A Presentation of the 2013 Drainage Research Forum

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SDSU Extension Regional Center
Sioux Falls, SD

IOWA STATE UNIVERSITY
University Extension

SDSU Extension

Woodchip Bioreactors

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NRCS
United States Department of Agriculture
Natural Resources Conservation Service

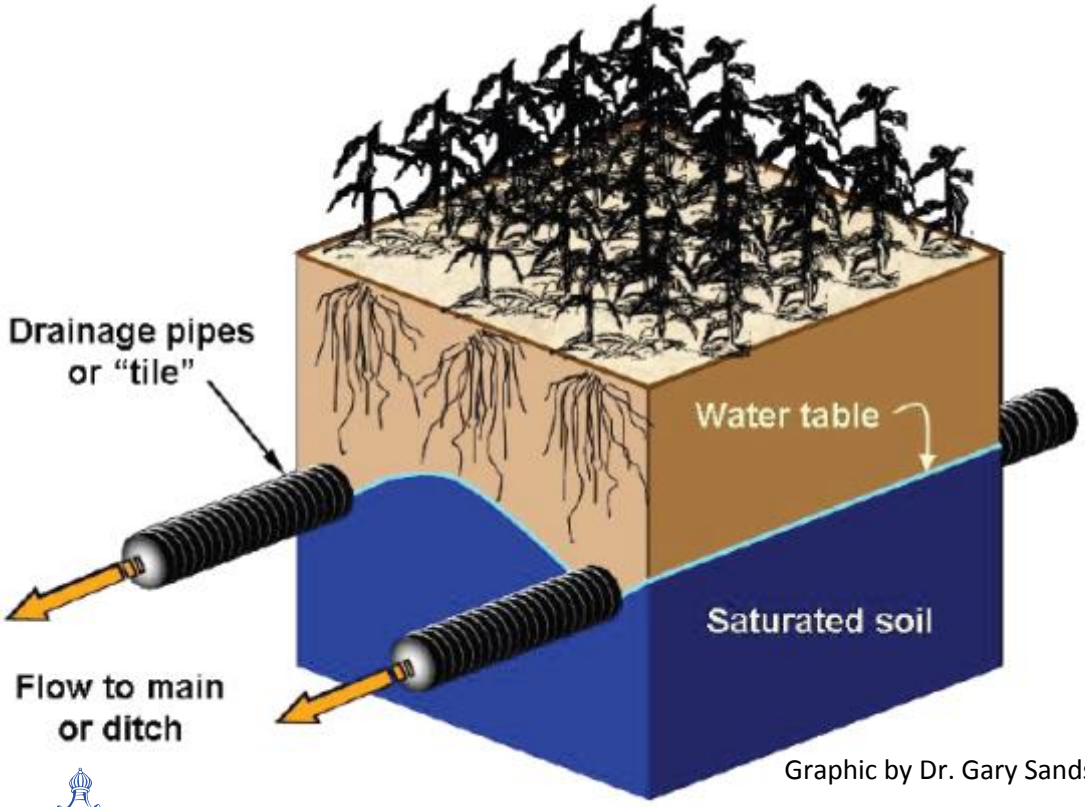
SOUTH DAKOTA STATE UNIVERSITY
SDSU

Bioreactor performance in South Dakota

Project sponsors

South Dakota USDA NRCS
East Dakota Water Development District
South Dakota Soybean Research and Promotion Council
South Dakota Farm Bureau
South Dakota Corn Utilization Council
Vermillion Basin Water Development District
South Dakota State University

Subsurface Tile Drainage



Graphic by Dr. Gary Sands

Photo courtesy of USDA NRCS

Water Quality Impacts of Drainage

In general, compared to surface runoff tile drainage runoff have been found to

- **Reduce soil erosion and sediment loss**
- **Reduce phosphorus loss**
- **Increase nitrate-nitrogen loss**

Lake algae bloom

Too much of a good thing:
Elevated concentrations of nitrogen can have severe effects on aquatic ecosystems and can be a public health concern

What is conservation drainage?

Emerging set of designs and practices designed to maintain the benefits of conventional agricultural drainage while addressing water quality and flow issues

