29th annual ENVIRONMENTAL PERMITTING SUMMER SCHOOL

LOW IMPACT DEVELOPMENT
CASE STUDIES

MARTY WANIELISTA

STORMWATER MANAGEMENT ACADEMY

JULY, 2015 ORLANDO FLORIDA

WWW.STORMWATER.UCF.EDU

Florida Environmental Network, Inc

University of Central Florida

PURPOSE OF PRESENTATION IS TO:

- Present **Case Studies** when LID BMPs are used.
- Introduce **BMPTRAINS… B**est **M**anagement **P**ractices used for **T**reatment and calculations for **R**emoval on an **A**nnual basis **I**nvolving **N**utrients in **S**tormwater

Best Management Practices Selection
BMPTRAINS

BMPTRAINS Available from: www.stormwater.ucf.edu
and www.SMADAONLINE.COM for legacy programs

LID CASE STUDIES
BEING USED MORE FREQUENTLY… ESPECIALLY IN URBAN AREAS

- LIDs used to meet Post=Pre Nutrient Loadings.
  - Depression areas used to store runoff
  - Combinations of LIDs such as greenroofs, pervious pavements and reuse of stormwater.
- BMPs including regional ones with LID to meet TMDL loading reductions.
  - Wet detention ponds and reuse after dis-connecting impervious areas
  - Retention basins with swales rather than with curb and gutters.
- LIDs in urban redevelopment to help provide TMDL credits.
  - Using landscaping with tree wells and rain gardens to reduce runoff.
  - Pervious pavement to reduce runoff.
  - Wet detention ponds with up-flow filters.

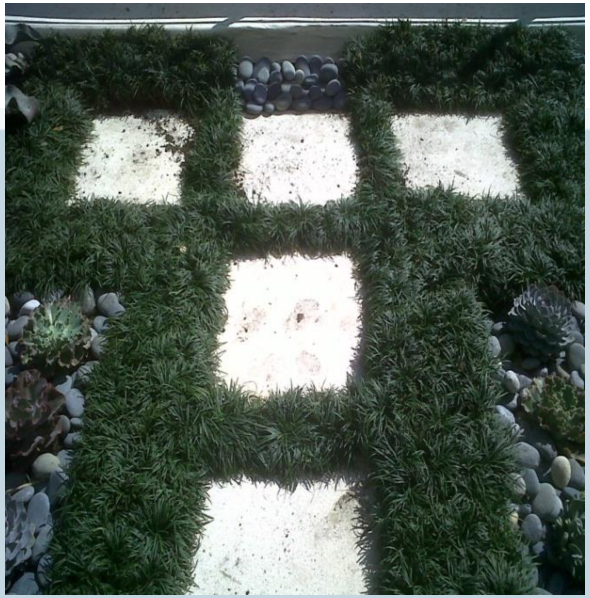
PERVIOUS PAVEMENT LID OPTION

Unit Individual Level

RETENTION BASIN	WET DETENTION	EXFILTRATION TRENCH	RAIN (BIO) GARDEN
PERVIOUS PAVEMENT	STORMWATER HARVESTING	FILTRATION including Up-Flow Filters	LINED REUSE POND & UNDERDRAIN INPUT
GREENROOF	RAINWATER HARVESTING	FLOATING ISLANDS WITH WET DETENTION	
VEGETATED NATURAL BUFFER	VEGETATED FILTER STRIP	VEGETATED AREA Example tree well	CATCHMEN

Community level

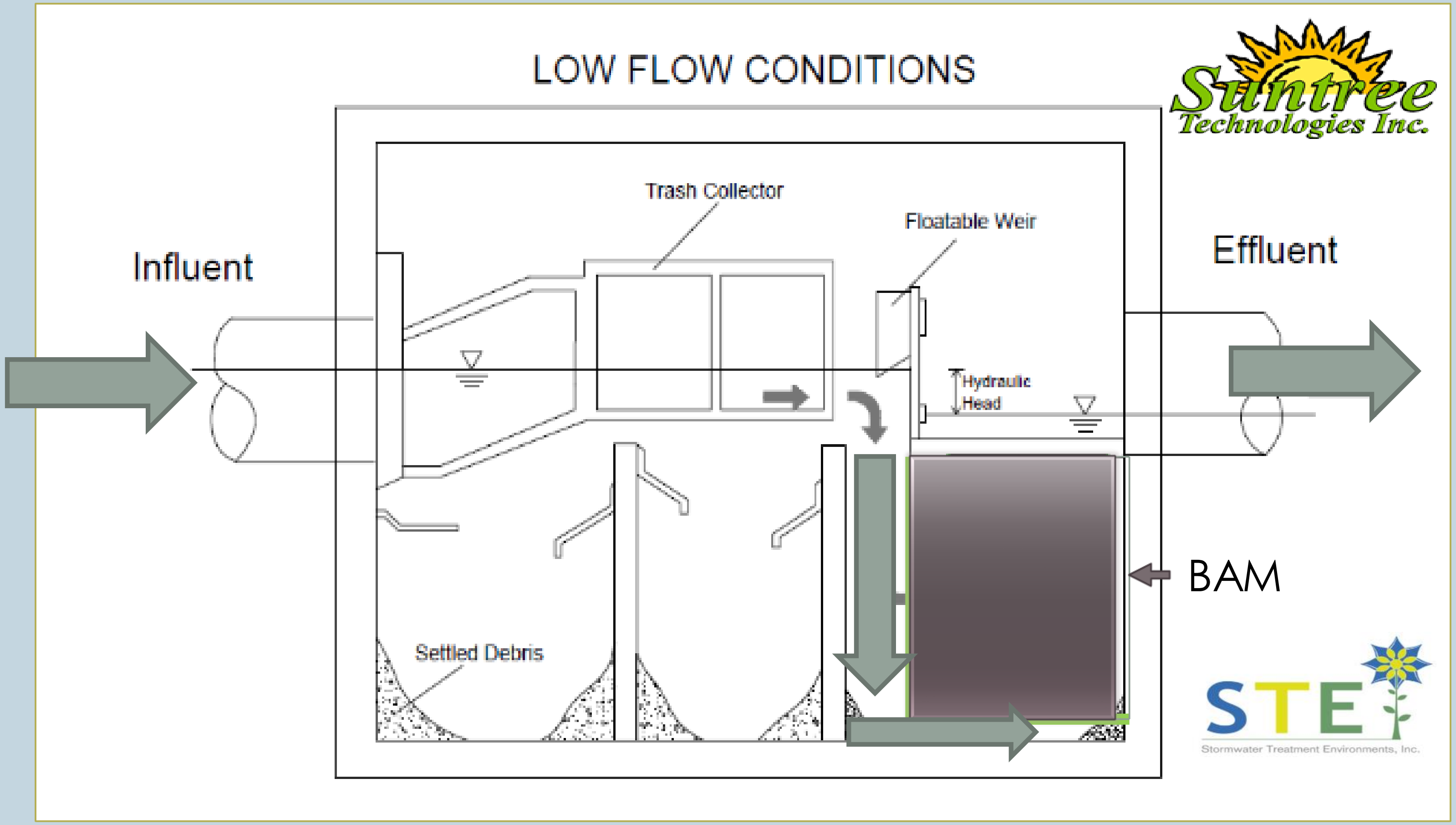
WEST COAST HOME (NEAR SARASOTA)



Mondo, Muhly, Coontie,
And “specimen” plants
In a bed of rounded rock
Over B&G media

