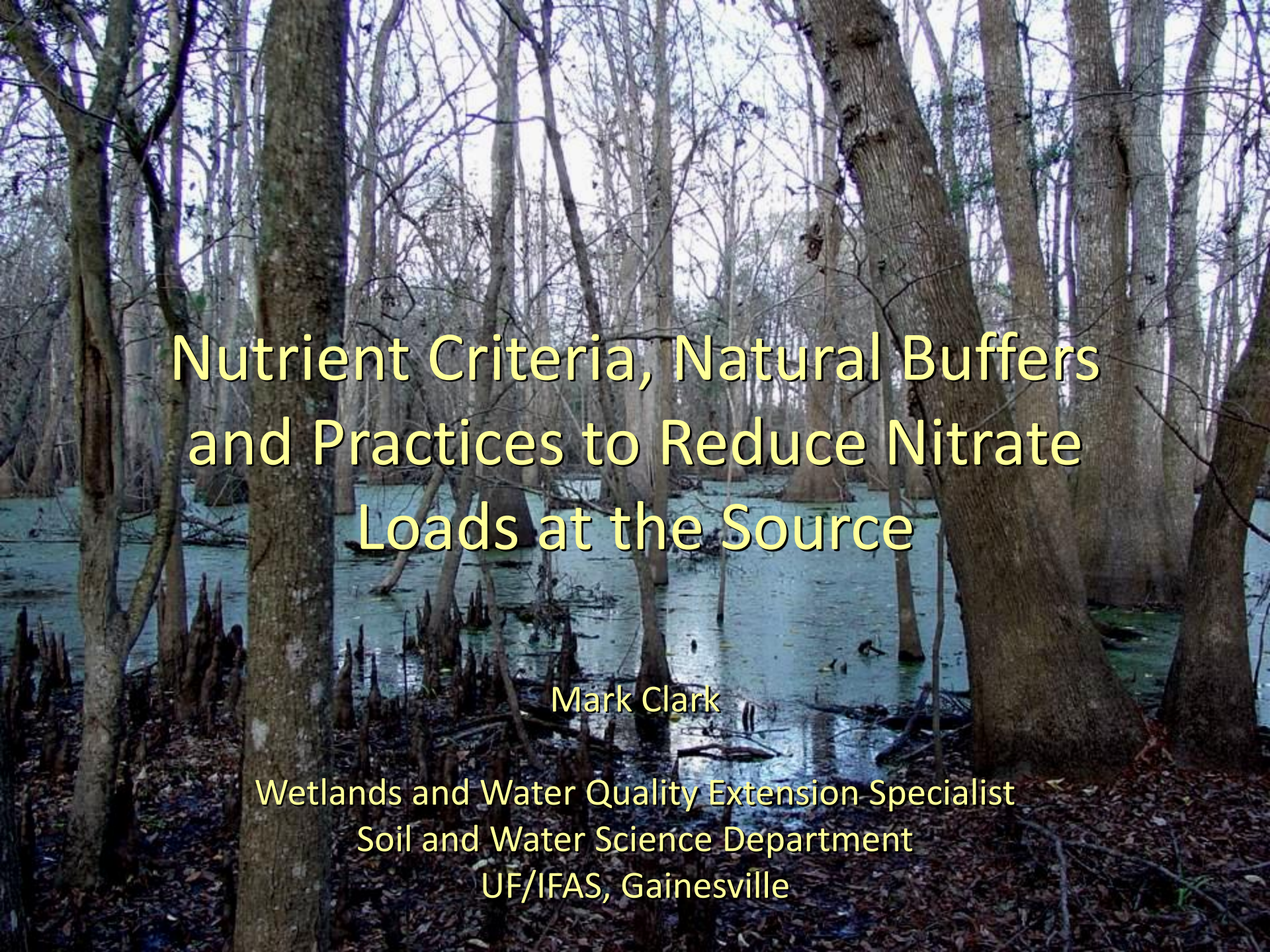


Nutrient Criteria, Natural Buffers and Practices to Reduce Nitrate Loads at the Source

Mark Clark

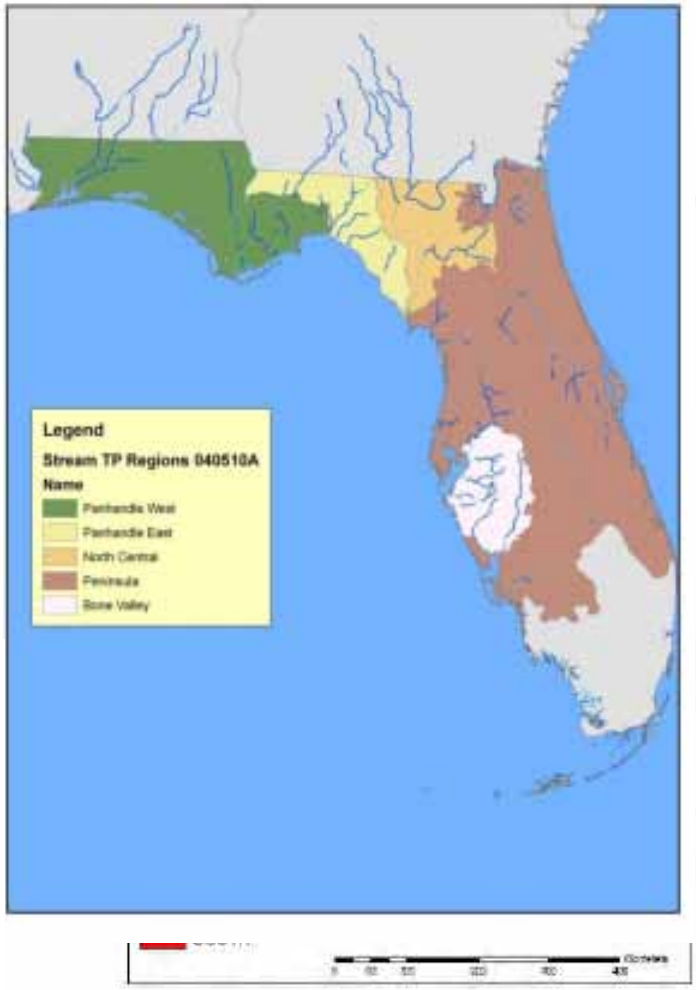
Wetlands and Water Quality Extension Specialist
Soil and Water Science Department
UF/IFAS, Gainesville

Overview

- Numeric nutrient criteria for streams (and spring?)
- Wetland buffers and nitrate reduction in a tributary of the middle Santa Fe River Basin
- Nitrate source controls in a container nursery
  - Fine tuning irrigation
  - Surface runoff interception and treatment
  - Groundwater interception and treatment

EPA's Stream Protection Criteria for Total Nitrogen and Phosphorus

Nutrient Watershed Region (NWR)	Instream Protection Value Criteria	
	TN (mg/L)	TP (mg/L)
Panhandle West	0.67	0.06
Panhandle East	1.03	0.18
West Central	1.65	0.49
Peninsula	1.54	0.12
North Central	1.87	0.30



In-stream protection <u>and</u> downstream protection

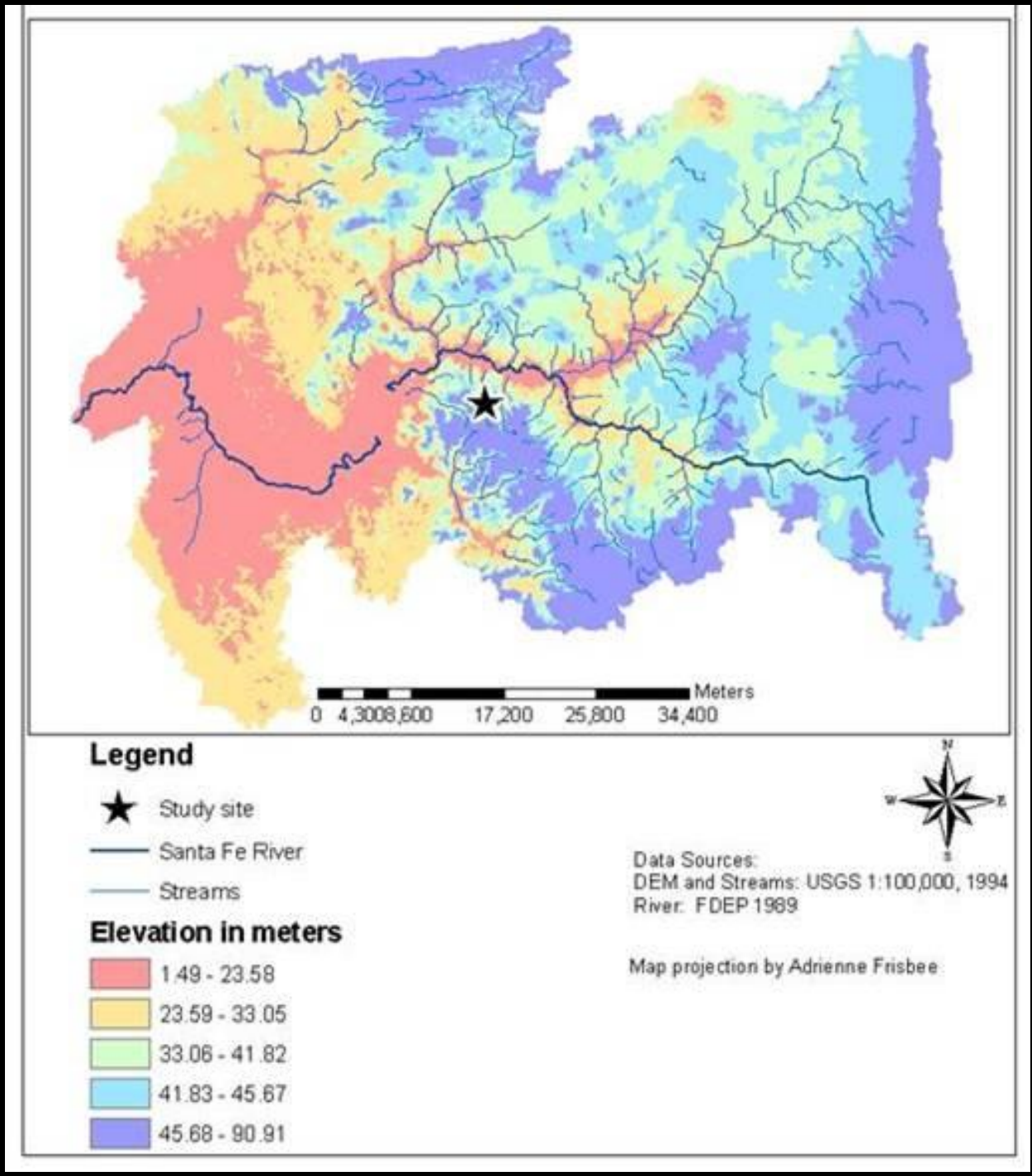
Criteria for Springs

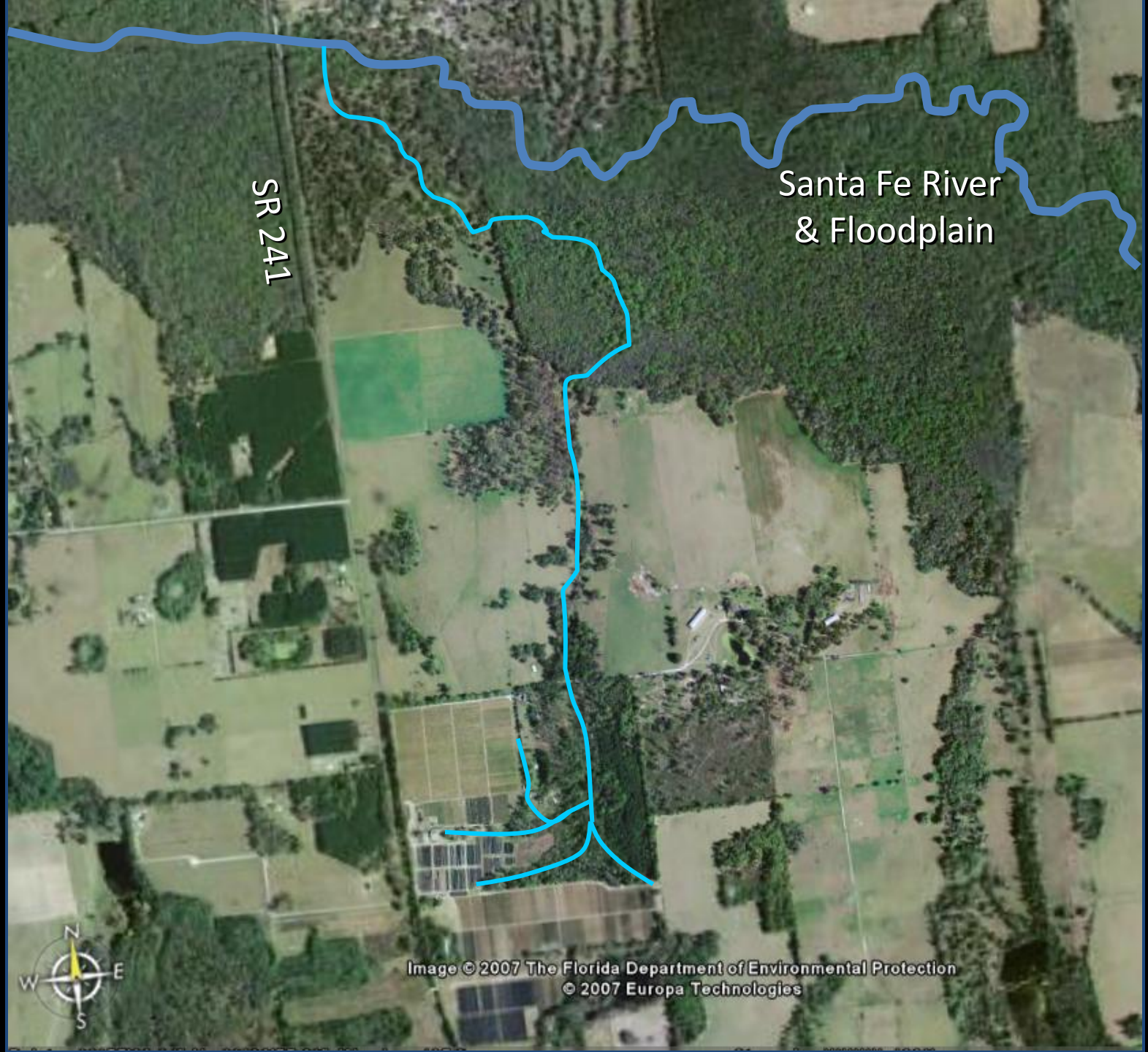
- Definition
  - "Spring" means a site at which ground water flows through a natural opening in the ground onto the land surface or into a body of surface water

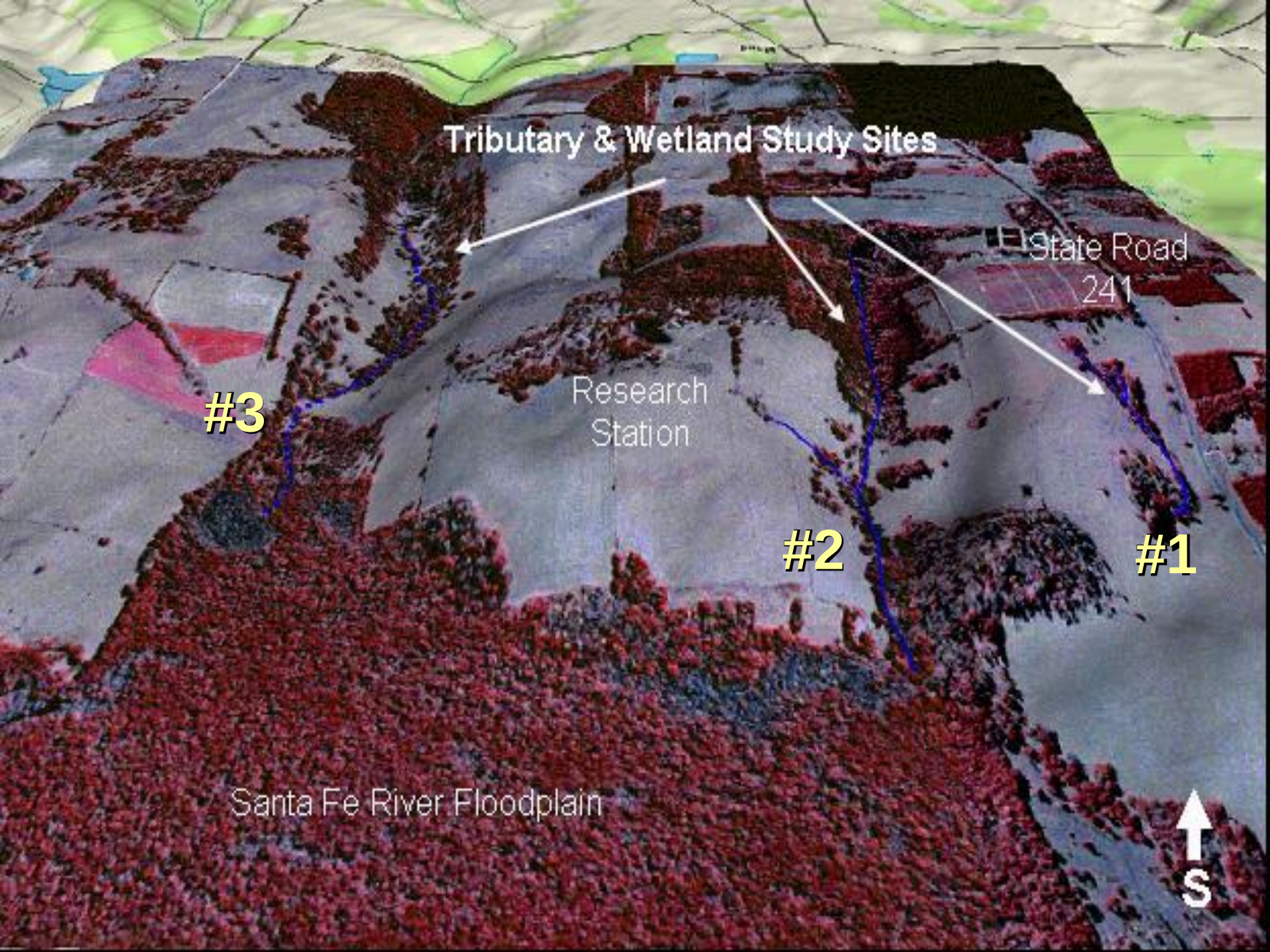
- Rule
  - Establishes nitrate-nitrite criterion of 0.35 mg/L as an annual geometric mean, not to be exceeded more than once in a three year period