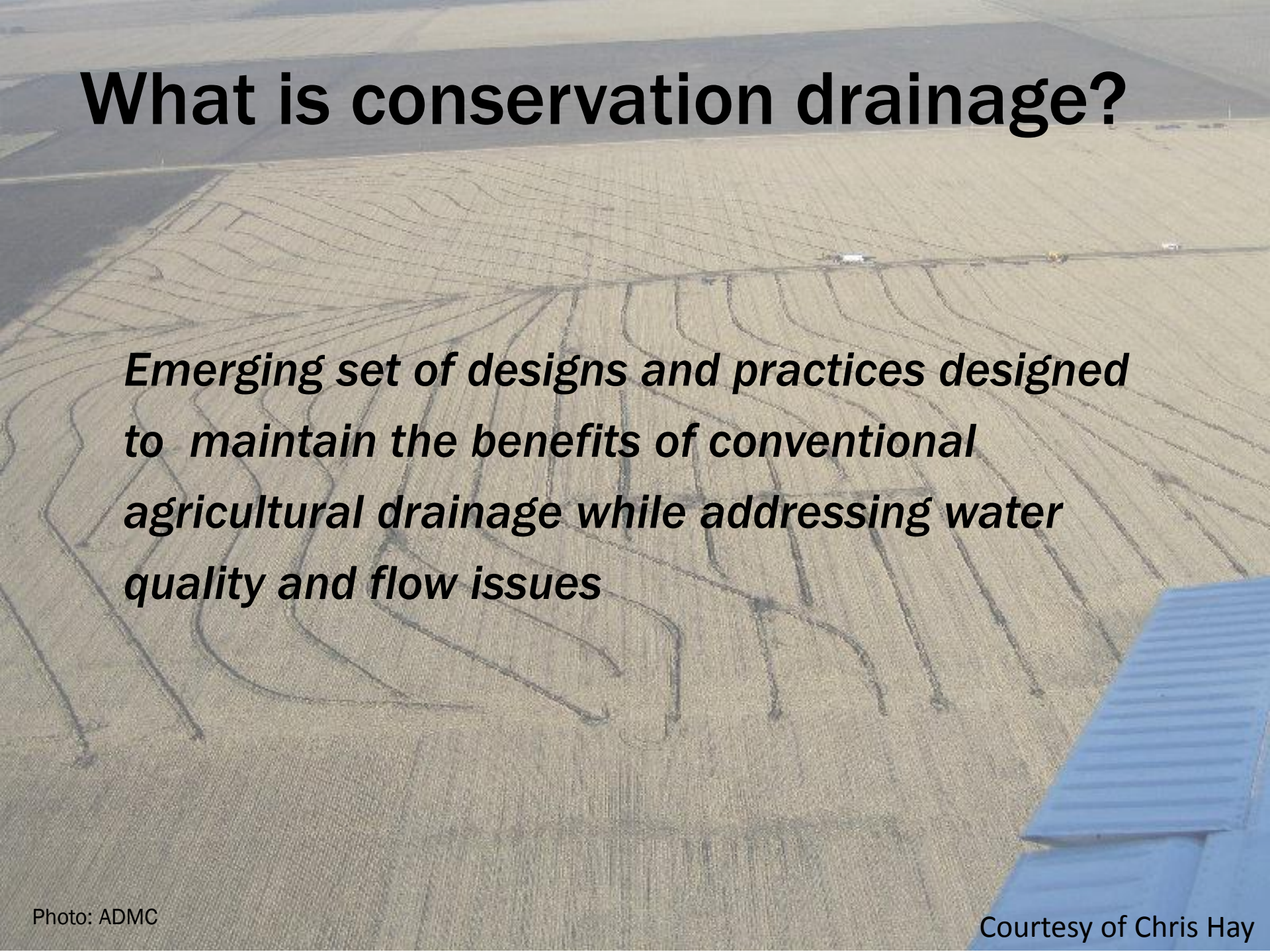
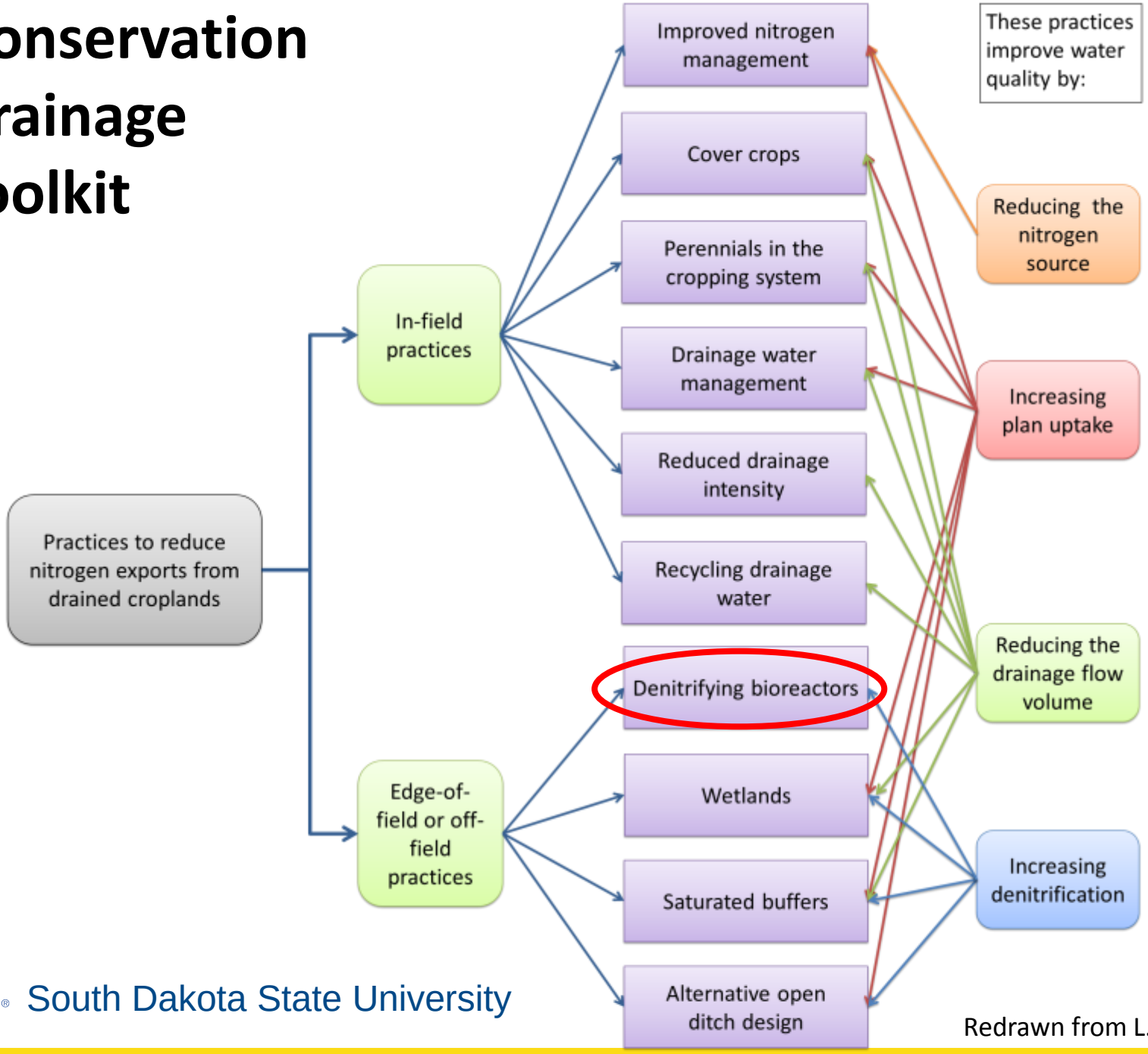


