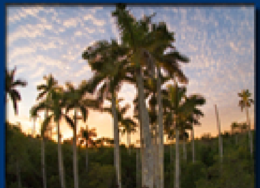
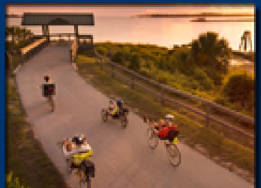
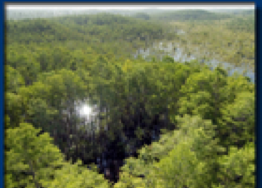
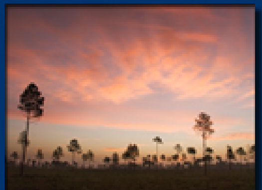
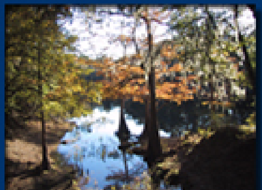
Florida Department of Environmental Protection

Water Quality Evaluation & TMDL Program

Nutrient TMDL for Chassahowitzka Springs Group, Crab Creek Spring, Chassahowitzka River-Baird Creek, Baird Springs, Ruth Spring, and Beteejay Springs (WBIDs 1348Z, 1348D, and 1361B)

September 30, 2014

Presentation Outline

1. What is a TMDL
2. Verified List of Impaired Waters
3. Data Providers
4. Nitrogen Trends
5. Nutrient Sources w/in Contributing Area
6. Critical Conditions/Seasonality
7. Existing Concentration & Establishing the WQ Target Threshold
8. TMDL Calculation & Allocation

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What is a TMDL?

Total

Maximum

Daily

Load

- **Establishes maximum amount of a pollutant that a water body can receive without causing exceedances of water quality standards (water quality criteria & designated uses)**

Developing the TMDL

A Total Maximum Daily Load does not necessarily need to be <u>Daily</u>, nor does it need to be a <u>Load</u>

- For more typical TMDLs, we may use hydraulic and water quality models to simulate loading and the effect of the loading within a given waterbody, with the TMDL expressed as a load.

- However, there are other appropriate methods to develop TMDLs that are just as credible as a modeling approach.

- A different approach in the case of Springs where the pollution source is a diffuse non-point source contributing over a large area.

What does proposing a TMDL mean?

- It means we are proposing a formal target for achieving the water quality component of restoration.

- When we identify a waterbody as impaired (not meeting it’s standard), we use the best available science and local knowledge to come up with this target.

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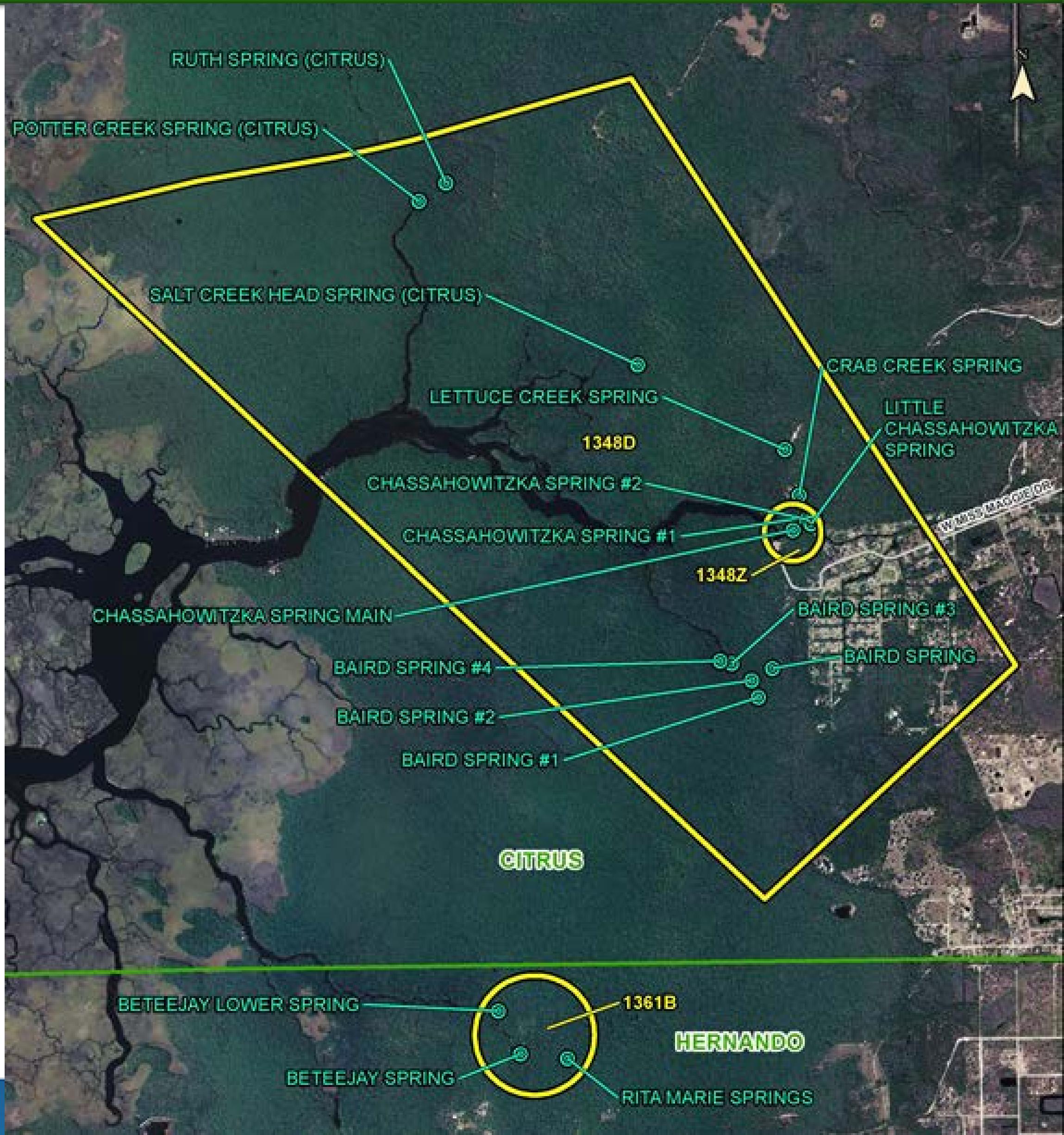
Florida Impaired Waters Rule (IWR)

- Assessments are conducted per 62-302 FAC (water quality standards) and 62-303 FAC (IWR)
- The IWR contains:
  - Data quantity requirements
  - Data quality requirements
  - Assessment methodology and statistics
- The Group 5 Springs Coast Verified List was adopted by DEP Secretary Herschel Vinyard Jr on February 2, 2012
- The Department develops TMDLs for waters on the Verified List
- Copies of the IWR assessment tool are available

Location of Impaired Waterbody Segments

<u>Sampled Waterbodies</u>

1. Chassahowitzka River (Upper Segment)
2. Chassahowitzka Main Spring
3. Chasssahowitzka #1 Spring
4. Crab Creek Spring
5. Baird #1 Spring
6. Beteejay Spring
7. Ruth Spring

