Comprehensive Strategies to Protect Drinking Water from Harmful Algal Blooms

Webinar Series #2: Source Water Protection in the Watershed

US Army Corps of Engineers®

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

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Webinar Logistics:

- The meeting will begin at 1300 CDT.
- To access the audio select “Call Me” – this is the preferred option to reduce feedback.
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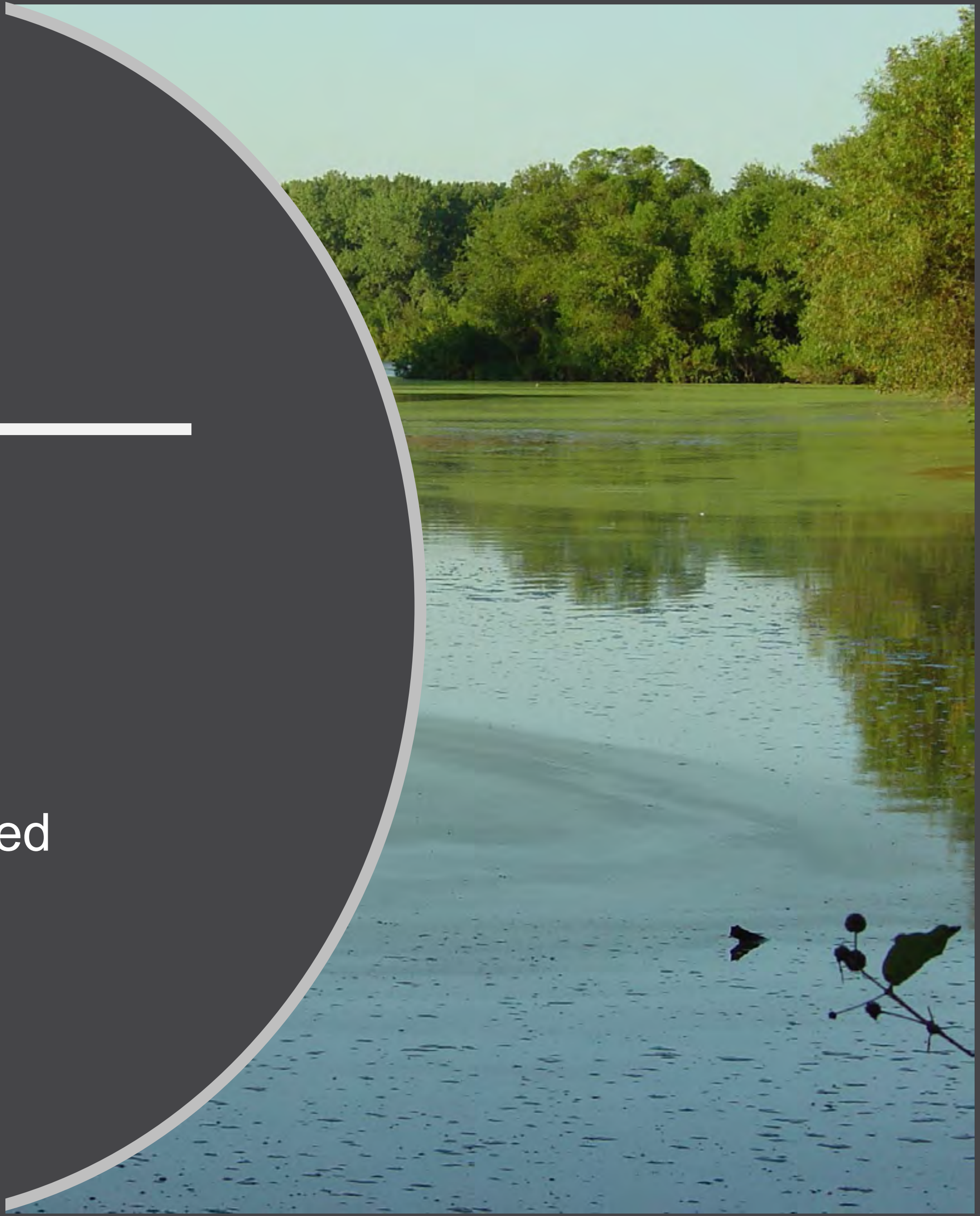
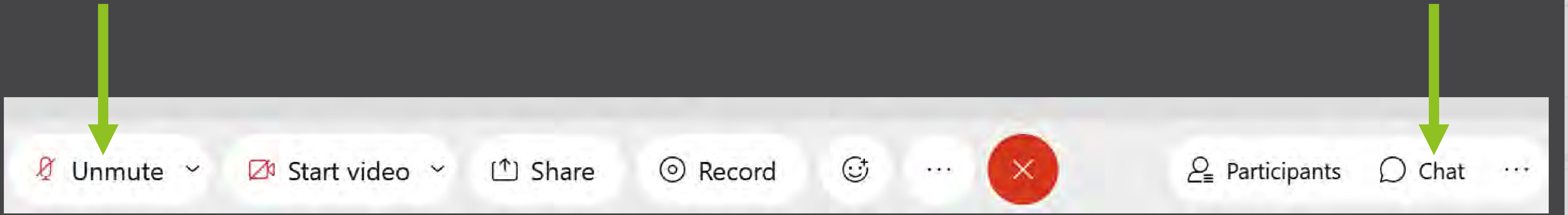
  - Dial: 1-844-800-2712
  - Access: 199 565 7227#



Webinar Instructions

- All lines are muted.
- Submit questions or comments in the Chat Box to "Everyone".
- The webinar is being recorded and will be shared following the meeting.



Webinar Series: Comprehensive Strategies to Protect Drinking Water from Harmful Algal Blooms

American Water Works Association

NALMS NORTH AMERICAN LAKE MANAGEMENT SOCIETY™

APMS The Aquatic Plant Management Society

1st Presentation

Dr. Stephen J. Souza is the Owner of Clean Waters Consulting, LLC. He is also the Founding Partner of Princeton Hydro, LLC. Over the past 35 years he has dedicated his career to the management and restoration of aquatic ecosystems, in particular lakes, ponds and reservoirs.

Dr. Souza has served over the past 25 years as an instructor and course coordinator for the Rutgers NJAES Office of Continuing Professional Education, developing and implementing multiple short courses focused on the management and restoration of aquatic ecosystems.

Dr. Souza is a past president of the North American Lake Management Society (NALMS) as well as the Pennsylvania Lake Management Society (PALMS). He serves on the Board of Trustees of the Association of New Jersey Environmental Commissions (ANJEC).

Watershed Management and Source Water Protection

Stephen J. Souza, Ph.D.
Clean Waters Consulting, LLC
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Thanks To…

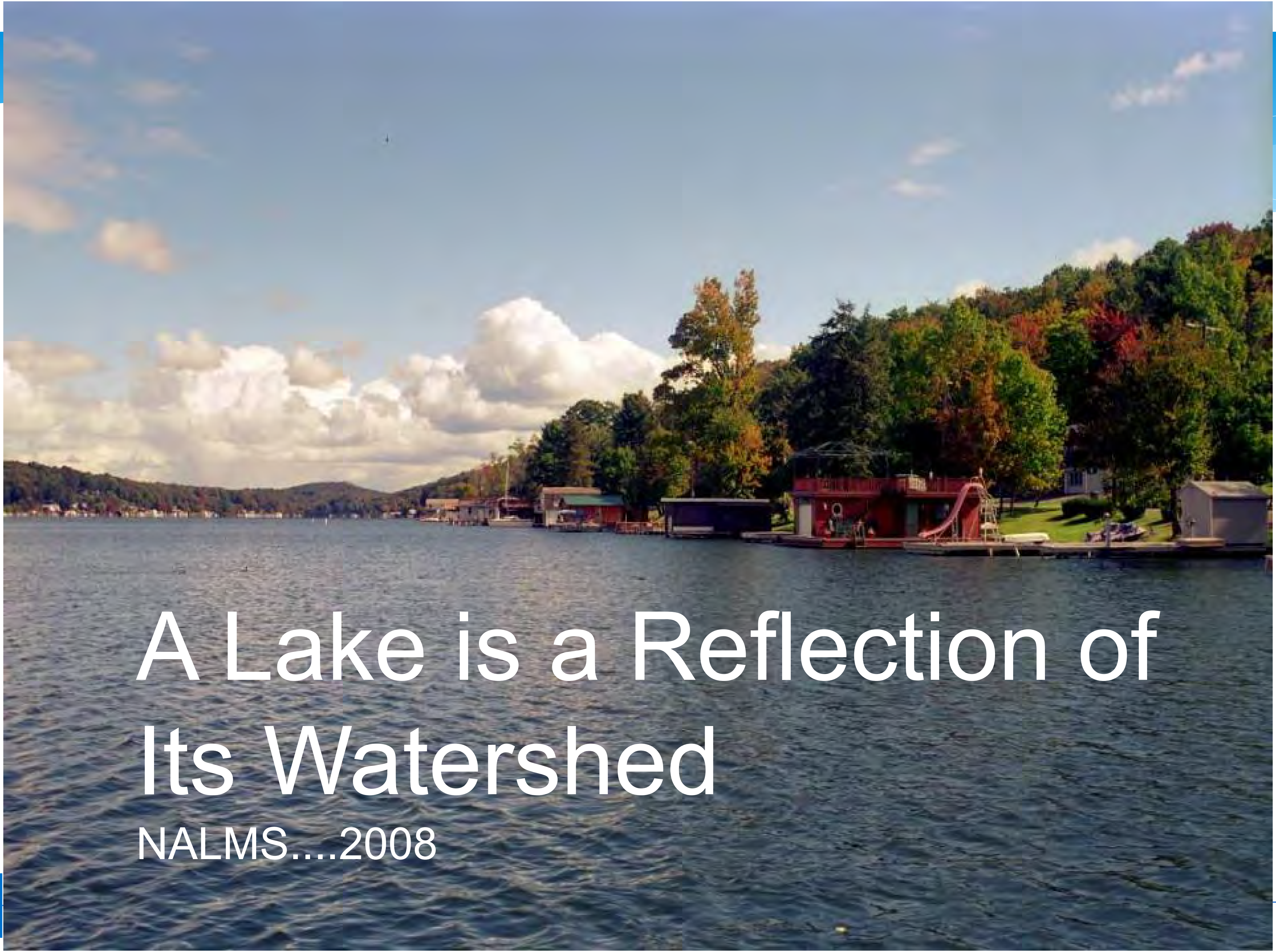
NALMS North American Lake Management Society

American Water Works Association

APMS
The Aquatic Plant Management Society

What We'll Be Covering

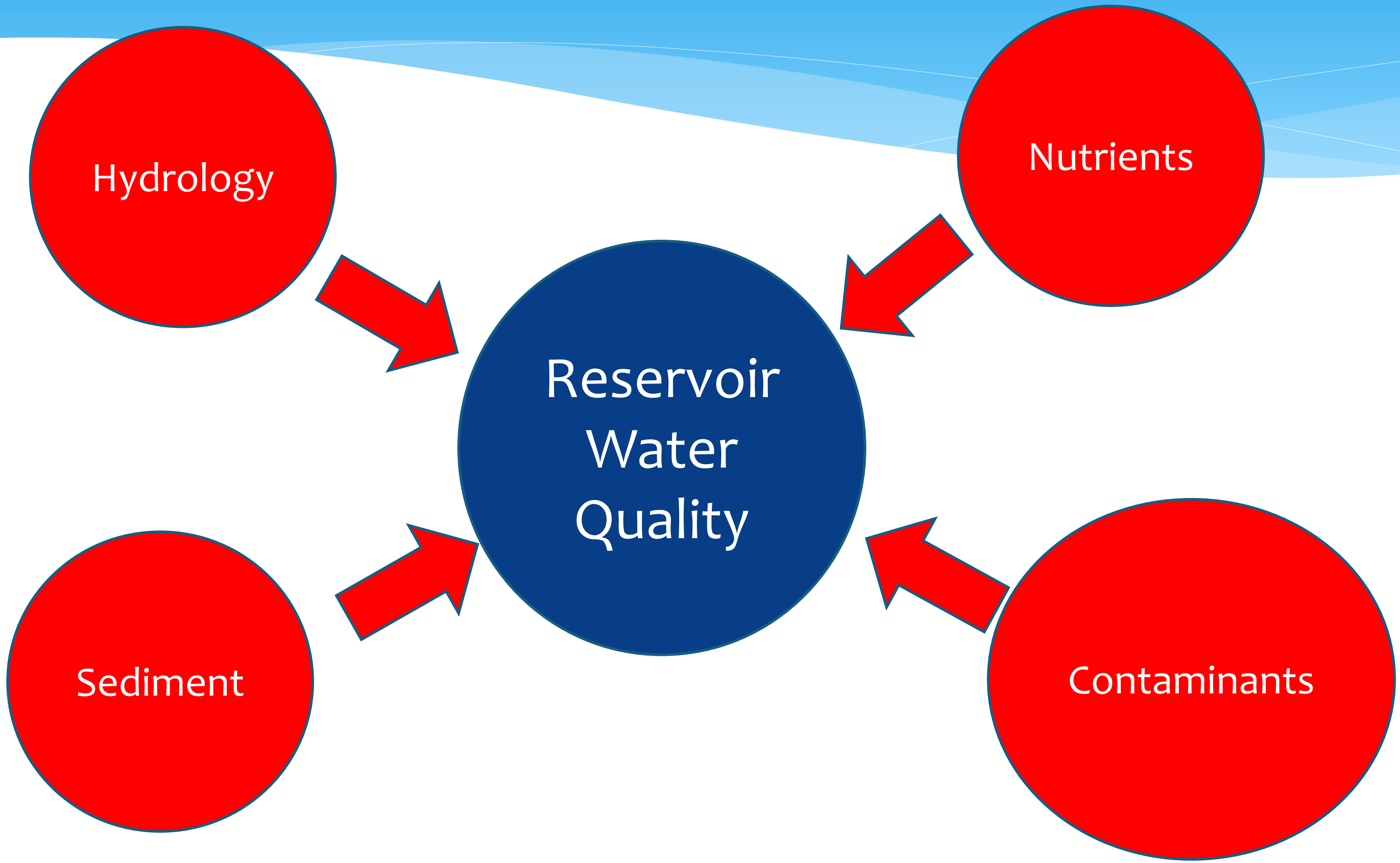
- Eutrophication risks to surface water reservoirs.
- How the chemical, hydrologic and trophic state properties of surface water reservoirs are directly linked to watershed development.
- How to assess and quantify such impacts.
- How reservoir managers can use such data to protect and improve the raw water quality… better raw water quality = less in-plant treatment needs and costs



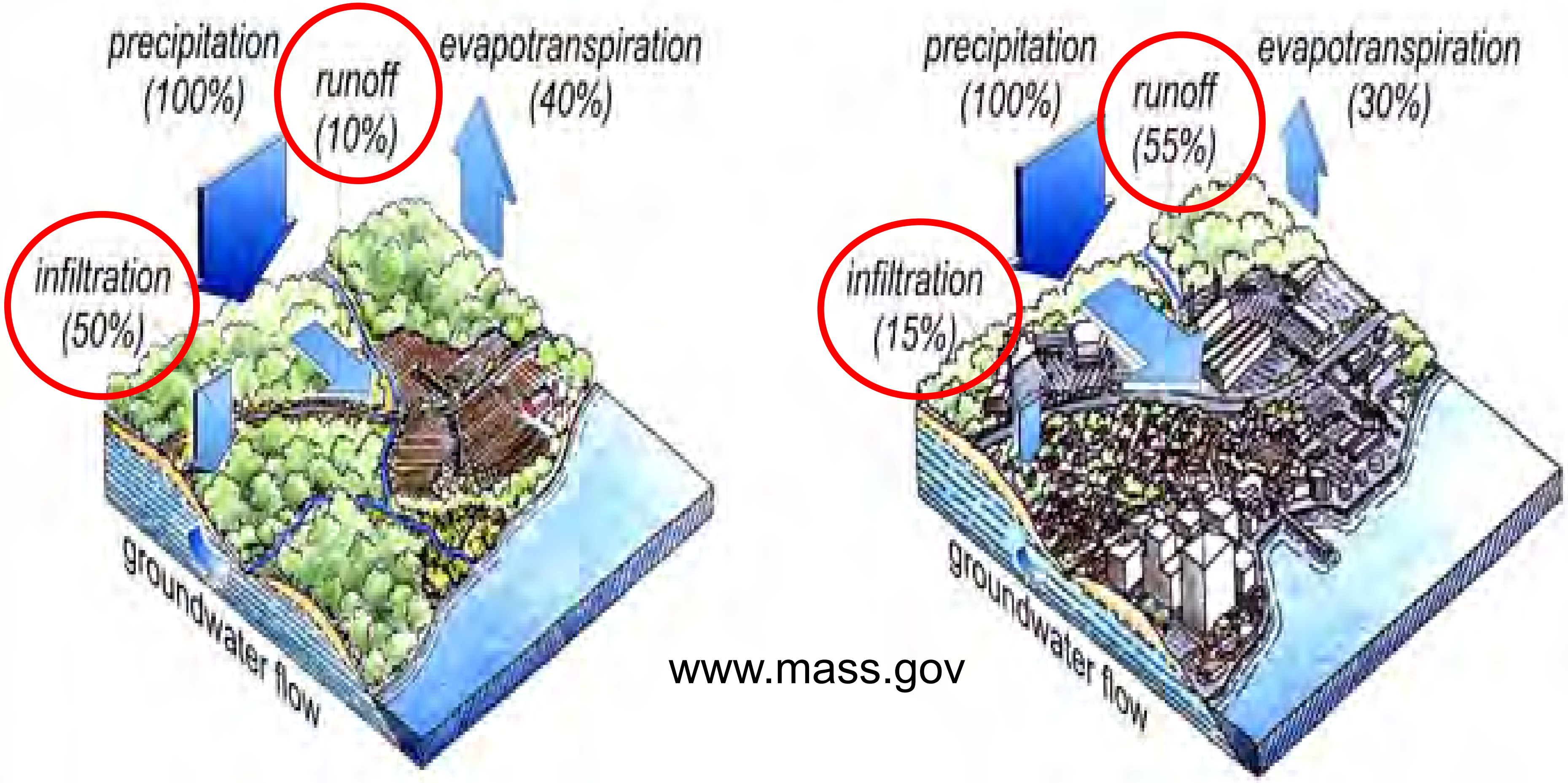
A Lake is a Reflection of Its Watershed

NALMS....2008

Its An Intimate Connection



Development Driven Hydrologic Changes



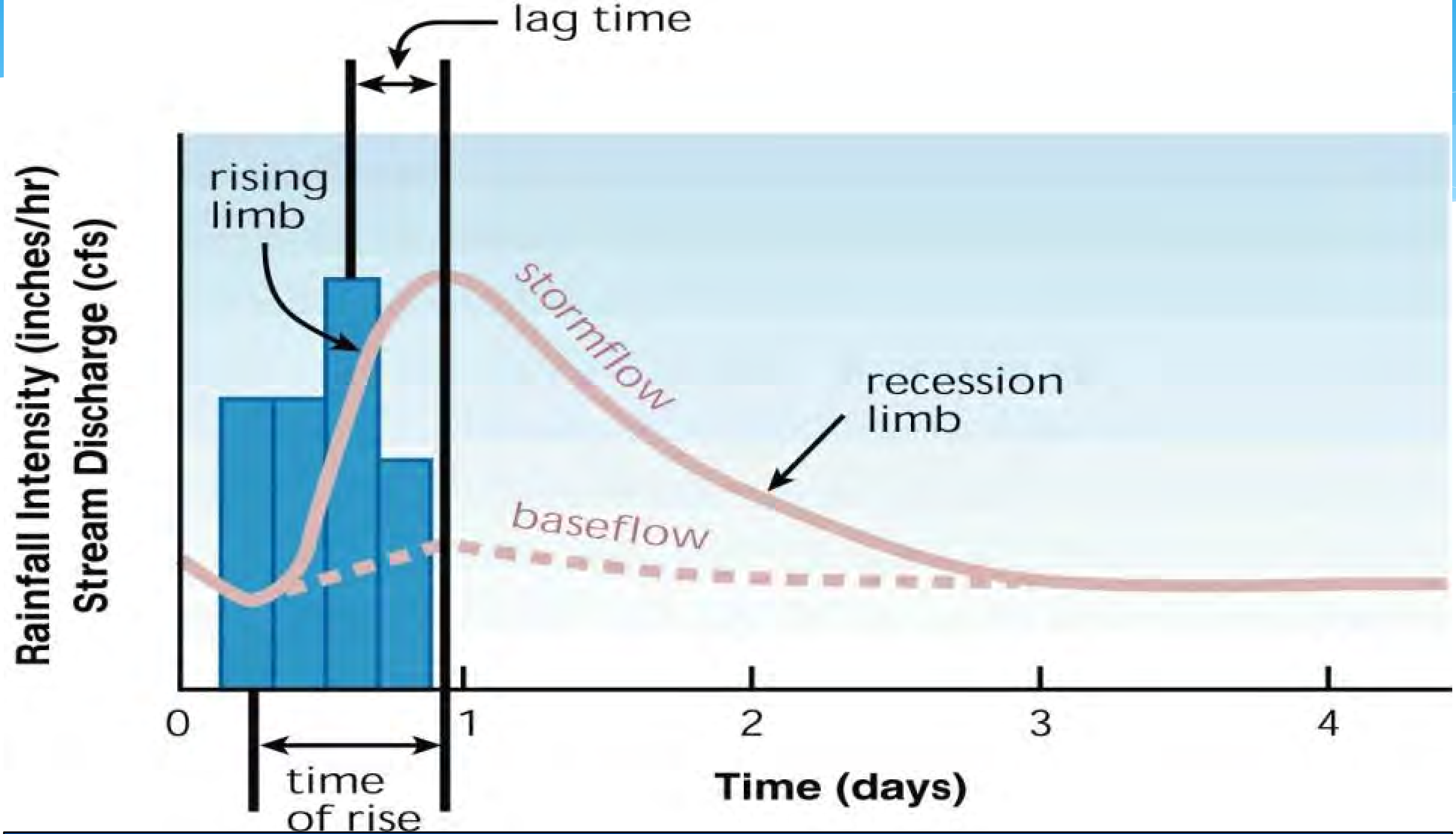
www.mass.gov

What's the Fuss?...
Its Only a Little Runoff!!