Study Site

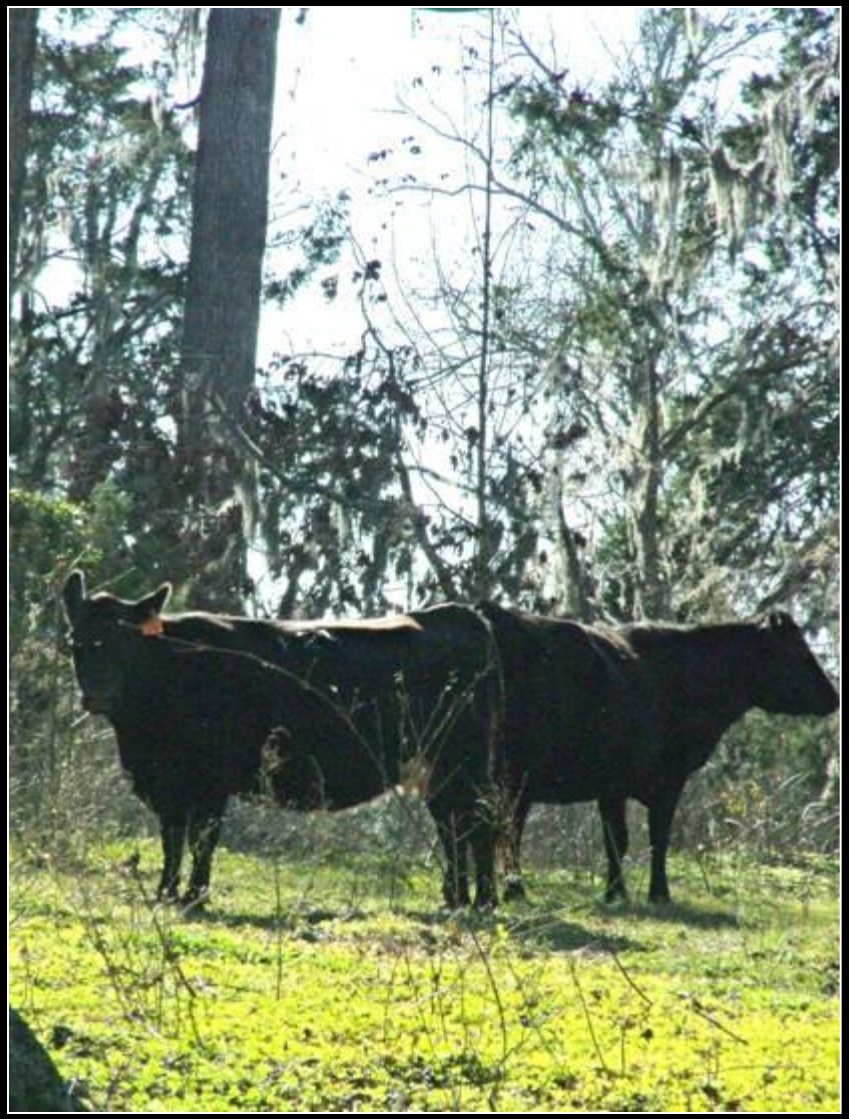
A tributary in the Middle Santa Fe River Watershed




SR 241
Santa Fe River
& Floodplain
N
E
W
S
Image © 2007 The Florida Department of Environmental Protection
© 2007 Europa Technologies

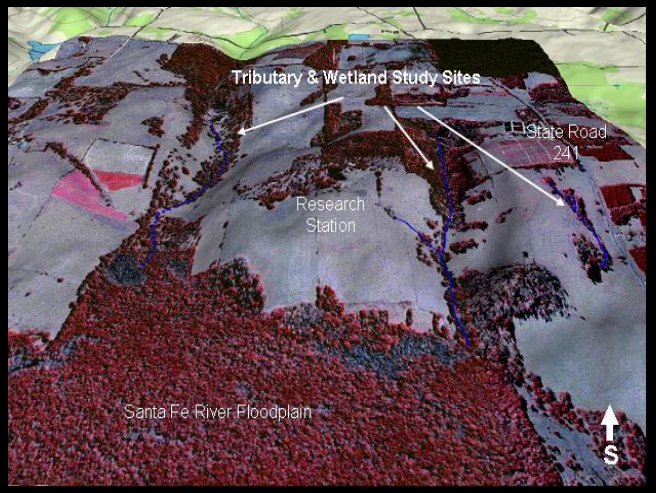

Tributary & Wetland Study Sites
State Road 241
Research Station
#3
#2
#1
Santa Fe River Floodplain
S

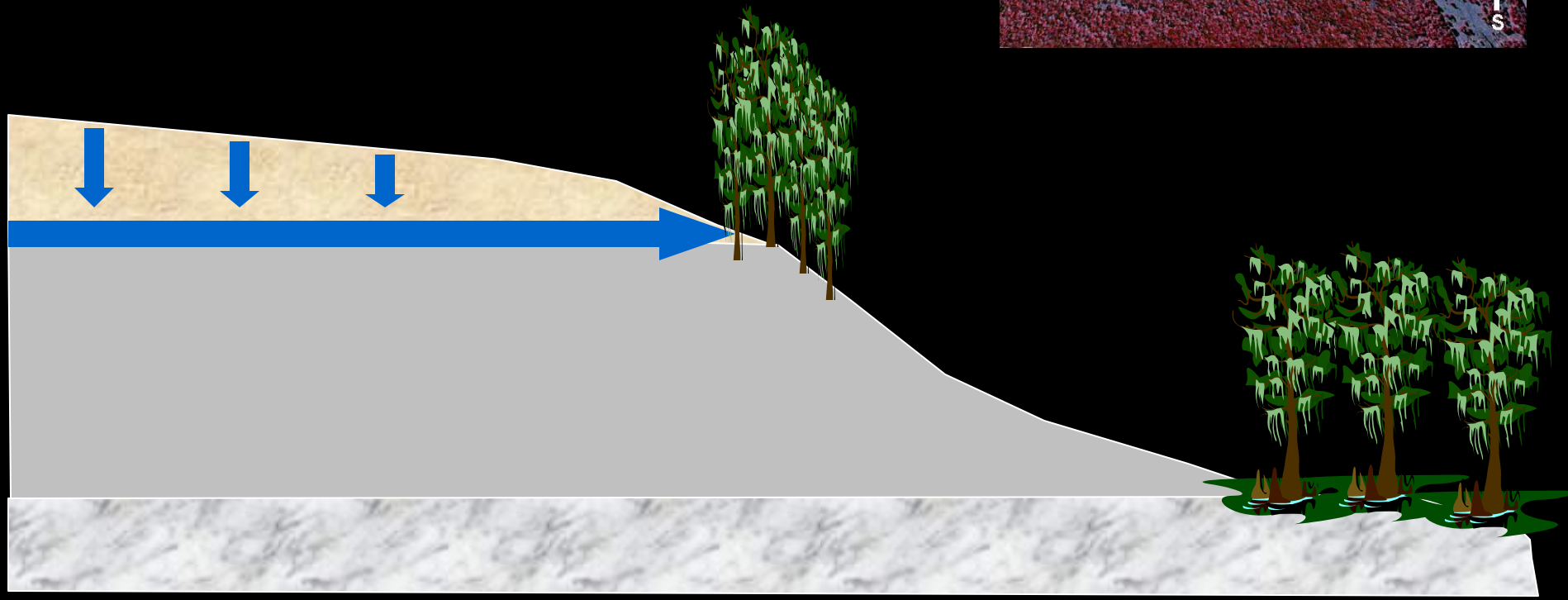
Land Use



Soils and Geology

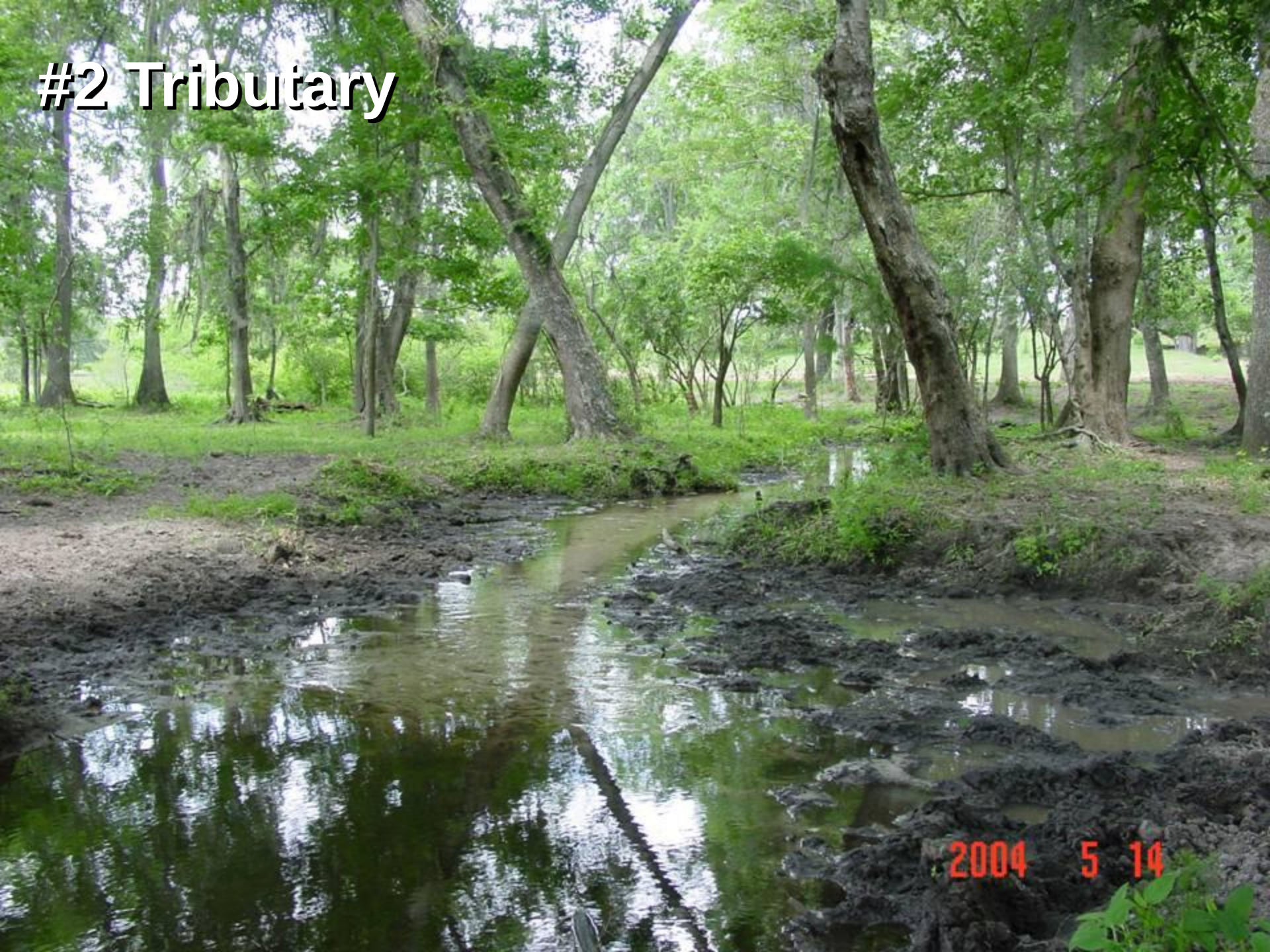
Geology


Tributary & Wetland Study Sites
State Road 241
Research Station
Santa Fe River Floodplain
S