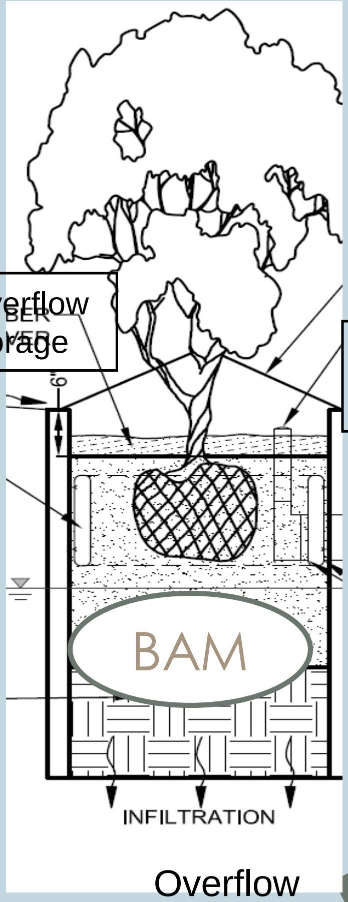
John Wheeler
Landscaping

UNDERGROUND SYSTEMS IN HIGH WATER TABLE AREAS
UP-FLOW FILTER AT THE DISCHARGE



ON-SITE RETENTION LIDS
EXFILTRATION, SWALES,

Tree Well and Interceptor Design

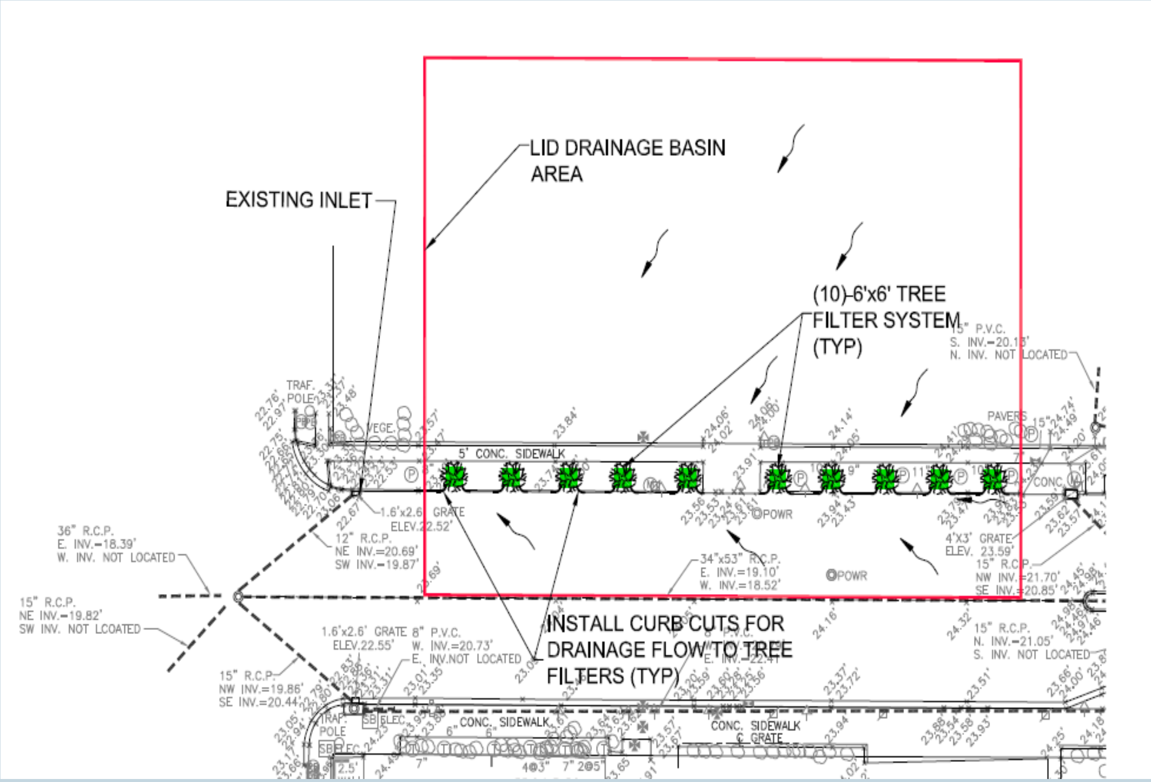


tree anchors

Overflow storage

Overflow if not diverted

Overflow



Flow to Tree Wells

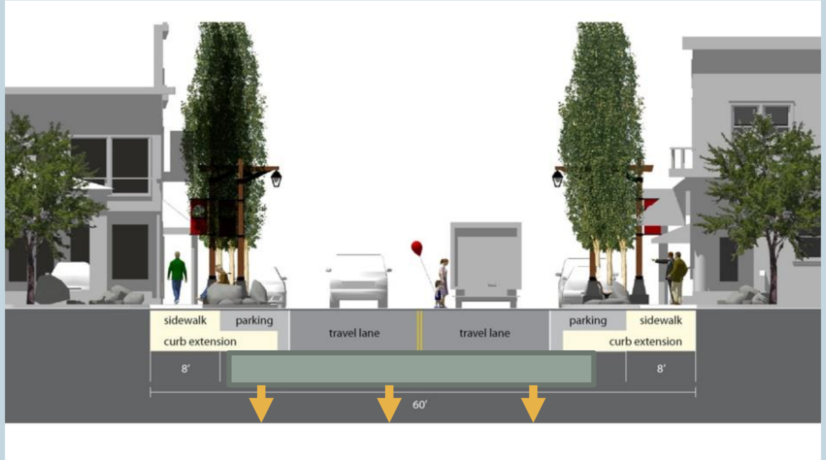
Flow to Tree Well

Overflow

Street and Parking Lot Rain Gardens

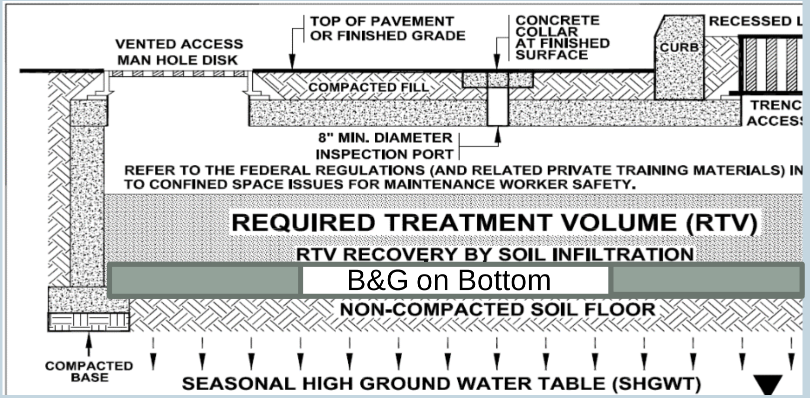
COMBINING LID METHODS (COMMUNITY LEVEL)

Retrofit Opportunities

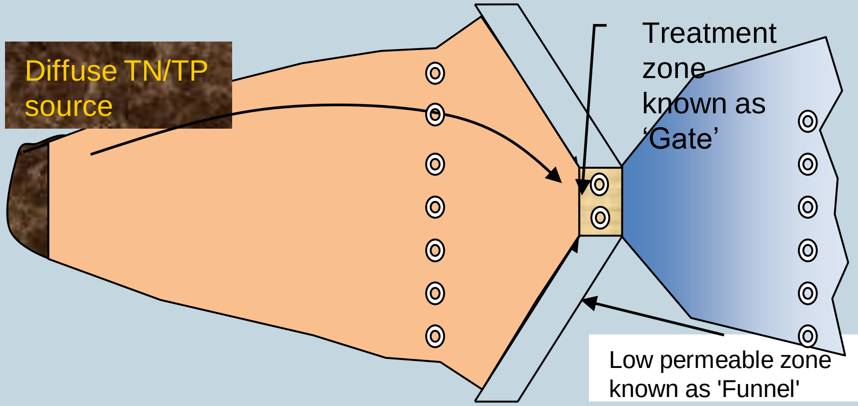


UNDER GROUND TREATMENT WITH BAM
IF NO BAM IN THE GROUND, USE B&G

On-Site Under Ground Treatment



Regional Treatment

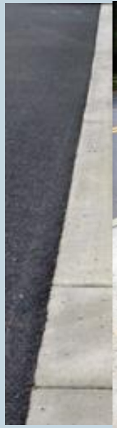


UNDER GROUND TREATMENT WITH BAM

- Flow Through BAM with Plants

University of Central Florida

ABOVE GROUND LID OPTIONS PERVIOUS PAVEMENTS, SWALES, AND RAIN GARDENS



BMPTRAINS MODEL AND USERS MANUAL

Available from: www.stormwater.ucf.edu

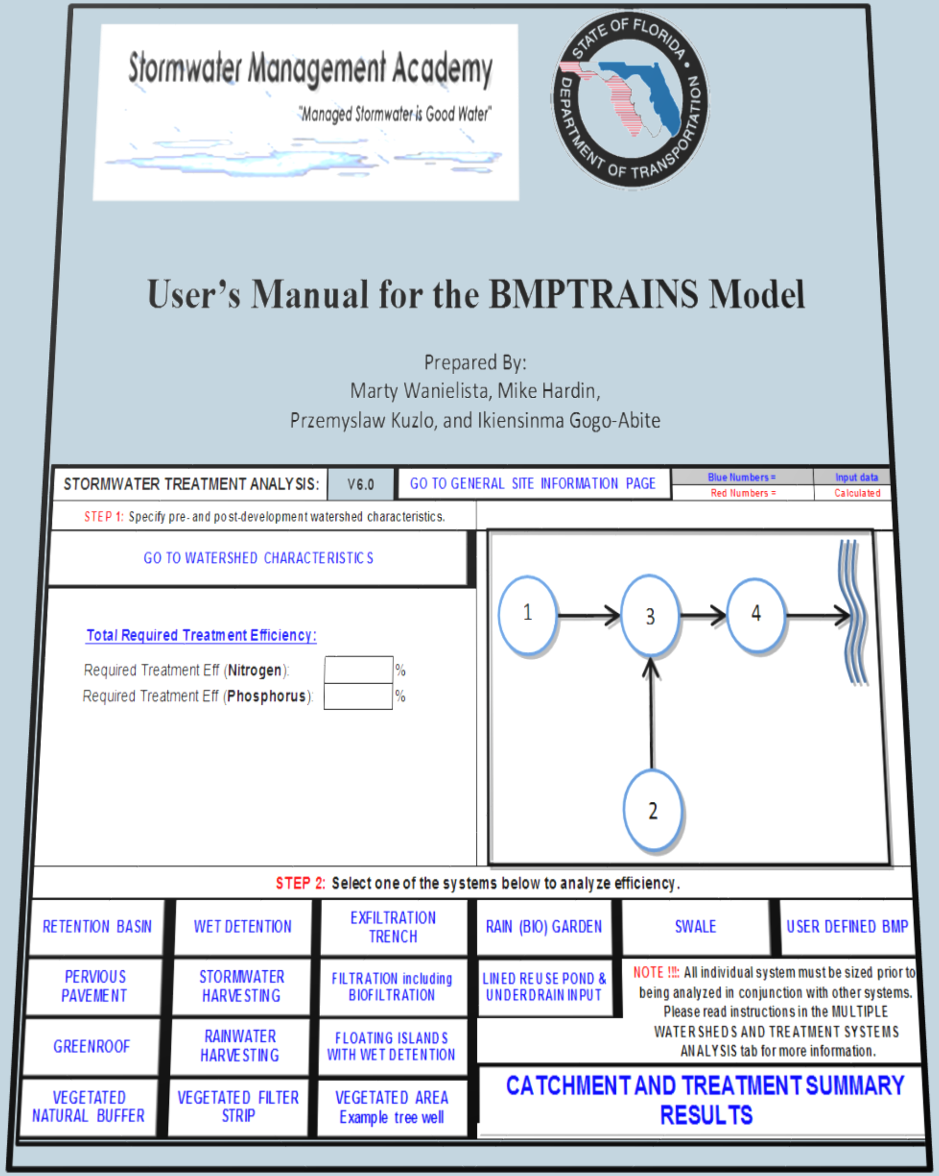
What's New

BMPTRAINS Stormwater Best Management Practices Analysis Model (Version 7.5) Model, and User's Manual

FREE

VALUE OF BMPTRAINS

- Quantification of information from many sources into one relatively easy to use computer program.
- Assists in the selection from among 15 BMPs. There is also a user defined BMP for those BMPs not always generally acceptable.
- Program inputs cover a wide range of Florida conditions, including both meteorological and land use.
- High acceptance by WMDs for ERPs. Also can have value in BMAP, TMDL and impaired water situations.
- Flexible program, some default values can be changed but only with agreement with regulatory agencies.