Photo: ADMC

Courtesy of Chris Hay

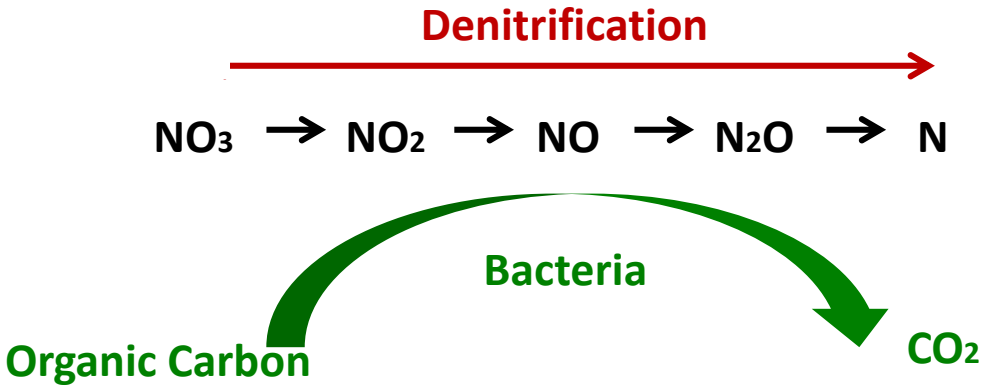
Conservation drainage toolkit



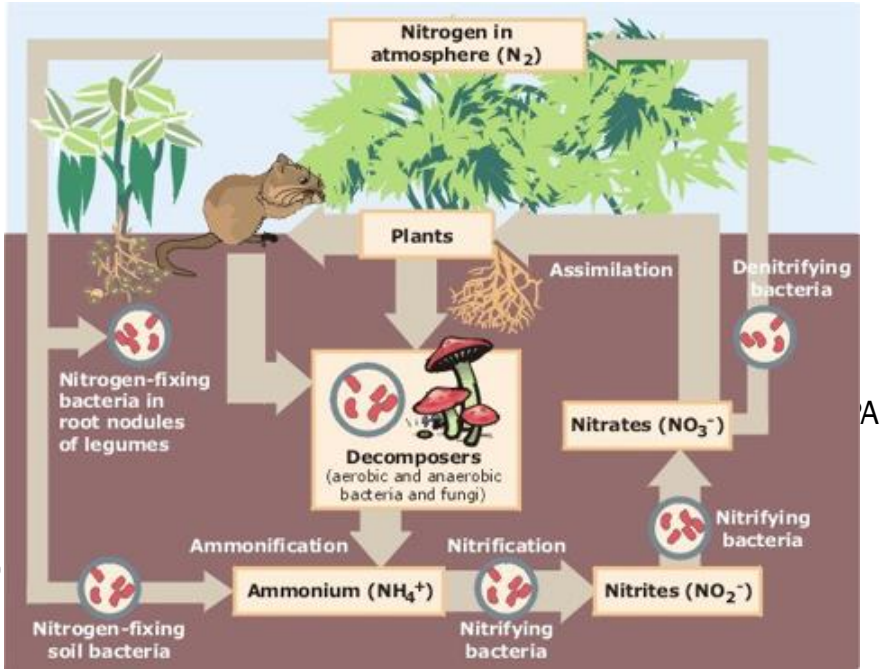
Redrawn from L. Christianson

Denitrifying woodchip bioreactors

Denitrification basics



- Presence of NO_3
- Denitrifying bacteria
- Oxygen-free conditions
- Food (carbon) source
- Favorable pH and temp



