FSA

2024 Annual Conference

"Charging up" The New BMPTrains Software

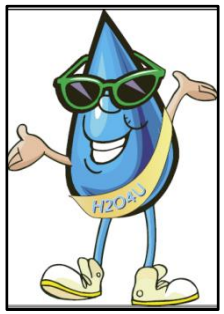
1. How the BMPTrains software has included some recent proposed changes and other possible inputs.

2. What can be done in the future or "charging up" the software in a constantly changing environment.

Dingbao Wang, Ron Eaglin and Marty Wanielista, presenting
on behalf of the research teams

2024 Annual FSA Conference

Sanibel Harbour Marriott **,** June 12-14, 2024



UCF

Department of Civil, Environmental and Construction Engineering

Questions or Topics for Discussion

- **How can BMPTrains help with the new rule?**
- **What changes must be done to BMPTrains to accommodate new input?**
- **What is in the future to help with other most probable changes?**
  - **Last 20+ years of rainfall data affecting retention**
  - **Consideration of volume and peak discharges in addition to annual mass loadings or an integrated surface and groundwater analysis**
- **Discussion of future training and releases?**

What is BMPTrains?

Software to aid in Calculations of Annual Mass Loadings and Volume Control

BMP Trains 2020: a C# and VB based software for **analysis**.

The acronym is derived for the analysis of stormwater BMPs in series
The software is used to evaluate **B**est **M**anagement **P**ractice **T**reatment options based on **R**emoval using **A**nnual loadings by those **I**nterested in **N**utrients in **S**tormwater.

Note: volume control important in resiliency and sea level planning

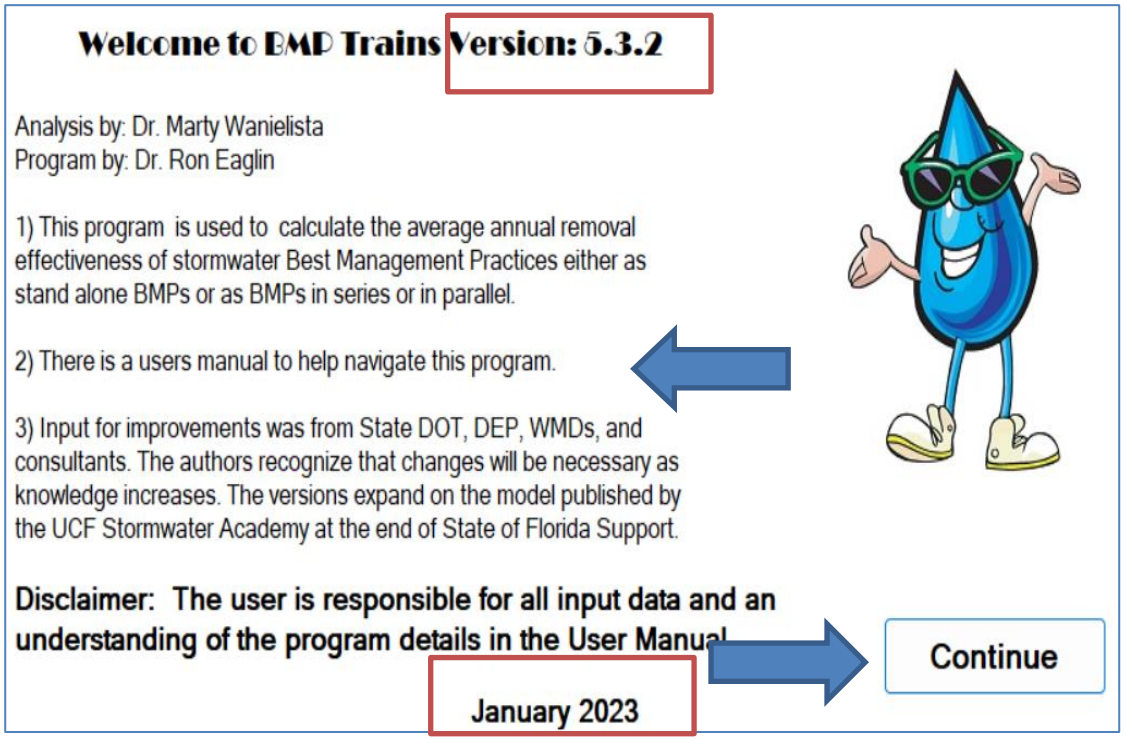
for the January 2023 release and the **manual, download from**:
https://roneaglin.online/bmptrains/

Source code is copyrighted

Screen Capture of BMPTrains

BMPTrains 2020

Initial "splash" screen for the BMP Trains 2020 software



In its present C# VB form, it was funded by FDOT until 2017 and released for general use in 2020. UCF continues making enhancements to improve the use of the software. We always welcome input for options to meet regulatory rules and local ordinances. Most say it is easy to use (see) and thus calling it a **2020** program as well as being released in 2020. We hope to get funding to incorporate changes and release another version of the software.

BMPTrains 2020 has and will continue to incorporate research and regulatory decisions

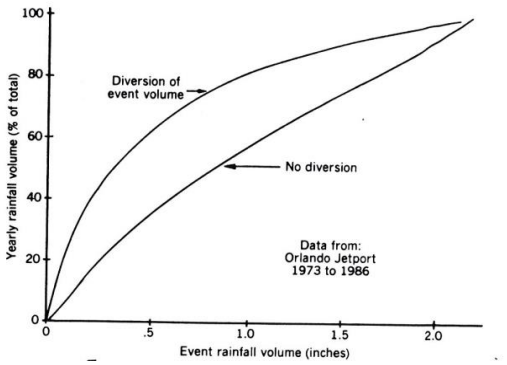
- **Uses Florida rainfall, soils, EMCs, and physical land uses.**
- **Abides by principles from Hydrology, Hydraulics, Chemistry and Biology.**
- **It is a history of research, field monitoring results, and regulatory decisions to include:**
  - **Incorporation of rules, comp plans, and regulations.**
  - **Follows information in the applicant's handbooks (AH Vol 1 & 2).**
  - **Annual removal effectiveness for many BMPs and LIDs (GSI).**
  - **Peer reviewed and "passed" administrative hearings.**
  - **Acceptable to many practicing professionals, and updated by local, regional (WMD), Department of Transportation (FDOT), and FDEP regulatory and review professionals.**
- **BMPTrains 2020 provides all of the above.**

BUT it must do more to incorporate other new regulatory and technical issues and changes.

