# Florida Department of Environmental Protection

Water Quality Evaluation & TMDL Program

# Nutrient TMDL for Homosassa-Trotter-Pumphouse Springs Group, Bluebird Springs, and Hidden River Springs (WBIDs 1345G, 1348A, and 1348E)

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 Daily, nor does it need to be a Load**

- 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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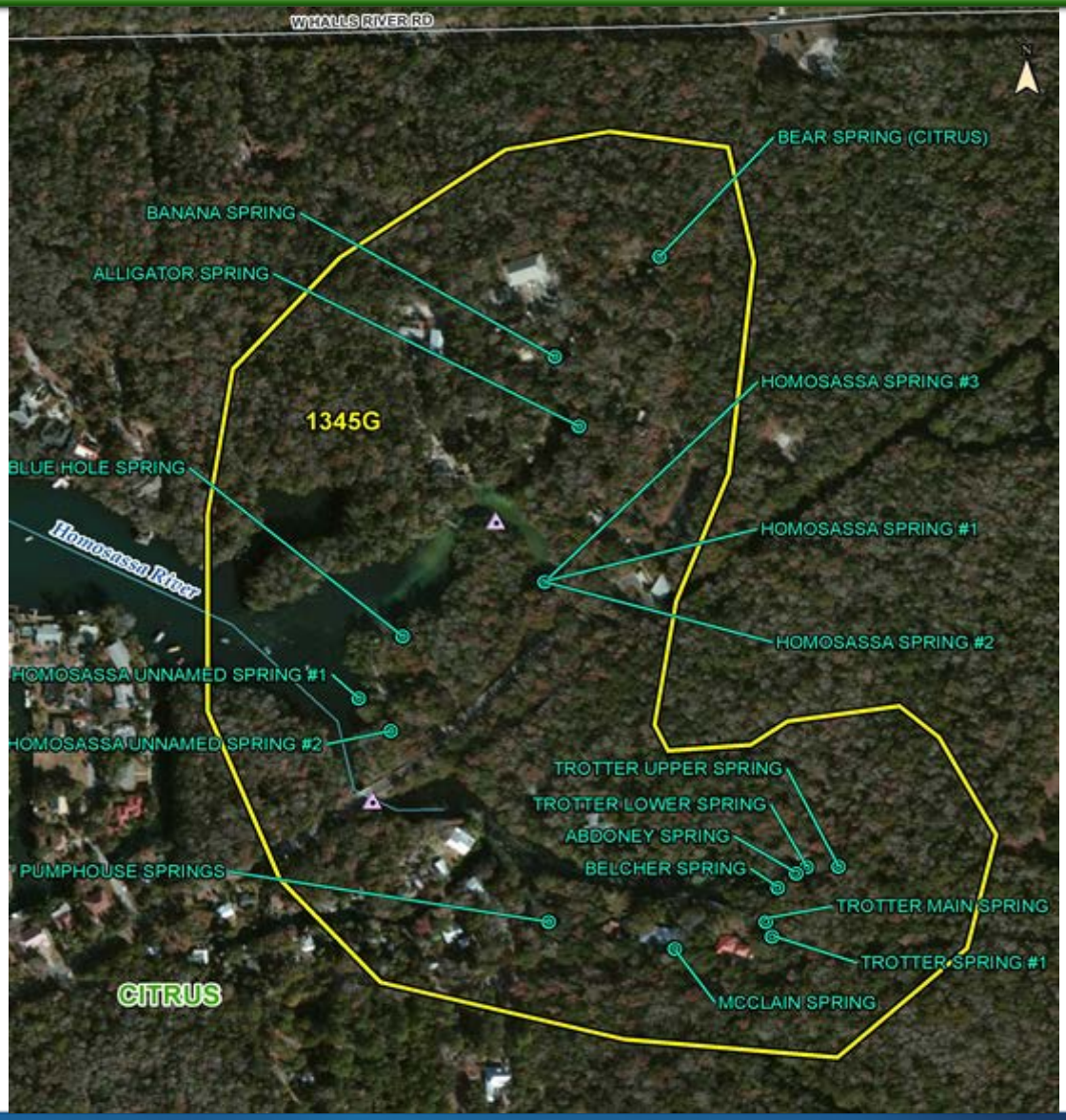
# Florida Impaired Waters Rule (IWR)

- 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

## Sampled Waterbodies

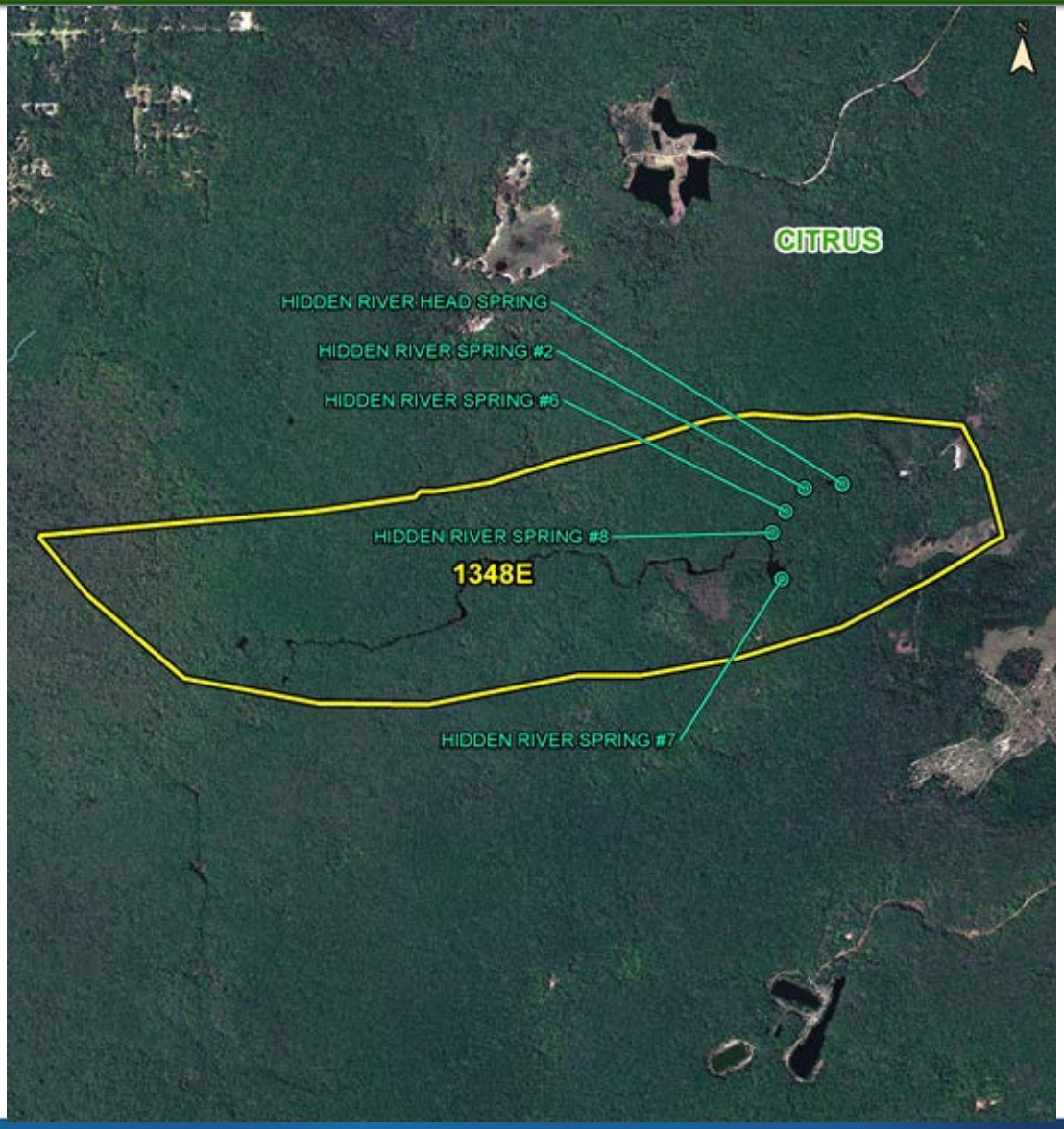
1. Homosassa #1 Spring
2. Homosassa #2 Spring
3. Homosassa #3 Spring
4. Trotter Main Spring
5. Pumphouse Spring