Stormwater Management Academy
"Managed Stormwater is Good Water"
STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
User's Manual for the BMPTRAINS Model
Prepared By:
Marty Wanielista, Mike Hardin,
Przemyslaw Kuzlo, and Ikiensinma Gogo-Abite
STORMWATER TREATMENT ANALYSIS:
V6.0
GO TO GENERAL SITE INFORMATION PAGE
STEP 1: Specify pre- and post-development watershed characteristics.
GO TO WATERSHED CHARACTERISTICS
Total Required Treatment Efficiency:
Required Treatment Eff (Nitrogen):
Required Treatment Eff (Phosphorus):
1
2
3
4
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

COMPARISON OF MODELS BASED ON BMPS

Stormwater Model / BMPs	Retention inc. Bioretention	Dry Detention	Swale	Green Roof	Filter Strip inc. Grass Buffer	Permeable Pavement	Sand Filter	Water Harvesting	Wet Detention	Wetland	Rain Garden inc. Tree Wells	Exfiltration
Jordan/Falls Lake Model	x	x	x	x	x	x	x	x	x	x		
BMP SELECT Model	x	x	x		x	x	x		x	x		
Clinton River SET	x	x	x	x	x	x	x		x			
Virginia Runoff Reduction Method Worksheet	x	x	x	x		x			x			
DES Simple Method Pollutant Loading Spreadsheet Model[1]	x	x	x	x	x	x	x	x	x	x		
Colorado	x	x	x			x	x		x	x	x	
SMADA	x		x					x	x			
BMPTRAINS	**X**	**X**	**x**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**

Most Models are
For a single BMP.

BMPTRAINS is used
For Series and
Parallel Configurations

However
USER INPUT to
BMPTRAINS

NAVIGATING and INFORMATION for the BMPTRAINS Model

Enable Macros

EXCEL 2007 or Newer

Example NAVIGATION BUTTON

HELP VIDEOS

Stormwater BMP Treatment Trains [BMPTRAINS©]

CLICK HERE TO START

HELP - INTRODUCTION

HELP AND BACKGROUND

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.

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: 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.

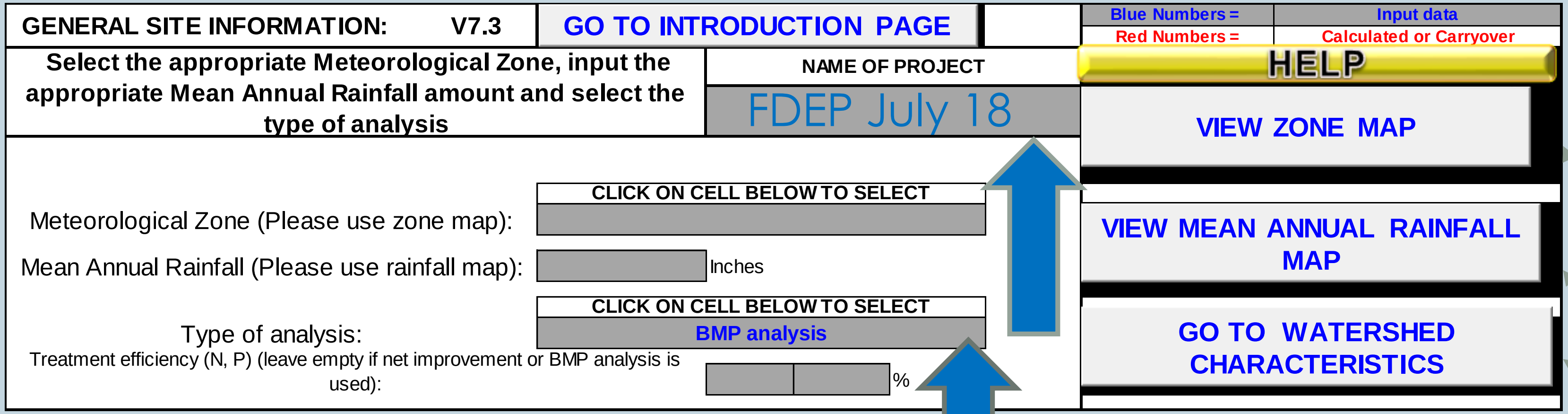
The authors of this program were Christopher Kuzlo, Marty Wanielista, Mike Hardin, and Ikiensinma Gogo-Abite.
This is version 7.3 of the program, updated on June 20, 2014. Comments are appreciated.

HELP - HYDROGRAPH AND LEGACY PROGRAMS

SMADA ONLINE

HELP VIDEOS

RAINFALL AND TYPE OF ANALYSIS WORKSHEET



GENERAL SITE INFORMATION: V7.3

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

FDEP July 18

HELP

VIEW ZONE MAP

CLICK ON CELL BELOW TO SELECT

Meteorological Zone (Please use zone map):

Mean Annual Rainfall (Please use rainfall map): Inches

VIEW MEAN ANNUAL RAINFALL MAP

CLICK ON CELL BELOW TO SELECT

Type of analysis: BMP analysis

GO TO WATERSHED CHARACTERISTICS

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

NAVIGATION BUTTONS

NOTE: Blue Color Entries on grey are **input** data
For this case the name of the project
and the type of analysis (**drop down menu**)
activated by "clicking" twice.

GENERAL SITE INFORMATION PAGE

RAINFALL AND TYPE OF EFFECTIVENESS ANALYSIS

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

	CLICK ON CELL BELOW TO SELECT		
Meteorological Zone (Please use zone map):	Zone 2		Drop down menu
Mean Annual Rainfall (Please use rainfall map):	50.00	Inches	input
	CLICK ON CELL BELOW TO SELECT		
Type of analysis:	Specified removal efficiency		Drop down menu
Treatment efficiency (N, P) (leave empty if net improvement or BMP analysis is used):		%	