Brief Comments on BMPTrains Development

- Started in the early 1970's with retention systems, refereed publications, Stormwater Management, Ann Arbor Science, 1978, pg 105.
- Expanded to wet detention (1980-2010).
- EXCEL spreadsheets programming 1980-2014 with support from the WMDs, FDEP and FDOT, named BMPTrains in 2004.
- State-wide annual effectiveness retention from Dr. Harper 2007.
- Design details and effectiveness from research, ex. harvesting, rain gardens, pervious pavements, and sorption media, 1990-present.
- C# and visual basic programming by UCF team and Dr. Eaglin with support from the FDOT 2014-2017.
- Continued expansion to add tech changes and regulatory decisions related to the ERP, TMDL and other programs by Wanielista, Eaglin, Harper, and Wang (2017-2023).

Minor difference in capture (<1%) for new 13 yr period. Graph used for the 1-inch rule in Orange County and in our State.



What is the vision for the new "charged up" release of BMPTrains?

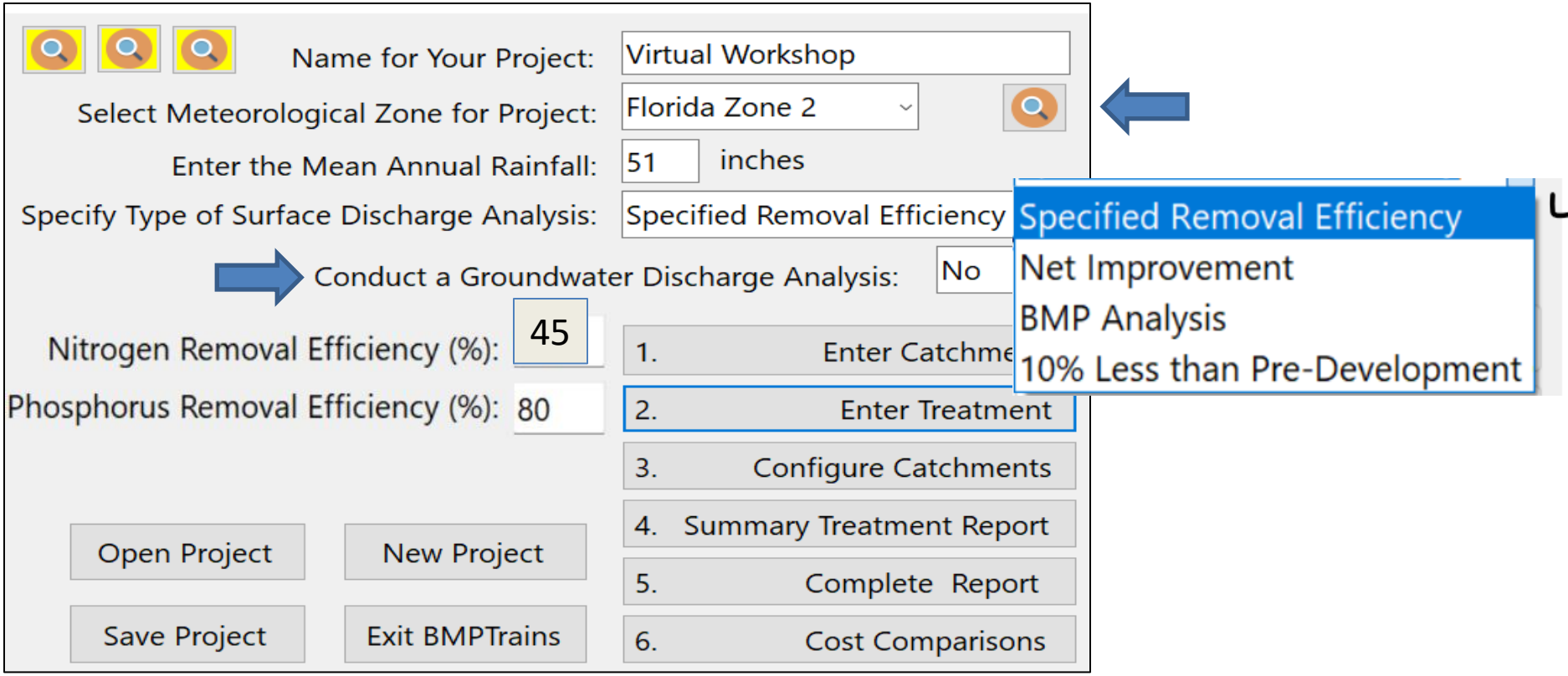
1. Make changes based on TAC and regulatory directives.
2. BMPs are used to achieve water quality and quantity objectives (recognize interdependency).

Some example objectives, 55% TN removal, 80% TP removal, peak discharge, flood levels, water supply, springs and estuaries concentration limits, etc.

So… We will have software that meet current TAC and regulatory practice. Also, predict and evaluate combinations of BMPs that meet many objectives. The methods must be supported by science and engineering applications and are acceptable to review agencies. Science and regulatory acceptance have been the basic premise of past BMPTrains efforts and will be continued in the future.

Let’s consider first some changes for annual removal

Specified Annual Removal % from draft rule



Note: The BMPs discharge to groundwater average annual concentration (mg/L) and recharge (inches/year) is in the current release.

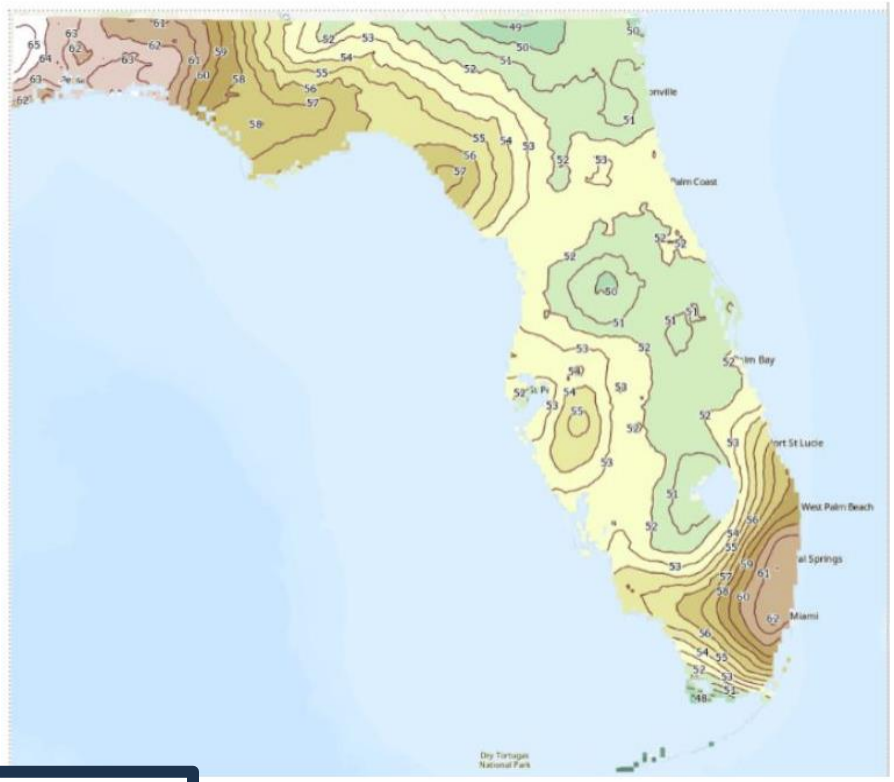
Examples problems in the BMPTrains 2020 Manual and the FDOT DDG, Ch 9.3.1, 2024.