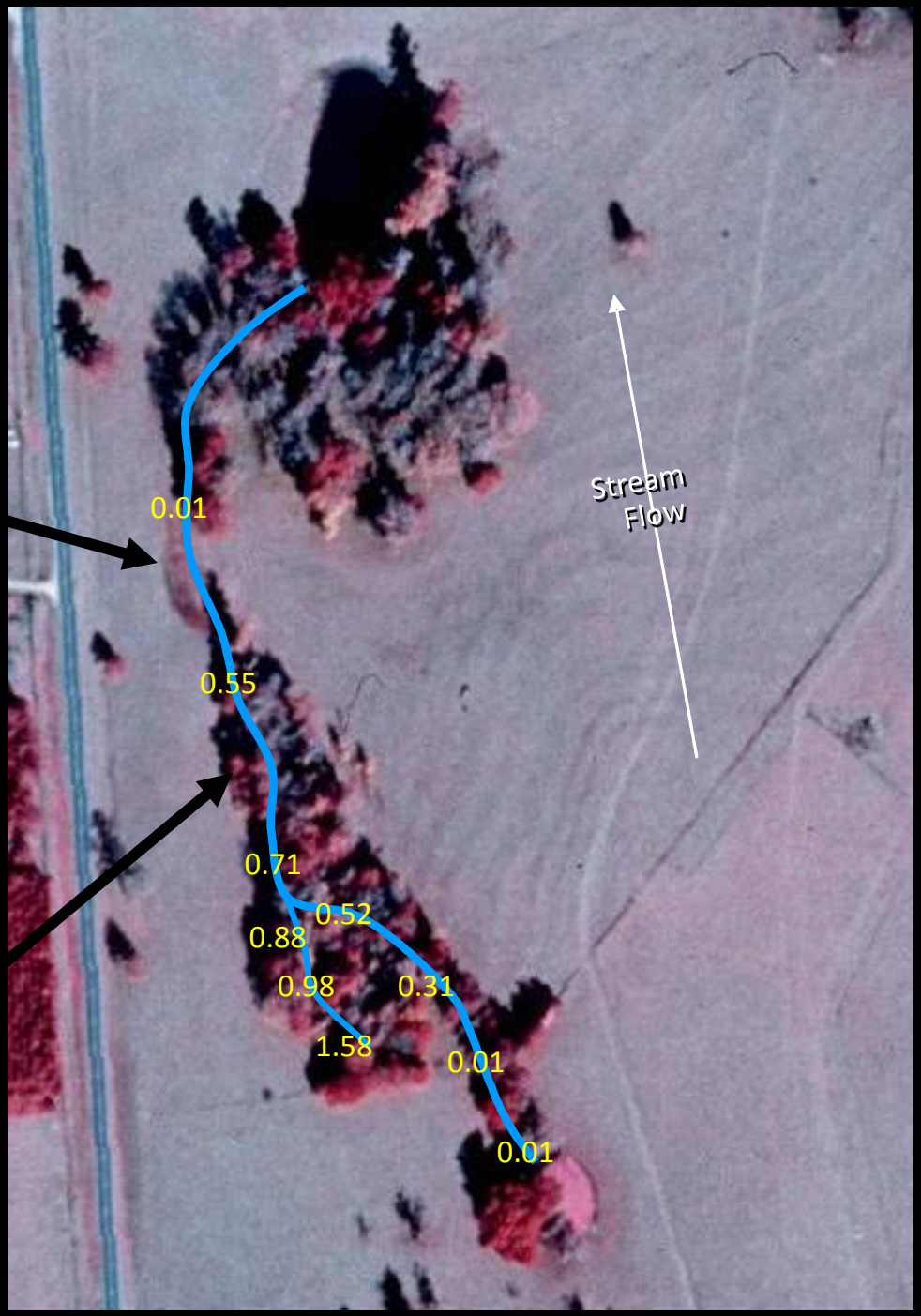



#3 Tributary
2004 5 14

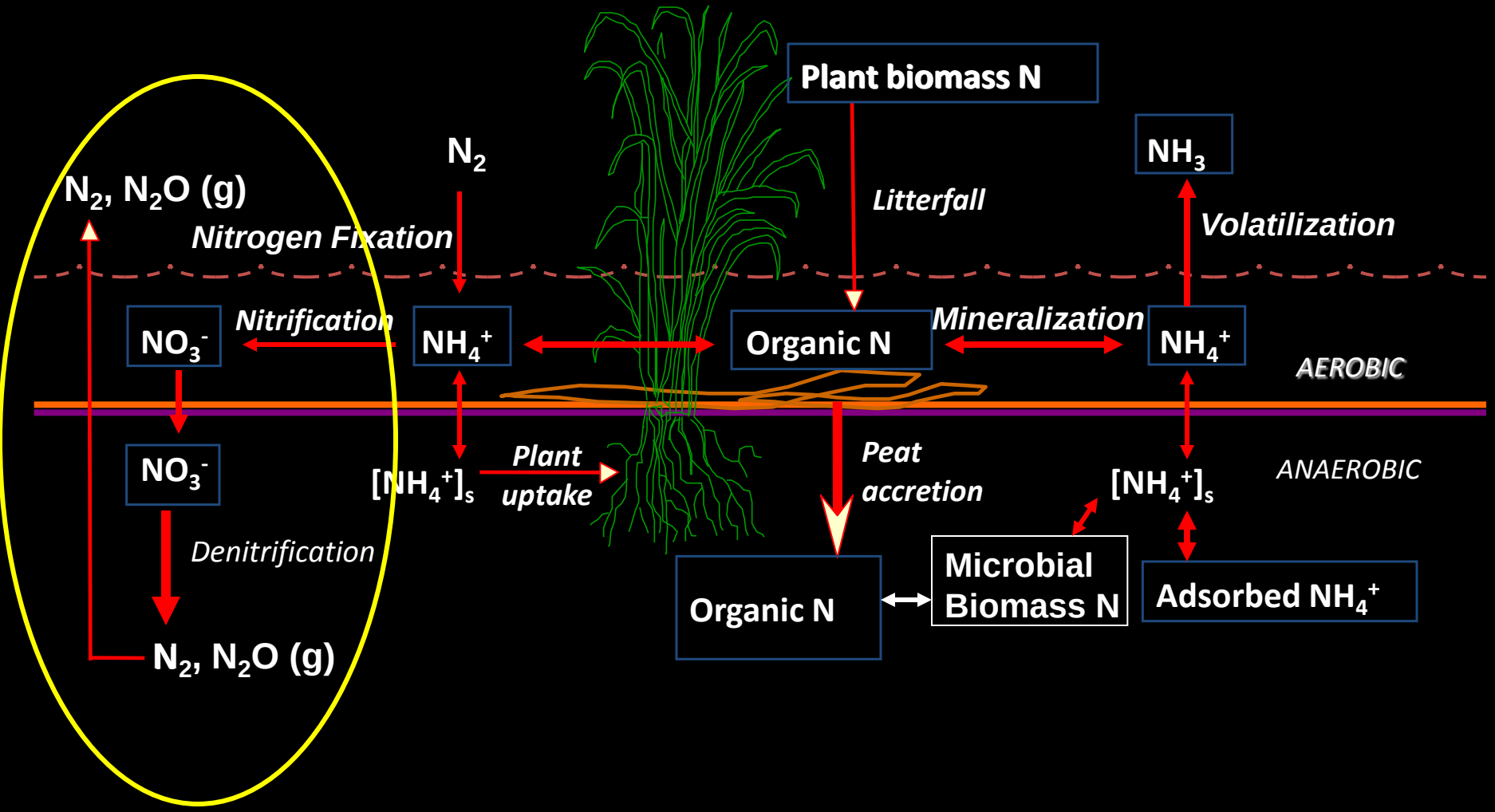
#3 Tributary

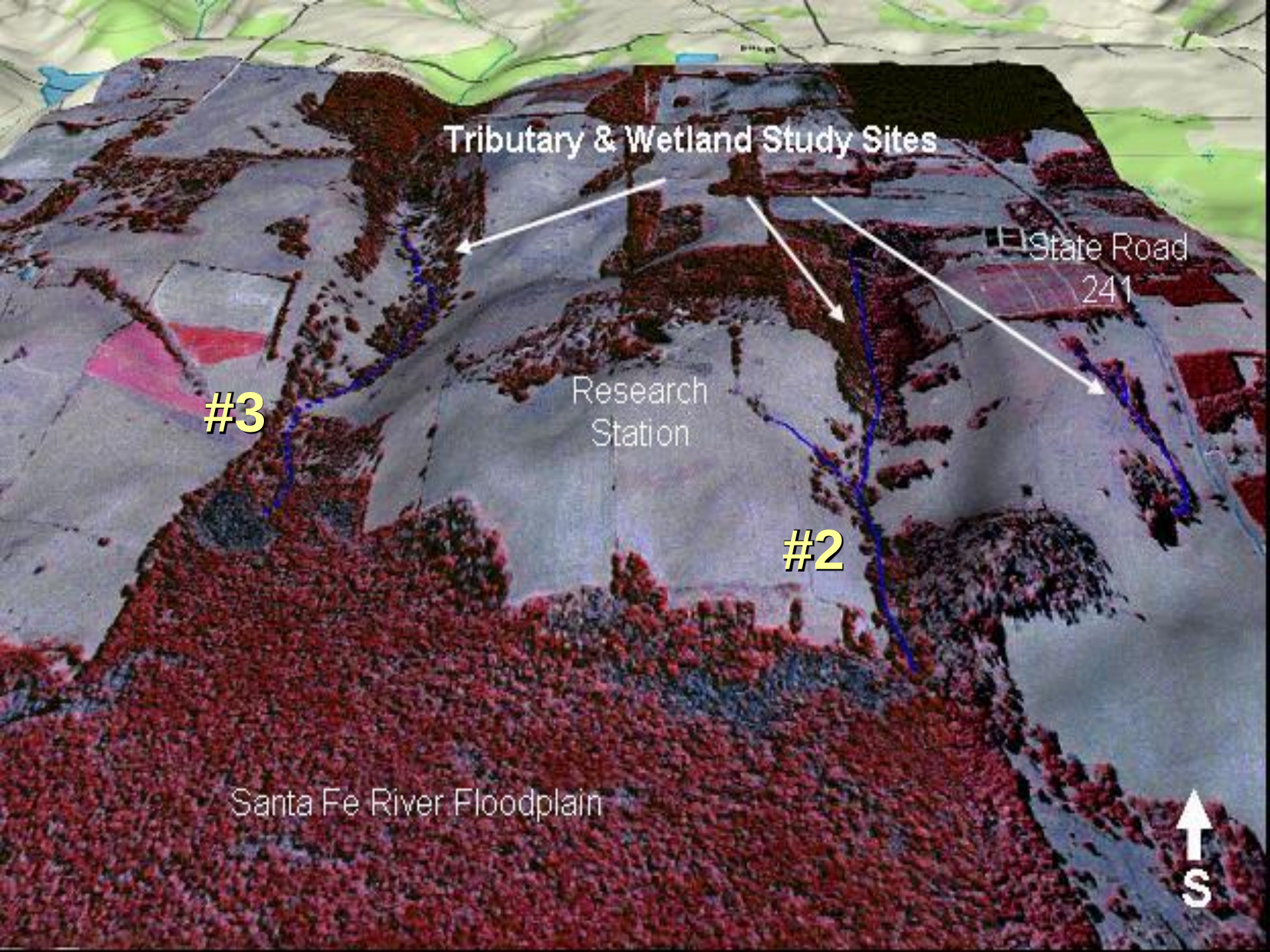

#2 Tributary
2004 5 14

#1 Tributary



Nitrogen Cycling in Wetlands




Tributary & Wetland Study Sites
State Road 241
Research Station
#3
#2
Santa Fe River Floodplain
S

2005 Average Nitrate Concentration in Tributaries

	Tributary 2 (mg/L)			Tributary 3 (mg/L)		
March	5.37	±	0.91	0.014	±	0.007
April	4.56	±	1.72	0.058	±	0.027
May	5.29	±	0.68	0.026	±	0.055
June	4.42	±	0.69	0.030	±	0.028
August	4.03	±	0.70	0.035	±	0.040
September	4.57	±	0.45	0.010	±	0.004
October	5.73	±	0.80	0.017	±	0.006
November	4.88	±	0.89	0.027	±	0.041

Depositional Woody

Slightly Incised Woody

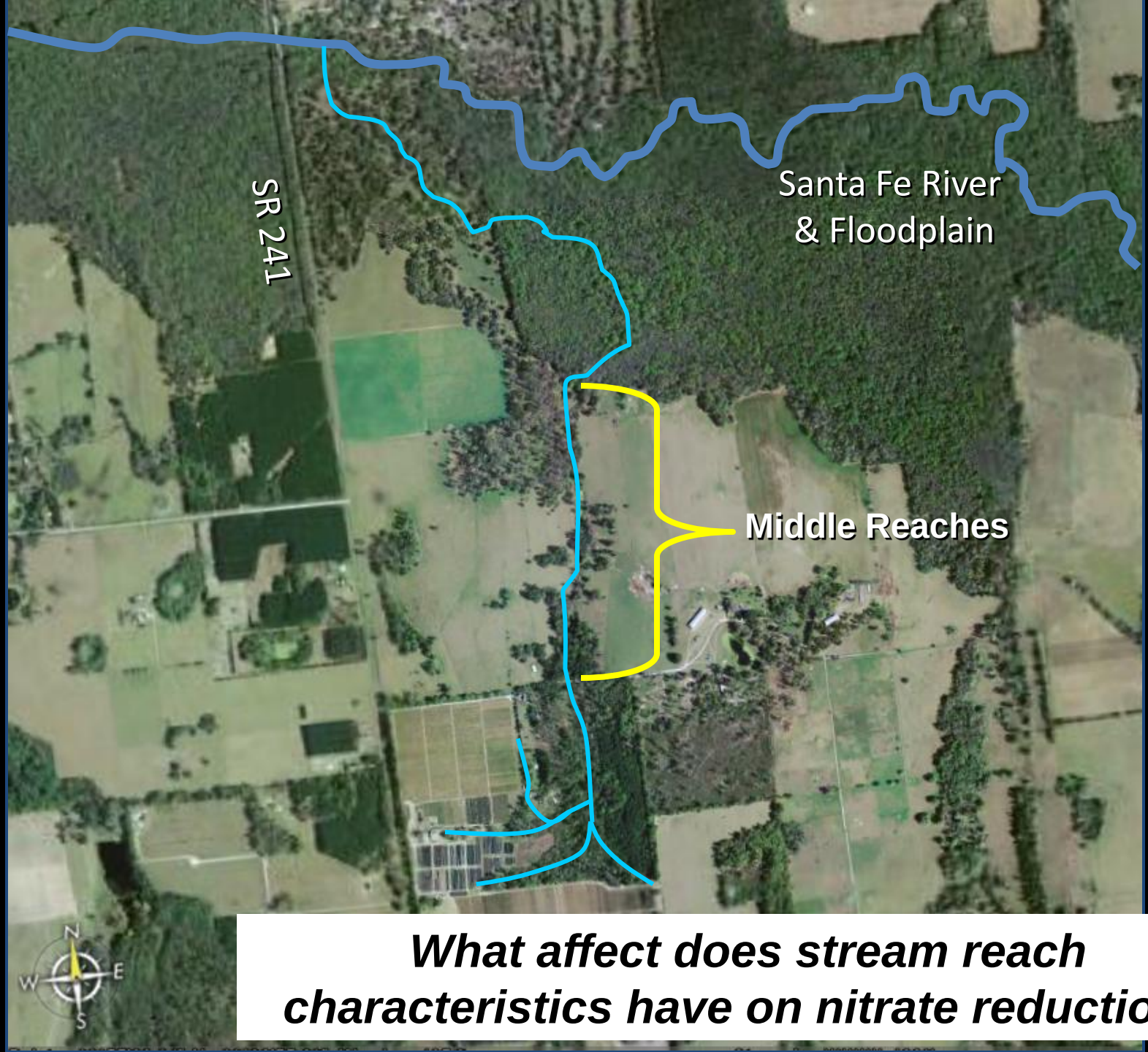
Moderately Incised Woody

Deeply Incised Woody

Depositional Herbaceous

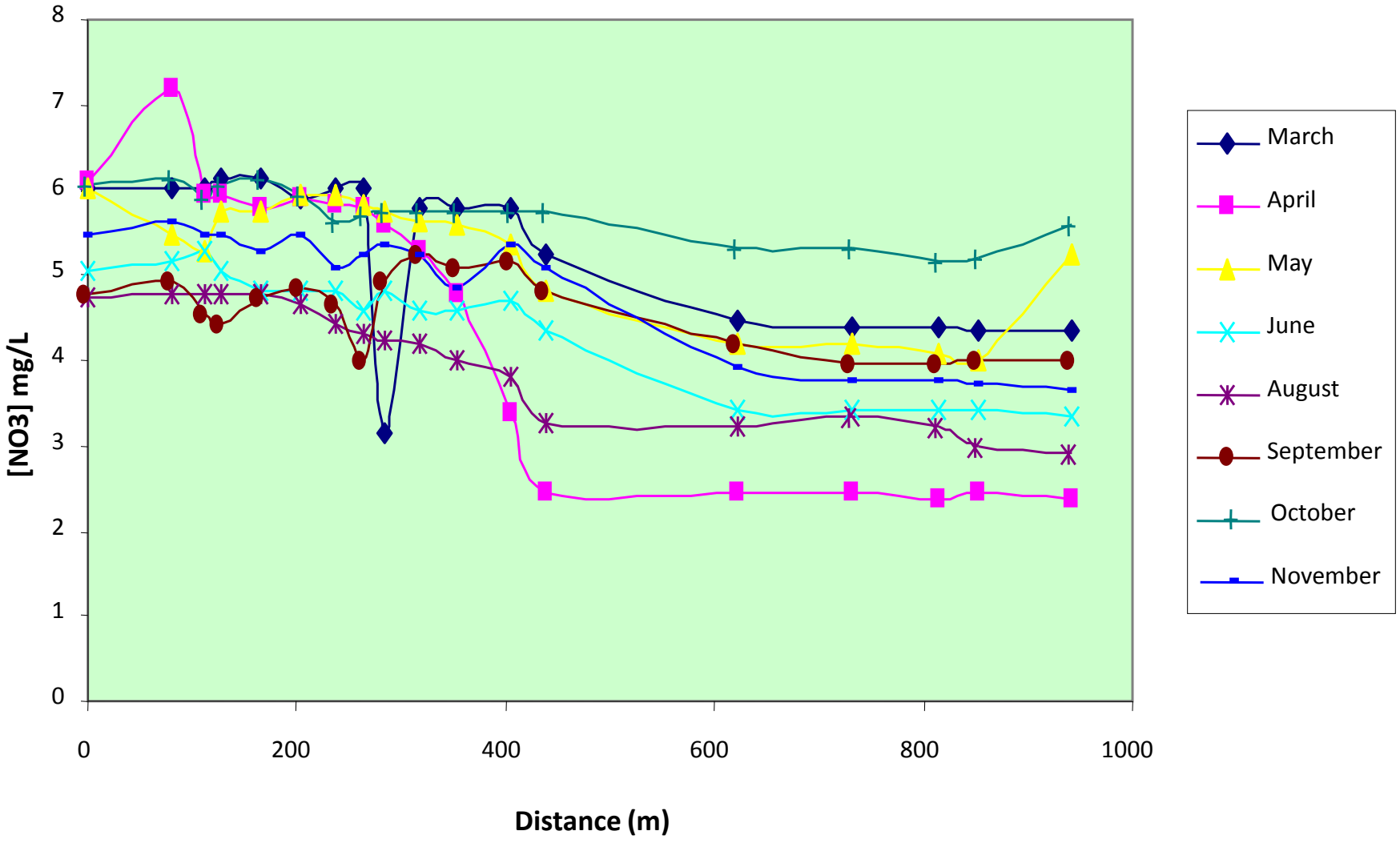
Slightly Incised Herbaceous

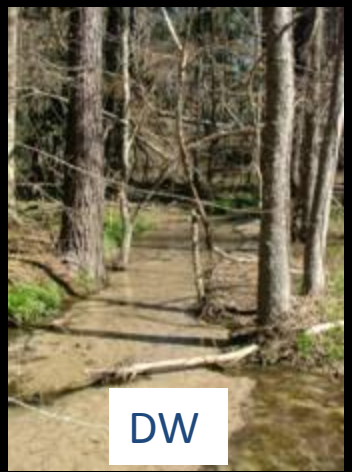
Open Water



What affect does stream reach characteristics have on nitrate reduction?