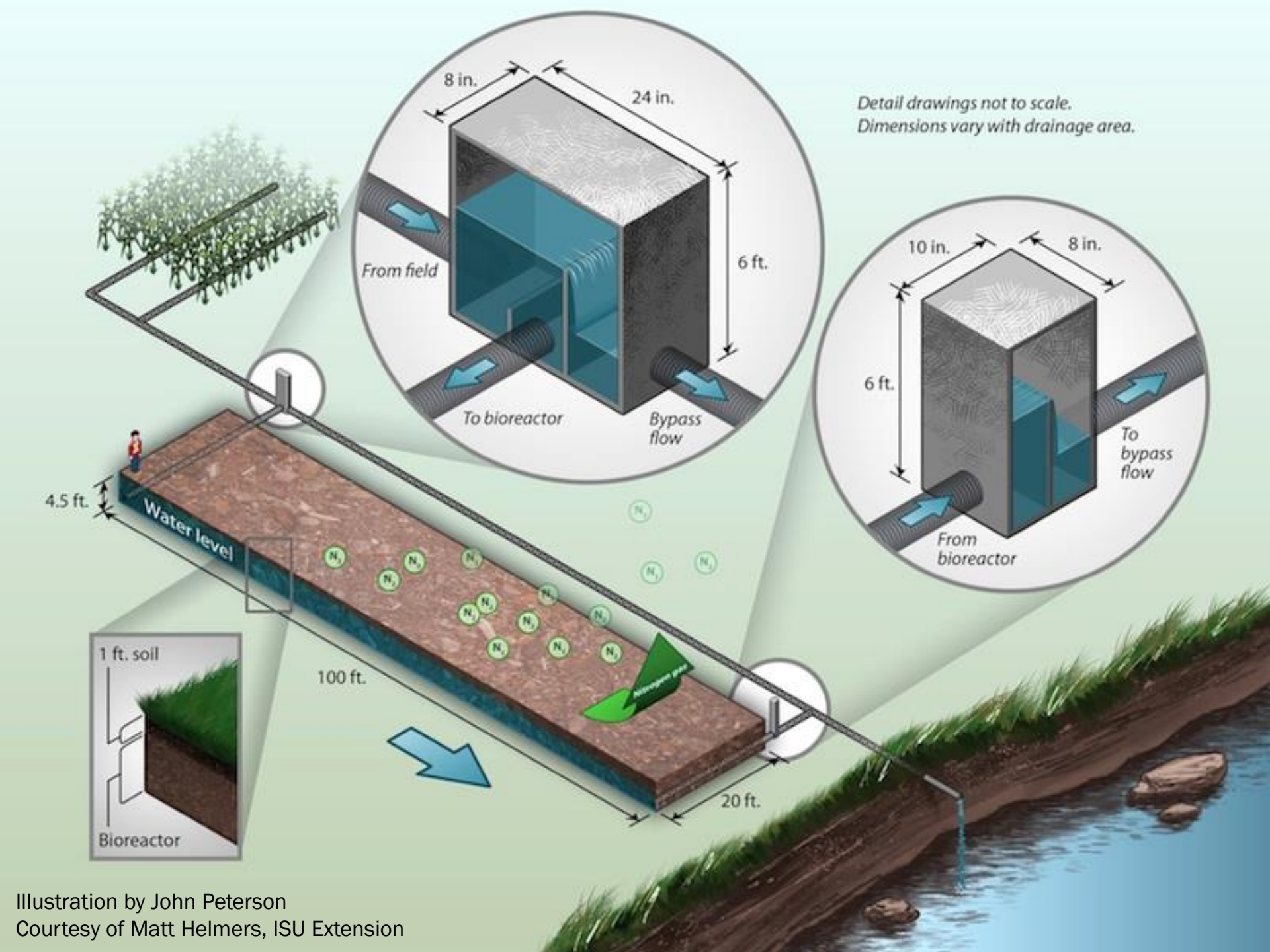
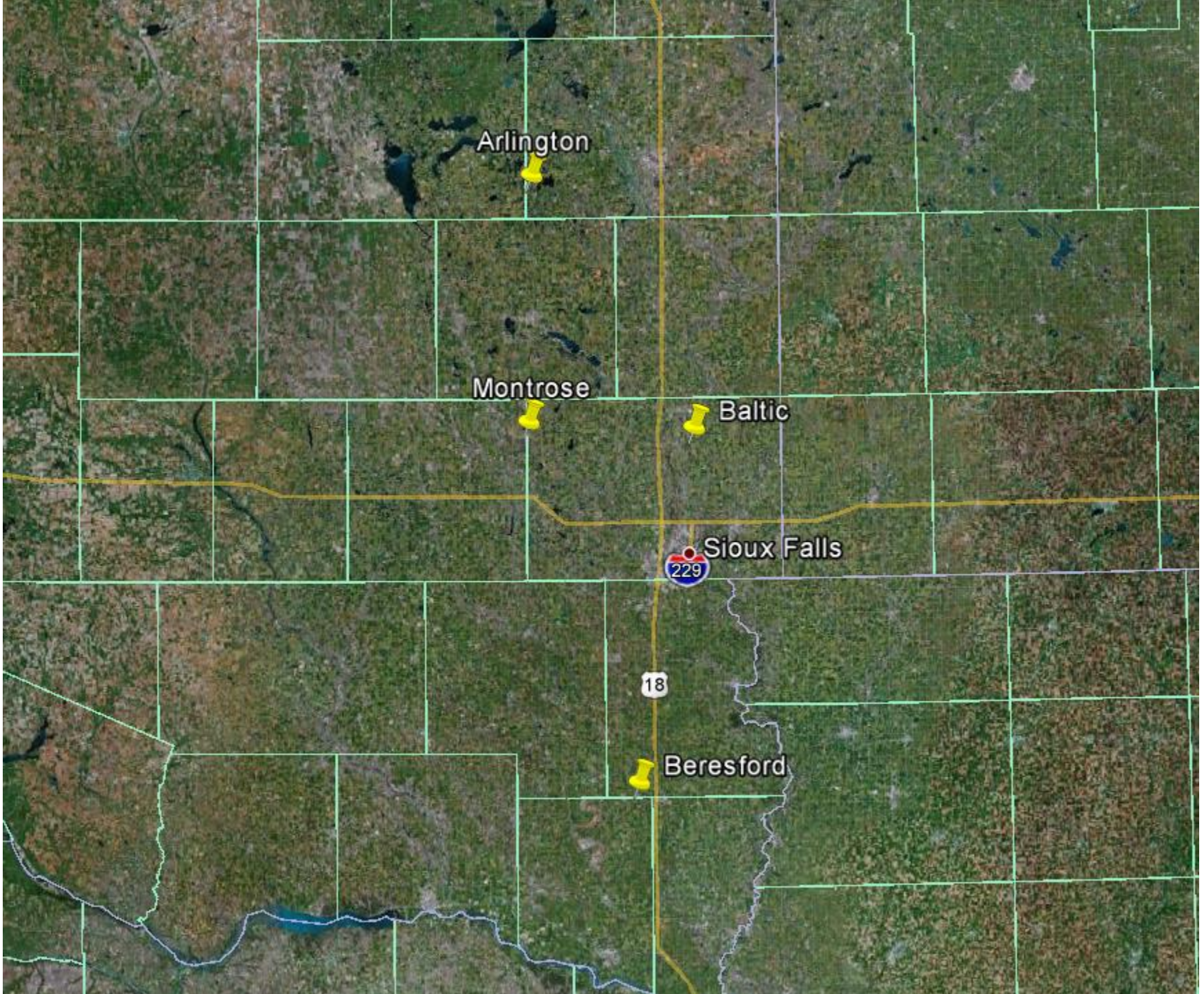
