Waukesha County 2018 Stormwater Conference

March, 2018

WinSLAMM v 10.3 Update

Using WinSLAMM v10.3.4 to Meet Urban Stormwater Management Goals

John Voorhees

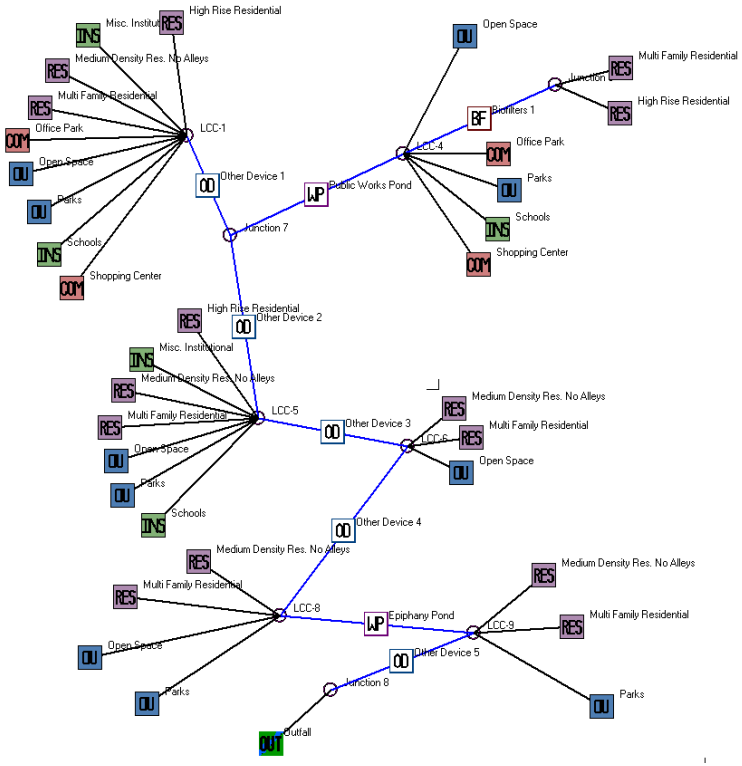
AECOM

Middleton, WI

Waukesha County Parks and Land Use Land Resources

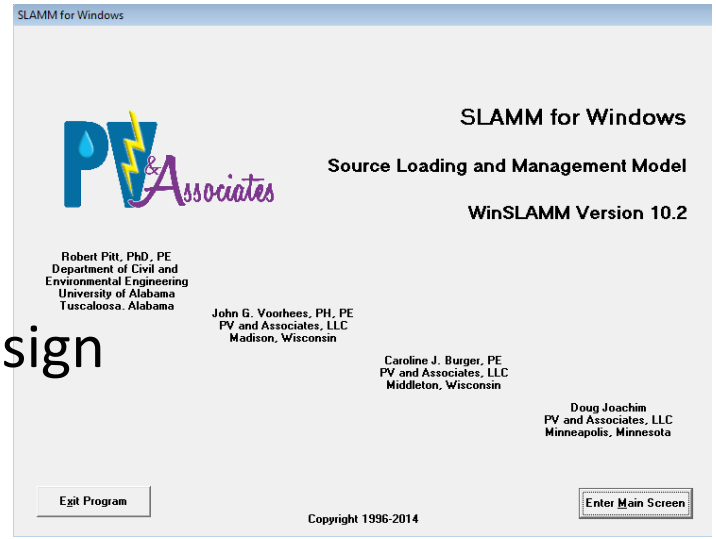
We will cover . . .

1. WinSLAMM Purpose and History
2. High Traffic Urban Highways
3. Particle Size Distribution Files
4. Importing Images
5. Other Device
6. Filtering and Settling Devices
7. Pipes
8. Command Line Model Runs
9. ArcSLAMM Plus
10. Modeling Issues
11. Planned Modifications



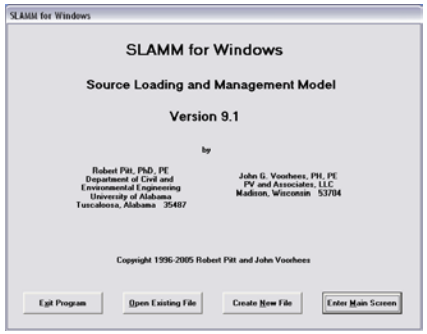
WinSLAMM – What is it?

- Source Loading And Management Model for Windows
- Calculates Urban Stormwater Volumes and Pollutant Loads, and Quantifies their Reductions through the application of Stormwater Control Practices
- Applicable to:
  - Specific Control Practice Design
  - Site Development Analysis
  - Drainage Basin/MS4 Planning and Design
  - TMDL Reduction Determination



Background & History

- Development Began in mid-1970's, with EPA Street Cleaning Projects in Southern California, by Dr. Robert Pitt
- Mid-1980's - Model used in Agency Programs (Interpreter Basic):
  - Toronto Area Watershed Management Strategy
  - Wis. Dept. of Natural Resources: Priority Watershed Program
- First Compiled Basic version released in late 80's
- First Windows Version Developed in 1995
- Version 10 released in 2012
- Continuously being updated based on user needs and new research
- PV & Associates
  - Bob Pitt
  - John Voorhees
  - Caroline Burger
  - Doug Joachim
  - and others



New Source Area in Freeway LU
High Traffic Urban Highways

- Accounts for high volume traffic corridors in Urban Areas
- Allows street cleaning for these corridors
- Data developed from USGS/DNR studies of highways
- Assumptions
  - ADT > 6,000 vpd
  - Speed Limit ≥ 30 mph
  - No Parking
  - Curb and Gutter in Good Condition
  - Used with Vacuum-Assisted Street Cleaning Machines
- **Preferred Source Area for Freeway Analysis**

Particle Size Distribution by Source Area

Source Area Particle Size Distribution and Peak-To-Average Rainfall Ratio Standard Files

Select Source Area File (.csv) to Edit: C:\WinSLAMM Files\NURP Source Area PSD Files.csv

Browse to Particle Size Distribution (.cpz) File Path: C:\WinSLAMM Files\

Source Area Particle Size Distributions | Peak to Averge Flow Ratio - Light Rains | Peak to Averge Flow Ratio - Moderate Rains | Peak to Averge Flow Ratio - Heavy Rains

	Residential Land Use	Institutional Land Use	Commercial Land Use	Industrial Land Use	Other Urban Land Use	Freeway Land Use
Roofs	NURP	NURP	NURP	NURP	NURP	NURP
Paved Parking	NURP	NURP	NURP	NURP	NURP	NURP
Unpaved Parking	NURP	NURP	NURP	NURP	NURP	NURP
Driveways	NURP	NURP	NURP	NURP	NURP	NURP
Sidewalks	NURP	NURP	NURP	NURP	NURP	NURP
Streets	NURP	NURP	NURP	NURP	NURP	NURP
Sandy Pervious Areas	NURP	NURP	NURP	NURP	NURP	NURP
Silty Pervious Areas	NURP	NURP	NURP	NURP	NURP	NURP
Clayey Pervious Areas	NURP	NURP	NURP	NURP	NURP	NURP
Paved Playgrounds	NURP	NURP	NURP	NURP	NURP	NURP
Other Pervious Areas	NURP	NURP	NURP	NURP	NURP	NURP
Other Direct Con Imp	NURP	NURP	NURP	NURP	NURP	NURP
Other Part Con Imp Areas	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 1	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 2	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 3	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 4	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 5	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 6	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 7	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 8	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 9	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 10	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 11	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 12	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 13	NURP	NURP	NURP	NURP	NURP	NURP
Other Imp Area 14	NURP	NURP	NURP	NURP	NURP	NURP

Cancel | Apply Default Values to All Source Areas | Save .csv File and Exit

Particle Size Distribution by Source Area

Source Area Particle Size Distribution and Peak-To-Average Rainfall Ratio Standard Files

Select Source Area File (.csv) to Edit: C:\WinSLAMM Files\PSD source area SSC.csv

