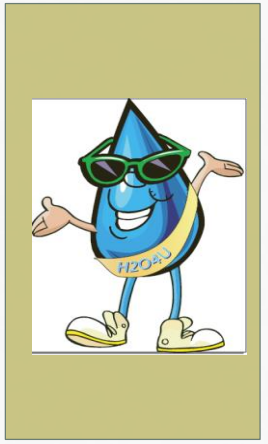
BMPTRAINS MODEL:

A TRAINING WORKSHOP

BY: MARTY WANIELISTA, HARVEY HARPER, ERIC LIVINGSTON AND MIKE HARDIN.



January 28, 2016

PURPOSE OF TRAINING IS TO:

- Present the theory essential for estimating annual nutrient mass removal.
- Understand the basis of removal for 15 Stormwater Best Management Practices Options within BMPTRAINS.
- Define input data required for the BMPTRAINS program.
- Use BMPTRAINS for the selection of stormwater best management practices.
- Solicit comments for improvements to BMPTRAINS

BMPTRAINS MODEL AND USERS MANUAL

BMPTRAINS: an EXCEL and VB based model for sizing BMPs and estimating annual removal effectiveness.

It's acronym is derived from the analysis of stormwater BMPs in series, but can also evaluate parallel and series treatment.

The model is used to evaluate **B**est **M**anagement **P**ractice **T**reatment options for **R**emoval on an **A**nnual basis by those **I**nterested in **N**utrients in **S**tormwater.

Available from: www.stormwater.ucf.edu

What's New

BMPTRAINS Stormwater Best Management Practices Analysis Model (Version 7.7) Registration, Model, and User's Manual

Credit and thanks for the programming and technical skills of: Dr. Mike Hardin, Dr. Harvey Harper, Dr. Ikiensinma Gogo-Abite, Eric Livingston, and Chris Kuzlo

BMPTRAINS MODEL:

INTRODUCTION TO AND NAVIGATION OF THE MODEL

BY: MARTY WANIELISTA

NAVIGATING the BMPTRAINS Model

ENABLE the macros

Stormwater BMP Treatment Trains [BMPTRAINS©]	CLICK HERE TO START	HELP - INTRODUCTION

FDOT University of Central Florida

INTRODUCTION PAGE

Model requires the use of Excel 2007 or newer

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.

HELP AND BACKGROUND

1) There is a users manual to help navigate this program and it is available at www.stormwater.ucf.edu

2) This spreadsheet is best viewed at 1280 BY 1080 PIXELS screen resolution. If the maximum resolution of your computer screen is lower than 1280 BY 1080 PIXELS you can adjust the view in the Excel VIEW menu by zooming out to value smaller than 100 PERCENT.

3) This spreadsheet has incorporated ERROR MESSAGE WINDOWS. Your analysis is not valid unless ALL ERROR MESSAGE WINDOWS are clear.

4) PRINTING INSTRUCTIONS: Many options. One is to print the page to MICROSOFT OFFICE DOCUMENT IMAGE WRITER (typically the default) or ADOBE PDF, save the page as an image document, then print the document you saved.

5) Click on the button located on the top of this window titled CLICK HERE TO START to begin the analysis.

Disclaimer: These workbooks were created to assist in the analysis of Best Management Practice calculations. All users are responsible for validating the accuracy of the internal calculations. If improvements are noted within this model, please e-mail Marty Wanielista, Ph.D., P.E. at martin.wanielista@ucf.edu with specific information so that revisions can be made.

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The authors of this prog[7.7] Christopher Kuzlo, M[November 18, 2015]mma Gogo-Abite.
This is version[7.7] program, updated or[November 18, 2015]eciated.

HELP - HYDROGRAPH AND LEGACY PROGRAMS

SMADA ONLINE

NAVIGATING the BMPTRAINS Model

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BUTTONS

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Stormwater BMP Treatment Trains [BMP

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GENERAL SITE INFORMATION

GREY colored cell for input data

GENERAL SITE INFORMATION: V7.4

GO TO INTRODUCTION PAGE

Blue Numbers =	Input data
Red Numbers =	Calculated or Carryover

HELP

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

NAME OF PROJECT

one watershed

VIEW ZONE MAP

Meteorological Zone (Please use zone map): CLICK ON CELL BELOW TO SELECT — Zone 2

Mean Annual Rainfall (Please use rainfall map): 50.00 Inches

VIEW MEAN ANNUAL RAINFALL MAP

Type of analysis: CLICK ON CELL BELOW TO SELECT — BMP analysis

Treatment efficiency (N, P) (leave empty if net improvement or BMP analysis is used): % %

GO TO WATERSHED CHARACTERISTICS

Select the STORMWATER TREATMENT ANALYSIS Button below to begin analyzing the effectiveness of Best Management Practices.

Model documentation and example problems.

STORMWATER TREATMENT ANALYSIS

Systems available for analysis:
Retention Basin with option for calculating effluent concentration
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
Lined reuse pond
User Defined BMP

There is a user's manual for the BMPTRAINS model. It can be downloaded from www.stormwater.ucf.edu. The results from the example problems shown in the manual however may not reflect current model results due to ongoing updates of the model.

