EWRI
ASCE
ENVIRONMENTAL & WATER RESOURCES INSTITUTE
East Central FL Chapter

Selecting Best Management Practices using BMPTRAINS

Marty Wanielista

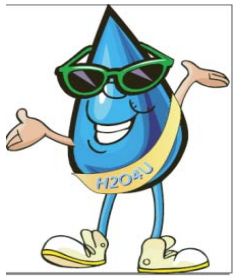
Stormwater Management Academy

November 14, 2013 Orlando Florida

www.stormwater.ucf.edu

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

University of Central Florida

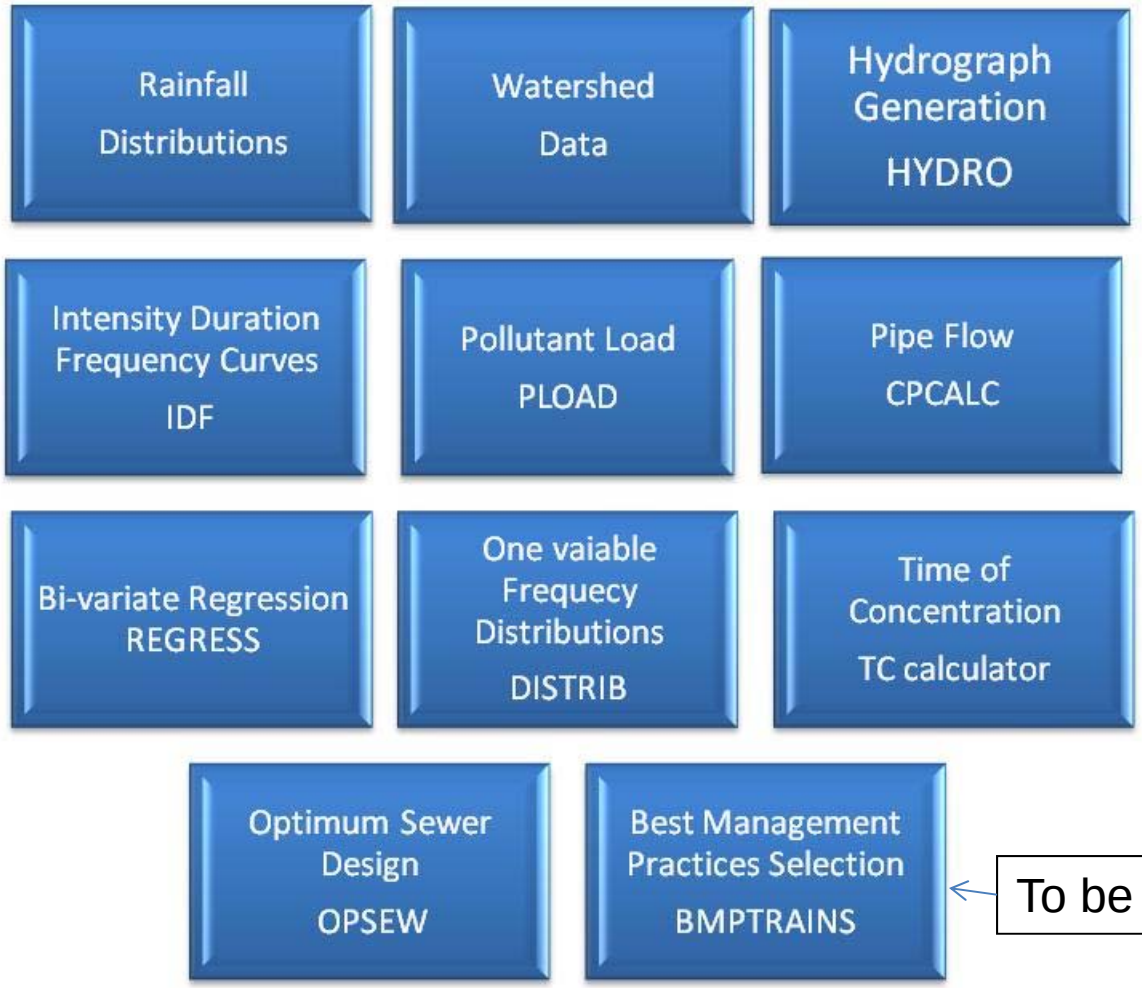


Purpose of Presentation

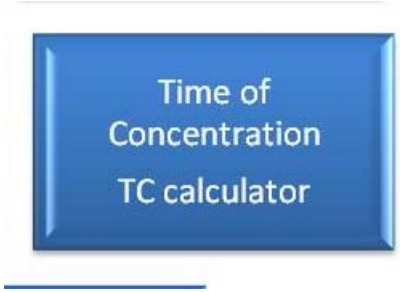
- Review methods for analysis and design of BMPs.
- Provide the basic principles for average annual removal calculations.
- Discuss a computer program for the quantification of nutrient removal that can be used as a basis for review for permits and mass reduction calculations.

Credit and thanks to: Mike Hardin, Ikiensinma Gogo-Abite and Chris Kuzlo

SMADAonline.com (origin in the 80's)



To be loaded December 2013



7 t_c calculation options

- Length of Travel (Feet L) 1000
- Slope (fraction S) .01
- Rainfall Intensity (inches/hour i) 4
- Watershed Area (Square Miles A) .1
- Roughness Coefficient (n) .05
- Retardance Coefficient (Cr) .4
- Mannings Overland Flow Roughness (N) .015
- NRCS Curve Number (CN) 85
- FAA Rational Coefficient (C) .7

- RESULTS (time of concentration values in minutes)
- FAA 22.7 Izzard 16.5 Kerby 15.1 Kinematic 10.8 Kirpich 9.378
- Bransby Williams 12.8 NRCS 26.9

BMPTRAINS
Download From:
www.stormwater.ucf.edu

WHAT'S NEW

BMPTRAINS Stormwater Best Management Practices Analysis Model (Version 5) *Please register before you download the model for the first time after April 25, 2013.* Registration, Model, and User's Manual.

Or After December 15, 2013
from SAMADAonline.com

NOTE>>> first time users, please enable the macros (under options)

BMP Nutrient Model BMPTRAINS

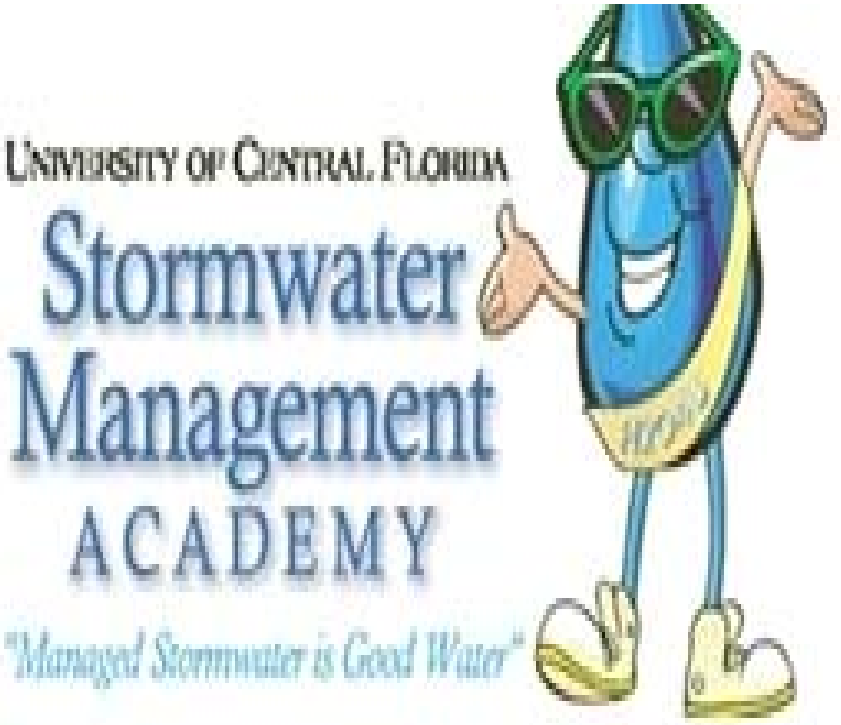
Stormwater BMP Treatment Trains [BMPTRAINS©]

CLICK HERE TO START

INTRODUCTION PAGE

This program is compiled from stormwater management publications and deliberations during a two year review of the stormwater rule in the State of Florida.
Input from the members of the Florida Department of Environmental Protection Stormwater Review Technical Advisory Committee and the staff and consultants from the State Water Management Districts is appreciated.

The State Department of Transportation provided guidance and resources to compile this program. The Stormwater Management Academy is responsible for the content of this program.



Download from www.stormwater.ucf.edu and use from www.smadaonline.com.

BMP Rainfall Inputs

STEP 1: Select the appropriate Meteorological Zone, input the appropriate Mean Annual Rainfall amount and select the type of analysis

Meteorological Zone (Please use zone map):	CLICK ON CELL BELOW TO SELECT Zone 2	
Mean Annual Rainfall (Please use rainfall map):	50.00	Inches
Type of analysis:	CLICK ON CELL BELOW TO SELECT Specified removal efficiency	
Treatment efficiency (leave empty if net improvement analysis is used):	80.00	%