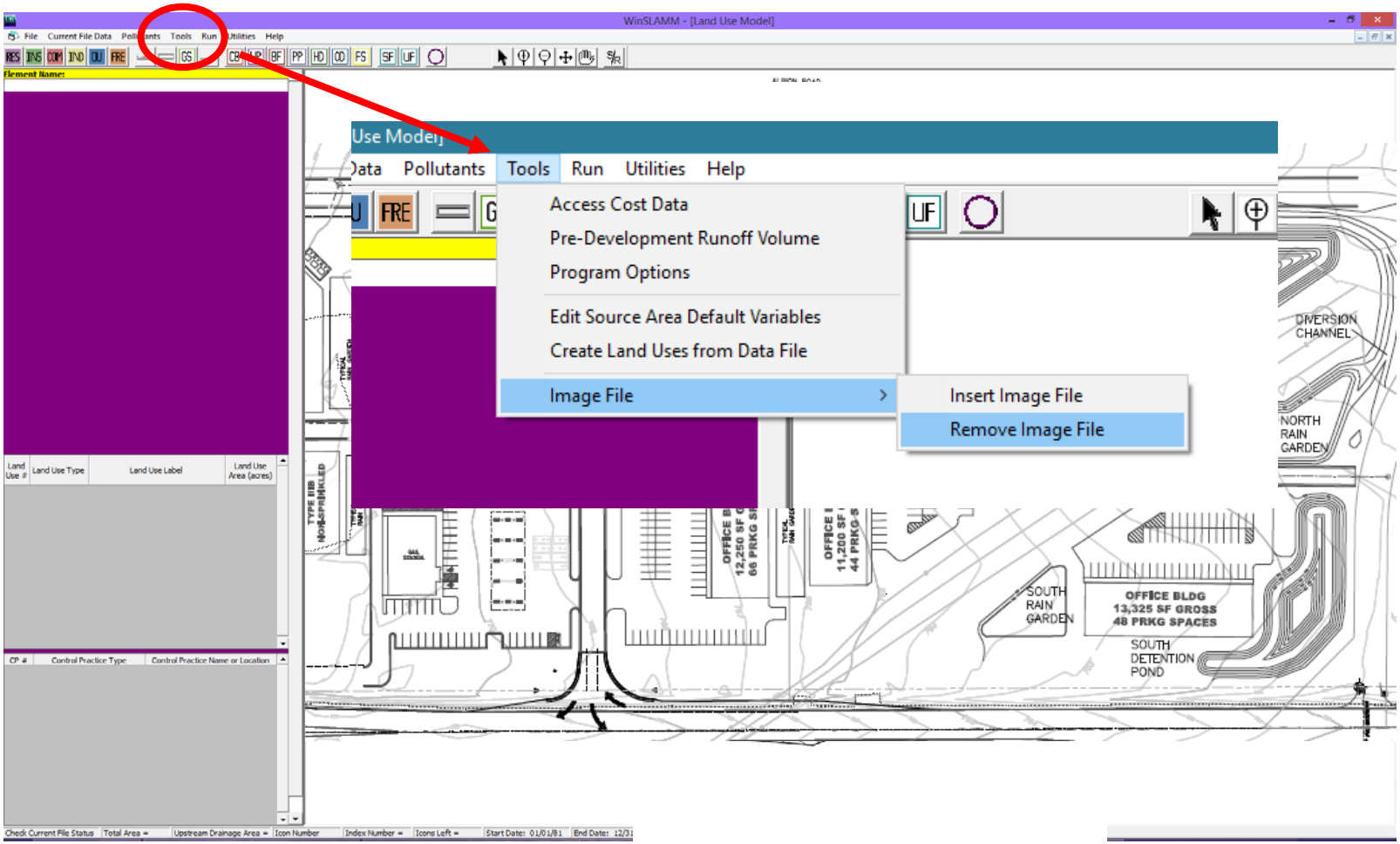
Browse to Particle Size Distribution (.cpz) File Path: C:\WinSLAMM Files\psd files\

Source Area Particle Size Distributions | Peak to Averge Flow Ratio - Light Rains | Peak to Averge Flow Ratio - Moderate Rains | Peak to Averge Flow Ratio - Heavy Rains

	Residential Land Use	Institutional Land Use	Commercial Land Use	Industrial Land Use	Other Urban Land Use	Freeway Land Use
Roofs	SSC roof average	SSC roof average	SSC roof average	SSC roof average	SSC roof average	SSC roof average
Paved Parking	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Unpaved Parking	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average
Driveways	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Sidewalks	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Streets	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Sandy Pervious Areas	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average
Silty Pervious Areas	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average
Clayey Pervious Areas	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average
Paved Playgrounds	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Pervious Areas	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average	SSC landscaped average
Other Direct Con Imp	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Part Con Imp Areas	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 1	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 2	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 3	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 4	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 5	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 6	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 7	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 8	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 9	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 10	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 11	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 12	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 13	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average
Other Imp Area 14	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average	SSC pavement average

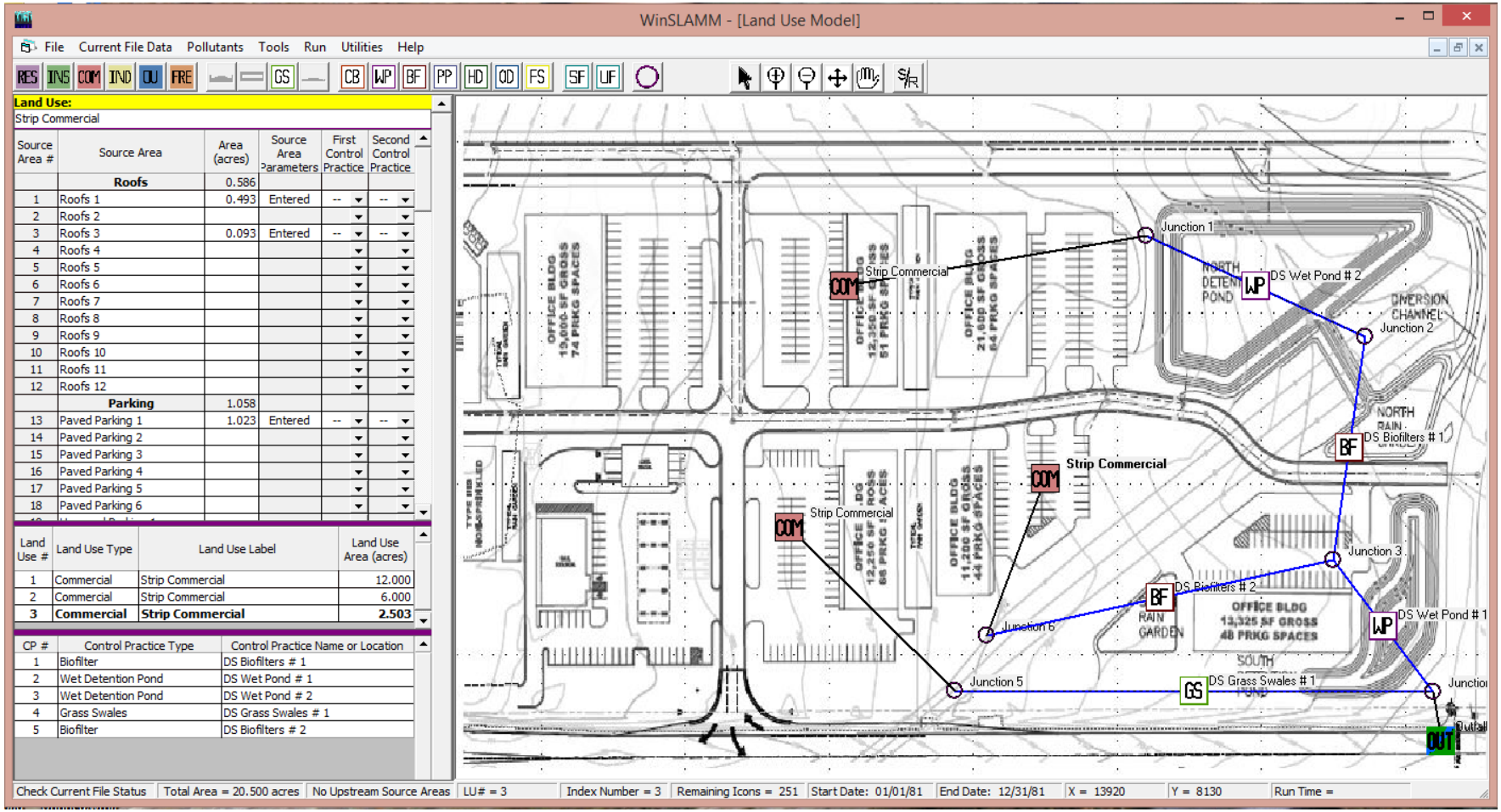
Cancel | Apply Default Values to All Source Areas | Save .csv File and Exit

To Add Drainage System Map Images



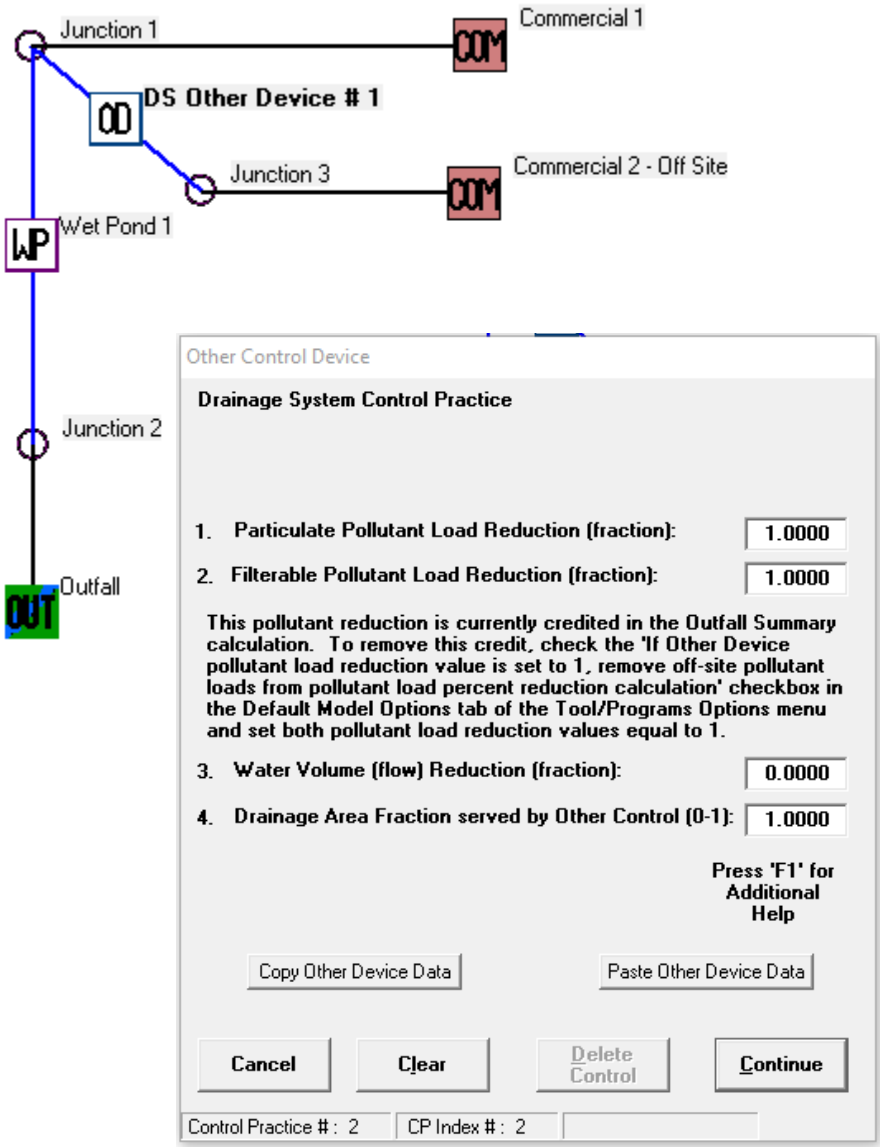
In 'Tools/Image File'

Add Images to the Drainage System Map



Using the 'Other Device' for Off-site Drainage

The Problem: Excluding the pollutant load from an analysis that includes off-site drainage can inflate the water quality performance of a drainage system because the No Control off-site pollutant load is included in the Percent Particulate Solids Reduction and other Pollutant calculations.



