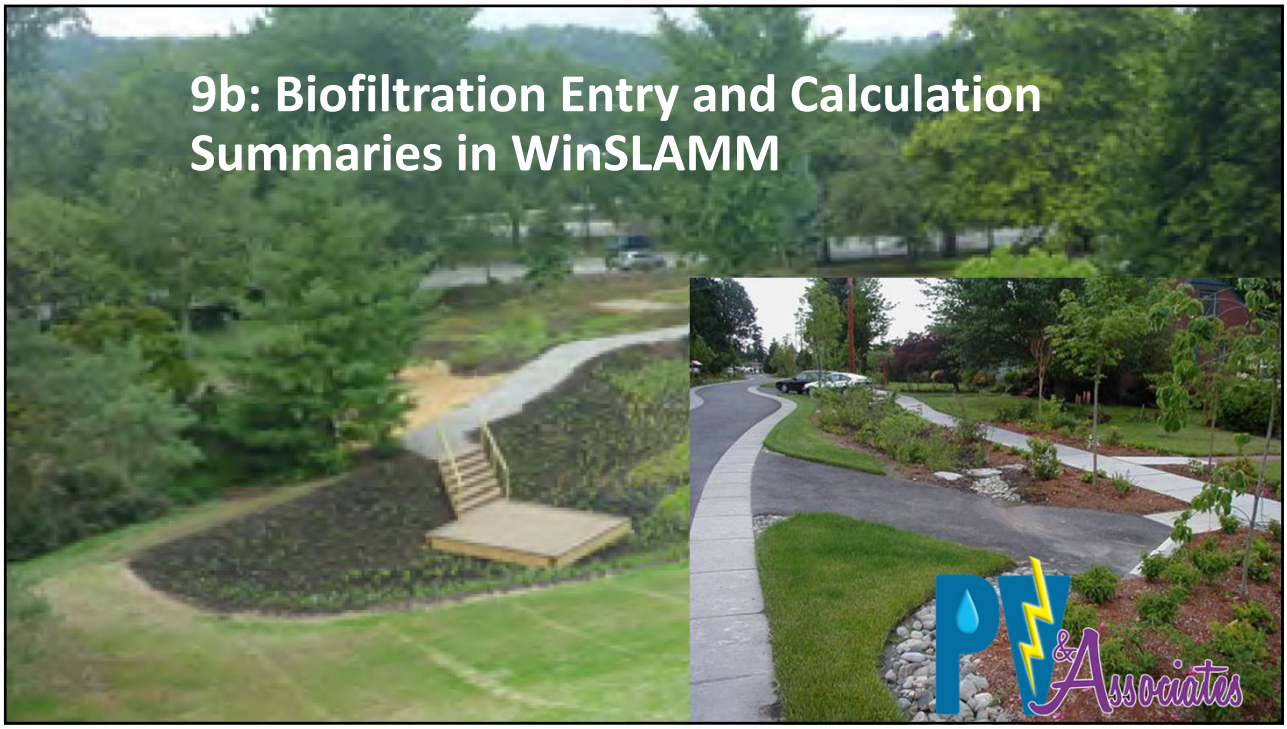


The new data components for media types include:

- Flow rate equations based on media type, organic content, texture, and uniformity
- Regression equations for removal of several particle size ranges
- Flow rate reduction and clogging due to particulate retention
- Filterable and particulate pollutant retention
- Filterable pollutant retention based on contact time (coming)
- Breakthrough of pollutants as media retains filterable pollutants (coming)

Incorporating these data significantly expands the ability to compare alternative biofilter design options.

2

We will cover . . .

- **Biofilter Design Concepts and Issues**
- **Biofilter Model Algorithms**
- **Entering Biofilter Data into the Model**

The biofiltration control option uses full routing calculations associated with pond storage.

The "outlet" devices include natural soil infiltration (considering the wide range of variability in infiltration rates in urban soils), evaporation, surface discharges through overflows (a stand pipe or weirs), or through a rain barrel/cistern.

Biofiltration controls are usually numerous in an area and can be represented in the model individually or by specifying how many of each unit is treating the flow from an individual or combination of source areas.