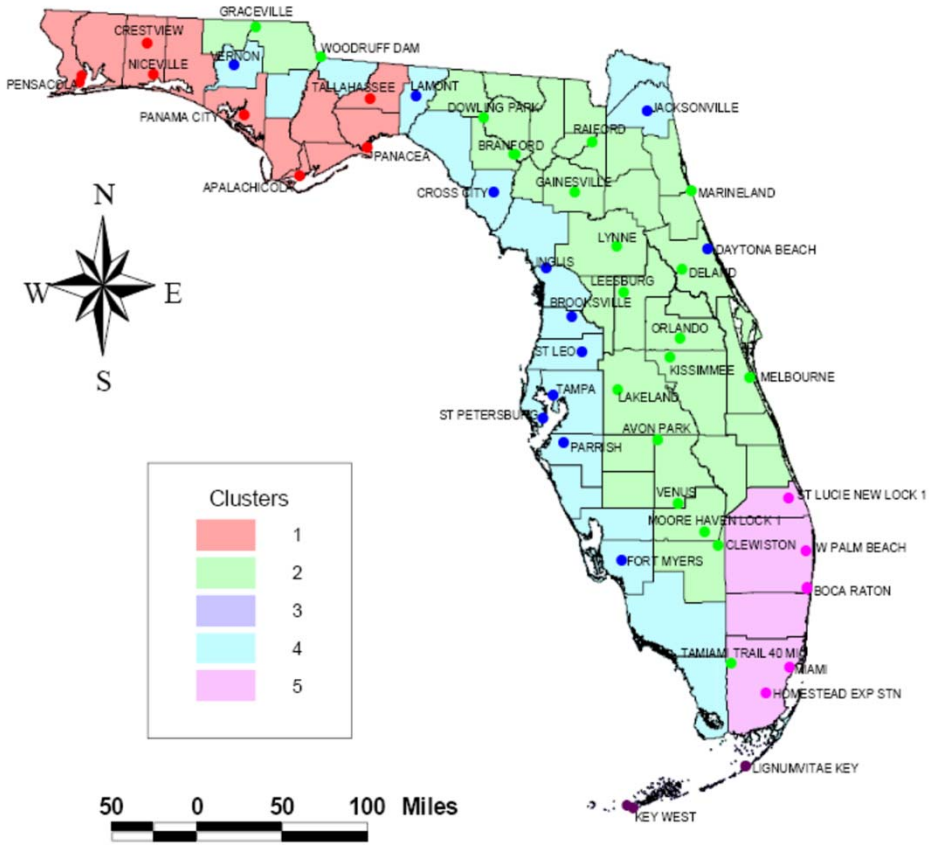
Buttons For

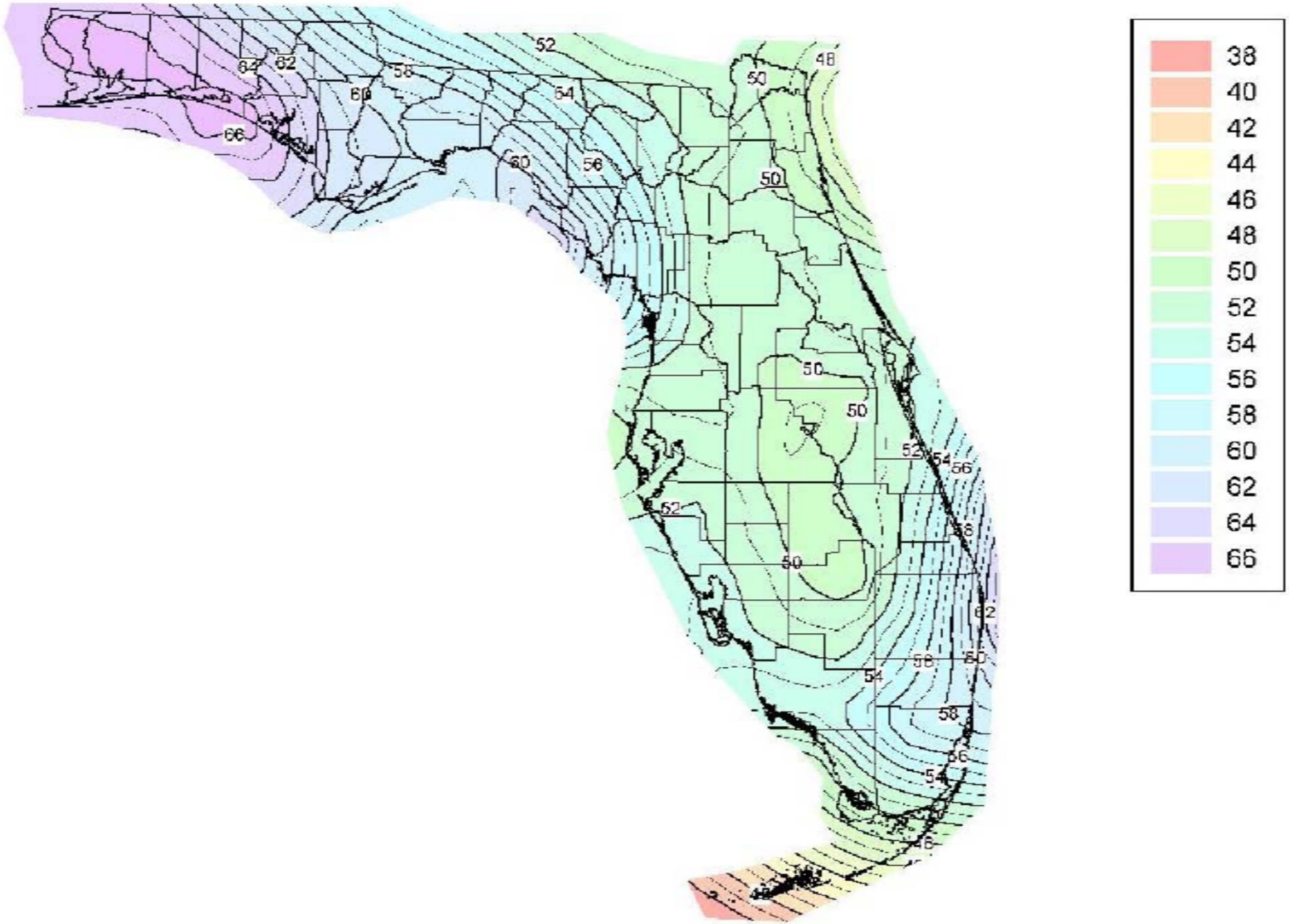
View Zone Maps

View Mean Annual Rainfall Map

Rainfall Distributions

- Average Annual Removal is the target.
- Considers rainfall distributions are regionally different.
- Selection of site date are facilitated.

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BMP Rainfall and Watershed Inputs

STEP 1: Select the appropriate Meteorological Zone, input the appropriate Mean Annual Rainfall amount and select the type of analysis

Meteorological Zone (Please use zone map):	CLICK ON CELL BELOW TO SELECT Zone 2	
Mean Annual Rainfall (Please use rainfall map):	50.00	Inches
Type of analysis:	CLICK ON CELL BELOW TO SELECT Specified removal efficiency	
Treatment efficiency (leave empty if net improvement analysis is used):	80.00	%

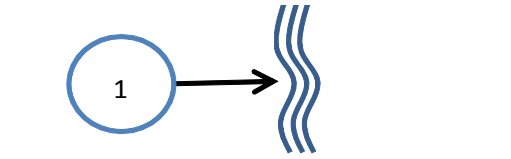
WATERSHED CHARACTERISTICS

SINGLE SYSTEM TREATEMENT ANALYSIS

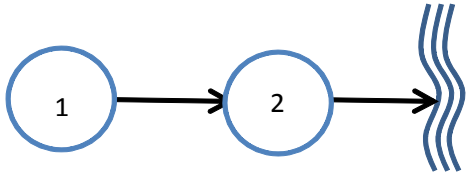
WATERSHED NO.1 CHARACTERISTICS:

Pre Developed Land Use:	CLICK ON CELL BELOW TO SELECT Undeveloped - Wet Flatwoods		
Post Developed Land Use:	CLICK ON CELL BELOW TO SELECT Highway		
Total pre-developed watershed area:	0.55	AC	
Post-developed area watershed area:	0.55	AC	
Pre-Developed Non DCIA CN:	80.00		Pre-development Annua
Pre-Developed DCIA Percentage:	0.00	%	Pre-development Annua
Post-Developed Non DCIA CN:	80.00		Post-development Annu
Post-Developed DCIA Percentage:	100.00	%	Post-development Annu

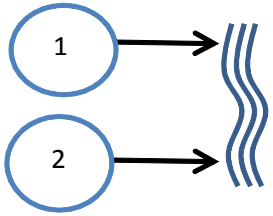
Up to four catchments and up to three BMPs in each catchment



A - Single Catchment



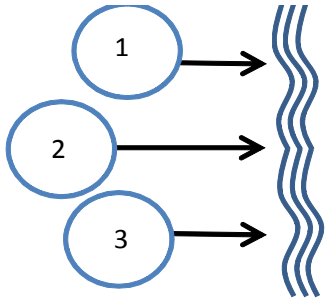
B - 2 Catchment-Series



C - 2 Catchment-Parallel

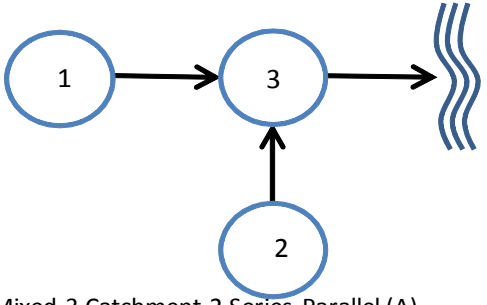
Up to 3 BMPs in Each catchment

E



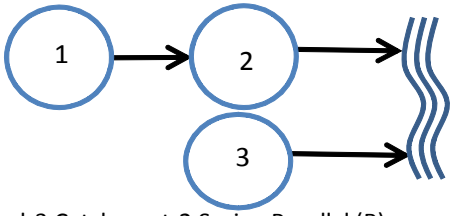
E - 3 Catchment-Parallel

F



F - Mixed-3 Catchment-2 Series-Parallel (A)

G

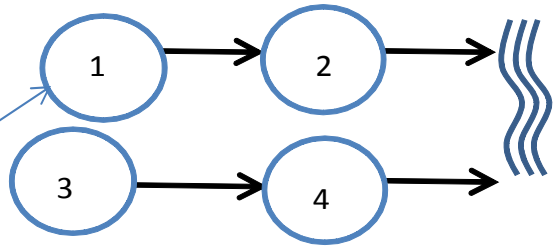


G - Mixed-3 Catchment-2 Series-Parallel (B)

Up to 4 catchments
(up to 14 configurations)

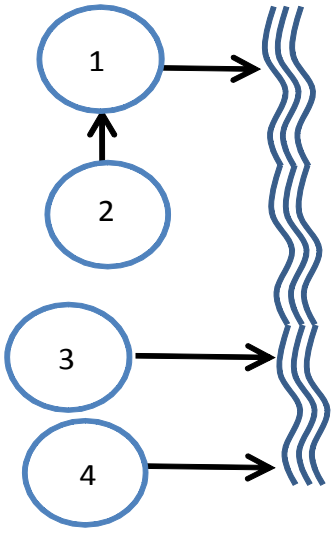
Up to 3 BMPs in Each catchment with no increase in catchment area between the BMPs

M



M - Mixed-4 Catchment-2 Series

N



N - Mixed-4 Catchment-2 Series-2 Parallel

Loading Results & Change Data

Blue Numbers =	Input data
Red Numbers =	Answers

Pre-development Annual Mass Loading - **Nitrogen:**	**0.369**	kg/year
Pre-development Annual Mass Loading - **Phosphorus:**	**0.005**	kg/year
Post-development Annual Mass Loading - **Nitrogen:**	**3.750**	kg/year
Post-development Annual Mass Loading - **Phosphorus:**	**0.503**	kg/year

OVERWRITE DEFAULT CONCENTRATIONS:

	PRE:		POST:	
EMC(**N**):		mg/L		mg/L
EMC(**P**):		mg/L		mg/L

NOTE: If any changes to the default values are made the numbers “carry” to the end

EMC Default Values

as of June 3, 2013

LAND USE CATEGORY	Event Mean Concentration (mg/l)	
	TOTAL Nitrogen	TOTAL Phosphorus
Low-Density Residential[1]	1.51	0.178
Single-Family	1.87	0.301
Multi-Family	2.1	0.497
Low-Intensity Commercial	1.07	0.179
High-Intensity Commercial	2.2	0.248
Light Industrial	1.19	0.213
Highway	1.37	0.167
Agricultural - Pasture	3.3	0.621
Agricultural - Citrus	2.07	0.152
Agricultural - Row Crops	2.46	0.489
Agricultural - General Agriculture[2]	2.79	0.431
Undeveloped	1.15	0.055
Mining / Extractive	1.18	0.15

1. Average of single-family and undeveloped loading rates

2. Mean of pasture, citrus, and row crop land uses

GENERAL SITE INFORMATION:	GO TO INTRODUCTION PAGE	Blue Numbers =	Input data
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Mean Annual Rainfall (Please use rainfall map):	50.50 Inches	VIEW MEAN ANNUAL RAINFALL MAP
Type of analysis:	CLICK ON CELL BELOW TO SELECT Specified removal efficiency	
Treatment efficiency (leave empty if net improvement analysis is used):	80.00 %	

STEP 2: Select the STORMWATER TREATMENT ANALYSIS to begin analyzing Best Management Practices.