Off-Site Drainage Setup

Other Control Device

Drainage System Control Practice

1. **Particulate Pollutant Load Reduction (fraction):** 1.0000
2. **Filterable Pollutant Load Reduction (fraction):** 1.0000

To credit this pollutant load reduction towards the overall drainage system reduction in the Outfall Summary calculation, uncheck the 'If Other Device pollutant load reduction values are set to 1, remove off-site pollutant loads from pollutant load percent reduction calculations' checkbox in the Default Model Options tab of the Tool/Programs Options menu.

3. **Water Volume (flow) Reduction (fraction):** 0.0000
4. **Drainage Area Fraction served by Other Control (0-1):** 1.0000

Press 'F1' for Additional Help

Copy Other Device Data | Paste Other Device Data

Cancel | Clear | Delete Control | Continue

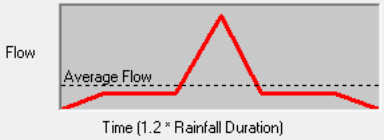
Control Practice # : 2 | CP Index # : 2

Program Options

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

- [x] Turn 'Save File Upon Exit' Message Off
- [ ] Suppress the Wet Detention Pond Overflow Warning Message
- [x] Save Backup File
- [ ] Save Outfall Runoff and Particulate Loading for WinDETPOND Analysis
- [ ] If Other control device concentration reduction value is set to 1, remove off-site pollutant loads from polutant load percent reduction calculations.

Default Peak Flow to Average Flow Ratio 3.8



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

- [x] Route Hydrographs and Particle Sizes Between Control Practices
  - [ ] Create Hydrograph and Particle Size Distribution .csv Files
- [x] Use Default Time Increment for all Hydrograph Analyses (required for hydrograph routing between control practices)

Default Time Increment (min): 6

Default Monthly Stormwater Temperature (degrees F)

January	40
February	45
March	50
April	55
May	60
June	65
July	65
August	60
September	50
October	40
November	35
December	35

Soil Compaction Infiltration Factors

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

File Update Options | Cancel Changes | Save .INI File

Output Comparison

Without 'Other Device' Adjustment

Outfall Output Summary

	Runoff Volume (cu. ft.)	Percent Runoff Reduction	Runoff Coefficient (Rv)	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Total of All Land Uses without Controls	435503		0.43	120.4	3274	
Outfall Total with Controls	436625	-0.26 %	0.43	29.72	810.1	75.26 %
Current File Output: Annualized Total After Outfall Controls	437824	Years in Model Run:	1.00		812.3	

Pollutant	Concen-tration - No Controls	Concen-tration - With Controls	Concen-tration Units	Pollutant Yield - No Controls	Pollutant Yield - With Controls	Pollutant Yield Units	Percent Yield Reduction
Particulate Solids	120.4	29.72	mg/L	3274	810.1	lbs	75.26 %
Particulate Phosphorus	0.2491	0.06529	mg/L	6.774	1.780	lbs	73.73 %
Filterable Phosphorus	0.07756	0.06673	mg/L	2.109	1.819	lbs	13.74 %

With 'Other Device' Adjustment

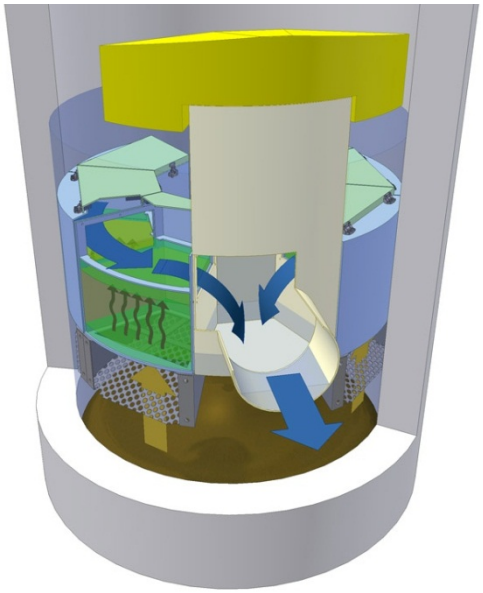
Outfall Output Summary

	Runoff Volume (cu. ft.)	Percent Runoff Reduction	Runoff Coefficient (Rv)	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Total of All Land Uses without Controls	435503		0.43	91.66 (1)	2492 (1)	
Outfall Total with Controls	436625	-0.26 %	0.43	29.72	810.1	67.49 %
Current File Output: Annualized Total After Outfall Controls	437824	Years in Model Run:	1.00		812.3	

(1) Values reduced to remove off-site loadings due to setting Other Control Device Concentration Reduction values to 1.

Pollutant (1)	Concen-tration - No Controls	Concen-tration - With Controls	Concen-tration Units	Pollutant Yield - No Controls	Pollutant Yield - With Controls	Pollutant Yield Units	Percent Yield Reduction
Particulate Phosphorus	0.2491	0.06529	mg/L	5.373	1.780	lbs	66.88 %
Filterable Phosphorus	0.07756	0.06673	mg/L	1.816	1.819	lbs	-0.17 %
Total Phosphorus	0.3267	0.1320	mg/L	7.189	3.599	lbs	49.94 %