# Location of Impaired Waterbody Segments

**Sampled Waterbodies**

1. Hidden River Head Spring
2. Hidden River #2 Spring



# Location of Impaired Waterbody Segments

**Sampled Waterbodies**

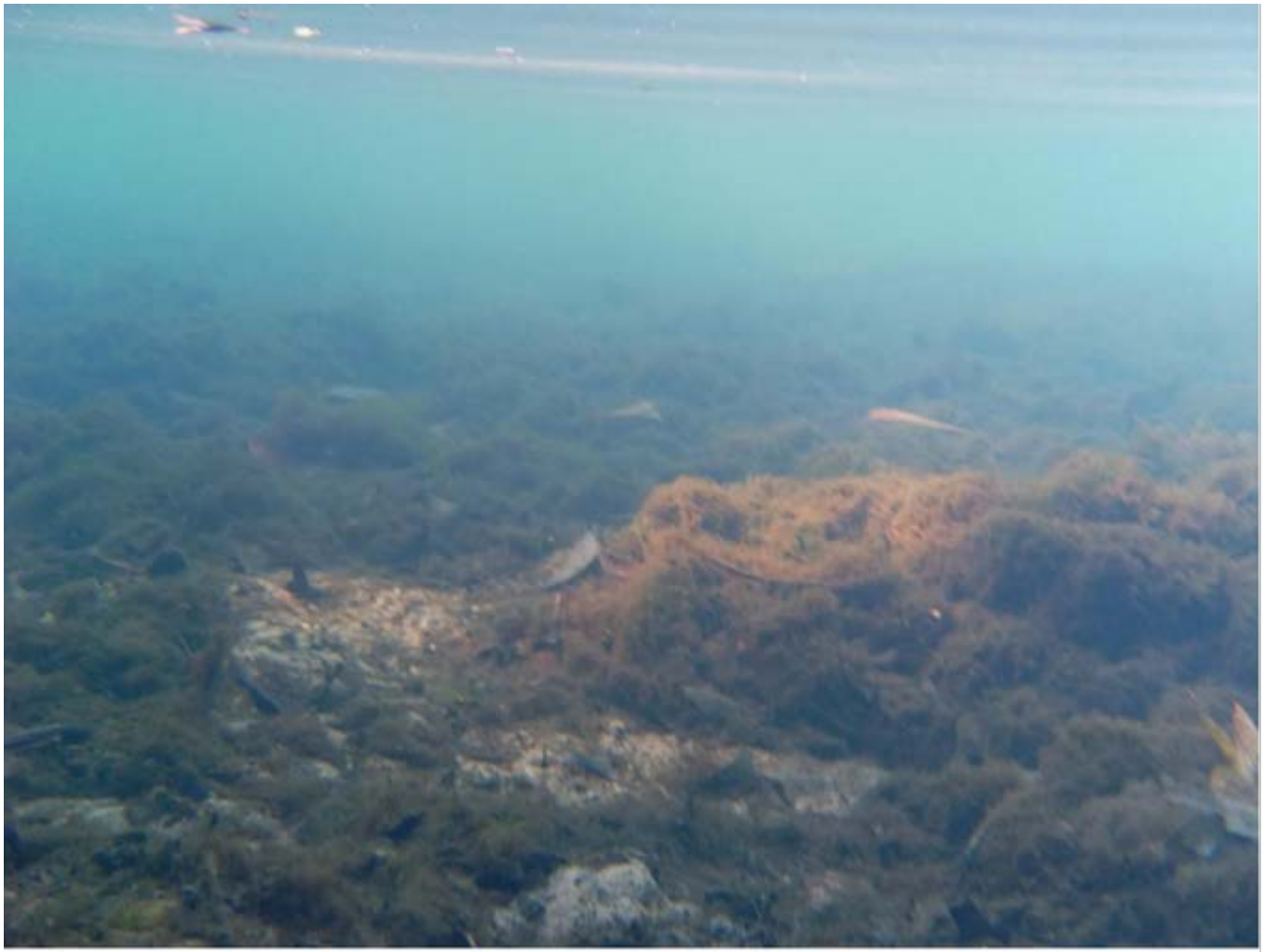
1. Bluebird Springs

# 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 |
|---|---|---|---|---|---|
| 1245G | Homosassa-Trotter-Pumphouse Springs Group | Spring | Nutrients (algal mats) | Balanced natural population of flora and fauna | Impaired |
| 1348A | Bluebird Springs | Spring | Nutrients (algal mats) | Balanced natural population of flora and fauna | Impaired |
| 1348E | Hidden River Springs | Spring | Nutrients (algal mats) | Balanced natural population of flora and fauna | Impaired |

