clogging rate is matched to the soil type with an infiltration rate closest to that soil's rate

2. Biofilter Media

Or . . .

2. Select the **User Defined Amendment** option from the new Media Table

Soil, Media Mixtures and Components Table

Soil Type Texture	Saturation Water Content % (Porosity)	Field Capacity (Percent)	Permanent Wilting Point (Percent)	Infiltration Rate (in/hr)	Fraction of Soil Type Texture in Treatment Soil (0-1)					
User-Defined Media Type										
Soil										
Well Graded Sand	38	8	2.5	13						
Loamy Sand	39	13.5	4.5	2.5						
Sandy Loam	40	19.5	6.5	1						
Loam	43	34	14	0.15						
Silt Loam	43	34	14	0.15						
Silt	42	30	12	0.3						
Sandy Clay Loam	42	26.5	10.5	0.5						
Clay Loam	50	34.5	17	0.1						
Silty Clay Loam	50	34.5	17	0.1						
Sandy Clay	40	34	17	0.05						
Silty Clay	55	33.5	18	0.015						
Clay	55	33.5	18	0.015						
Other Media										
Fine Rhyolite Sand	38	8	2.5	13						
Fine Sand	38	8	2.5	13						
Filter Sand	38	8	2.5	13						
Coarse Sand	32	4	0	40						
Gravel	32	4	0	40						
Light Media for Green Roofs	50	20	5	13						
Chemically Active Amendments										
Activated Carbon	32	4	0	40						
Fine Zeolite (SMZ)	32	4	0	40						
Coarse Zeolite	32	4	0	40						
Compost	61	55	5	Varies						
Peat Moss	70	50	5	Varies						
User Defined Amendments										
*BF Other Media Data Loamy Sand Inde	39	13.5	4.5	2.5	1.000					
Pre-Defined Media Mixtures										
Composite Media Mixture Properties										
	39.0	13.5	4.5	0.000	1.000					
Apply Soil Mixture Values as a User Defined Soil Mixture	<input checked="" type="checkbox"/>	Apply Porosity	<input checked="" type="checkbox"/>	Apply Field Capacity	<input checked="" type="checkbox"/>	Apply Wilting Point	<input checked="" type="checkbox"/>	Apply Infiltration Rate	<input checked="" type="checkbox"/>	Apply All Values

User Defined Media Data Requirements

- Physical properties – Saturation water content, Field capacity, Permanent wilting point, Infiltration rate, D_{60} , D_{50} , D_{10}
- Clogging load
- TSS removal equations by particle size range – Linear equation format for TSS removal
- For each pollutant
 - Four removal equation types – 1) Constant, 2) Linear, 3) Log-Log, 4) Fraction Reduction
 - Removal equation coefficients for the equation type
 - Dataset minimum and maximum values for range

Program Options

Detailed Output File Options **Default Model Options** Default Current File Data

Turn 'Save File Upon Exit' Message Off
 Suppress the Wet Detention Pond and Biofilter Overflow Warning Messages
 Save Backup File
 Save Outfall Runoff and Particulate Loading for WinDETPOND Analysis
 Maximum allowable biofilter surface ponding duration (hrs) 72

Biofilter User Defined Media File Z:\Files\Projects & Analysis\Biofiltration\BF Other Media Data Template.txt

If Other Device pollutant load reduction values are set to 1, remove off-site pollutant loads from pollutant load percent reduction calculations.

Soil Compaction Infiltration Factors

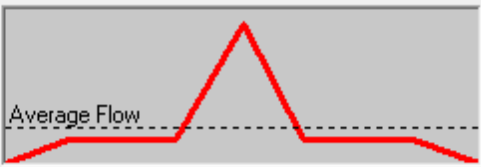
	Sandy	Silty	Clayey
Moderately Compacted	0.50	0.20	0.10
Severely Compacted	0.20	0.10	0.00

Create Hydrograph and Particle Size Distribution .csv Files
 Use Default Time Increment for all Hydrograph Analyses (required for hydrograph routing between control practices)
 Default Time Increment (min): 6