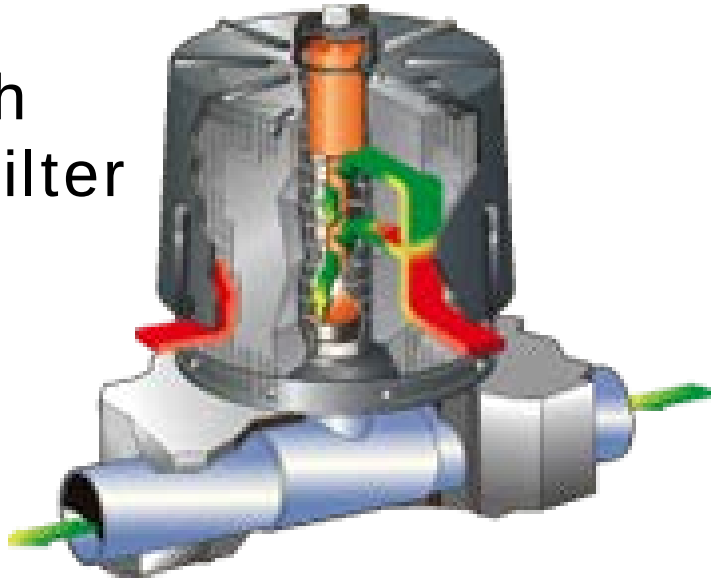
Proprietary Filtering Devices



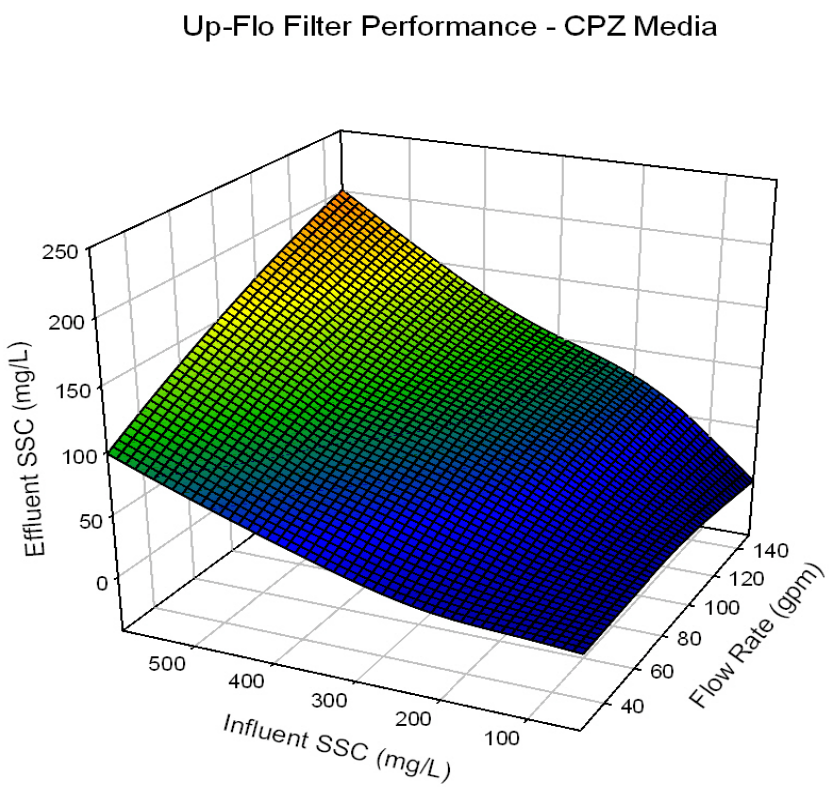
Hydro International
Up-Flo® Filter

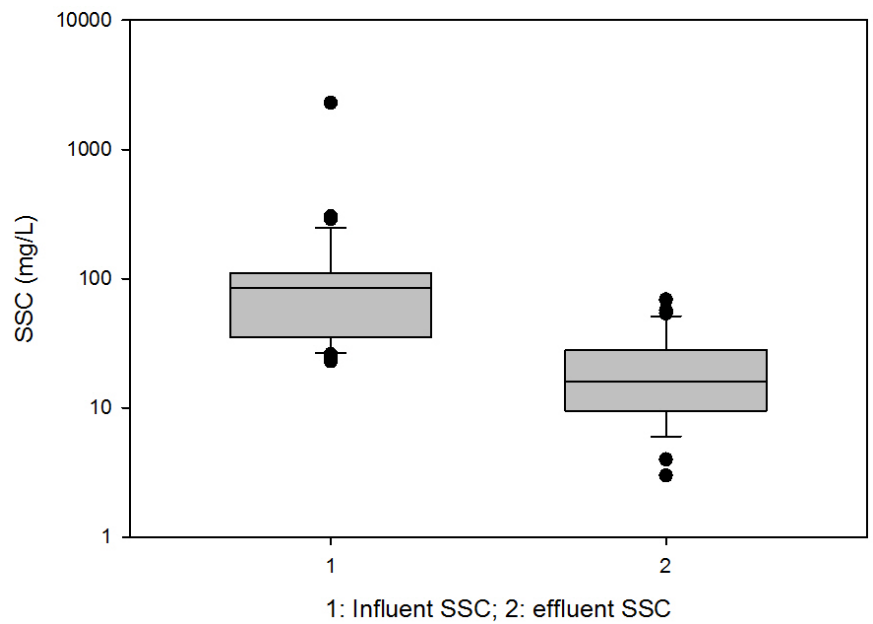
- WinSLAMM v 10.2.1 will include two proprietary stormwater treatment filtering devices
  - StormFilter from Contech
  - Upflo Filter from Hydro International

Contech
StormFilter

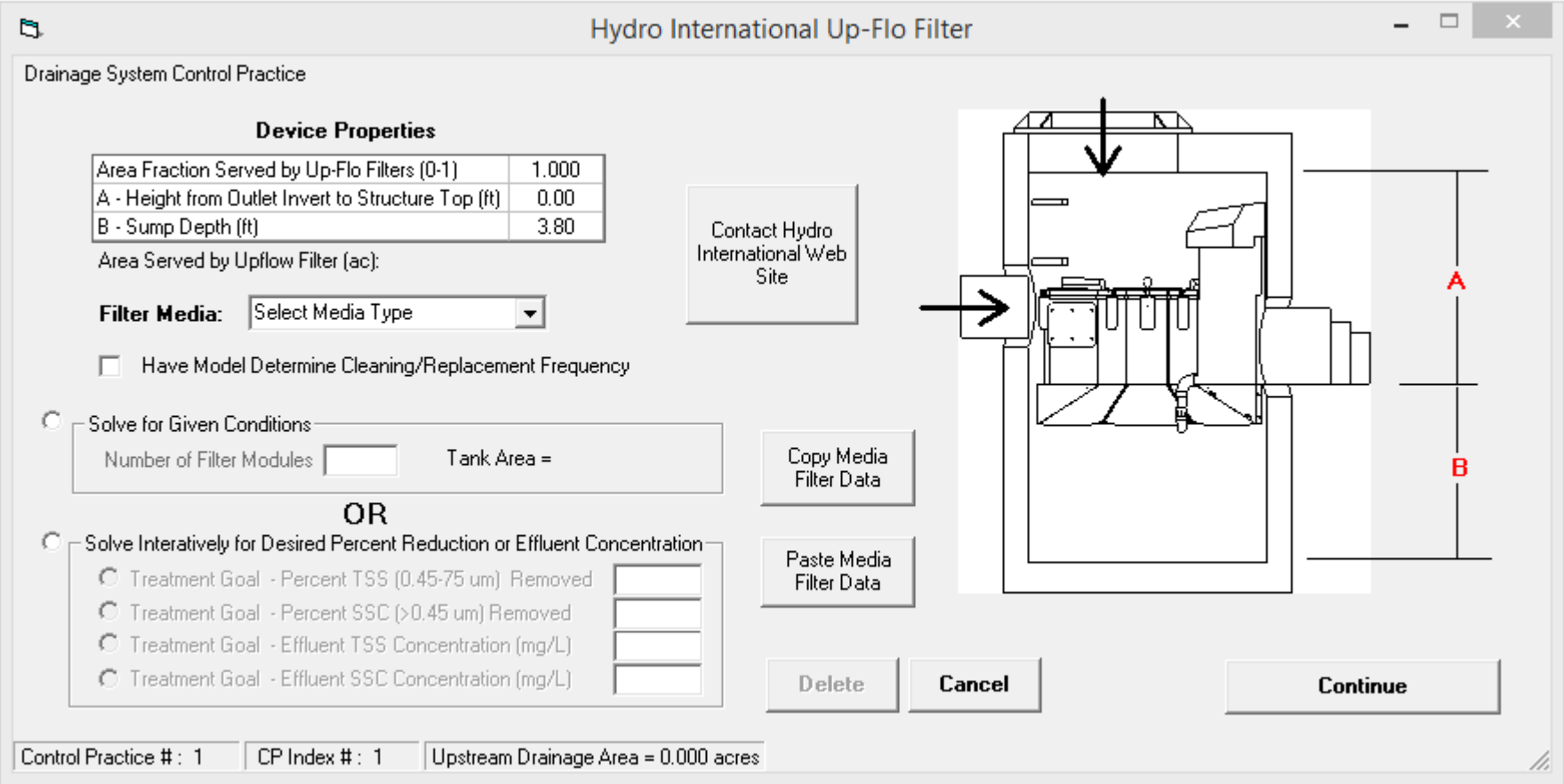


SSC Influent and Effluent Concentrations during 40 Monitored Events at Full-Scale UpFlo® Filter Installation at BamaBelle Site, Tuscaloosa, AL

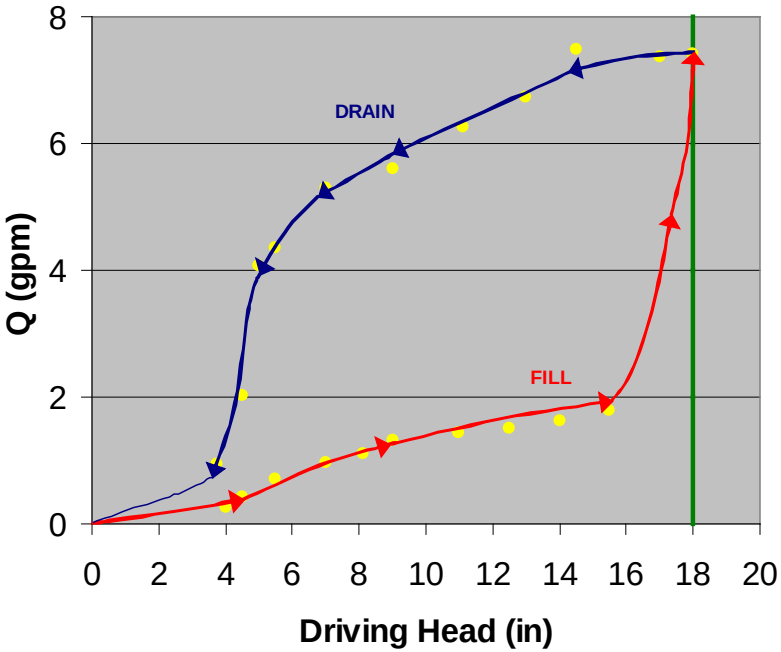


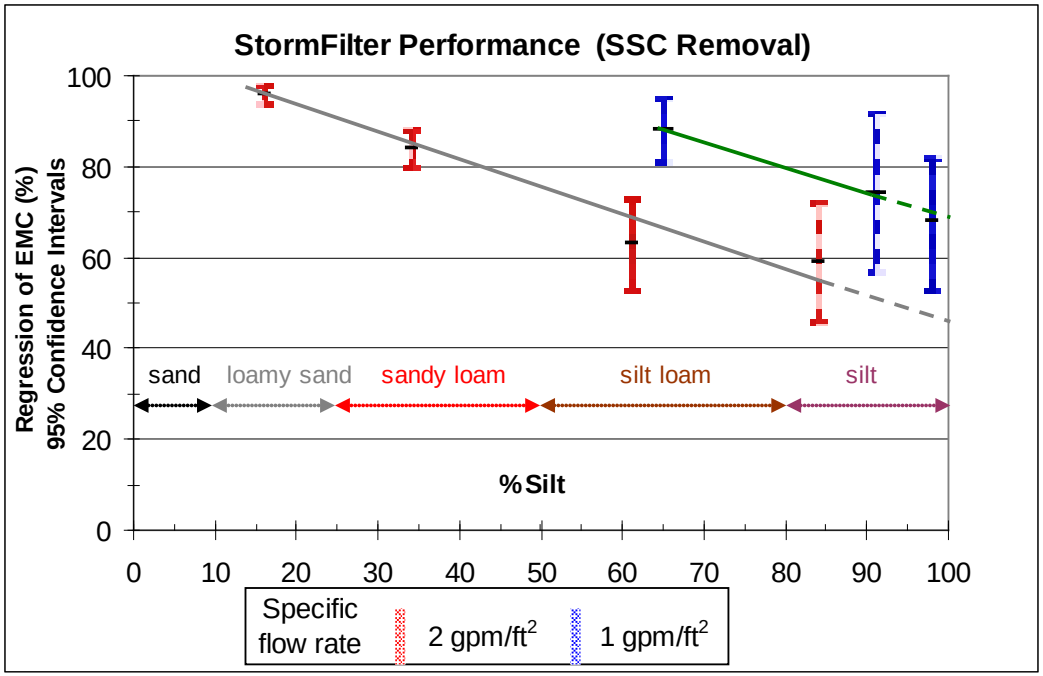


Up-flo® Filter incorporated into WinSLAMM version 10.2.1



Contech StormFilter also has substantial performance information from both laboratory and field tests