# Elevated nitrate is a major cause of algal growth

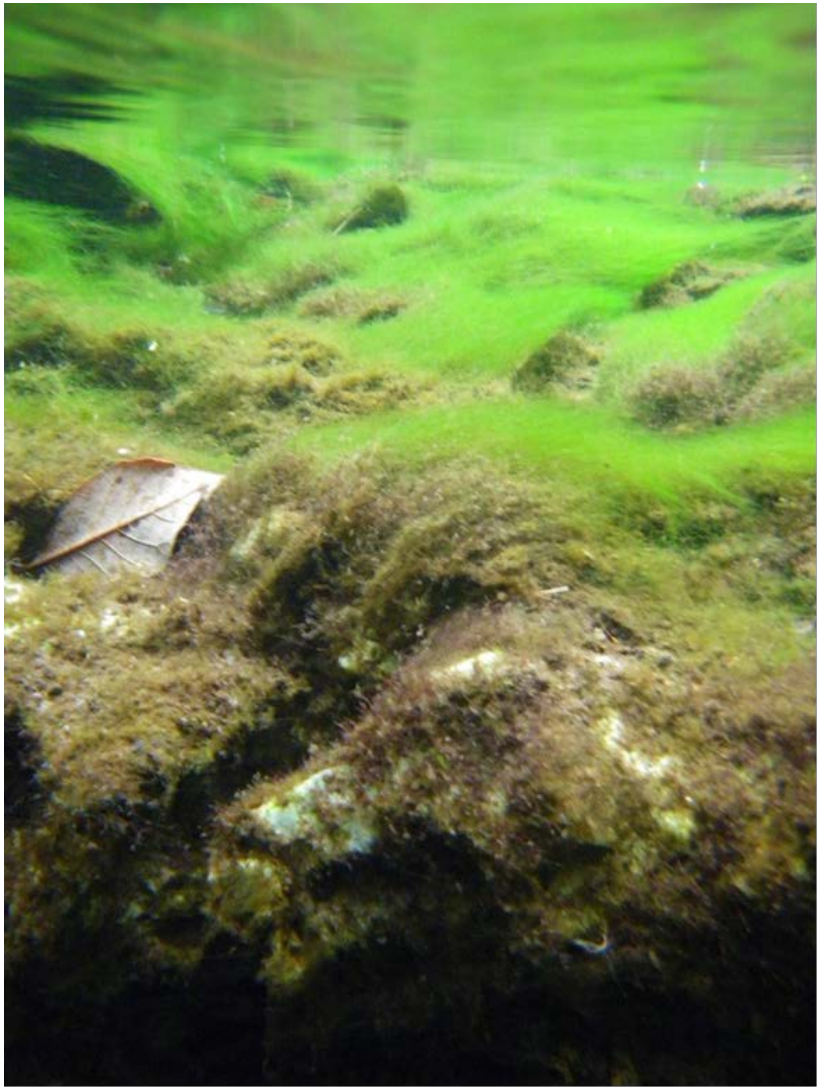


Underwater photo of Homosassa Spring Run algae and leaf litter, December 10, 20

# Elevated nitrate is a major cause of algal growth

Underwater photo of Trotter Spring Run algae and leaf litter, December 10, 2010 (

# Elevated nitrate is a major cause of algal growth

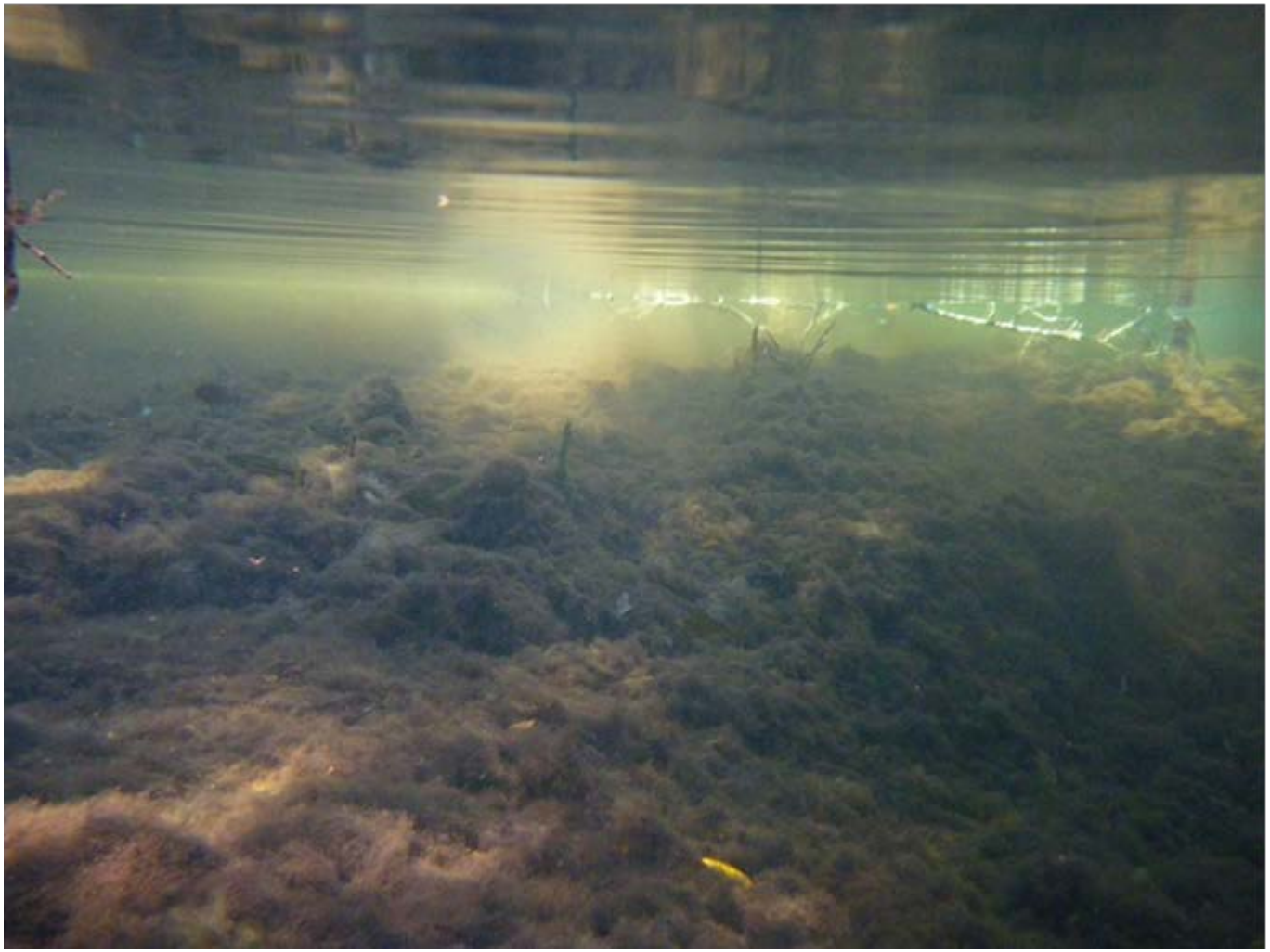


Underwater photo of Pumphouse Spring, December 10, 2010 (FDEP)

# Elevated nitrate is a major cause of algal growth

Underwater photo of Bluebird Spring, December 10, 2010 (FDEP)

# Elevated nitrate is a major cause of algal growth



Underwater photo of Hidden River Spring, January 26, 2011 (FDEP)