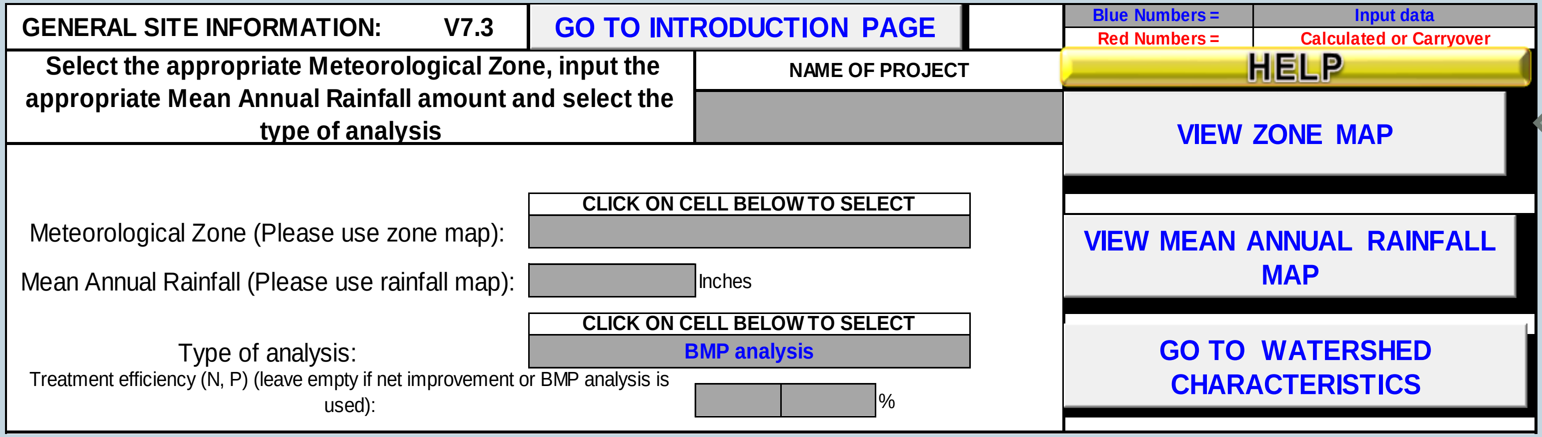
80.00 80.00

Buttons For

View Zone Maps

View Mean Annual Rainfall Map

VIEW RAINFALL DATA



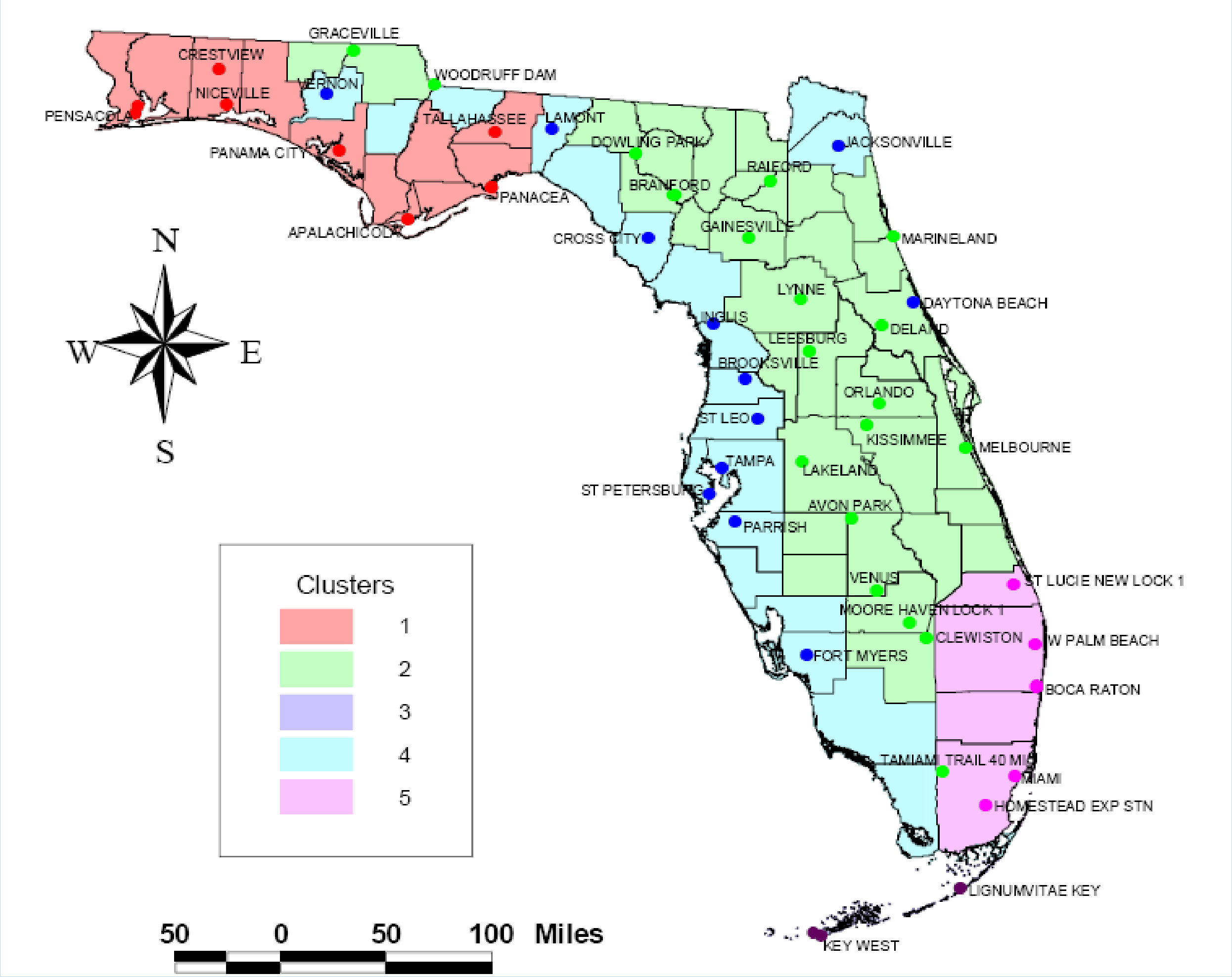
Navigation Buttons For

View Zone Maps

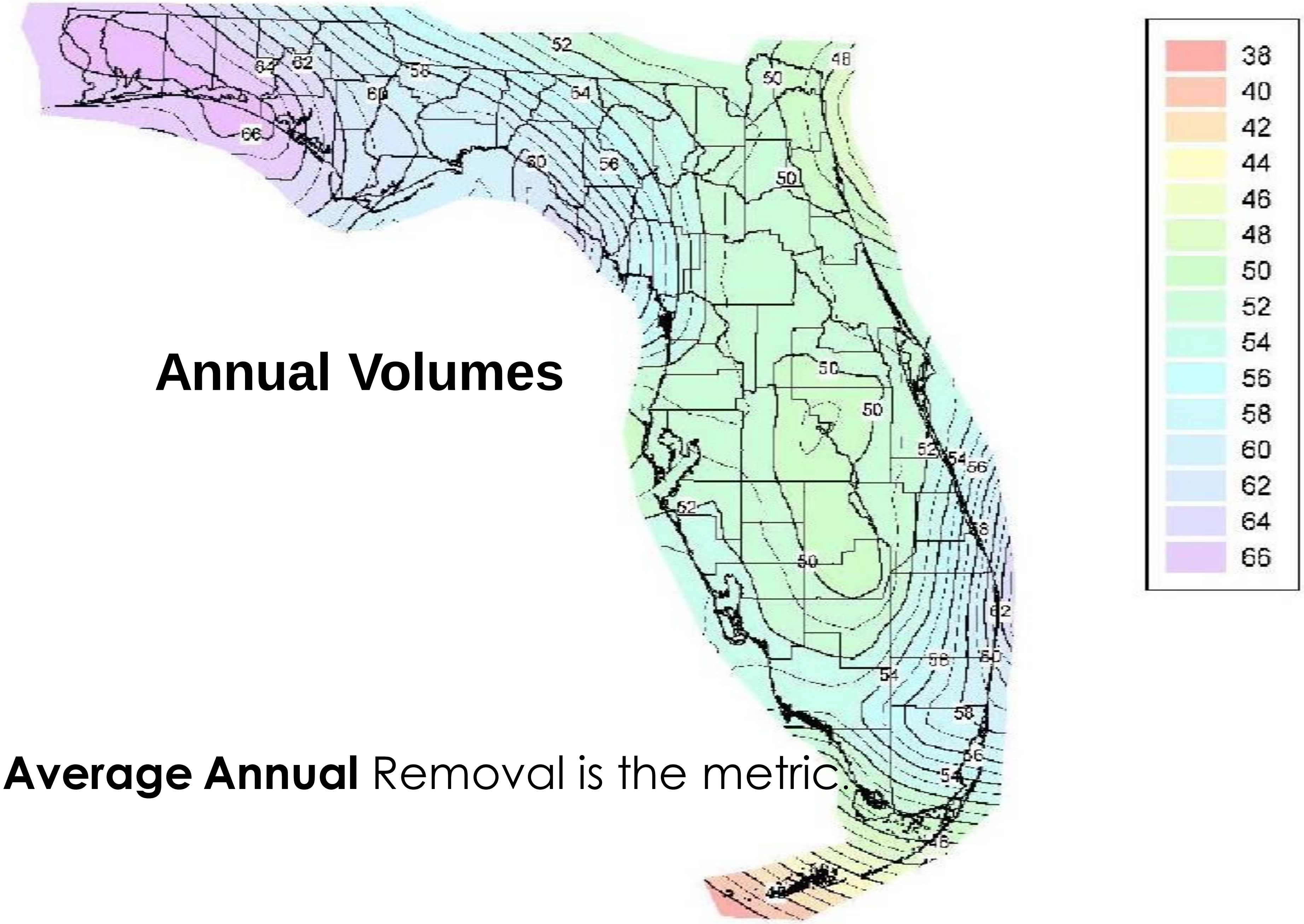
View Mean Annual Rainfall Map

RAINFALL DISTRIBUTIONS

- Rainfall distributions are regionally different.



Annual Volumes



Average Annual Removal is the metric.

WATERSHEDS
CATCHMENT INPUTS

WATERSHED CHARACTERISTICS	GO TO STORMWATER TREATEMENT ANALYSIS
SELECT CATCHMENT CONFIGURATION	CLICK ON CELL BELOW TO SELECT CONFIGURATION

CATCHMENT NO.1 CHARACTERISTICS: \ **If mixed land uses (side calculation)**

		Land use	Area Acres	non DCIA CN	%DCIA
	CLICK ON CELL BELOW TO SELECT				
Pre-development land use: with default EMCs	Multi-Family: TN=2.230 TP=0.520				
	CLICK ON CELL BELOW TO SELECT				
Post-development land use: with default EMCs	Highway: TN=1.640 TP=0.220				
		Total			

Drop Down Menu

Drop Down Menu

Total pre-development catchment area:	0.55	AC
Total post-development catchment or BMP analysis area:	0.55	AC
Pre-development Non DCIA CN:	80.00	
Pre-development DCIA percentage:	0.00	%
Post-development Non DCIA CN:	80.00	
Post-development DCIA percentage:	100.00	%
Estimated Area of BMP (used for rainfall excess not loadings)	0.03	AC

Pre and Post data inputs

LOADING RESULTS & CHANGE DATA

Blue Numbers =	Input data
Red Numbers =	Answers

Pre-development Annual Mass Loading - **Nitrogen:**	0.886	kg/year
Pre-development Annual Mass Loading - **Phosphorus:**	0.199	kg/year
Post-development Annual Mass Loading - **Nitrogen:**	3.751	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: Changes can be made to the default values and “carry” to the end