STORMWATER TREATMENT ANALYSIS

Systems available for analysis:
Retention Basin
Wet Detention
Exfiltration Trench
Pervious Pavement
Stormwater Harvesting
Underdrain Biofiltration
Greenroof
Rainwater Harvesting
Floating Island with Wet Detention
Vegetated Natural Buffer
Vegetated Filter Strip
Swale
Rain Garden

RESET INPUT FOR SINGLE SYSTEM TABS

METHODOLOGY FOR CALCULATING REQUIRED TREATMENT EFFICIENCY

METHODOLOGY FOR RETENTION SYSTEMS

METHODOLOGY FOR WET DETENTION SYSTEMS

METHODOLOGY FOR STORMWATER AND RAINWATER HARVESTING

METHODOLOGY FOR GREENROOF SYSTEMS

Mean Annual Runoff Coefficient

Zone 1
Mean Annual Runoff Coefficients (C Values) as a Function of DCIA Percentage and Non-DCIA Curve Number (CN)

NDCIA CN	Percent DCIA																				
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
30	0.006	0.048	0.090	0.132	0.175	0.217	0.259	0.301	0.343	0.386	0.428	0.470	0.512	0.554	0.596	0.639	0.681	0.723	0.765	0.807	0.849
35	0.009	0.051	0.093	0.135	0.177	0.219	0.261	0.303	0.345	0.387	0.429	0.471	0.513	0.555	0.597	0.639	0.681	0.723	0.765	0.807	0.849
40	0.014	0.056	0.098	0.139	0.181	0.223	0.265	0.307	0.348	0.390	0.432	0.474	0.515	0.557	0.599	0.641	0.682	0.724	0.766	0.808	0.849
45	0.020	0.062	0.103	0.145	0.186	0.228	0.269	0.311	0.352	0.394	0.435	0.476	0.518	0.559	0.601	0.642	0.684	0.725	0.767	0.808	0.849
50	0.029	0.070	0.111	0.152	0.193	0.234	0.275	0.316	0.357	0.398	0.439	0.480	0.521	0.562	0.603	0.644	0.685	0.726	0.767	0.808	0.849
55	0.039	0.079	0.120	0.161	0.201	0.242	0.282	0.323	0.363	0.404	0.444	0.485	0.525	0.566	0.606	0.647	0.687	0.728	0.768	0.809	0.849
60	0.052	0.092	0.132	0.172	0.212	0.252	0.291	0.331	0.371	0.411	0.451	0.491	0.531	0.570	0.610	0.650	0.690	0.730	0.770	0.810	0.849
65	0.069	0.108	0.147	0.186	0.225	0.264	0.303	0.342	0.381	0.420	0.459	0.498	0.537	0.576	0.615	0.654	0.693	0.732	0.771	0.810	0.849
70	0.092	0.130	0.167	0.205	0.243	0.281	0.319	0.357	0.395	0.433	0.471	0.508	0.546	0.584	0.622	0.660	0.698	0.736	0.774	0.812	0.849
75	0.121	0.158	0.194	0.230	0.267	0.303	0.340	0.376	0.412	0.449	0.485	0.522	0.558	0.595	0.631	0.667	0.704	0.740	0.777	0.813	0.849
80	0.162	0.196	0.230	0.265	0.299	0.334	0.368	0.402	0.437	0.471	0.506	0.540	0.574	0.609	0.643	0.678	0.712	0.746	0.781	0.815	0.849
85	0.220	0.252	0.283	0.315	0.346	0.378	0.409	0.441	0.472	0.503	0.535	0.566	0.598	0.629	0.661	0.692	0.724	0.755	0.787	0.818	0.849
90	0.312	0.339	0.366	0.393	0.419	0.446	0.473	0.500	0.527	0.554	0.581	0.608	0.634	0.661	0.688	0.715	0.742	0.769	0.796	0.823	0.849
95	0.478	0.496	0.515	0.533	0.552	0.571	0.589	0.608	0.626	0.645	0.664	0.682	0.701	0.719	0.738	0.757	0.775	0.794	0.812	0.831	0.849
98	0.656	0.666	0.676	0.685	0.695	0.705	0.714	0.724	0.734	0.743	0.753	0.763	0.772	0.782	0.792	0.801	0.811	0.821	0.830	0.840	0.849

From Harper and Baker

Interpolating Challenge

NDCIA CN	Percent DCIA											
	0	5	10	15	20	25	30	35	40	45	50	55
30	0.006	0.048	0.090	0.132	0.175	0.217	0.259	0.301	0.343	0.386	0.428	0.470
35	0.009	0.051	0.093	0.135	0.177	0.219	0.261	0.303	0.345	0.387	0.429	0.471
40	0.014	0.056	0.098	0.139	0.181	0.223	0.265	0.307	0.348	0.390	0.432	0.474
45	0.020	0.062	0.103	0.145	0.186	0.228	0.269	0.311	0.352	0.394	0.435	0.476
50	0.029	0.070	0.111	0.152	0.193	0.234	0.275	0.316	0.357	0.398	0.439	0.480
55	0.039	0.079	0.120	0.161	0.201	0.242	0.282	0.323	0.363	0.404	0.444	0.485

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Greenroof
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Floating Island with Wet Detention
Vegetated Natural Buffer
Vegetated Filter Strip
Swale
Rain Garden

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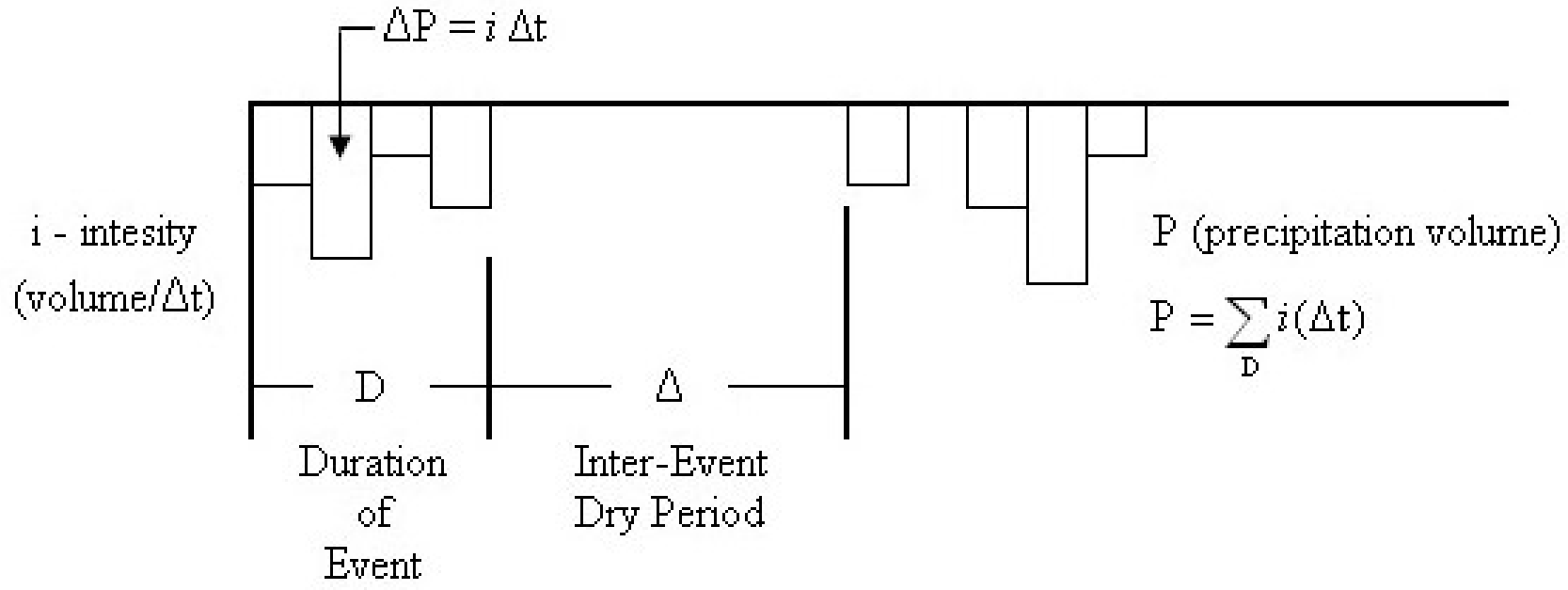
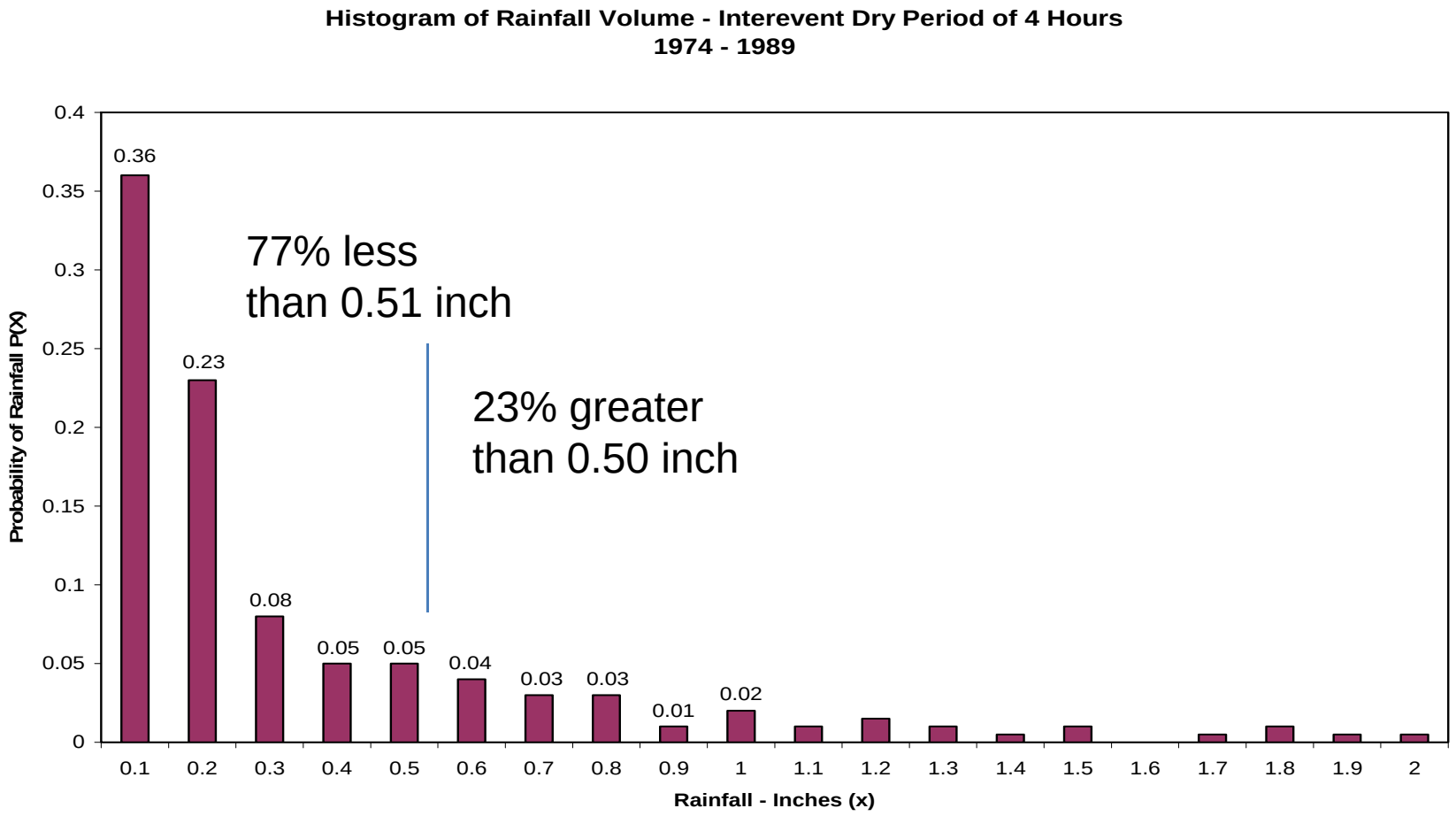
Basic Principles