Monthly Nitrate Concentration

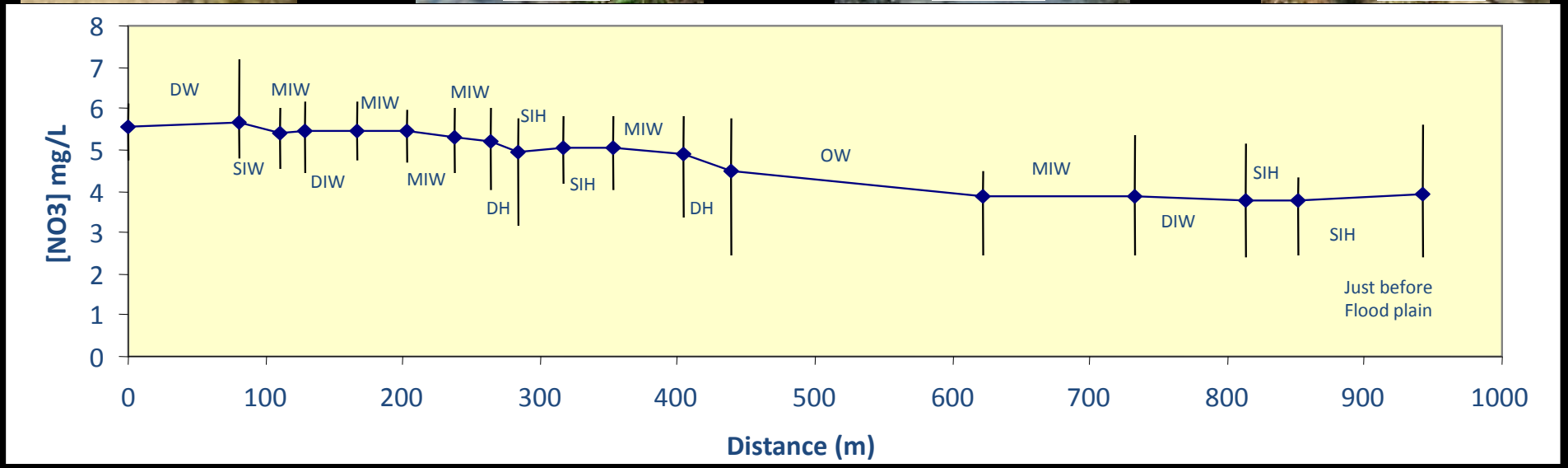



DW


SIW

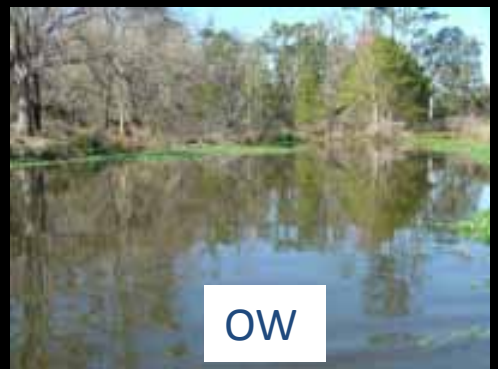

MIW


DIW


[NO3] mg/L
0
1
2
3
4
5
6
7
8
0
100
200
300
400
500
600
700
800
900
1000
Distance (m)
DW
SIW
MIW
DIW
MIW
MIW
MIW
DH
SIH
SIH
MIW
DH
OW
MIW
DIW
SIH
SIH
Just before
Flood plain


SIH


DH

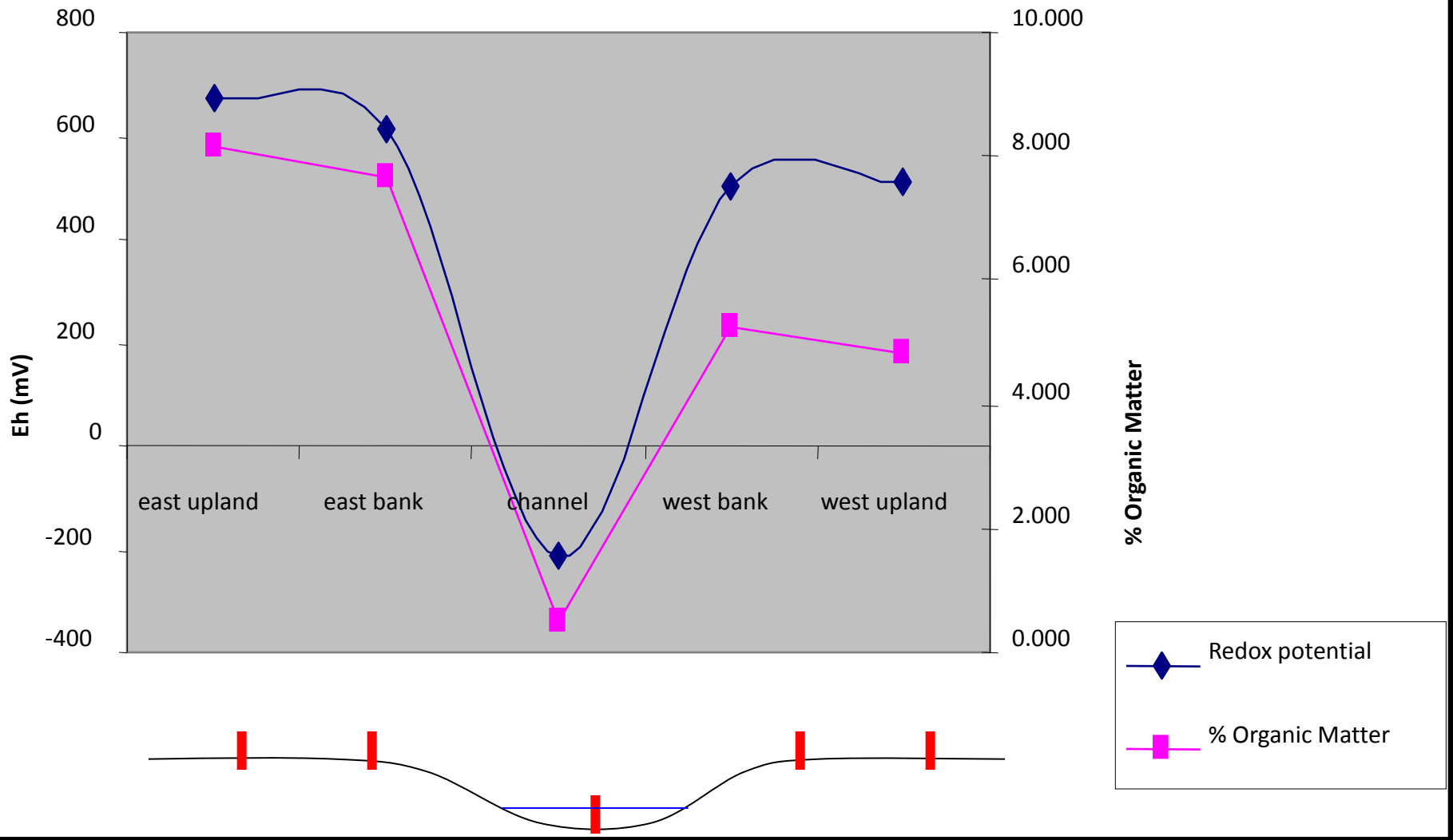

OW

Middle Reaches that Removed the most NO_3^-

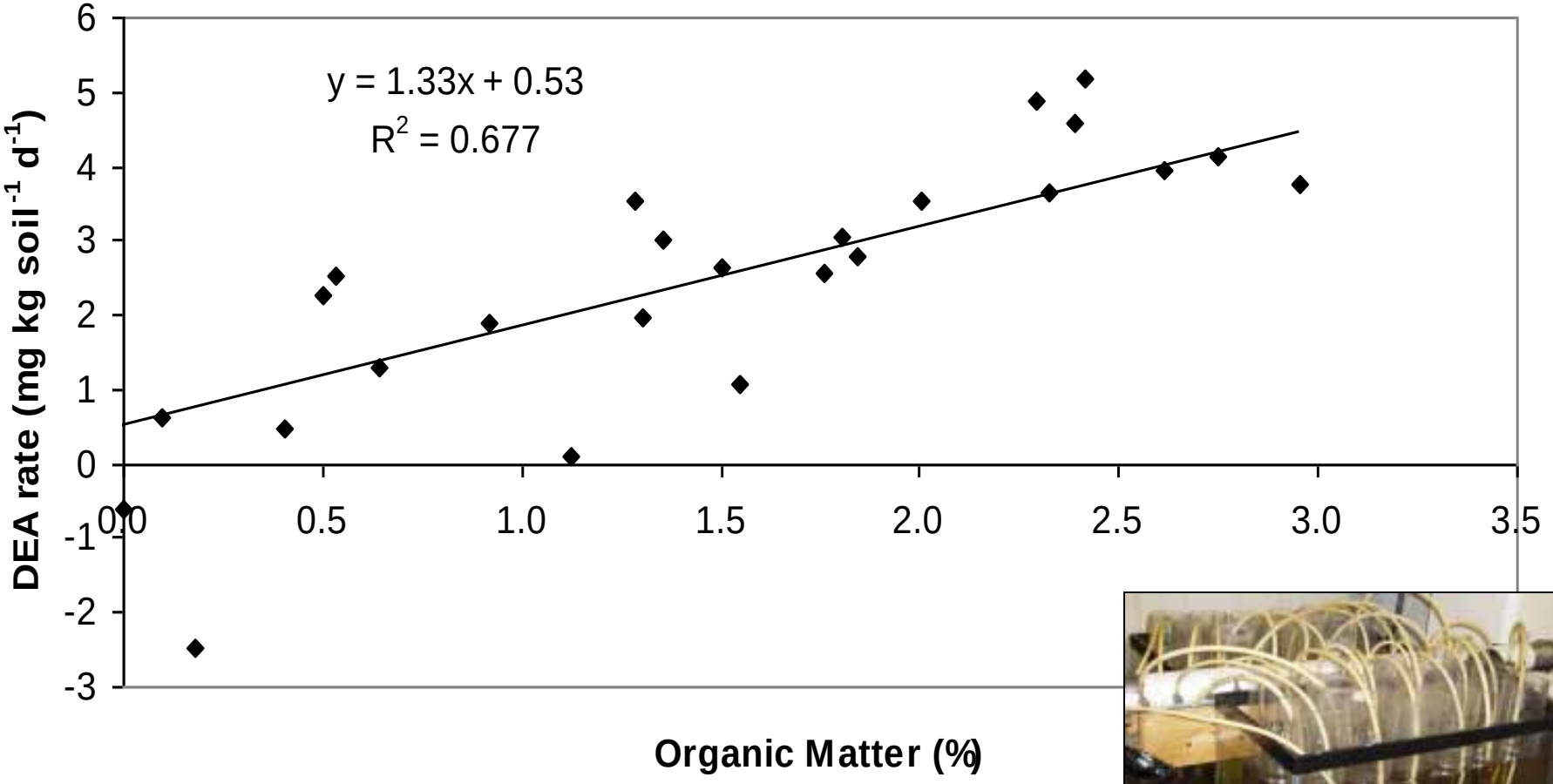
Reach Type	Mean	SD	SL
	% m^{-1}		
OW	0.27	0.21	a
DH	0.13	0.65	ab
MIH	0.08	0.09	abc
SIW	0.04	0.10	abc
PFP	0.02	0.08	bc
DIH	0.01	0.02	c
FP	0.00	0.14	c
MIW	-0.01	0.36	bc
DIW	-0.04	0.20	bc
SIH	-0.04	0.42	abc

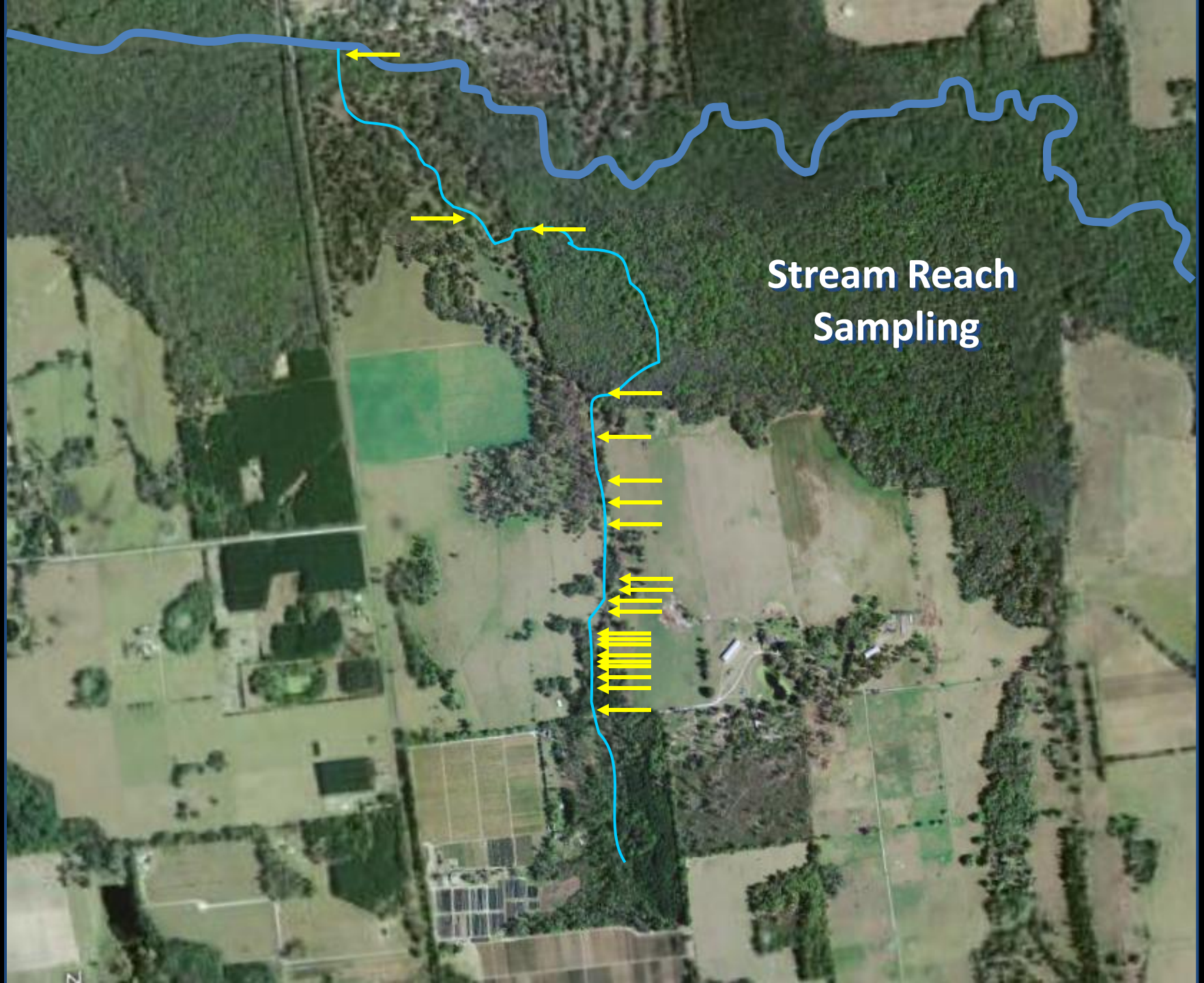
Reach classifications: DW= Depositional Woody, SIW= Slightly Incised Woody, MIW= Moderately Incised Woody, MIH= Moderately Incised Herbaceous, SIH= Slightly Incised Herbaceous, DH= Depositional Herbaceous, OW= Open Water, DIH= Deeply Incised Herbaceous, and FP= Floodplain.