The Contech StormFilter in WinSLAMM version 10.2.1

Stormwater Management StormFilter(R) (by Contech)

First Source Area Control Practice
Land Use: Residential 1
Source Area: Paved Parking 1

Media Type: Perlite

Cartridge Height: 12 inches | 18 inches | 27 inches

Cartridge Specific Flow Rate: 0.27 gpm/sf | 1 gpm/sf | 2 gpm/sf

Head Difference (ft) Between Inlet and Outlet Inverts (Recommended Minimum Difference = 2.3'): 3

Bypass Structure Location
- Online - Within cartridge chamber
- Offline - Upstream of cartridge chamber

Activate Upstream Storage Gallery

Volume Based Chamber Size
- Runoff Depth (in)
- Storage Chamber Depth (ft)

Pipe Storage
- Storage Pipe Diameter (ft): 4
- Storage Pipe Length (ft): 20
- Chamber Sump Depth (ft): .5

Box Storage
- Chamber Depth (ft)
- Chamber Footprint Area (sf)
- Chamber Sump Depth (ft)

Solve for Given Conditions
- Number of Cartridges

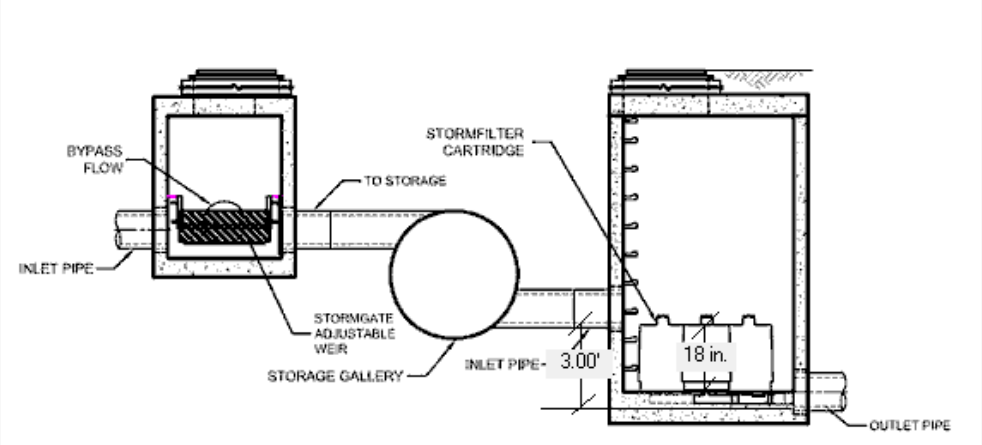
OR

Solve Interatively for Desired Percent Reduction or Effluent Concentration
- Treatment Goal - Percent TSS Removed
- Treatment Goal - Percent SSC Removed
- Treatment Goal - Effluent TSS Concentration (mg/L): 50
- Treatment Goal - Effluent SSC Concentration (mg/L)
- Minimum Time Between Maintenance Events (Months)

Select Particle Size Distribution File
C:\Program Files\WinSLAMM\NURP.CPZ

Copy Media Filter Data | Delete Control
Paste Media Filter Data | Cancel
Continue
Contact Contech Web Site

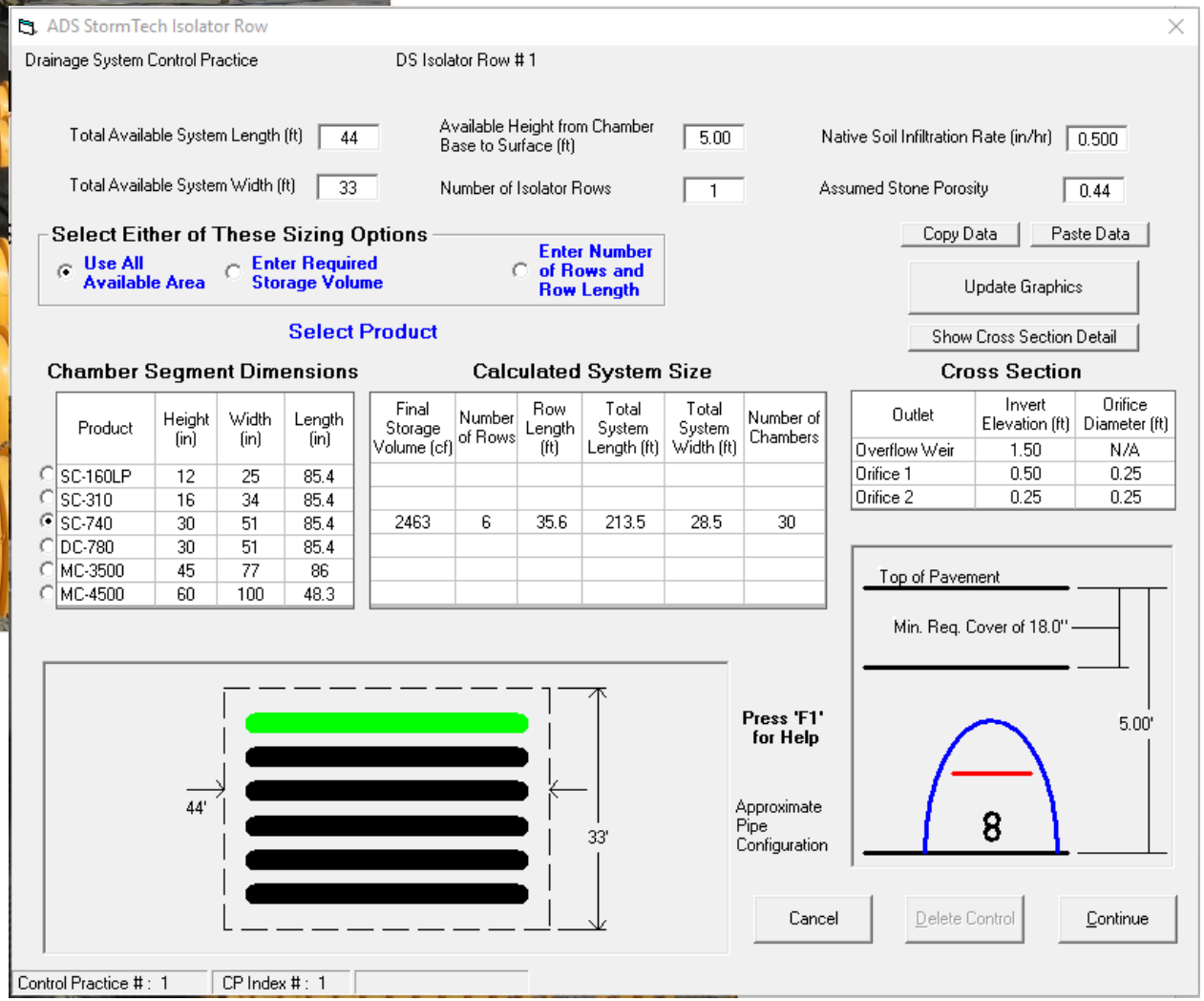
Cartridge Flow Rate = 7.5 gpm
Total Flow Rate TBD