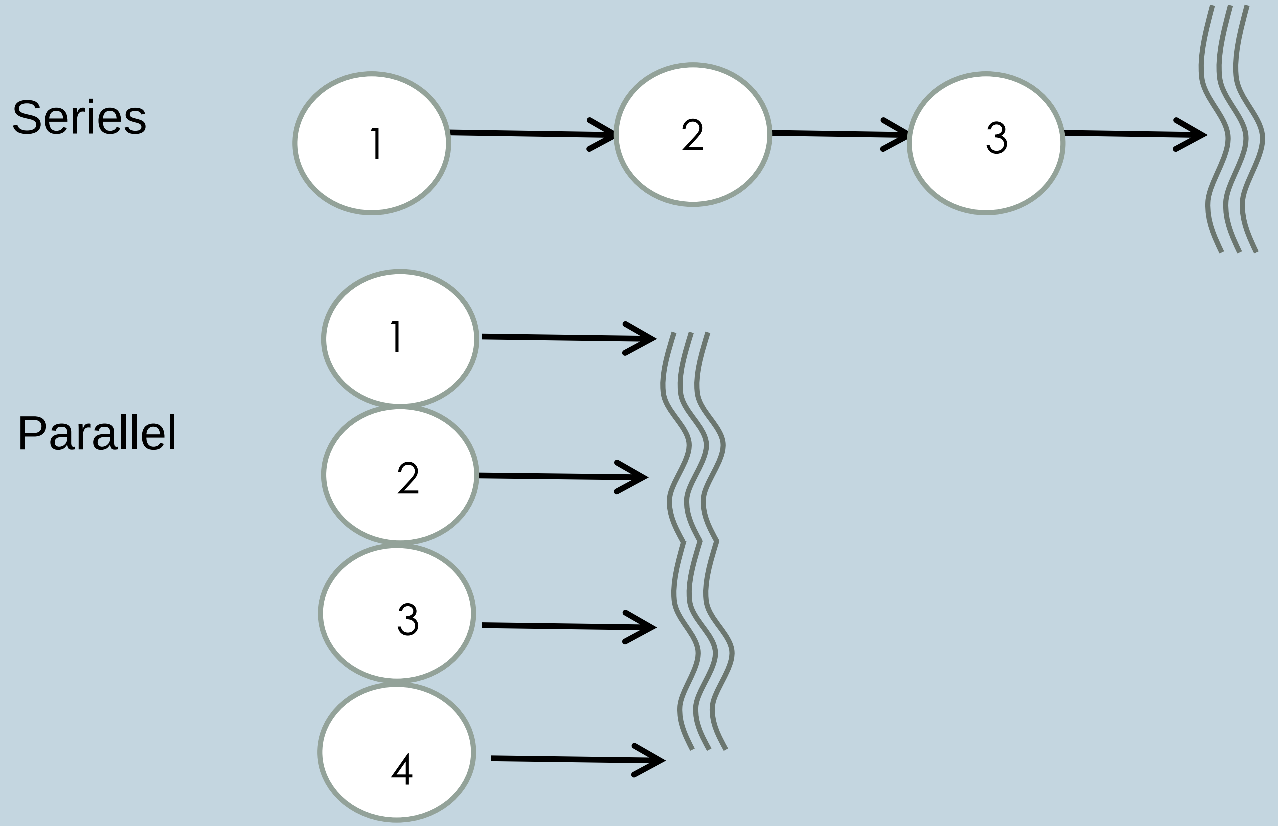
WATERSHEDS

CATCHMENT CONFIGURATIONS

WATERSHED CHARACTERISTICS

SELECT CATCHMENT CONFIGURATION

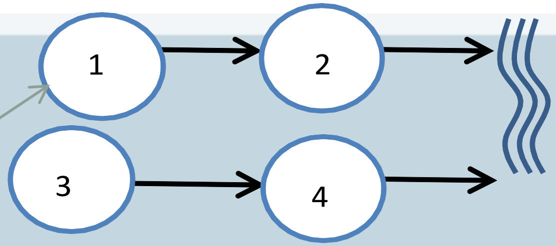
VIEW CATCHMENT CONFIGURATION



UP TO 15 CONFIGURATIONS

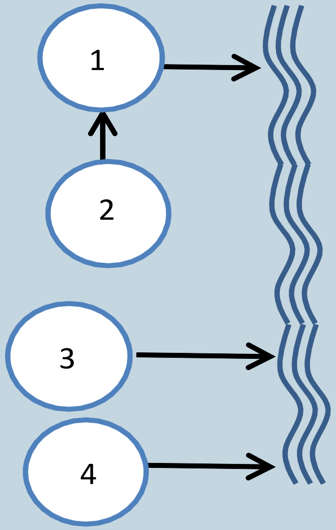
Up to 3 BMPs in Each catchment with no increase in catchment area between the BMPs

M

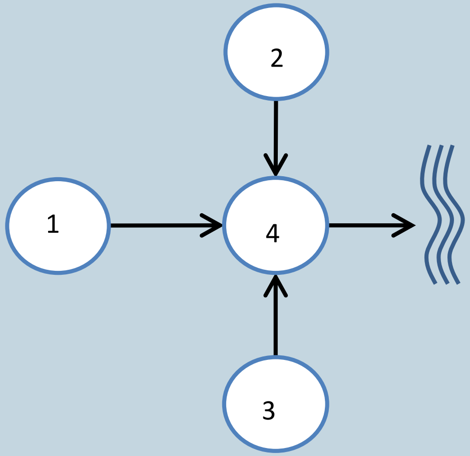


M - Mixed-4 Catchment-2 Series

N



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



O - Mixed-4 Catchment- Parallel- Series

MEAN ANNUAL RUNOFF
(RESULTS USING 116 RAINFALL STATIONS IN THE STATE, MANY YEARS OF DATA)

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

Harper and Baker, FDEP 2007

INTERPOLATING NIGHTMARE

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

Harper and Baker, FDEP 2007

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

NAVIGATION BUTTONS

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

CLICK ON CELL BELOW TO SELECT

Met

Mean

Treatm

VIEW ZONE MAP

VIEW MEAN ANNUAL RAINFALL MAP

METHODOLOGIES

Descriptions with the HELP buttons and
In the model itself
See below for access using the model.

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

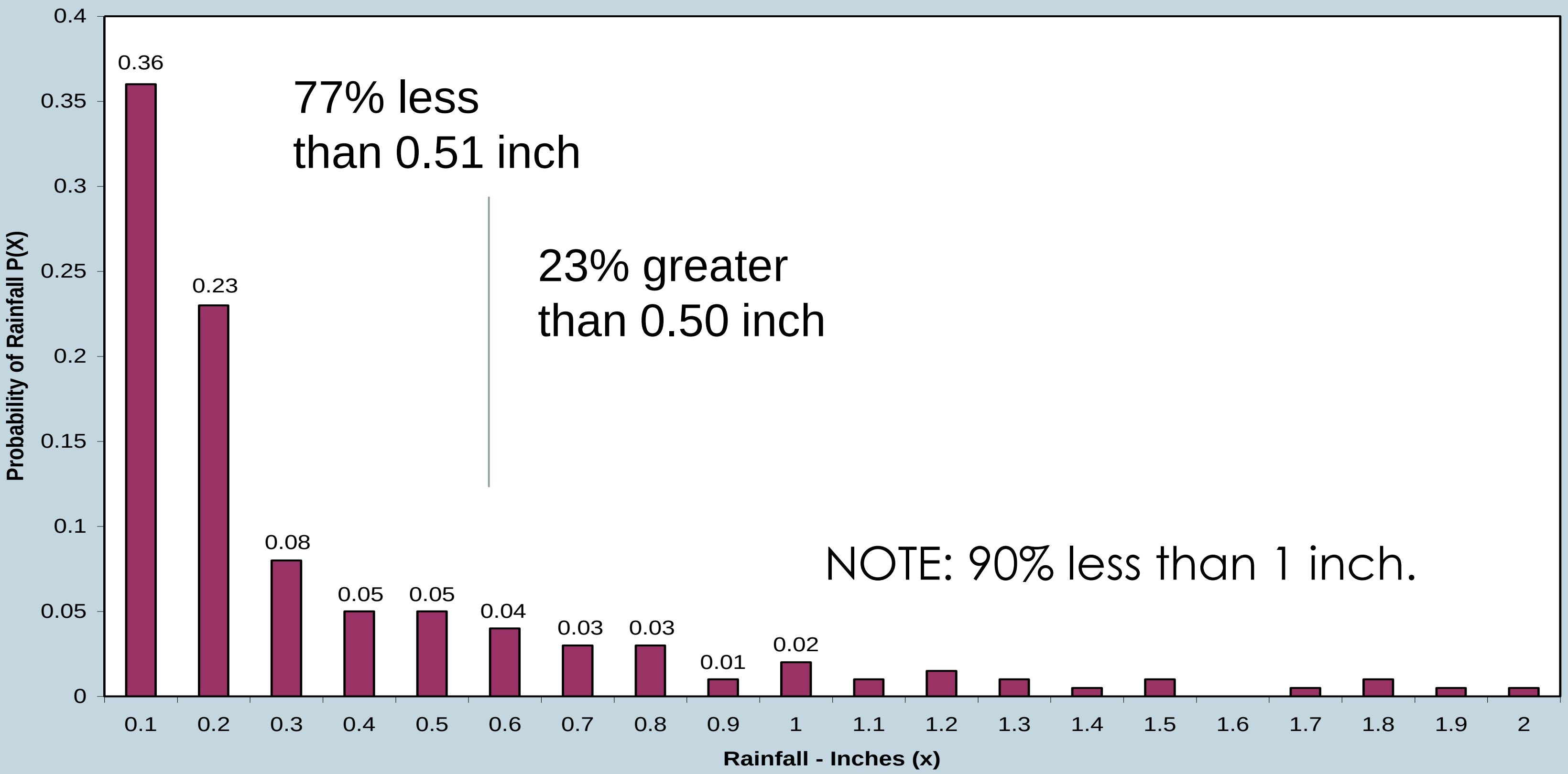
METHODOLOGY FOR GREENROOF SYSTEMS

Harper and Baker, FDEP 2007

HISTORY : HISTOGRAM (PROBABILITY DISTRIBUTION) Wanielista, Stormwater Management, Ann Arbor Science, 1978.

- N=130 events per year

Hourly Data Used for Central Florida sites over at least 15 years



METHODOLOGY FOR RETENTION SYSTEMS

Mean Annual Mass Removal Efficiency table from Appendix D of the evaluation report (1 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

Harper and Baker, FDEP 2007

INTERPOLATING DIFFICULTIES
(**NOT LINEAR** BETWEEN RETENTION DEPTHS)

Harper and Baker, FDEP 2007

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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Mean Annual Mass Removal Efficiencies for 0.50-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
30	91.8	91.5	88.3	84.0	79.5	75.0	70.7	66.6	62.9	59.6	56.5	53.6	51.1	48.7	46.6	44.6
35	88.2	89.1	86.6	82.8	78.6	74.3	70.1	66.2	62.6	59.3	56.3	53.5	51.0	48.7	46.5	44.6
40	84.0	86.3	84.4	81.2	77.4	73.4	69.4	65.7	62.2	59.0	56.0	53.3	50.8	48.5	46.4	44.5
45	79.6	82.9	81.9	79.3	75.9	72.2	68.5	65.0	61.7	58.6	55.7	53.0	50.6	48.4	46.3	44.4
50	74.8	79.1	79.0	77.0	74.1	70.8	67.4	64.1	61.0	58.0	55.3	52.7	50.4	48.2	46.2	44.3
55	70.1	74.9	75.6	74.2	71.9	69.1	66.1	63.0	60.1	57.3	54.7	52.3	50.0	47.9	46.0	44.2
60	65.5	70.4	71.7	71.1	69.4	67.0	64.4	61.7	59.1	56.5	54.1	51.8	49.6	47.6	45.8	44.0
65	61.0	65.8	67.5	67.6	66.4	64.7	62.5	60.2	57.8	55.5	53.3	51.1	49.1	47.2	45.5	43.8
70	56.7	61.1	63.1	63.6	63.1	61.9	60.2	58.3	56.3	54.3	52.3	50.3	48.5	46.8	45.1	43.5
75	52.7	56.6	58.6	59.3	59.3	58.6	57.5	56.0	54.4	52.7	51.0	49.3	47.7	46.1	44.6	43.2
80	49.1	52.2	54.1	55.0	55.2	54.9	54.2	53.2	52.1	50.8	49.4	48.0	46.6	45.3	44.0	42.7