Redox and % Organic Matter Content

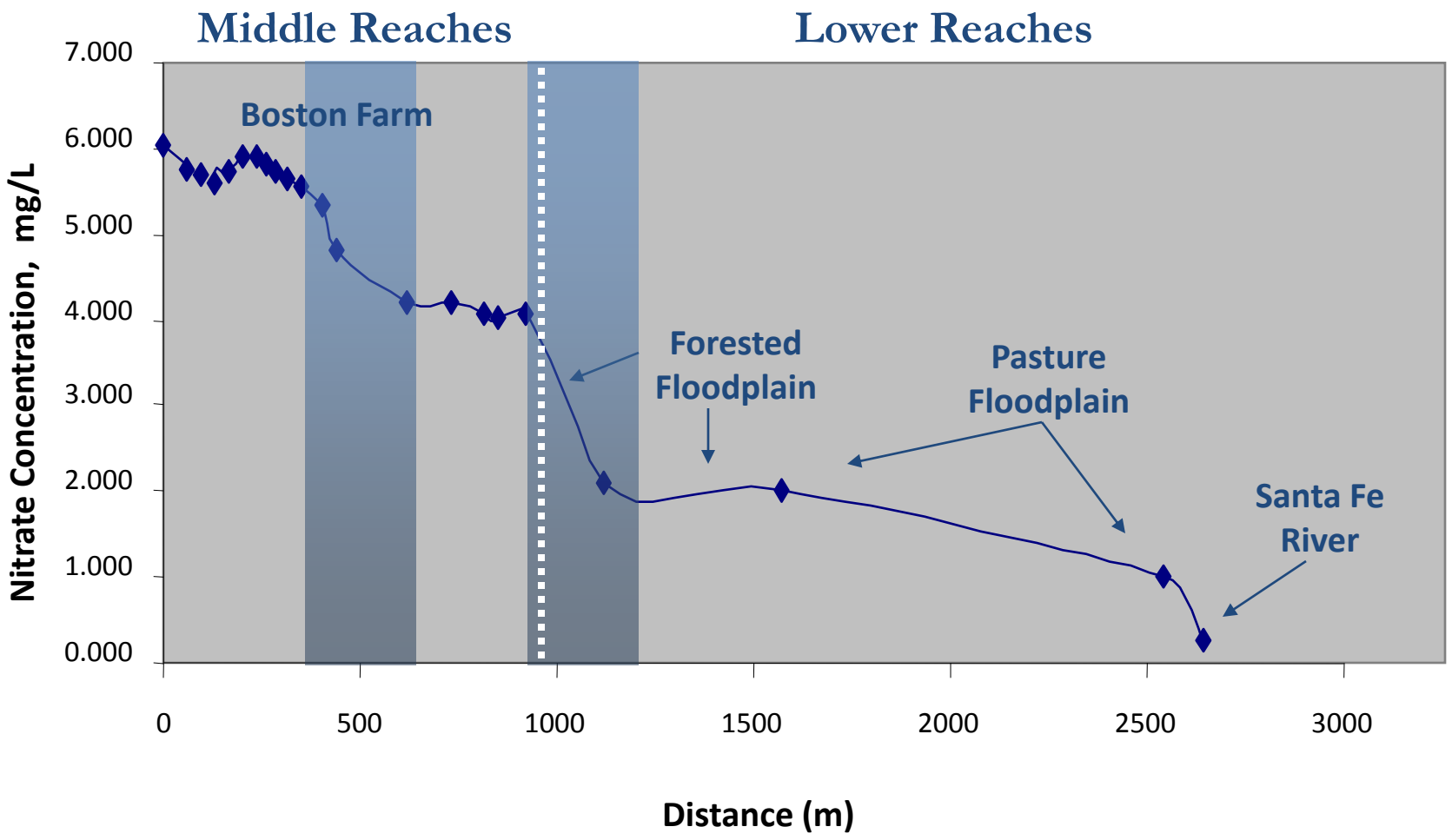


Denitrification Potential vs. Organic Matter Content

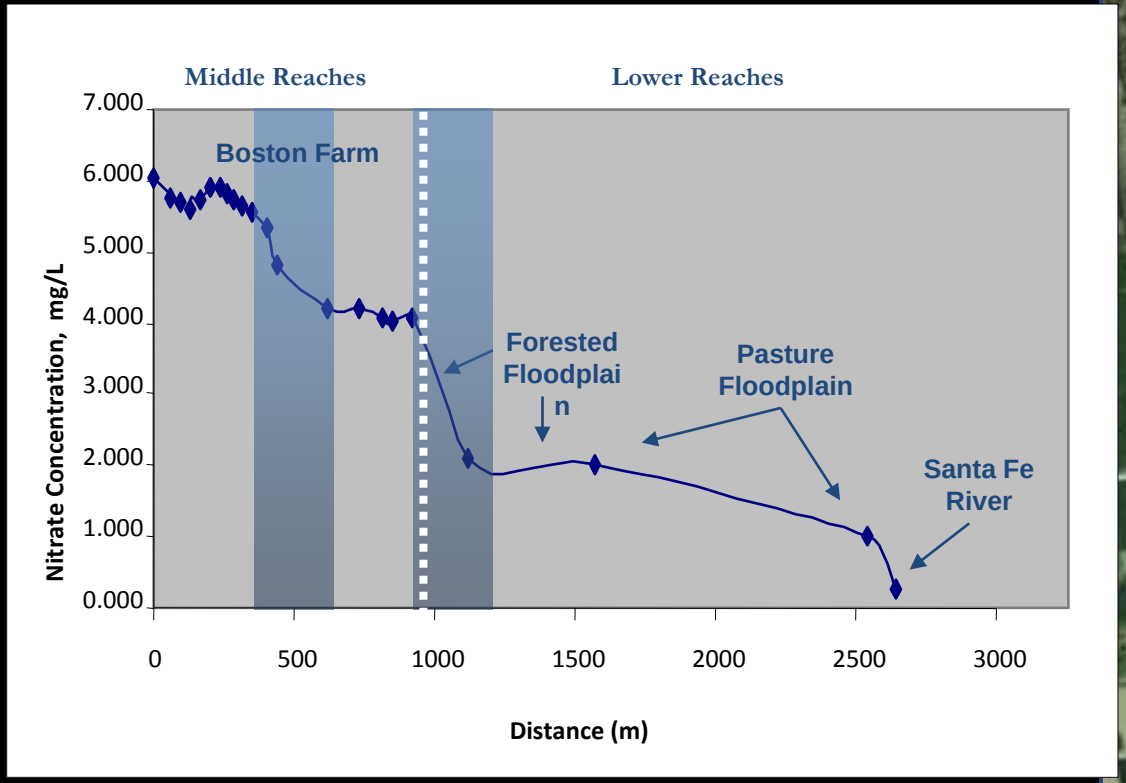


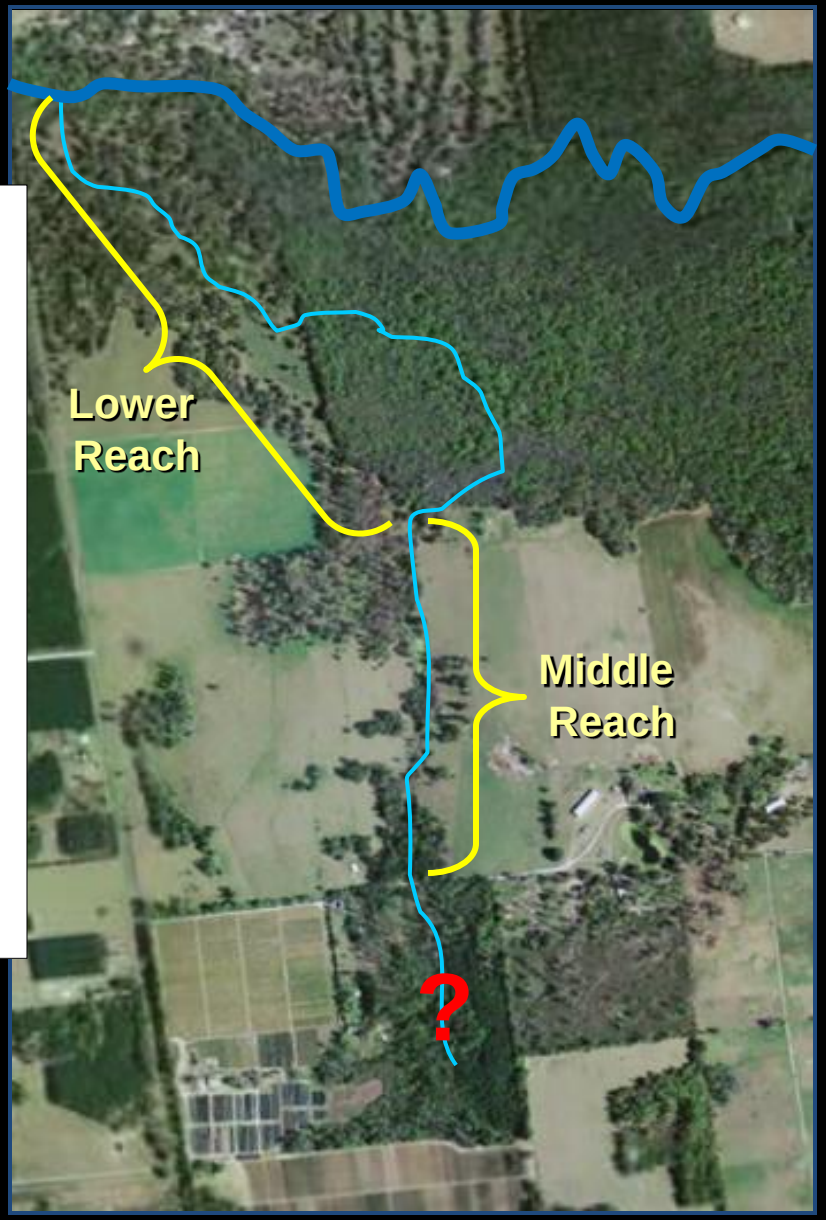

Stream Reach
Sampling

Nitrate Nitrogen Concentration in Middle and Lower Reaches of Tributary 2



The Rest of the Story





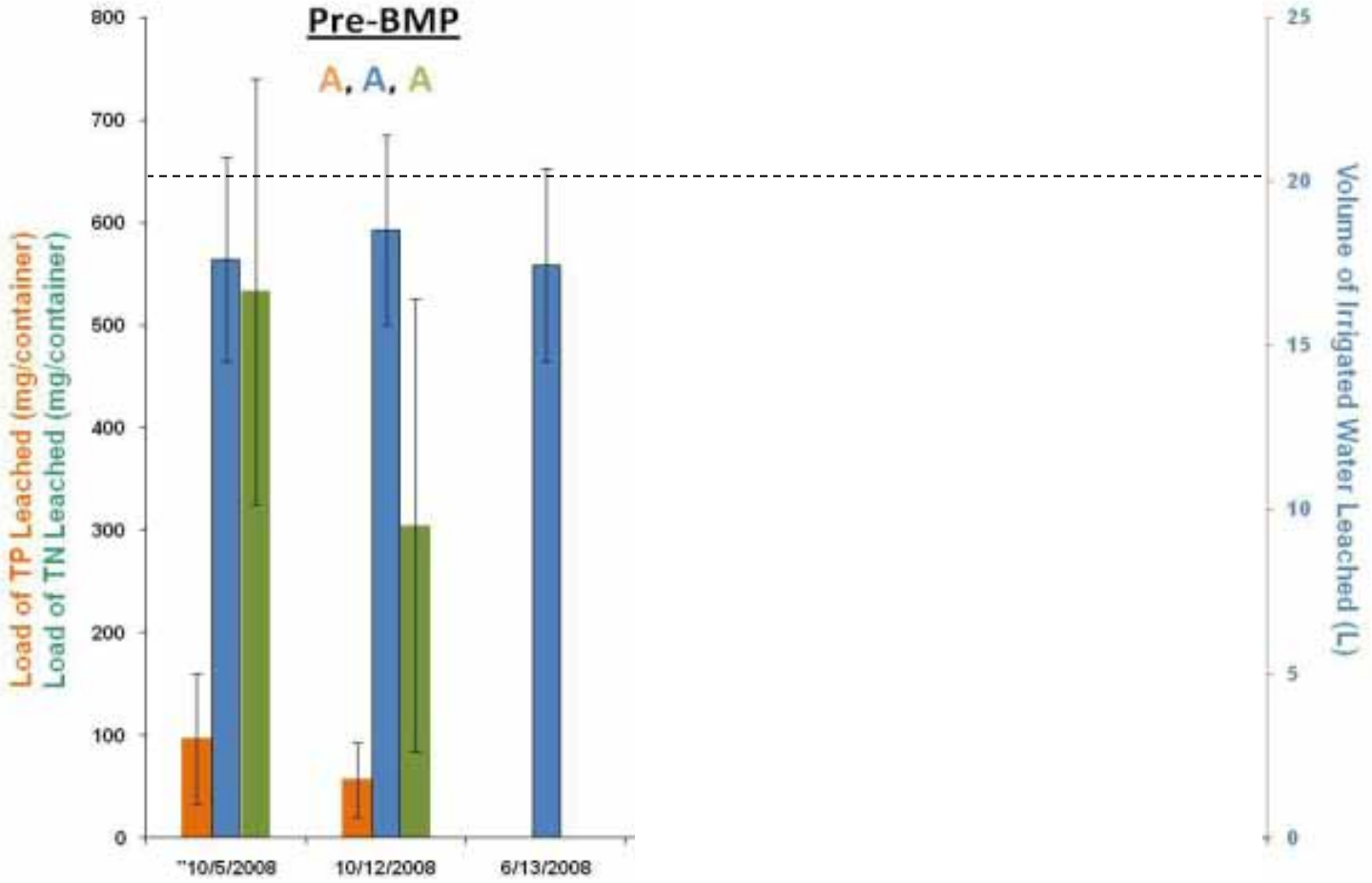

8.4
.01
0.64
2.68
8.0
8.4
10.9
0.4
3.1
8.9
4.3
3.3
5.2
9.2

Agricultural BMP's
Container Nursery BMP Manual

- By signing Notice of Intent (NOI) and implementing practices, producer is granted a "presumption of compliance" by FDEP
- Presumption of compliance does not guarantee water quality standards are going to be met.
- Limited information on efficacy of practices

“If you can control the water, you can control the nutrients!”

Container Leaching Study



Irrigation Volume (L)	20.8	19.7	19.7
Ave. Irrigat. Volume (L)		**20.1**	
Irrigation Duration (min)	30	30	30
Irrigation Frequency/24 Hr	1	1	1

Container Leaching Study

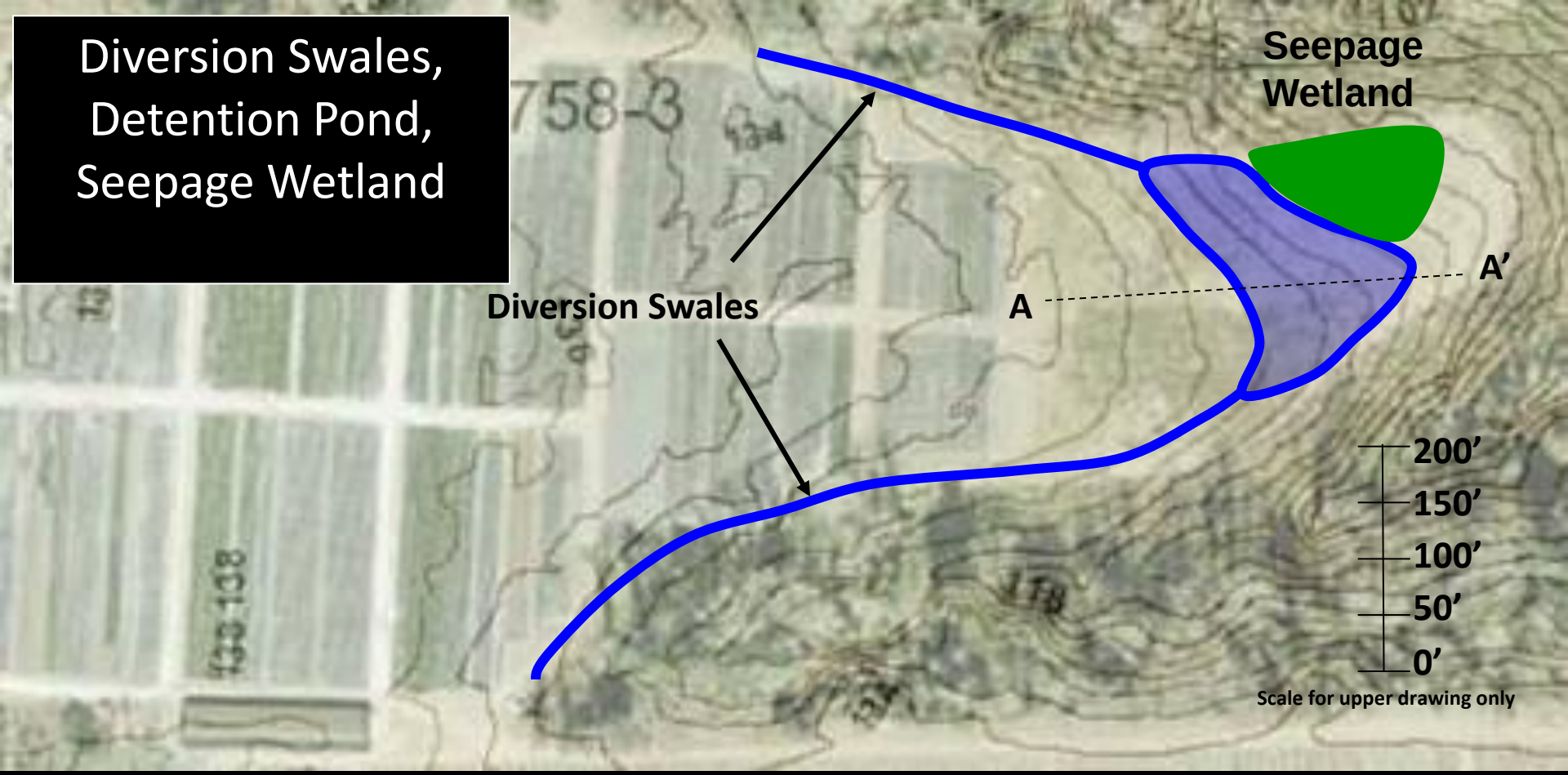
- Daily Pre-BMP Leaching = 2,168,400 L (0.573 MGD)