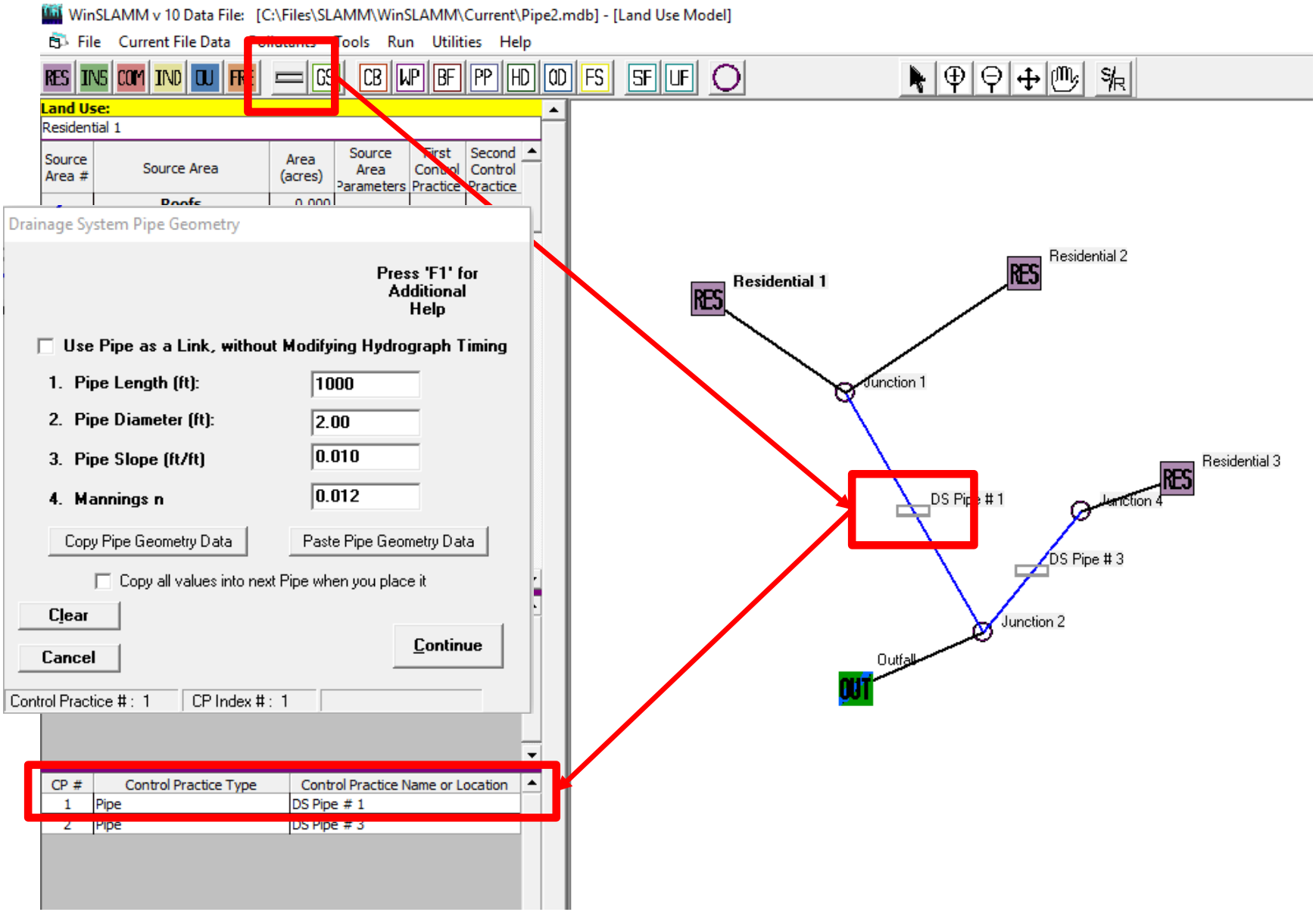
Control Practice # : 1 | Land Use # : 1 | Source Area # : 13

StormTech Isolator Row

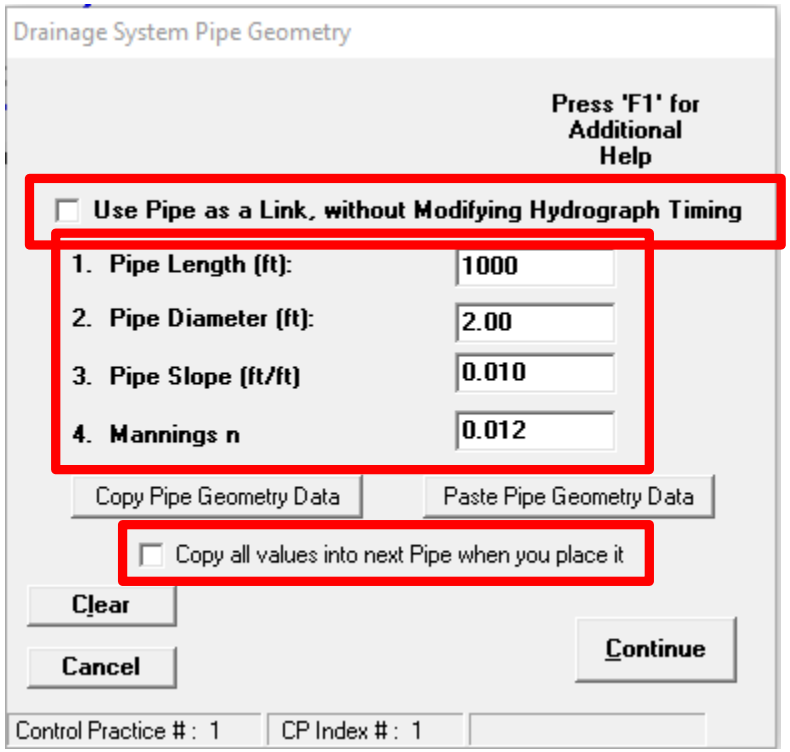
The StormTech Isolator Row will be added to WinSLAMM v 10.4



Entering Pipes in the Model



Data Entry Options



Options

1. Use Pipe as a Link, without Modifying Hydrograph Timing (Check the Checkbox)
2. Modifying the Hydrograph Timing by entering in Pipe Data
3. Copy all Four Variables from selected pipe to every pipe created after the selected pipe (some modifications may be needed)

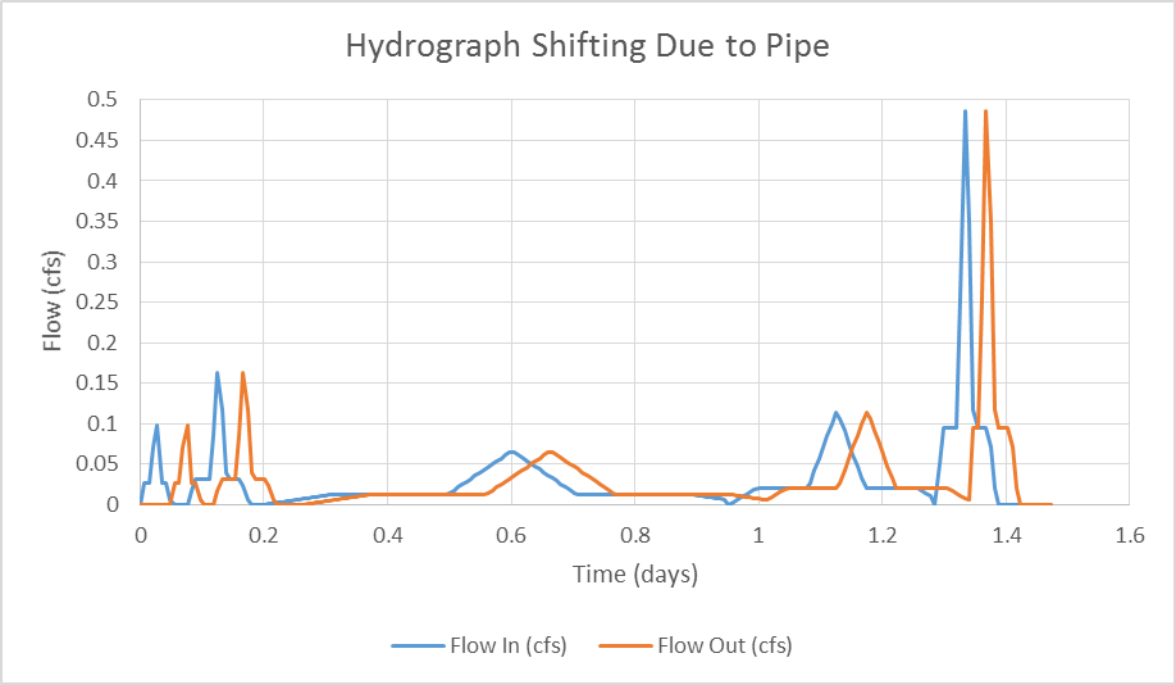
Pipe Output

Rain No.	Rainfall Depth (in)	Pipe No.	Avg Vel (ft/s)	Avg Depth (ft)	Travel Time (min)	Starting Increment No.	Ending Increment No.	Total No. of Incs.	Adj. No. of Increments	No. of Positive Flow Incs	No. of Incre. Shifts	Volume Shifted to Next Event (cf)	Max Flow (cfs)	Max Vel (ft/s)	Max Depth (ft)	Surcharged?
1	0.1	1	1.235059	6.71E-02	67.47315	0	10	10	0	7	7	1.562756	9.74E-02	1.619576	0.101573	#FALSE#
2	0.2	1	1.30847	7.33E-02	63.68759	11	28	17	0	14	6	0.624069	0.16368	1.89696	0.129636	#FALSE#
3	0.5	1	0.976864	4.70E-02	85.307	29	136	107	0	107	9	0.852409	6.51E-02	1.432696	8.42E-02	#FALSE#
4	0.4	1	1.16082	6.10E-02	71.78835	137	184	47	0	47	7	1.244993	0.114166	1.700002	0.10944	#FALSE#
5	0.5	1	1.823753	0.121976	45.69334	185	212	27	0	14	5	0	0.486276	2.636818	0.217113	#FALSE#

Detailed Output

1. Pipe Event Summary
2. Average Pipe Flow and Velocity
3. Maximum Pipe Flow and Velocity

Hydrograph Shifting Example



Command Line Processing

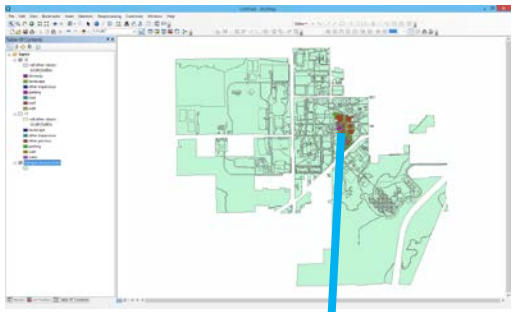
1. Run WinSLAMM from the command line using input and providing output not dependent upon the graphic user interface
2. Input file is a WinSLAMM program input file
3. Standard output is an event-by-event text file