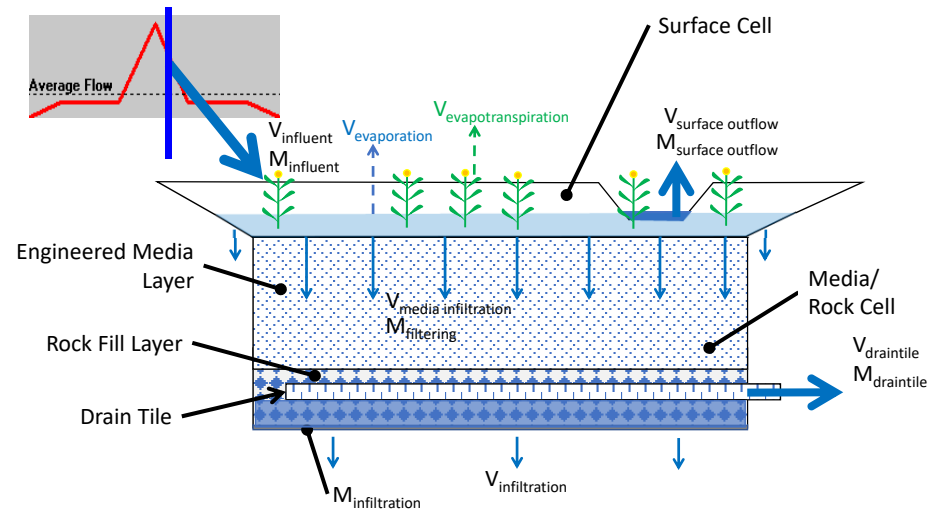
Modeling Notes

- **Biofilter routing is performed using the Modified Puls Storage – Indication Method.**
- **Time increments are established by the user**
- **Yield reductions due to:**
  - **Runoff volume reduction through infiltration**
  - **Filtering through engineered soil**

Biofilters can be used as control devices in individual source areas, in land uses, and as a part of the drainage system or at the outfall.

To model biofilters in a source area, describe the geometry and other characteristics of a typical biofilter. Then enter the number of biofilters you want to model in the source area. The model divides the runoff volume by the number of biofilters in the source area, creates a triangular hydrograph that it routes through that biofilter, and then multiplies the resulting losses by the number of biofilters to apply the results to the source area.

Biofilter Runoff and TSS Removal Processes



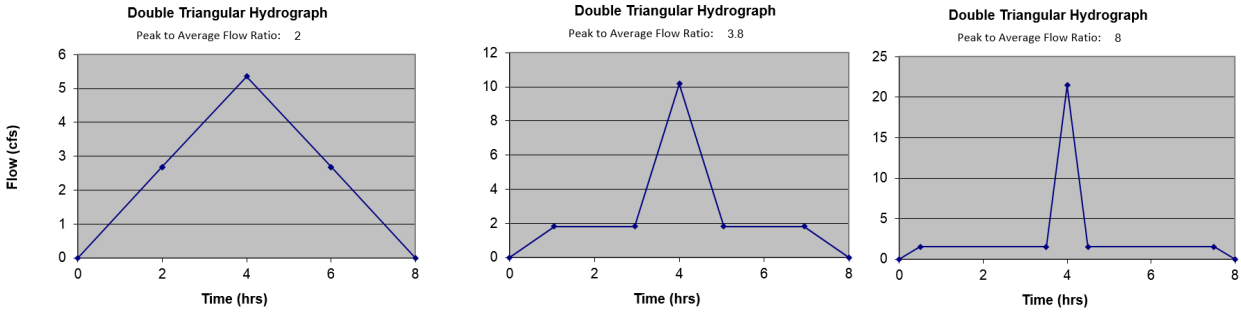
$V_{surface\ effluent} = V_{influent} - V_{infiltration} - V_{evapotranspiration} - V_{evaporation} - V_{surface\ overflow} - V_{media\ infiltration}$

$V_{media/rock\ cell\ effluent} = V_{media\ infiltration} - V_{infiltration} - V_{draintile}$

$M_{effluent} = M_{influent} - M_{filtering} - M_{infiltration} - M_{surface\ outflow}$

Biofilter Hydrograph Creation

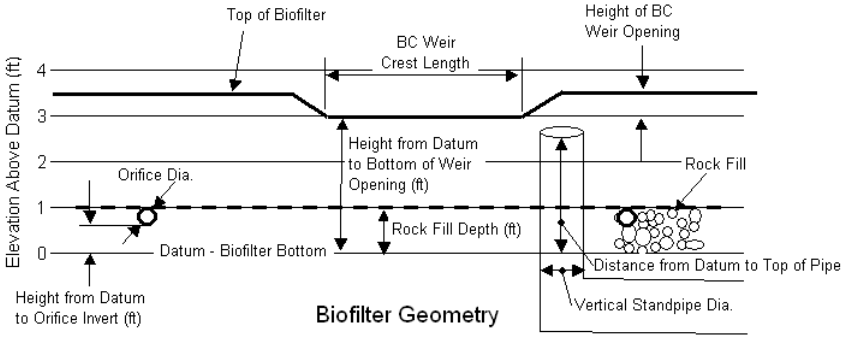
- Flow rate calculated using Complex Triangular Hydrograph
  - Runoff Volume calculated from WinSLAMM
  - Runoff Duration = 1.2 times rainfall duration
  - Peak to Average Flow Ratio set by user