- Inter-Event Dry Period



Histogram (Probability Distribution)

- N=130 events per year



Volume Abstracted or Diverted

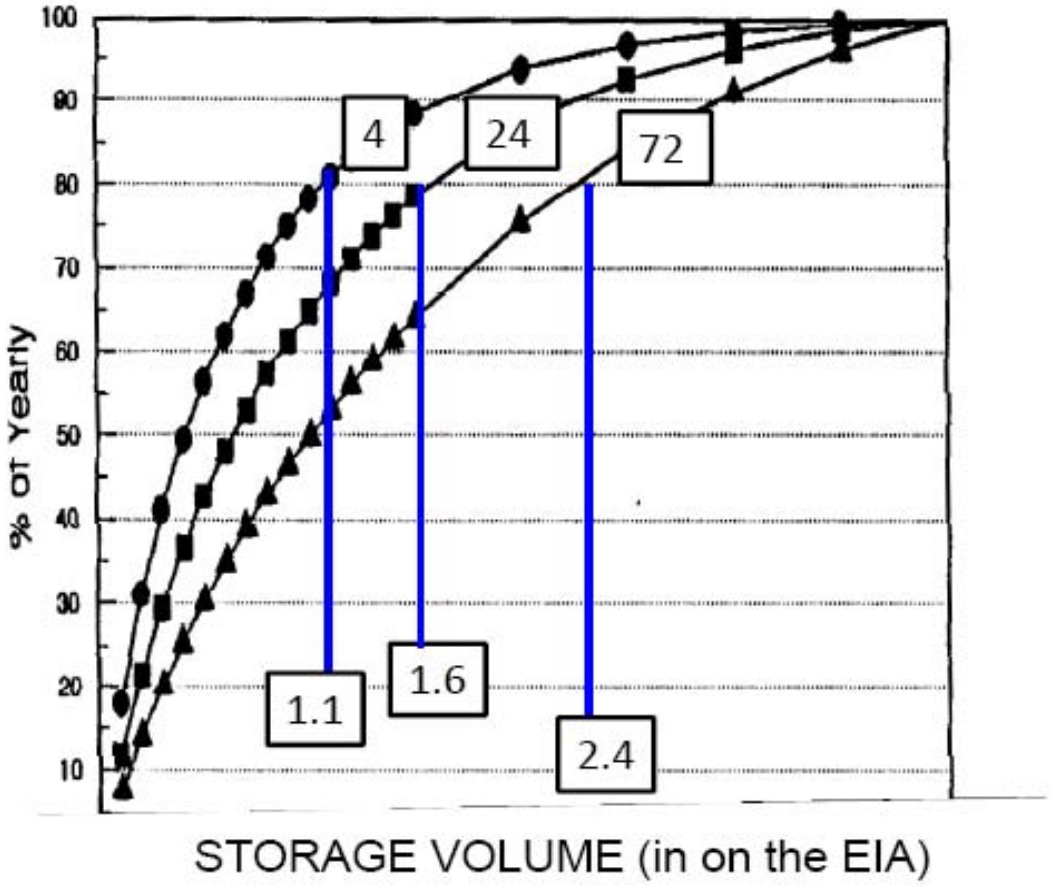
- Using probability basic principles

$$\text{Volume Abstracted} = \sum_{i}^{\text{AbstractionVol.}} P(i)_i \, \bar{x}_i \, n + \sum_{i=\text{AbstractionVol.}}^{\infty} P(i)_i \, (\text{Abstraction Vol.})(n)$$

Where the first term is the Expected Value of the abstraction volume up to the abstraction depth,
and the second term the abstraction volume for all storm events greater than or equal to the abstraction depth.

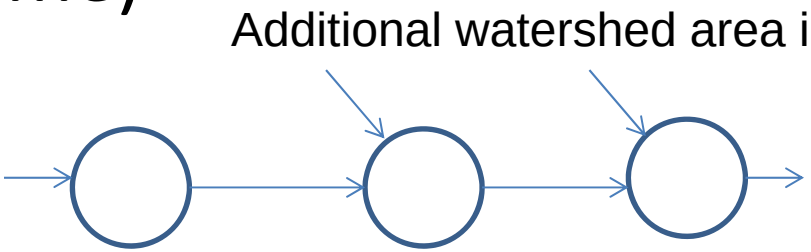
Mass Curve

for 4, 24, and 72 hour treatment times (inter-event)

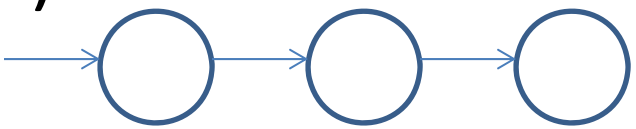


Important to note transport time and treatment time if one catchment drains through another one

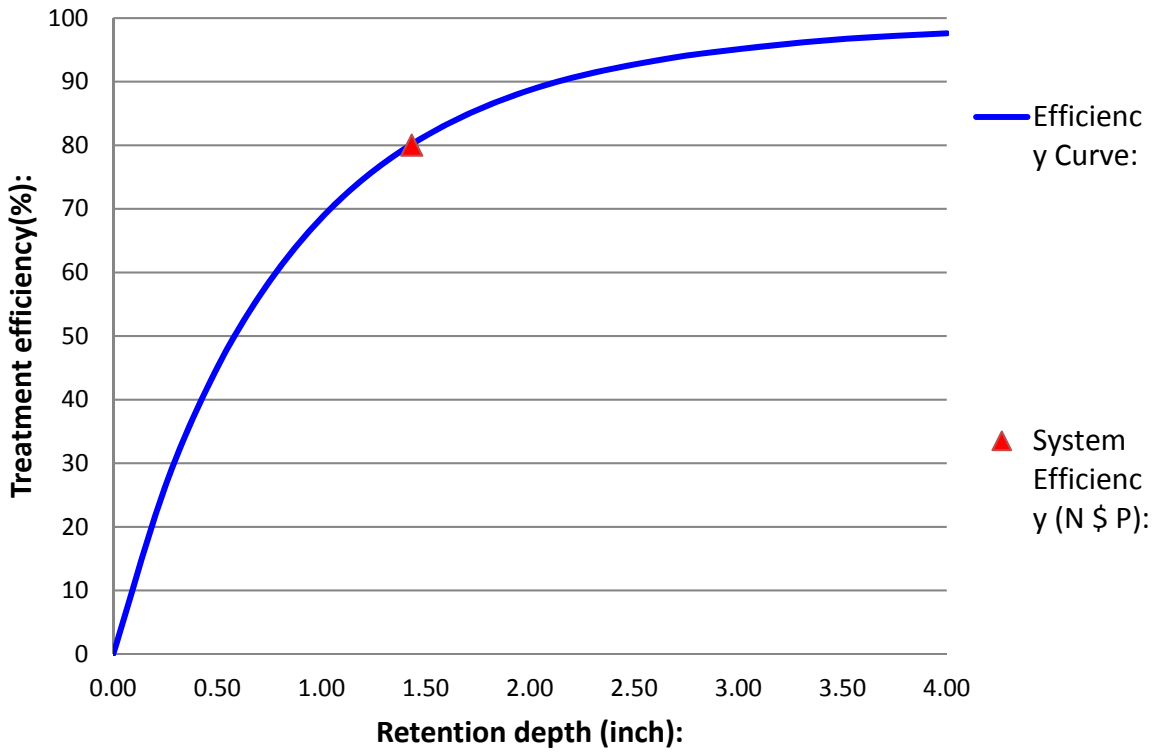
- Time of concentration
- Time for treatment (infiltration or recovery of treatment volume)
- 3 catchments



- One catchment with three BMPs (ex. pervious pave to baffle box to swale).



Example Output Retention Design



Effectiveness over the equivalent impervious area increases with the depth of retention over the area and rate of increase decreases with depth

Methodology For Retention Systems

Mean Annual Mass Removal Efficiency table from Appendix D of the evaluation report (1 out of 80):

Mean Annual Mass Removal Efficiencies for 0.25-inches of Retention for Zone 1

NDCIA	Percent DCIA																		
CN	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	86.2	81.3	73.3	65.5	58.7	53.0	48.3	44.2	40.8	37.9	35.3	33.1	31.1	29.4	27.8	26.4	25.1	24.0	22.9	21.9
35	81.6	78.7	71.7	64.5	58.0	52.5	47.9	44.0	40.6	37.7	35.2	33.0	31.0	29.3	27.8	26.4	25.1	23.9	22.9	21.9
40	76.4	75.5	69.6	63.1	57.1	51.9	47.4	43.6	40.3	37.5	35.0	32.9	30.9	29.2	27.7	26.3	25.1	23.9	22.9	21.9
45	70.7	71.7	67.2	61.4	55.9	51.0	46.8	43.1	40.0	37.2	34.8	32.7	30.8	29.1	27.6	26.3	25.0	23.9	22.9	21.9
50	64.7	67.5	64.2	59.4	54.5	50.0	46.0	42.6	39.5	36.9	34.6	32.5	30.7	29.0	27.5	26.2	25.0	23.9	22.9	21.9
55	58.6	62.8	60.9	57.0	52.7	48.7	45.1	41.8	39.0	36.5	34.2	32.3	30.5	28.9	27.4	26.1	24.9	23.9	22.9	21.9
60	52.8	57.8	57.1	54.2	50.7	47.1	43.9	40.9	38.3	35.9	33.8	31.9	30.2	28.7	27.3	26.0	24.9	23.8	22.8	21.9
65	47.3	52.6	53.0	51.1	48.3	45.3	42.5	39.8	37.4	35.3	33.3	31.5	29.9	28.4	27.1	25.9	24.8	23.8	22.8	21.9
70	42.2	47.3	48.6	47.6	45.6	43.2	40.8	38.5	36.4	34.4	32.6	31.0	29.5	28.1	26.9	25.7	24.7	23.7	22.8	21.9
75	37.8	42.2	43.9	43.7	42.4	40.7	38.8	36.9	35.1	33.4	31.8	30.4	29.0	27.8	26.6	25.5	24.5	23.6	22.7	21.9
80	34.0	37.5	39.1	39.4	38.8	37.7	36.4	34.9	33.5	32.1	30.8	29.5	28.3	27.2	26.2	25.2	24.3	23.5	22.7	21.9
85	30.8	33.1	34.3	34.8	34.7	34.2	33.4	32.5	31.4	30.4	29.4	28.4	27.4	26.5	25.7	24.8	24.1	23.3	22.6	21.9
90	27.9	29.2	29.9	30.3	30.3	30.2	29.8	29.3	28.8	28.2	27.5	26.8	26.2	25.5	24.9	24.2	23.6	23.0	22.5	21.9
95	25.3	25.6	25.8	25.9	26.0	25.9	25.8	25.6	25.4	25.2	24.9	24.6	24.3	24.0	23.6	23.3	23.0	22.6	22.3	21.9
98	23.8	23.8	23.8	23.7	23.7	23.6	23.5	23.4	23.3	23.2	23.1	23.0	22.9	22.8	22.6	22.5	22.4	22.2	22.1	21.9

From Harper and Baker

GENERAL SITE INFORMATION:	GO TO INTRODUCTION PAGE	Blue Numbers =	Input data
		Red Numbers =	Answers

STEP 1: Select the appropriate Meteorological Zone, input the appropriate Mean Annual Rainfall amount and select the type of analysis

Meteorological Zone (Please use zone map):	CLICK ON CELL BELOW TO SELECT Zone 2	VIEW ZONE MAP
Mean Annual Rainfall (Please use rainfall map):	50.50 Inches	VIEW MEAN ANNUAL RAINFALL MAP
Type of analysis:	CLICK ON CELL BELOW TO SELECT Specified removal efficiency	
Treatment efficiency (leave empty if net improvement analysis is used):	80.00 %	

STEP 2: Select the STORMWATER TREATMENT ANALYSIS to begin analyzing Best Management Practices.