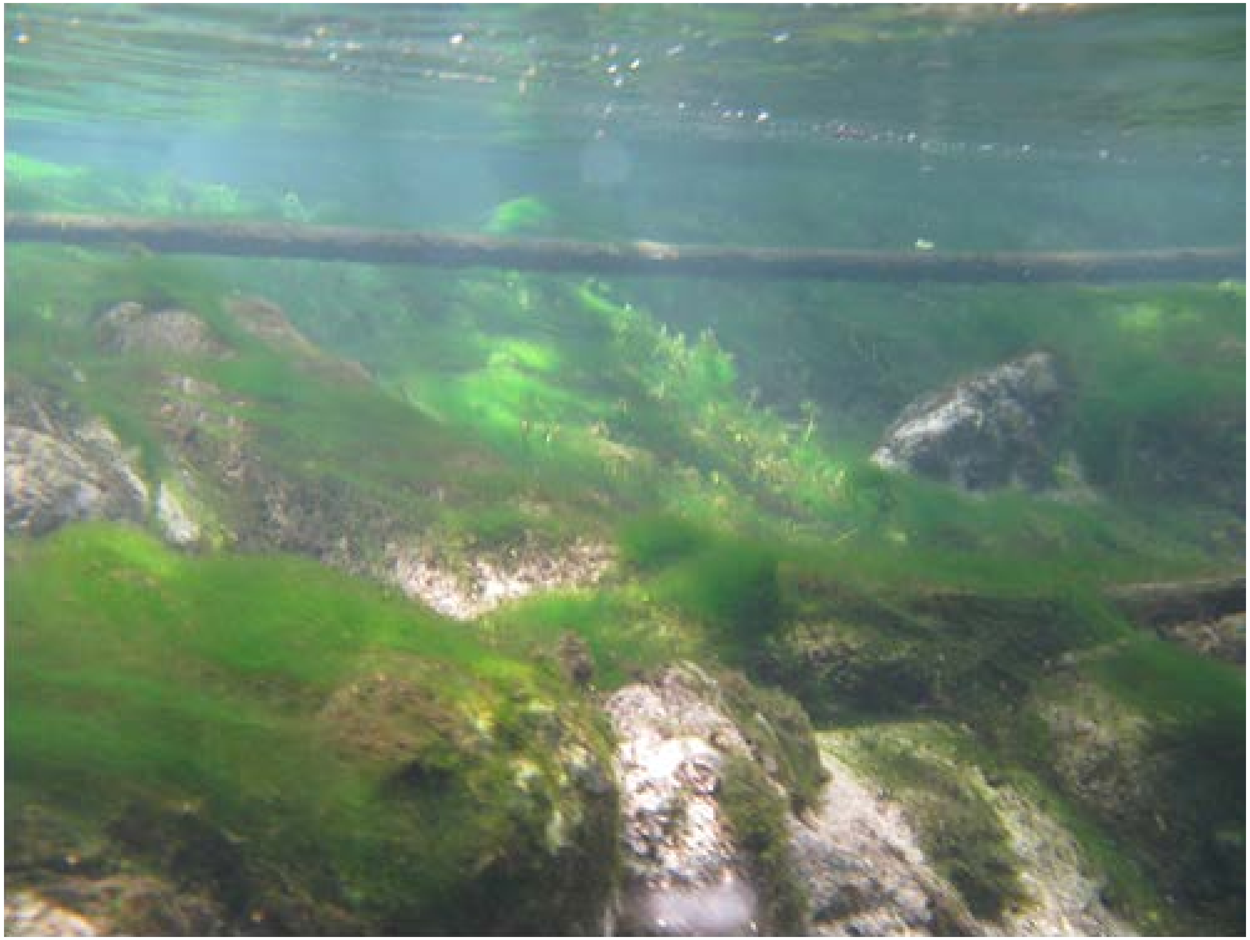


Florida Impaired Waters Rule (IWR)

- Verified impaired due to an "imbalance of flora or fauna" linked to elevated nutrients (Chapter 62-303, F.A.C.).

WBID	Waterbody Segment	Waterbody Type	Parameters Assessed Using the IWR	Concentration or Criterion or Threshold Not Met	Assessment Status
1348Z	Chassahowitzka Springs Crab Creek Spring	Spring	Nutrients (algal mats)	Balanced natural population of flora and fauna	Impaired
1348D	Chassahowitzka River-Baird Creek	Stream	Nutrients (algal mats)	Balanced natural population of flora and fauna	Impaired
1348D	Baird Springs Ruth Spring	Spring	Nutrients (algal mats)	Balanced natural population of flora and fauna	Impaired
1361B	Beteejay Springs	Spring	Nutrients (algal mats)	Balanced natural population of flora and fauna	Impaired

Elevated nitrate is a major cause of algal growth



Algal growth in Chassahowitzka Main Spring, Sept. 2008 (FDEP)

Elevated nitrate is a major cause of algal growth

Diatoms at Crab Creek Spring, October 2008 (FDEP)

Elevated nitrate is a major cause of algal growth

Horse hair algae at Beteejay Spring Run, 2011 (FDEP)

Elevated nitrate is a major cause of algal growth

Algae at Chassahowitzka #1 Spring, October 2008 (FDEP)

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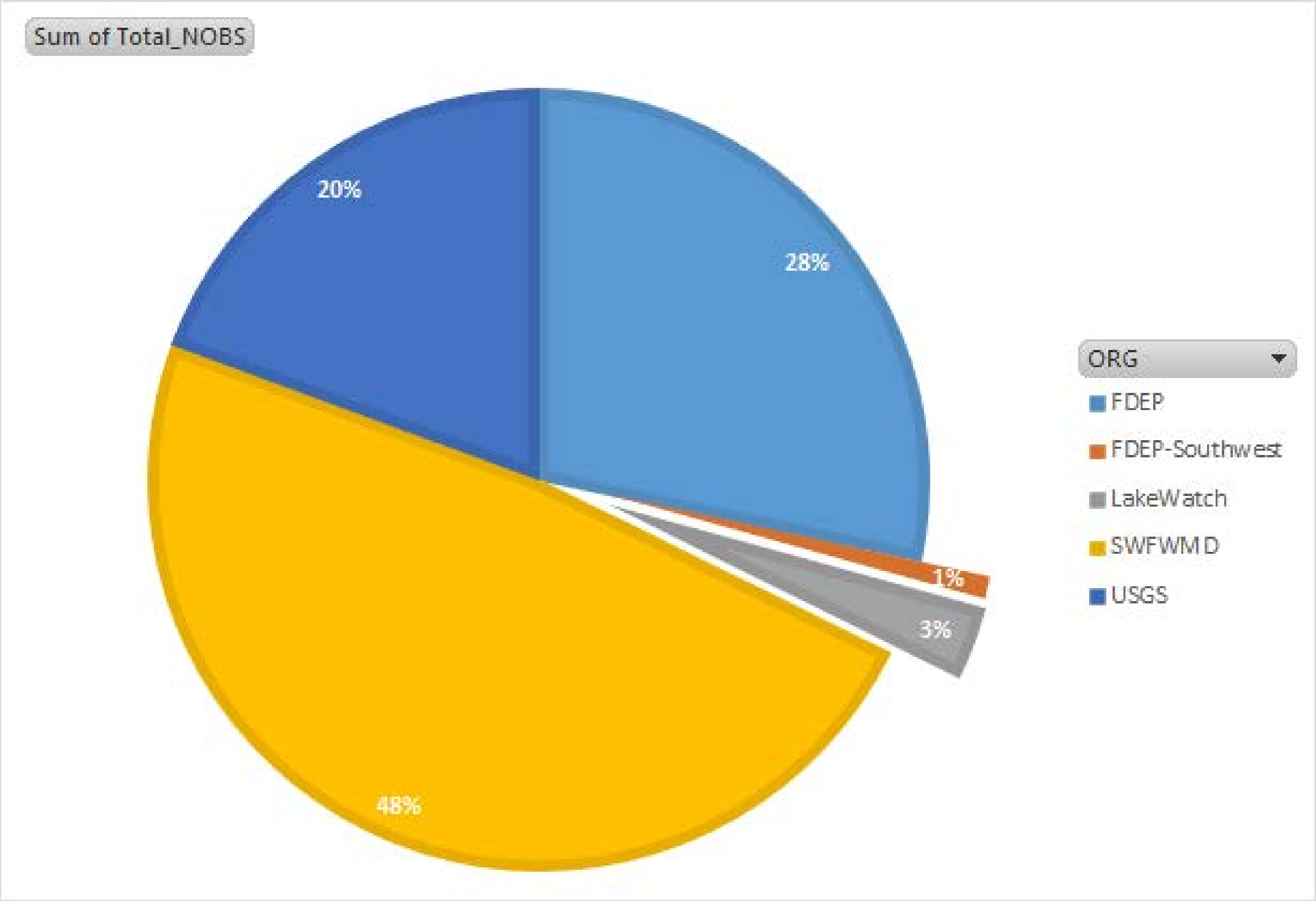