Four Components to Modeling Biofilters

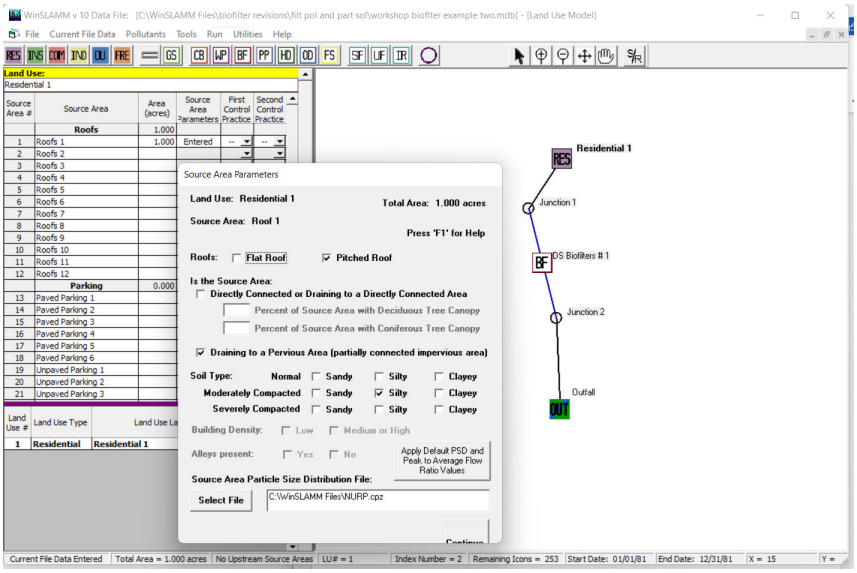
1. Structure Geometry
2. Outlet Information
3. Infiltration Data
4. Hydrograph and Flow Routing Information

Biofilter Geometry



Biofilter Datum is always zero ft.

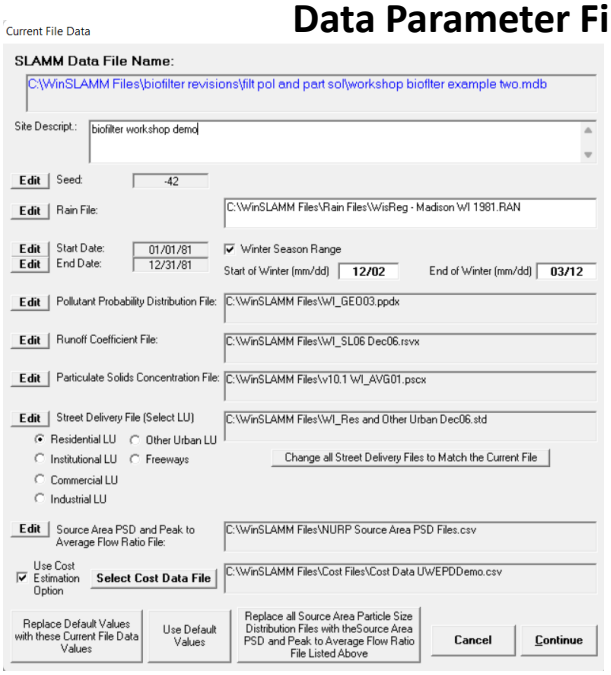
Basic WinSLAMM Layout and Source Area Descriptions

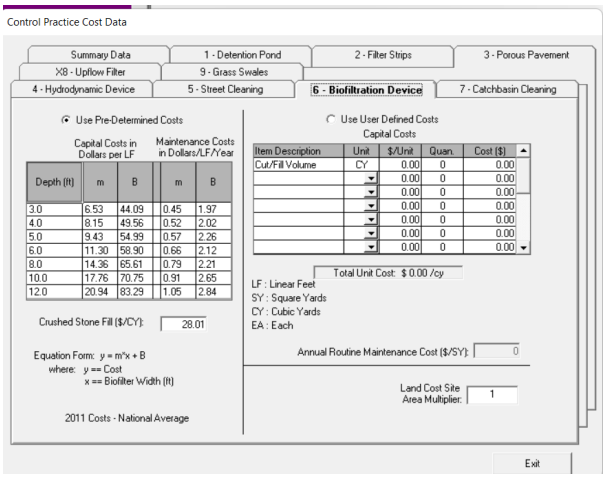


This is not a very reasonable design but is used in this example for its simplicity.