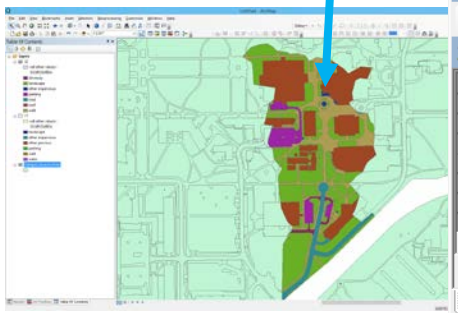
Event Number	Rain Start Date	Rain Start Time	Julian Start Date & Time	Rain Duration (hrs)	Rain Interevent Period (days)	Runoff Duration (hrs)	Rain Depth (in)	Runoff Volume (cf)	R sub v	Average Flow (cfs)	Peak Flow (cfs)	Suspended Solids Conc. (mg/L)	Suspended Solids Mass (lbs)	Pre-Development Runoff Volume (cf)
15	03/25/81	21:00	13,598.88	4	3.04	4.8	0.07	107	0.42	0.01	0.02	130	0.8662	
16	03/29/81	02:00	13,602.08	3	0.25	3.6	0.05	68	0.37	0.01	0.02	130	0.5513	
17	03/29/81	11:00	13,602.46	2	0.29	2.4	0.06	87	0.4	0.01	0.04	130	0.702	
18	03/29/81	20:00	13,602.83	9	4.13	10.8	0.07	107	0.42	0	0.01	130	0.8662	
19	04/03/81	08:00	13,607.33	1	0.58	1.2	0.02	13	0.18	0	0.01	130	0.1048	
20	04/03/81	23:00	13,607.96	4	3.71	4.8	0.26	553	0.59	0.03	0.12	130	4.486	
21	04/07/81	20:00	13,611.83	12	0.29	14.4	0.71	1,841	0.71	0.04	0.13	130	14.94	
22	04/08/81	15:00	13,612.63	6	1.96	7.2	0.41	959	0.64	0.04	0.14	130	7.78	
23	04/10/81	20:00	13,614.83	3	1.17	3.6	1.06	3,022	0.79	0.23	0.89	130	24.53	
24	04/12/81	03:00	13,616.13	1	1.62	1.2	0.13	236	0.5	0.05	0.21	130	1.917	
25	04/13/81	19:00	13,617.79	6	2.54	7.2	0.32	709	0.61	0.03	0.1	130	5.751	
26	04/16/81	14:00	13,620.58	1	2.54	1.2	0.01	3	0.09	0	0	130	0.02619	
27	04/19/81	04:00	13,623.17	5	3.17	6	0.04	51	0.35	0	0.01	130	0.4141	

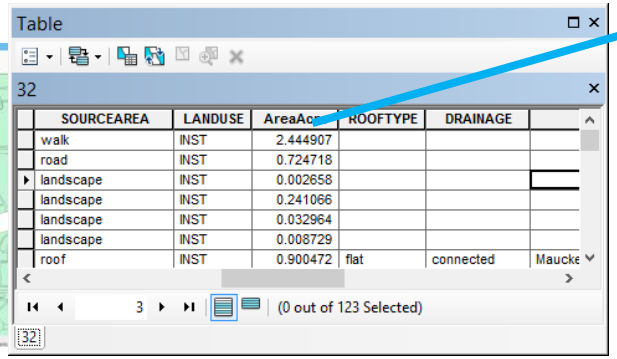
ArcGIS and WinSLAMM

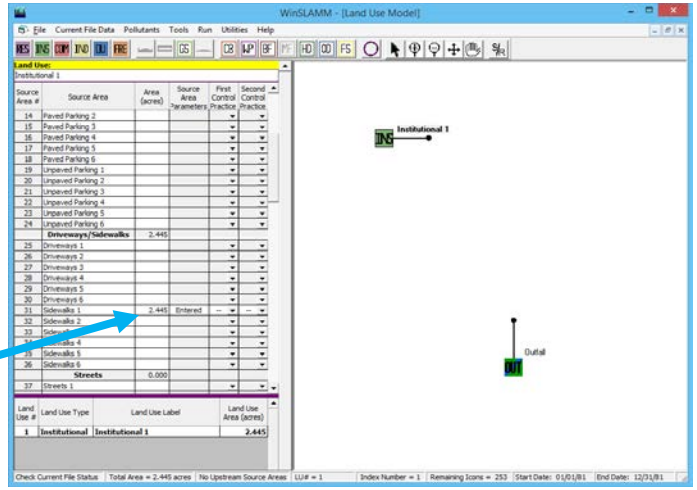
A user could use GIS to develop source areas and then manually enter values into the WinSLAMM interface

– This can be extremely time consuming



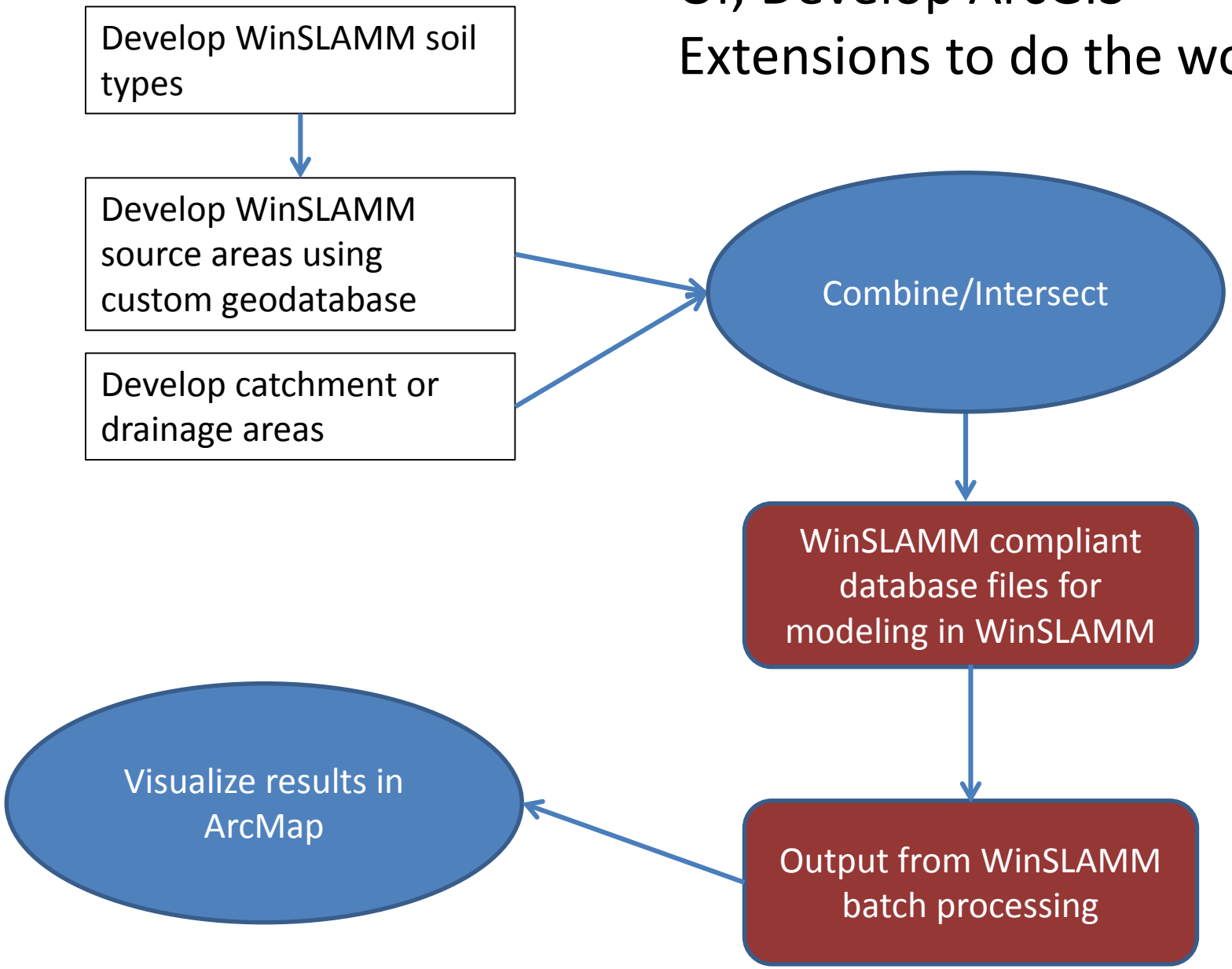






Previously, digitize in ArcGIS (or other), manually transfer to WinSLAMM

Or, Develop ArcGIS Extensions to do the work

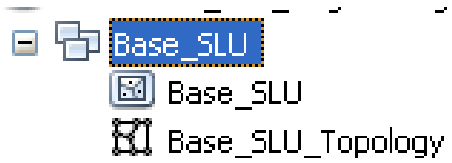


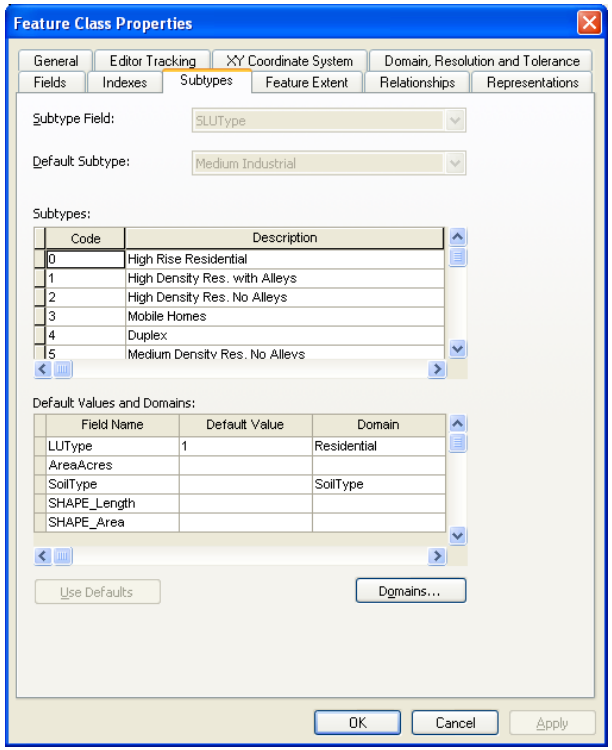
ArcSLAMM+ is Applied Through Standard Land Uses