Change to meet need for updated annual rainfall

Annual Rainfall

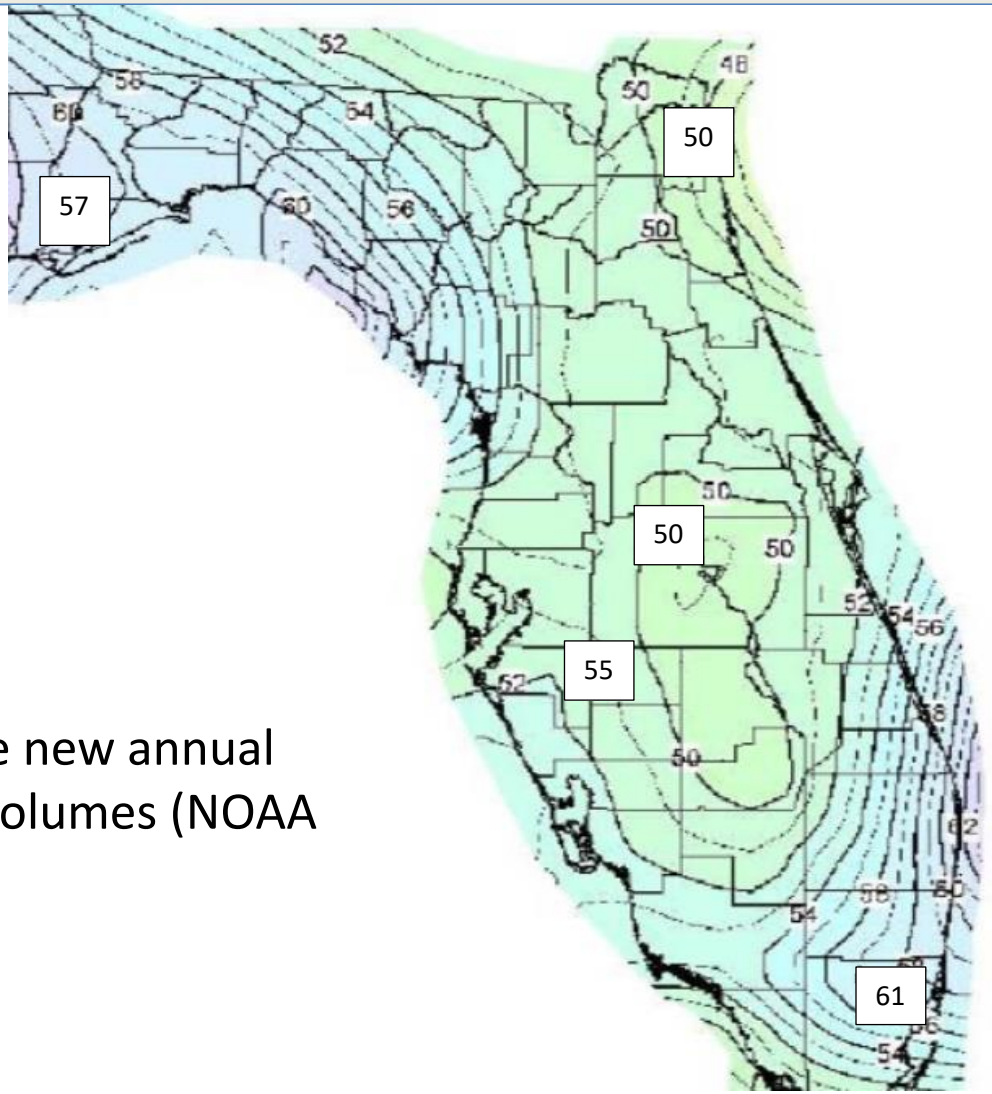
From Appendix M
Figure 2
Draft Rule 2023

2022 NOAA Average Annual Rainfall Depths (inches)



Range: 41.60 to 65.70 Keys to the Northwest Pan Handle

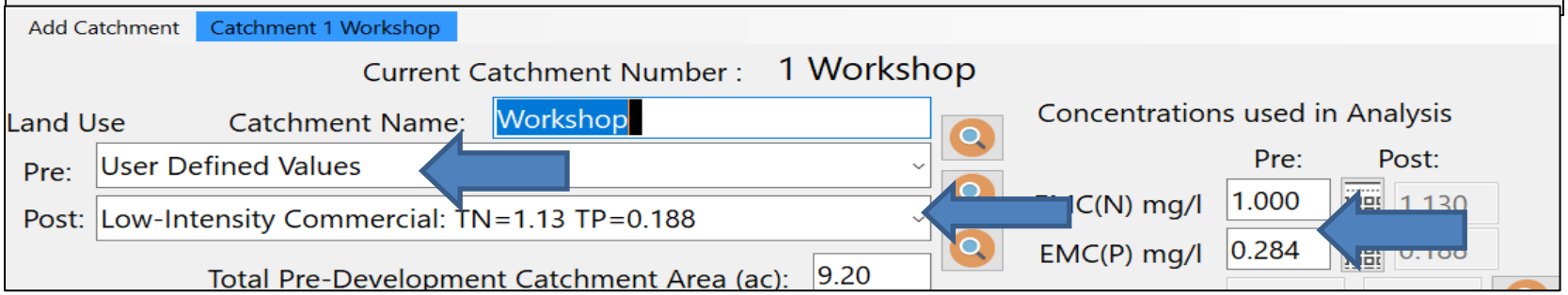
Comparison 2000 and 2022 annual rain (inches)



Legend
Boxes are new annual
Rainfall volumes (NOAA
2022)