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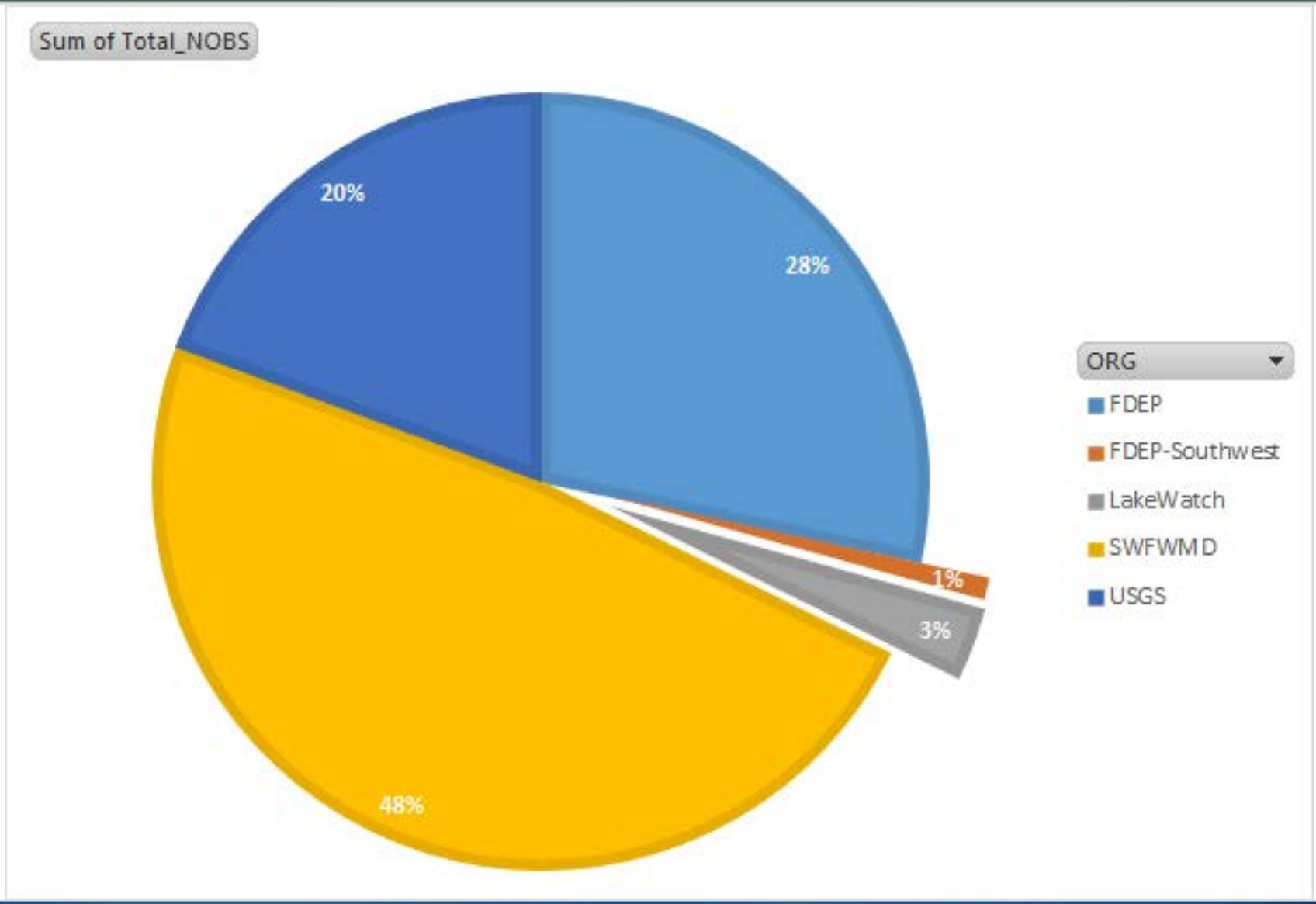

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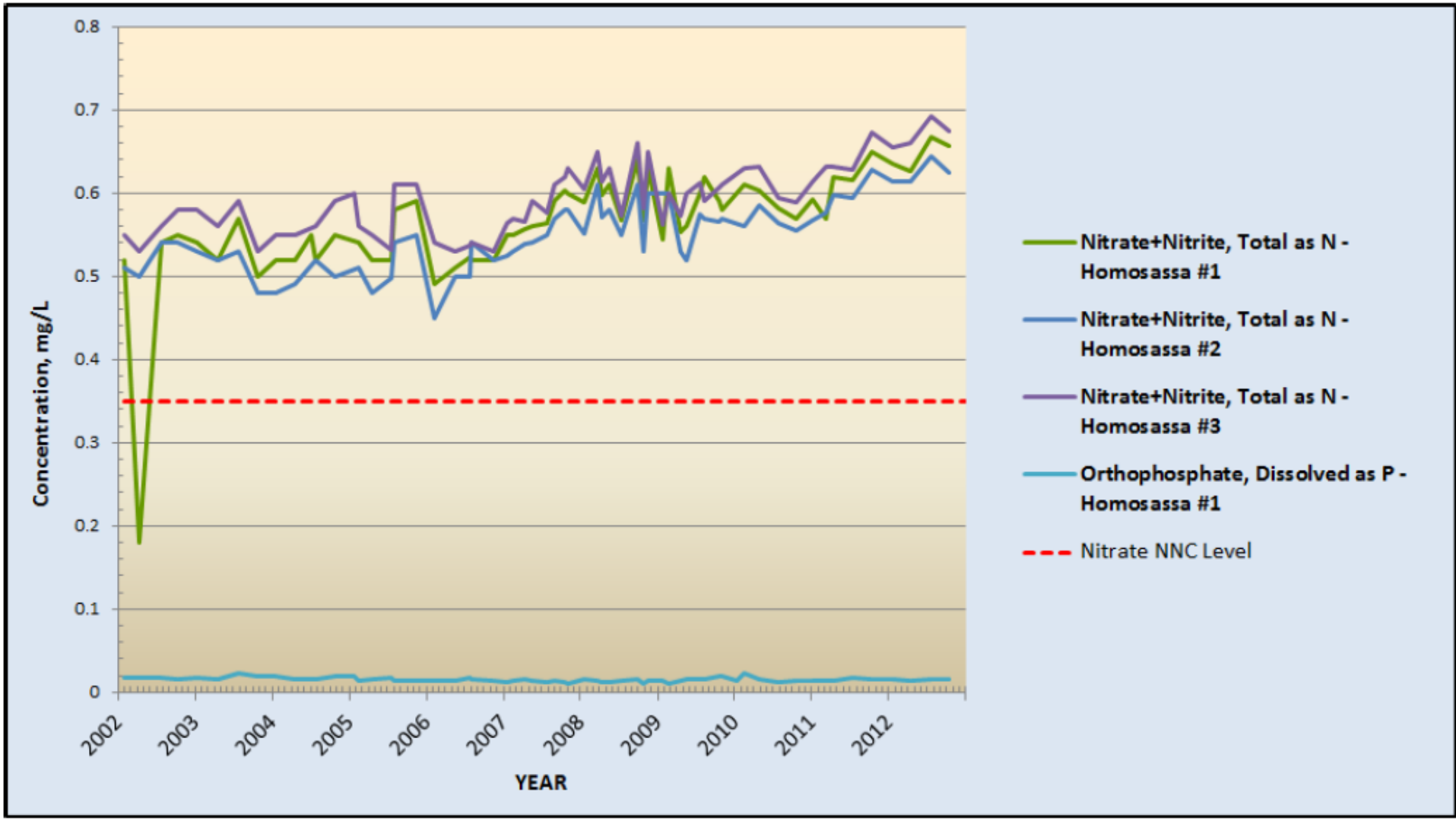
# Nitrate Concentrations have steadily increased