Stormwater Runoff

- Stormwater runoff is typically THE root cause of most eutrophication problems.
- Better stormwater management = less water quality problems
- Stormwater management should be key element of source water protection.

Rainfall/Stream Flow Relationship



Source: USDA/NRCS – Stream Restoration Handbook

Effect of Watershed Development On Storm Hydrograph

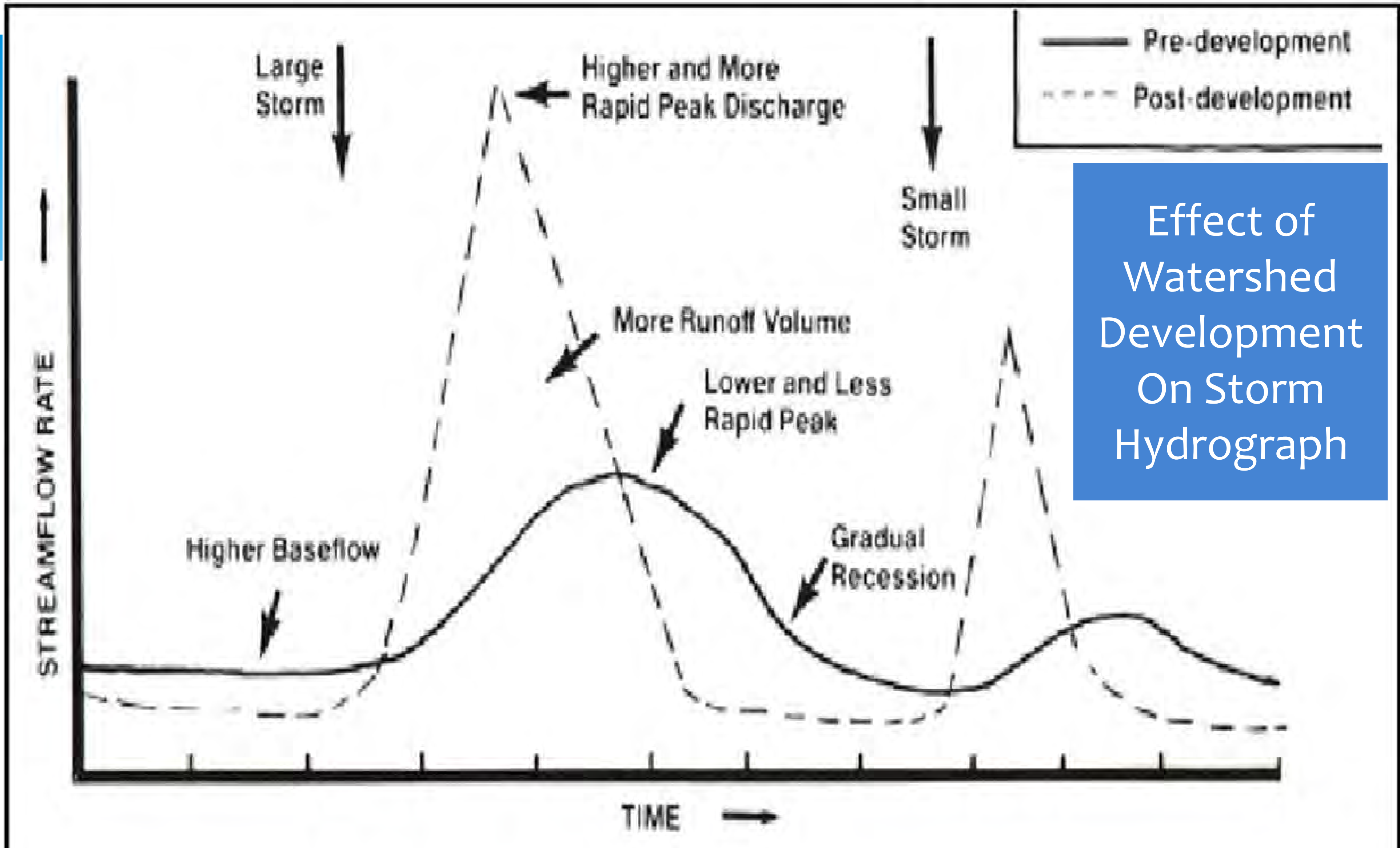
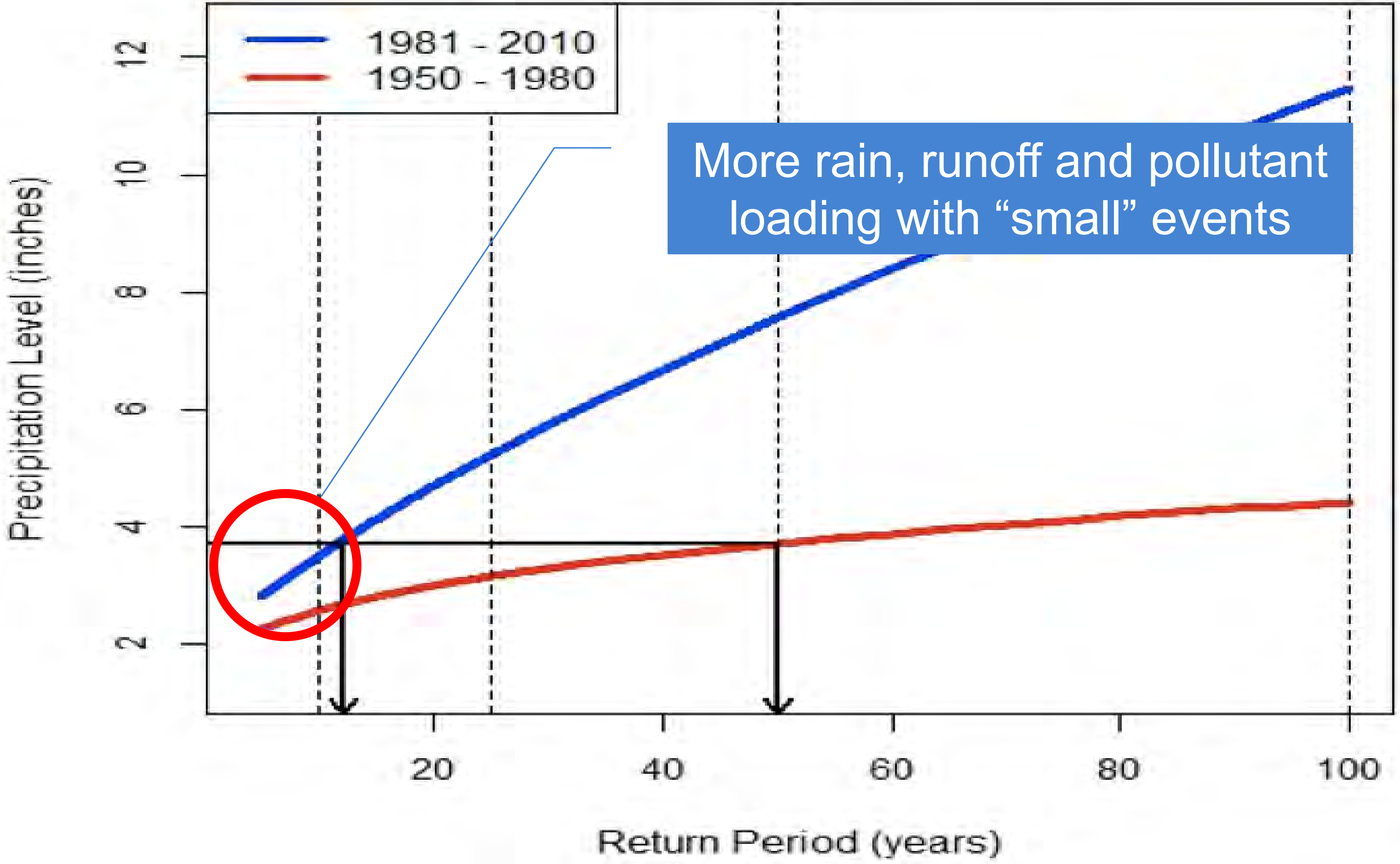


Figure 6: Altered Hydrograph in Response to Urbanization (Schueler, 1987)

CWC

Increasing Storm Frequency



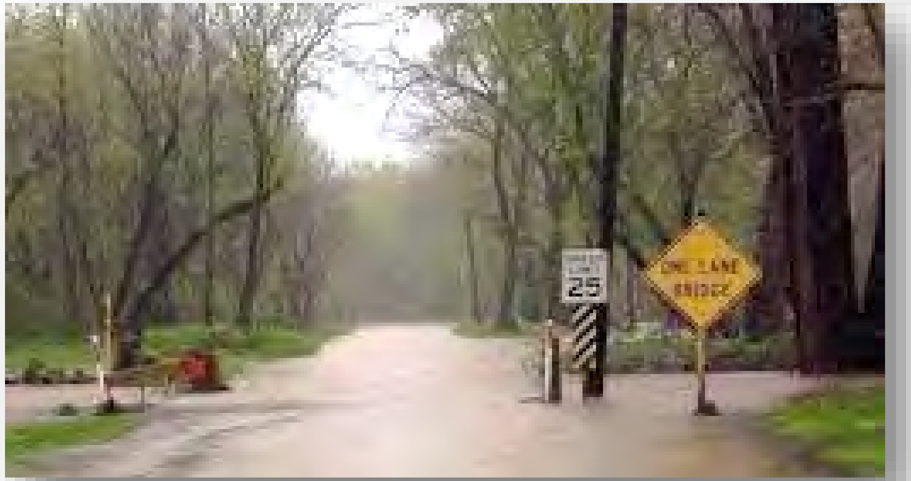
https://extension.umaine.edu/maineclimatenews/home/adapting-to-extreme-rainfall/

So Its Not Just The Extreme Events

- "Smaller", storms with greater return frequency (e.g., 0.5-yr, 1-yr and 2-yr events) now generate more rain and runoff.
- Increases opportunity to mobilize and transport pollutants, sediment and nutrients.
- Exacerbates environmental stress.
- Results in chronic, repeating impacts.

Flooding, Erosion, Eutrophication and Contamination

- All storms represent environmental risk
- Acute impacts - extreme events and flashy storms
- Chronic impacts - smaller, reoccurring events



Hydraulic Impacts

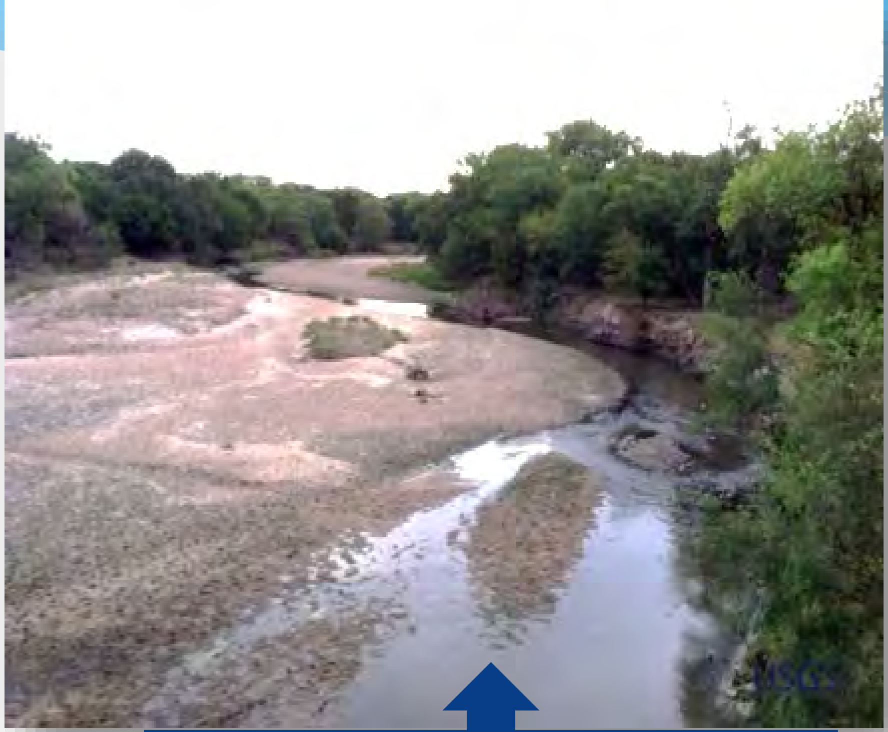
Erosion

Bank Subsidence

Too much water, too fast… function of rate (CFM)

Hydrologic Impacts

Flooding



Reduced Baseflow

Function of too much/too little volume (gallons, m^3, Ac-ft)

Water Quality Impacts

Over 70% of water quality problems in US due to non-point source pollution conveyed by SW runoff

Increases cost to produce quality potable water.

Altered Ecological Services and Functions

Eutrophication

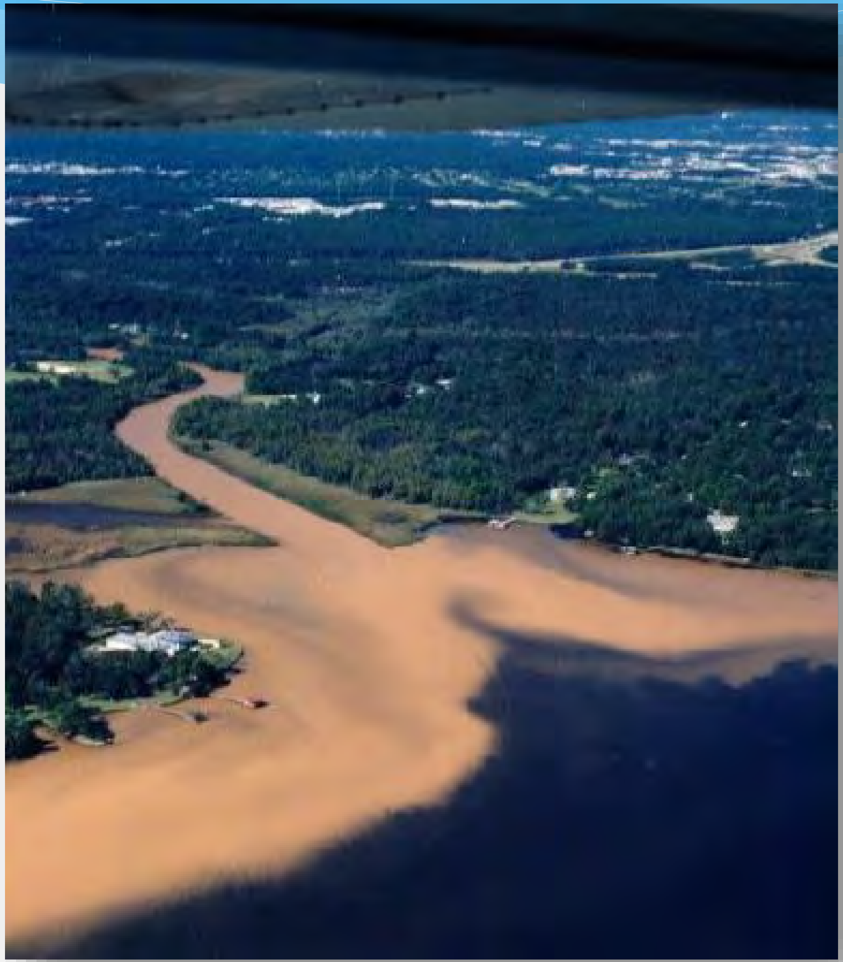
Fish Kills

HABs

Algae Toxins Prompt Toledo To Ban Its Drinking Water

August 3, 201410:31 AM ET

So Yes…A Little Runoff Can Create a Lot of Problems



It All Flows Downhill…

What happens in your watershed eventually effects your reservoir.

- Land development alters hydrology and hydraulics.
- Stormwater runoff mobilizes and transports nutrients, sediments and contaminants.
- Industrial, commercial and municipal wastewater discharges introduce additional contaminants.
- Septic system clusters another nutrient source.
- Agriculture generates nutrients and contaminants.
- Extreme events increase catastrophic, acute risks

Watershed Risk Management Plan

- Eutrophication Risks – Small Storms
  - Hydrologic load
  - Nutrient load
  - Sediment load
  - Septic Clusters
  - Trophic response

Chronic Impact

- Hazard Risks – Extreme Storms
  - Eroding Streams
  - Flooding of WWTPs, and Industrial, Chemical Storage and Contaminated Sites,
  - Failing Dams/Levees

Acute Impact

CWC

Reservoir Eutrophication

Accelerated by nutrient inputs, especially phosphorus

- Phosphorus and stormwater runoff
  - Dissolved, particulate, organic, and inorganic
  - Typical TP conc in SW 0.28 mg/L[1]
- The majority of nutrient and sediment loading is typically from external, watershed sources
- Less phosphorus loading = less eutrophication.
- Watershed management thus intrinsic to successful long-term protection of reservoir water quality.

[1]Yang & Toor. 2018. Scientific Reports 8:11681

Where Do I Start?
Thou Shall Know Thy Watershed!