RESET INPUT FOR STORMWATER TREATMENT ANALYSIS

METHODOLOGY FOR CALCULATING REQUIRED TREATMENT EFFICIENCY

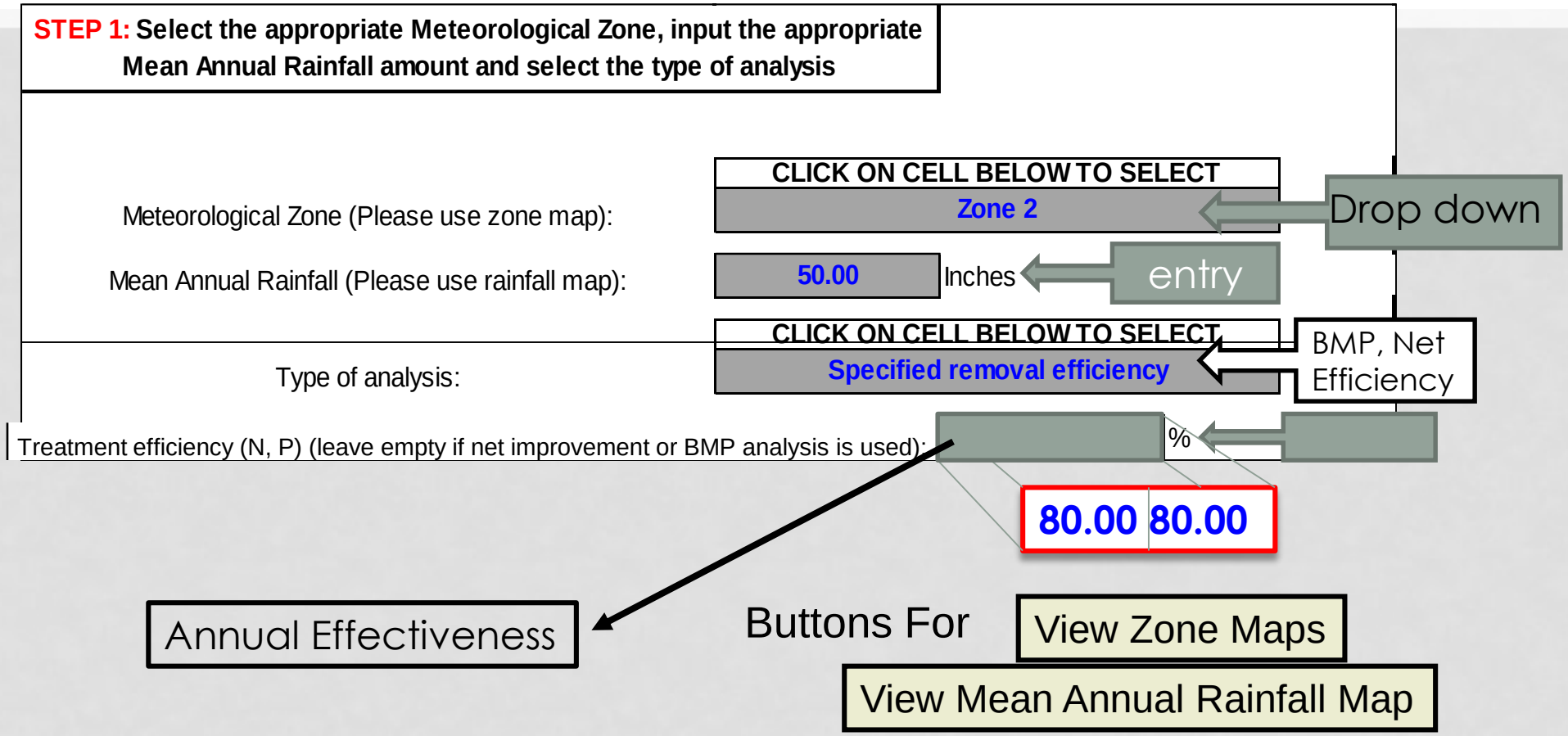
METHODOLOGY FOR RETENTION SYSTEMS

METHODOLOGY FOR WET DETENTION SYSTEMS

METHODOLOGY FOR GREENROOF SYSTEMS

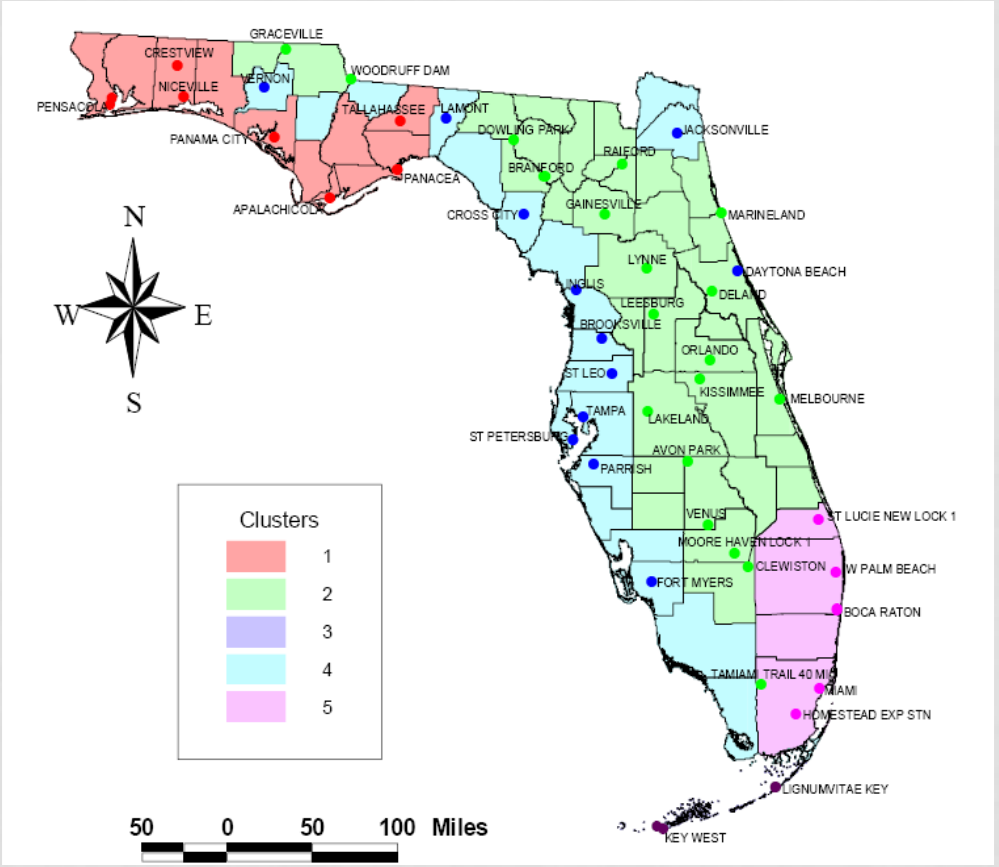
METHODOLOGY FOR WATER HARVESTING SYSTEMS

RAINFALL AND TYPE OF EFFECTIVENESS ANALYSIS



RAINFALL ZONE MAP BASED ON WATER QUALITY VOLUMES AND DISTRIBUTIONS

- Rainfall distributions are regionally different.



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Watershed input data are next

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METHODOLOGY FOR GREENROOF SYSTEMS

METHODOLOGY FOR WATER HARVESTING SYSTEMS

WATERSHEDS
CATCHMENT INPUTS

WATERSHED CHARACTERISTICS V 7.5	GO TO STORMWATER TREATMENT ANALYSIS	Blue Numbers = Input data / Red Numbers = Calculated	HELP - LAND USES/EMC
SELECT CATCHMENT CONFIGURATION	CLICK ON CELL BELOW TO SELECT CONFIGURATION: A - Single Catchment	VIEW CATCHMENT CONFIGURATION	SELECT

CATCHMENT NO.1 CHARACTERISTICS:

	CLICK ON CELL BELOW TO SELECT
Pre-development land use: with default EMCs	Agricultural - Pasture: TN=3.470 TP=0.616
Post-development land use: with default EMCs	Highway: TN=1.640 TP=0.220

VIEW AVERAGE ANNUAL RUNOFF "C" Factor

VIEW EMC & FLUCCS

OVERWRITE DEFAULT CONCENTRATIONS USING:

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