Continuing with changes to meet technical advisory inputs

Catchment Data: Land Use and EMCs

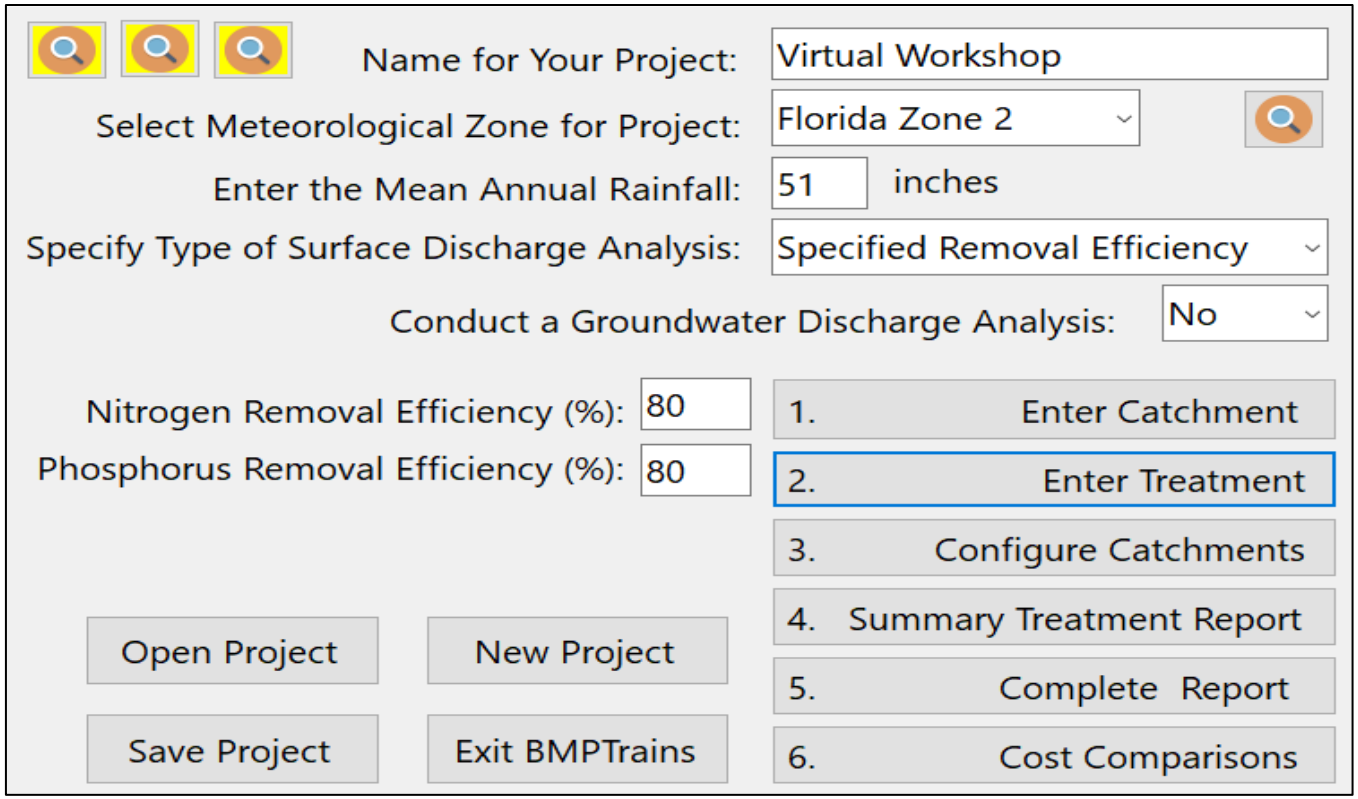


LAND USE CATEGORY	TN	TP
Agricultural - Citrus TN =2.11 TP=0.180	2.24	0.183
Agricultural - General TN= 2.55 TP= 0.450	2.8	0.487
Agricultural - Pasture TN= 3.03 TP=0.593	3.51	0.686
Agricultural - Row Crop TN= 2.50 TP = 0.577	2.65	0.593
Conventional Roofs: TN=1.050 TP=0.120	1.05	0.12
High-Intensity Commercial: TN=2.40 TP=0.345	2.4	0.345
Highway: TN=1.520 TP=0.200	1.52	0.2
Light Industrial: TN=1.200 TP=0.260	1.2	0.26
Low-Density Residential: TN=1.645 TP= 0.27	1.645	0.27
Low-Intensity Commercial: TN=1.13 TP=0.188	1.13	0.188
Mining / Extractive: TN=1.180 TP=0.150	1.18	0.15
Multi-Family: TN=2.320 TP=0.520	2.32	0.52
Single-Family: TN=2.070 TP=0.327	2.07	0.327
Undeveloped - Dry Prairie: TN=2.025 TP=0.184	2.025	0.184
Undeveloped - Marl Prairie: TN=0.684 TP=0.012	0.684	0.012
		043

Proposed

If an EMC not in the “Pull-Down” list, there are others listed in the Manual and User Defined is suggested.
New rural EMCs are being considered for the pull-down menu.