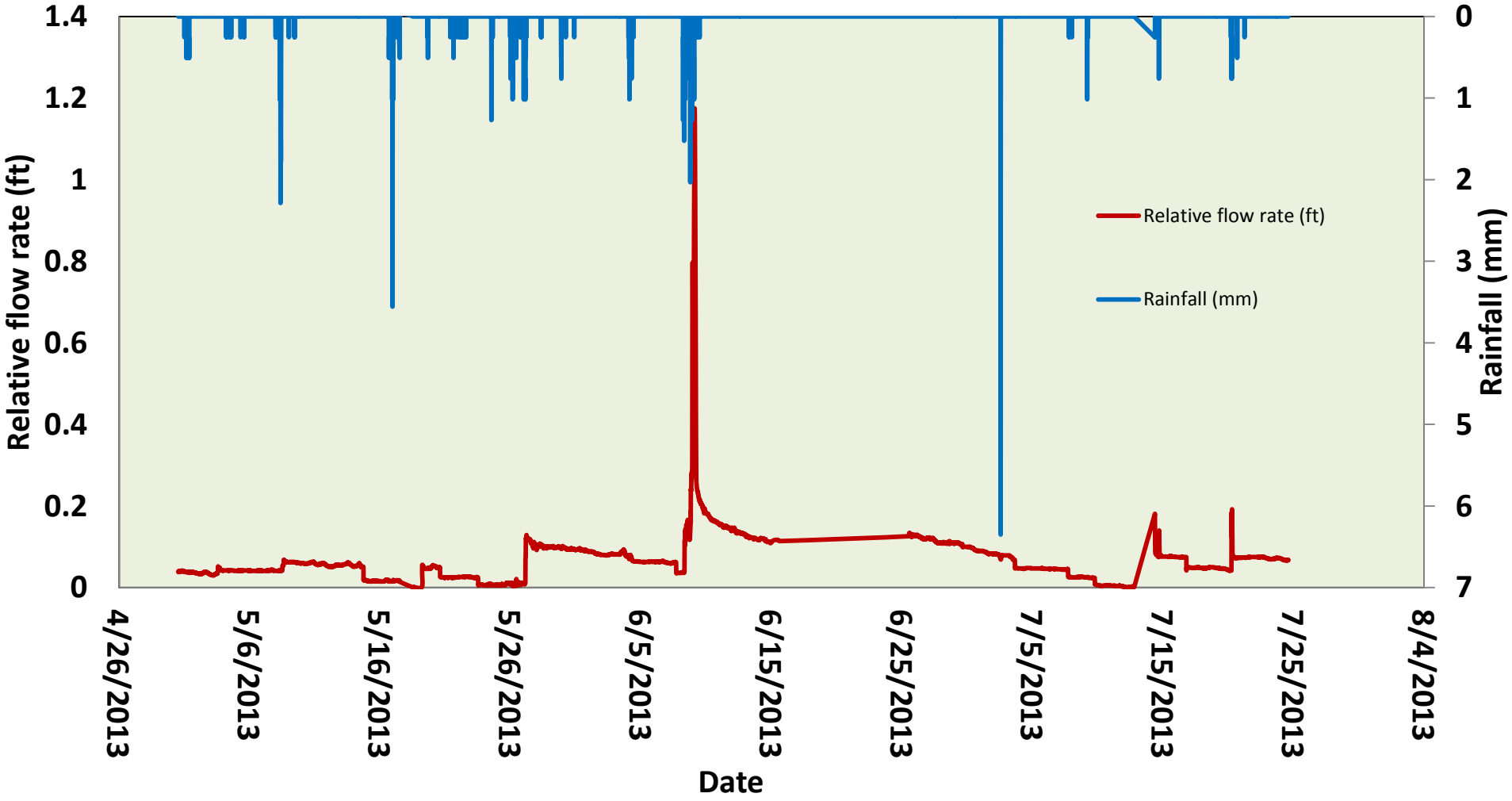
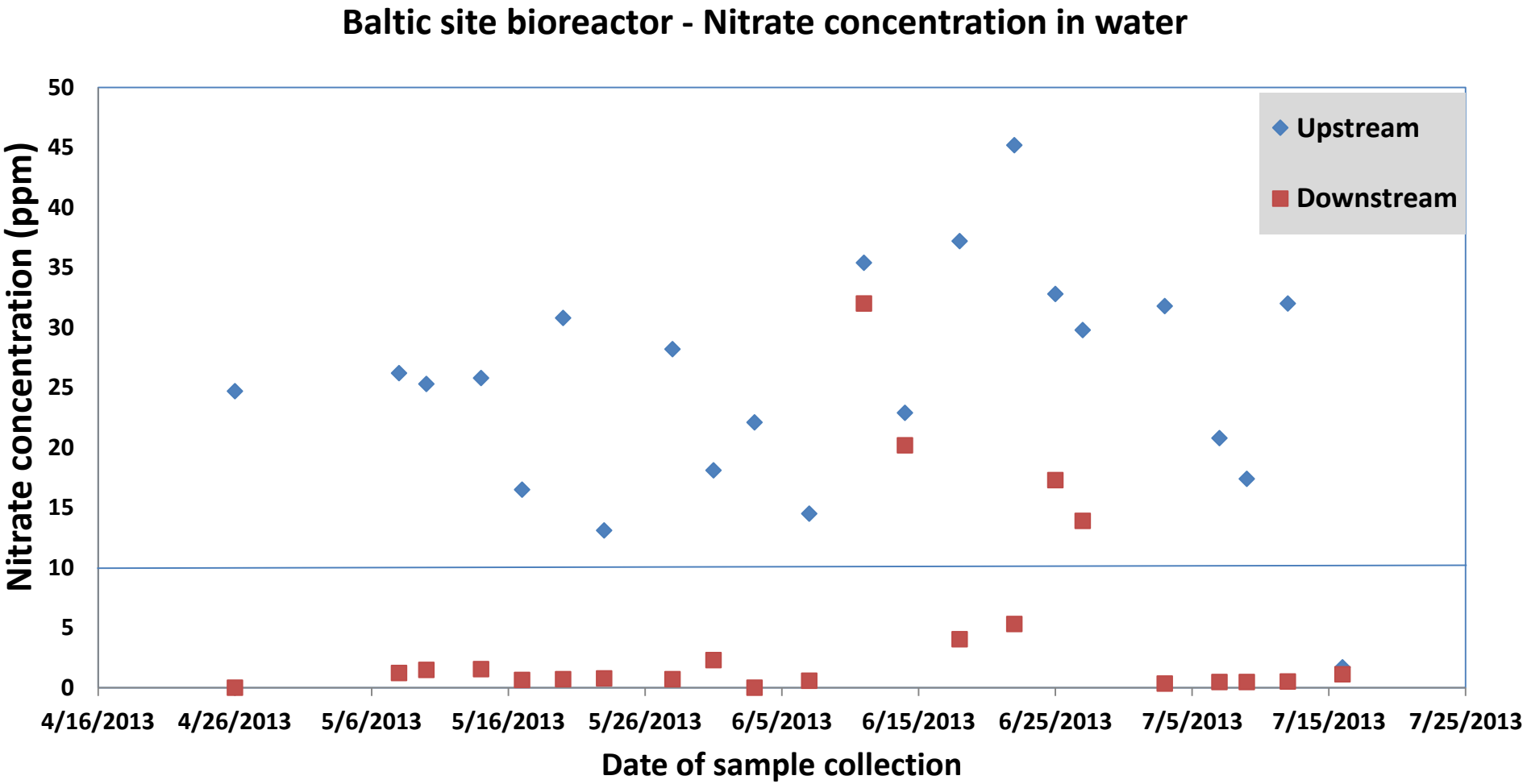