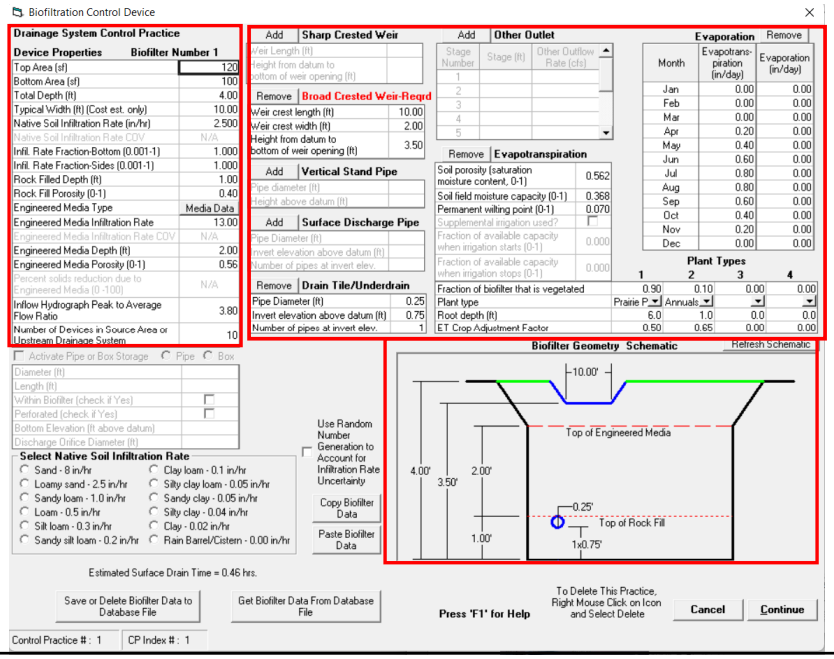
The example shown here is very basic for a total of 1 acre of pitched residential roofs (multiple buildings), draining to silty soils of moderate compaction).