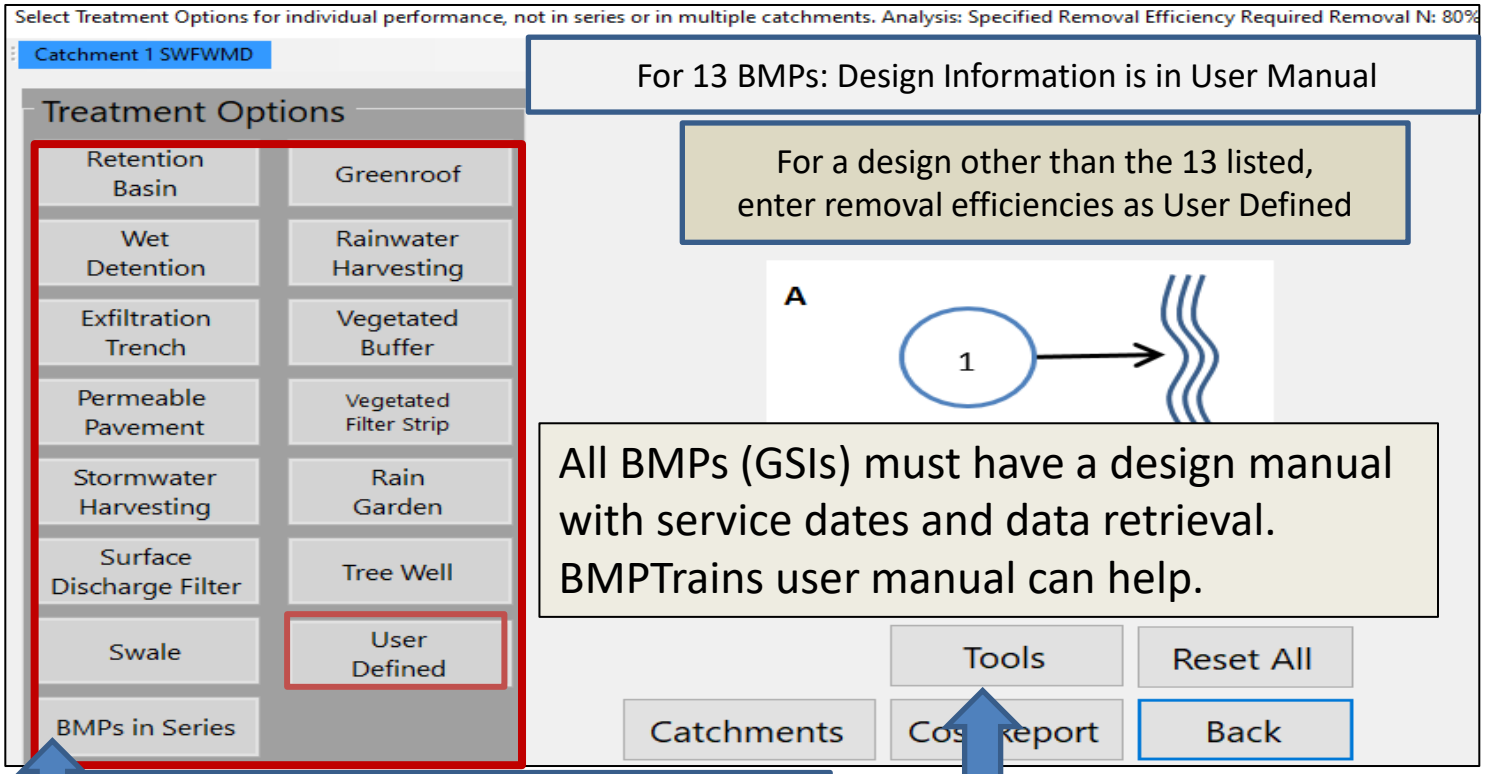
BMP Treatment Effectiveness



Input from consultants and review agencies must continue to ID more BMPs

There are BMPs in the software, others will be added

14 Treatment BMP Options



For 13 BMPs: Design Information is in User Manual

For a design other than the 13 listed, enter removal efficiencies as User Defined

All BMPs (GSIs) must have a design manual with service dates and data retrieval. BMPTrains user manual can help.

For more than one BMP in the same catchment (no additional runoff between BMPs)

Calculating tools helpful for design or discovery

Using the many Charts for Retention in Draft Rule

Retention Tables, set for 0.25, 0.50, 0.75, .. Up to 4”

From Appendix O: 80 Figures Draft Rule 2023

Your design is for .33 inch

Retention Efficiency

Use BMPTains and enter data

Rainfall Zone: Florida Zone 2 | Retention Depth (> 0.25): 0.33

NDCIA CN 64.0 Find | DCIA % 27.0 Find | Efficiency: 64.5 Find

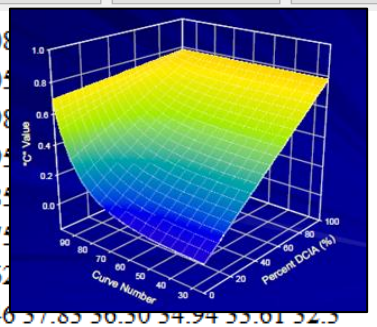
Efficiency at Retention Depth: 0.33 (in) for Rainfall Florida Zone 2

Lw =H/S

Tools | Reset All | Catchments | Cost Report | Back

Percent DCIA

NDCIA CN	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65
30.0	95.23	92.42	86.78	80.41	74.37	68.91	63.99	59.65	55.85	52.42	49.42	46.66	44.30	42.08	40.08
35.0	92.89	90.94	85.78	79.75	73.90	68.51	63.73	59.42	55.65	52.32	49.29	46.66	44.20	42.04	40.05
40.0	89.70	88.97	84.41	78.75	73.17	68.01	63.33	59.19	55.42	52.16	49.19	46.53	44.17	41.94	39.98
45.0	85.92	86.39	82.60	77.52	72.31	67.28	62.83	58.82	55.19	51.92	49.03	46.40	44.07	41.91	39.95
50.0	81.33	83.22	80.40	75.92	71.08	66.42	62.17	58.26	54.72	51.59	48.80	46.20	43.87	41.81	39.85
55.0	76.24	79.50	77.70	73.88	69.61	65.32	61.30	57.60	54.26	51.23	48.46	45.97	43.71	41.68	39.75
60.0	70.95	75.26	74.42	71.48	67.75	63.92	60.21	56.80	53.60	50.66	48.03	45.70	43.48	41.45	39.62
65.0	65.50	70.51	70.62	68.55	65.45	62.13	58.81	55.67	52.70	50.07	47.54	45.24	43.14	41.22	39.46



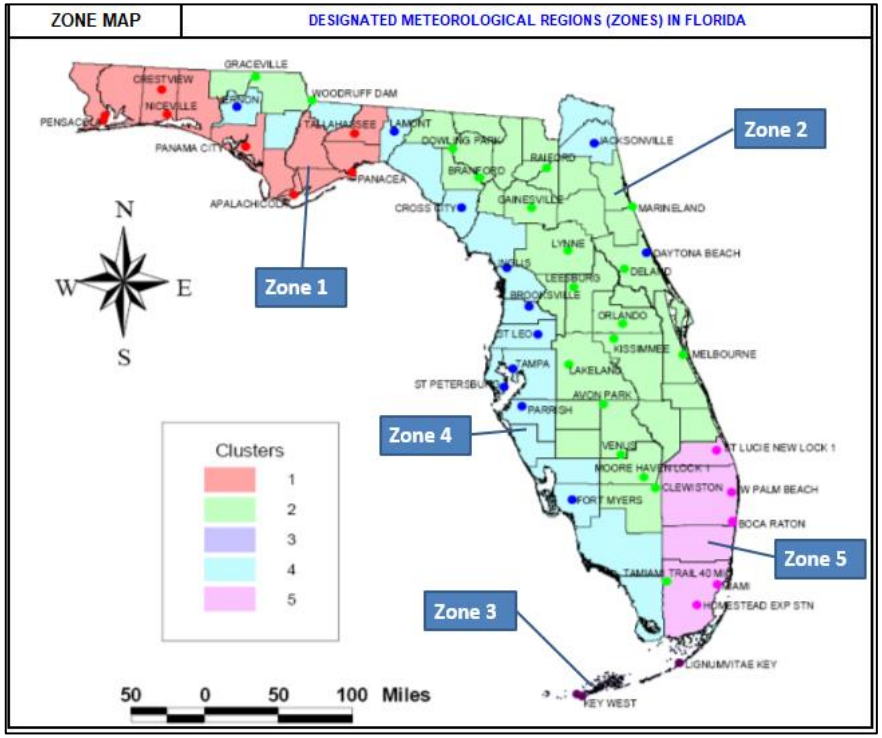
Retention depth (in) = treatment volume (Ac-in) / catchment area (Ac)

More changes being considered but will take significantly more time

Do rainfall inter events over the past 20+ years affect the met zone boundaries and annual mass removal of retention systems?