USE DEFAULT CONCENTRATIONS

Total pre-development catchment area:	4.00	AC
Total post-development catchment or BMP analysis area:	4.00	AC
Pre-development Non DCIA CN:	60.00	
Pre-development DCIA percentage:	0.00	%
Post-development Non DCIA CN:	60.00	
Post-development DCIA percentage:	50.00	%
Estimated BMPArea (No loading from this area)	0.25	AC

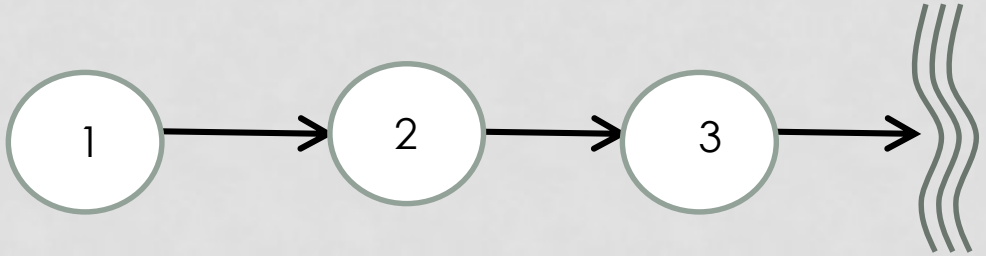
Average annual pre runoff volume:	0.500	ac-ft/year
Average annual post runoff volume (note no BMP area):	6.563	ac-ft/year
Pre-development Annual Mass Loading - **Nitrogen:**	2.140	kg/year
Pre-development Annual Mass Loading - **Phosphorus:**	0.380	kg/year
Post-development Annual Mass Loading - **Nitrogen:**	13.273	kg/year
Post-development Annual Mass Loading - **Phosphorus:**	1.781	kg/year

WATERSHEDS

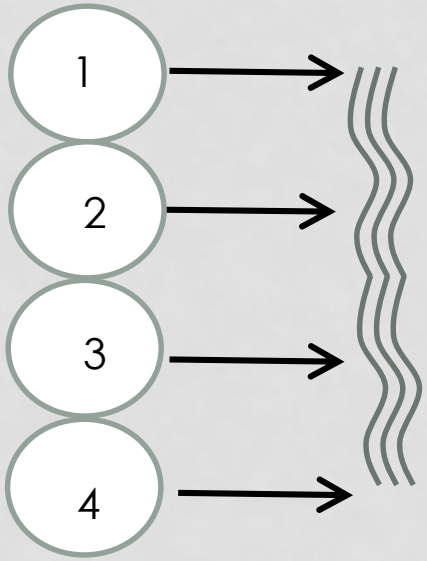
CATCHMENT CONFIGURATIONS

WATERSHED CHARACTERISTICS	VIEW CATCHMENT CONFIGURATION
SELECT CATCHMENT CONFIGURATION	

Series



Parallel



Up to 3 BMPs in Each catchment

14 configurations

WATERSHEDS
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PRE

POST

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EMC DEFAULT VALUES

AVERAGE ANNUAL DATA

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

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Input Data in Grey Field And For Each Worksheet in BLUE COLOR