- Boundary
- Topography
- Land cover
- Land use
- Hydrology
- Pollutant sources
- Pollutant load

Quantifying "Pollutant" Loads

Need to account for spatial and temporal variations

Focus on phosphorus, nitrogen and sediment

- Annual total watershed load
- Annual sub-watershed specific load
- Sub-watershed load by land use/source category
- Seasonal/Monthly sub-watershed load
- Manageable vs non-manageable load

Hydrologic Data

Water in… Water out

- Stormwater runoff, groundwater, and direct precipitation on reservoir surface.
- Affects:
  - Nutrient and sediment loading
  - Flushing rate / pollutant retention/ nutrient assimilation
  - Water column mixing and stability
- Need to quantify seasonally
- May want to quantify on storm-specific scale

Generating Hydrologic / Pollutant Loading Data

- Direct field data collection and sampling
- Indirect quantification and estimation
  - Stream Stat
  - USDA Soil Mapper
  - State GIS Land Use Data
  - UAL or MapShed Models
  - Various Trophic State Models

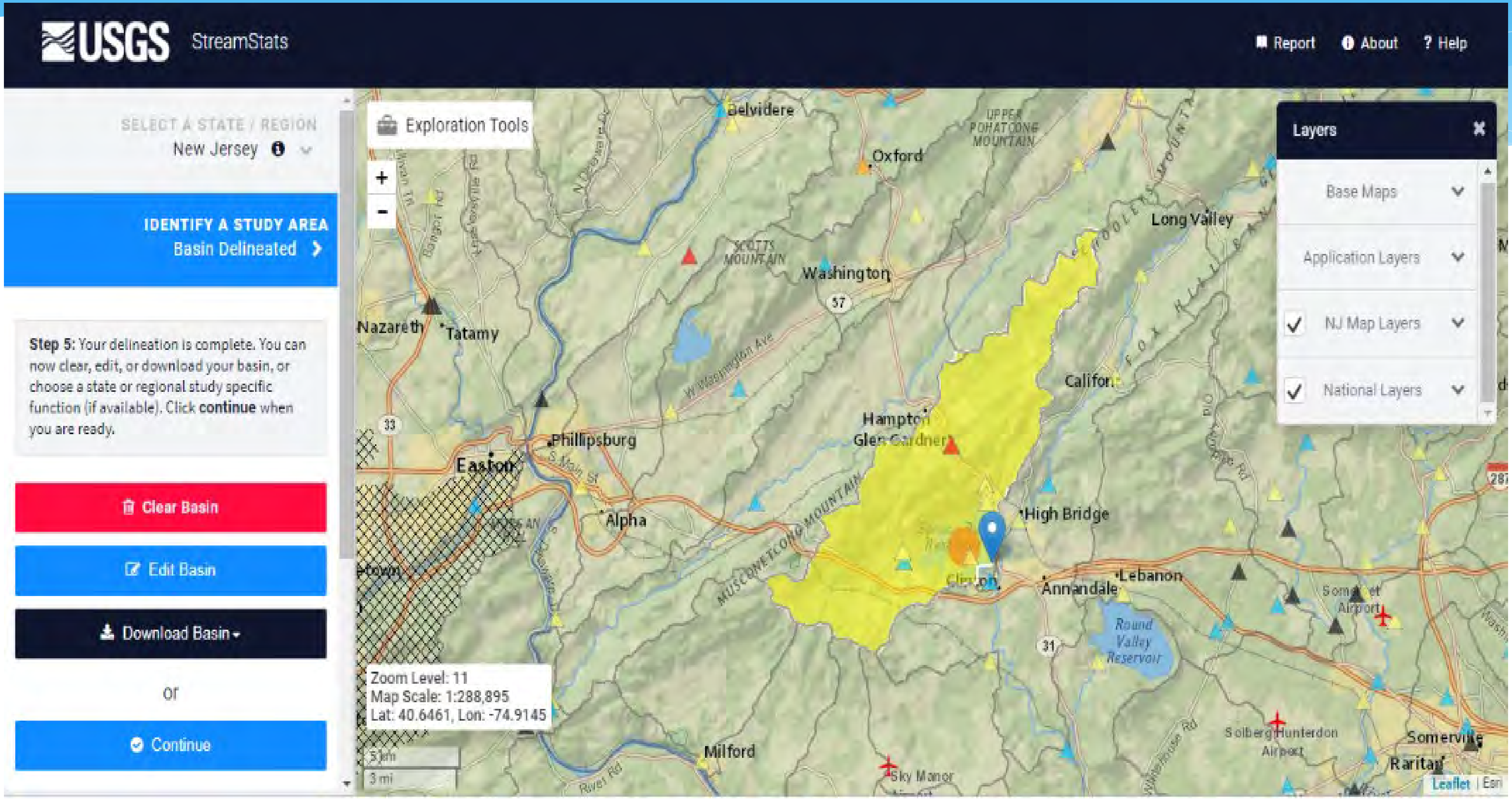
Watershed Mapping and Information Sources

- Stream Stat
  - https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools?qt-science_center_objects=0#qt-science_center_objects
- USDA Web Soil Survey
  - https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- NJDEP GeoWeb
  - https://www.nj.gov/dep/gis/geowebsplash.htm
- Climate Data – Rutgers State Climate Database
  - https://climate.rutgers.edu/stateclim_v1/nclimdiv/

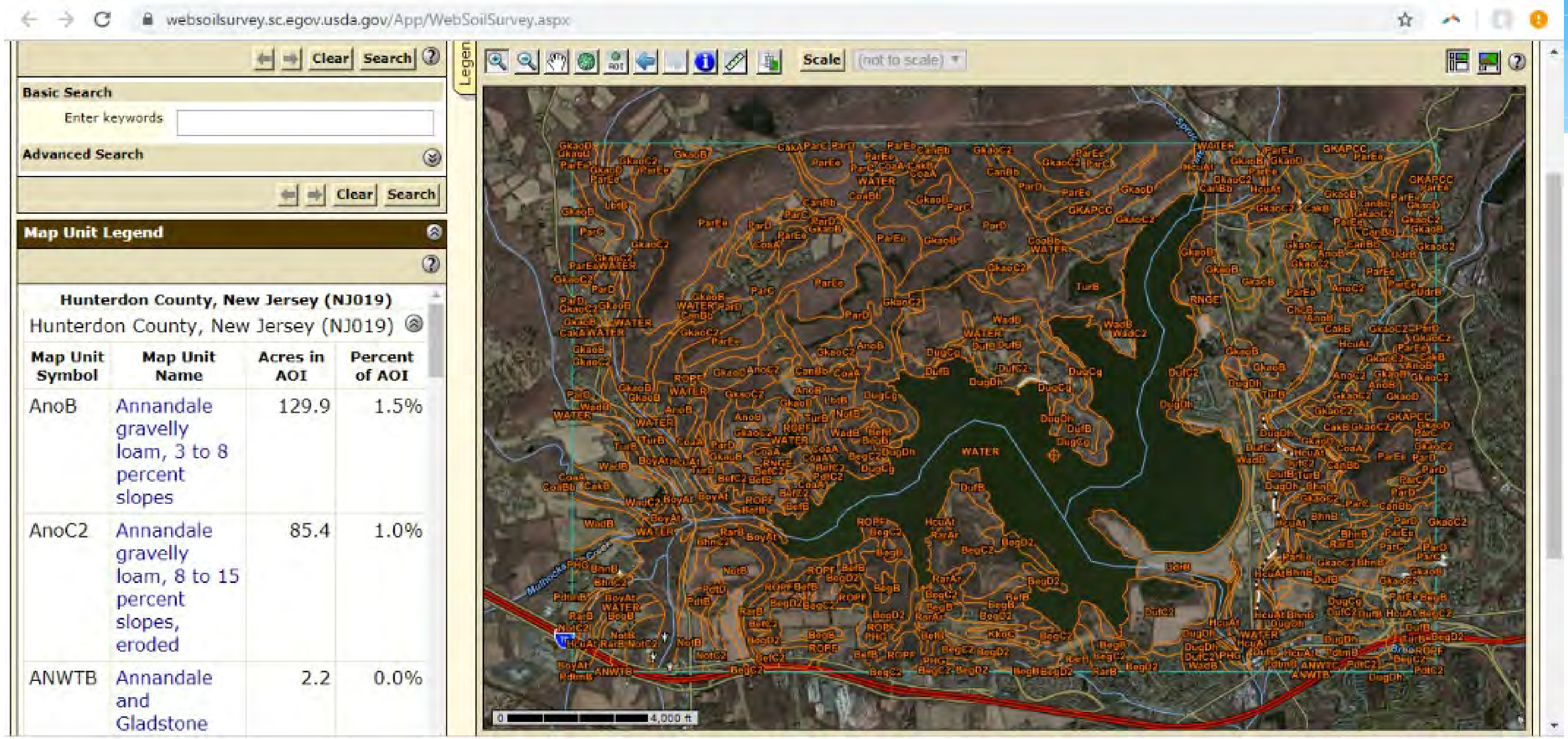
Essential Watershed Data

- Use StreamStat to delineate watershed and sub-watersheds
- Use USDA/SCS digital soil mapper to map primary soils and slope
- Map and quantify land use
- Compute monthly precipitation, evapotranspiration data using local climate data
- Synthesize data using pollutant loading and trophic state models

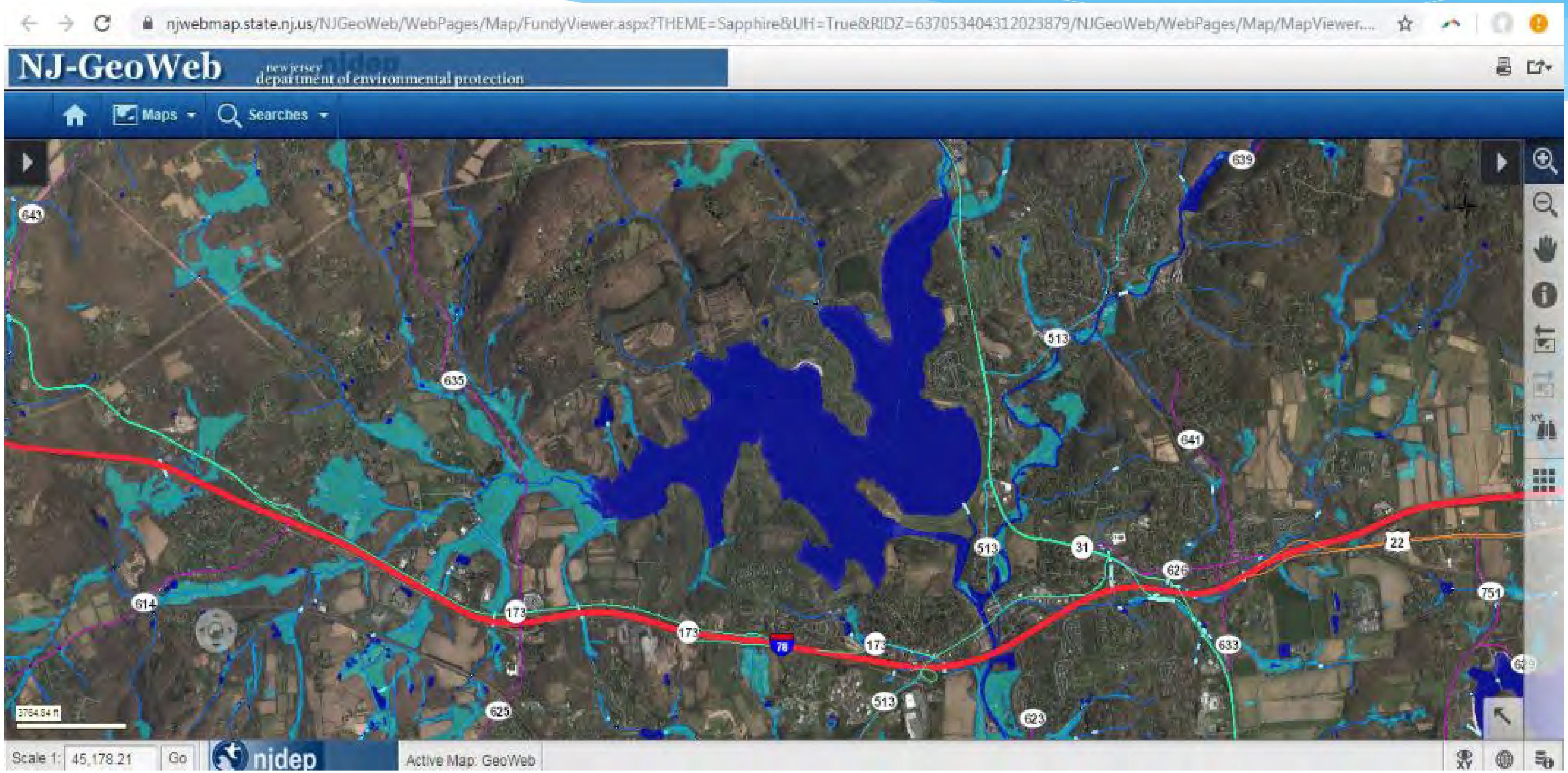
Watershed Delineated With StreamStats



Soils Mapped With USDA Soil Mapper



Land Cover, Wetlands and Streams Mapped with NJDEP GeoWeb



Rutgers Rainfall and Climatic Data

climate.rutgers.edu/stateclim_v1/nclimdiv/index.php?stn=NJ019&elem=pcpn

Monthly Climate Tables — Office of the NJ State Climatologist, Rutgers University

The National Centers for Environmental Information (NCEI) has launched a new divisional climate dataset called **nClimDiv**. This dataset replaces the traditional **Drd964x** values that NCEI and the ONJSC have used for many years.
[show more]

Select State/Division/County

Hunterdon County, NJ

NJ Climate Divisions Map

Select Element

Maximum Temperature
Minimum Temperature
Average Temperature
Precipitation

Legend

M — missing data
max value in a column
top 5 max values in a column
min value in a column
bottom 5 min values in a column

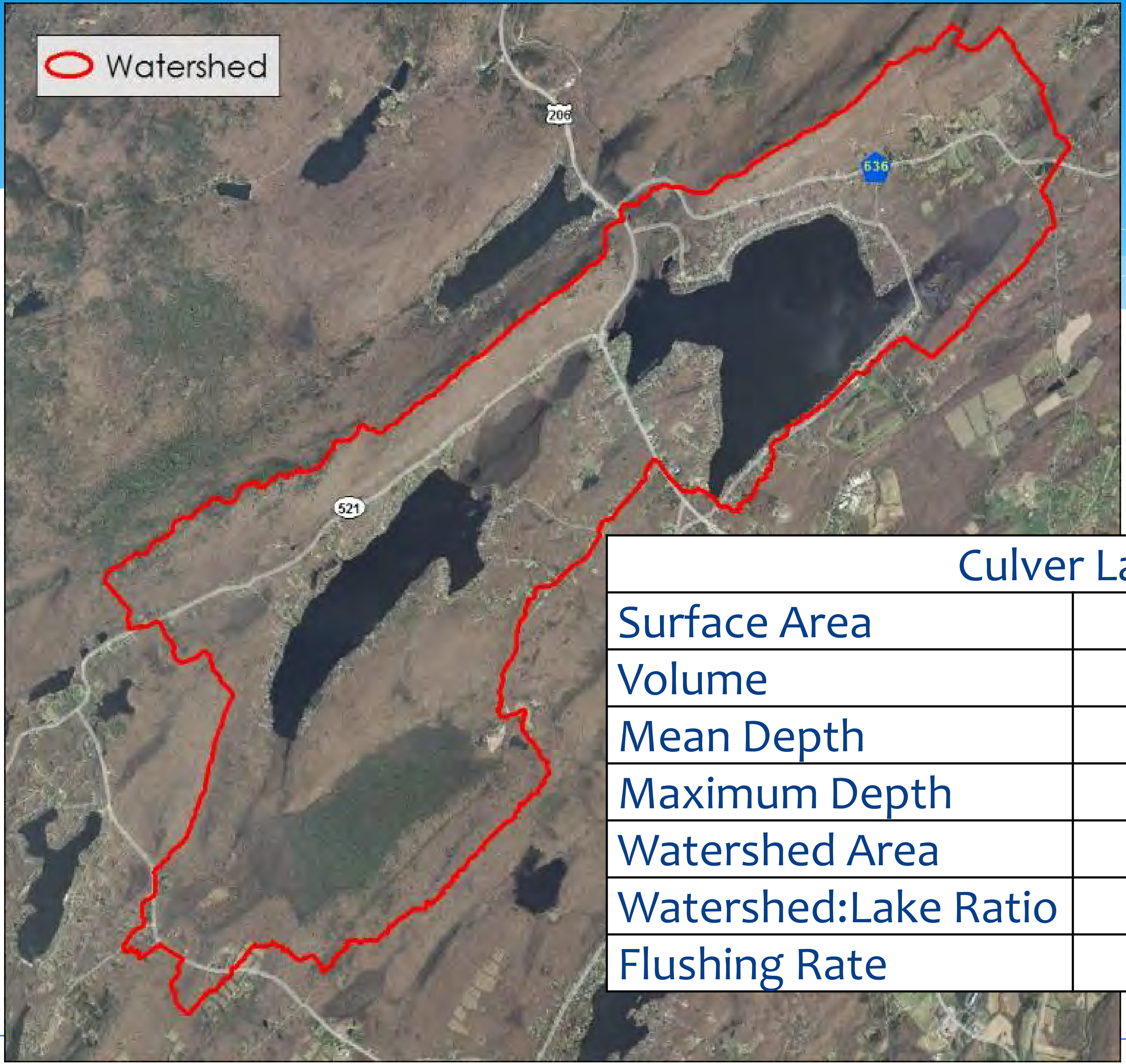
Data provided by... NCEI — National Centers for Environmental Information

Hunterdon County, NJ
Monthly Total Precipitation (in.)

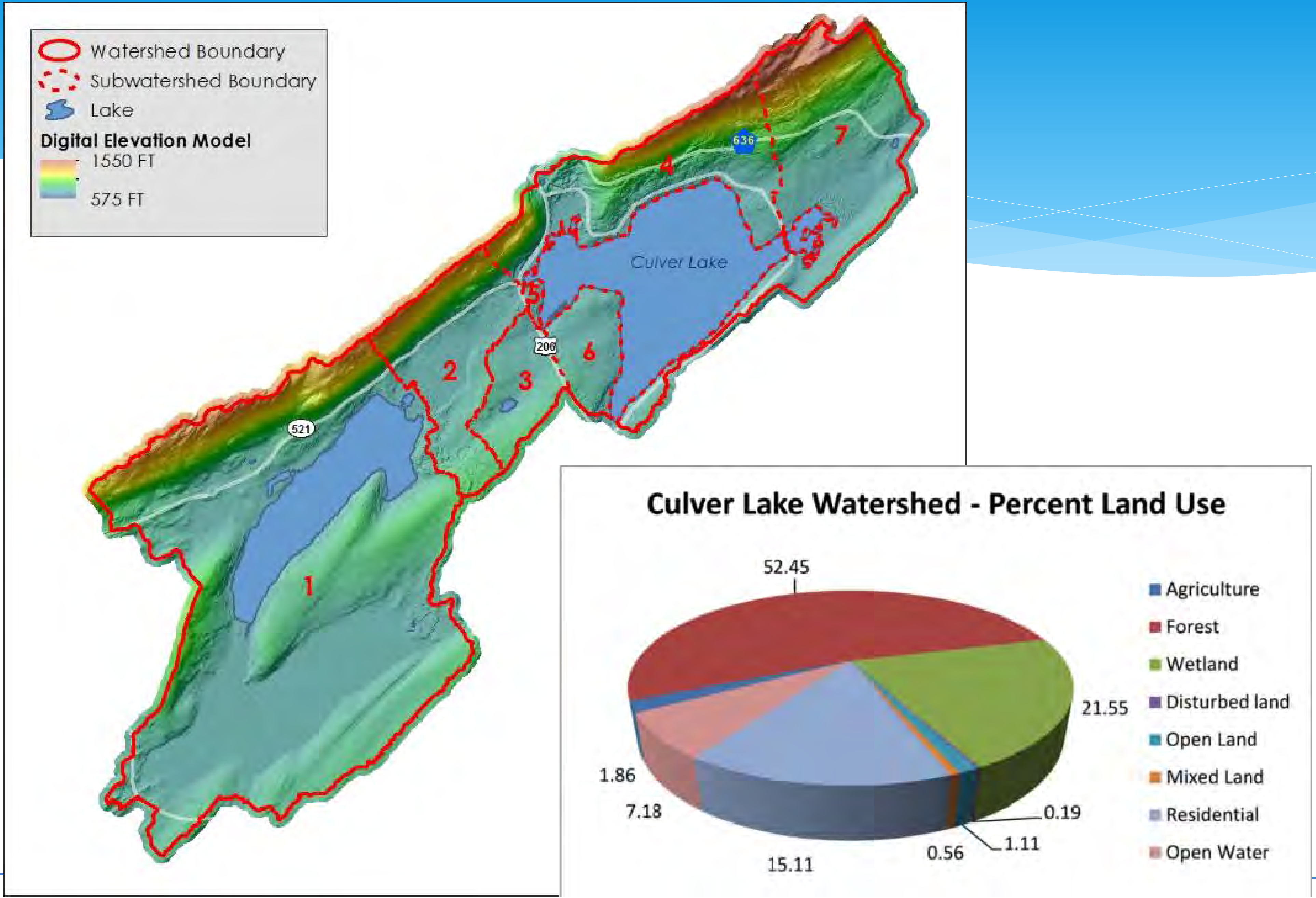
Rank	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	1895	3.92	1.20	2.89	4.71	3.14	3.94	4.65	2.72	0.83	4.32	3.10	2.98	38.40
2	1896	1.41	7.00	6.06	1.45	4.43	5.11	8.09	1.77	5.19	2.58	4.03	1.13	48.25
3	1897	2.70	3.19	2.98	3.96	7.46	3.73	10.93	4.74	2.20	1.78	5.69	5.11	54.47
4	1898	4.49	3.35	3.28	3.94	7.63	1.84	5.28	6.14	2.09	5.36	7.05	3.89	54.34

MapShed

- Created by Dr. Barry Evans, Penn State… managed by Stroud Institute
- GIS-based watershed modeling tool that integrates hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to model sediment and nutrient transport.
- Includes numerous analytical e.g., simulation of pathogen loads, pollutant transport processes in urban settings, and effectiveness of BMPs (using PreDICT module).
- Uses both spatial and "non-spatial" input parameters.
- https://wikiwatershed.org/help/model-help/mapshed/