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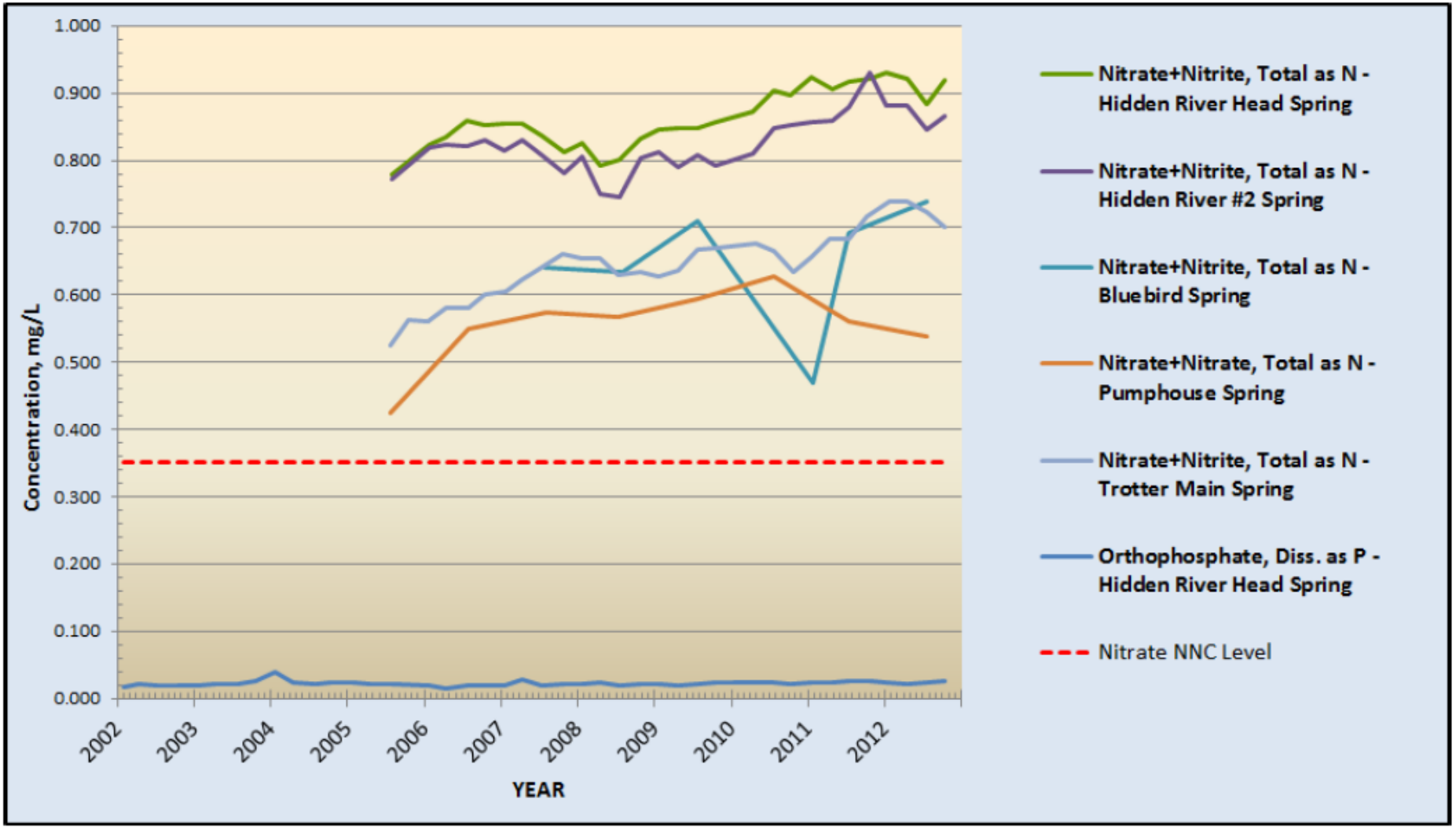

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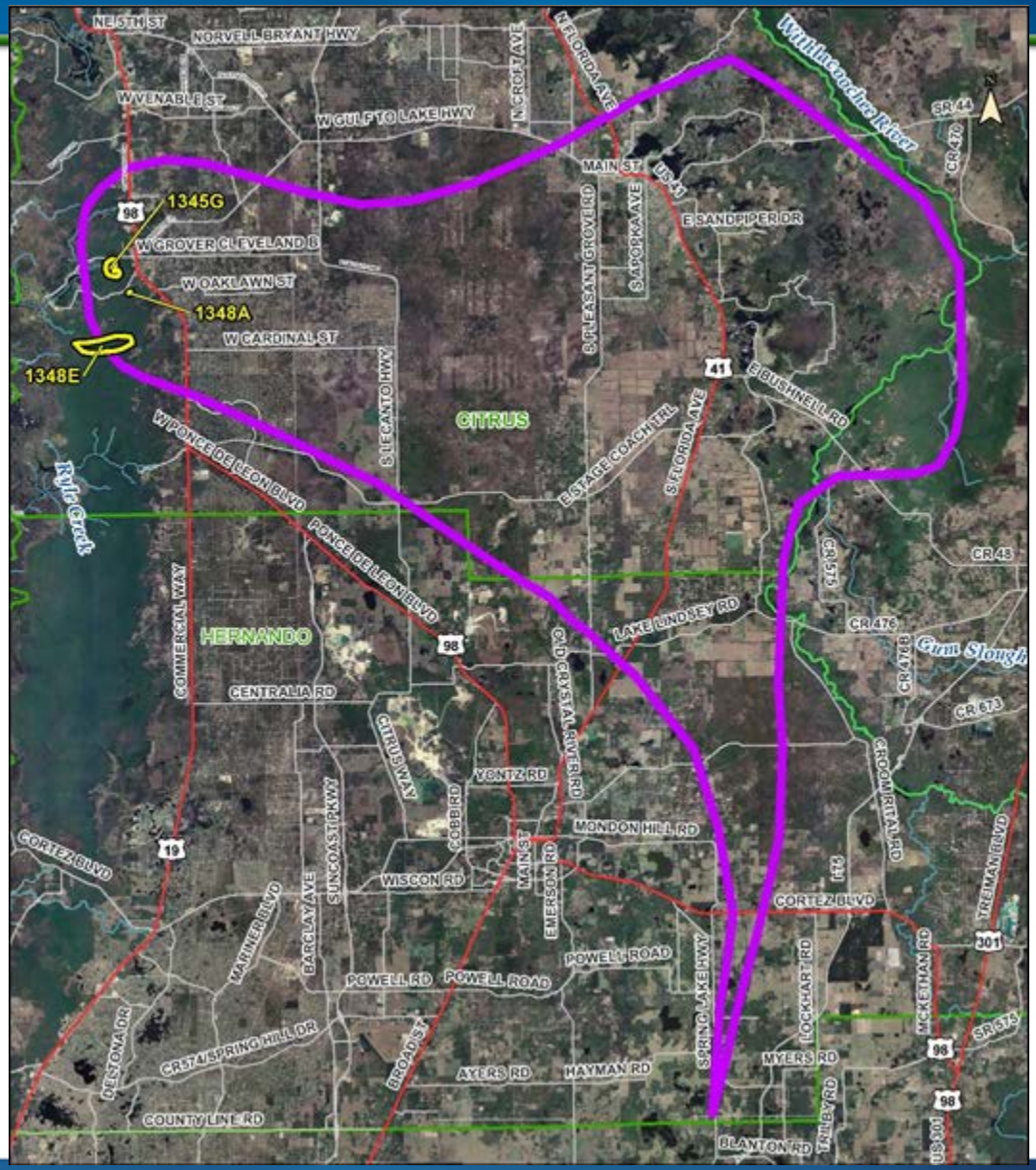
# Contributing Area