Data Parameter Files used in Example





Biofilter Data Entry Form

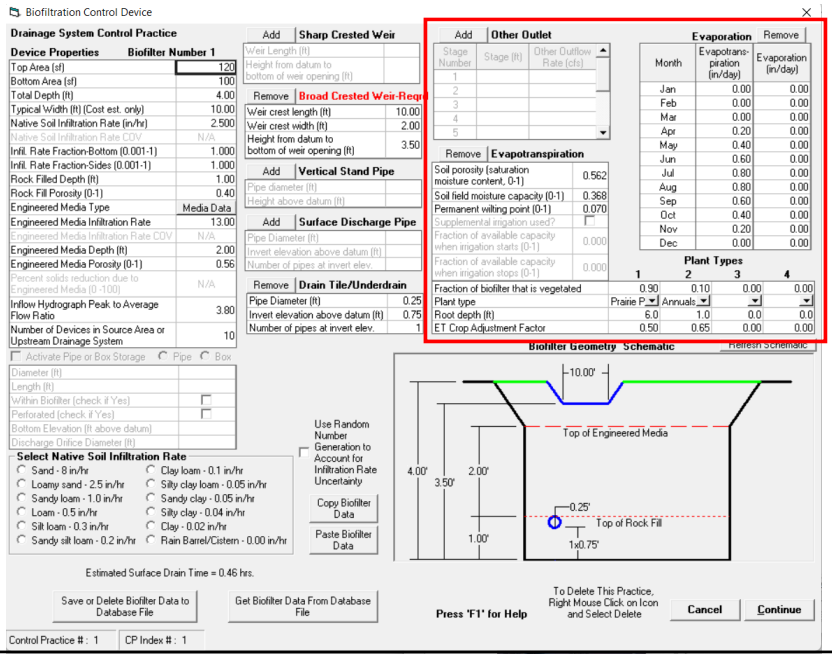


Biofilter geometry and media

Outflow structure information

Rough schematic of biofilter drawn as geometry data entered

Biofilter Data Entry Form

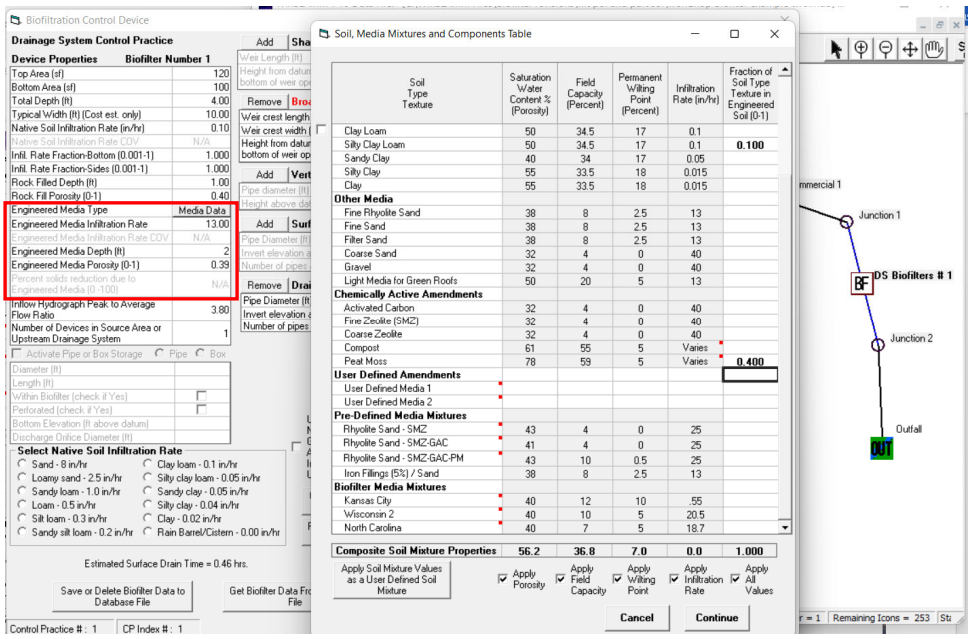


Evapotranspiration daily rates and plant type selection

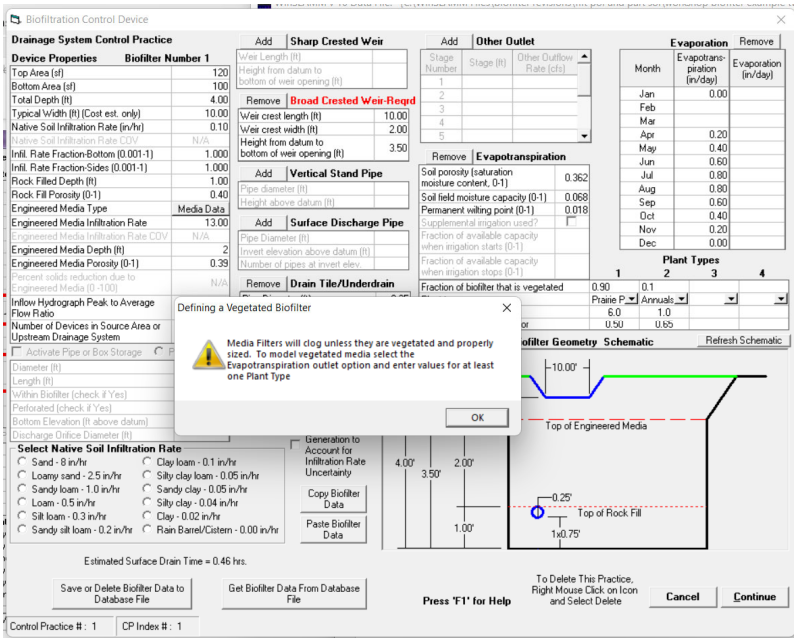
ET Plant Type Variables

Plant Type	Root Depth (ft)	ET Crop Adjustment Factor
User-Defined		
Turfgrass	1	0.80
Trees	3	0.70
Annuals	1	0.65
Shrubs	2	0.50
Other Grasses	1	0.55
Prairie Plants	6	0.50