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Post-development land use: with default EMCs	CLICK ON CELL BELOW TO SELECT: Highway: TN=1.640 TP=0.220

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STREAM GAGING DATA

- Actual Data from a stream nearby UCF, gage operated by USGS.
- Average Streamflow = 1.926 CFS/SQ MI/yr = 26.19 inches streamflow/yr
  - Conversion factor is 13.6 inches on the watershed = 1 CFS/SQ MI.
- Hydrograph separation is 50% runoff or 13.1 inches runoff per year
- Stream is located in meteorological zone 2 with annual rain of 50 inches
- Annual "C" factor is 13.1/50 = 0.262

	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Zone 2 Mean Annual Runoff Coefficients (C Values) as a Function of DCIA Percentage and Non-DCIA Curve Number (CN)																					
NDCIA	**Percent DCIA**																				
CN	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
30	0.002	0.043	0.083	0.123	0.164	0.204	0.244	0.285	0.325	0.366	0.406	0.446	0.487	0.527	0.567	0.608	0.648	0.688	0.729	0.769	0.809
35	0.004	0.044	0.085	0.125	0.165	0.205	0.246	0.286	0.326	0.366	0.407	0.447	0.487	0.528	0.568	0.608	0.648	0.689	0.729	0.769	0.809
40	0.007	0.047	0.087	0.127	0.167	0.207	0.248	0.288	0.328	0.368	0.408	0.448	0.488	0.528	0.569	0.609	0.649	0.689	0.729	0.769	0.809
45	0.010	0.050	0.090	0.130	0.170	0.210	0.250	0.290	0.330	0.370	0.410	0.450	0.490	0.530	0.570	0.610	0.650	0.690	0.729	0.769	0.809
50	0.015	0.055	0.095	0.134	0.174	0.214	0.254	0.293	0.333	0.373	0.412	0.452	0.492	0.531	0.571	0.611	0.651	0.690	0.730	0.770	0.809
55	0.022	0.061	0.101	0.140	0.179	0.219	0.258	0.298	0.337	0.376	0.416	0.455	0.494	0.534	0.573	0.613	0.652	0.691	0.731	0.770	0.809
60	0.030	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	0.731	0.770	0.809
65	0.042	0.080	0.119	0.157	0.195	0.234	0.272	0.311	0.349	0.387	0.426	0.464	0.502	0.541	0.579	0.618	0.656	0.694	0.733	0.771	0.809
70	0.057	0.095	0.133	0.170	0.208	0.245	0.283	0.321	0.358	0.396	0.433	0.471	0.509	0.546	0.584	0.621	0.659	0.697	0.734	0.772	0.809
75	0.079	0.116	0.152	0.189	0.225	0.262	0.298	0.335	0.371	0.408	0.444	0.481	0.517	0.554	0.590	0.627	0.663	0.700	0.736	0.773	0.809
80	0.111	0.146	0.181	0.216	0.251	0.285	0.320	0.355	0.390	0.425	0.460	0.495	0.530	0.565	0.600	0.635	0.670	0.705	0.740	0.774	0.809
85	0.160	0.192	0.225	0.257	0.290	0.322	0.355	0.387	0.420	0.452	0.485	0.517	0.550	0.582	0.614	0.647	0.679	0.712	0.744	0.777	0.809
90	0.242	0.270	0.299	0.327	0.355	0.384	0.412	0.440	0.469	0.497	0.526	0.554	0.582	0.611	0.639	0.667	0.696	0.724	0.753	0.781	0.809
95	0.404	0.424	0.444	0.464	0.485	0.505	0.525	0.546	0.566	0.586	0.606	0.627	0.647	0.667	0.688	0.708	0.728	0.749	0.769	0.789	0.809
98	0.595	0.605	0.616	0.627	0.638	0.648	0.659	0.670	0.680	0.691	0.702	0.713	0.723	0.734	0.745	0.756	0.766	0.777	0.788	0.799	0.809

NOTE: Pre-application meeting frequent discussion

0.262

FLUCCS CODES AND MODEL LAND USES

CODE

2210	Citrus groves	Citrus	AG - CITRUS
2220	Fruit Orchards	Citrus	AG - CITRUS
1400	Commercial and Services	Commercial	HIGH INTENSITY COMMERCIAL
1410	Retail Sales and Services	Commercial	HIGH INTENSITY COMMERCIAL
3212	Dry Prairie	Dry Prairie	DRY PRAIRIE*
3220	Coastal Strand	Dry Prairie	DRY PRAIRIE*
3300	Mixed Rangeland	Dry Prairie	DRY PRAIRIE*
1300	Residential, High-Density	High-Density Residential	MULTI FAMILY RES
1310	Fixed Single Family Units	Single Family Residential	SINGLE FAMILY RES
1330	Residential, High-Density; Multiple Dwelling Units, Low Rise <Two stories or less>	High-Density Residential	MULTI FAMILY RES

Reference:
Refining the Indian River Lagoon TMDL- Tech Memo Report
Assessment and Evaluation of Model Input Parameters
Prepared by ERD, July 2013

* Can also use the general undeveloped rangeland.