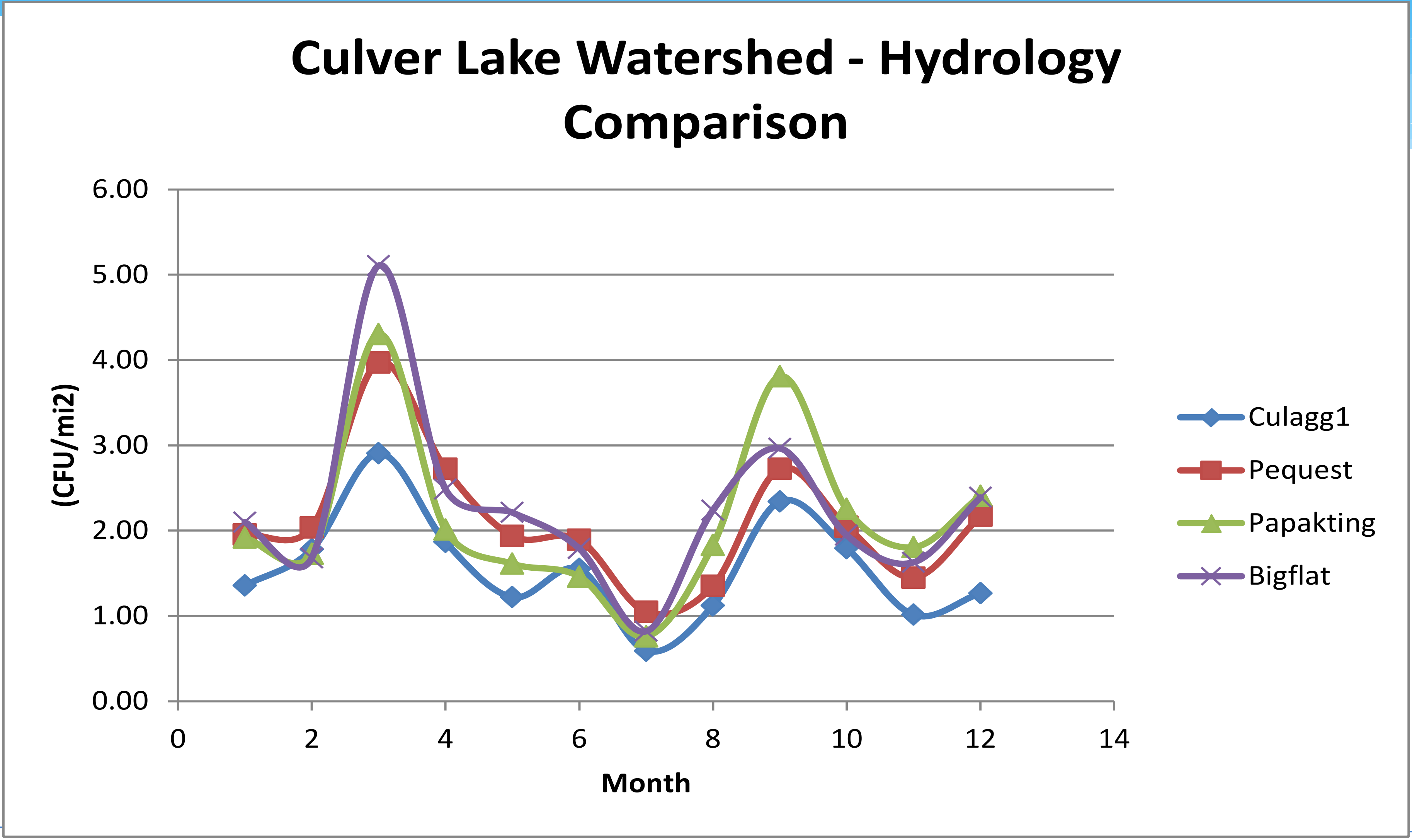
Culver Lake	
Surface Area	539 acres
Volume	5,275.5 x 10^6 gallons
Mean Depth	27 feet
Maximum Depth	55 feet
Watershed Area	3,991 acres
Watershed:Lake Ratio	7.4:1
Flushing Rate	2.47 years


Watershed Boundary
Subwatershed Boundary
Lake
Digital Elevation Model
1550 FT
575 FT
Culver Lake
1
2
3
4
5
6
7
521
206
636
Culver Lake Watershed - Percent Land Use
52.45
21.55
0.19
1.11
0.56
15.11
7.18
1.86
Agriculture
Forest
Wetland
Disturbed land
Open Land
Mixed Land
Residential
Open Water

Culver Lake Hydrologic Load
Ave Flow by Month by Watershed

Subwatershed	Area (ha)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	808	3.96	4.33	7.79	5.06	3.44	4.27	1.70	3.17	6.53	5.06	2.75	3.68
2	146	4.12	4.34	7.63	4.80	3.21	4.18	1.70	3.40	6.62	4.78	2.62	3.68
3	68	4.21	4.81	8.98	5.34	3.52	4.41	1.66	3.29	6.68	5.56	2.92	4.11
4	185	5.09	5.66	9.60	5.62	4.22	5.03	2.27	4.13	7.27	6.37	4.03	5.19
5	55	4.39	4.90	9.11	5.53	4.15	5.25	2.39	4.19	7.50	6.55	3.19	4.73
6	236	4.28	4.93	8.89	5.19	3.47	4.36	1.74	3.50	6.72	4.97	2.75	3.75
Aggregate	1499	3.97	4.75	8.51	5.29	3.57	4.39	1.73	3.28	6.64	5.25	2.87	3.71

Localized Flow Calibration of Modeled Data



MapShed Computed External Loading

Culver Lake - Pollutant Loading							
Subwatershed	Area (Ha)	Erosion kgx1000/yr	Sediment kgx1000/yr	Dis. N kg/yr	TN kg/yr	Dis. P kg/yr	TP kg/yr
1	808	177	15	2234	2537	83	117
2	146	41	2	371	426	14	20
3	68	4	4	210	290	10	16
4	185	75	28	660	930	35	66
5	55	4	10	225	360	14	27
6	236	1470	81	931	1573	32	157
Sum	1498	1771	140	4631	6116	188	403
Aggregate	1499	1833	148	4670	6150	185	391

Culver Lake – Phosphorus Loading Summary (Kg/Yr)

Source	TP (kg/yr)	% of Total
External NPS	255.2	12%
Internal Regeneration	831.4	41%
Direct Precipitation	71.4	4%
Septic Loading	866.7	43

Trophic State Models

- Vollenweider, R.A. 1968. Scientific fundamentals of the eutrophication of lakes and flowing water, with particular reference to nitrogen and phosphorus as factors in eutrophication. OECD, Paris, Tech Rpt DA 5/SCI/68.27, 250 pp.

- *P. J. Dillon, F. H. Rigler. 1975.* A Simple Method for Predicting the Capacity of a Lake for Development Based on Lake Trophic Status. **Journal of the Fisheries Research Board of Canada,** Vol. 32, No. 9 : pp. 1519-1531

$$TP_s = \frac{L(1-R)T}{Z_m}$$

TP_s = Predicted Spring TP Concentration g/m^3

L = Annual Areal P Load $g/m^2/yr$

R = P retention Coeficient

T = Hydraulic Retention Time yr^{-1}

Z_m = Mean Depth meters

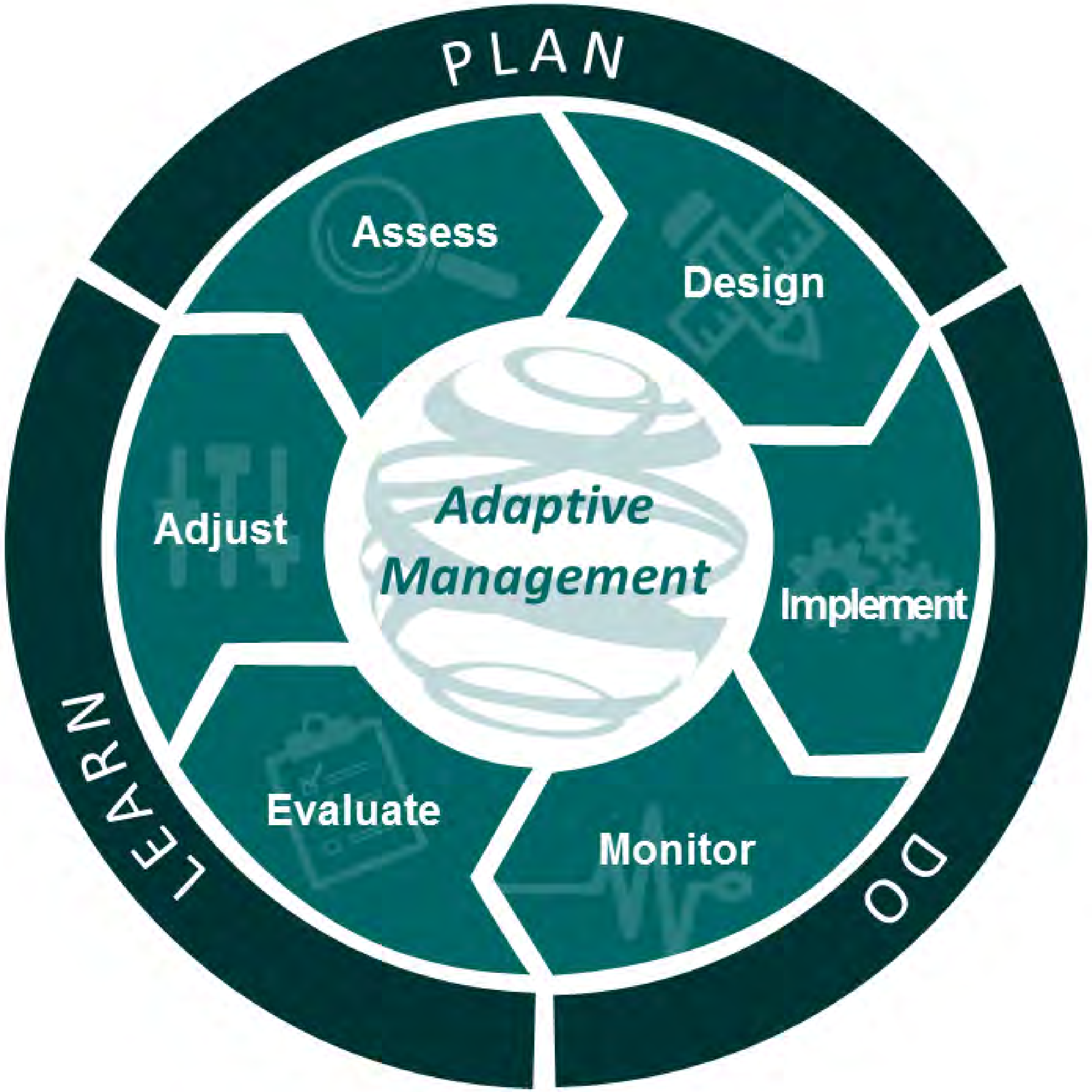
OK Steve… But How Do I Use This Information

Watershed management is a challenge for most surface water supply systems

- Scale… Large contributing watershed with multiple tributaries
- Lack direct control over the majority of the watershed
- No regulatory driver, requirement or support for watershed management or pollutant load reduction

Watershed Data Foundation of Adaptive Management

- Improves reservoir management decision making.
- Enables you to understand how reservoir raw water quality changes seasonally and how to respond to changing conditions.
- Understanding sources, quantity and timing of nutrient and sediment loading enables you to plan for the worst.
- Quantification of loading by source enables you to focus nutrient and sediment reduction strategies on major, chronic, or easiest sources to control.



https://essa.com/approach/ "Embrace Uncertainty"

React – Prevent, Control, and Reduce

Root Cause Management Actions

- Prevent - Limit P Loading (Internal and External)…SW Mgmt, Septic Mgmt, Internal Load Control (Nutrient inactivation, Aeration)

Responsive Management Actions

- Prevent/Control – Nutrient inactivation, Aeration, Biomanipulation
- Reduce – Algaecides, Sonic devices

Working With the Watershed Community

- Seek watershed management and stream restoration funding.
- Education and outreach:
  - Green infrastructure SW management.
  - Septic management.
- Participant in grant applications.
- Provide independent source of funding:
  - Green infrastructure rebates.

In Summary

- What happens in your watershed is often the major driver of reservoir eutrophication and eutrophication related problems including HABs.
- Development increases runoff which increases eutrophication risks to your reservoir.
- Knowing your watershed entails quantification of external nutrient, sediment and hydrologic loads.
- Resulting data should help identify major risks to raw water quality and prioritize management decisions.
- Overall goal is to be proactive not reactive.
- Maximizing raw water quality minimizes in-plant treatment.

Thank You… Questions
Stephen J. Souza, Ph.D.

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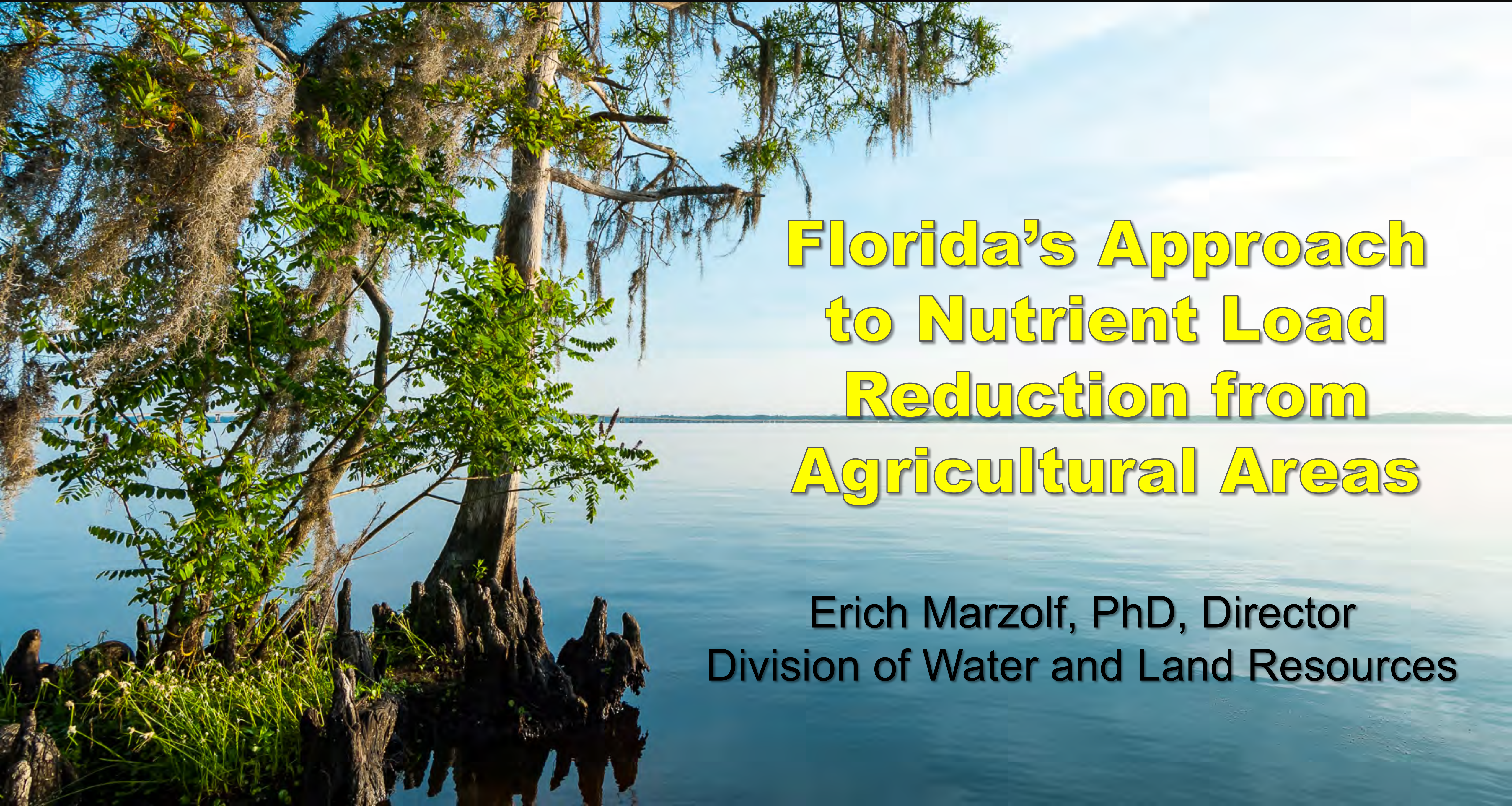
CWC

CWC

2nd Presentation

Dr. Erich Marzolf is the Director of the Division of Water and Land Resources with the St. Johns River Water Management District where he oversees data collection, land management and ecosystem restoration planning.

In this role he works on integrating aquatic and terrestrial restoration and management efforts to meet the District's core missions.



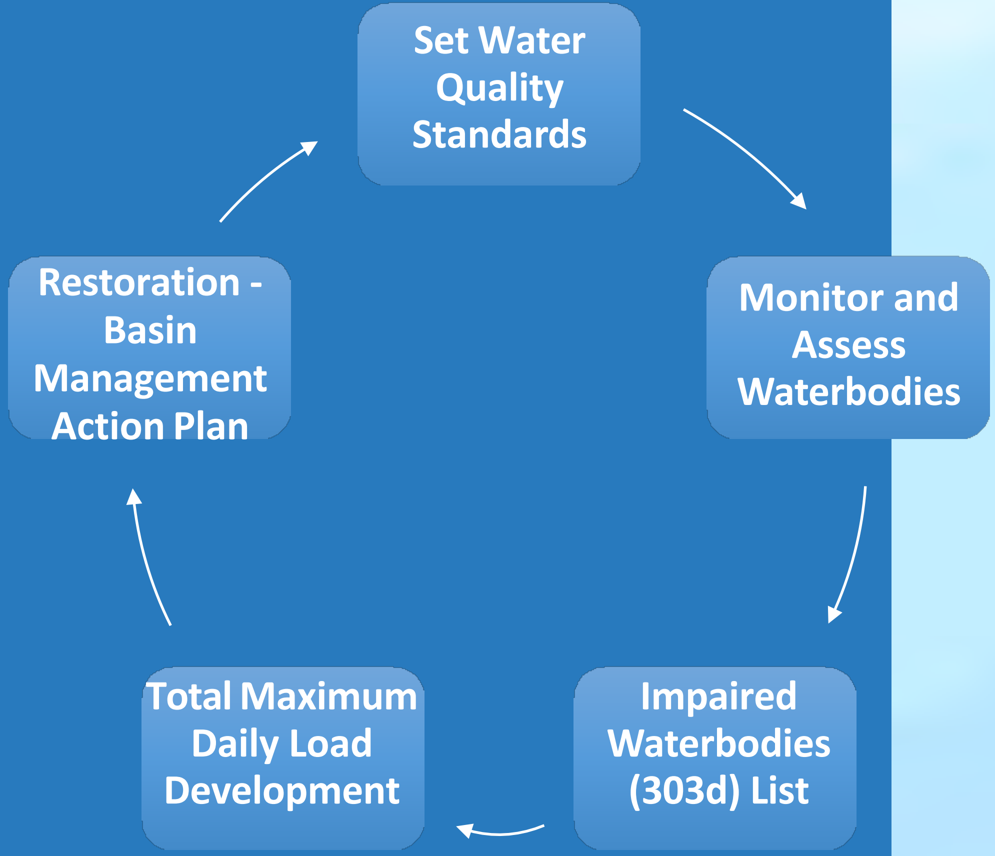
Florida's Approach to Nutrient Load Reduction from Agricultural Areas

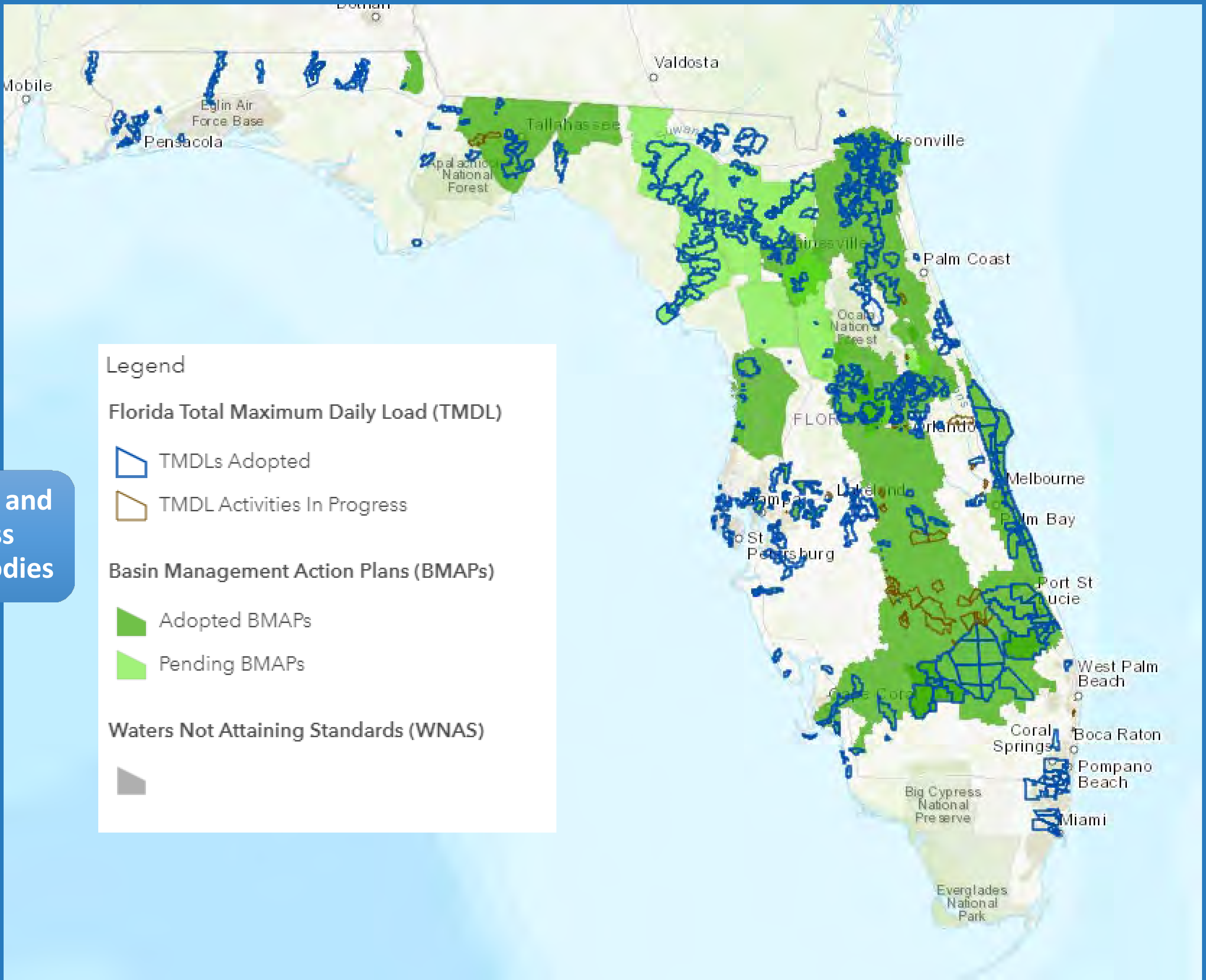
Erich Marzolf, PhD, Director
Division of Water and Land Resources