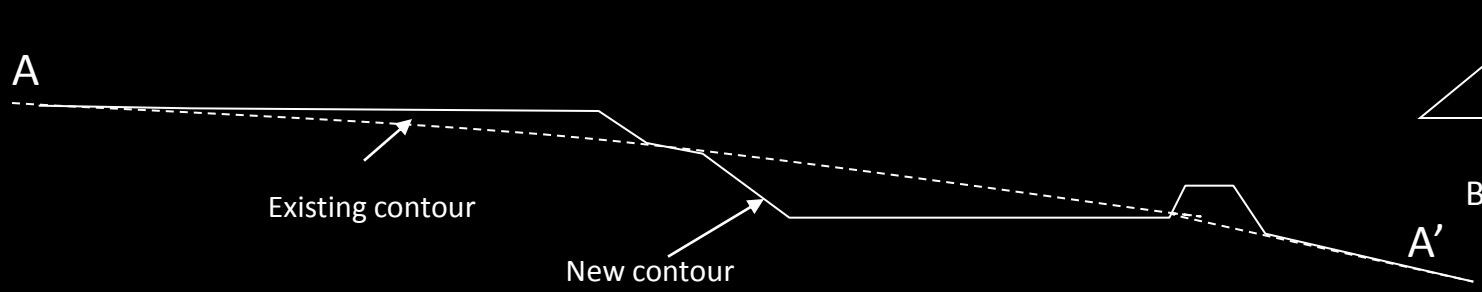
- Daily Pre-BMP Nitrogen Load = 50.3 kg (20.22 ton/yr)

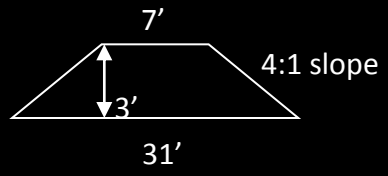

?
How can we enhance denitrification?


1000’

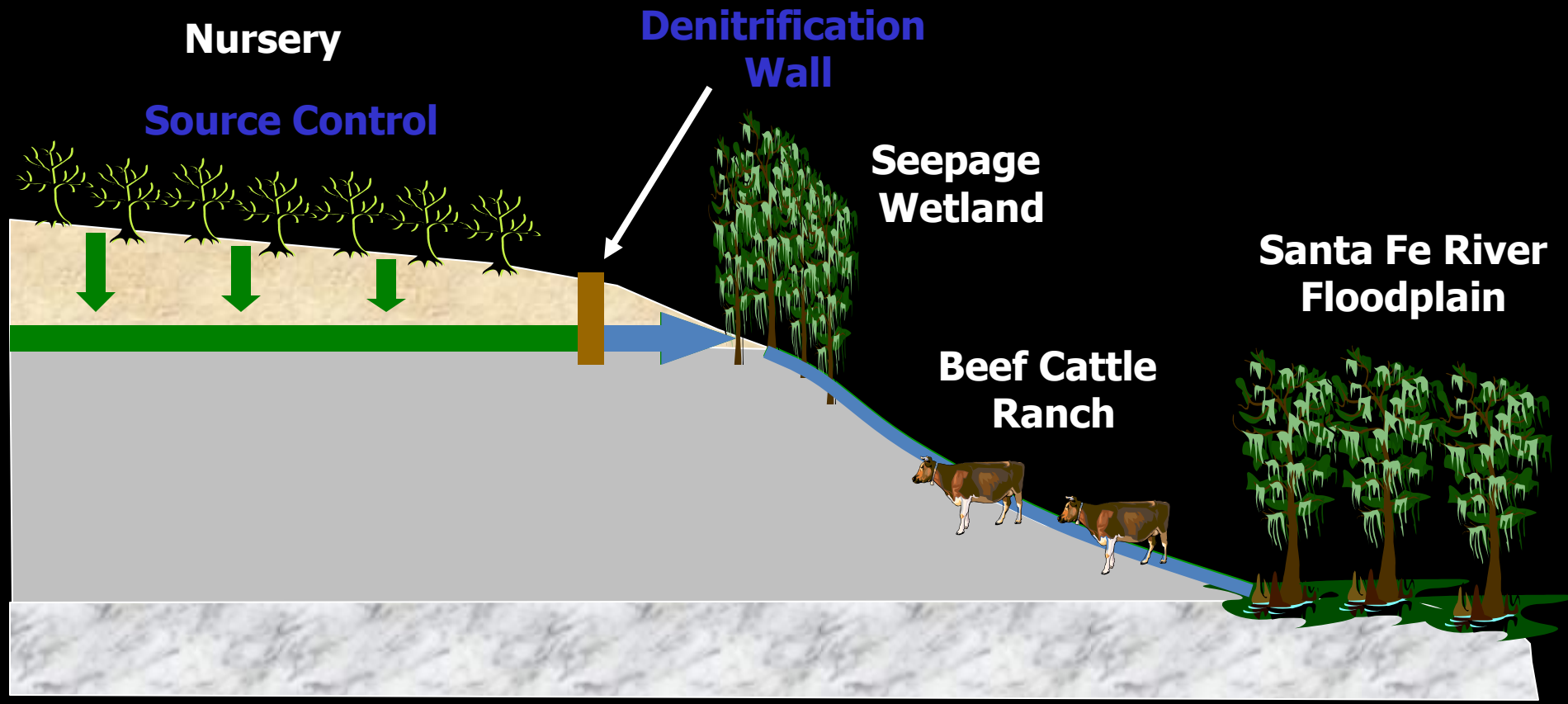
Diversion Swales, Detention Pond, Seepage Wetland

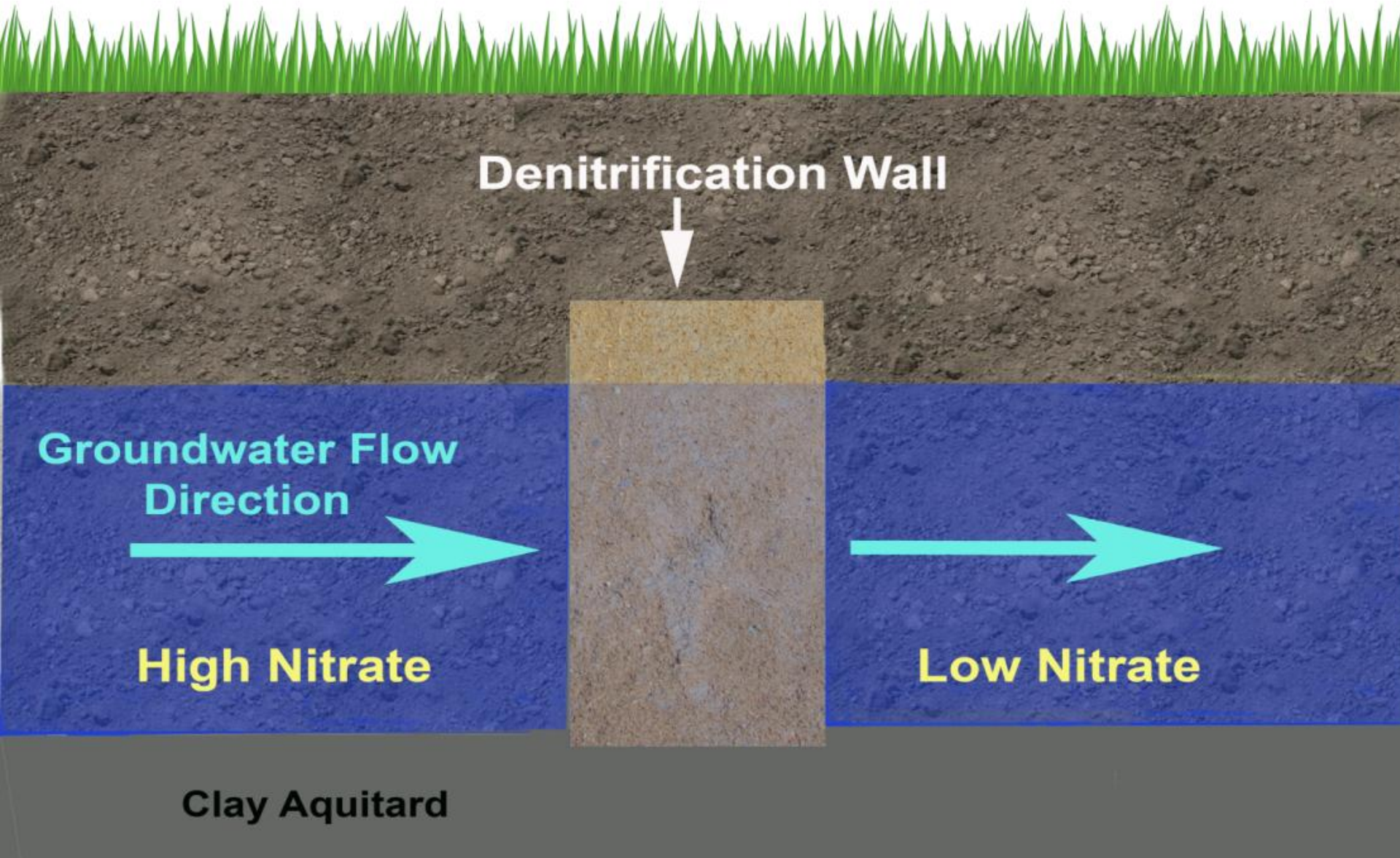






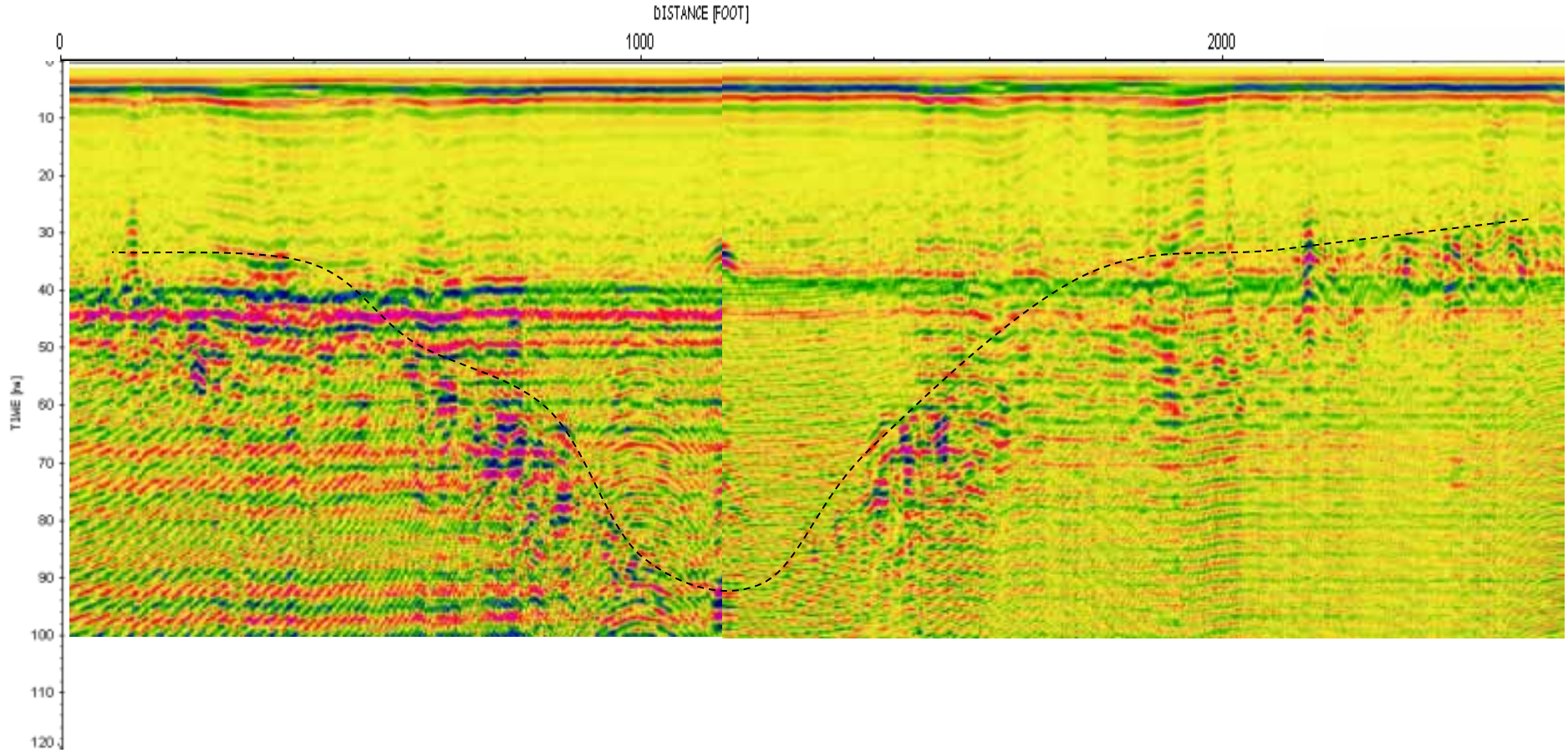
Denitrification Wall




Denitrification Wall
Groundwater Flow Direction
High Nitrate
Low Nitrate
Clay Aquitard