INTERPOLATING DIFFICULTIES (**NOT LINEAR** BETWEEN RETENTION DEPTHS)

Harper and Baker, FDEP 2007

.25 inch

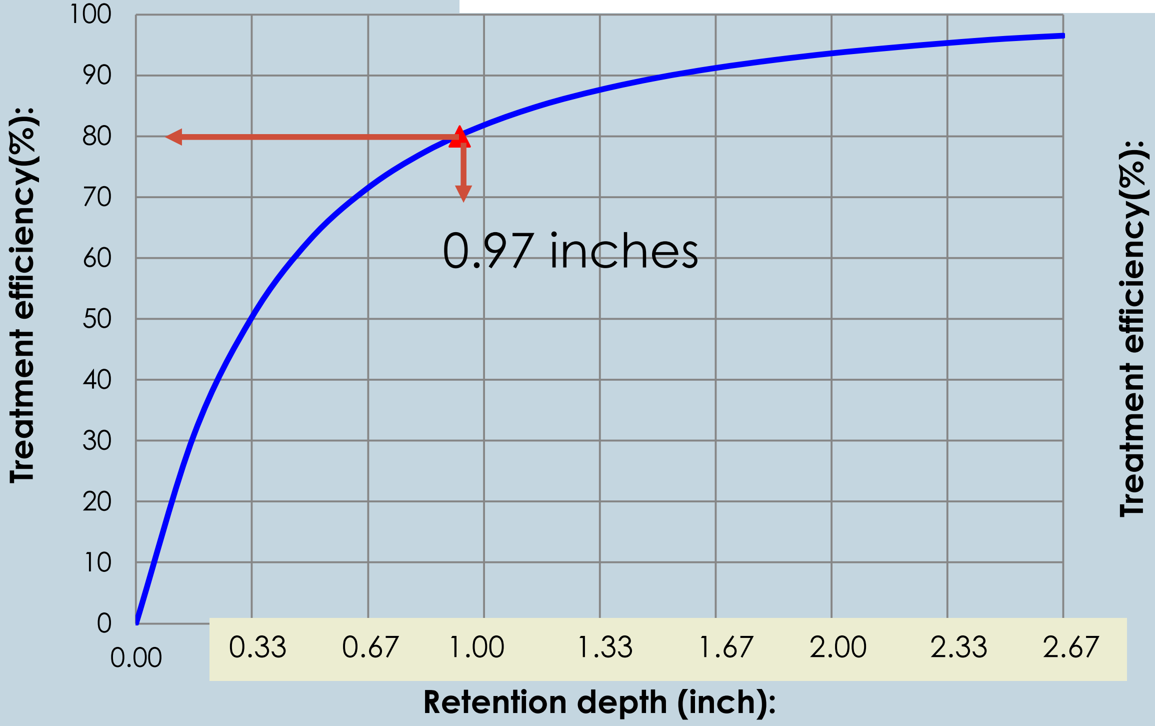
Percen
50
37.9
37.7
37.5
37.2

0.50 inch

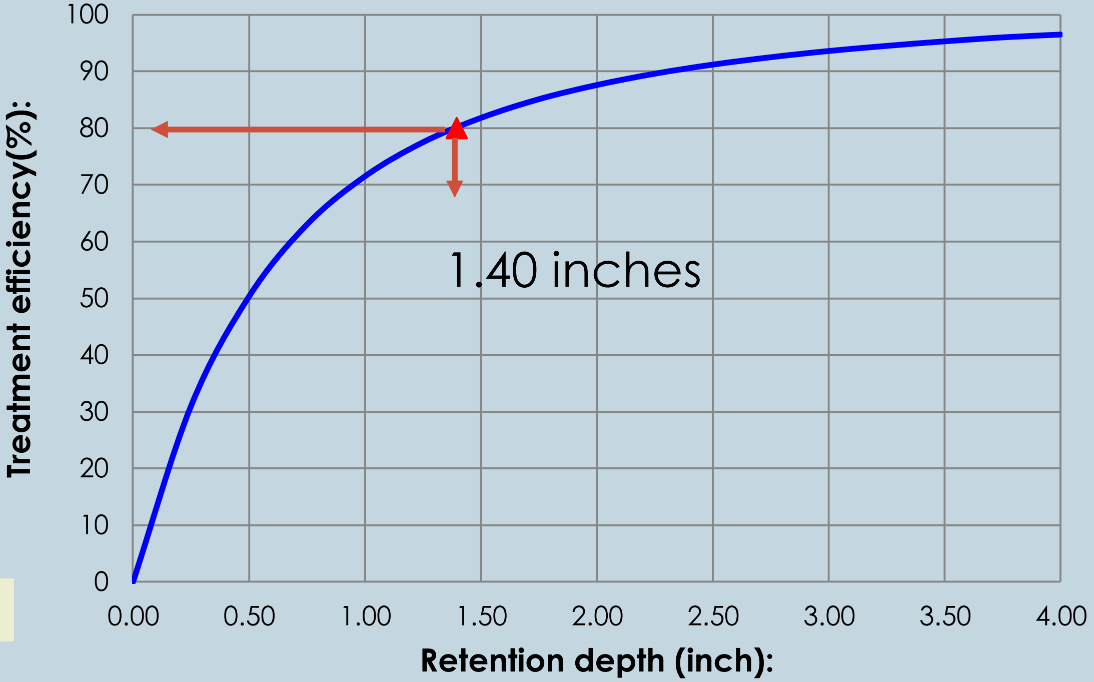
Percent
50
59.6
59.3
59.0
58.6

METHODOLOGY for RETENTION DESIGN
Examples Showing Climatological Differences in Design

RESULTS from BMPTRAINS modeling analysis at 80% capture



Central and east central Florida

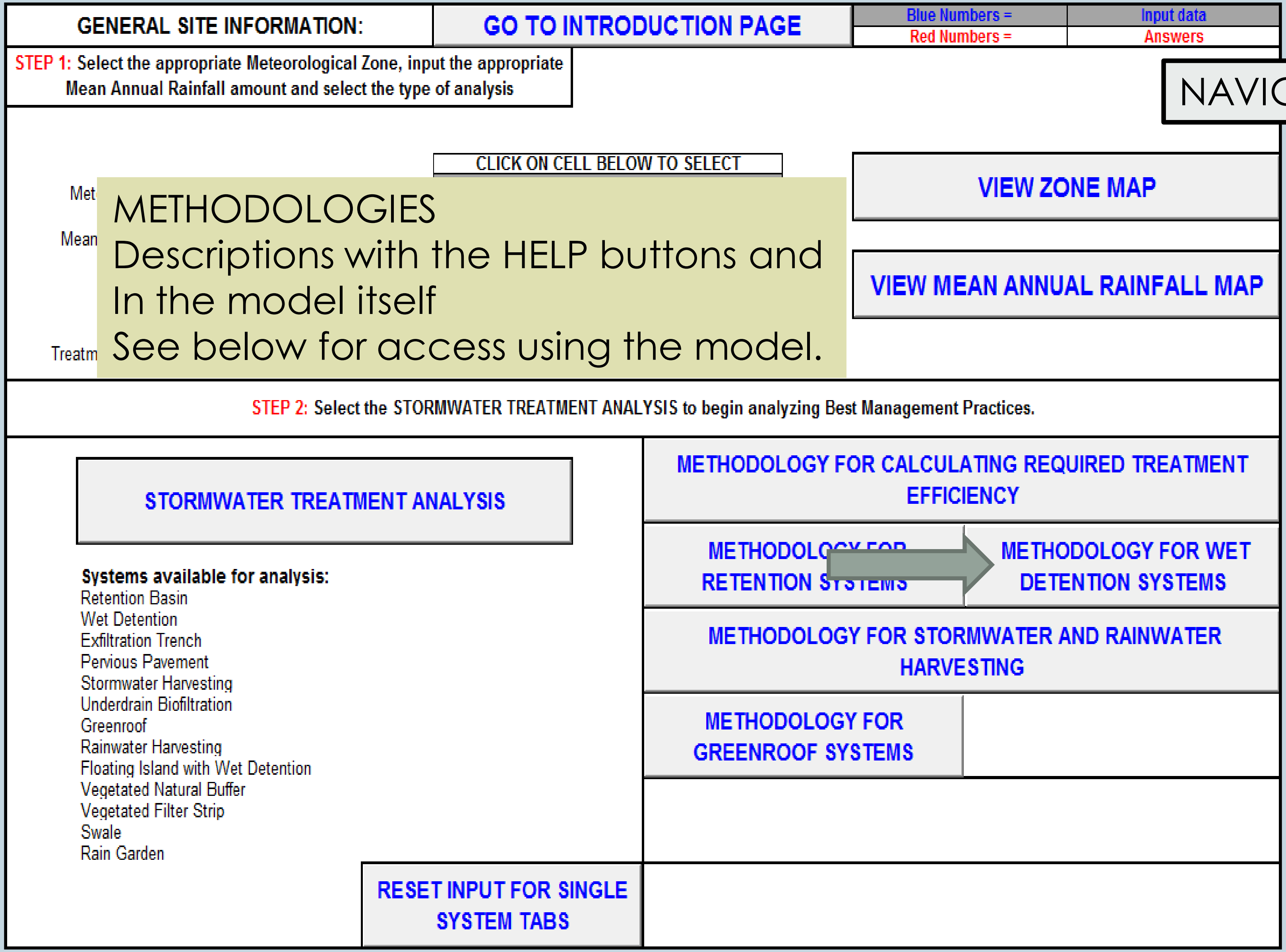


Pan handle of Florida

Effectiveness increases with the depth of retention and rate of increase decreases with depth BUT varies within the STATE for a specific removal effectiveness

WHAT TO DO ABOUT SENSITIVE AREAS? LIKE ESTUARIES AND SPRINGS

- The BMPTRAINS allows for options to improve water quality before it enters into the groundwater that discharges to springs or estuaries.
- Remove pollutants from surface flows using treatment trains, reactive media, chemical treatment, and stormwater reuse.
- For infiltration BMPs including Retention Basins.
  - Removed the pollutant before it enters the ground
  - Bottom of basins (Marion County)
  - Swales with reactive media



NAVIGATION BUTTONS

METHODOLOGIES
Descriptions with the HELP buttons and
In the model itself
See below for access using the model.