Springshed + Watershed = Contributing Area

# Contributing Area for Homosassa

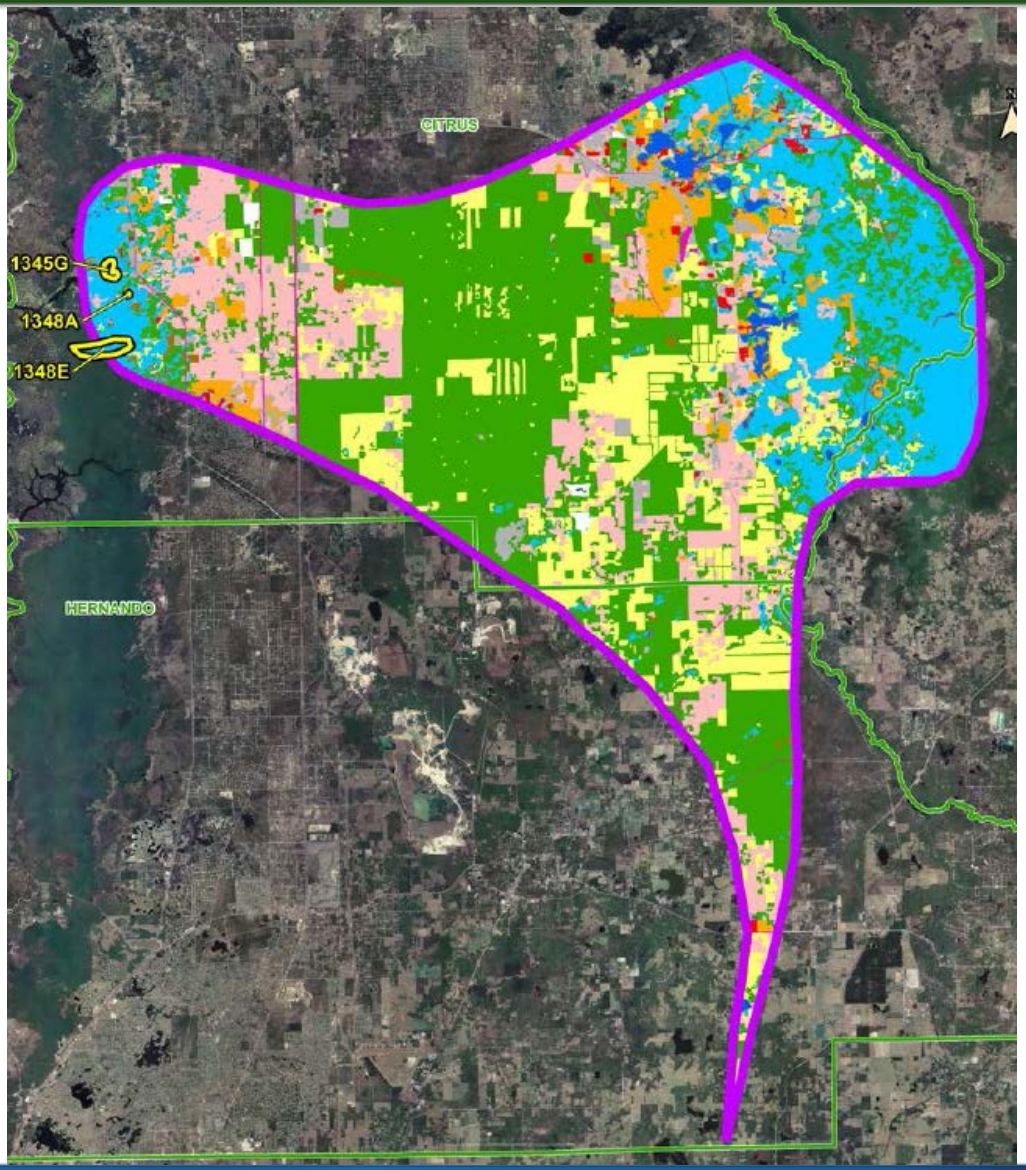
Springshed = USGS Ground Water Feature

Watershed = Surfacewater Feature



# Assessment of potential sources

Estimated
contributing area
(289 square miles)
13% agriculture
21% residential
42% forest
18% 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

**N**itrogen **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 5.1a. Monthly average nitrate concentrations for Homosassa Main #1 Spring, 2004–13**

- = Empty cell/no data

| Month | N | Mean | Max | Min |
|---|---|---|---|---|
| 1 | 8 | 0.58 | 0.64 | 0.52 |
| 2 | 5 | 0.56 | 0.63 | 0.49 |
| 3 | 2 | 0.60 | 0.63 | 0.57 |
| 4 | 9 | 0.58 | 0.63 | 0.52 |
| 5 | 4 | 0.56 | 0.61 | 0.51 |
| 6 | - | - | - | - |
| 7 | 11 | 0.58 | 0.67 | 0.52 |
| 8 | 4 | 0.58 | 0.62 | 0.52 |
| 9 | 1 | 0.64 | 0.64 | 0.64 |
| 10 | 8 | 0.60 | 0.66 | 0.55 |
| 11 | 5 | 0.58 | 0.63 | 0.52 |
| 12 | - | - | - | - |

**Table 5.1e. Monthly average nitrate concentrations for Trotter Main Spring, 2004–13**

- = Empty cell/no data

| Month | N | Mean | Max | Min |
|---|---|---|---|---|
| 1 | 10 | 0.64 | 0.74 | 0.56 |
| 2 | - | - | - | - |
| 3 | - | - | - | - |
| 4 | 10 | 0.64 | 0.74 | 0.53 |
| 5 | - | - | - | - |
| 6 | - | - | - | - |
| 7 | 8 | 0.65 | 0.72 | 0.52 |
| 8 | 2 | 0.63 | 0.65 | 0.61 |
| 9 | - | - | - | - |
| 10 | 10 | 0.65 | 0.72 | 0.56 |
| 11 | - | - | - | - |
| 12 | - | - | - | - |

# Critical Conditions/Seasonality

**Table 5.1d. Monthly average nitrate concentrations for Pumphouse Spring, 2004–13**

- = Empty cell/no data

| Month | N | Mean | Max | Min |
|---|---|---|---|---|
| 1 | 3 | 0.57 | 0.69 | 0.49 |
| 2 | - | - | - | - |
| 3 | - | - | - | - |
| 4 | - | - | - | - |
| 5 | - | - | - | - |
| 6 | - | - | - | - |
| 7 | 8 | 0.56 | 0.63 | 0.42 |
| 8 | 1 | 0.57 | 0.57 | 0.57 |
| 9 | - | - | - | - |
| 10 | - | - | - | - |
| 11 | - | - | - | - |
| 12 | - | - | - | - |