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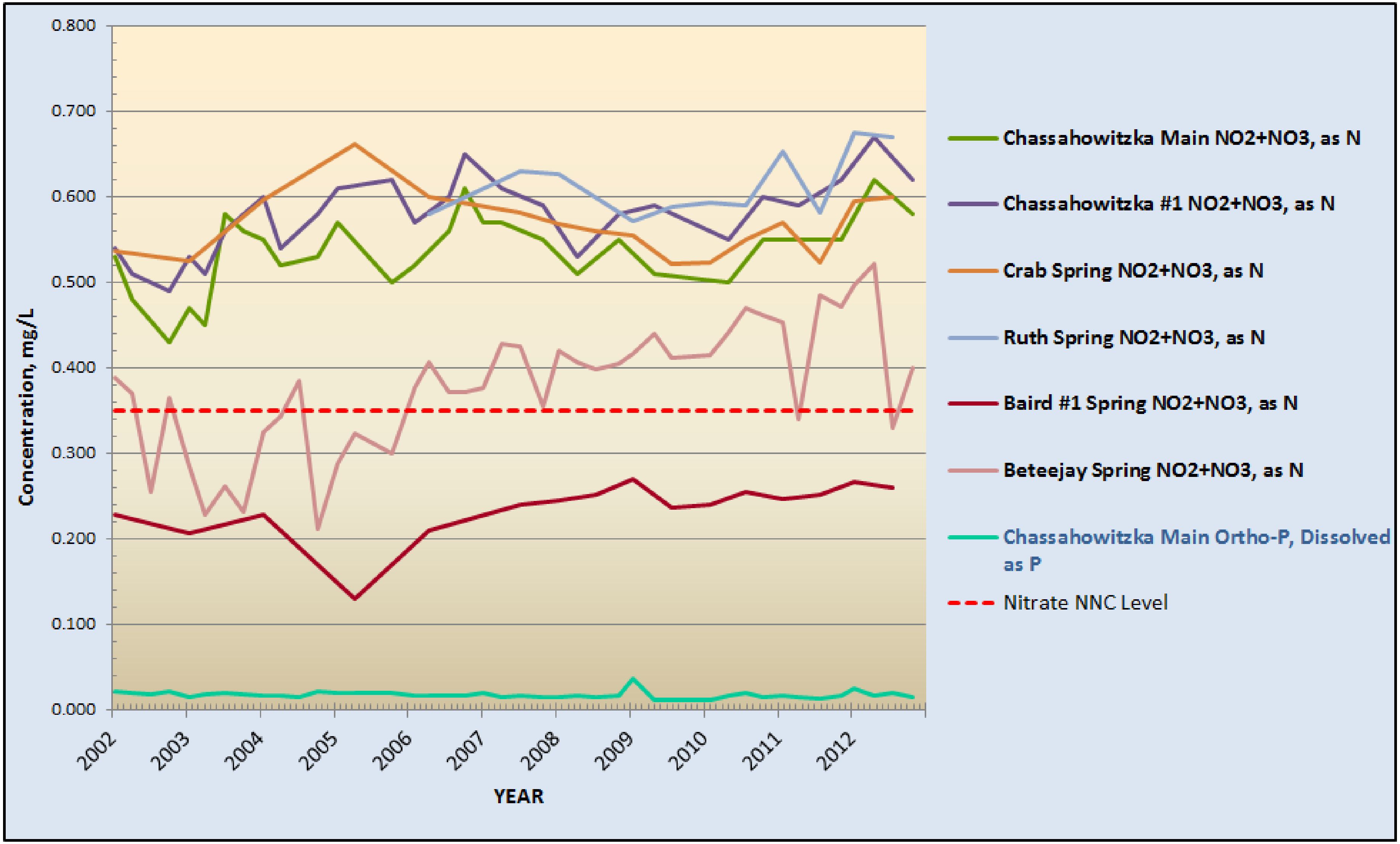
Nitrate Concentrations have steadily increased



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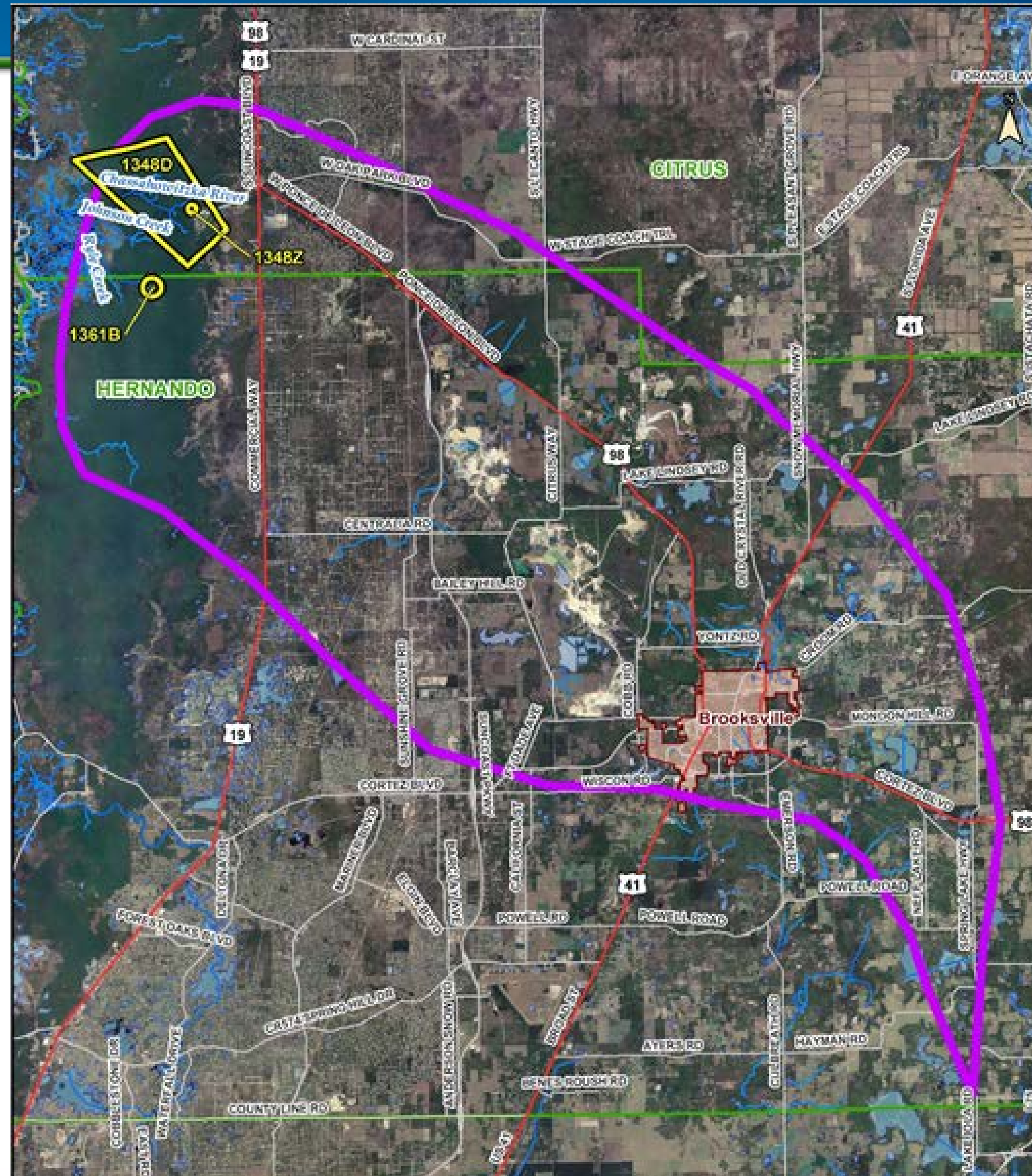
Contributing Area