STORMWATER TREATMENT ANALYSIS

Systems available for analysis:
Retention Basin
Wet Detention
Exfiltration Trench
Pervious Pavement
Stormwater Harvesting
Underdrain Biofiltration
Greenroof
Rainwater Harvesting
Floating Island with Wet Detention
Vegetated Natural Buffer
Vegetated Filter Strip
Swale
Rain Garden

RESET INPUT FOR SINGLE SYSTEM TABS

METHODOLOGY FOR CALCULATING REQUIRED TREATMENT EFFICIENCY

METHODOLOGY FOR RETENTION SY... → METHODOLOGY FOR WET DETENTION SYSTEMS

METHODOLOGY FOR STORMWATER AND RAINWATER HARVESTING

METHODOLOGY FOR GREENROOF SYSTEMS

Methodology for Wet Detention Systems

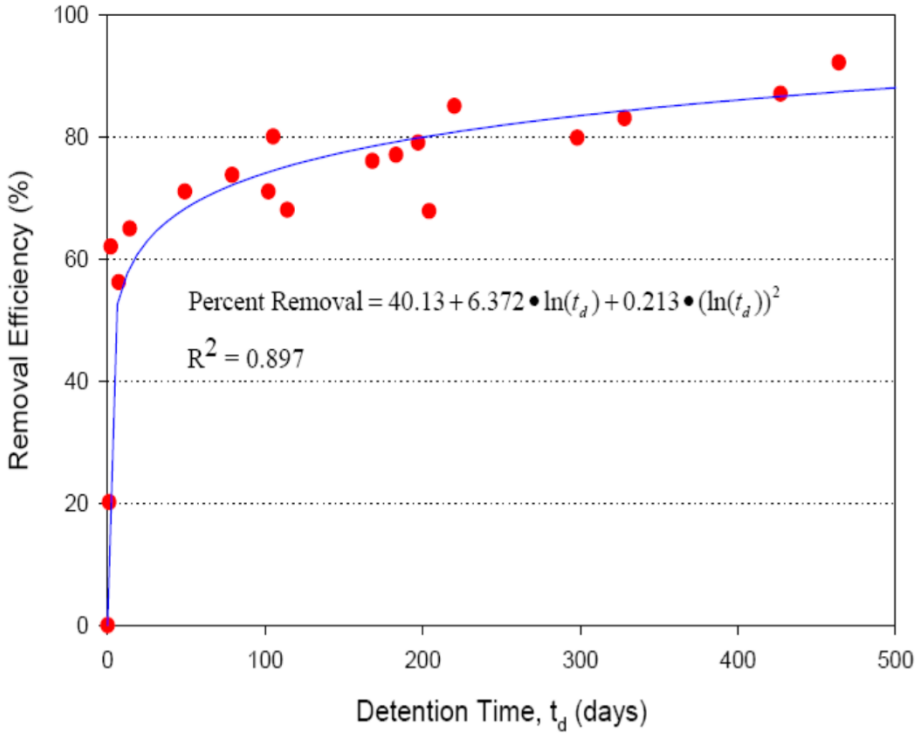


Figure 7.5-1 Removal Efficiency of Total Phosphorus in Wet Detention Ponds as a Function of Residence Time.

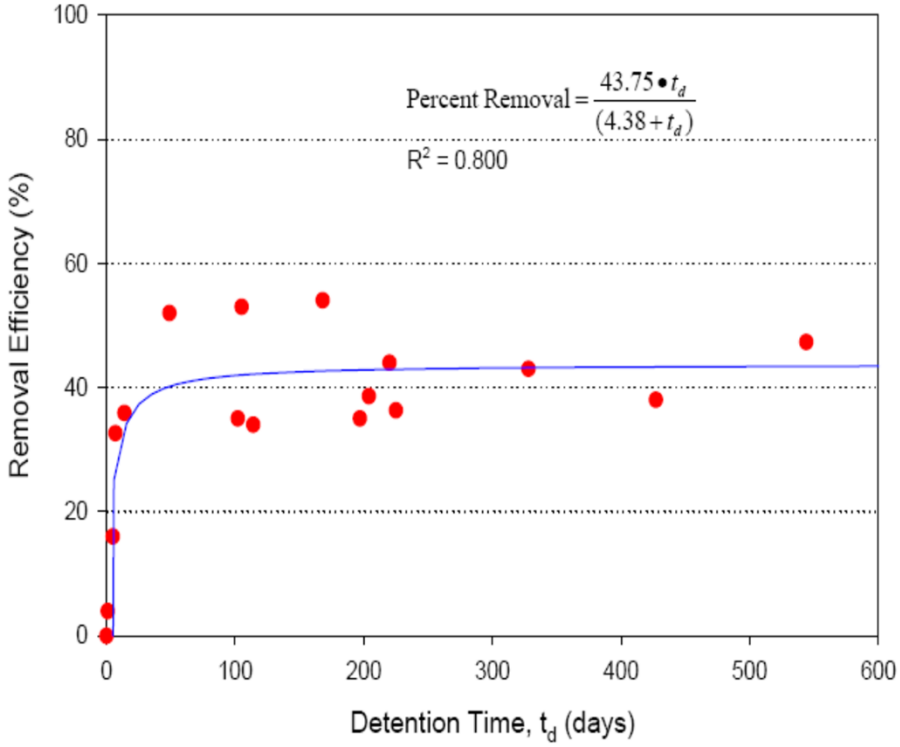


Figure 7.5-2 Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Residence Time.

Watershed Input Data and Summaries of Mass Loadings

Pre-development watershed characteristics:

Pre-development non DCIA CN:	80.00	
Pre-development DCIA percentage:	0.000	%
Annual runoff volume:	0.254	ac-ft/year
Annual Mass Loading - **Nitrogen**	0.369	kg/year
Annual Mass Loading - **Phosphorus**	0.005	kg/year

Post-development watershed characteristics:

Post-development non DCIA CN:	80.00	
Post-development DCIA percentage:	100.000	%
Annual runoff volume:	1.854	ac-ft/year
Annual Mass Loading - **Nitrogen**	3.750	kg/year
Annual Mass Loading - **Phosphorus**	0.503	kg/year

Required Treatment Efficiency:

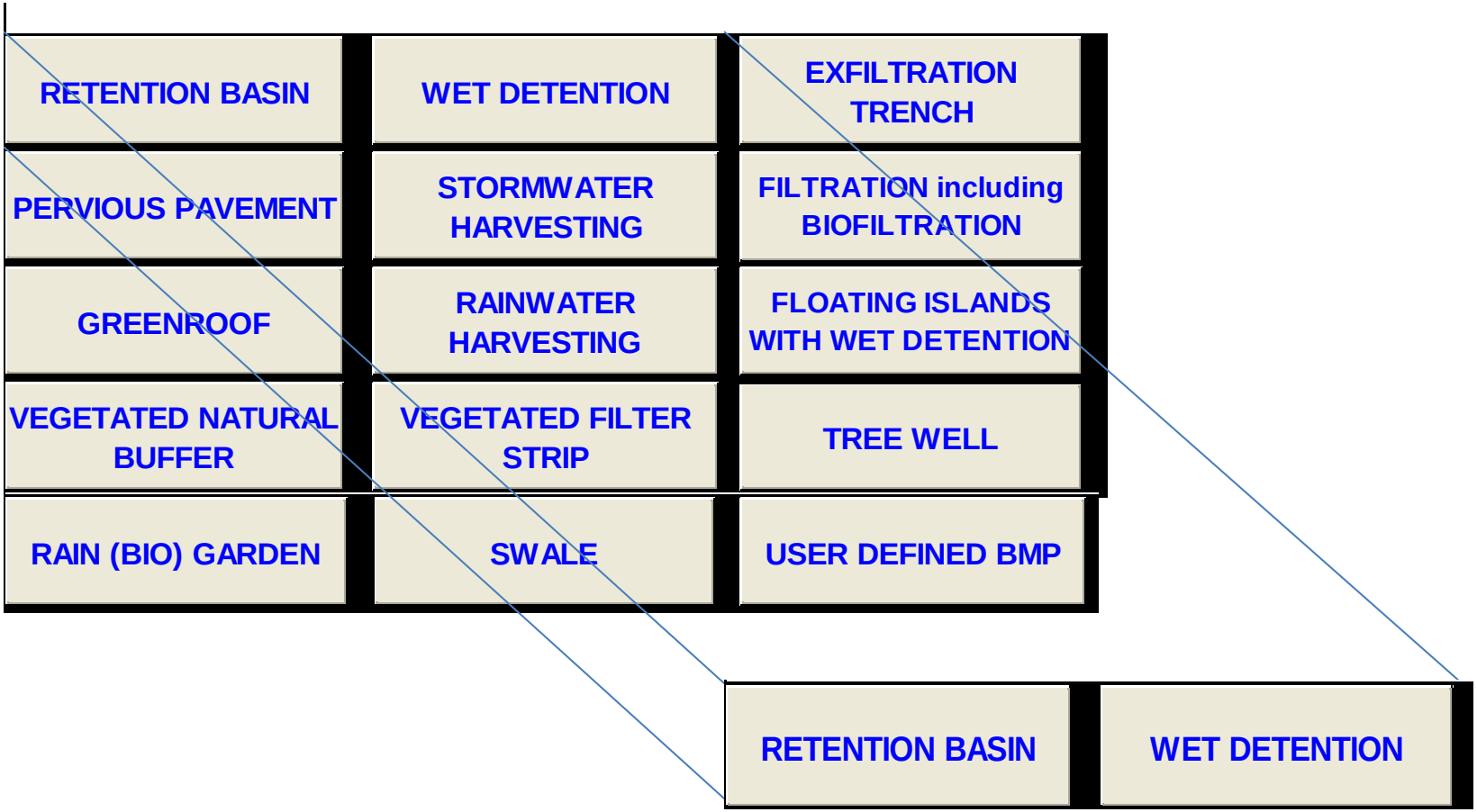
Required Treatment Eff (**Nitrogen**):	80.000	%
Required Treatment Eff (**Phosphorus**):	80.000	%

15 BMPs and One User Defined

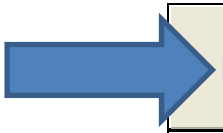
STEP 2: Select one of the systems below to analyze efficiency.