Florida's Multi-Scale Approach To Nutrient Load Reduction from Agriculture

- On the Farm
  - Ag BMPs
  - Advanced BMPs (not in manual), not obligatory but cost-share eligible
- Change in Farming
  - Crop Conversion
  - Buyout
- Regional Treatment
  - Dispersed Water Treatment – Public payment for treatment on Private Land
  - Government Treatment System on Public Land
  - Integration with large USACOE Flood Control Projects

Florida's Water Quality Status

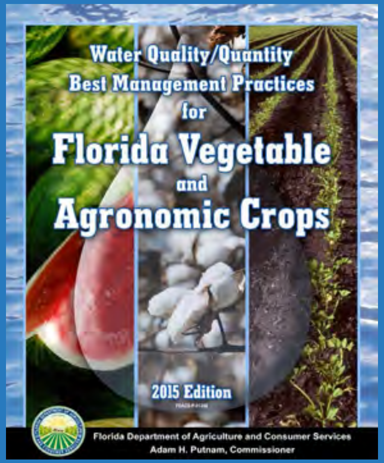


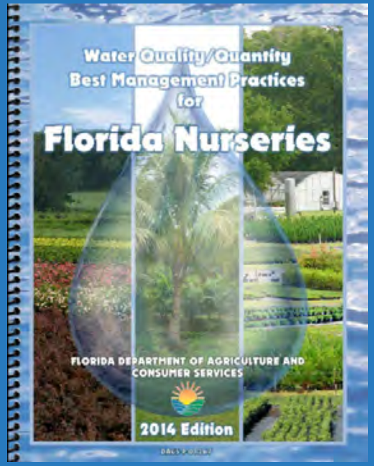


~~Best~~ Better Management Practices (BMPs)

Once a BMAP is adopted growers in watershed must sign a Notice of Intent to

- Monitor and demonstrate runoff is not contributing to problems, or
- Implement measures in appropriate BMP Manual

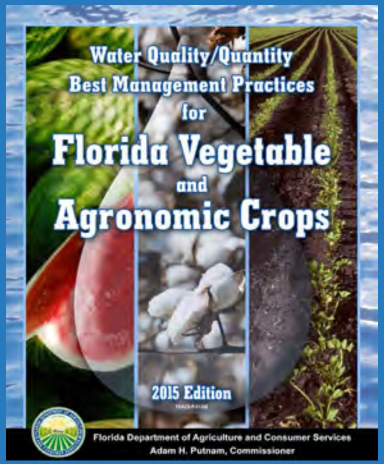


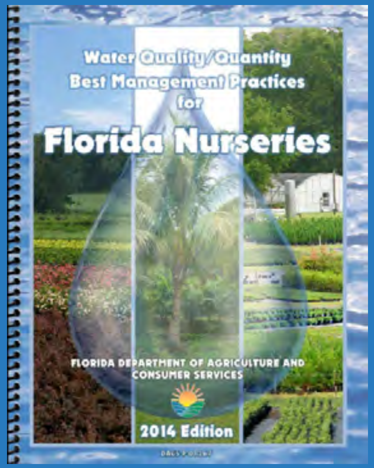


BMP Manuals

Two categories:

- Nutrient management
  - Amount, timing, placement and type of fertilizer
- Irrigation management
  - Maintenance, scheduling and overall efficiency rating of irrigation systems
- Living Documents = Evolving





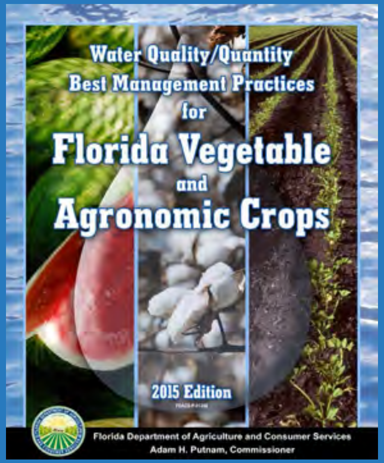
fdacs.gov/Agriculture-Industry/Water/Agricultural-Best-Management-Practices

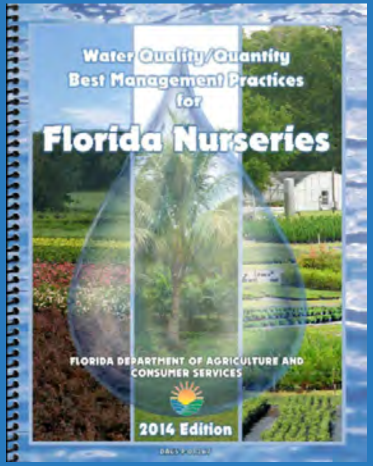
BMPs

- BMPs are practical measures that reduce the amount of fertilizers, pesticides, animal waste, and other pollutants entering our water resources
- BMPs must be economically and technically feasible for the producer to implement
- Developed by the Florida Department of Agriculture and Consumer Services
- Verified by the Florida Department of Environmental Protection

Ag BMP Limitations

- Not Site Specific
- Not Designed to Meet Specific Water Quality Goals
- Do Not Obligate a Specific Load Reduction Allocation
- Therefore,
  - Watersheds with extensive Ag,
  - Atypical conditions,
  - WQ goals may not be met by BMPs alone





Florida's Multi-Scale Approach To Nutrient Load Reduction from Agriculture

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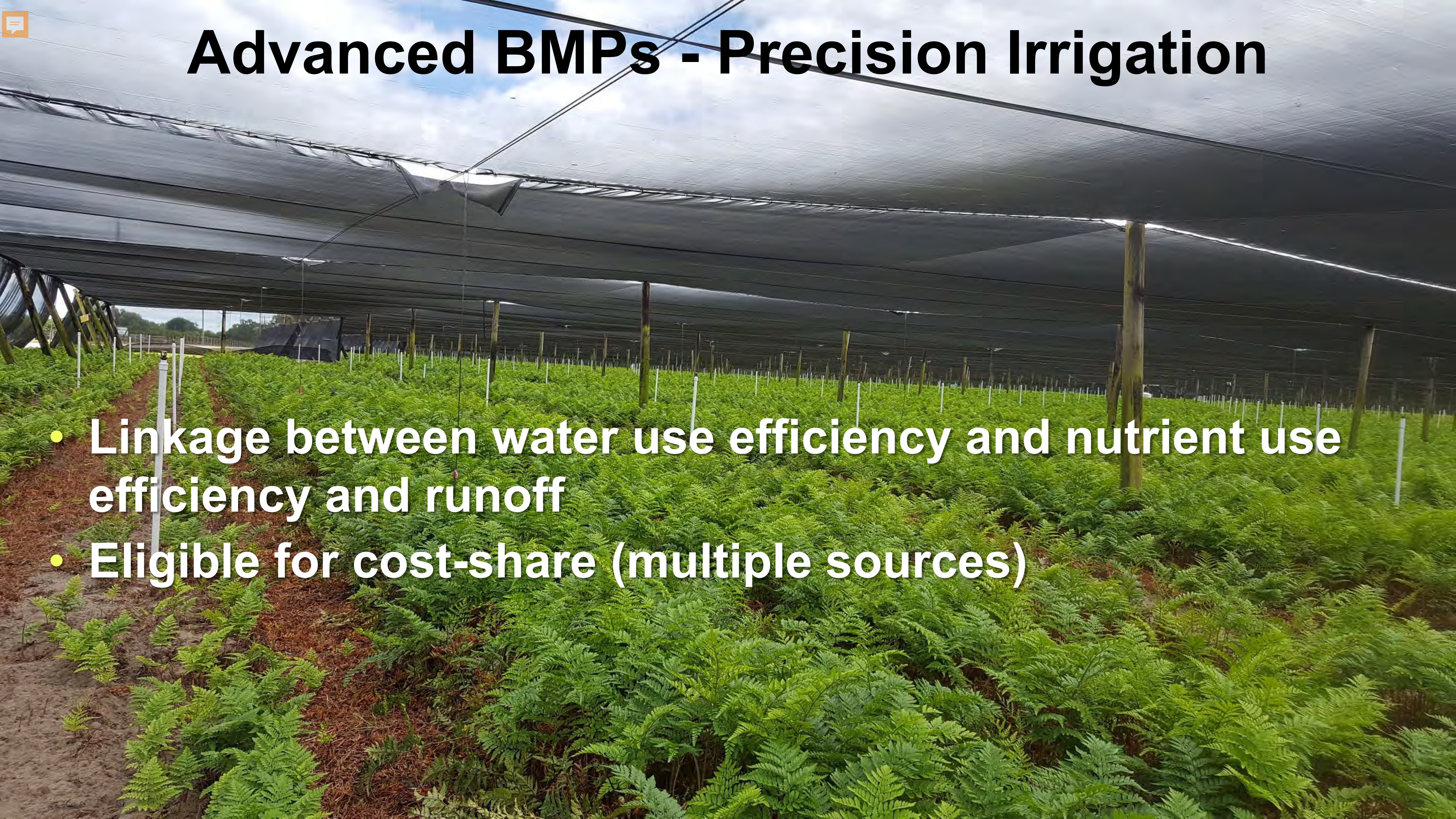
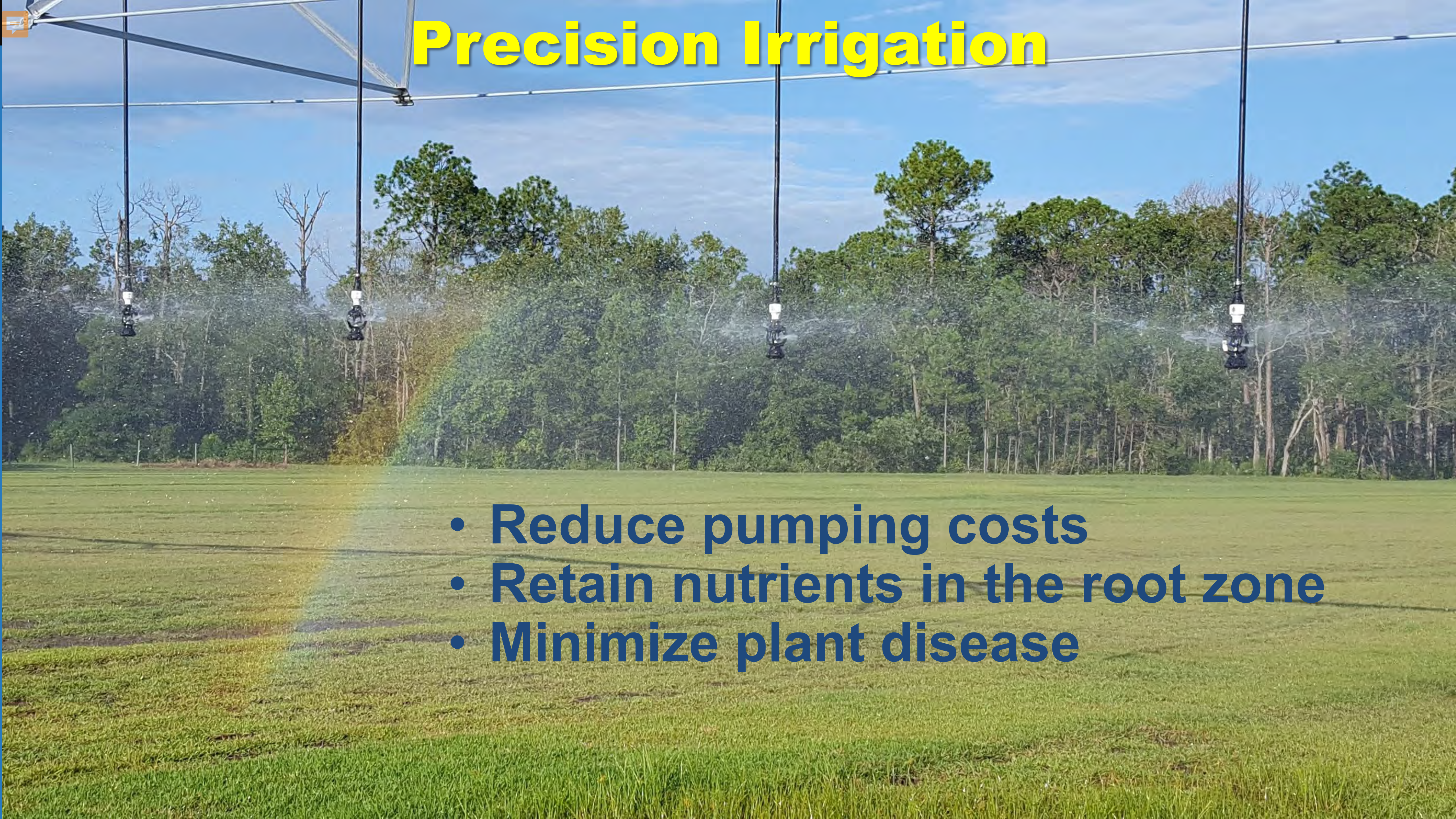
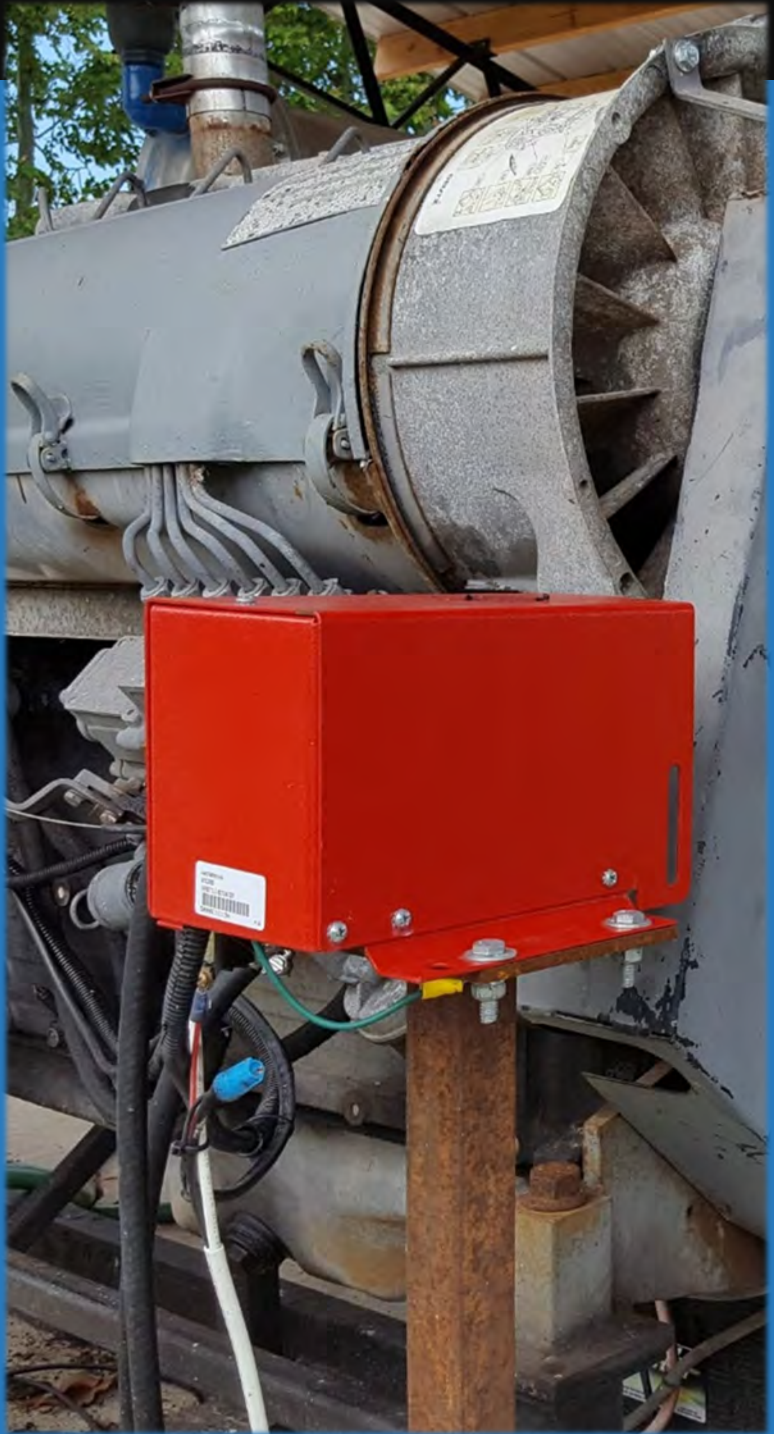
Advanced BMPs - Precision Irrigation



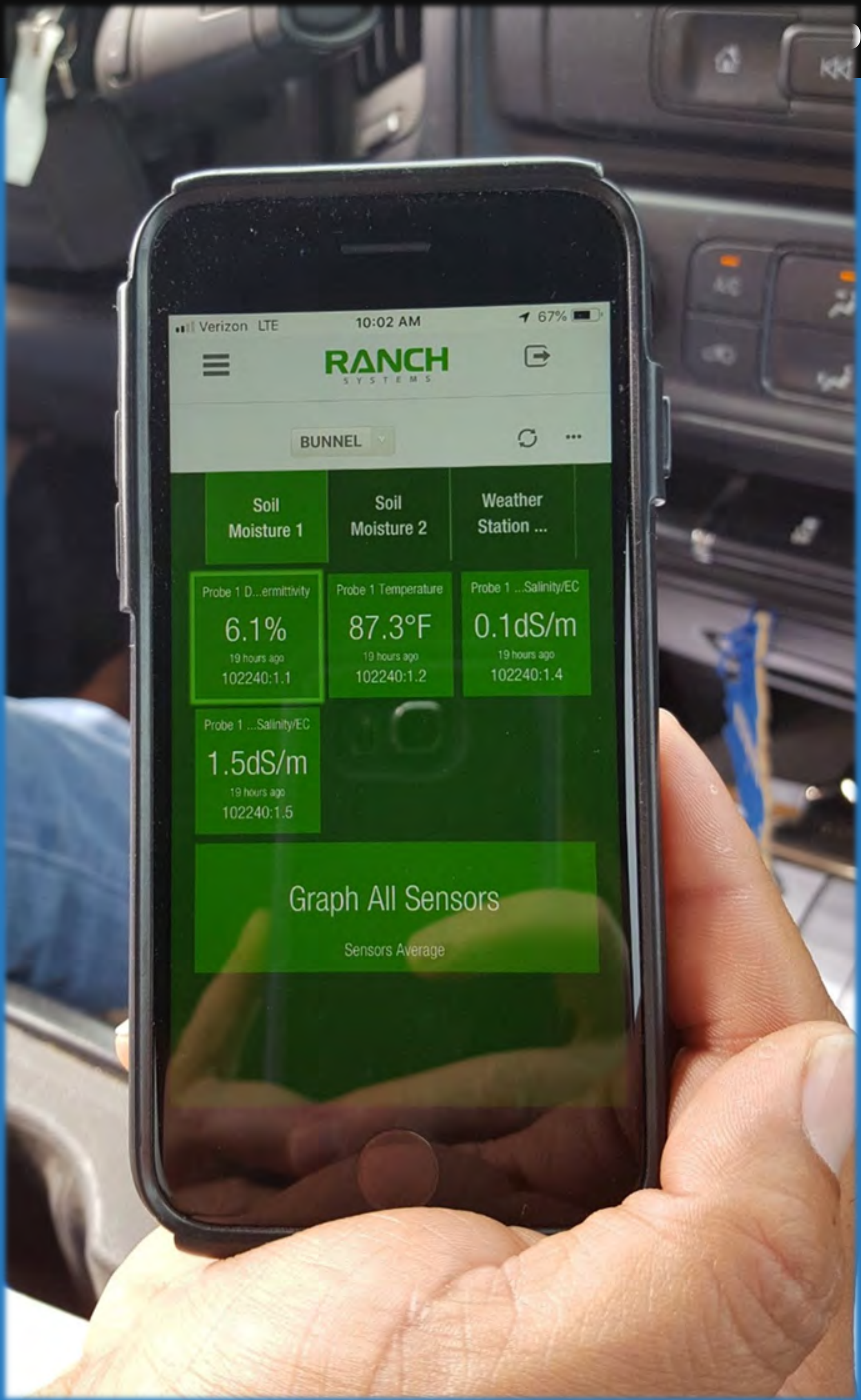
- Linkage between water use efficiency and nutrient use efficiency and runoff
- Eligible for cost-share (multiple sources)