METHODOLOGY FOR WET DETENTION SYSTEMS

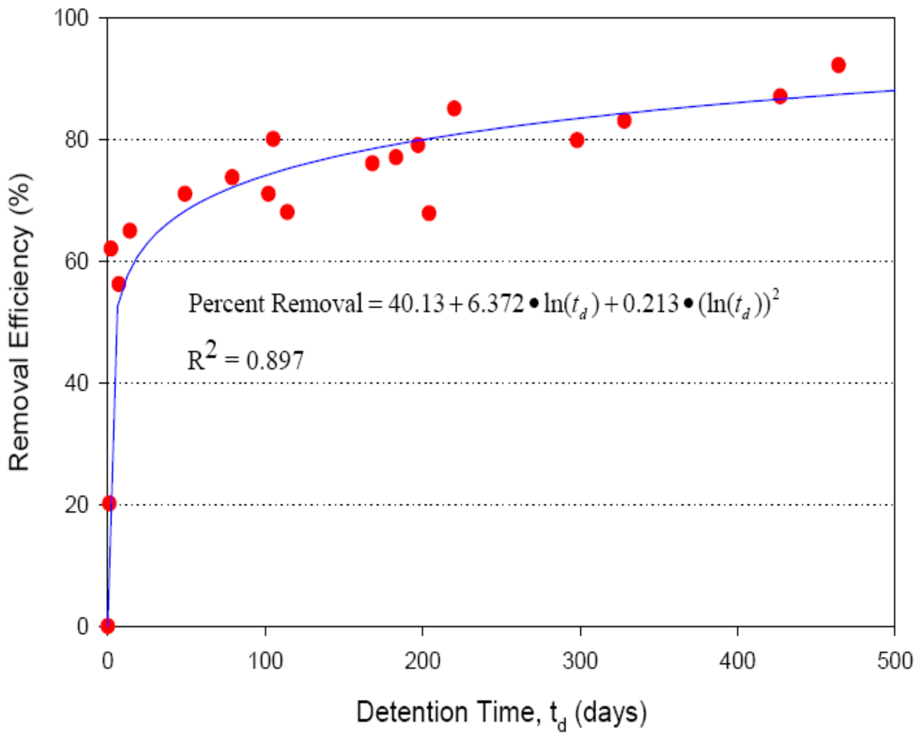


Figure 7.5-1 Removal Efficiency of Total Phosphorus in Wet Detention Ponds as a Function of Residence Time.

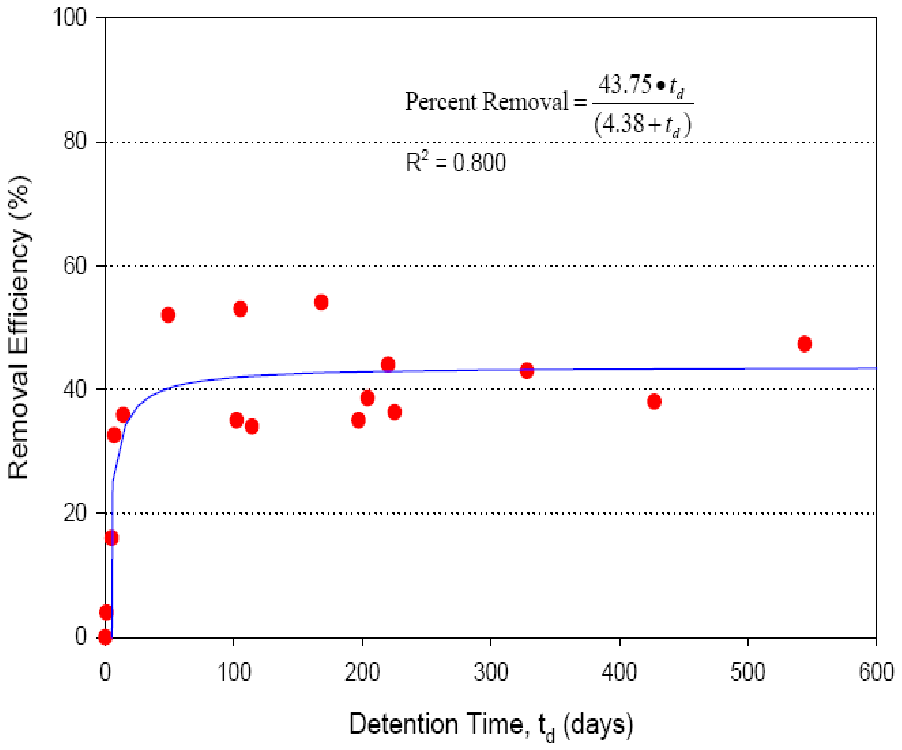


Figure 7.5-2 Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Residence Time.

15 BMPs AND ONE USER DEFINED

Select one of the BMPs below to analyze efficiency or review the summary data.					
RETENTION BASIN	WET DETENTION	EXFILTRATION TRENCH	RAIN (BIO) GARDEN	SWALE	USER DEFINED BMP
PERVIOUS PAVEMENT	STORMWATER HARVESTING	FILTRATION including Up-Flow Filters	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 CATCHMENT AND TREATMENT SUMMARY RESULTS 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		

15 BMPs and17 NAVIGATION BUTTONS

THE QUESTIONS OF MEETING LOADING REDUCTIONS

- Can one BMP meet loading reduction target? Not always….
  - Wet ponds do not achieve 80% reduction of N, or must occupy large areas to meet only the P reduction (about 200 days residence time).
  - Thus use a treatment train of swales before the wet pond.
  - Convert a wet pond to a reuse pond (stormwater harvesting).
  - There may not be sufficient area for a swale or need for reuse water. Thus use an up-flow filter within a drainage pipe that you can provide storage and use a sorption media and in a treatment train.

AN EXAMPLE USING BMPTRAINS MODEL

Stormwater BMP Treatment Trains [BMPTRAINS©]

CLICK HERE TO START

HELP - INTRODUCTION

HELP AND BACKGROUND

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.

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: 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.

The authors of this program were Christopher Kuzlo, Marty Wanielista, Mike Hardin, and Ikiensinma Gogo-Abite.
This is version 7.3 of the program, updated on June 20, 2014. Comments are appreciated.