Within the current release of BMPTrains

- Volume captured for the same design depth can be assigned to a meteorological zone.
- Based on recent rainfall patterns, is volume captured the same?



Source: Harper, 2007.

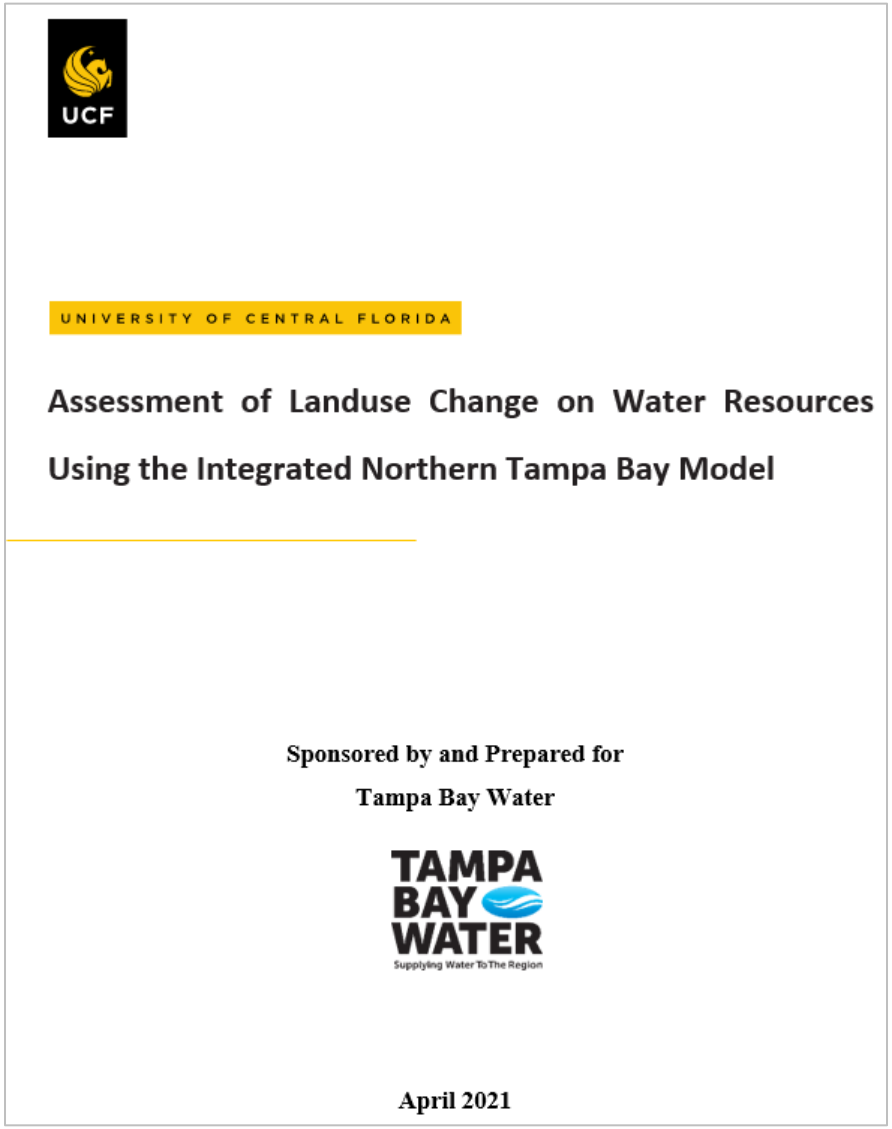
Integration of Water Quality and Quantity Objectives

This is the “one water” or “water is water” concept.
One software so that the input data is the same when multiple objectives are addressed at the same time. Some objectives are:

1. Pollution control
2. Peak discharge
3. Flood control
4. Groundwater table levels
5. Base flow in flowing waters and lake levels
6. Water supply and pumping rates
7. Springs discharge
8. Community or regional specifications, affecting locations

Now for an example of an integrated surface and groundwater software

An Integrated Surface Water and Groundwater Study



UNIVERSITY OF CENTRAL FLORIDA

Assessment of Landuse Change on Water Resources Using the Integrated Northern Tampa Bay Model

Sponsored by and Prepared for

Tampa Bay Water

April 2021

An Integrated Surface Water and Groundwater Study

Project objectives:

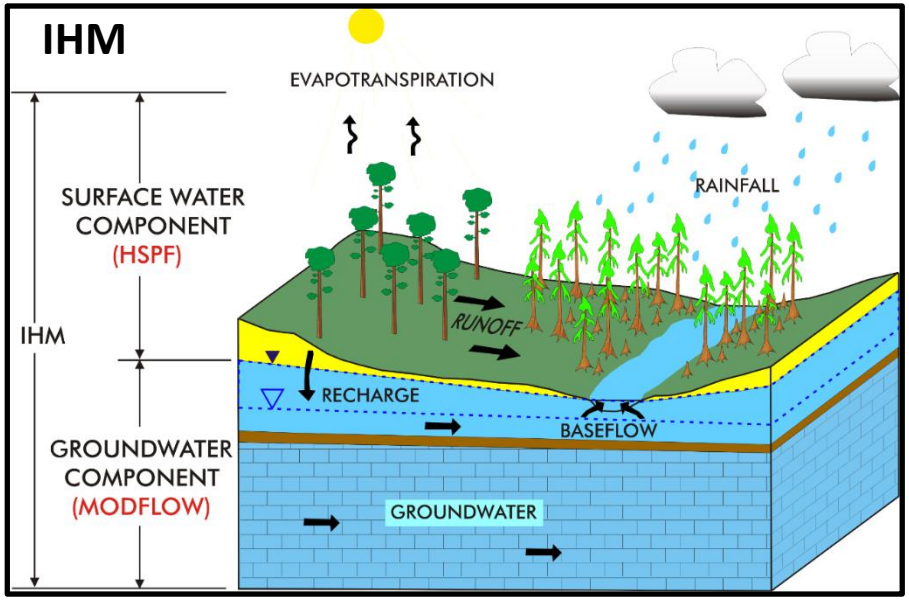
1. Identify and quantify transition patterns in landuse change;