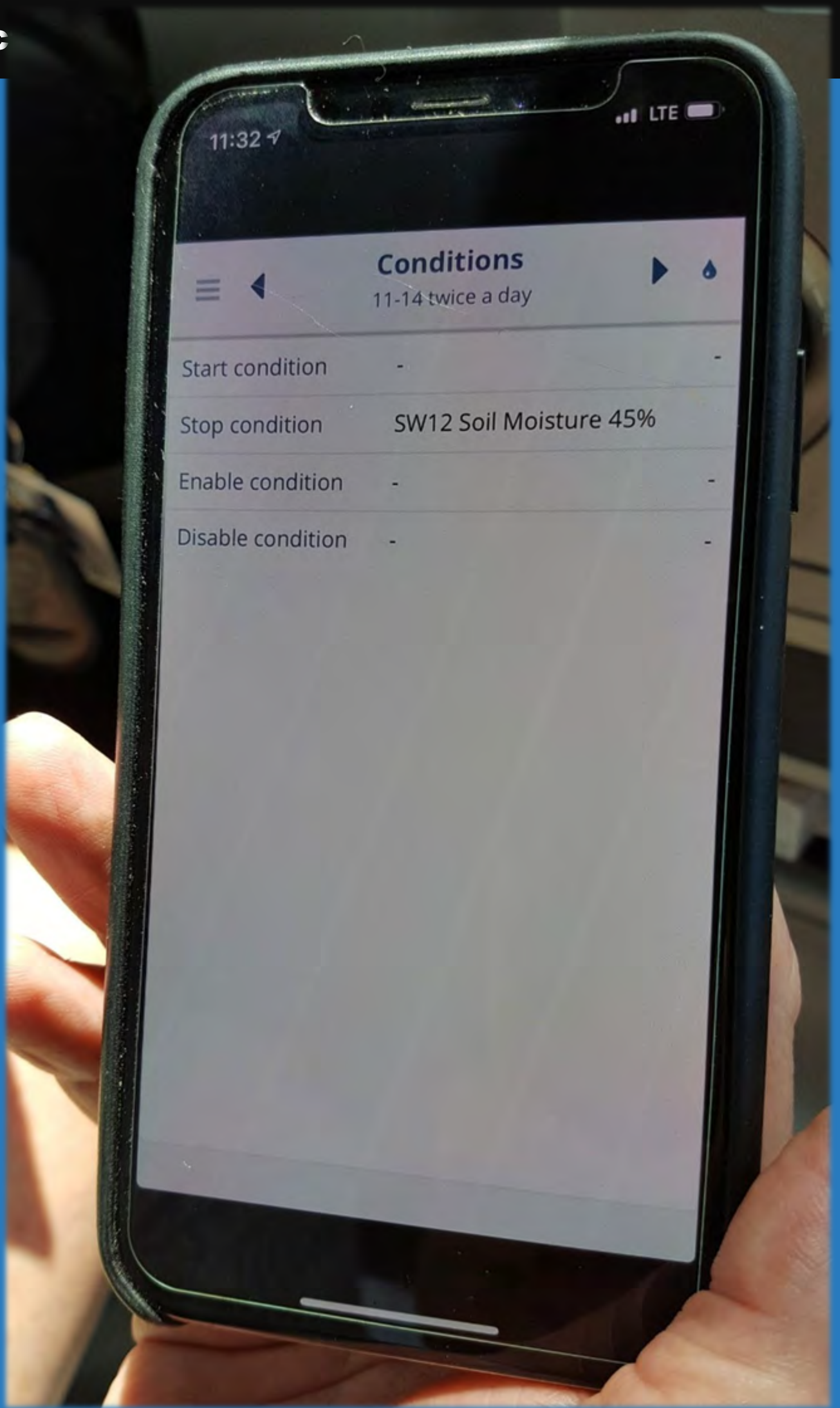

Precision Irrigation
• Reduce pumping costs
• Retain nutrients in the root zone
• Minimize plant disease


St. ct



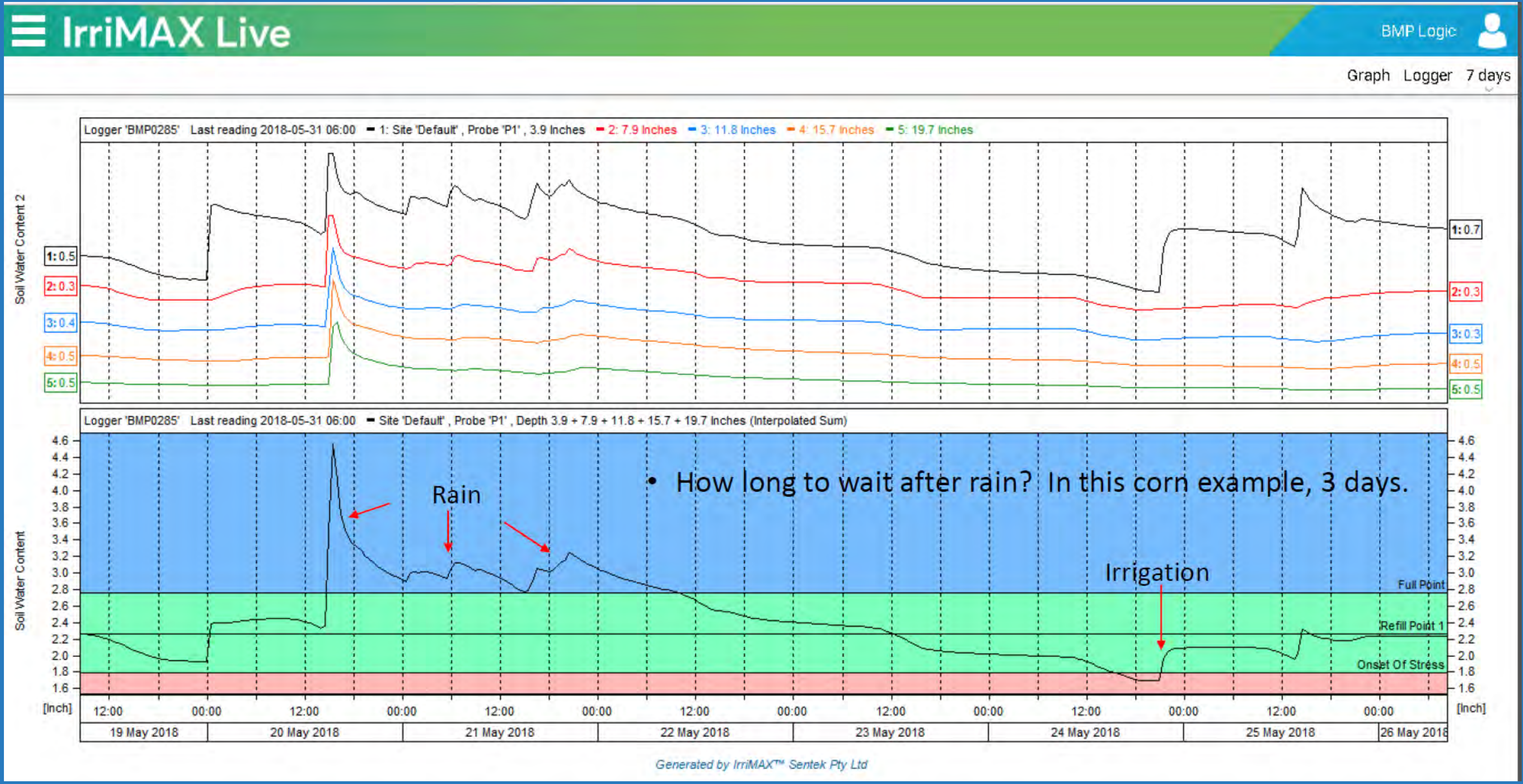
Distric


Verizon LTE
10:02 AM
67%
RANCH
SYSTEMS
BUNNEL
Soil Moisture 1
Soil Moisture 2
Weather Station ...
Probe 1 D...ermittivity
6.1%
19 hours ago
102240:1.1
Probe 1 Temperature
87.3°F
19 hours ago
102240:1.2
Probe 1 ...Salinity/EC
0.1dS/m
19 hours ago
102240:1.4
Probe 1 ...Salinity/EC
1.5dS/m
19 hours ago
102240:1.5
Graph All Sensors
Sensors Average

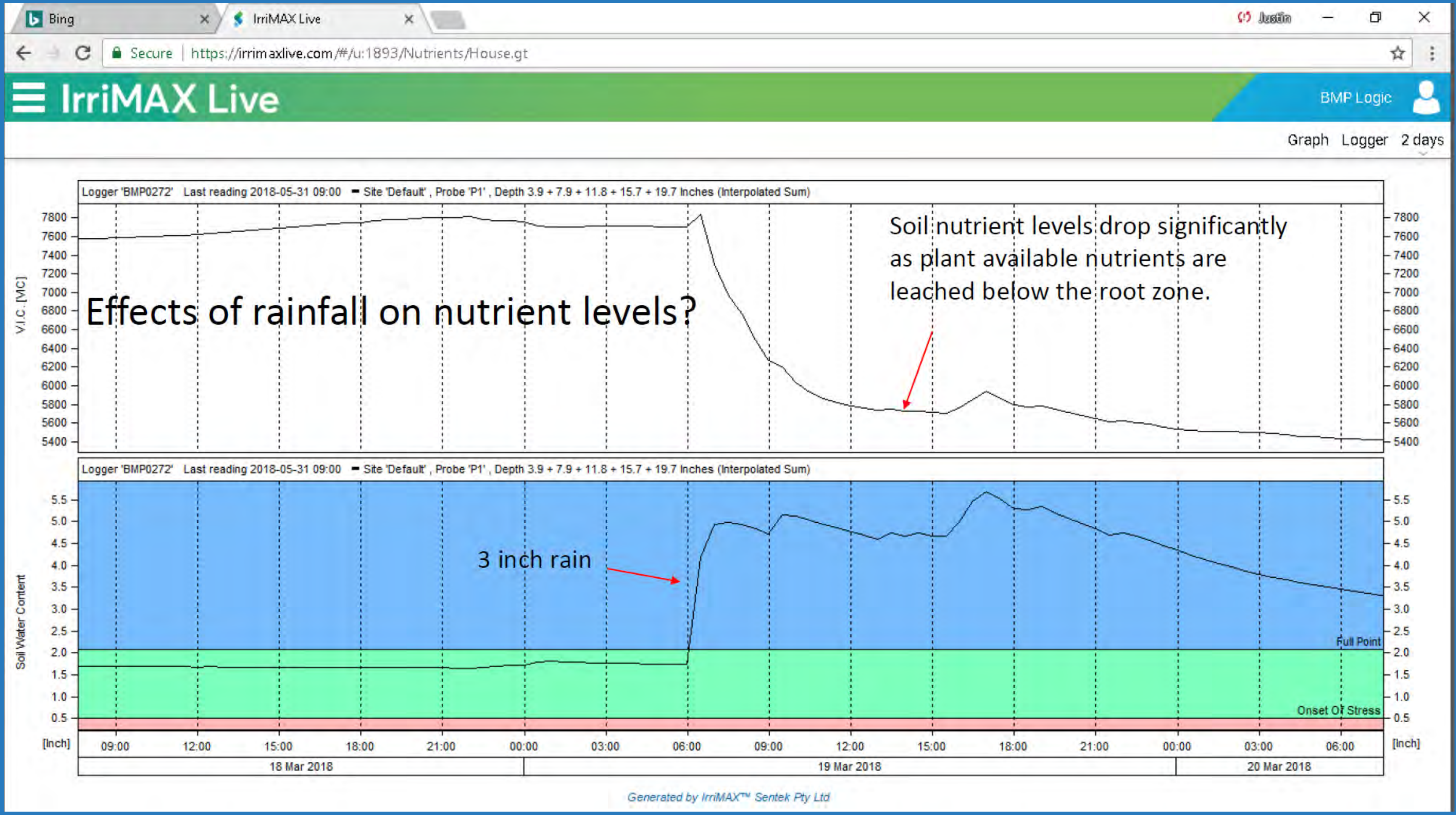

11:32
LTE
Conditions
11-14 twice a day
Start condition -
Stop condition SW12 Soil Moisture 45%
Enable condition -
Disable condition -

S ict

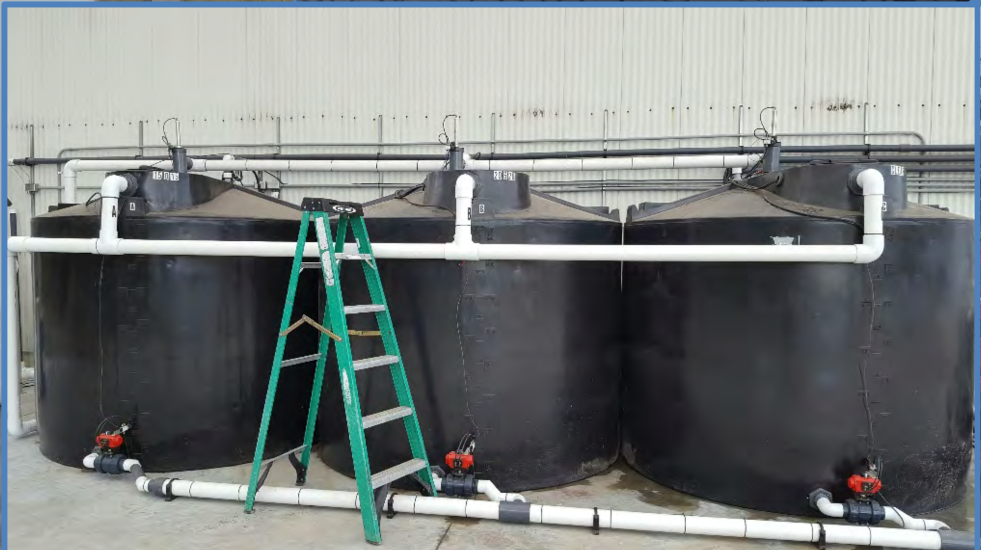
Soil Moisture — Smarter Irrigation



Smarter Irrigation — Less Nutrient Loss




Flow Filter







Precision Fertilizer Application

CC-Eye Tree Sense Technology and Variable Rate Fertilizer Application

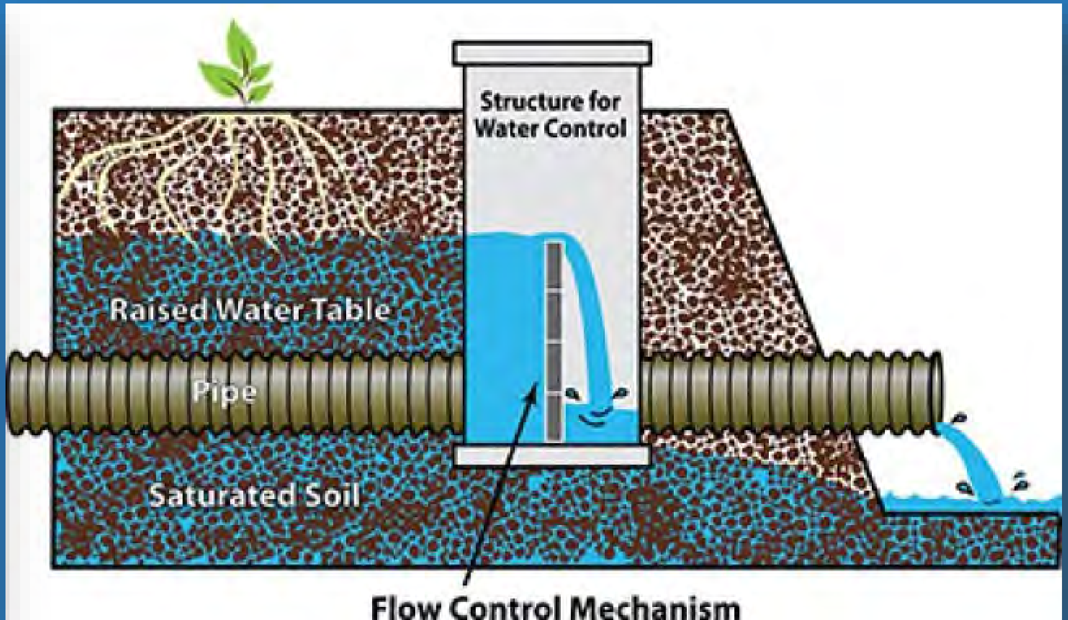
St. Johns River Water Management

Field Fertility Mapping and Precision Fertilization

St. Johns River Water Management District

Seepage Irrigation Conversion

Sub-Irrigation Drain Tile



Edge of Field Denitrification Bioreactor

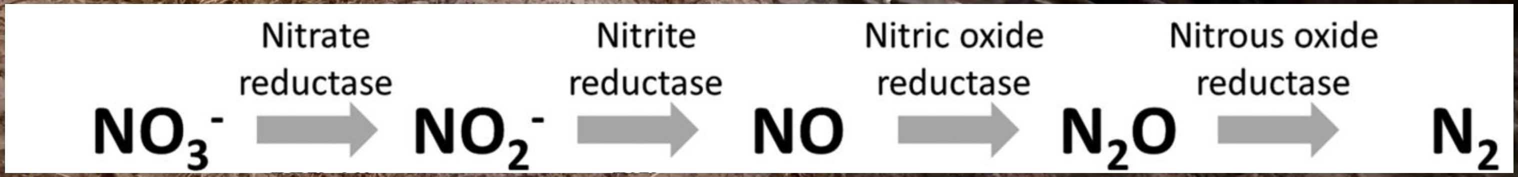
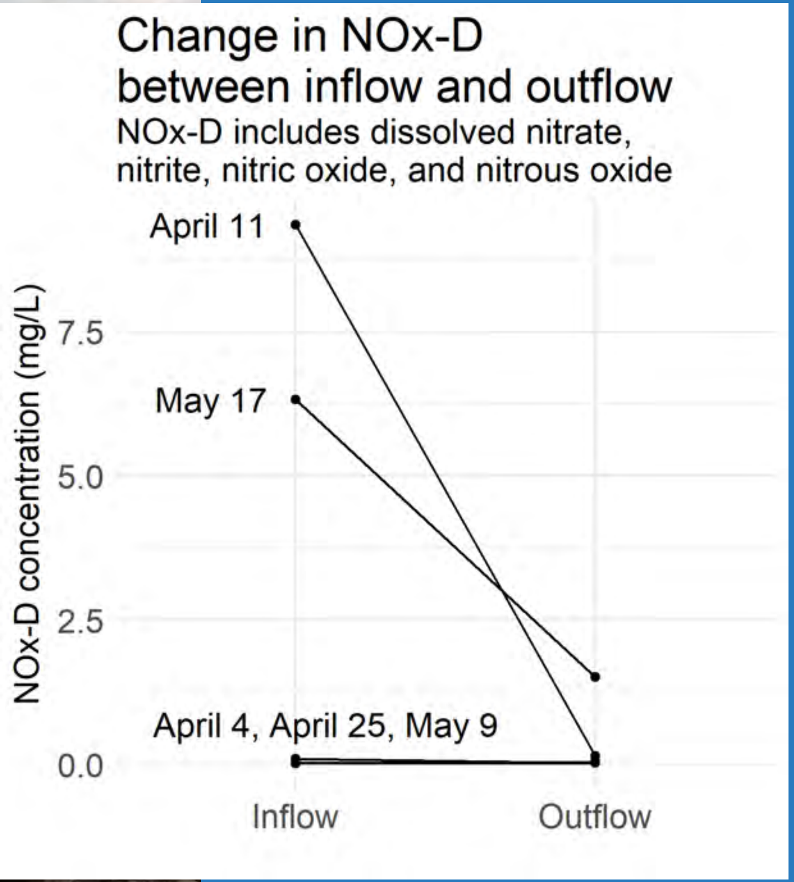


Diagram from Laura Alvarez et al. Appl. Environ. Microbiol. 2014;80:19-28



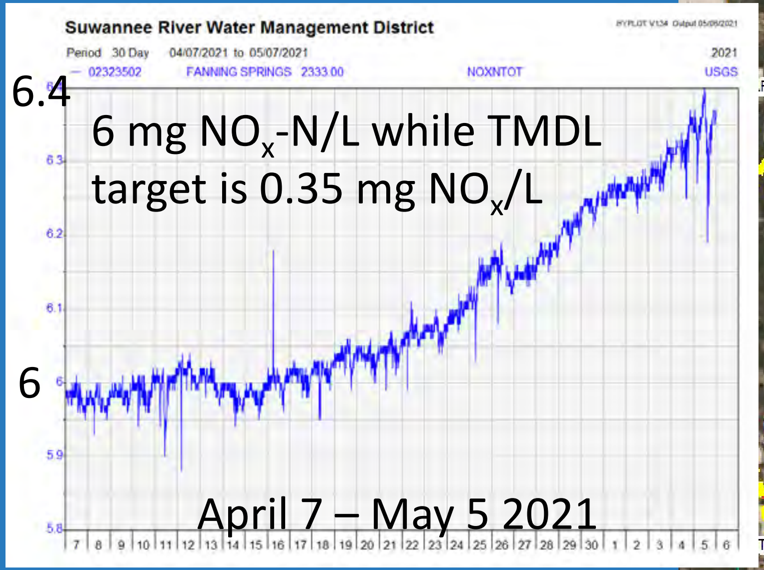
Florida's Multi-Scale Approach To Nutrient Load Reduction from Agriculture