First day of Spring 03/15
 First day of Summer 06/15
 First day of Fall 09/15
 First day of Winter 12/15

Standard Land Use File C:\WinSLAMM Files\StandardLandUses.000

Default Peak Flow to Average Flow Ratio 3.8



Flow

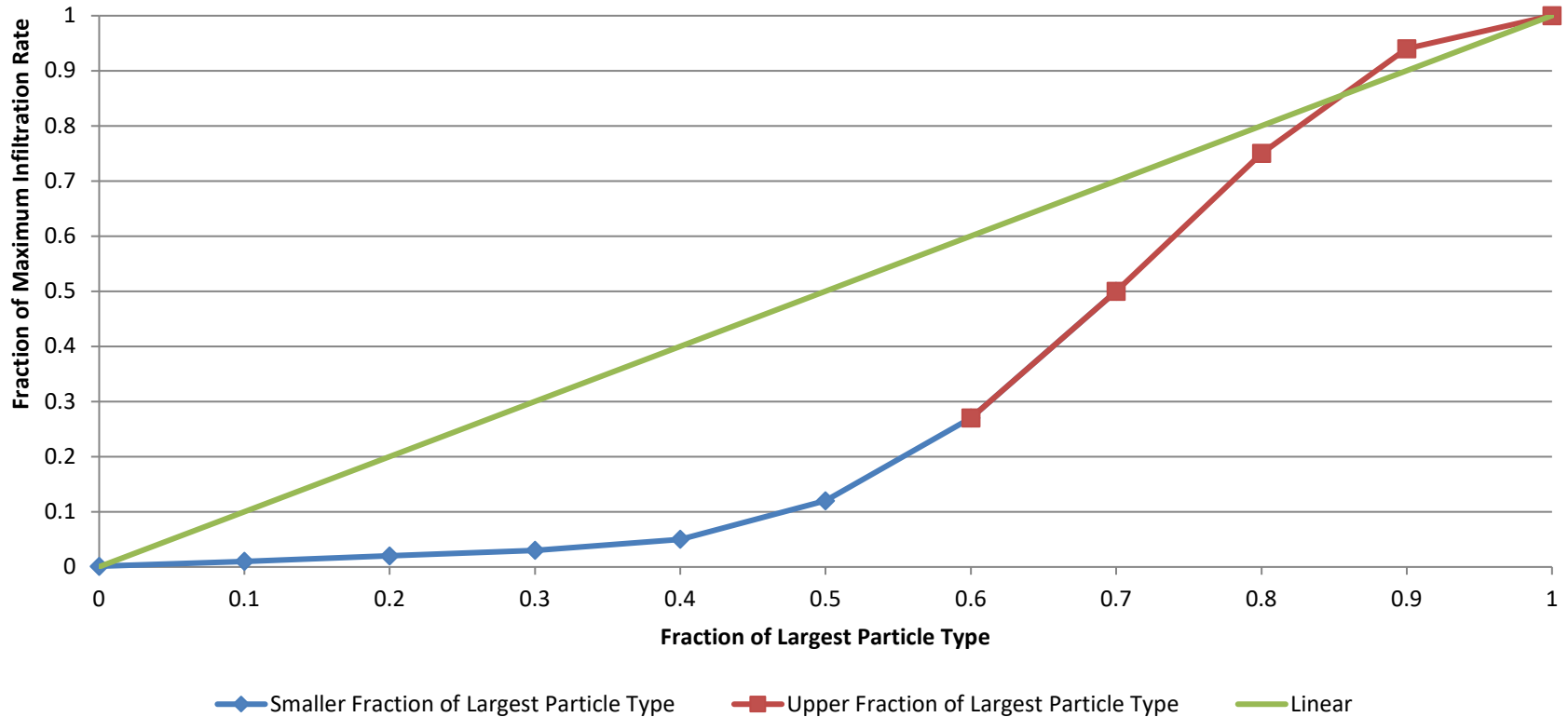
Average Flow

Time (1.2 * Rainfall Duration)