2. Assess hydrologic responses due to landuse change and well pumping distribution differences;

3. Assess effectiveness of the integrated model to evaluate influence of landuse change on hydrologic responses.

Integration of Surface Water and Groundwater Models

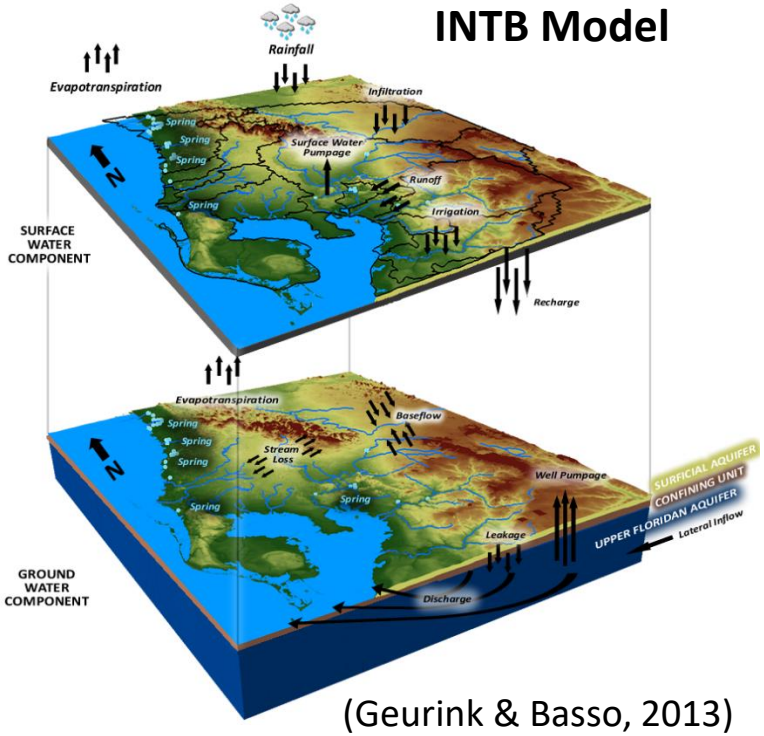
Integrated Hydrologic Model (IHM)



(Geurink et al., 2018)
IntegratedHydrologicModel.org

- The Integrated Hydrologic Model (IHM) dynamically integrates two models, HSPF and MODFLOW

INTB Model



(Geurink & Basso, 2013)

- The Integrated Northern Tampa Bay (INTB) model (Geurink & Basso, 2013) is a calibrated application of the IHM which is developed cooperatively by Tampa Bay Water and the Southwest Florida Water Management District

TAMPA BAY WATER
Supplying Water To The Region

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

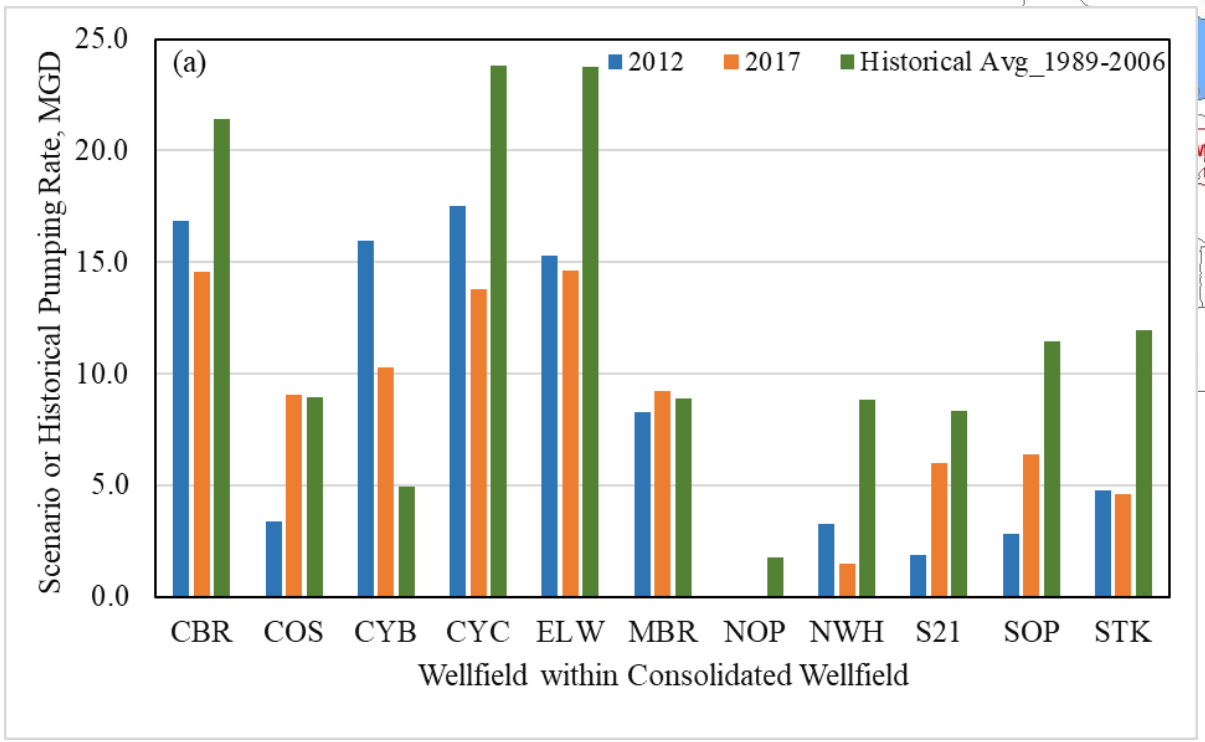
Landuse Change

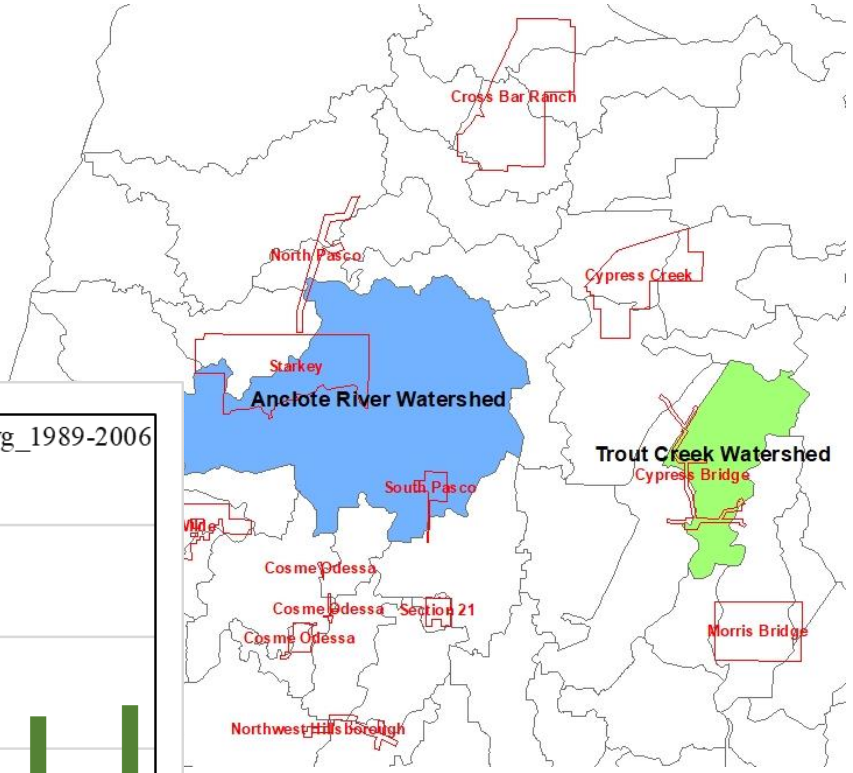
Normalized Land Area Change from 1995 to 2010