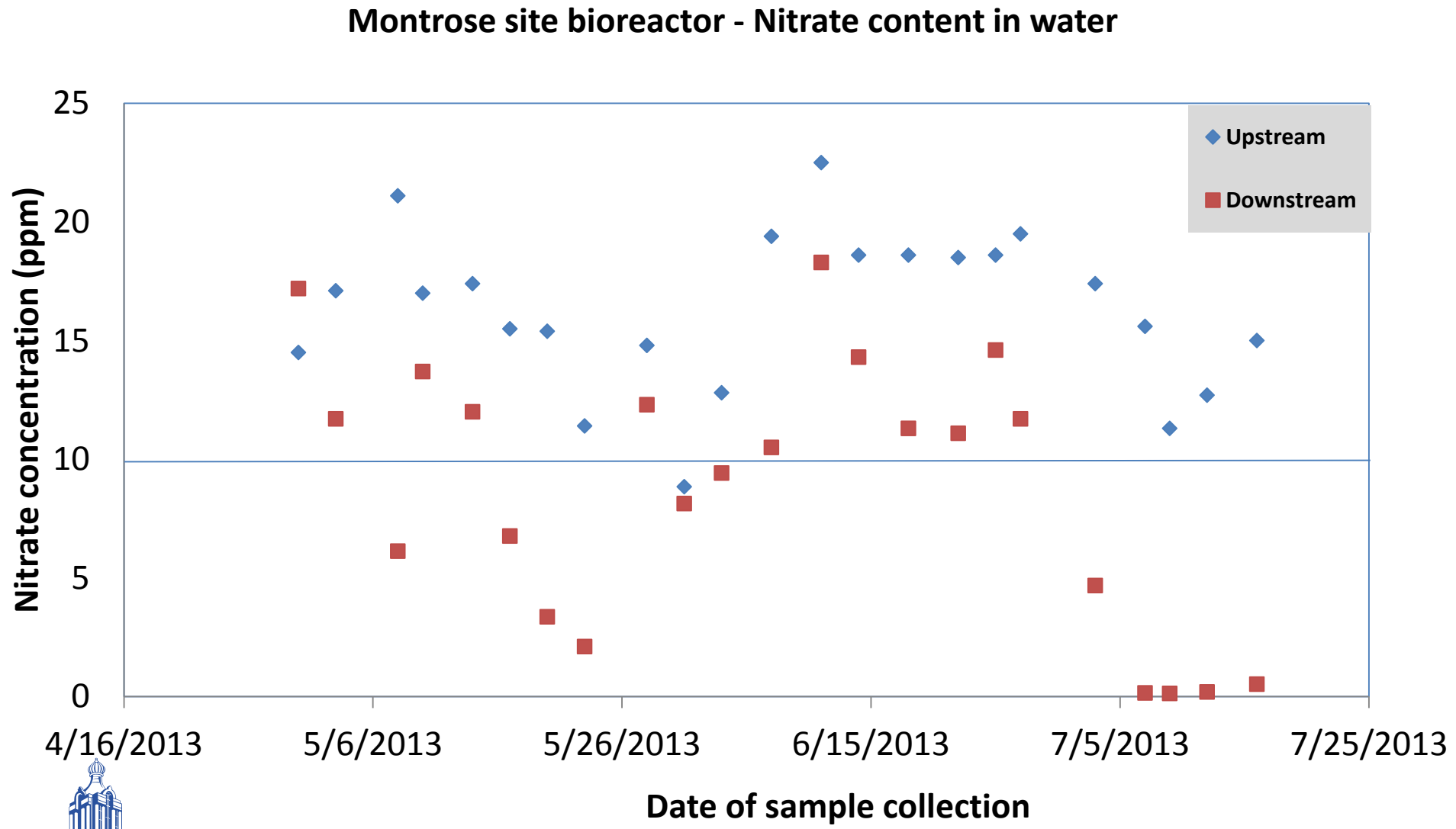
Illustration by John Peterson
Courtesy of Matt Helmers, ISU Extension