This data is stored as a text file in the Default Model Options tab of the Program Options form

Infiltration Rate Modifications

Biofilter Media Infiltration Rate Adjustment for Small Particle Sizes in Media



Porosity, Field Moisture Capacity, Wilting Point are Linear

2. Biofilter Media

Data Summary Table for Pollutants and Media

- Ref: Pitt et al, “Biofilter Media Performance Updates for WinSLAMM” (2022)
- Lists standard pollutants and TSS
- Pollutants added in v 10.5
- Based upon available data – if no data, effluent concentration = influent concentration

		Soil												Other Media						Chemically active amendments					Pre-defined media mixtures				Biofilter media mixtures		
Media Type	Index No ==>	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	21	23	24	25	26	27	32	33	34	35	38	40	41
Index	Pollutant	Well graded sand	loamy sand	sandy loam	loam	silt loam	silt	sandy clay loam	clay loam	silty clay loam	sandy clay	silty clay	clay	fine Rhyolite sand	fine sand	filter sand	coarse sand	gravel	light media for green roofs	activated carbon	fine zeolite (SMZ)	coarse zeolite	compost	peat moss	Rhyolite sand - SMZ	Rhyolite Sand - SMZ - GAC	Rhyolite Sand - SMZ - GAC - PM	Iron fillings (5%) / sand	Kansas City	Wisconsin 2	North Carolina
	Total Suspended Solids (TSS)	T10 (2)	T10	T10	T10	T10	T10	T10	T10	T10	T10	T10	T10	T15	T10	T11	T11	T12	T12	T13	T18	T17	T14	T14	T19	T20	T21	T10	T22	T23	T23
2	Total Dissolved Solids (TDS)																												T37	T37	T37
5	Filtered Phosphorus	T34	T34	T37	T37	T37	T37	T37	T37	T37	T37	T37	T37	T27	T28	T28	T36			T25	T30	T29	T38				T33	FeRpt (1)	T38	T37	T37
8	Nitrate + Nitrite	T36	T36				T37	T37	T37	T37	T37	T37					T36			T25							T32		T38	T38	T38
11	Filtered TKN	T36	T36														T36														
14	COD	T36	T36														T36														
17	Fecal Coliforms	T34	T34	T28	T28	T28	T37	T37	T37	T37	T37	T37	T37	T27	T28	T28					T34	T34	T34	T34				T28	T37	T37	T37
20	Chromium (Cr)																			T25	T30	T29	T26	T26	T31	T32	T33				
23	Copper (Cu)	T36	T36				T37	T37	T37	T37	T37	T37	T37				T36			T25		T29	T26	T26		T32	T33		T26	T37	T37
26	Lead (Pb)	T36	T36														T36														
29	Zinc (Zn)	T36	T36				T37	T37	T37	T37	T37	T37	T37				T36												T37	T37	T37

2. Biofilter Media

Example Tables for Pollutants and Media, T10 and T26

T10 – TSS Removal for Typical Soil Types

Table 10. Low to High Concentrations (100 to 800 SSC mg/L), fine media (about 300 um) (data from Sileshi 2013)

>1000 um		301 to 1000 um		101 to 300 um		31 to 100 um		11 to 30 um		4 to 10 um		1 to 3 um		total	
inf	efl	inf	efl	inf	efl	inf	efl	inf	efl	inf	efl	inf	efl	inf	efl
no sign regression		no sign regression		no sign regression		intercept sign		intercept sign		intercept sign		no likely removal		intercept sign	
mean	efl = 0	mean	efl = 0	mean	efl = 0.06	mean	efl = 0.30	mean	efl = 1.55	mean	efl = 2.43			mean	efl = 4.5
COV	n/a	COV	n/a	COV	1.33	COV	0.5	COV	0.66	COV	0.3			COV	0.39

sign == significant

T26 – Pollutant Removal for Peat Moss and Compost

Table 26. Removals for Peat Moss for Full-Depth Column Tests (50/50 mix with filter sand) (SSFL)