NOTE: Pre-application meeting frequent discussion

GENERAL SITE INFORMATION

GENERAL SITE INFORMATION: V7.4 | **GO TO INTRODUCTION PAGE**

Blue Numbers = Input data
Red Numbers = Calculated or Carryover

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

NAME OF PROJECT: one watershed

HELP

VIEW ZONE MAP

Meteorological Zone (Please use zone map): CLICK ON CELL BELOW TO SELECT → Zone 2

Mean Annual Rainfall (Please use rainfall map): 50.00 Inches

VIEW MEAN ANNUAL RAINFALL MAP

Type of analysis: CLICK ON CELL BELOW TO SELECT → BMP analysis

Treatment efficiency (N, P) (leave empty if net improvement or BMP analysis is used): % %

GO TO WATERSHED CHARACTERISTICS

Select the STORMWATER TREATMENT ANALYSIS Button below to begin analyzing the effectiveness of Best Management Practices.

STORMWATER TREATMENT ANALYSIS

Source: ***Evaluation of Current Stormwater Design Criteria within the State of Florida*** dated June 2007 by Harvey H. Harper, P.E., PhD., available at: http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/SW_TreatmentReportFinal_71907.pdf

Model documentation and example problems.

There is a user's manual for the BMPTRAINS model. It can be downloaded from www.stormwater.ucf.edu. The results from the example problems shown in the manual however may not reflect current model results due to ongoing updates of the model.