Biofilter Media Selection

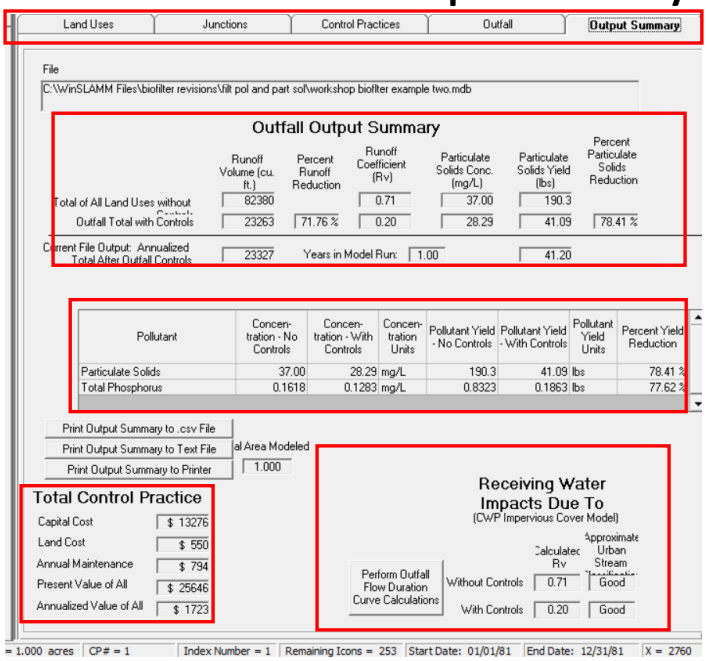


Media data filled in when media selected (components must equal 1.0) and "apply all values" to use in model. Media depth also needed by user



Reminder to add vegetation thru the evapotranspiration (ET) option to enhance biofilter useful life (incorporates added silt into root zone instead of concentrating on surface, for example).

Calculation Output Summary



Tabs to select output tables (summary shown here)

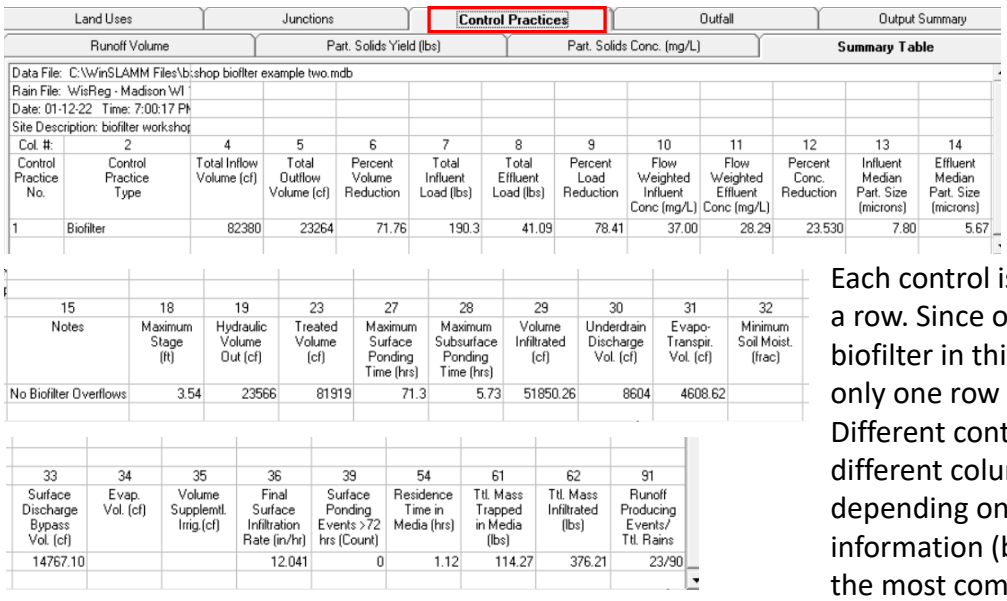
Basic performance data for runoff and particulate solids

Performance data for selected constituents

Life cycle cost data (if selected)

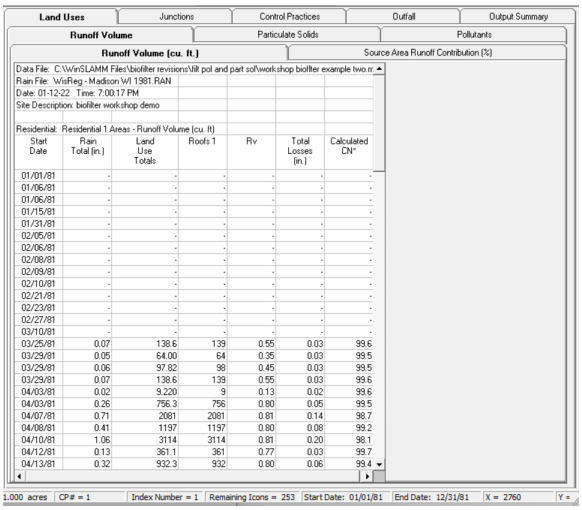
Receiving water impacts associated with runoff amounts (based on Center for Watershed Protection Impervious Cover Model)