- WinSLAMM allows users to utilize more generalized spatial data on source areas by assigning specific empirical source area data based on average land use proportions
- This alleviates the need to digitize detailed data by source area
- Makes it easier to carry out WinSLAMM simulations for a large areas

SLU Database in ArcSLAMM+

- UNI has developed a base SLU geodatabase which allows the user to develop polygon features efficiently for SLU categories used by WinSLAMM





ArcSLAMM+ SLU Tools

- The SLU Tools will allow a user to develop WinSLAMM compliant databases just like those developed in ArcSLAMM
- A user will be able run WinSLAMM simulations for many catchments based on the SLU features using ArcSLAMM+
- The SLU tools are available from the WinSLAMM web site – www.winslamm.com

ArcSLAMM Status

UNI has developed the databases and tools for the Standard Land Use module in WinSLAMM

- ArcSLAMM for WinSLAMM v 10.3 is available free from the UNI web site, http://www.geotree.uni.edu/extensions/
- A license for ArcSLAMM/ArcSLAMM Plus for WinSLAMM v 10.3 costs $150. It is available from the WinSLAMM web site
- This fee is transferred to UNI to cover the SLU module development costs and to support updates by the UNI GeoTREE Center

Modeling Issues

Municipal Issues

1. Large networks may exceed WinSLAMM processing capabilities
2. Credit from private treatment practices allowable if municipalities have authority to require maintenance
3. DNR assessing Dry Pond modifications in WinSLAMM, with a reduction ratio calculated when the water surface elevation is less than three feet but above the lowest outlet invert, for each time step.
4. Large models

Site Level Issues

1. Connected vs Disconnectedness. See DNR Post-Construction Modeling Guidance, Items 35-38: http://dnr.wi.gov/topic/stormwater/documents/Modeling_Post-Construction_Guidance_2011.pdf
2. Permanent pool of wet detention ponds must be included as a Water Body Area.
3. DNR assessing Dry Pond modifications in WinSLAMM, with a reduction ratio calculated when the water surface elevation is less than three feet but above the lowest outlet invert, for each time step.
4. Source area soil types: A: Sandy, B: Silty, C/D: Clayey.

Site Level Issues

5. Hard copy submittals should include
   1. Input (use File/Print Input Data menu option)
   2. Output Summary (use Print Output Summary button on Outfall Output Summary tab)
   3. Drainage system diagram
6. Use Infiltration Rates from SOC Standard 1002, not default values in WinSLAMM.
7. Filter strips are for sheet flow, not concentrated flow.
8. Enter Dynamic, not Static, Infiltration rates for swales and filter strips.
9. Always enter the wet pond initial elevation equal to the lowest outlet invert elevation.

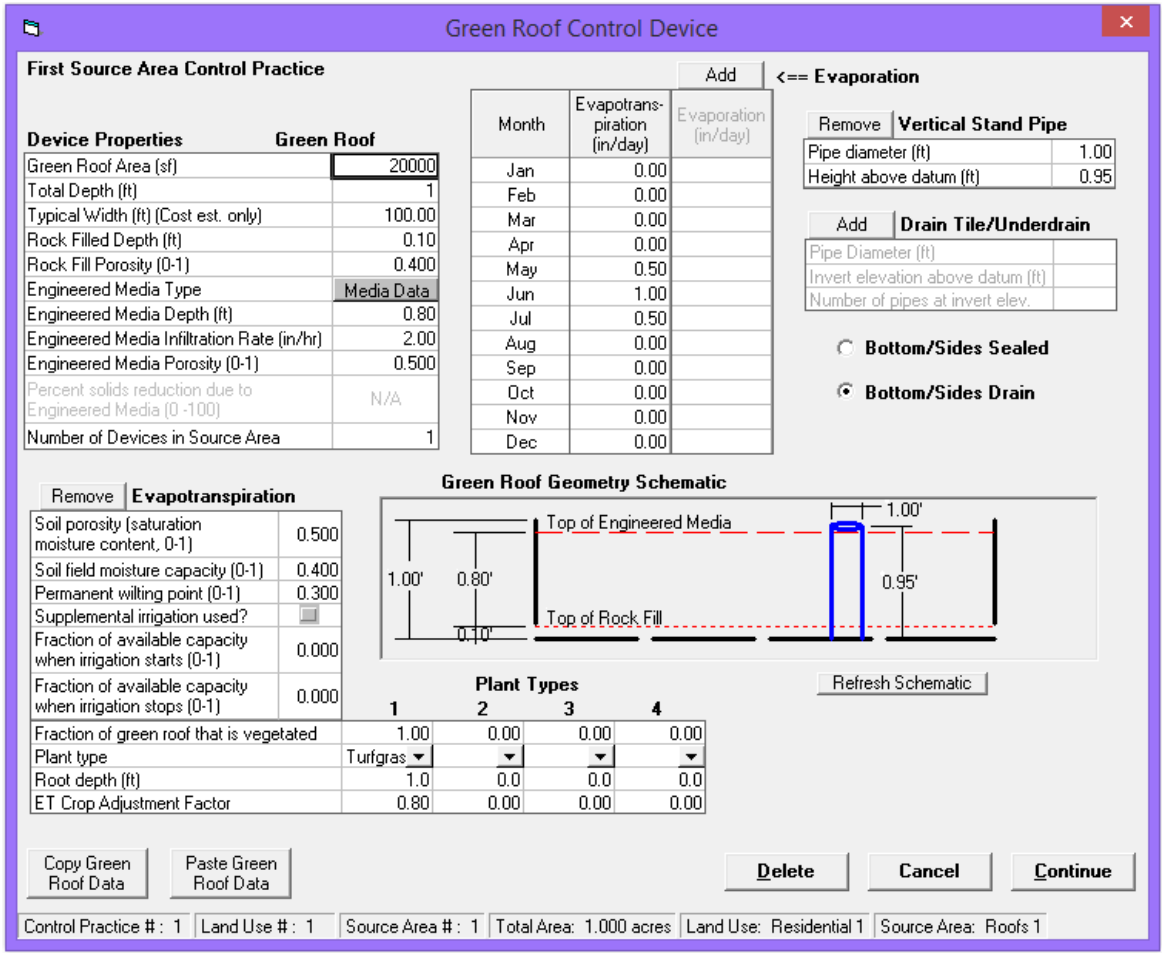
Site Level Issues

10. Entering underdrain invert elevation above datum depth that exceeds the 72 hour drain time tech standard criteria for bioretention and permeable pavement systems.
11. Not entering “80” for the biofilter percent solids reduction due to engineered media
12. Not entering “65” for the permeable pavement underdrain discharge percent TSS reduction.

Planned Modifications

- Seasonal Phosphorus Reduction through Leaf Pickup
- Provide the ability to combine files
- Add inflow hydrograph option
- Add limited bypass routing
- Media filter performance update
- Green Roofs

Green Roof – v 10.5

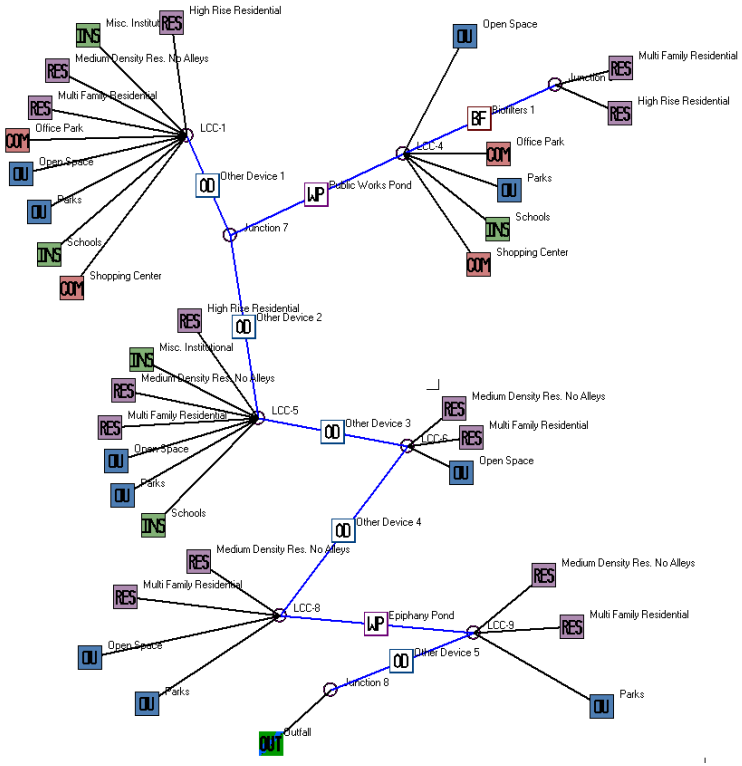


Planned Modifications

- Trash removal
- ✓ Credit Cards
- Linking files
- Opening two models at the same time
- Migrate to VB.net

We covered . . .

1. WinSLAMM Purpose and History
2. High Traffic Urban Highways
3. Particle Size Distribution Files
4. Importing Images
5. Other Device
6. Filtering and Settling Devices
7. Pipes
8. Command Line Model Runs
9. ArcSLAMM Plus
10. Modeling Issues
11. Planned Modifications



Questions?