RETENTION BASIN	WET DETENTION	EXFILTRATION TRENCH	RAIN (BIO) GARDEN	SWALE	USER DEFINED BMP
PERVIOUS PAVEMENT	STORMWATER HARVESTING	FILTRATION including BIOFILTRATION	LINED REUSE POND & UNDERDRAIN INPUT	NOTE !!!: All individual system must be sized prior to being analyzed in conjunction with other systems. Please read instructions in the MULTIPLE WATERSHEDS AND TREATMENT SYSTEMS ANALYSIS tab for more information.	
GREENROOF	RAINWATER HARVESTING	FLOATING ISLANDS WITH WET DETENTION			
VEGETATED NATURAL BUFFER	VEGETATED FILTER STRIP	VEGETATED AREA Example tree well	CATCHMENT AND TREATMENT SUMMARY RESULTS		

Retention Basins and Wet Detention Ponds are Traditional



Treatment Options

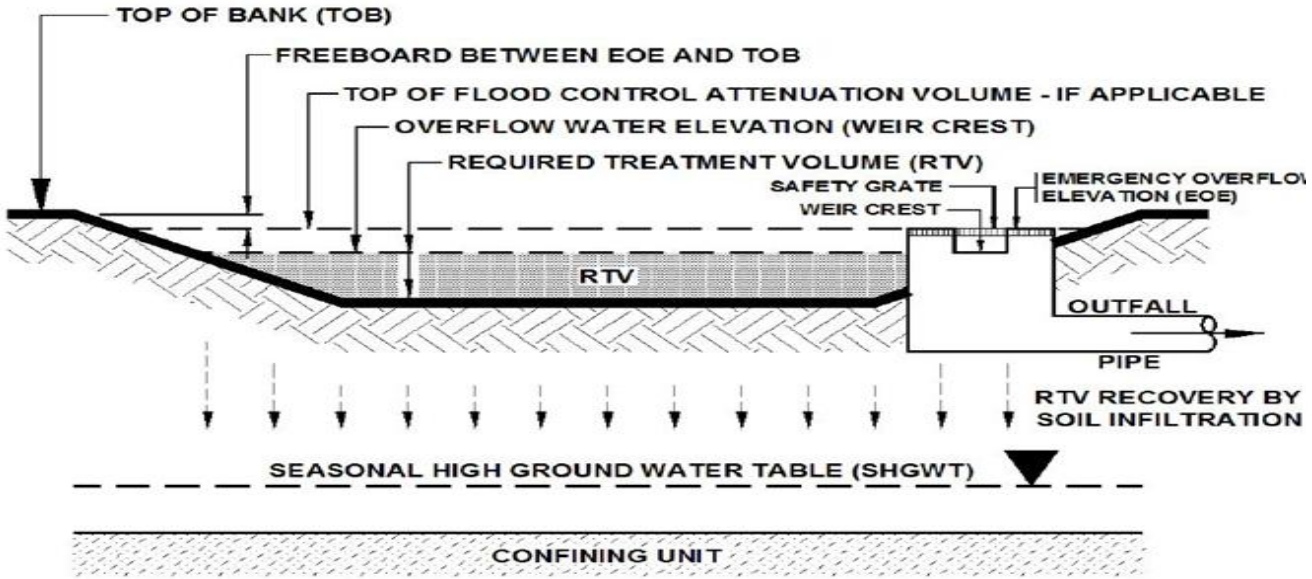


RETENTION BASIN	WET DETENTION	EXFILTRATION TRENCH
PERVIOUS PAVEMENT	STORMWATER HARVESTING	UNDERDRAIN BIOFILTRATION
GREENROOF	RAINWATER HARVESTING	FLOATING ISLANDS WITH WET DETENTION
VEGETATED NATURAL BUFFER	VEGETATED FILTER STRIP	TREE WELL

Retention Basin Size Section

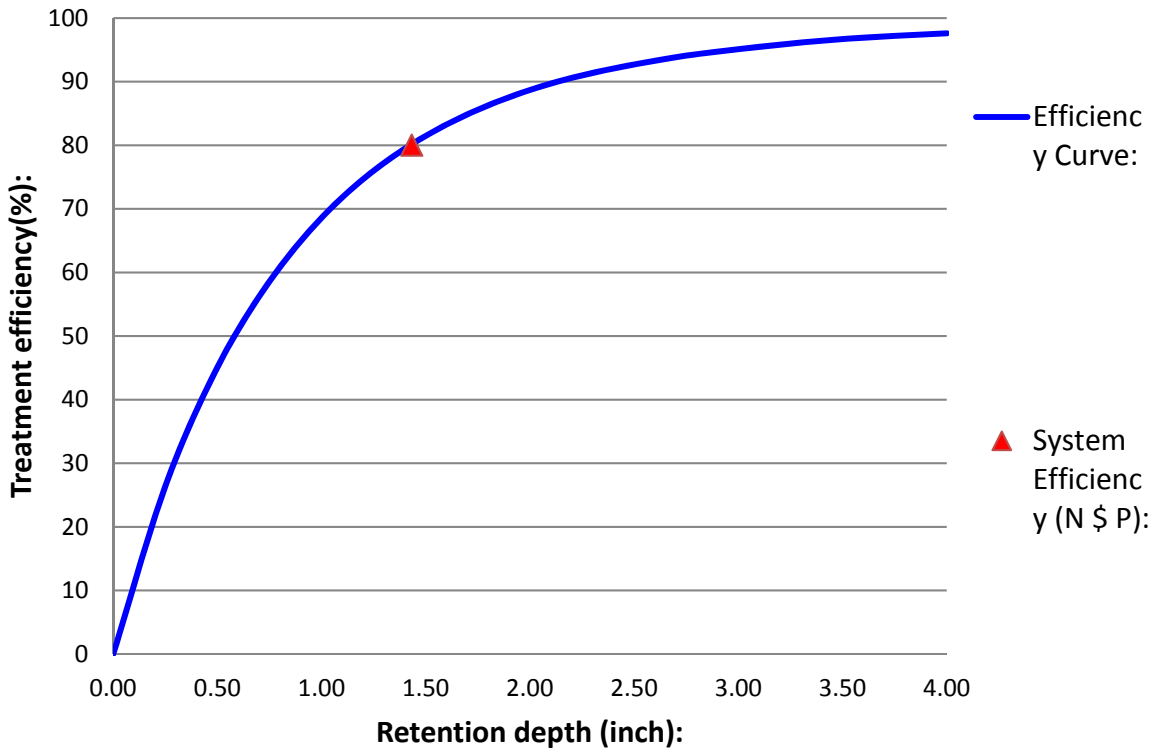
DRY RETENTION BASIN SERVING ENTIRE CONTRIBUTING WATERSHED:

Contributing watershed area:	0.55	ac
Required treatment efficiency:	80.00	%
Required retention for the entire watershed to meet required efficiency:	1.43	in
Required water quality retention volume:	2,864	cf
Required water quality retention volume:	0.066	ac-ft



Example of a basin size at the bottom was 31.5’ x 31.5’ x 3’ deep and a limiting infiltration rate of 1.5 in/hr for a 24 hour recovery time.

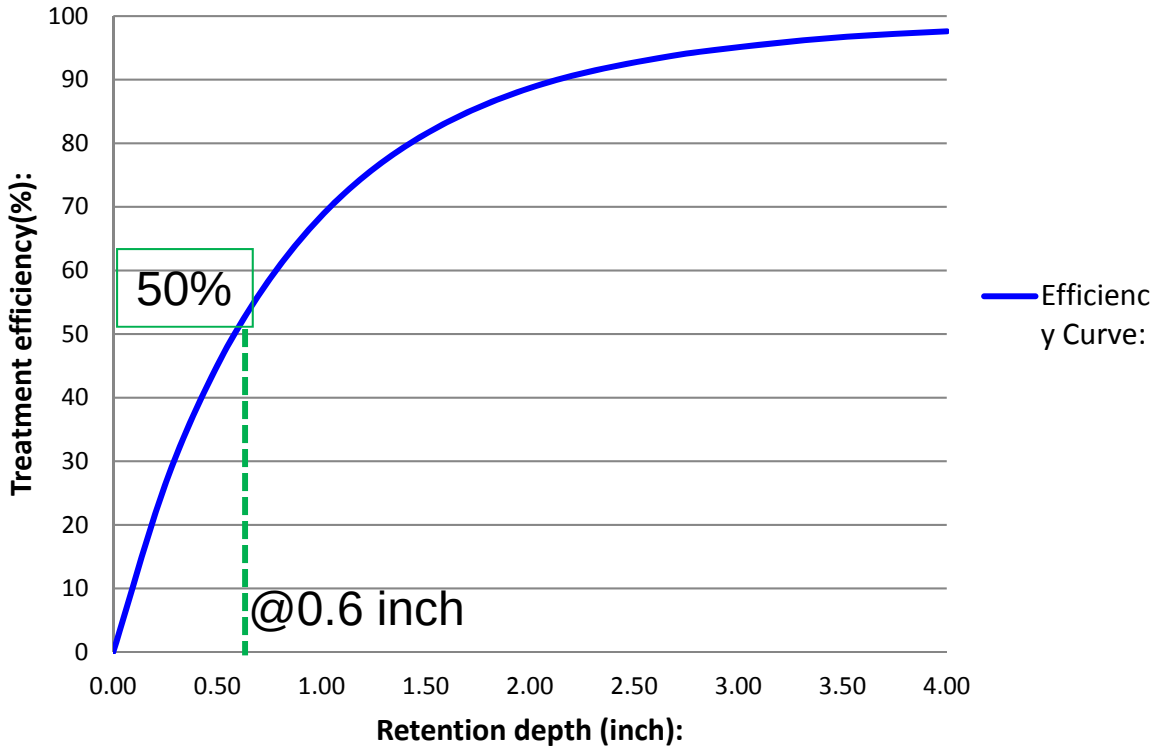
Example Output Retention Basin Design



Retention depth over the equivalent impervious area is 1.43 inches for the watershed conditions and rainfall zone.

BUT not enough area for the retention basin
Thus use 3 BMPs in Series in one Watershed

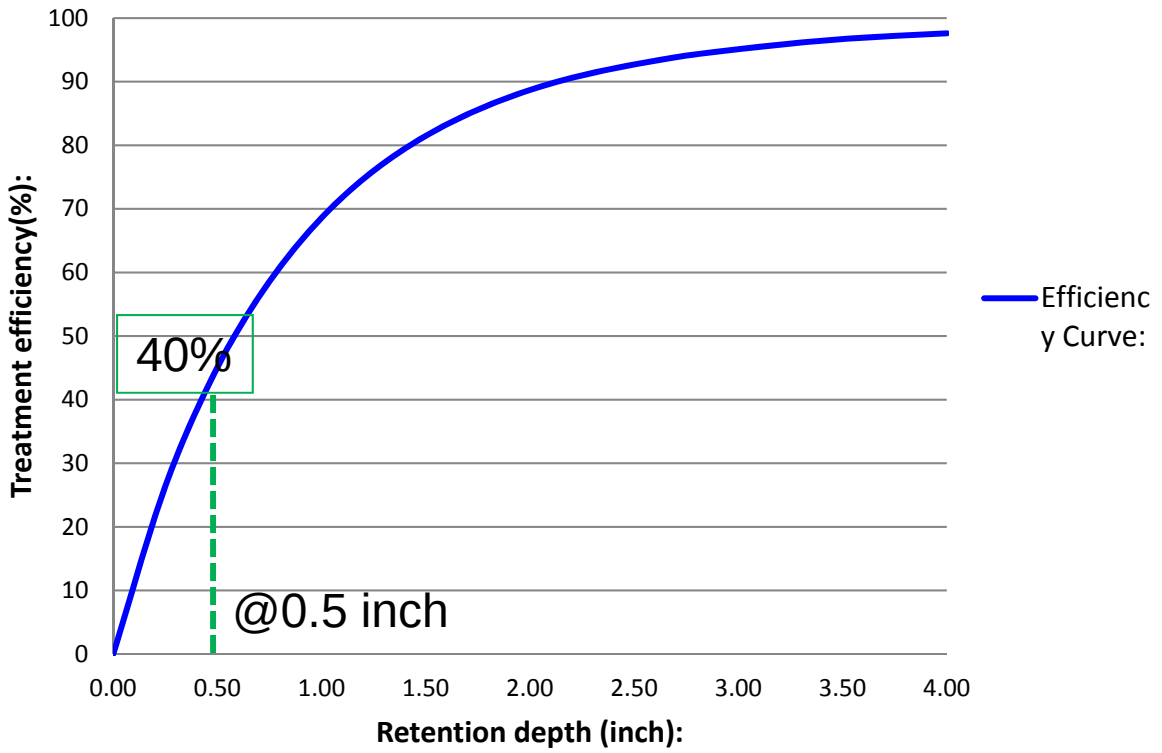
1st BMP is pervious pavement @ 0.6 inch treatment



Retention depth over the equivalent impervious area is 0.60 inches for a pervious pavement with reservoir.