Springshed + Watershed = Contributing Area

Contributing Area for Chassahowitzka

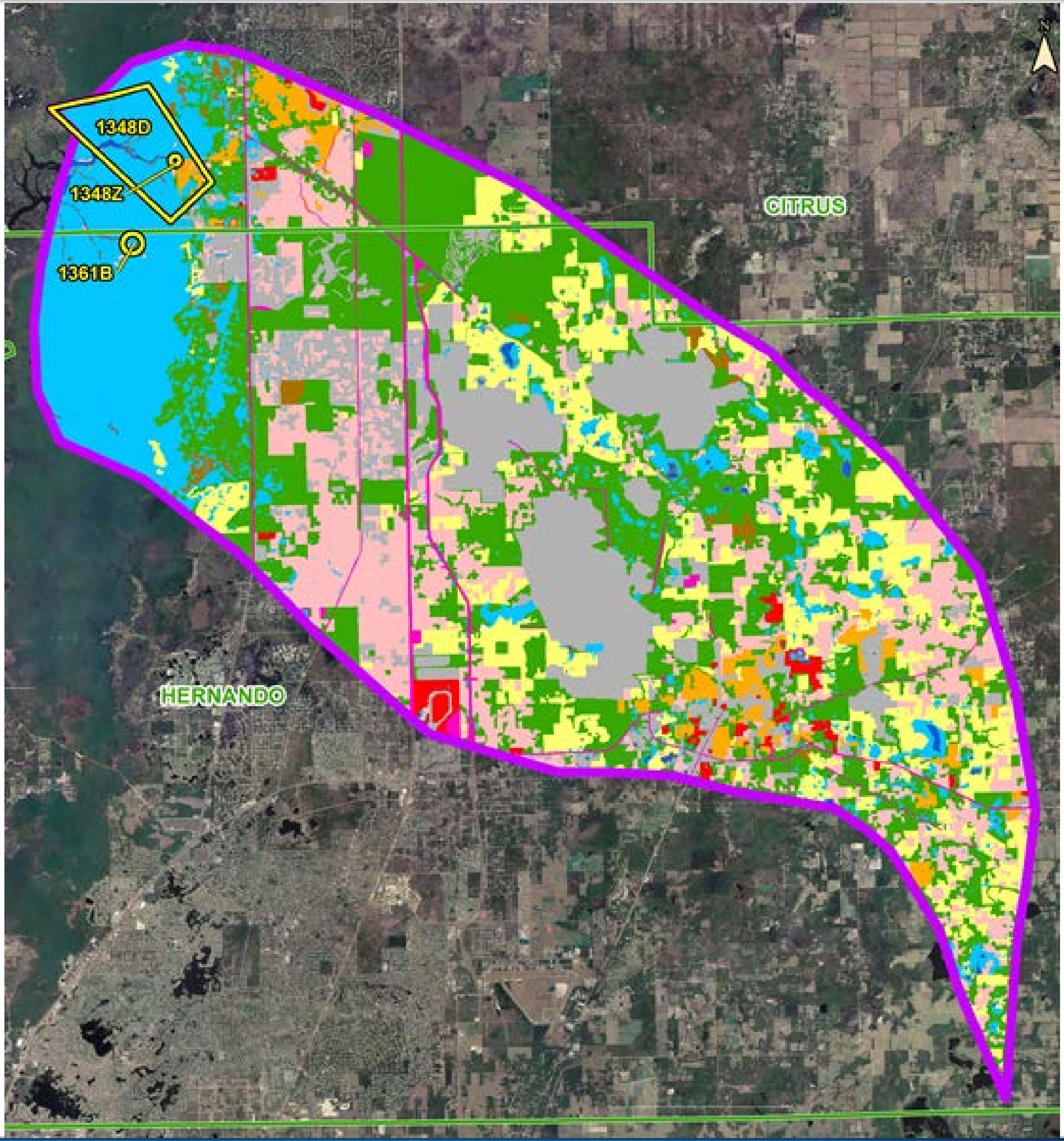
Springshed = USGS Ground Water Feature

Watershed = Surfacewater Feature



Assessment of potential sources

Estimated
contributing area
(190 square miles)
14% agriculture
21% residential
30% forest
16% wetlands



Assessment of Current Sources

Inputs from typical sources of nutrients that influence springs:

- Septic Tanks (OSTDS)
- Stormwater Runoff
  Inorganic Fertilizer
- Atmospheric Deposition
- Animal Waste (Livestock & Wildlife)
- Wastewater Application Sites
- Sediments
- Decaying Organic Matter from Algal Mats

Nutrient Source Loading Assessment

Nitrogen **S**ource **I**nventory **L**oading **T**ool (NSILT)

- Performed by FDEP with extensive input from stakeholders
- Occurs during BMAP development
- Will become basis for planning activities to address nitrogen sources

< BREAK >

Developing the TMDL

How the TMDLs were developed:

- FIRST – Determine Critical Conditions Seasonality Effects
- SECOND - Established the algal-growth-based threshold for nitrogen
- THIRD - Calculate the reductions needed in the existing concentrations to reach the TMDL target

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Critical Conditions/Seasonality

Table 5.1b. Monthly average nitrate concentrations for Chassahowitzka #1 Spring, 2004–13

- = Empty cell/no data

Month	N	Mean	Max	Min
1	5	0.63	0.65	0.60
2	5	0.62	0.66	0.58
3	-	-	-	-
4	6	0.60	0.64	0.54
5	3	0.60	0.62	0.59
6	1	0.61	0.61	0.61
7	5	0.62	0.65	0.58
8	4	0.60	0.63	0.58
9	1	0.62	0.62	0.62
10	6	0.62	0.65	0.55
11	4	0.61	0.67	0.53
12	-	-	-	-