Constituent, mg/L unless noted otherwise	regression equation (or Y = constant, and COV also shown)**	Mean Influent Concentration (approximate range)***
pH	Y = X - 3.0	7.7 (7.3 to 8.2)
Chloride	Y = 33 (0.15)	18 (1 to 34)
Fluoride	Y = 0.67X	2.6 (1.7 to 3.1)
Aluminum, filtered, µg/L	Y = 778 (0.48)	73 (<LOD to 121)
Calcium, filtered, µg/L	Y = 0.40 X	30,400 (22,150 to 42,400)
Cadmium, filtered, µg/L	almost all effluent <LOD	28 (1 to 54)
Copper, filtered, µg/L	Y = 12.3 (0.26)	42 (23 to 69)
Manganese, filtered, µg/L	Y = 230 (0.64)	3.4 (<LOD to 13)
Nickel, filtered, µg/L	Y = 4.8 (0.62)	27 (7 to 68)
Chromium, filtered, µg/L	Y = 3.8 (0.9)	14 (7 to 19)
Thallium, filtered, µg/L	Y = 13 (0.63)	64 (27 to 94)
Antimony, filtered, µg/L	Y = 8.1 (1.7)	56 (39 to 86)

Why Vegetate the Media? **Clogging**

WinSLAMM Defines Four Conditions

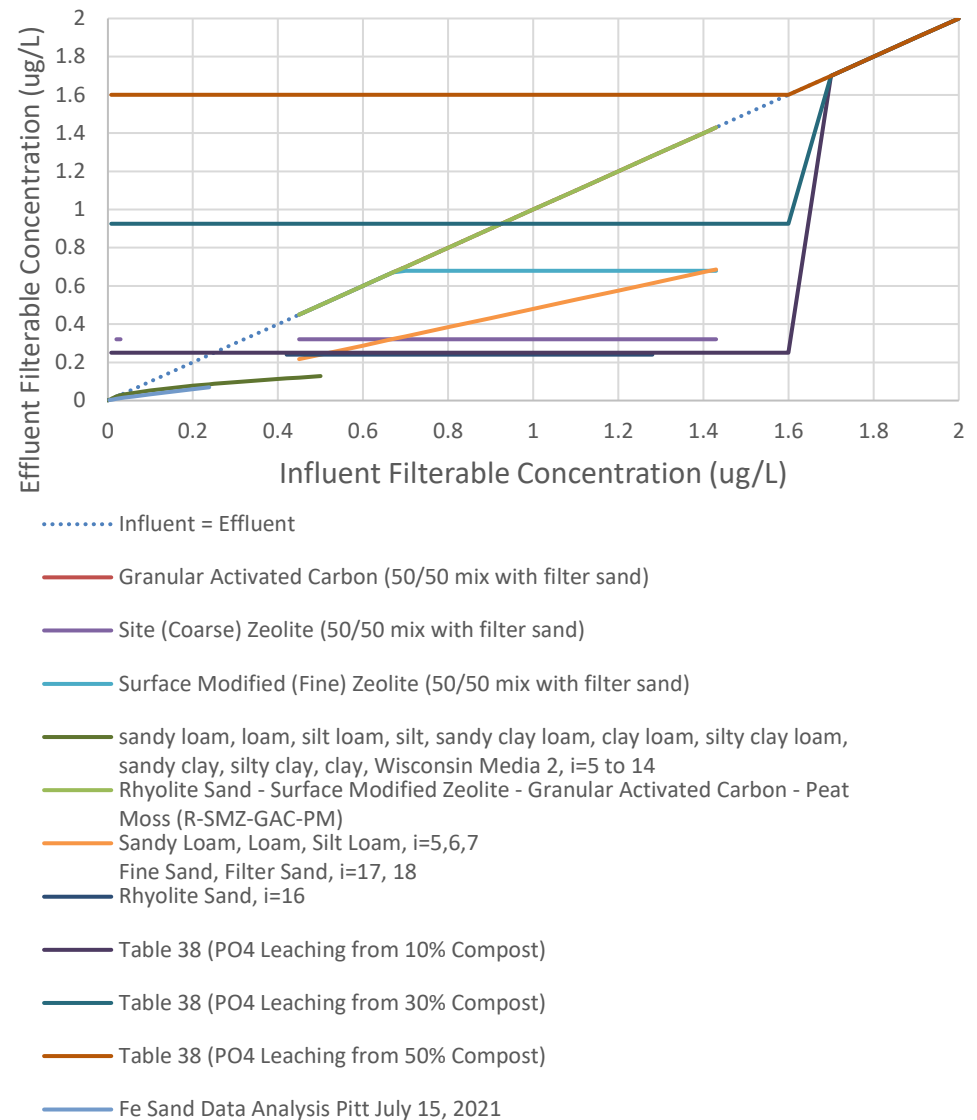
	Not Vegetated	Vegetated
<1/10 max load in first year	Continue to decrease infiltration rate after each event and shut down when the maximum load is reached	Hold infiltration rate constant after the first year and do not decrease further
>1/10 max load in first year	Continue to decrease infiltration rate after each event and shut down when the maximum load is reached	Continue to decrease infiltration rate after each event and shut down when the maximum load is reached