Methodologies

METHODOLOGY FOR CALCULATING REQUIRED TREATMENT EFFICIENCY

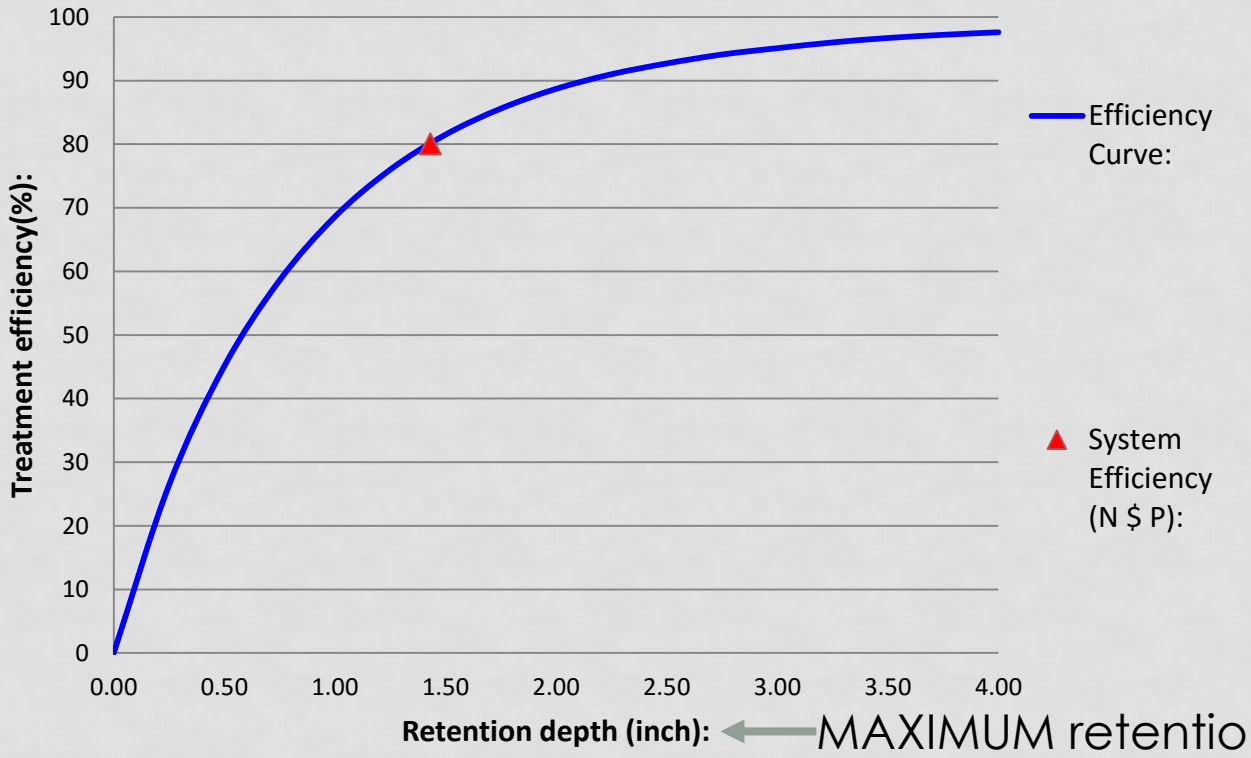
METHODOLOGY FOR RETENTION SYSTEMS

METHODOLOGY FOR WET DETENTION SYSTEMS

METHODOLOGY FOR GREENROOF SYSTEMS

METHODOLOGY FOR WATER HARVESTING SYSTEMS

Example Demonstration Retention in Series

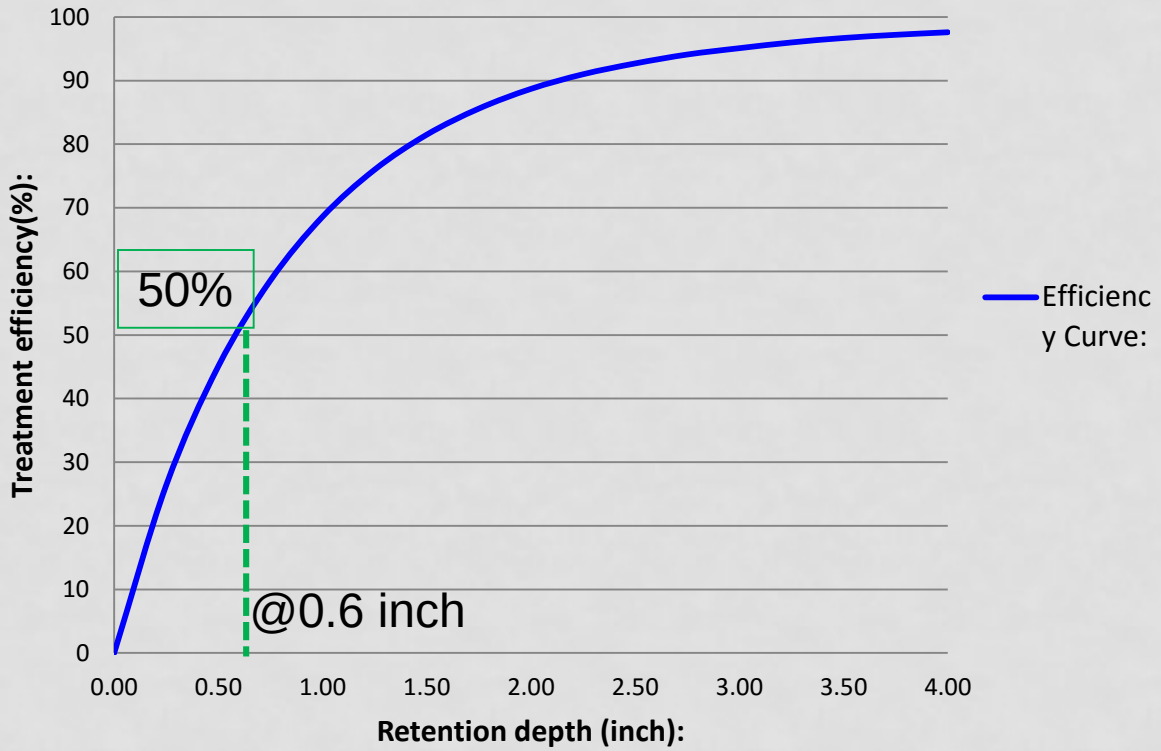


MAXIMUM retention for all events in a year

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

BUT not sufficient area for one retention basin
But may use 3 BMPs for each catchment in Series in one Watershed

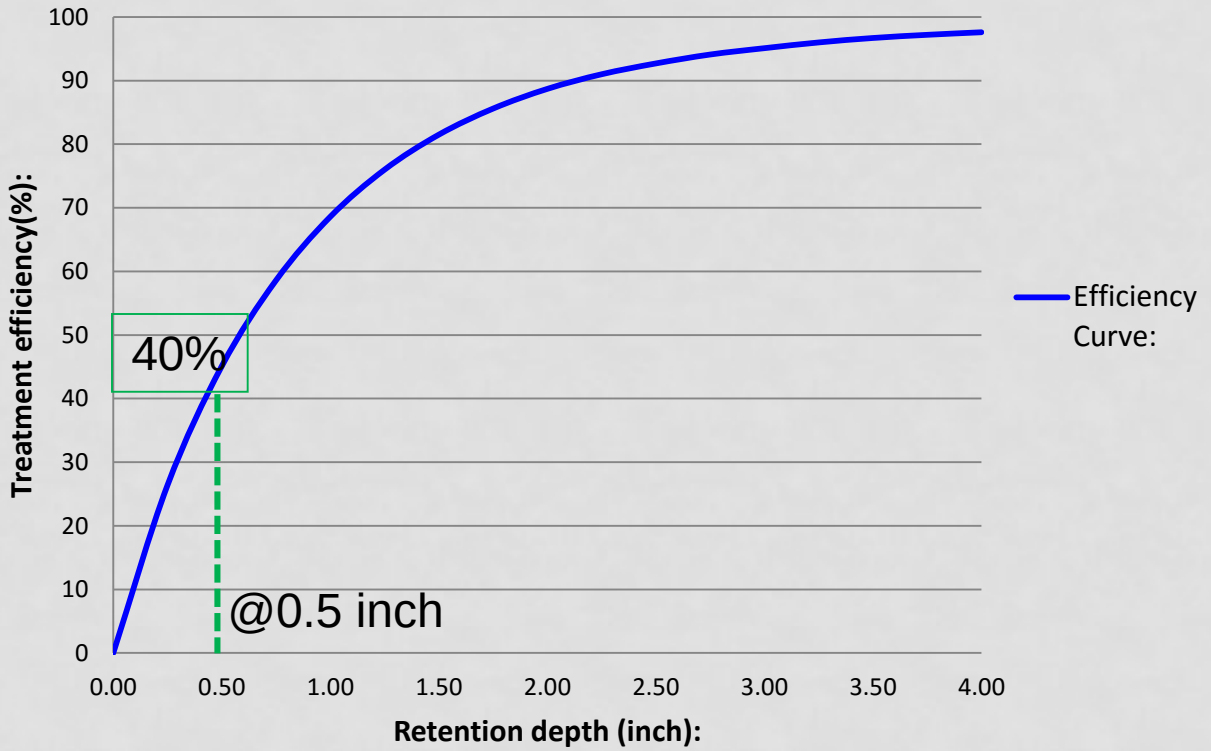
1st BMP is pervious pavement @ 0.6 inch treatment