Example 3 BMPs in Series in one Watershed

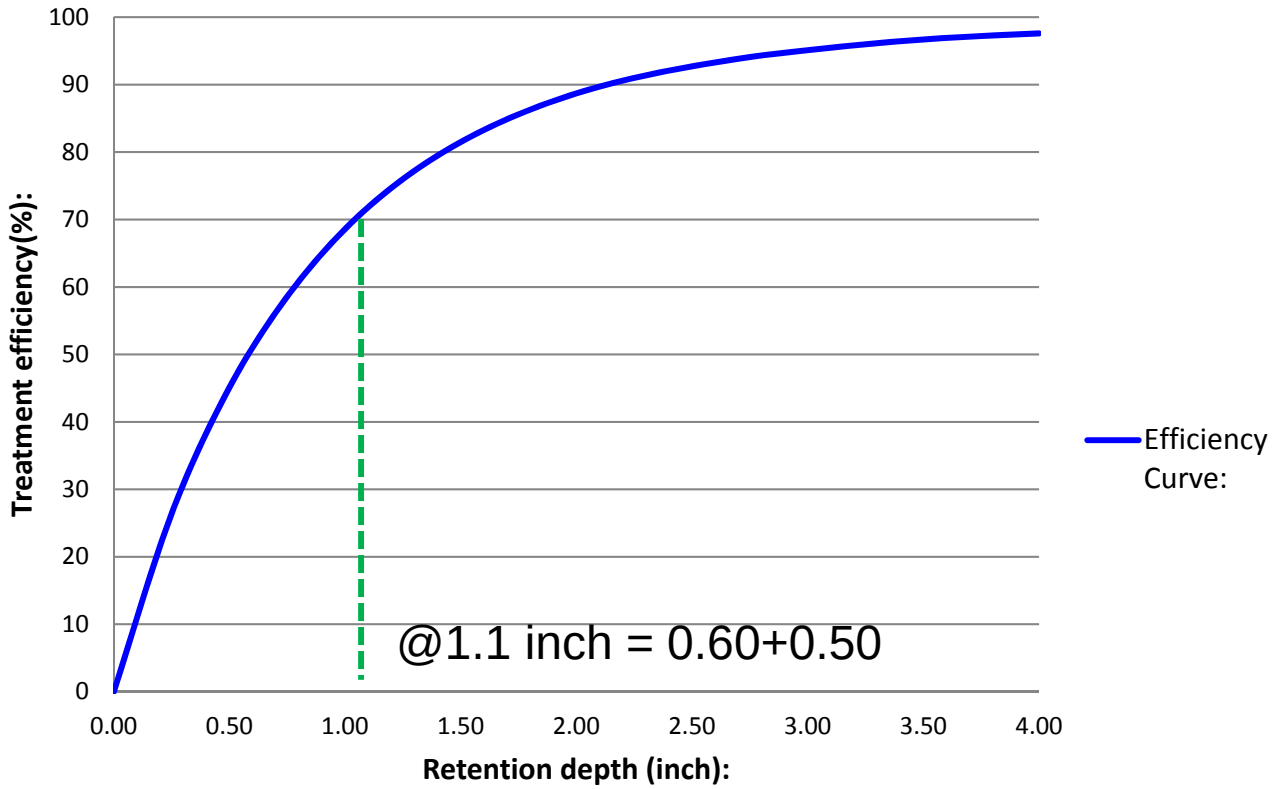
2nd BMP in series is exfiltration @ 0.5 inch treatment



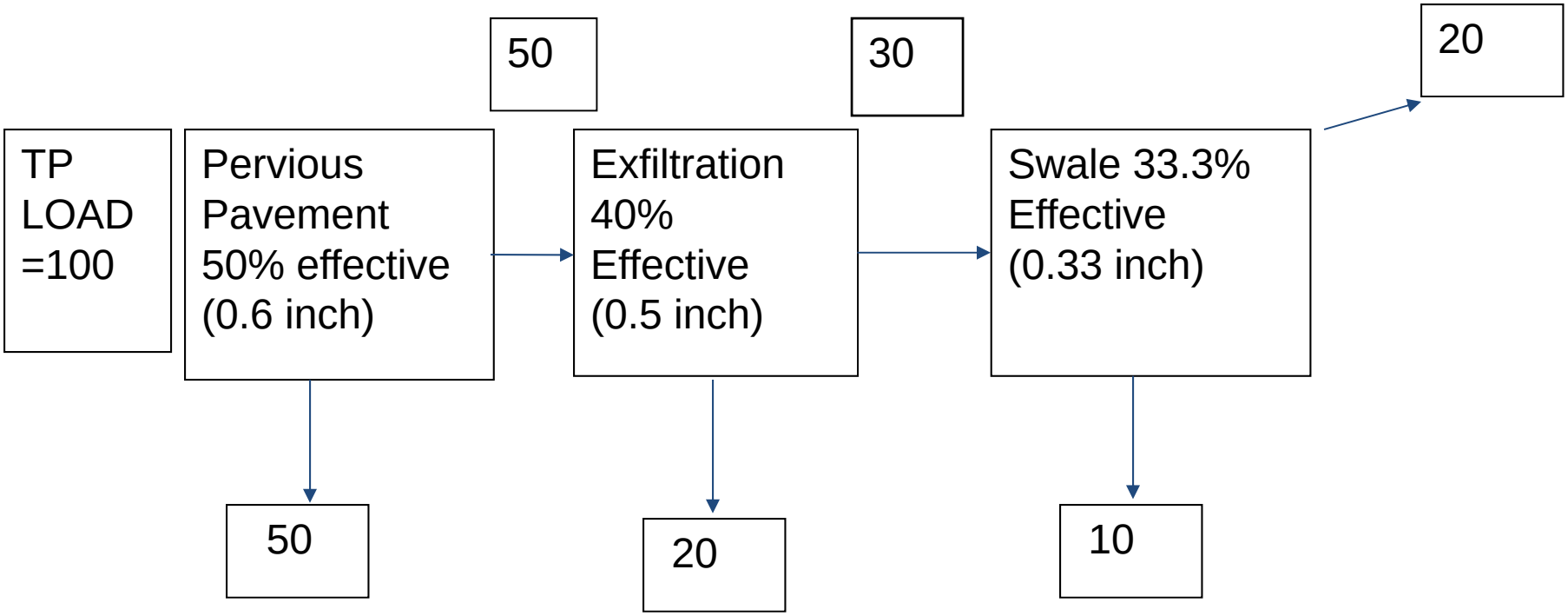
Retention depth over the equivalent impervious area is 0.50 inches for an exfiltration system.

For retention basins
stay true to the underlying principles

Annual effectiveness is **not** the sum of the two efficiencies (50+40= 90%)
It is however the annual effectiveness at 1.1 inch retention or 70%.



BMP TREATMENT TRAIN CREDITS
more ridiculous when three efficiencies are added



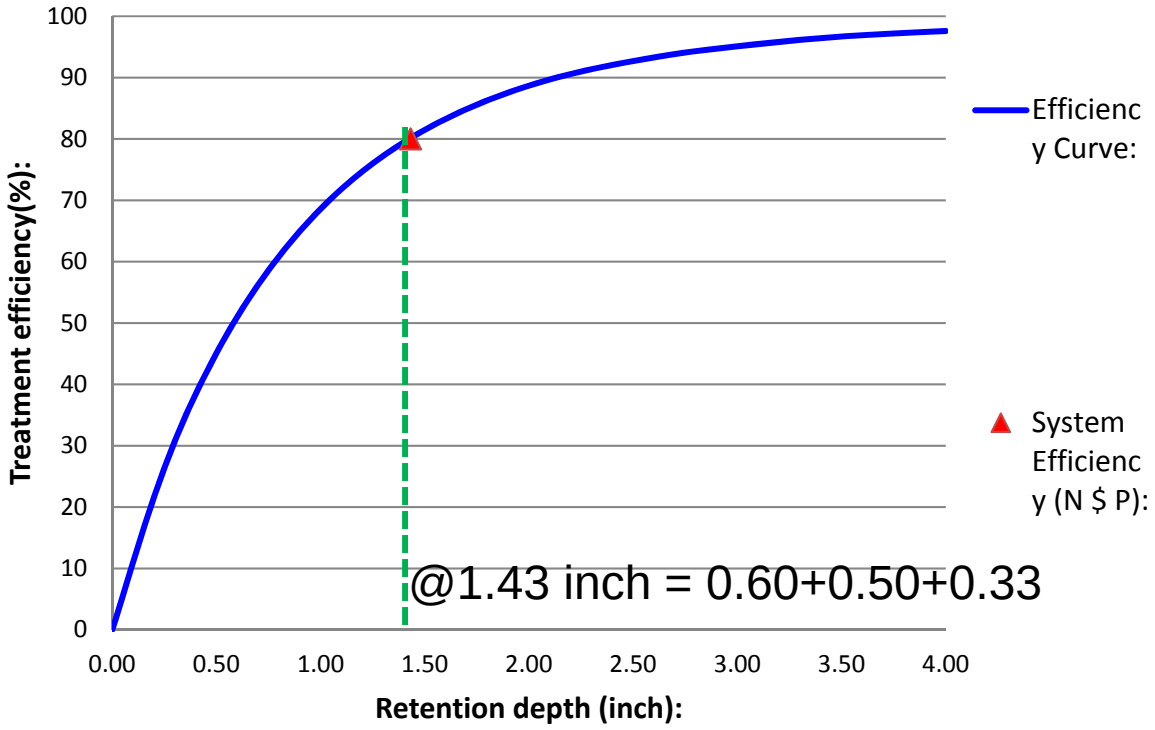
M = 100 [1- {(1-0.5)(1-0.4)(1-.33)}] = 100[1-.20] = 80 % removed

NOT 50+40+33.3=123.3%

NOTES 1. Example flow diagram for this problem only.
2. There was no input or additional catchment flow between BMPs

3 BMPs Output Retention Design

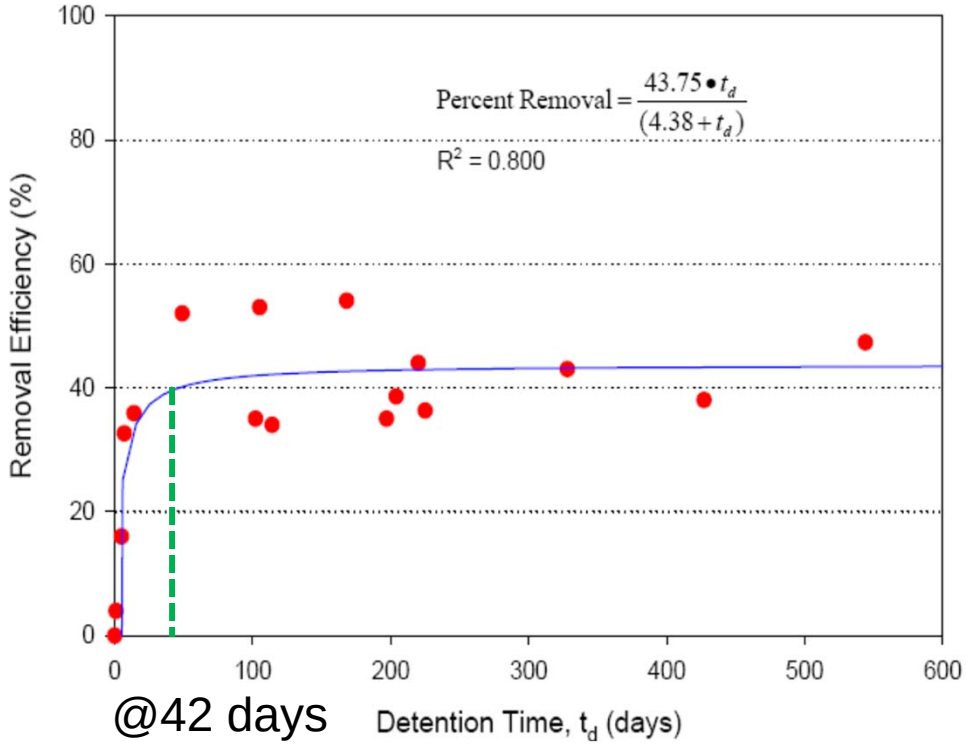
Assumes water entering ground has all pollution removed. However, the BMPTRAINS model allows an estimate of groundwater concentrations using special media blends (ex. Biosorption Activated Media).