Landuse	Trout Creek basin	Anclote River basin
	$\frac{\text{LU10} - \text{LU95}}{\text{Basin Area}}$	$\frac{\text{LU10} - \text{LU95}}{\text{Basin Area}}$
	%	%
Forested	-6.9	0.4
Grass/Pasture	-18.1	-10.0
Agric/Irrigated	0.2	-1.0
Mining/Other	-0.1	-0.5
Pervious Urban	12.8	6.0
Pervious	-12.1	-5.2
Reach	2.3	1.6
Impervious	9.9	3.6

"Pervious" category includes pervious land from all five upland landuse categories including pervious urban

Consolidated Wellfield Pumping Scenarios





Simulation Scenarios

Simulation Scenario	Landuse Scenario	Consolidated Wellfield Pumping Scenario
Scenario 1: 2010 landuse + 2017 pumping	2010	2017
Scenario 2: 1995 landuse + 2017 pumping	1995	2017
Scenario 3: 2010 landuse + 2012 pumping	2010	2012

Groundwater Pumping Impact

Long-Term Average Change with Uncertainty in Hydrologic Response Due to Landuse Change or Wellfield Pumping Rate Distribution Differences for Ensemble Rainfall and Rainfall Uncertainty

Hydrologic Term	Trout Creek Basin		Anclote River Basin	
	LUΔ S1-S2	QΔ S1-S3	LUΔ S1-S2	QΔ S1-S3
Streamflow (cfs)	2.5 ± 0.15	2.0 ± 0.12	1.3 ± 0.11	-2.1 ± 0.09
Streamflow (in/yr)	1.9 ± 0.12	1.6 ± 0.10	0.3 ± 0.02	-0.4 ± 0.02
Total ET (in/yr)	-1.6 ± 0.11	0.9 ± 0.02	-0.1 ± 0.03	-0.3 ± 0.02
Groundwater ET (in/yr)	-1.0 ± 0.06	1.0 ± 0.01	-0.3 ± 0.02	-0.3 ± 0.01
Groundwater Recharge (in/yr)	-1.7 ± 0.04	-0.3 ± 0.04	-0.8 ± 0.01	0.1 ± 0.01

Values shown represent response change with uncertainty due to rainfall uncertainty as mean ± 1 standard deviation.

Hydrologic Responses to Landuse Change and Groundwater Pumping Rate

Hydrologic Term	Hydrologic Response Change Due to Landuse Change	Hydrologic Response Change Due to Well Pumping Distribution Difference
Basin-Scale Hydrologic Response		
Streamflow	Increase	Inverse of pumping change
Total ET	Decrease	Inverse of pumping change
Groundwater ET	Decrease	Inverse of pumping change
Recharge	Decrease	Direct change with pumping change
Baseflow Index	• Increase for river with small BFI • Decrease for river with moderate BFI	• Inverse of pumping change for river with small BFI • Inverse of pumping change for river with moderate BFI, except direct change with pumping change in Spring
Grid-Cell Scale Hydrologic Response		
SAS Head	• Decrease for change to urban, grass to forest, grass to wetland, wetland to forest • Increase for forest to grass	Inverse of pumping change
UFA Head	Same as SAS but smaller magnitude. Can be absent if very small in SAS. If SAS magnitude large enough, UFA areal coverage can be larger than SAS areal coverage.	Inverse of pumping change

Expected Initial Integration into BMPTrains

1. Storms with different return periods (e.g., 1-year, 10-year, 25-year, 50-year). Typical guidelines are found in the FDOT DDG publication.
    a) Runoff volume
    b) Peak discharge

2. Seasonality
    a) Monthly runoff, mass loading and concentration

3. Annual mass loading and concentration of groundwater recharge and baseflow. This expands on the stormwater recharge and annual concentration now part of BMPTrains.

Error Checks and AI

1. Input parameter; ex. % vs fraction, CN>100 etc.
2. Compound value; ex. Non DCIA area + DCIA area = Total Area.
3. New: Introduction of statistical comparisons; ex. Identification of results outside of 2-SD of the mean (95%) to raise additional justification needed or to discover valuable information.
4. New: Consistency of input data; ex. EMCs used for an ERP vs TMDLs, volume of BMPs use for flood control vs ERP mass loadings, land use delineations for peak discharge vs ERP land use data.
5. New: For output results; ex. Inventory of water in BMPs plus groundwater infiltration, pumping, and discharge equal to the input from a rain event, Loadings. Stream loadings include base flow.

The first two are simple error catches already used and more are expected at each release. The other 3 are expected to be added as time passes and will add to a greater understanding and ease of satisfying permits applications.

We hope formal steering committee and regulatory input on what is needed will guide our work.

Software Oversight and Training Course Considerations (talking points)

1. A steering committee will oversee development.
2. How to address quality and quantity objectives.
3. Hold training courses on-line at least “X” # of times a year. Option for face-to-face training “Y” # of times a year.
4. A competency test at the end of each training session to receive a certificate of completion. Need training (complex & time saving).
5. Certified professionals have on-line access to all publications, manuals and new releases, with expansion of existing library.
6. Release updated software once a year with new regulatory decisions and technical data.
7. BMPTrains 2020 is a copyright of UCF from 2004-2024. Thus, assignment or license or continuation with sponsor funding for future releases are all possible.

Potential Steering Committee Representation

- Florida Stormwater Association
- Florida Department of Environmental Protection & WMDs
- WMDs
- ERD and other consultants
- Ron Eaglin, Daytona State College
- Dingbao Wang, University of Central Florida
- Florida Department of Transportation
- Vendor Organizations, Ferguson Waterworks,
  Oldcastle Infrastructure.

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“Charging up” The New BMPTrains Software

Will accommodate changes

Questions, Input and Discussion

Dingbao Wang, Ron Eaglin and Marty Wanielista

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