2. Biofilter Media

Example Performance Plot - Filterable Phosphorus Removal

- Many media options
- Some media effluent concentrations > influent concentrations
- Includes Fe media performance from SAFL

Influent and Effluent Filterable Phosphorus Concentration for Media (mg/L)



2. Biofilter Media

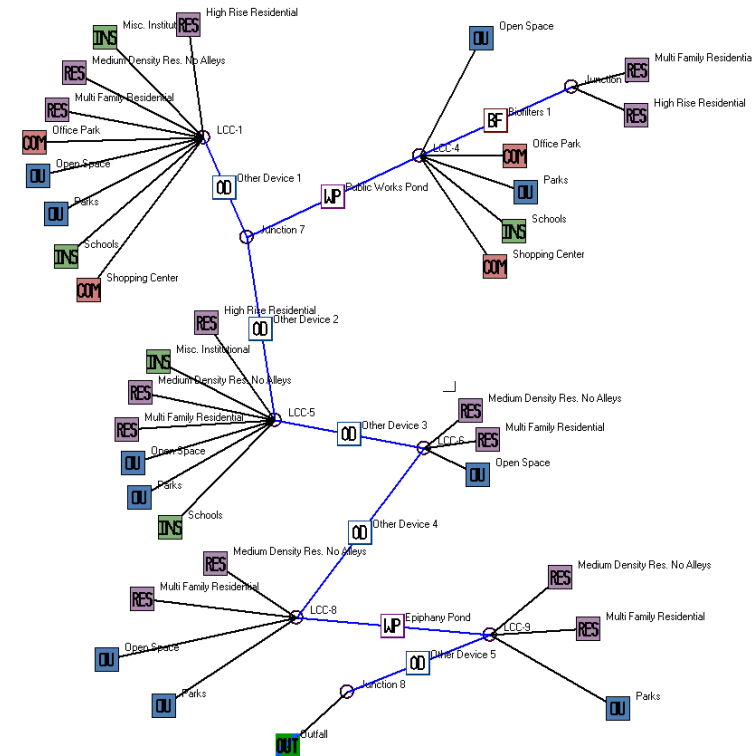
Detailed Output Options

Table 100-
BF Media
Constants

BF Number =	1			
Media Name =	Well Graded Sand	Fraction of Total Media Mixture -	TSS Equation Set Name = 1	Fine PSD
Biofilter Bottom Area (sf) =	850			
Media Mixture Median Particle Size (micr	140			
First Year Media Weighted Clogging Capa	0.20481			
First Year Cumulative Surface Loading (lb	1.25586			
Biofilter Vegetated:	#FALSE#			
Biofilter Failed by Clogging:	#FALSE#			
Biofilter Depth (ft) =	5			
Default Time Increment (min) =	6			
Number of Filterable Solids (mg/L) Influent Concentration Values that are less than the monitored data range:	0			
Number of Filterable Solids (mg/L) Influent Concentration Values that are greater than the monitored data range:	0			
Number of Filterable Phosphorus (mg/L) Influent Concentration Values that are less than the monitored data range:	90			
Number of Filterable Phosphorus (mg/L) Influent Concentration Values that are greater than the monitored data range:	0			

We will cover . . .