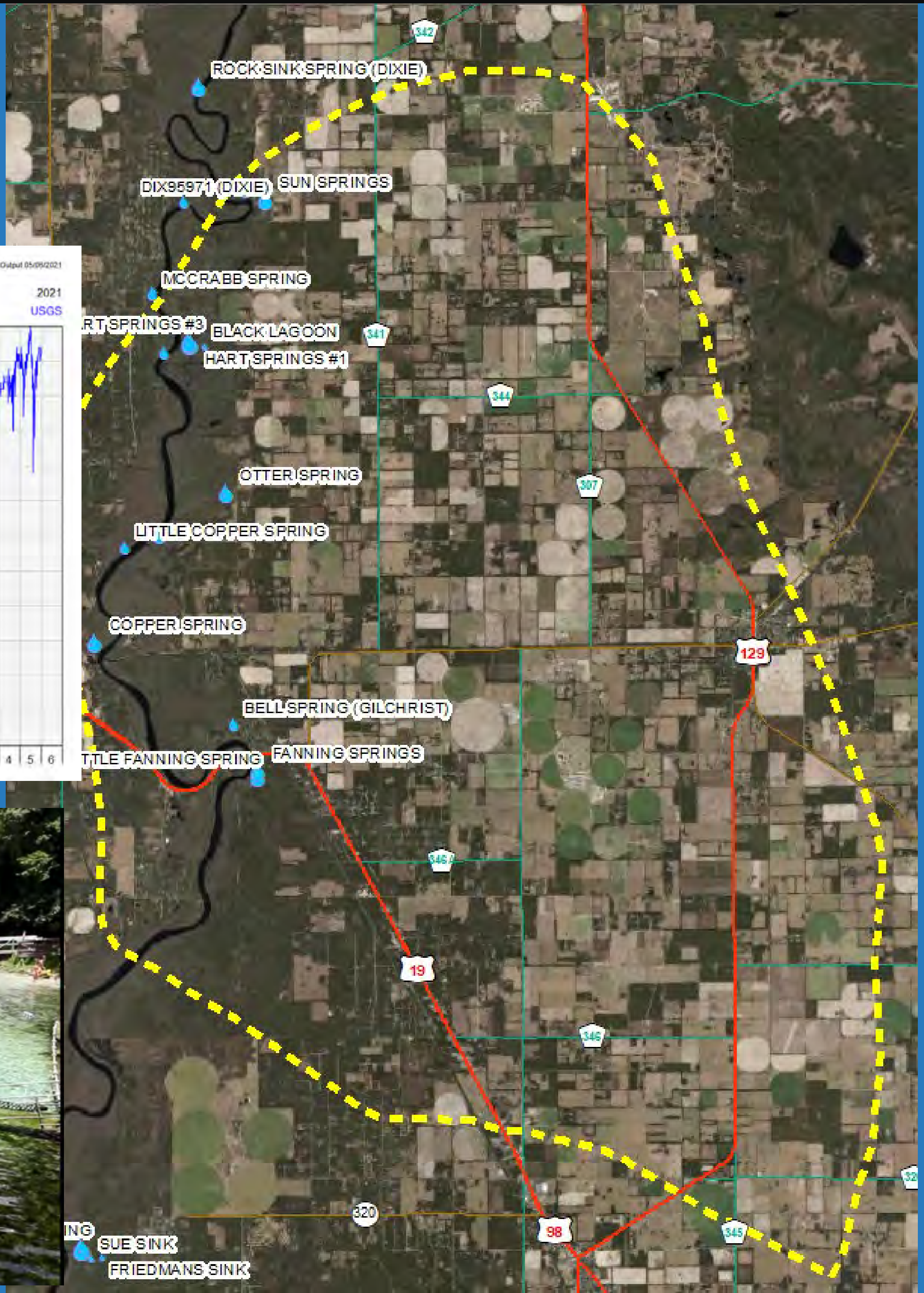
- On the Farm
  - Ag BMPs
  - Advanced BMPs (not in manual), not obligatory but cost-share eligible
- Change in Farming
  - Crop Conversion
  - Buyout
- Regional Treatment
  - Dispersed Water Treatment – Public payment for treatment on Private Land
  - Government Treatment System on Public Land
  - Integration with large USACOE Flood Control Projects

Payment for Crop Conversion

- In particularly sensitive areas, ie. springsheds, provide economic incentives to encourage growers to switch from water and nutrient intensive crops to crops with less runoff, ie. trees
- Multiple attempts, but not yet attracted participants

Fanning Springs Continuous Nitrate Data





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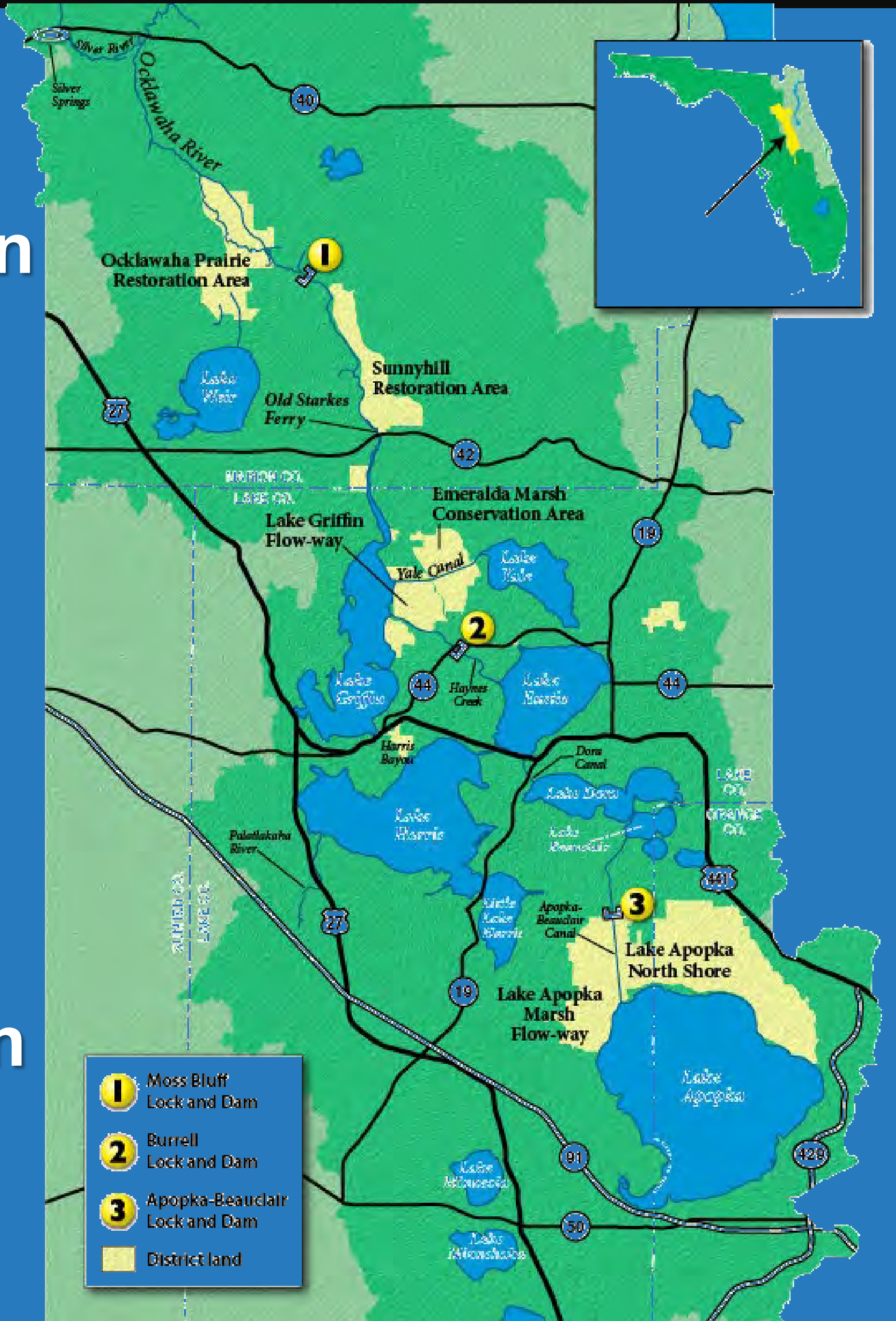
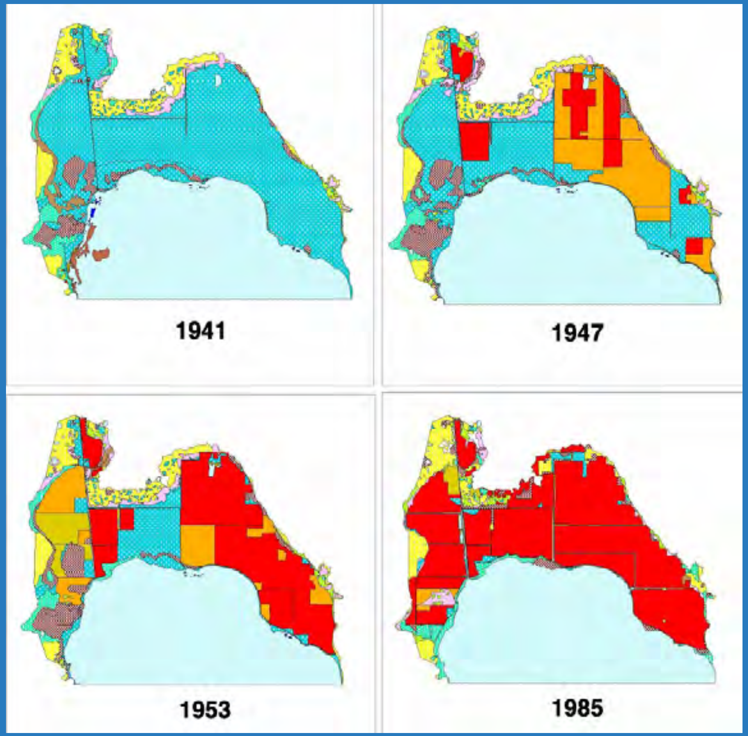
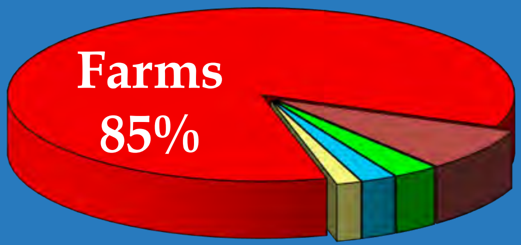
Farm Buyout

- Unusual as typical land purchase focuses on only willing sellers
- Focus on highest loads, typically muck farms, developed on former floodplain wetlands
  - Restore farms to wetlands
  - Convert to reservoir for water storage and treatment
- One "unwilling" example where Legislature directed buyout of muck farm businesses on Lake Apopka, both land and equipment

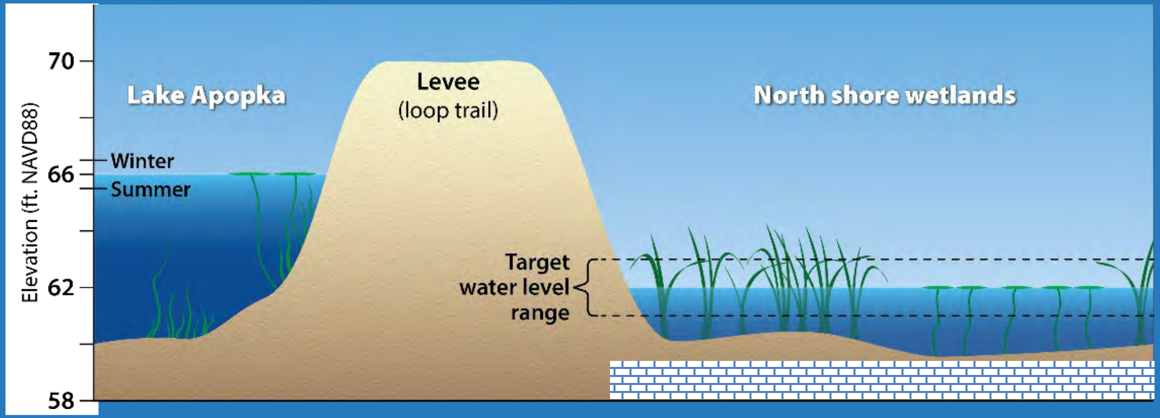


Lake Apopka and Watershed





Total Phosphorus
Loading ~7X Ambient



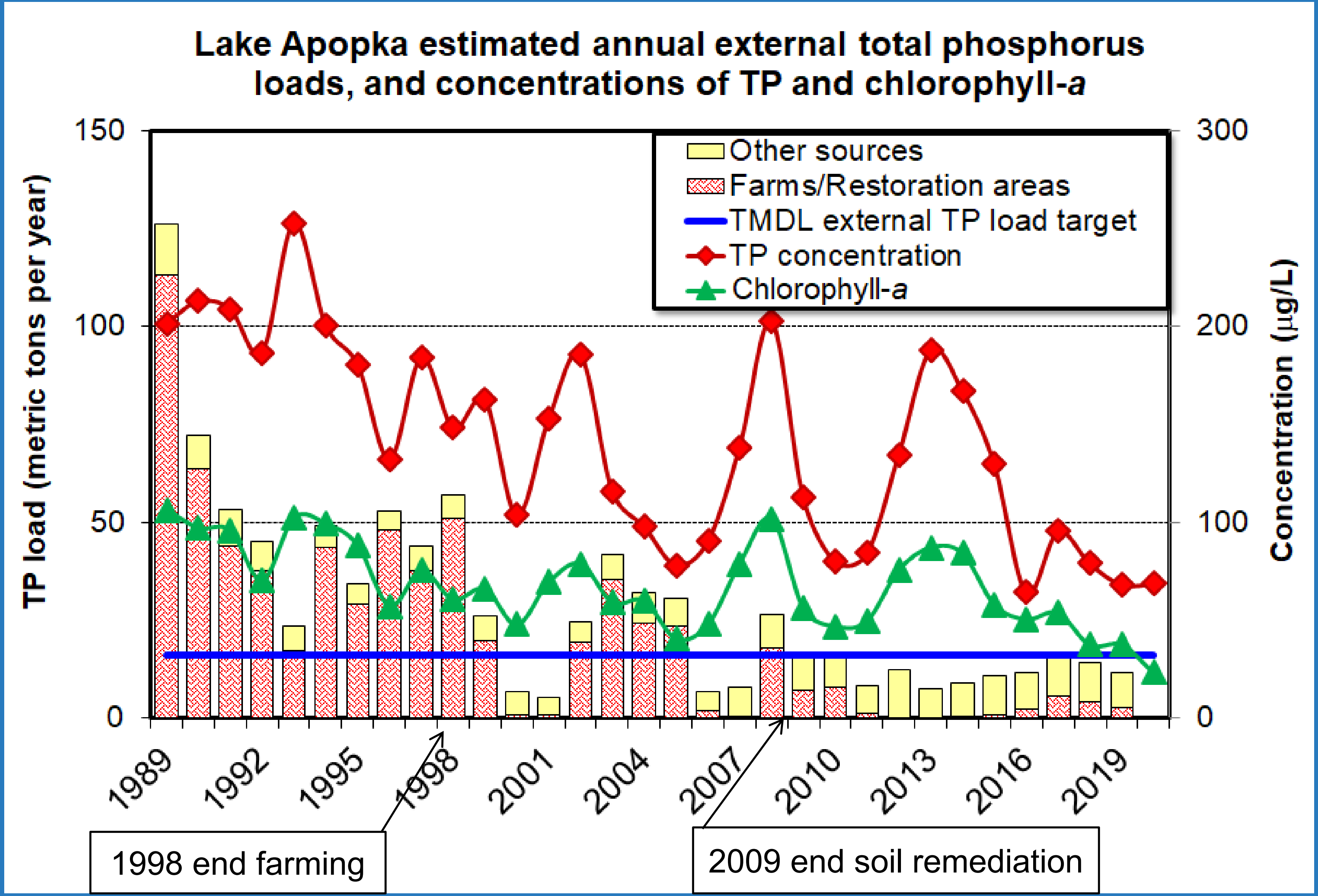
wetland restoration

Watershed

Lake Apopka North Shore Muck Farms The Key to "the Diet"

- 1996 – Lake Apopka Restoration Act directed the St. Johns River Water Management District to buy the North Shore farms
- Initiated process of restoring area to wetlands to halt soil oxidation and phosphorus release
- Highly successful in reducing phosphorus loads

Phosphorus Load Reductions "The Diet"



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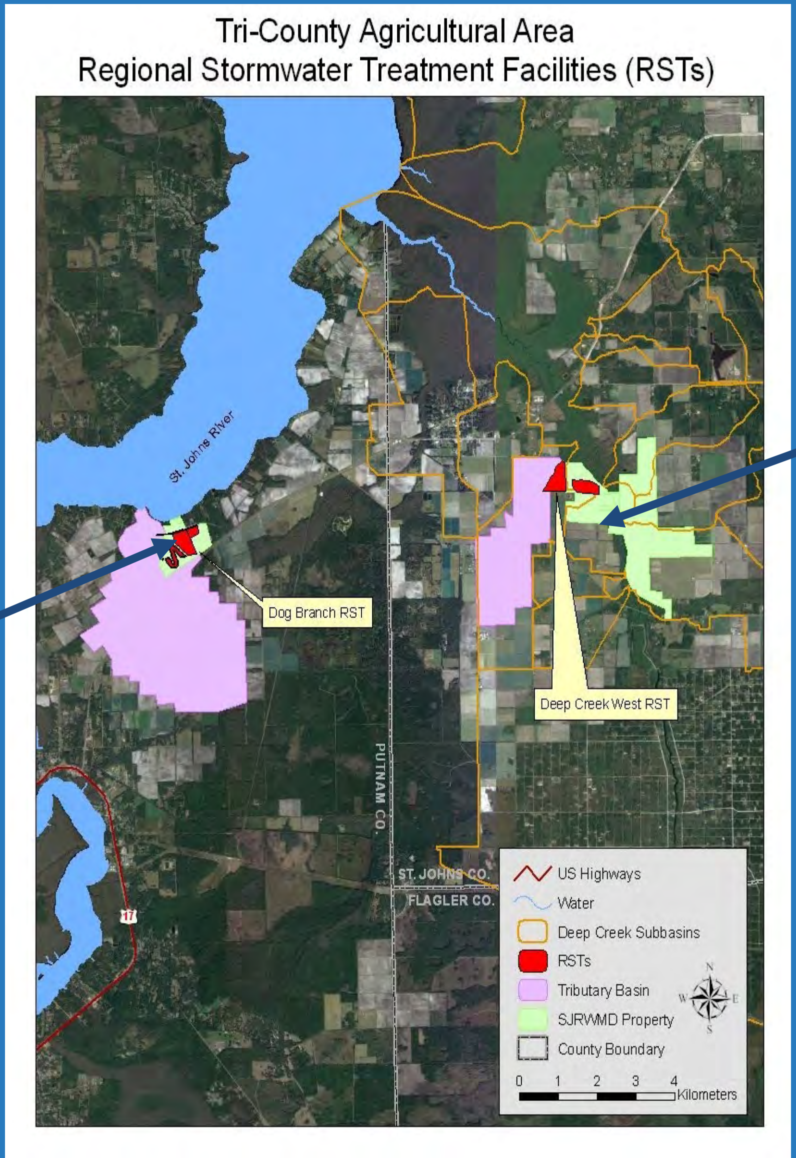
Regional Stormwater Treatment Facilities