Table 5.1c. Monthly average nitrate concentrations for Crab Creek Spring, 2004–13

- = Empty cell/no data

Month	N	Mean	Max	Min
1	8	0.61	0.67	0.55
2	-	-	-	-
3	-	-	-	-
4	7	0.60	0.65	0.55
5	-	-	-	-
6	-	-	-	-
7	9	0.58	0.62	0.52
8	-	-	-	-
9	-	-	-	-
10	8	0.61	0.66	0.52
11	-	-	-	-
12	-	-	-	-

Critical Conditions/Seasonality

Table 5.1d. Monthly average nitrate concentrations for Baird #1 Spring, 2004–13

- = Empty cell/no data

Month	N	Mean	Max	Min
1	8	0.25	0.29	0.13
2	-	-	-	-
3	-	-	-	-
4	7	0.27	0.31	0.24
5	-	-	-	-
6	-	-	-	-
7	9	0.26	0.29	0.21
8	-	-	-	-
9	-	-	-	-
10	8	0.27	0.28	0.24
11	-	-	-	-
12	-	-	-	-

Table 5.1f. Monthly average nitrate concentrations for Ruth Spring, 2004–13

- = Empty cell/no data

Month	N	Mean	Max	Min
1	9	0.40	0.50	0.29
2	1	0.38	0.38	0.38
3	-	-	-	-
4	9	0.41	0.52	0.32
5	1	0.44	0.44	0.44
6	-	-	-	-
7	9	0.41	0.48	0.33
8	-	-	-	-
9	-	-	-	-
10	8	0.35	0.46	0.21
11	3	0.29	0.47	0.01
12	-	-	-	-

Critical Conditions/Seasonality

An Annual Average was used because…

- River and Springs are sampled on a quarterly basis (Jan, April, July, and October)
- No seasonal variation
- Inter-year differences present

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Developing the TMDLs

How the TMDLs were developed:

- FIRST - Established the algal-growth-based threshold for nitrogen
- SECOND - Calculate the reductions needed in the existing concentrations to reach the target

Existing Concentration

- To make sure that the annual average concentrations will meet the concentration target even under the **worst case scenario**, the **highest annual average concentration** was used to calculate the percent reduction required to achieve the target.

Establishing **Spring** Threshold for Nitrate

Unique Nature of Chassahowitzka River

- Tidally Influenced
- Shallow Coastal River
- Long Residence Time 6. 5 days (SWFWMD 2012)
- Warm Temperatures
- Increased photozone and accelerated plant growth
- Spring discharge source Upper Floridan, which is very vulnerable to pollutants

NNC for Springs

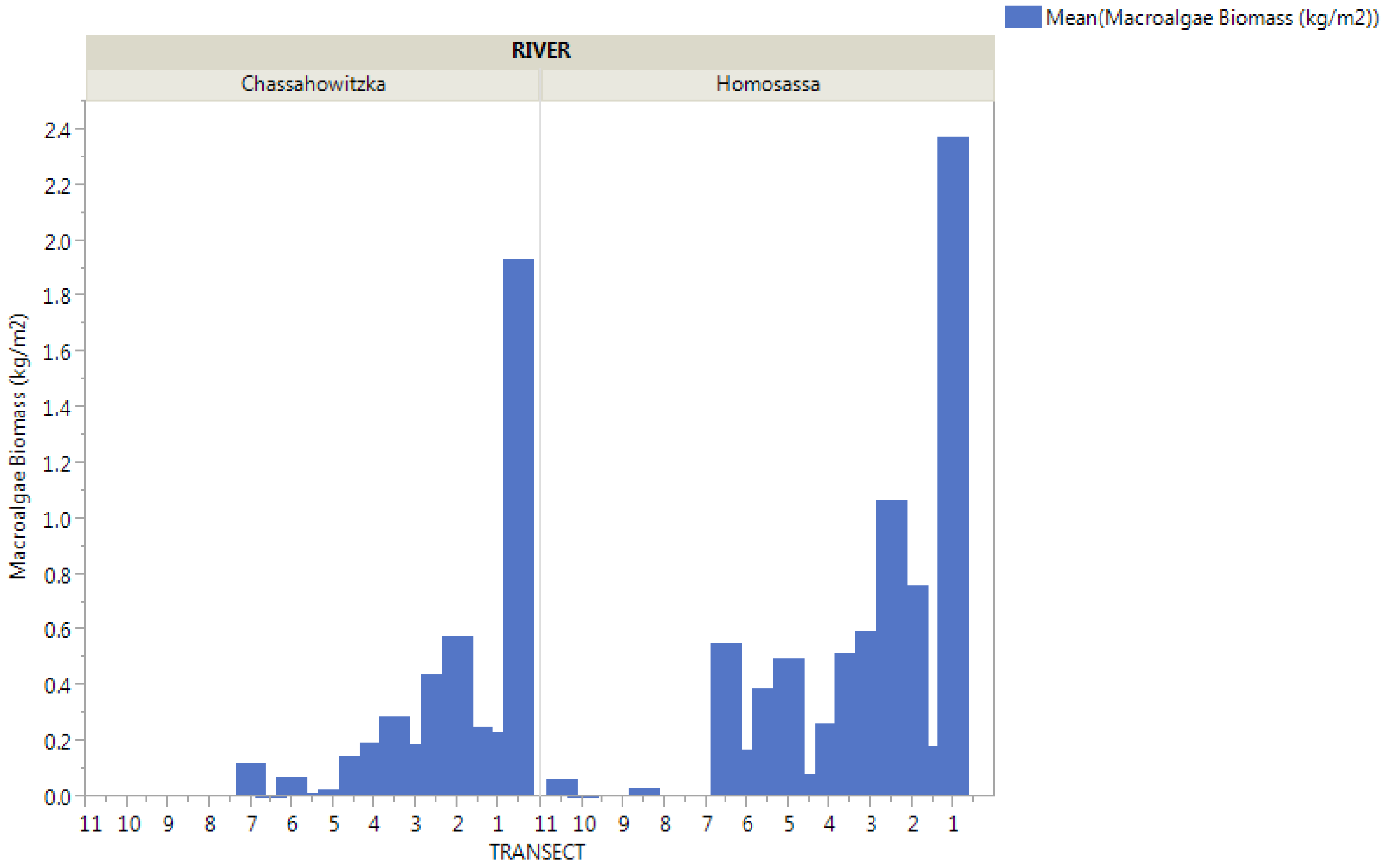
Numeric Nutrient Criteria for Springs

0.35 mg/L Nitrate

(Freshwater, High Flushing Spring Systems)

Not Applicable to these Springs

Frazer et al (2001 and 2006)



- Macroalgae most abundant at the headsprings

Albertin (2009)

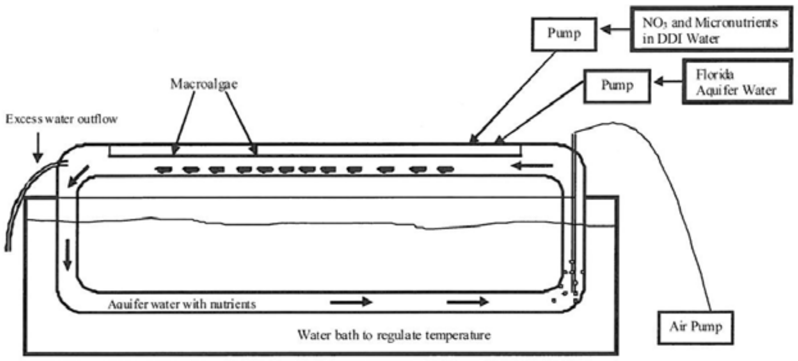


Figure 2-1. Cross-sectional view of a single stream channel.