**Table 5.1g. Monthly average nitrate concentrations for Hidden River Head Spring, 2004–13**

- = Empty cell/no data

| Month | N | Mean | Max | Min |
|---|---|---|---|---|
| 1 | 10 | 0.86 | 0.96 | 0.70 |
| 2 | - | - | - | - |
| 3 | - | - | - | - |
| 4 | 10 | 0.85 | 0.97 | 0.71 |
| 5 | - | - | - | - |
| 6 | - | - | - | - |
| 7 | 9 | 0.87 | 0.97 | 0.80 |
| 8 | 1 | 0.78 | 0.78 | 0.78 |
| 9 | - | - | - | - |
| 10 | 9 | 0.87 | 0.92 | 0.81 |
| 11 | - | - | - | - |
| 12 | - | - | - | - |

# Critical Conditions/Seasonality

An Annual Average was used because…

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

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# 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 Homosassa River

- Tidally Influenced
- Shallow Coastal River
- Long Residence Time 6. 2 days (SWFWMD 2012)
- Warm Temperatures
- Increased photozone and accelerated plant growth
- Spring discharge source Upper Floridan, which is very vulnerable to pollutants

# FLD&E and ER&D (1988)

Field Inspection of Homosassa River in 1988

Lyngbya present and 0.34 mg/L Nitrate

# NNC for Springs

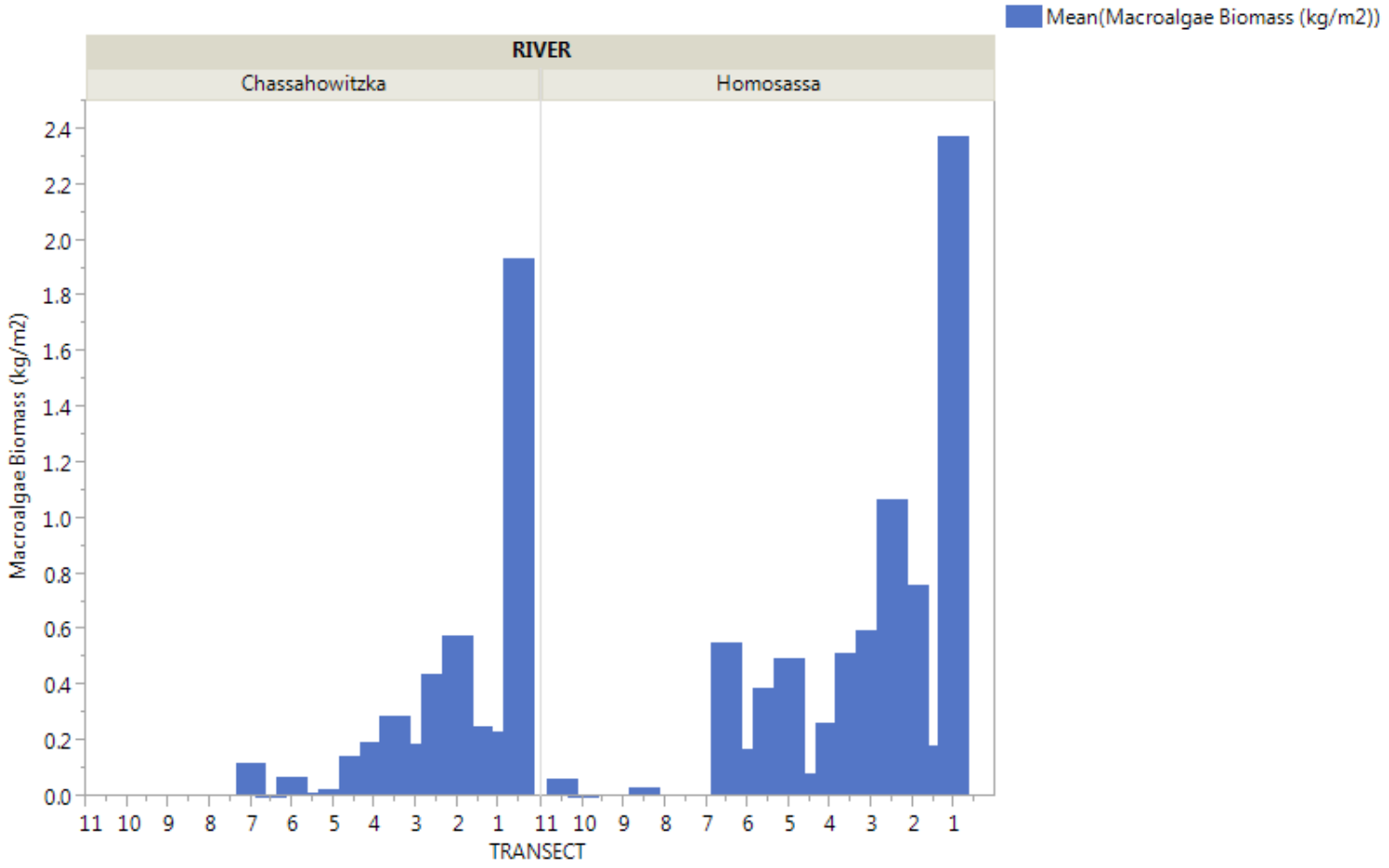
## Numeric Nutrient Criteria for Springs

# 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)

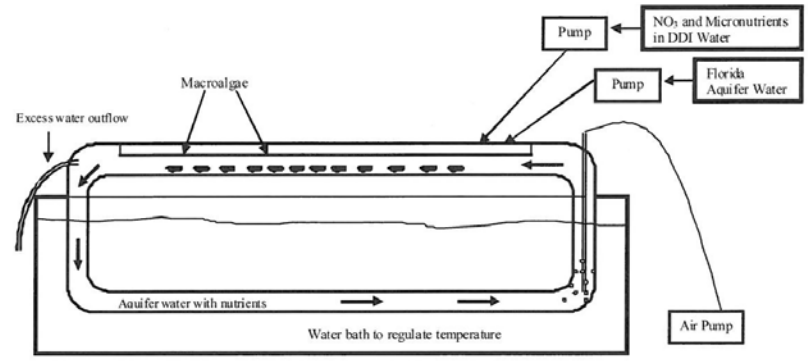



Figure 2-1. Cross-sectional view of a single stream channel.