1. v 10.5 updates and changes
2. Biofilter Changes
3. **Street Source Area Parameter Data Entry**



Different Street Source Area Data Entry Process

- Reconfigured this form due to confusion about street length and curb miles.
- The updated form requires an explicit selection of the number of street edges
- The form has units of edge-miles rather than curb-miles
- The default number of edges for a street is 2 - the same used in previously in WinSLAMM
- Enter either the total street length or the paved street width
- The form includes a graphic representation of the selected street edge option, dimensioned

3. Street Source Area Parameter Changes

Enter either the Total Street Length (miles) or the Paved Street Width (ft)

Select the Number of Street Edges

WinSLAMM calculates the Total Street Edge Length (edge-mi)

The graphic illustrates the selected condition

Modified

3. Street Source Area Parameter Changes


Area = 2.0 acres

Street Source Area Parameters

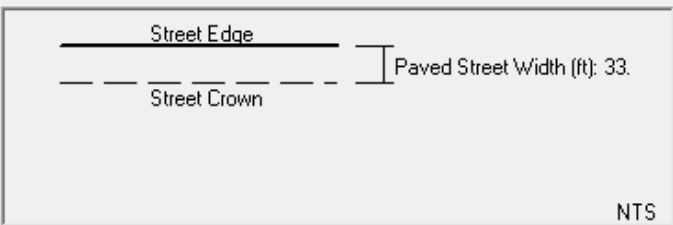
Land Use: Commercial 1
Source Area: Streets 1
Total Area: 2.000 acres

Enter --> Total Street Length (miles): 0.5000

Or --> Paved Street width (ft): 33.

Street Edges:  2 3 4

Total Street Edge Length (edge-miles): 0.5000




Street Texture: 1. Smooth 2. Intermediate

Street Source Area Parameters

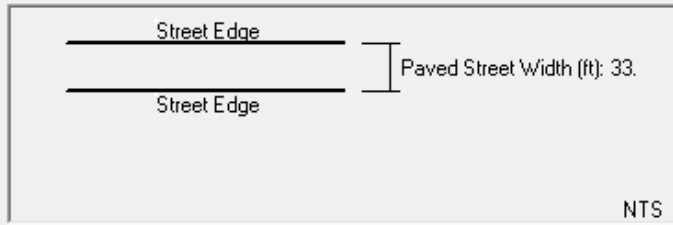
Land Use: Commercial 1
Source Area: Streets 1
Total Area: 2.000 acres

Enter --> Total Street Length (miles): 0.5000

Or --> Paved Street width (ft): 33.

Street Edges: 1  3 4

Total Street Edge Length (edge-miles): 1.0000




Street Texture: 1. Smooth 2. Intermediate

Street Source Area Parameters

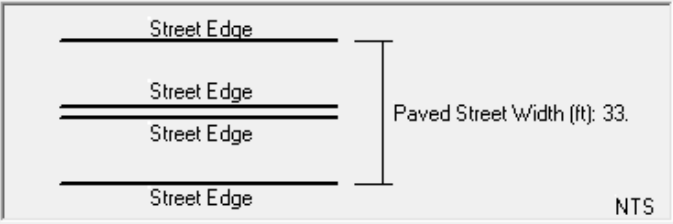
Land Use: Commercial 1
Source Area: Streets 1
Total Area: 2.000 acres

Enter --> Total Street Length (miles): 0.5000

Or --> Paved Street width (ft): 33.