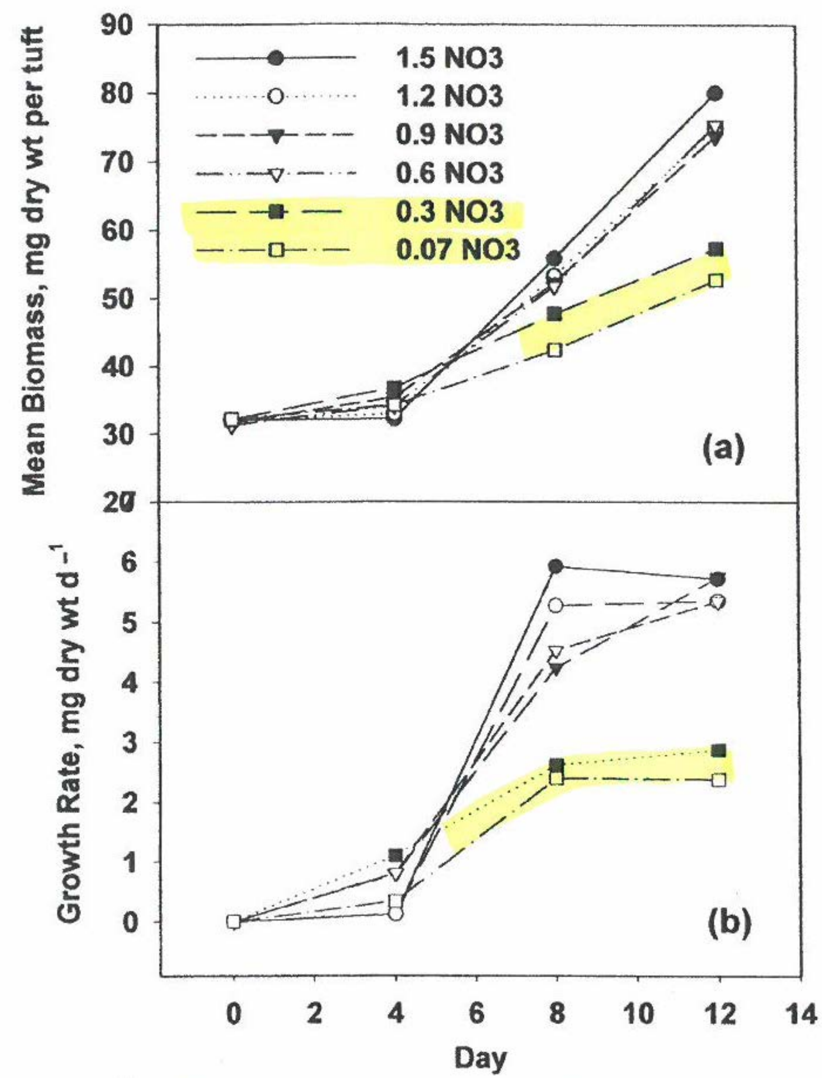
Table 2-10. Estimated effect doses (ED) of NO_3 for *Lyngbya wollei*.

Effect Dose (ED)	NO_3 dose ($\mu g\ L^{-1}$)	Standard error
10	15.6	6.47
50	41.5	8.39
90	110	46.3

- Conducted in Mesocosms
- High Flushing (0.25 m/s)
- Optimal temperature, light, micronutrients (Iron, etc)
- Nitrate level 0.11 mg/L limits algal growth

Cowell & Dawes (2004)

- Conducted in 400 mL flasks
- Low Flushing
- Water continuously replenished at a rate of 960 mL/day
- 6 Nitrate Increments (Crude)
- Nitrate levels < 0.3mg/L limit algal growth response



Stevenson et al (2007)

Microcentrifuge - Microcosms

Macroalgae	Logistic Parameter	Benchmark MTM Expt PO4 (mg/L)	MTM Expt NO3 (mg/L)	TP (mg/L)	TN (mg/L)
Lyngbya	ed10	0.011	0.034	0.013	0.037
Vaucheria	ed10	0.006	0.017	0.007	0.018
Lyngbya	ed90	0.028	0.230	0.033	0.250
Vaucheria	ed90	0.022	0.261	0.026	0.284

- Conducted in microcosms (microcentrifuge tubes)
- Low Flushing
- 11 Nitrate Increments (Refined)
- Nitrate level 0.23 mg/L limits algal growth

Water Quality Target Selection for Spring

Study	Flow	Design	Results
NNC for Springs	High Flushing	Ecological Efficiency Change Point Analysis	0.35 mg/L Nitrate
Albertin (2009)	High Flushing	Optimal Light, Temp, Micronutrients	0.11 mg/L Nitrate
Cowell & Dawes (2004)	Low Flushing	6 Nitrate Increments (Crude)	< 0.3 mg/L Nitrate
Stevenson et al (2007)	Low Flushing	11 Nitrate Increments (Refined)	0.23 mg/L Nitrate

Chassahowitzka River is Considered Low Flushing Environment

Long Residence Time 6.5 days (SWFWMD 2012)