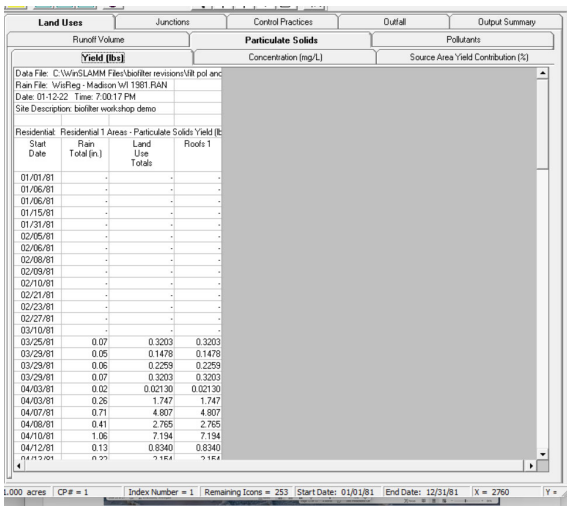
Control Practices Summary Tab Information



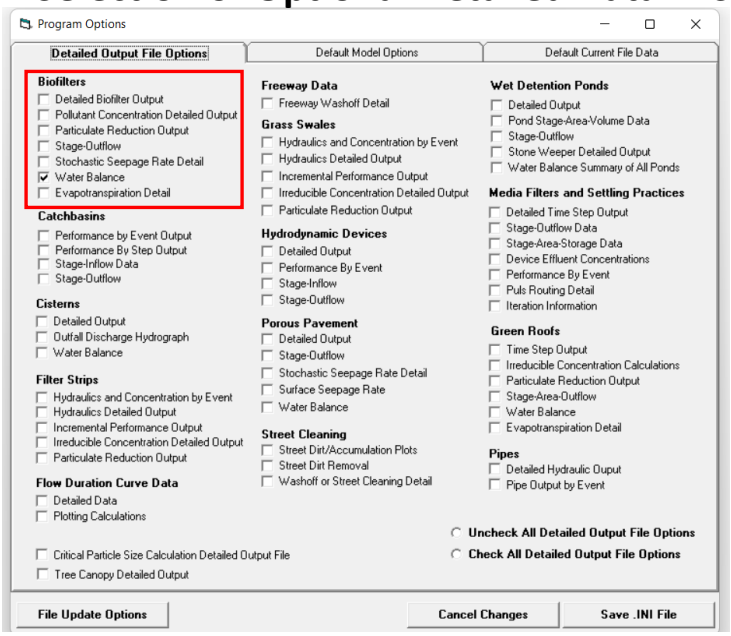
Each control is shown on a row. Since only one biofilter in this example, only one row is shown. Different controls have different columns, depending on summary information (biofilters are the most complex).

Examples of summary tables for other data tabs





Selection of Optional Detailed Data in Separate Spreadsheets



This shows the water balance optional spreadsheet selected for biofilters

Example of Detailed Data Spreadsheets for Biofilter Water Balance (1 of 2)