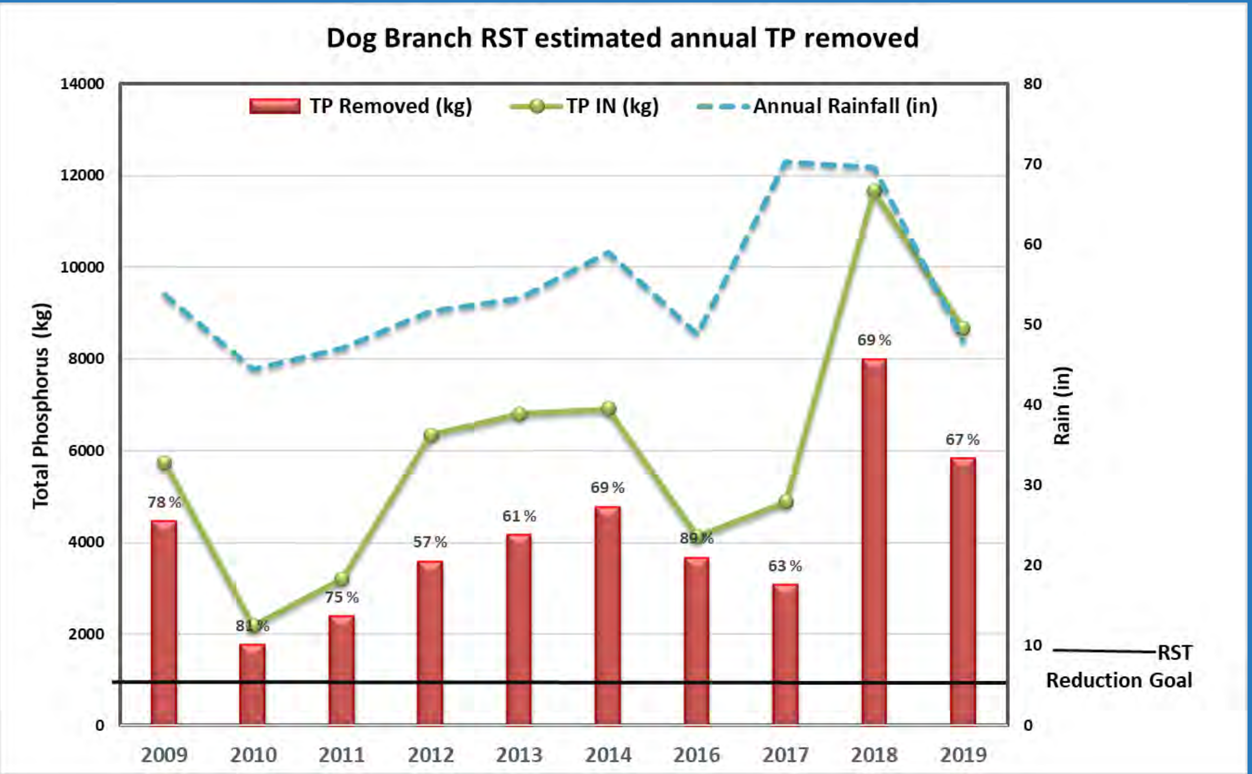
Edgefield - Dog Branch RST - 2007

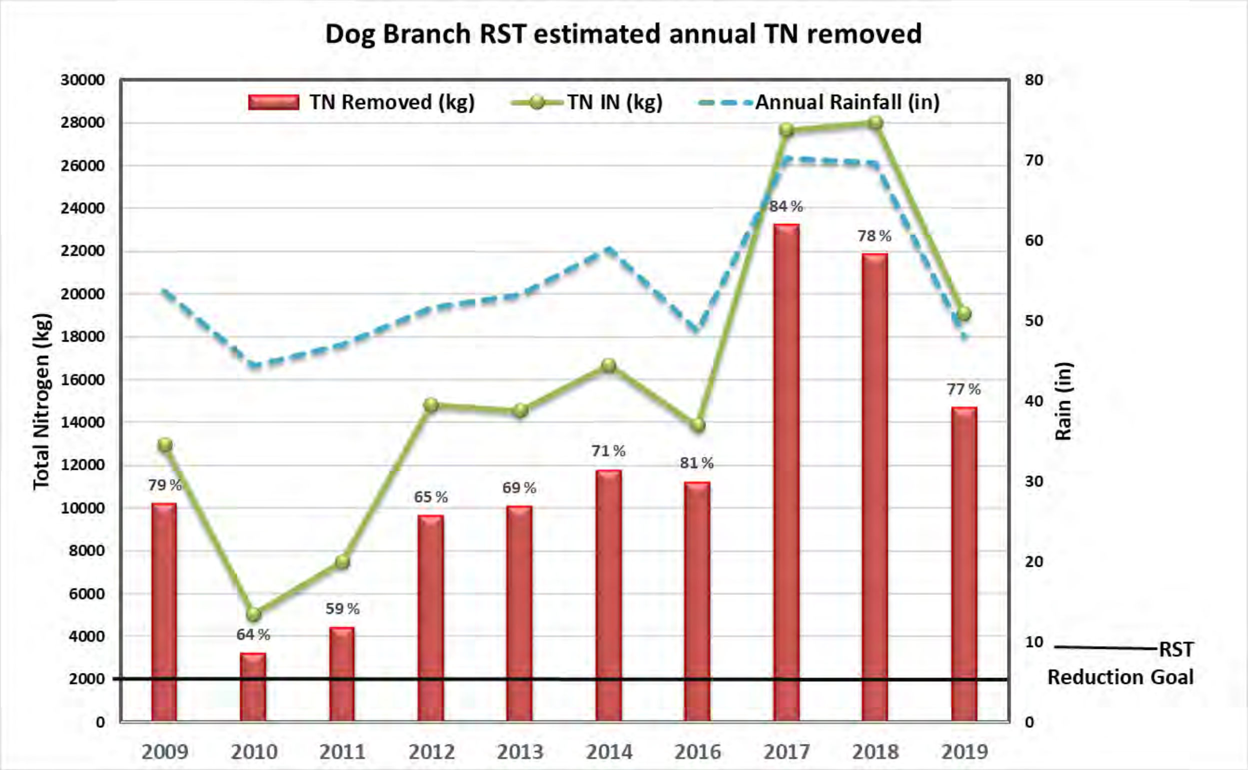
- 25 acre pond and 56 acre wetland
- Treats ag runoff from 2,000 acres (65% agriculture)
- Site was formerly used in row crop production

Deep Creek RST – 2006

- 19 acre pond and 38 acre wetland
- Treats ag runoff from 1,196 acres (95% ag)
- Site was formerly used in row crop production

Regional Stormwater Performance





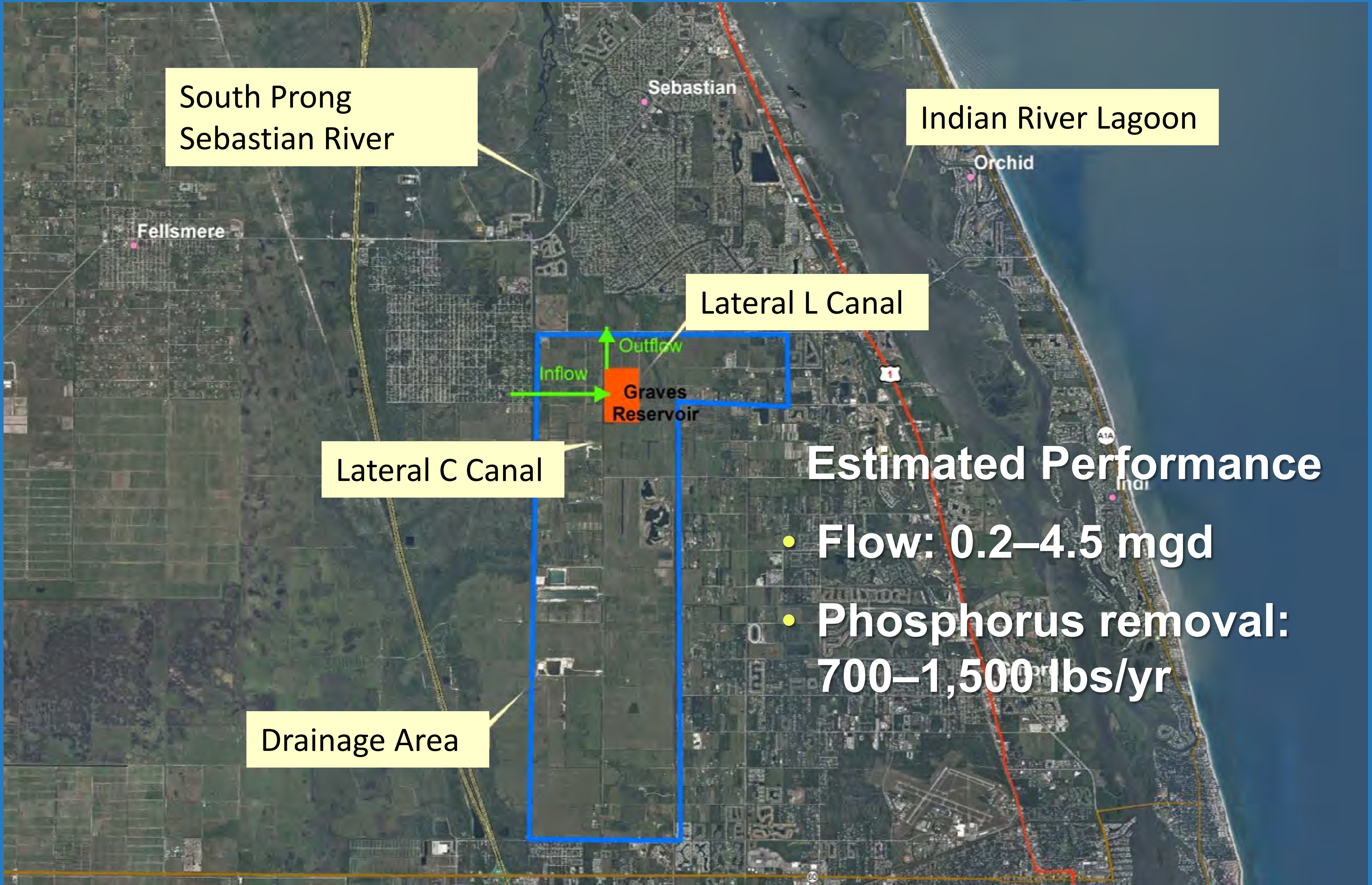
* 2015 – Pumps were not operating in 2015

Dispersed Water Treatment

- Public – Private Partnership using Private Lands
- Long-term agreements
- Two models at various stages of use
  - Utilize available private land for treatment
    - Wetter Areas
    - Citrus out of production due to Citrus Greening Disease
  - South Florida - payment for storage volume created, used as necessary to detain water and nutrient loading
  - North Florida Pilot Projects- payment for nutrient mass reduction and Ag water supply as privately designed and operated

Dispersed Treatment Pilot Project

- Public-private partnership
- Provides water supply and treatment
- Time-limited
- Not built yet

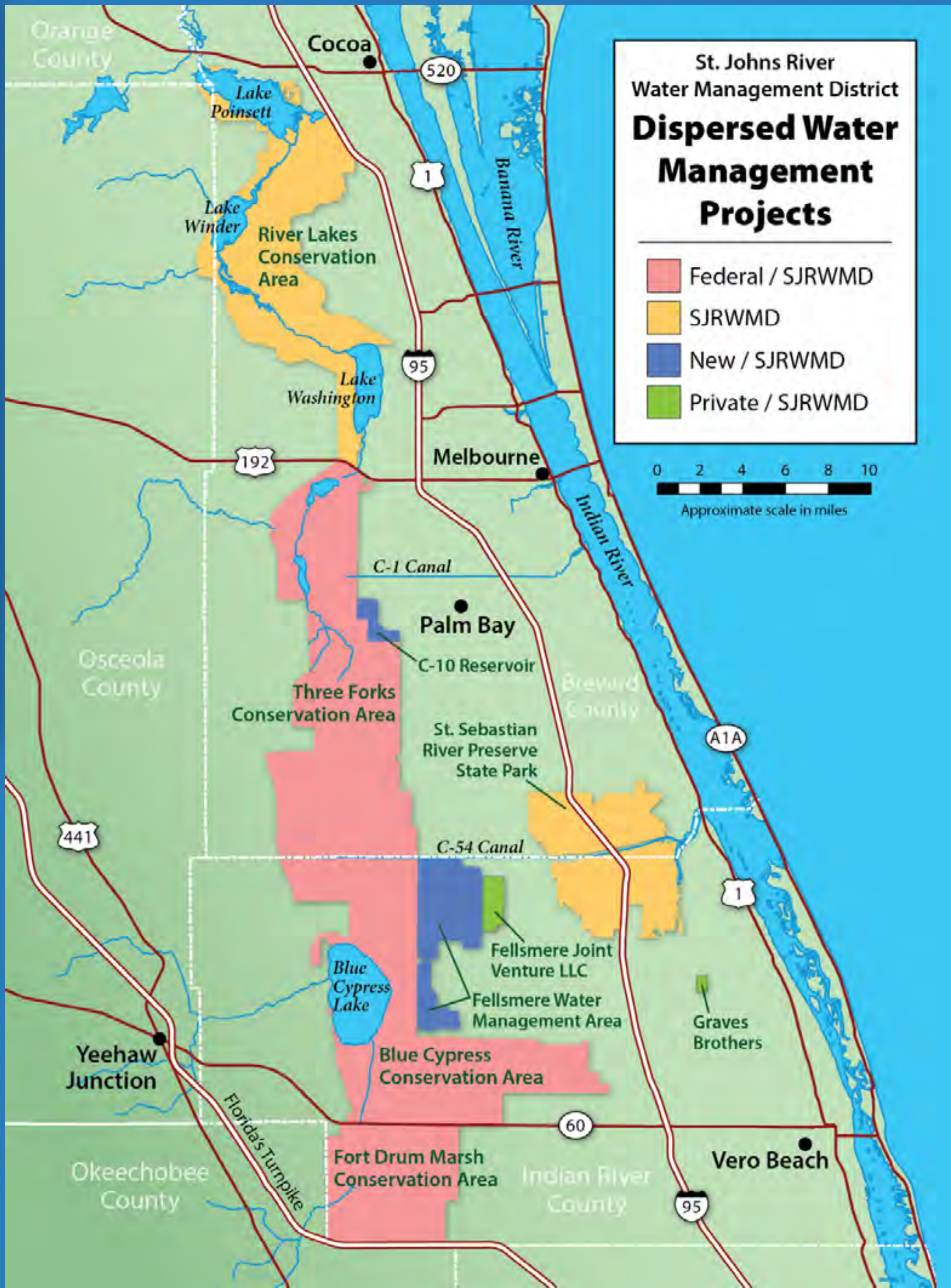


Estimated Performance

- Flow: 0.2–4.5 mgd
- Phosphorus removal: 700–1,500 lbs/yr

Upper St. Johns River Basin Project

- USACOE – District Flood Protection Project
- 247 mile^2
- ~ 30 years to build
- Water Quality Treatment
- Water Supply
- Habitat (fisheries, hunting, etc.)
- Additional Non-Federal Projects
    - Fellsmere Water Management Area
    - P3 - Dispersed Treatment

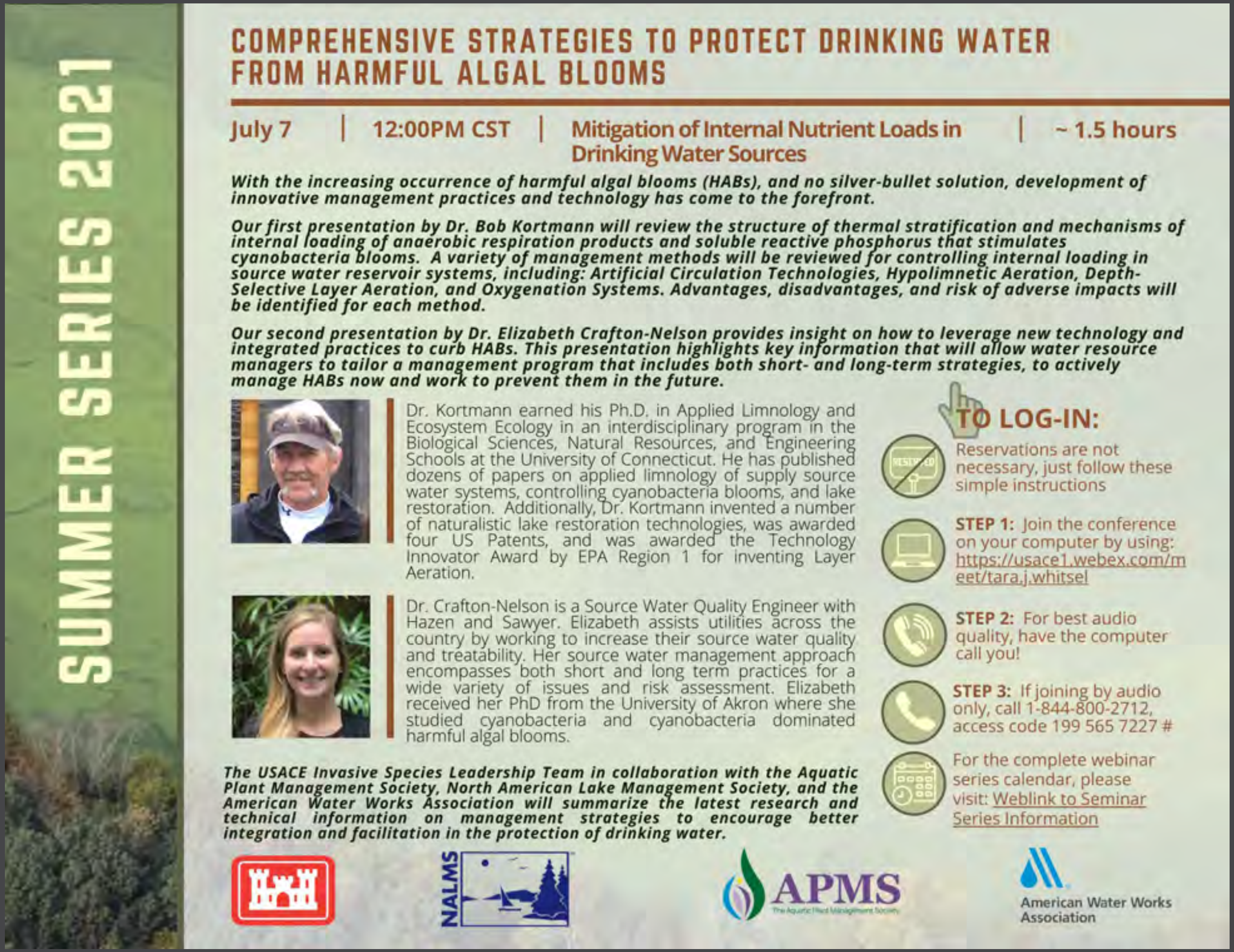



St. Johns River
Water Management District
Palatka
Tri-County Agricultural
Area Water Management
Partnership Cost-share
Pay to the order of
L&M Farms/Cracker Swamp II, LLC
Two hundred forty-six thousand
thirty-three and 68/100
Dollars
$ 246,033.68
For Conversion to sub-irrigation drain tile
NONNEGOTIABLE
Ann B. Shortelle, Ph.D., Executive Director
Thank You

Questions & Answers

Please post any questions to the "CHAT".

Please join us next week!



SUMMER SERIES 2021

COMPREHENSIVE STRATEGIES TO PROTECT DRINKING WATER FROM HARMFUL ALGAL BLOOMS

July 7 | 12:00PM CST | Mitigation of Internal Nutrient Loads in Drinking Water Sources | ~ 1.5 hours

With the increasing occurrence of harmful algal blooms (HABs), and no silver-bullet solution, development of innovative management practices and technology has come to the forefront.

Our first presentation by Dr. Bob Kortmann will review the structure of thermal stratification and mechanisms of internal loading of anaerobic respiration products and soluble reactive phosphorus that stimulates cyanobacteria blooms. A variety of management methods will be reviewed for controlling internal loading in source water reservoir systems, including: Artificial Circulation Technologies, Hypolimnetic Aeration, Depth-Selective Layer Aeration, and Oxygenation Systems. Advantages, disadvantages, and risk of adverse impacts will be identified for each method.

Our second presentation by Dr. Elizabeth Crafton-Nelson provides insight on how to leverage new technology and integrated practices to curb HABs. This presentation highlights key information that will allow water resource managers to tailor a management program that includes both short- and long-term strategies, to actively manage HABs now and work to prevent them in the future.

Dr. Kortmann earned his Ph.D. in Applied Limnology and Ecosystem Ecology in an interdisciplinary program in the Biological Sciences, Natural Resources, and Engineering Schools at the University of Connecticut. He has published dozens of papers on applied limnology of supply source water systems, controlling cyanobacteria blooms, and lake restoration. Additionally, Dr. Kortmann invented a number of naturalistic lake restoration technologies, was awarded four US Patents, and was awarded the Technology Innovator Award by EPA Region 1 for inventing Layer Aeration.

Dr. Crafton-Nelson is a Source Water Quality Engineer with Hazen and Sawyer. Elizabeth assists utilities across the country by working to increase their source water quality and treatability. Her source water management approach encompasses both short and long term practices for a wide variety of issues and risk assessment. Elizabeth received her PhD from the University of Akron where she studied cyanobacteria and cyanobacteria dominated harmful algal blooms.

The USACE Invasive Species Leadership Team in collaboration with the Aquatic Plant Management Society, North American Lake Management Society, and the American Water Works Association will summarize the latest research and technical information on management strategies to encourage better integration and facilitation in the protection of drinking water.

TO LOG-IN:

Reservations are not necessary, just follow these simple instructions

STEP 1: Join the conference on your computer by using: https://usace1.webex.com/meet/tara.j.whitsel

STEP 2: For best audio quality, have the computer call you!

STEP 3: If joining by audio only, call 1-844-800-2712, access code 199 565 7227 #

For the complete webinar series calendar, please visit: Weblink to Seminar Series Information

NALMS APMS American Water Works Association