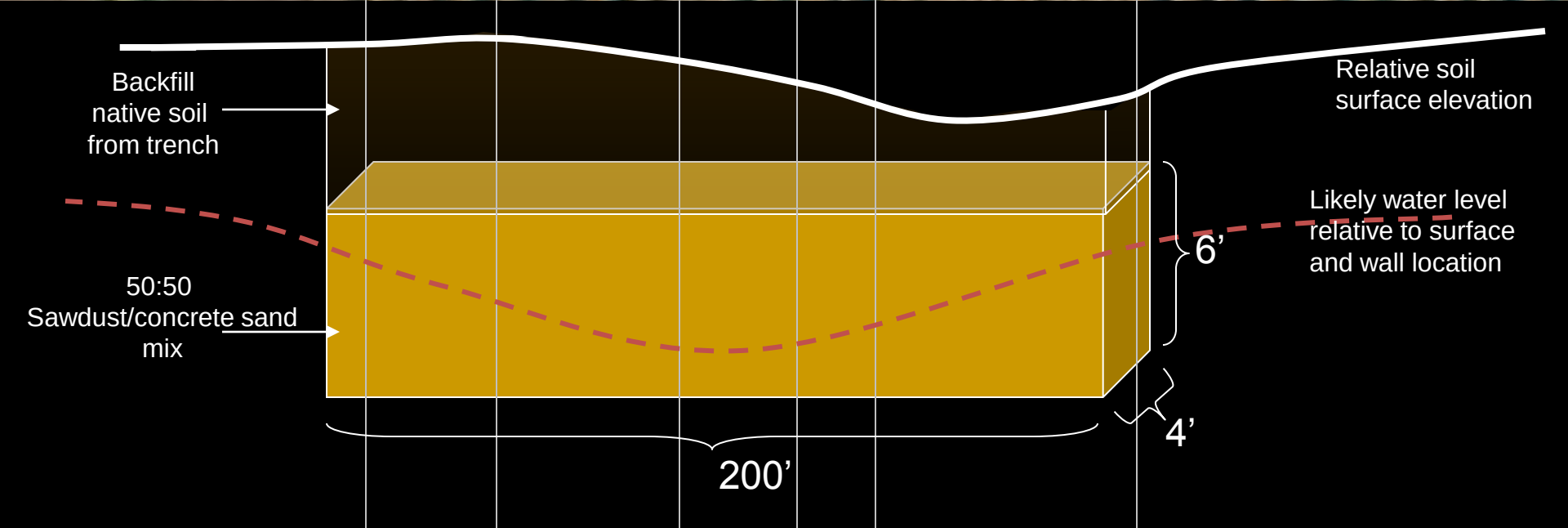
Holly Factory Nursery

July 24, 2008
File 4074

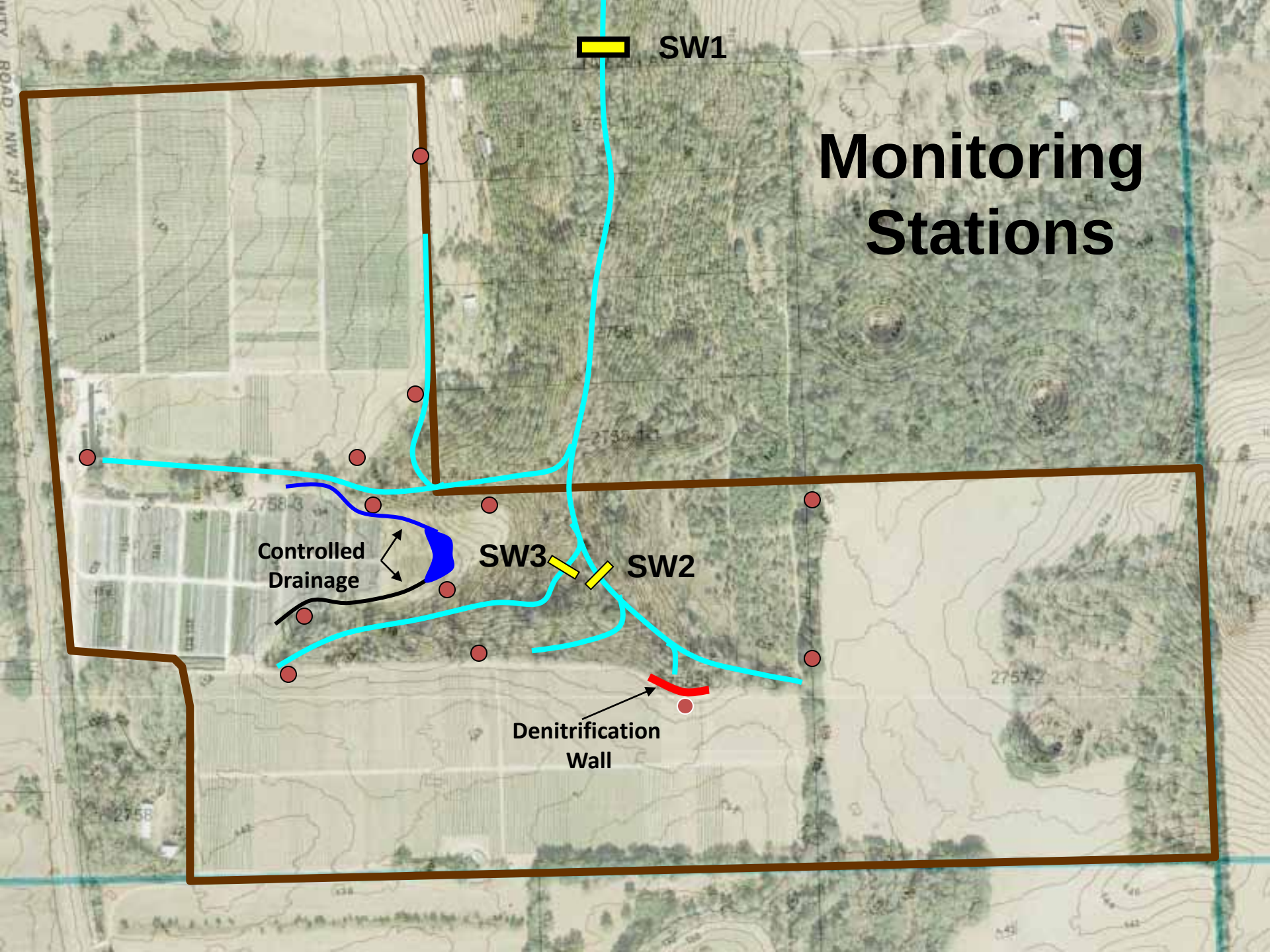


Going east to west ,
500 MHz, DE @ 12, range 120 ns

Denitrification Wall



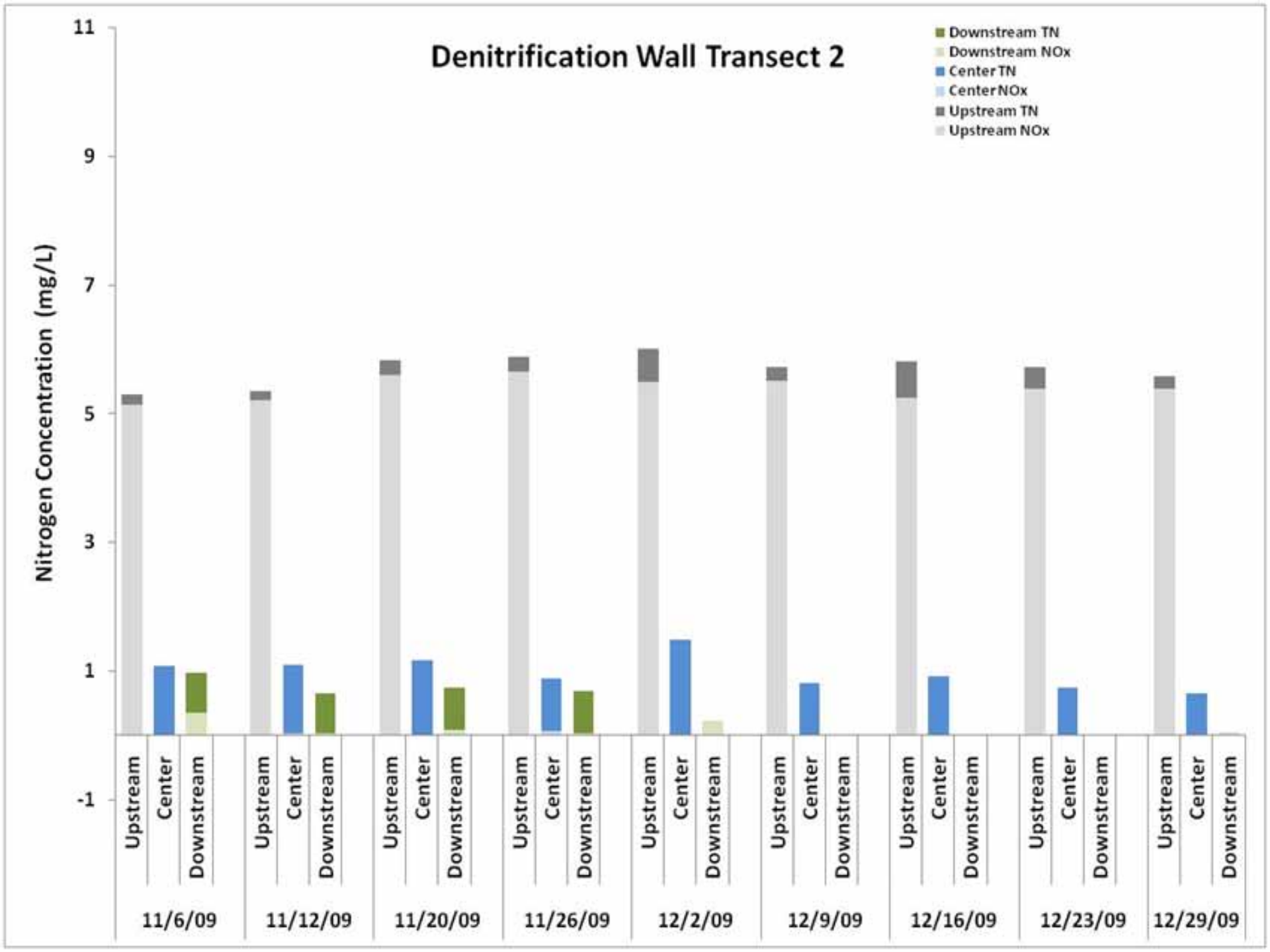

VOLVO

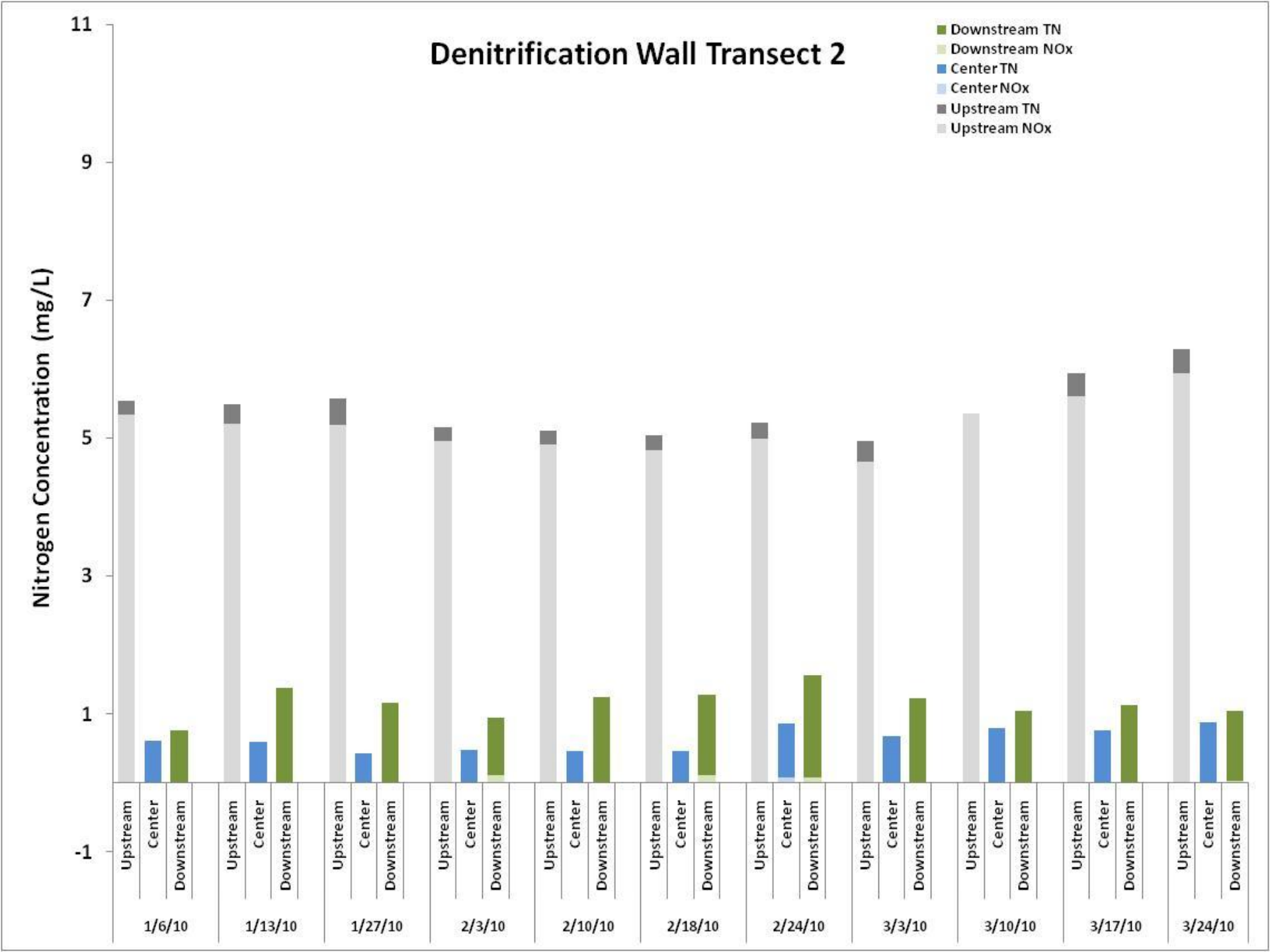

SW1
Monitoring Stations
Controlled Drainage
SW3
SW2
Denitrification Wall

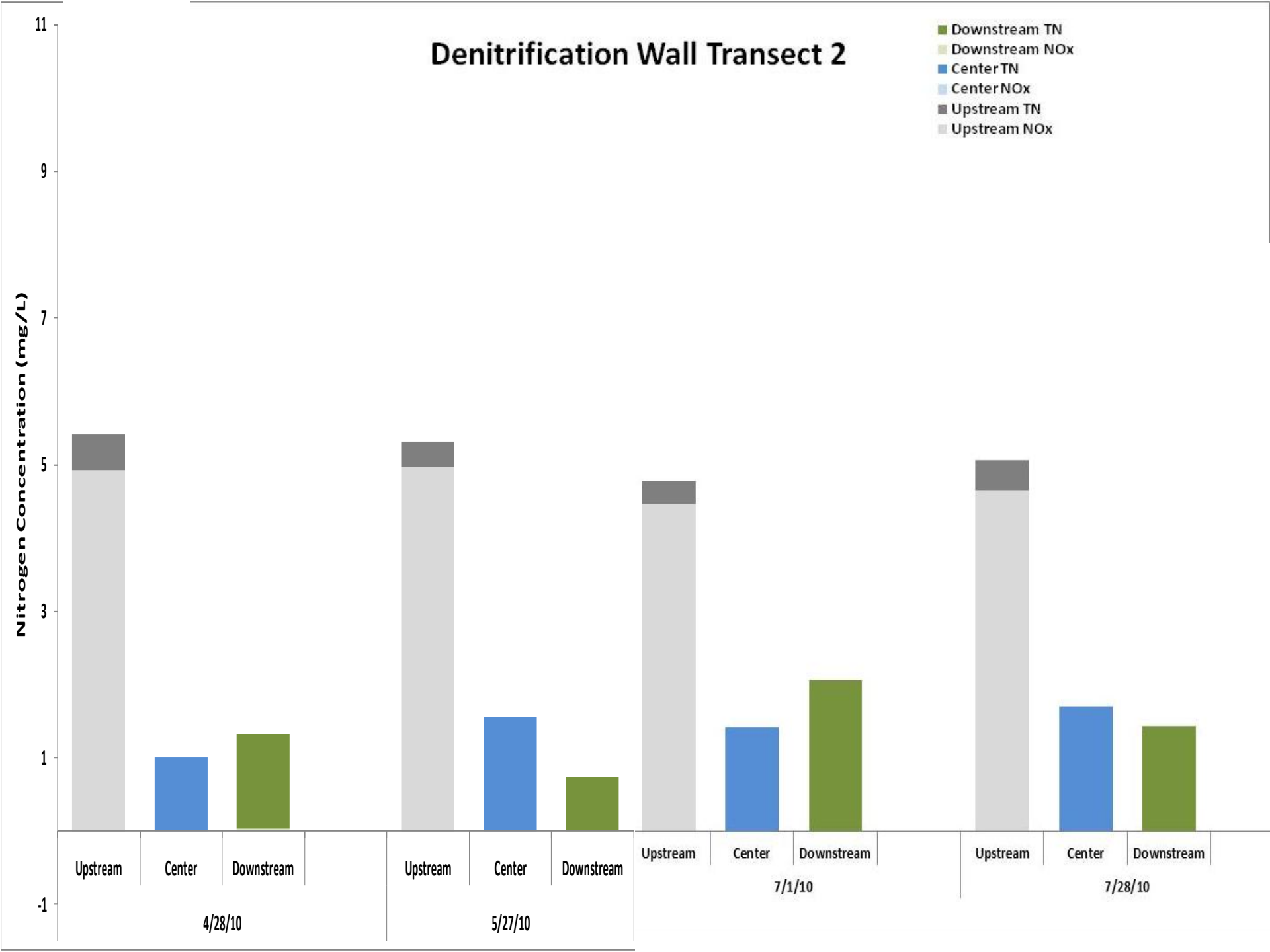
SW1

SW3

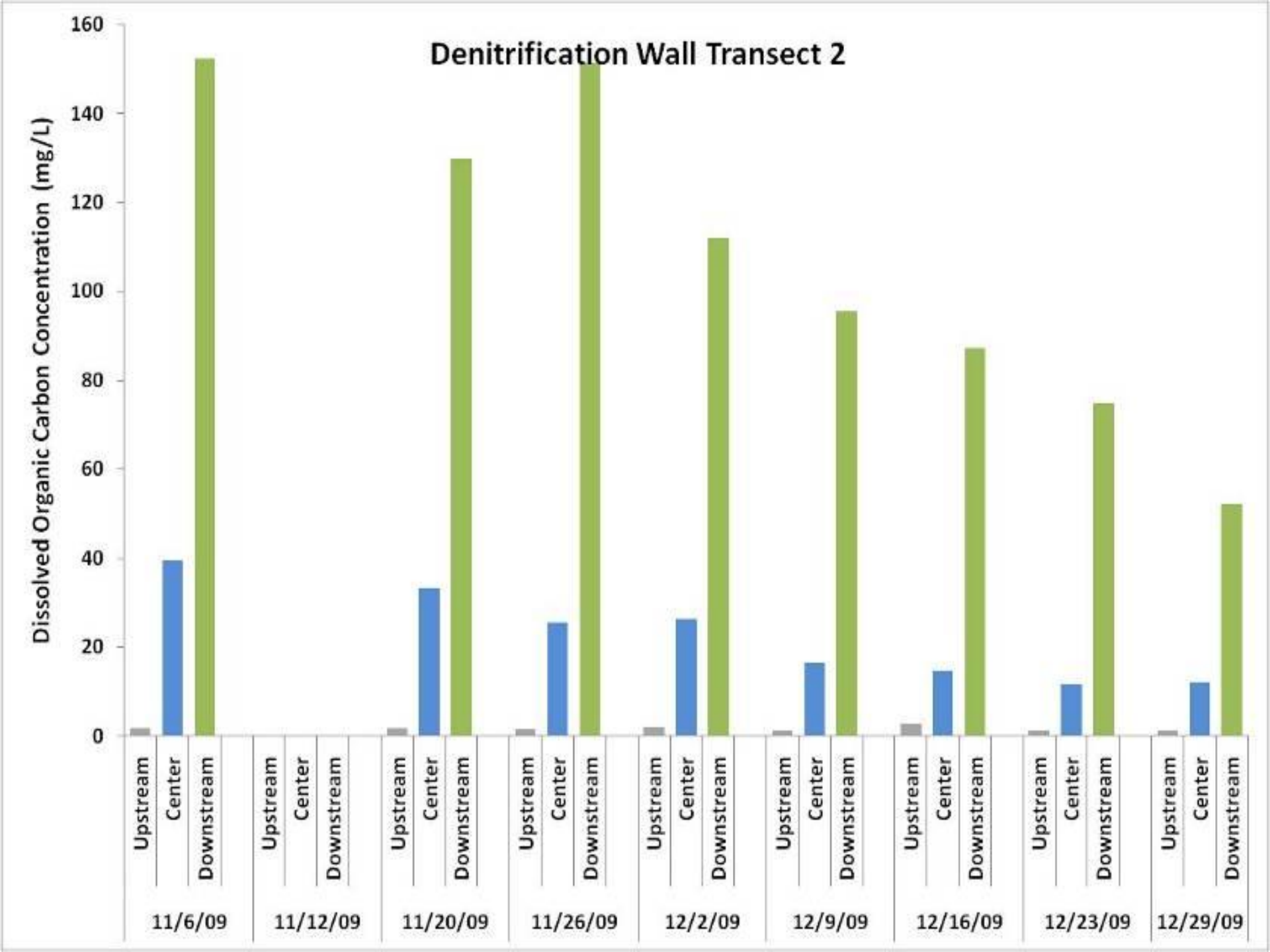
SW2


Denitrification Wall Transect 2
Downstream TN
Downstream NOx
Center TN
Center NOx
Upstream TN
Upstream NOx
Nitrogen Concentration (mg/L)
11
9
7
5
3
1
-1
Upstream
Center
Downstream
11/6/09
11/12/09
11/20/09
11/26/09
12/2/09
12/9/09
12/16/09
12/23/09
12/29/09

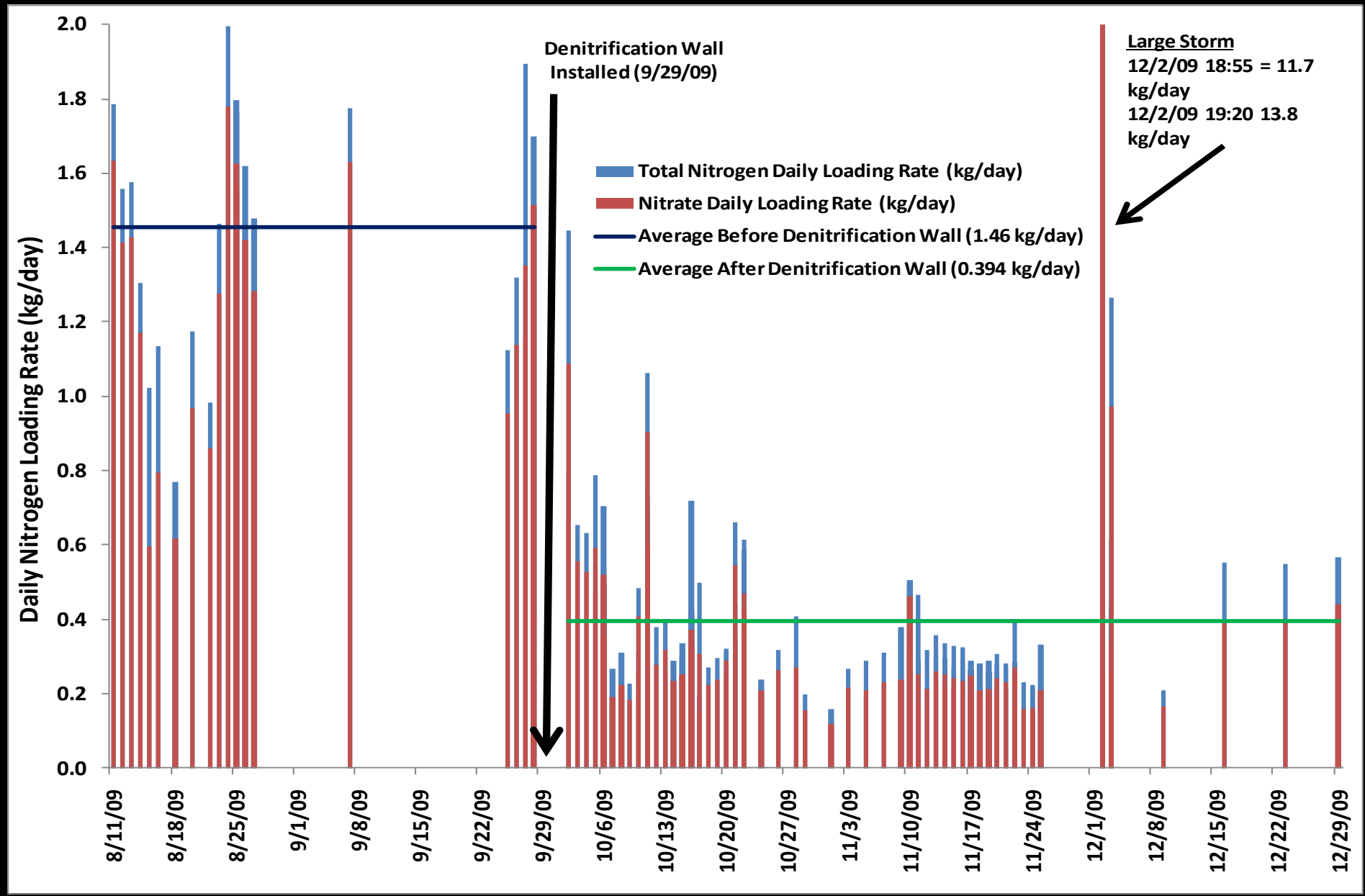

Denitrification Wall Transect 2
Downstream TN
Downstream NOx
Center TN
Center NOx
Upstream TN
Upstream NOx
Nitrogen Concentration (mg/L)
11
9
7
5
3
1
-1
Upstream
Center
Downstream
1/6/10
1/13/10
1/27/10
2/3/10
2/10/10
2/18/10
2/24/10
3/3/10
3/10/10
3/17/10
3/24/10


Denitrification Wall Transect 2
Downstream TN
Downstream NOx
Center TN
Center NOx
Upstream TN
Upstream NOx
Nitrogen Concentration (mg/L)
11
9
7
5
3
1
-1
Upstream
Center
Downstream
4/28/10
Upstream
Center
Downstream
5/27/10
Upstream
Center
Downstream
7/1/10
Upstream
Center