	BioF Number	Rain Number	Rain Depth (in)	Rain Duration (days)	Time (Julian Date)	Rainfall Date	Maximum BioF Stage (ft)	Minimum BioF Stage (ft)	Event Peak Inflow (cfs)	Event Peak Outflow (cfs)	Surface Ponding Duration (hrs)	Total Ponding Duration (hrs)	Event Inflow Volume (cf)	Event Hydraulic Outflow (cf)	Event Total Infil Outflow (cf)	Event Infil Outflow BG (cf)	Event Infil Outflow AG(cf)	Event Evap Outflow (cf)	Event Evapotranspiration Outflow (cf)	Event Orifice Outflow (cf)	Event Vert Standpipe Outflow (cf)	Event BC Weir Outflow (cf)
1																						
2	1	434	0.03	0.04	14523	10/06/83	3.597	0	0.1277	0.0064	6	5.7	149.7822	0	146.0702	141.0423	5.0279	0	0	0	0	0
3	1	435	0.06	0.17	14524	10/07/83	3.753	0	0.0951	0.0071	16.4	12.9	433.2603	0	394.8032	359.7266	35.0764	0	0	0	0	0
4	1	436	0.14	0.08	14524	10/07/83	4.044	0	0.5694	0.6303	28.1	26.6	1300.086	611.0956	729.7667	621.1223	108.645	0	0	0	0	611.0956
5	1	437	1.29	0.67	14528	10/11/83	4.062	0	1.0604	1.0553	38.1	22.4	19290.61	18073.97	1056.518	825.6942	230.8213	0	0	0	0	18073.97
6	Summary Statistics																					
7			Rain Depth	Rain Duration (days)			Maximum	Minimum I	Event Peal	Event Peal	Surface Po	Total Pond	Event Inflo	Event Hydi	Event Tota	Event Infil	Event Infil	Event Evaj	Event Evaj	Event Orifi	Event Vert	Event BC W
8	Number of Events		4	4	-	-	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
9	Total		1.52	0.96	-	-	-	-	-	-	88.6	67.6	21173.74	18685.06	2327.158	1947.585	379.571	0	0	0	0	18685.06
10	Equivalent Annual Tot		111.89	70.55	-	-	-	-	-	-	6522.157	4976.278	1558672	1375472	171310.1	143368.5	27941.49	0	0	0	0	1375472
11	Minimum		0.03	0.04	-	-	3.597	0	0.095	0.006	6	5.7	149.782	0	146.07	141.042	5.028	0	0	0	0	0
12	Maximum		1.29	0.67	-	-	4.062	0	1.06	1.055	38.1	26.6	19290.61	18073.97	1056.518	825.694	230.821	0	0	0	0	18073.97
13	Average of All Events		0.38	0.24			3.86	0	0.46	0.42	22.15	16.9	5293.43	4671.27	581.79	486.9	94.89	0	0	0	0	4671.27
14	Median		0.1	0.13			3.9	0	0.35	0.32	22.25	17.65	866.67	305.55	562.28	490.42	71.86	0	0	0	0	305.55
15	Stnd. Deviation		0.61	0.29			0.23	0	0.45	0.51	13.95	9.41	9344.27	8939.78	396.69	299.21	100.53	0	0	0	0	8939.78
16	COV		1.6	1.21			0.06	0.85	0.98	1.21	0.63	0.56	1.77	1.91	0.68	0.61	1.06	0	0	0	0	1.91
17	First Rain Date: 10/06/83																					
18	Last Rain Date: 10/11/83																					
19	Total Time Period (yrs): 1.358448E-02																					
20																						

Example of Detailed Data Spreadsheets for Biofilter Water Balance (2 of 2)

Event SC Weir Outflow (cf)	Event Other Outflow (cf)	Event Surface Drain Pipe Outflow (cf)	Event Total Outflow (cf)	Event Water Volume Balance (cf)	Cum. Water Balance (cf)	Moisture Content at Event Start	Volume Reduction Fraction	TSS Concentration Reduction Fraction	Event Residence Time (hrs)	Biofilter Influent Conc (mg/L)	Eng. Media Effluent Conc (mg/L)	Total Weighted Effluent Conc (mg/L)	Clogging Mass Retained on Media (lbs)	Cum Mass Retained on Media (lb/sf)	Infiltration Reduction Fraction	Eng Media Infil Rate (in/hr)
0	0	0	146.0702	3.7119	3.7119	0	1	0.1547	38.7	130	27.71942	0	0.9	6.89E-04	0.999664	0.2
0	0	0	394.8032	38.4571	42.169	0	1	0.1547	38.7	130	37.93419	0	2.3	2.45E-03	0.998806	0.2
0	0	0	1340.862	-40.7756	1.3934	0	0.5443	0.1547	38.7	130	90.42951	0	1.4	3.54E-03	0.998273	0.2
0	0	0	19130.48	160.1328	161.5262	0	0.0552	0.1547	38.8	130	125.7093	0	0.3	3.74E-03	0.998174	0.2
Event SC V	Event Othe	Event Surf	Event Tota	Event Wat	Cum. Wat	Moisture C	Volume Re	TSS Conce	Event Resi	Biofilter In	Eng. Media	Total Weig	Clogging M	Cum Mass	Infiltration	Eng Media
4	4	4	4	4	4	4	4	4	4	Number of Events						
0	0	0	161.526	161.526	1.309	-	-	-	-	Total						
0	0	0	1546781	11890.5	96.35	-	-	-	-	Equivalent Annual Total						
0	0	0	146.07	-40.776	-0.085	0	0.055	0.155	38.7	Minimum						
0	0	0	19130.48	160.133	1.101	0	1	0.155	38.767	Maximum						
0	0	0	5253.05	40.38	0.33	0	0.65	0.15	38.73	Average of All Events						
0	0	0	867.83	21.08	0.15	0	0.77	0.15	38.73	Median						
0	0	0	9265.92	86.17	0.54	0	0.45	0	0.03	Stnd. Deviation						
0	0	0	1.76	2.13	1.65	0	0.69	0	0	COV						

The next presentation will walk you thru the biofilter input screens.

Any further comments John, Doug, or Caroline

Any questions?

21