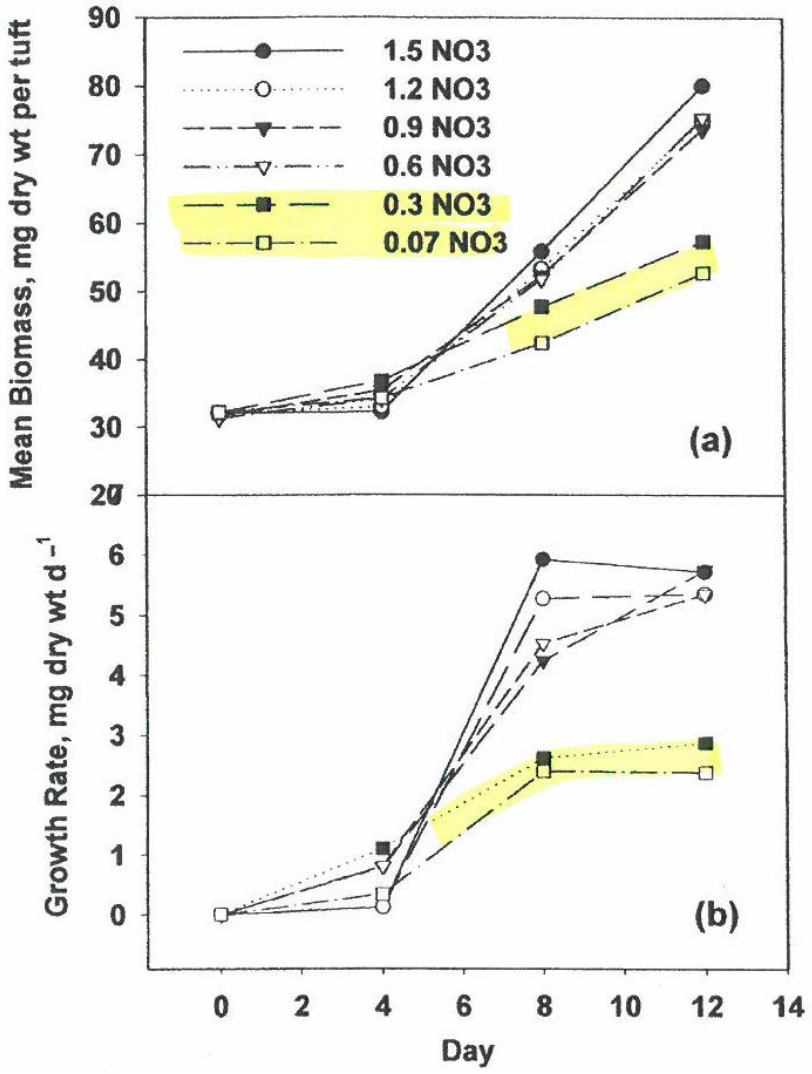
Table 2-10. Estimated effect doses (ED) of $NO_3$ for *Lyngbya wollei*.

| 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) | Benchmark MTM Expt NO3 (mg/L) | Benchmark TP (mg/L) | Benchmark 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<br>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 |

Homosassa River is Considered
Low Flushing Environment

Long Residence Time 6.2 days (SWFWMD 2012)
Data Period 1995 - 2009

# 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

# Percent Reduction Calculation

$$\frac{\text{(highest annual average concentration – target concentration)}}{\text{highest annual average concentration}} \times 100$$

| Waterbody Name (WBID) | Waterbody | Parameter | Year | Highest Annual Average (mg/L) | Nitrogen Target (mg/L) | % Red |
|---|---|---|---|---|---|---|
| Homosassa #1 Spring | Spring | Nitrate | 2012 | 0.65 | 0.23 | 65% |
| Homosassa #2 Spring | Spring | Nitrate | 2012 | 0.62 | 0.23 | 63% |
| Homosassa #3 Spring | Spring | Nitrate | 2012 | 0.67 | 0.23 | 66% |
| Trotter Main Spring | Spring | Nitrate | 2012 | 0.73 | 0.23 | 68% |
| Pumphouse Spring | Spring | Nitrate | 2013 | 0.65 | 0.23 | 65% |
| Bluebird Spring | Spring | Nitrate | 2012 | 0.74 | 0.23 | 69% |
| Hidden River Head Spring | Spring | Nitrate | 2013 | 0.95 | 0.23 | 76% |
| Hidden River #2 Spring | Spring | Nitrate | 2013 | 0.91 | 0.23 | 75% |

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# TMDL Calculation

$$TMDL \cong \sum WLAs_{NPDES\ wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS$$

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

- $\Sigma$ = “sum of”
- WLA = “wasteload allocations”
- LA = “load allocations”
- MOS = “margin of safety”

# Source categories

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

Nonpoint sources-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 Homosassa–Trotter–Pumphouse Springs Group, Bluebird Springs, and Hidden River Springs**

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 |
|---|---|---|---|---|---|---|---|
| Homosassa #1 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 65% | N/A | 65% | 65% | Implicit |
| Homosassa #2 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 63% | N/A | 63% | 63% | Implicit |
| Homosassa #3 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 66% | N/A | 66% | 66% | Implicit |
| Pumphouse Springs (WBID 1345G) | Nitrate as Annual Average | 0.23 | 65% | N/A | 65% | 65% | Implicit |
| Trotter Springs (WBID 1345G) | Nitrate as Annual Average | 0.23 | 68% | N/A | 68% | 68% | Implicit |
| Bluebird Springs (WBID 1348A) | Nitrate as Annual Average | 0.23 | 69% | N/A | 69% | 69% | Implicit |
| Hidden River Main Spring (WBID 1348E) | Nitrate as Annual Average | 0.23 | 76% | N/A | 76% | 76% | Implicit |
| Hidden River #2 Spring (WBID 1348E) | Nitrate as Annual Average | 0.23 | 75% | N/A | 75% | 75% | Implicit |

# Load Allocation

**Table 6.2. TMDL Components for Homosassa–Trotter–Pumphouse Springs Group, Bluebird Springs, and Hidden River Springs**

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 |
|---|---|---|---|---|---|---|---|
| Homosassa #1 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 65% | N/A | 65% | 65% | Implicit |
| Homosassa #2 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 63% | N/A | 63% | 63% | Implicit |
| Homosassa #3 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 66% | N/A | 66% | 66% | Implicit |
| Pumphouse Springs (WBID 1345G) | Nitrate as Annual Average | 0.23 | 65% | N/A | 65% | 65% | Implicit |
| Trotter Springs (WBID 1345G) | Nitrate as Annual Average | 0.23 | 68% | N/A | 68% | 68% | Implicit |
| Bluebird Springs (WBID 1348A) | Nitrate as Annual Average | 0.23 | 69% | N/A | 69% | 69% | Implicit |
| Hidden River Main Spring (WBID 1348E) | Nitrate as Annual Average | 0.23 | 76% | N/A | 76% | 76% | Implicit |
| Hidden River #2 Spring (WBID 1348E) | Nitrate as Annual Average | 0.23 | 75% | N/A | 75% | 75% | Implicit |

# Margin of Safety

**Table 6.2. TMDL Components for Homosassa–Trotter–Pumphouse Springs Group, Bluebird Springs, and Hidden River Springs**

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 |
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| Homosassa #3 Spring (WBID 1345G) | Nitrate as Annual Average | 0.23 | 66% | N/A | 66% | 66% | Implicit |
| Pumphouse Springs (WBID 1345G) | Nitrate as Annual Average | 0.23 | 65% | N/A | 65% | 65% | Implicit |
| Trotter Springs (WBID 1345G) | Nitrate as Annual Average | 0.23 | 68% | N/A | 68% | 68% | Implicit |
| Bluebird Springs (WBID 1348A) | Nitrate as Annual Average | 0.23 | 69% | N/A | 69% | 69% | Implicit |
| Hidden River Main Spring (WBID 1348E) | Nitrate as Annual Average | 0.23 | 76% | N/A | 76% | 76% | Implicit |
| Hidden River #2 Spring (WBID 1348E) | Nitrate as Annual Average | 0.23 | 75% | N/A | 75% | 75% | 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**

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# 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?