NOTE: This is the effectiveness curve if pervious pave is only used.
Retention depth over the 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

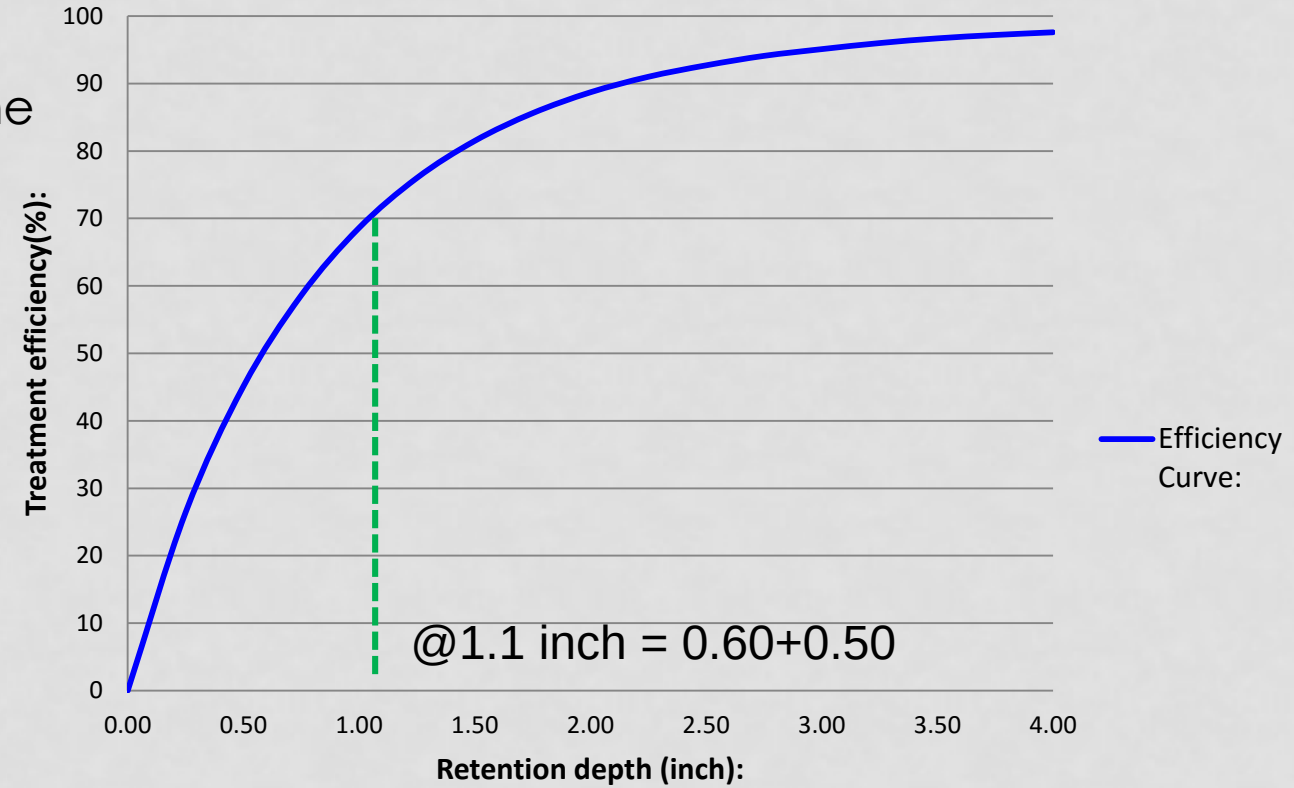


NOTE: This is the effectiveness curve if exfiltration is only used. Retention depth over the equivalent impervious area is 0.50 inches for an exfiltration system.