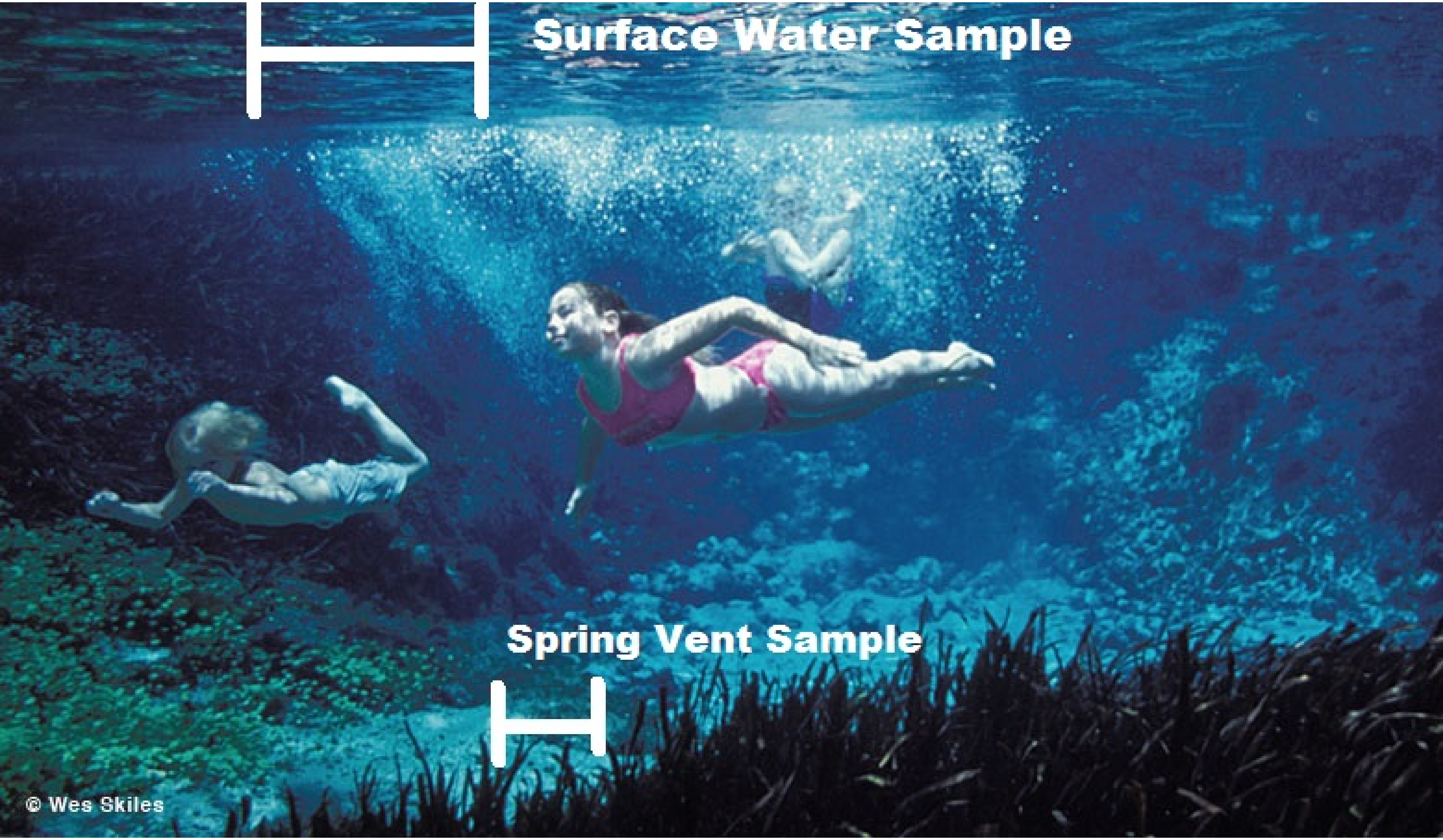
Data Period 1997 - 2007

Water Quality Target Selection for Spring

For TMDL purposes, the 0.23 mg/L Nitrate level from Stevenson et al (2007) is the maximum allowable target limit for the Spring Vents

Establishing **River** Threshold for Total Nitrogen

What happens to the nitrate as it discharges from springs?


Surface Water Sample
Spring Vent Sample
© Wes Skiles

Rapid Dilution and Attenuation

Plants Grow/Die
Converted to
Organic
Nitrogen

Chassahowitzka River

$$\underbrace{\text{NO3}}_{37\%} \quad \underbrace{+\ \text{NH4} + \text{Org N}}_{63\%}$$

TN = NO3 + NH4 + Org N

TN =Total Nitrogen
NO3 = Nitrate
Org N = Organic Nitrogen
NH4 = Ammonium

Establish TN Target for Chassahowitzka River

River CVO v. Spring Vent

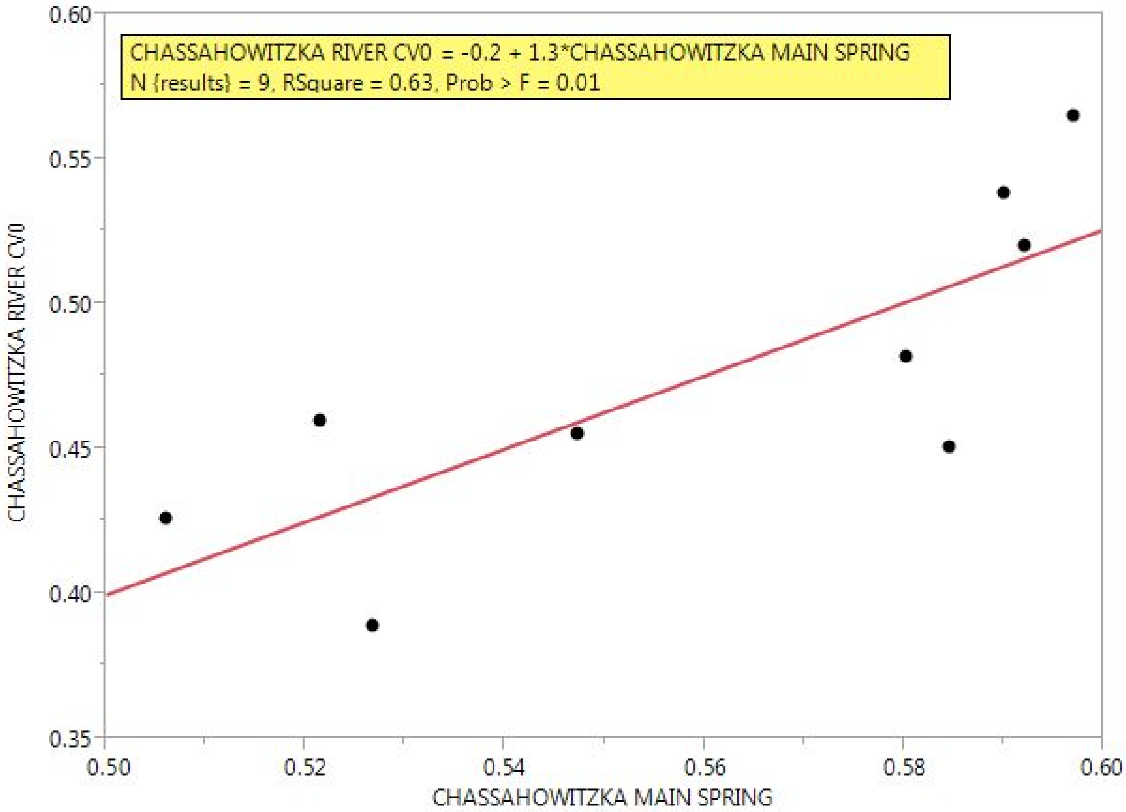


Figure 5.6. **Plot corresponding Chassahowitzka Main Spring and downstream surface water sampling station CV0 nitrate concentrations (mg/L) and regression curve**