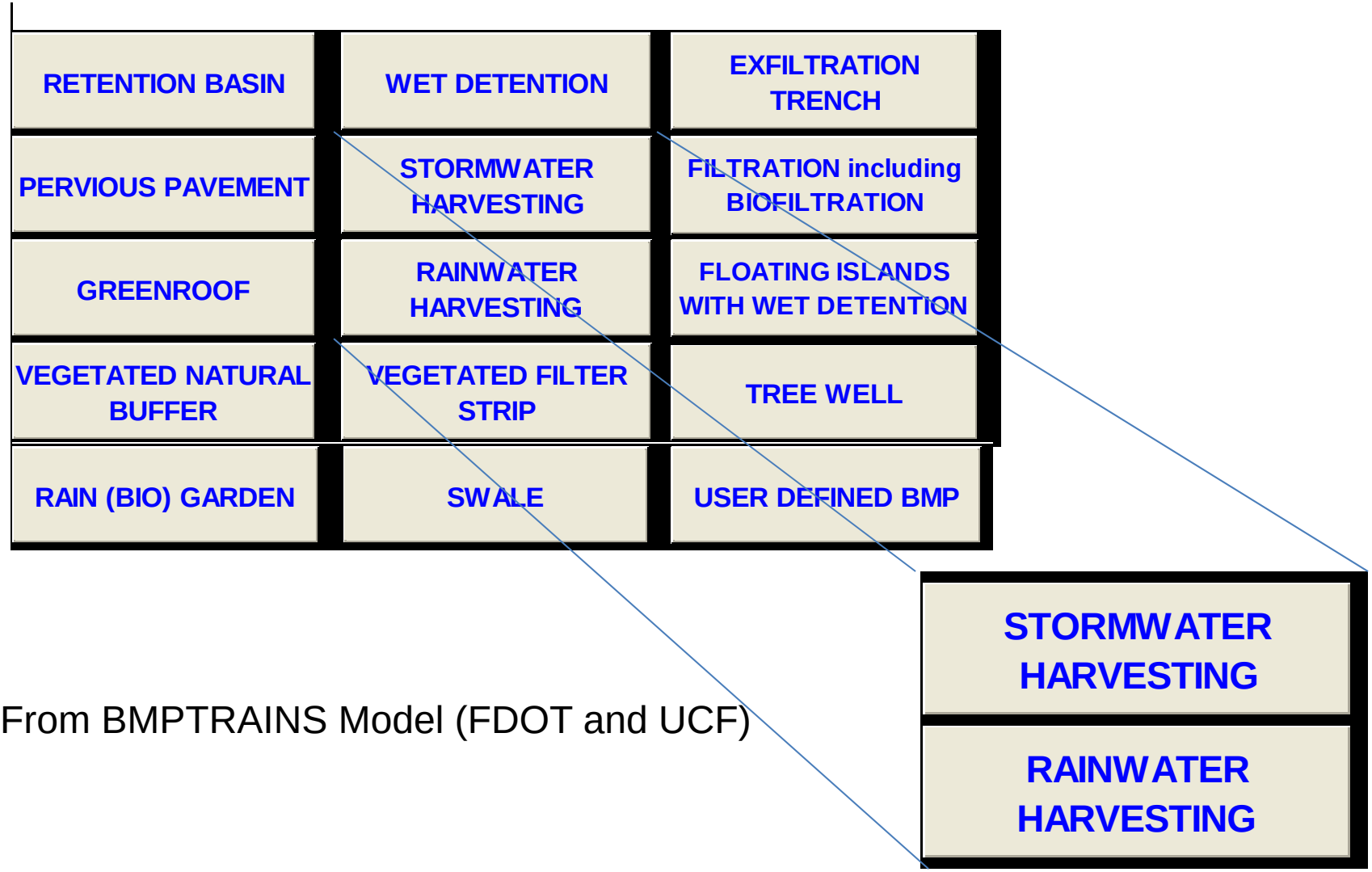
Retention depth over the equivalent impervious area is 1.43 inches.

For Wet Detention Ponds
Stay true to the underlying principles

Annual effectiveness is **not** the sum of the efficiencies for 2 wet ponds each with 42 days annual residence time. They do not get 80%. The annual effectiveness at 84 days is about 42%.



Many BMP Options



From BMPTRAINS Model (FDOT and UCF)

Enhanced Nitrogen Removal of a Detention Pond by Harvesting the Detained Water (note same catchment)

- 88% of water not discharged: N mass removed is 100[1-{(1-.88)(1-.4)}] = 93%
- 88 acre-feet supplied to 48 acres (from 24 acres, 50 inch rain, @ 88%)
- @$2.00/1000 gallons, net revenue is about $1000/acre irrigated/year.*
- **make up water** is = Need – Harvested = 145.6 – 88 = 57.6 Acre-Feet.

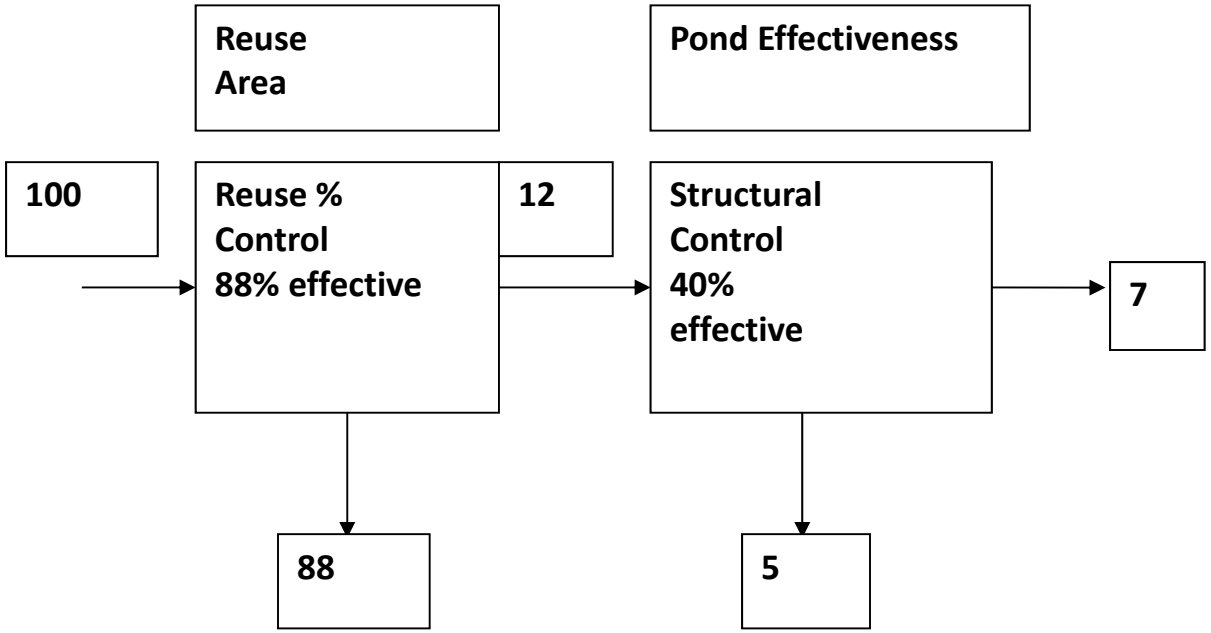


Photo Credit
FDOT

*Assumes a production and delivery cost of about $0.45/1000 gallons

4. City of Miramar – Supplement Reclaimed Water

- Source Estimated Capital Cost - $1.3 Million
- Capacity – 1 MGD
- Cost per 1,000 gallons (Reclaimed & Harvested IQ) - $0.80/1,000 gallons
  - Original estimates

Feet

Hartman Consulting & Design
301 E. Pine Street - Suite 1020 - Orlando, Florida 32801
Phone 407-447-9095 - Fax 407-447-9406

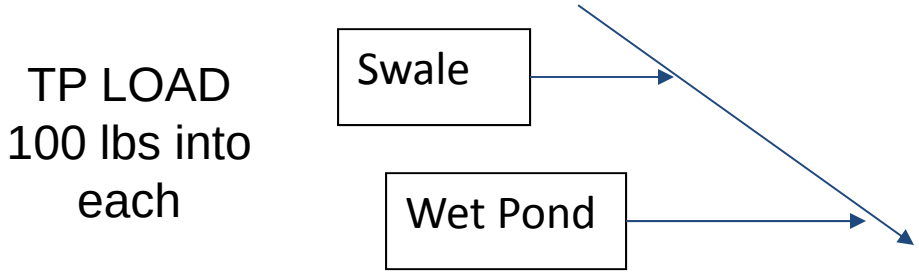
CITY OF MIRAMAR
PROPOSED STORMWATER SUPPLY SYSTEM
PLAN VIEW

FIGURE 1-2

Filepath: M:\CADD\CIVIL\2005\05.027.006\GIS\Fig 1-2 Aerial.mxd

BMP TREATMENT TRAIN CREDITS FOR PARALLEL BMPs – 2 Watersheds

Two BMPs in parallel – the discharge from each BMP goes into one system



- Efficiency = $(Rem_1 + Rem_2)$/input sum

SWALE	Wet Pond	TP LOAD
35% = 35lbs 65 lbs remaining	70% = 70 lbs 30 lbs remaining	95 lbs discharged From 200 input 52.5% effective

Seal of Approval

Conclusions

1. BMP treatment volumes are related to average annual effectiveness and are site specific.
2. BMP computation methods used for at least 30 years are on the “cloud”. The BMPTRAIN model is available for download.
3. Regional rainfall and site specific watershed characteristics are used to increase the accuracy in predicting BMP performance.
4. BMPs can be analyzed in either series or parallel structure. Stay “true” to the underlying principles.
5. Computation aids are available and are being used in Florida.

EWRI
ASCE
ENVIRONMENTAL & WATER RESOURCES INSTITUTE
East Central FL Chapter

Best Management Practices and Making BMPTRAINS

Marty Wanielista

Questions and Discussion Thank You…

www.stormwater.ucf.edu

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

University of Central Florida