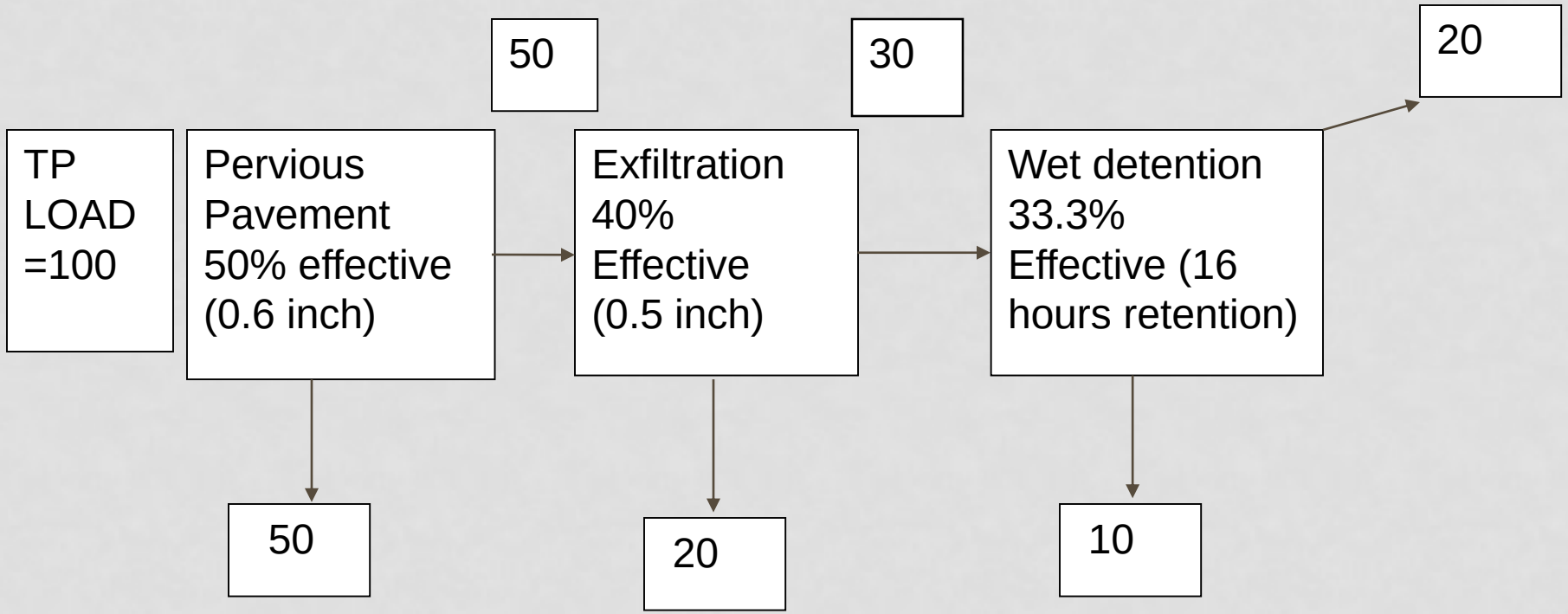
FOR RETENTION
STAY TRUE TO THE UNDERLYING PRINCIPLES

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%.

NOTE: order of retention BMPs has no affect on the removal.



BMP TREATMENT TRAIN CREDITS WHEN THREE EFFICIENCIES ARE IN SERIES



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

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**		

HOW TO USE THE USER DEFINED BMP WORKSHEET?

STARTING WORKSHEET

Name of BMP		
Contributing catchment area:	9.500	Ac
Required treatment efficiency (**Nitrogen**):	TBD	%
Required treatment efficiency (**Phosphorus**):	TBD	%
Is this a retention or other system*?		
If retention, storage depth is:		in
The calculated storage volume is:	0.000	Ac-Ft
Treatment efficiency (Nitrogen):		
Treatment efficiency (Phosphorus):		
Provided treatment efficiency (Nitrogen):		
Provided treatment efficiency (Phosphorus):		

* Examples of other systems are street sweeping, dry detention, chemical treatment, and pre-treatment devices

Enter a short description of BMP below (no more than 200 characters)

INPUT EXAMPLE

Name of BMP	PIPE R
Contributing catchment area:	9.500
Required treatment efficiency (**Nitrogen**):	TBD
Required treatment efficiency (**Phosphorus**):	TBD
Is this a retention or other system*?	Retention
If retention, storage depth is:	0.250
The calculated storage volume is:	0.198
Treatment efficiency (Nitrogen):	43.400
Treatment efficiency (Phosphorus):	43.400

Notes: Units defined on full worksheet and Blue font denotes input data for that worksheet

USER DEFINED BMP

STARTING WORKSHEET

Name of BMP	
Contributing catchment area:	9.500
Required treatment efficiency (**Nitrogen**):	TBD
Required treatment efficiency (**Phosphorus**):	TBD
Is this a retention or other system*?	
If retention, storage depth is:	
The calculated storage volume is:	0.000
Treatment efficiency (Nitrogen):	
Treatment efficiency (Phosphorus):	
Provided treatment efficiency (Nitrogen):	
Provided treatment efficiency (Phosphorus):	

* Examples of other systems are street sweeping, dry detention, chemical treatment, and pre-treatment devices

Enter a short description of BMP below (no more than 200 characters)

INPUT EXAMPLE

Name of BMP	Up-Flow Filters
Contributing catchment area:	9.500
Required treatment efficiency (**Nitrogen**):	TBD
Required treatment efficiency (**Phosphorus**):	TBD
Is this a retention or other system*?	Other
If retention, storage depth is:	
The calculated storage volume is:	
Provided treatment efficiency (Nitrogen):	54.00
Provided treatment efficiency (Phosphorus):	67.00

Seal of Approval

Learning Summary

1. Navigation of the BMPTRAINS model is by buttons. Input data are shown in blue while output data are in red.
2. BMPTRAINS model is used to size treatment systems and estimate an average annual nutrient removal effectiveness.
3. The average annual effectiveness is site and BMP specific incorporating rainfall conditions, impervious cover, soil conditions, type of land use, and type of BMP.
4. BMPs can be analyzed in either series or parallel structure. The estimates stay “true” to the underlying rainfall and catchment conditions.

QUESTIONS, REMARKS AND DISCUSSION

THANK YOU!