HELP - HYDROGRAPH AND LEGACY PROGRAMS

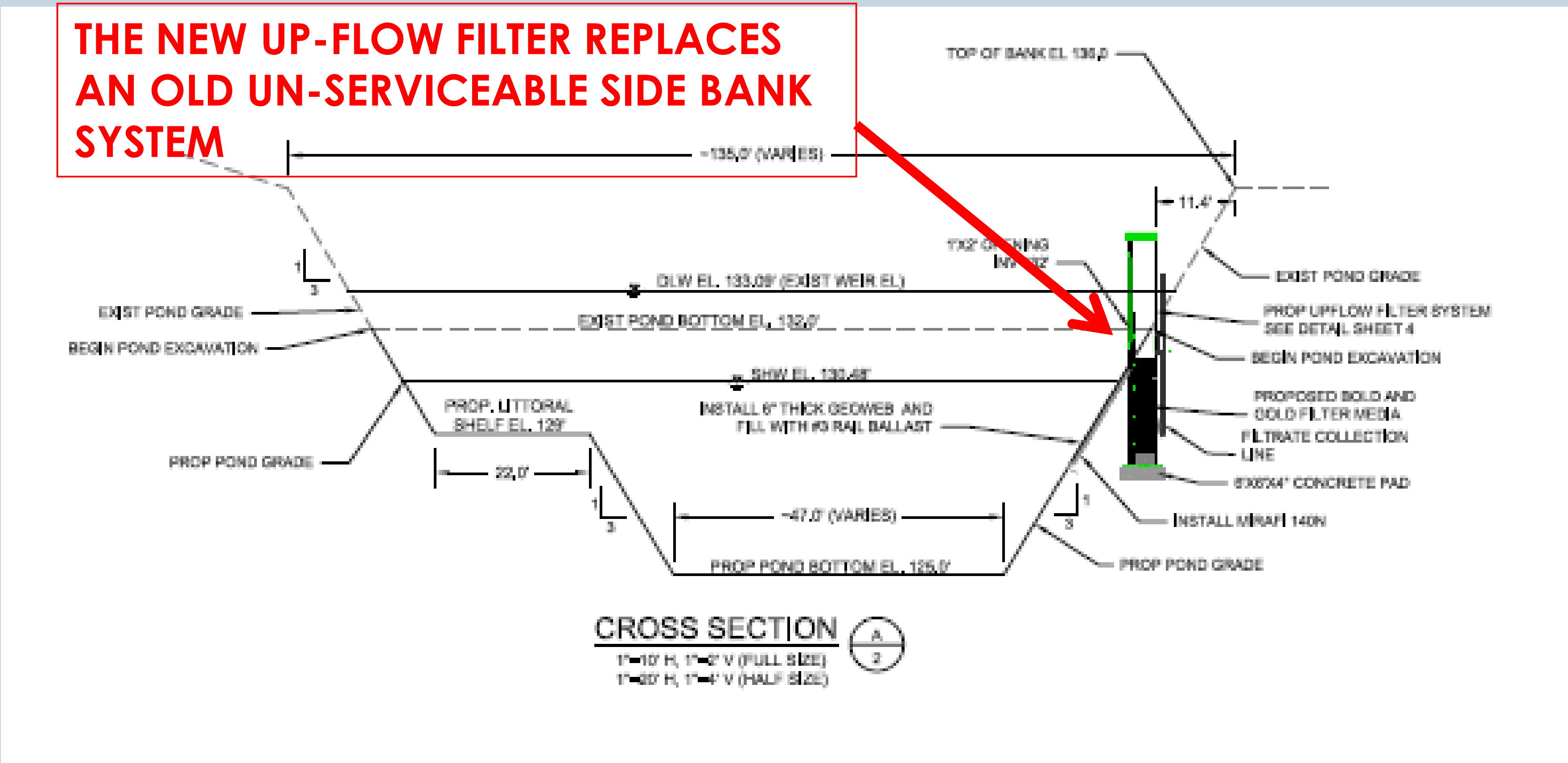
SMADA ONLINE

TYPICAL FAILURE PROBLEMS ASSOCIATED WITH SIDE BANK FILTERS

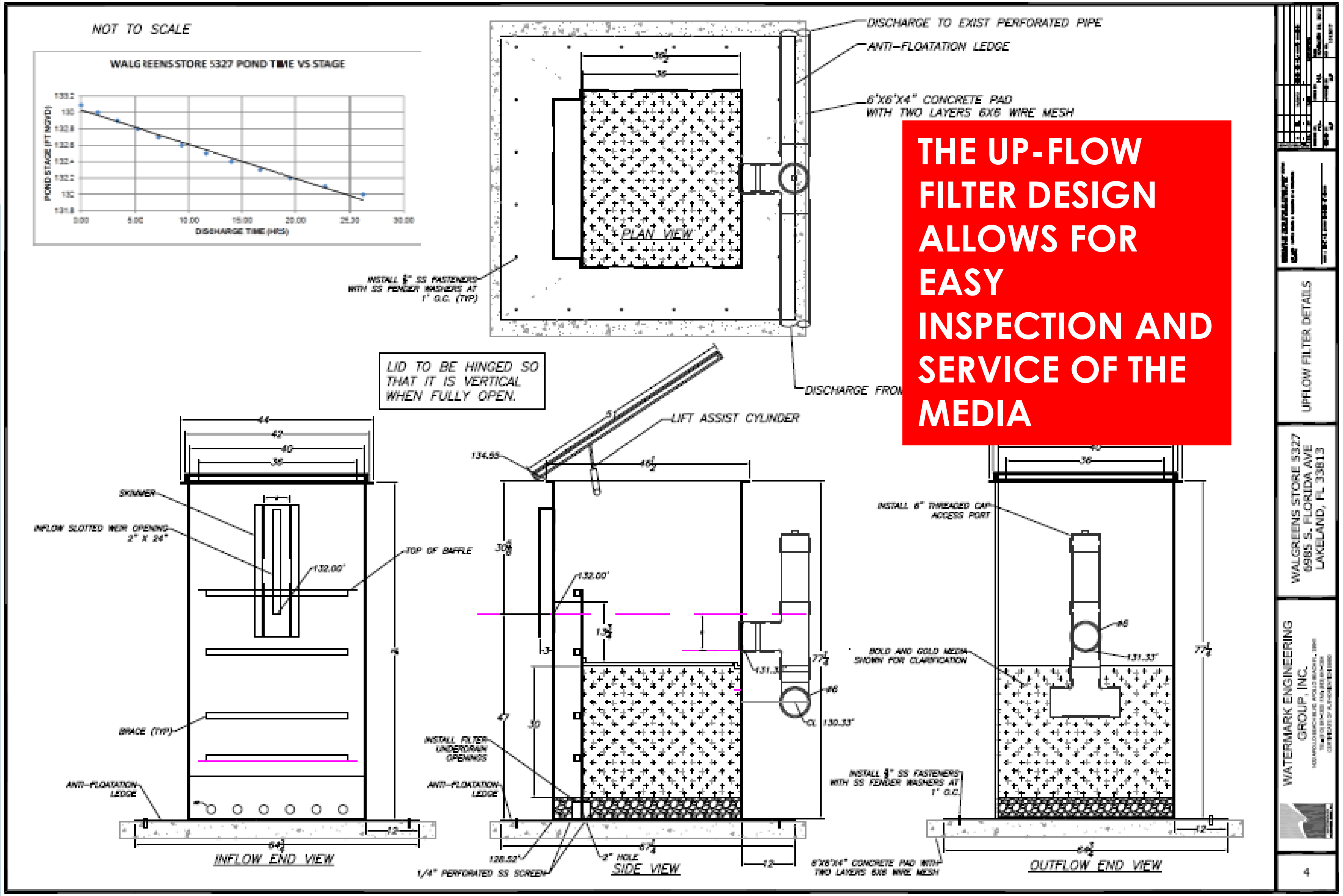
Some Failure Problems

- Filters are difficult to access to properly clean
- Because of slow filtration or no filtration, exotics take over
- Often difficult or very costly to replace

Example Pond Retrofit Design for Upflow Filter



WATERMARK
ENGINEERING GROUP, INC.



THE UP-FLOW FILTER DESIGN ALLOWS FOR EASY INSPECTION AND SERVICE OF THE MEDIA

DESIGN by Watermark Engineering Group

UP-FLOW FILTER INSTALLATION BY SUNTREE TECHNOLOGIES

Suntree Technologies Inc.

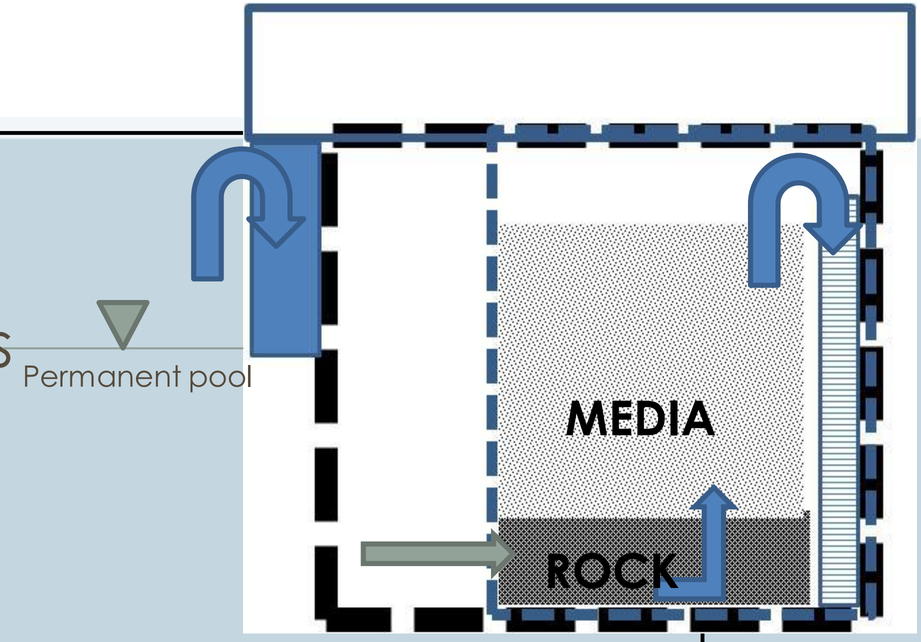
IMPROVED TREATMENT USING AN UP-FLOW FILTER WITH WET POND

Observations

- Filters can be designed to remove nitrogen without media replacement
- For phosphorus, media replacement time is specified
- Can be easily cleaned
- Can be used in BMP Treatment Train

UP-FLOW WITH WET DETENTION PERFORMANCE DATA

- **Summary Data**
  - Concentration data based
  - Averages based on 6 events
  - Construction cost less
    than under drains
  - Average yearly based
    1.0 inch design for filter



Parameter	TN	TP	TSS
Average Influent Concentration (mg/L)	1.83	0.73	42.7
Average Filter Removal (%)	**22**	**25**	**60**
Average Pond Removal (%)	**62**	**63**	**79**
Average Pond + Filter Removal (%)	**70**	**72**	**91**
Average Annual System Performance	**67**	**70**	**89**

USE THE BMPTRAINS MODEL TO CHECK FIELD DATA

Stormwater BMP Treatment Trains [BMPTRAINS©]

CLICK HERE TO START

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HELP - HYDROGRAPH AND LEGACY PROGRAMS

SMADA ONLINE

BMPTRAINS MODEL COMPARISON TO FIELD COLLECTED DATA
NOTE: average annual removal

Percent Removal				
	TN (Field)	**TN (Model)**	**TP (Field)**	**TP (Model)**
Pond + Filter	**67**	**66**	**70**	**78**

Notes: 1. Pond input measured TP of 0.73 mg/L is high and 81% of TP is dissolved. Thus, can change or alter the effectiveness of the pond

2. A wet pond effectiveness for TN removal has been increased by about 30% (66-35%). If more pond water is treated by the filter before discharge the effectiveness can increase by about 40-45%.

SPRINGS AND ESTUARIES PROTECTION

FIELD DATA

FIELD DATA

Date:	pH Pond In SU	pH Filter In SU	pH Filter Out SU	Turbidity Pond In NTU	Turbidity Filter In NTU	Turbidity Filter Out NTU	DO Pond In mg/L	DO Filter In mg/L	DO Filter Out mg/L	Temp ^{o}C
3/25	7.14	7.25	7.05	10.5	2.50	2.25	7.20	6.09	0.61	22.5
4/8	7.20	7.40	7.30	39.0	5.47	4.52	7.08	4.09	1.14	24.0
4/14	7.15	7.20	7.05	4.40	1.19	1.12	7.13	7.54	0.27	25.2
4/15	6.90	6.85	6.8				6.23	7.10	0.59	27.0
4/28	6.76	6.67	6.45	32.5	2.85	1.96	5.29	5.80	0.36	29.1
AVG	7.03	7.07	6.93	21.6	3.00	2.46	6.59	6.10	0.74	25.6
% Change based on pond influent					86%	89%		7%	89%	
% Change due to filter						18%			88%	

USING 5 SAMPLES: NOx (mg/L) IN=0.77 OUT=0.025 97% removal

Conclusions

1. Many examples of LIDs used in new- and re-development.
2. BMPTRAINS model is used to estimate annual nutrient removal effectiveness and size BMPs in treatment systems.
3. It is available at no cost to the users.
4. The average annual effectiveness is site specific incorporating rainfall conditions of an area and combinations of BMPs.
5. BMPs can be analyzed in either series or parallel structure. The estimates stay “true” to the underlying rainfall conditions.
6. BMPTRAINS can be used to assess protection of Springs and Estuaries.

Seal of Approval

QUESTIONS, REMARKS AND DISCUSSION

THANK YOU!

University of Central Florida