Street Edges: 1 2 3 

Total Street Edge Length (edge-miles): 2.0000




Street Texture: 1. Smooth 2. Intermediate

Street Source Area Parameters

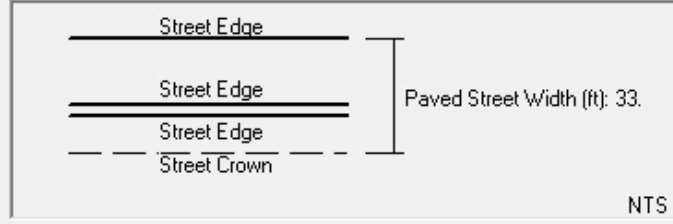
Land Use: Commercial 1
Source Area: Streets 1
Total Area: 2.000 acres

Enter --> Total Street Length (miles): 0.5000

Or --> Paved Street width (ft): 33.

Street Edges: 1 2  4

Total Street Edge Length (edge-miles): 1.5000



Street Texture: 1. Smooth 2. Intermediate

3. Street Source Area Parameter Changes

Area = 2.0 acres

Street Source Area Parameters

Land Use: Commercial 1
Source Area: Streets 1
Total Area: 2.000 acres

Enter --> Total Street Length (miles): 0.5000
Or --> Paved Street width (ft): 33.

Street Edges: 1 2 3 4

Total Street Edge Length (edge-miles): 2.0000

Diagram: A rectangle representing a street source area. It contains four horizontal lines, each labeled "Street Edge". A vertical dimension line on the right indicates a "Paved Street Width (ft): 33.". The text "NTS" is in the bottom right corner.

Street Texture: 1. Smooth 2. Intermediate

Copied from the previous slide, with 4 street edges

Street Source Area Parameters

Land Use: Commercial 1
Source Area: Streets 1
Total Area: 2.000 acres

Enter --> Total Street Length (miles): 0.2500
Or --> Paved Street width (ft): 66

Street Edges: 1 2 3 4

Total Street Edge Length (edge-miles): 1.0000

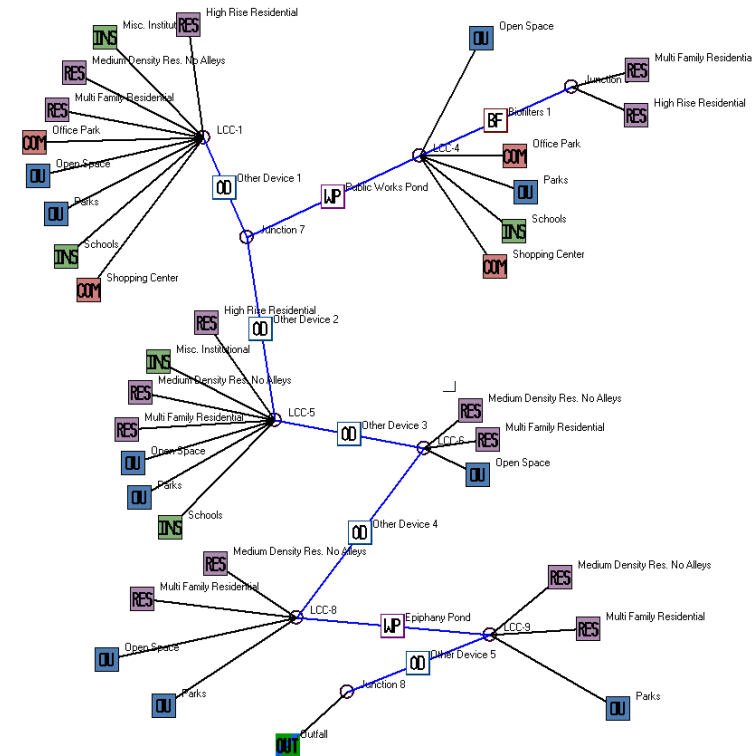
Diagram: A rectangle representing a street source area. It contains four horizontal lines, each labeled "Street Edge". A vertical dimension line on the right indicates a "Paved Street Width (ft): 66.". The text "NTS" is in the bottom right corner.

Street Texture: 1. Smooth 2. Intermediate

After doubling the Paved Street Width

We covered . . .

1. v 10.5 updates and changes
2. Biofilter Changes
3. Street Source Area Parameter Data Entry



Questions?