Arlington
Montrose
Baltic
Sioux Falls
229
18
Beresford

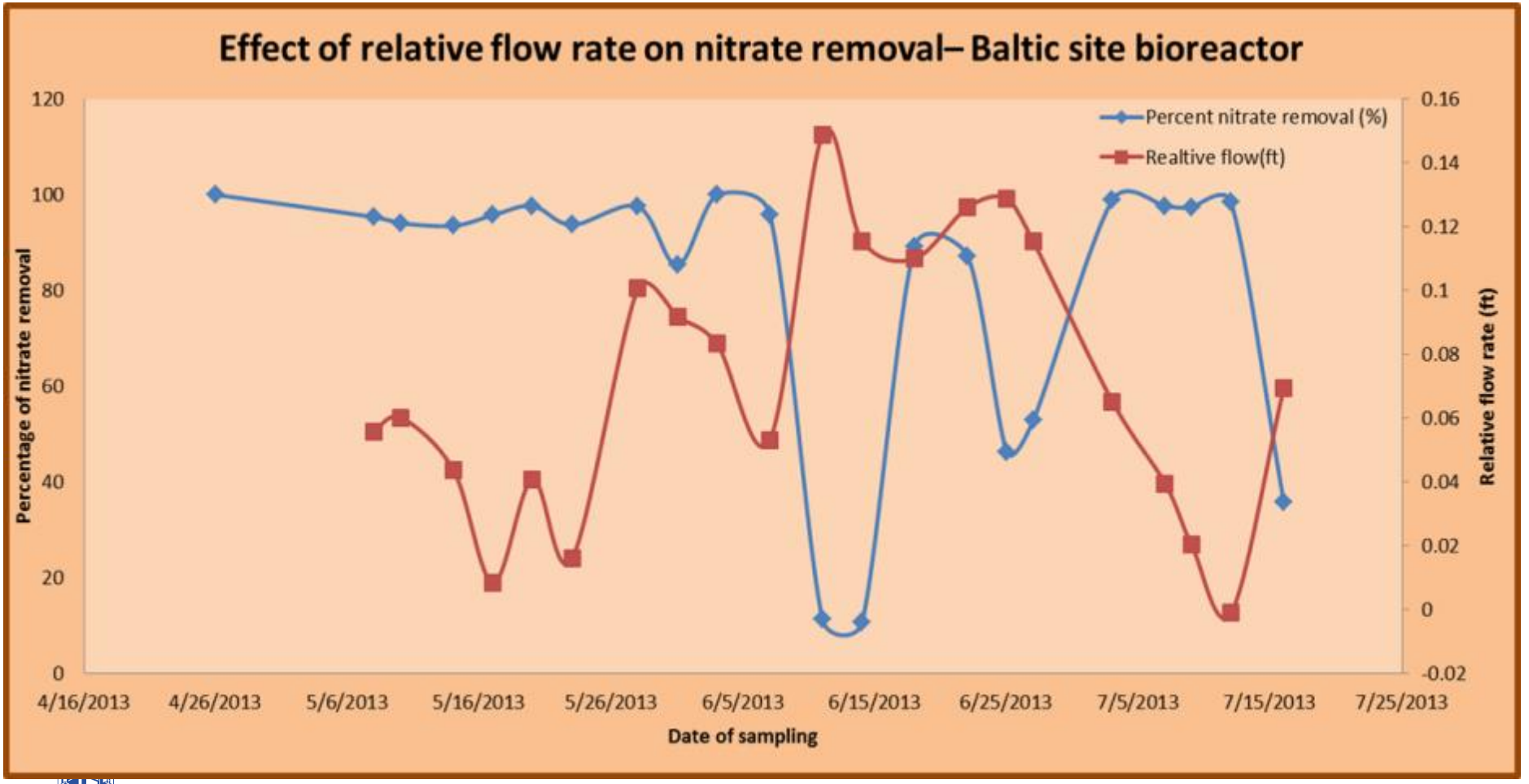
Relative flow rate of water through the control structure and rainfall