Downstream
7/28/10

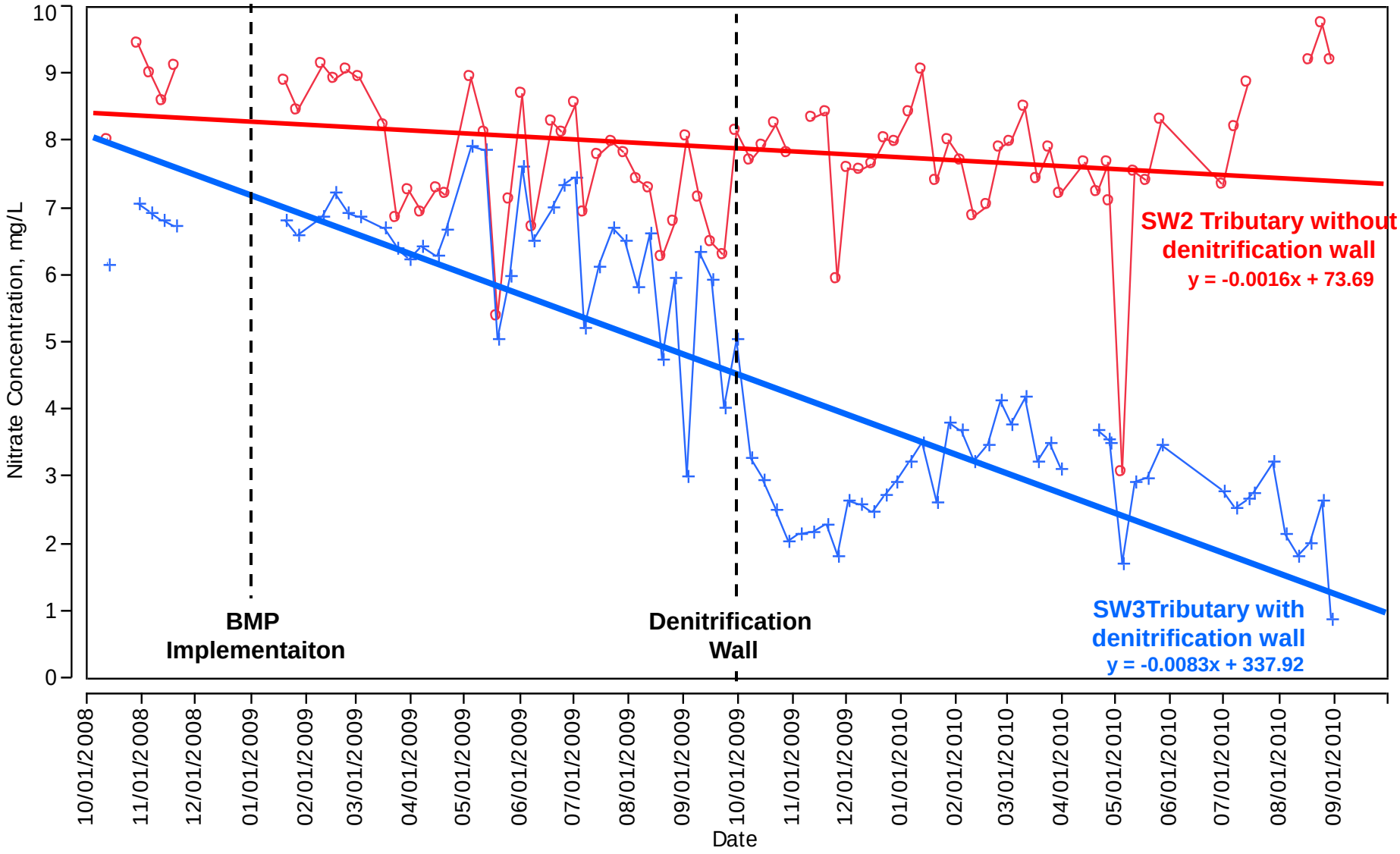
Caution


Denitrification Wall Transect 2
Dissolved Organic Carbon Concentration (mg/L)
160
140
120
100
80
60
40
20
0
Upstream
Center
Downstream
11/6/09
11/12/09
11/20/09
11/26/09
12/2/09
12/9/09
12/16/09
12/23/09
12/29/09

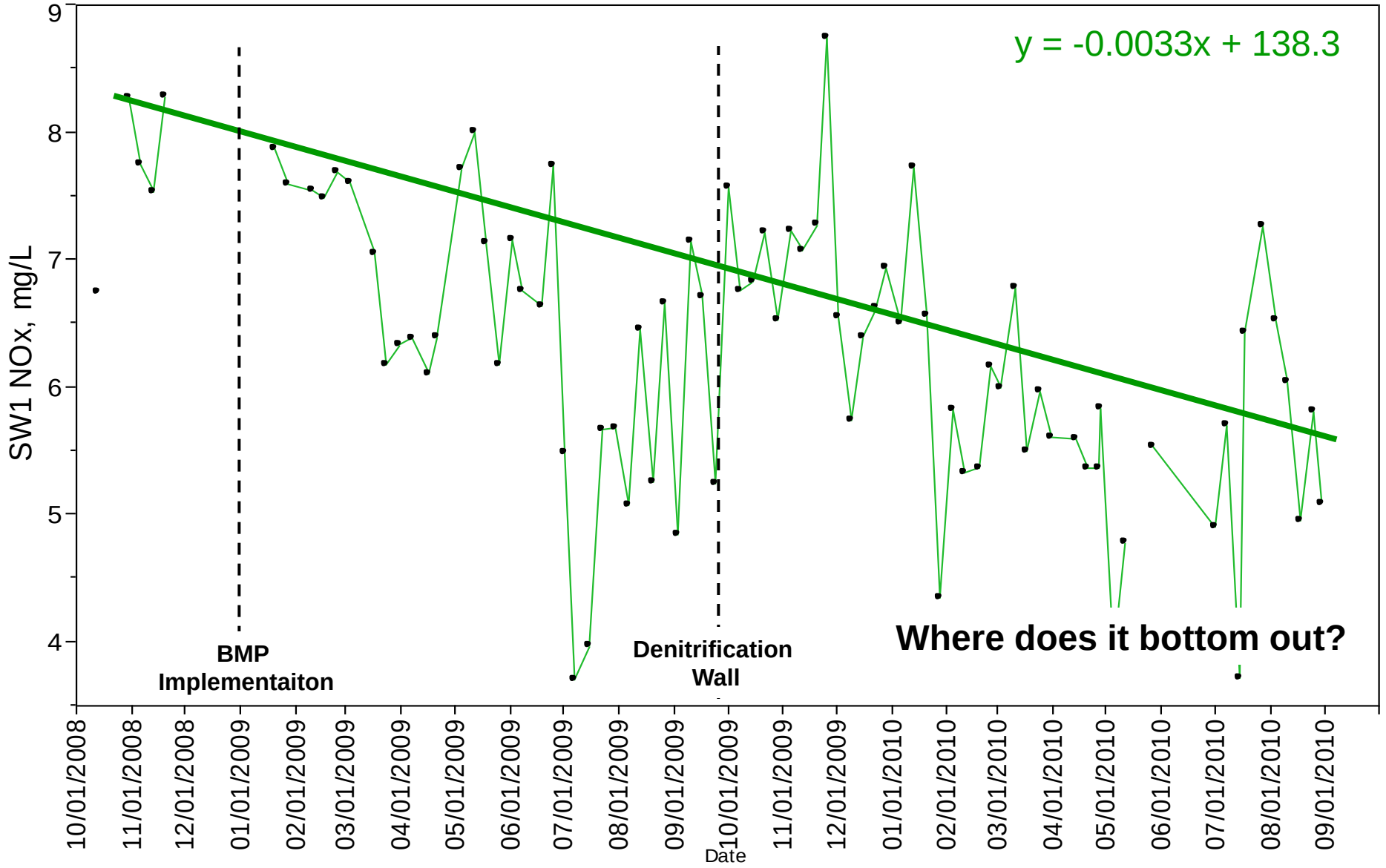
SW3 Nitrogen Loading



Nitrate Concentration at SW2 and SW3



Nitrate Concentration SW1



Summary

- Significant nitrate reduction potential in riparian areas with adequate carbon and saturated soils.
- Implementation and optimization of container nursery BMPs can result in significant nitrogen load reductions.
- Additional practices that enhance denitrification can further reduce nitrate nitrogen loads.
- Even with integration of BMP’s and enhanced practices it will be very challenging to meet nutrient criteria in upper reaches of streams.

Acknowledgements

- Funding
  - FDEP/USEPA 319 Grant
- Cooperators
  - Holly Factory – Todd Stevens
  - Santa Fe Beef Research Unit / UF Animal Science Department
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  - Casey Schmidt (PhD)
  - Adrienne Frisbee (MS)
- OPS
  - Patrick Moran, Ryan Hood,

    Ryan Tenbroeck, Daniel Mathews
- Student Interns
  - Laura Clark
  - Ilie Tomlin

Questions?

Clarkmw@ufl.edu

(352) 392-1804 ex 319