0.23 mg/L Nitrate Spring Vent = 0.10 mg/L Nitrate River CVO

Chassahowitzka River CVO: TN v. Nitrate

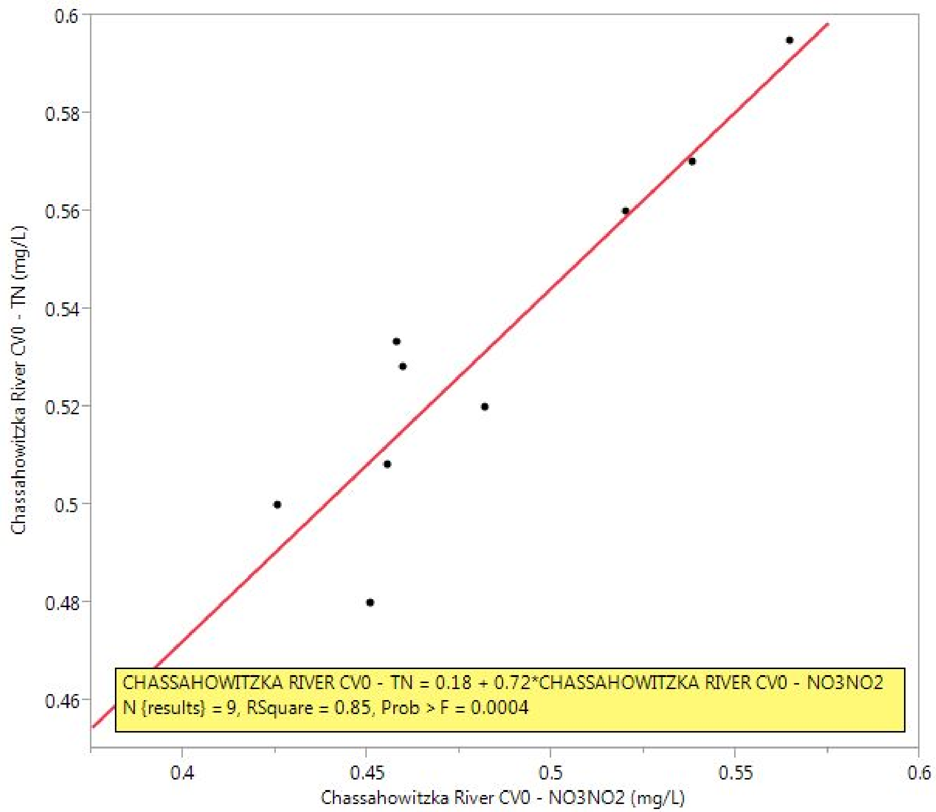


Figure 5.7. Plot for surface water sampling station CV0 corresponding TN and nitrate concentrations (mg/L) and regression curve

0.10 mg/L Nitrate = 0.25 mg/L TN

Water Quality Target Selection for Chassahowitzka River

For TMDL purposes, the 0.25 mg/L TN level is the maximum allowable target limit for Chassahowitzka River

Percent Reduction Calculation

$$\frac{\text{highest annual average concentration} - \text{target concentration}}{\text{highest annual average concentration}} \times 100$$

Waterbody Name (WBID)	Waterbody	Parameter	Year	Highest Annual Average (mg/L)	Nitrogen Target (mg/L)	% Red
Chassahowitzka River	Stream	TN	2010	0.58	0.25	57%
Chassahowitzka Main Spring	Spring	Nitrate	2013	0.60	0.23	62%
Chassahowitzka #1 Spring	Spring	Nitrate	2010 2013	0.64	0.23	64%
Crab Creek Spring	Spring	Nitrate	2010 2013	0.64	0.23	64%
Baird #1 Spring	Spring	Nitrate	2013	0.29	0.23	21%
Ruth Spring	Spring	Nitrate	2013	0.70	0.23	67%
Beteejay Spring	Spring	Nitrate	2010 2013	0.45	0.23	49%

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TMDL Calculation

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{NPDES wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

TMDL = “Point Sources” + “Nonpoint Sources” + Margin of Safety

- Σ = “sum of”
- WLA = “wasteload allocations”
- LA = “load allocations”
- MOS = “margin of safety”

Source categories

<u>Point sources</u>-sources that deliver pollutants directly to the impaired water (like a pipeline); these have NPDES permits (National Pollutant Discharge Elimination System)

<u>Nonpoint sources</u>-the vast majority of the sources in this area; nitrate delivered to springs via ground water transport

Representation of TMDL Allocations

General Categories

- Wasteload Allocations (WLA) = Point Sources
  - NPDES Wastewater & Industrial Facilities
  - NPDES Stormwater Discharges - MS4 permits
    - Represented as a percent reduction
- Load Allocations (LA) = Nonpoint Sources
  - Nonpoint source contributions from Urbanized and Agricultural areas and/or activities not included in MS4s
  - Wastewater Application Sites
  - Septic Tanks (OSTDs)
    - Represented as a percent reduction
- Margin of Safety (MOS)
  - Implicit MOS

Wasteload Allocation

Table 6.2. TMDL components for Chassahowitzka Springs Group, Crab Creek Spring, Chasshowitzka River–Baird Creek, Baird Springs, Ruth Spring and Beteejay Spring

N/A = Not applicable

Waterbody (WBID)	Parameter	TMDL (mg/L)	TMDL % Reduction	Wasteload Allocation for Wastewater	Wasteload Allocation for NPDES Stormwater % Reduction	Load Allocation % Reduction	MOS
Chassahowitzka Main Spring	Nitrate as Annual Average	0.23	62%	N/A	62%	62%	Implicit
Chassahowitzka #1 Spring	Nitrate as Annual Average	0.23	64%	N/A	64%	64%	Implicit
Crab Creek Spring	Nitrate as Annual Average	0.23	64%	N/A	64%	64%	Implicit
Chassahowitzka River-Baird Creek	TN as Annual Average	0.25	57%	N/A	57%	57%	Implicit
Baird #1 Spring	Nitrate as Annual Average	0.23	21%	N/A	21%	21%	Implicit
Ruth Spring	Nitrate as Annual Average	0.23	67%	N/A	67%	67%	Implicit
Beteejay Spring	Nitrate as Annual Average	0.23	49%	N/A	49%	49%	Implicit

Load Allocation

Table 6.2. TMDL components for Chassahowitzka Springs Group, Crab Creek Spring, Chasshowitzka River–Baird Creek, Baird Springs, Ruth Spring and Beteejay Spring

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Crab Creek Spring	Nitrate as Annual Average	0.23	64%	N/A	64%	64%	Implicit
Chassahowitzka River-Baird Creek	TN as Annual Average	0.25	57%	N/A	57%	57%	Implicit
Baird #1 Spring	Nitrate as Annual Average	0.23	21%	N/A	21%	21%	Implicit
Ruth Spring	Nitrate as Annual Average	0.23	67%	N/A	67%	67%	Implicit
Beteejay Spring	Nitrate as Annual Average	0.23	49%	N/A	49%	49%	Implicit

Margin of Safety

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Crab Creek Spring	Nitrate as Annual Average	0.23	64%	N/A	64%	64%	Implicit
Chassahowitzka River-Baird Creek	TN as Annual Average	0.25	57%	N/A	57%	57%	Implicit
Baird #1 Spring	Nitrate as Annual Average	0.23	21%	N/A	21%	21%	Implicit
Ruth Spring	Nitrate as Annual Average	0.23	67%	N/A	67%	67%	Implicit
Beteejay Spring	Nitrate as Annual Average	0.23	49%	N/A	49%	49%	Implicit

Reassessment of the TMDL

"Once the target concentration is consistently achieved, the WBID will be re-evaluated to determine if an imbalance of flora and fauna still exists as a result of algal smothering. If such a condition still exists, the waterbodies (WBIDs) will be reassessed as part of the Department's watershed assessment cycle. The TMDL target concentration may be changed if the Department determines that further reductions are needed to address the imbalance. The purpose of a TMDL is to set a pollutant reduction goal that, if achieved, will result in attainment of the designated uses for that waterbody."

Reassessment of the TMDL

- Waterbodies (WBIDs) reassessed as part of Department's Watershed Assessment Cycle.

- TMDL target concentration may be changed if the Department determines that further reductions are needed to address the imbalance.

For More Information on Draft TMDL

TMDL website:
http://www.dep.state.fl.us/water/tmdl/index.htm

Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
2600 Blair Stone Road, Mail Station 3575
Tallahassee, Florida 32399-2400

Rick Hicks
Richard.W.Hicks@dep.state.fl.us
850-245-8229

Steps Toward Adoption of TMDL

- Draft report comment period ends on October 31, 2014
- After changes are incorporated, final TMDL reviewed by Secretary of FDEP
- Final TMDL adopted Winter
- EPA review for concurrence


Questions?