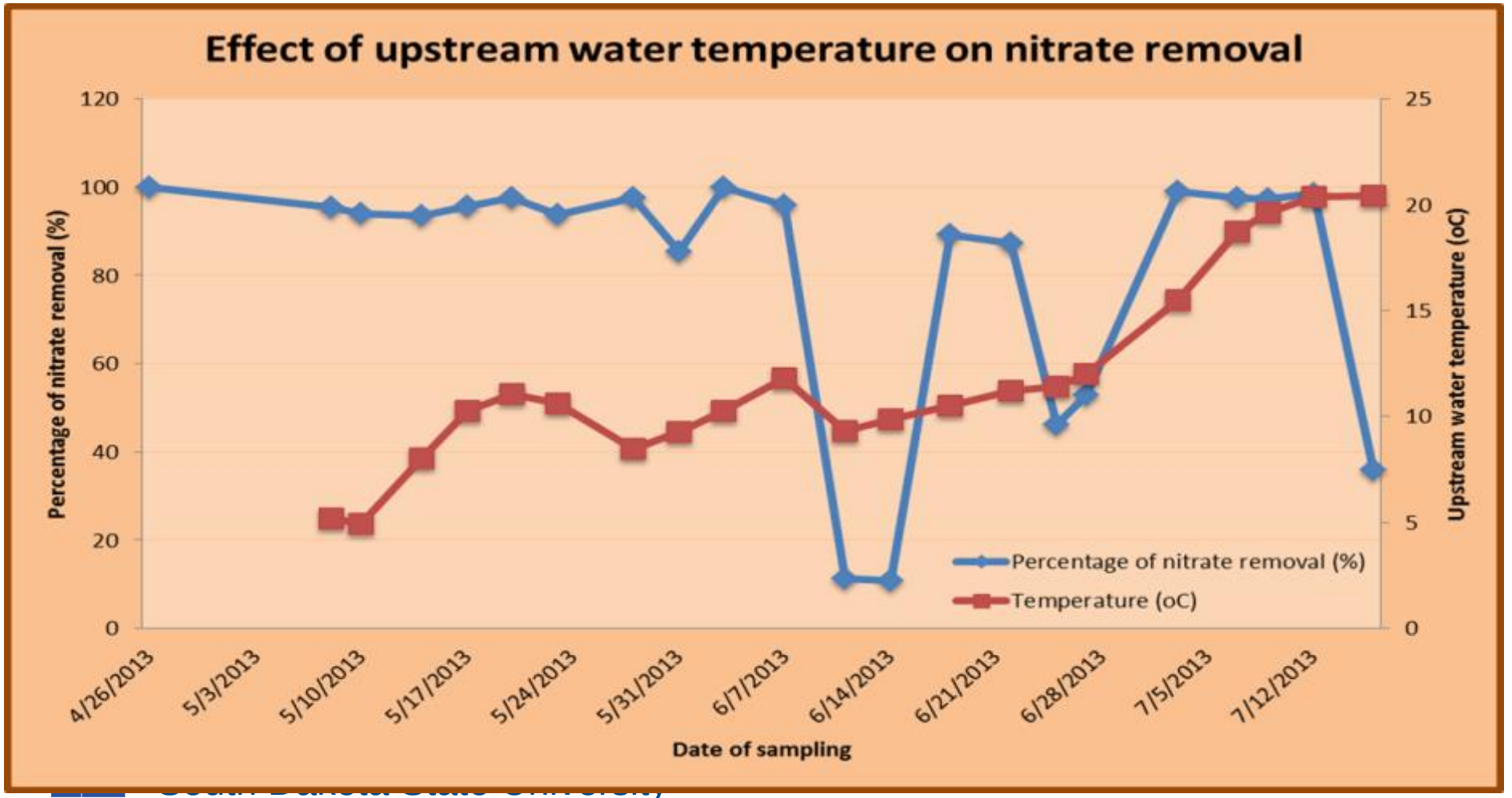

Baltic site bioreactor - Nitrate concentration in water
Nitrate concentration (ppm)
50
45
40
35
30
25
20
15
10
5
0
Upstream
Downstream
4/16/2013
4/26/2013
5/6/2013
5/16/2013
5/26/2013
6/5/2013
6/15/2013
6/25/2013
7/5/2013
7/15/2013
7/25/2013
Date of sample collection


Montrose site bioreactor - Nitrate content in water
Nitrate concentration (ppm)
25
20
15
10
5
0
4/16/2013
5/6/2013
5/26/2013
6/15/2013
7/5/2013
7/25/2013
Date of sample collection
Upstream
Downstream

Effect of flow on nitrate removal



Effect of water temperature on nitrate removal



Installation Cost, Baltic

Cost Category	Quantity	Total Cost	Comment
Earth work and backfilling	2.5 days	$1900	Backhoe and skid steer
Wood Chips	250 yd^3	$3925	Includes transportation
Control Structures[1]	2	$1675	A 3-chamber a 2-chamber structure
Plastic Liner[2]	1liner	$500	6 mil plastic film
Tile, joints and elbows[3]		$0	Donated by ADS and Hefty Seed
Personnel Transportation		$300	
Misc. supplies		$200	
Labor[4]	2 laborers	$500	
Total Installation Cost		**$9000**	

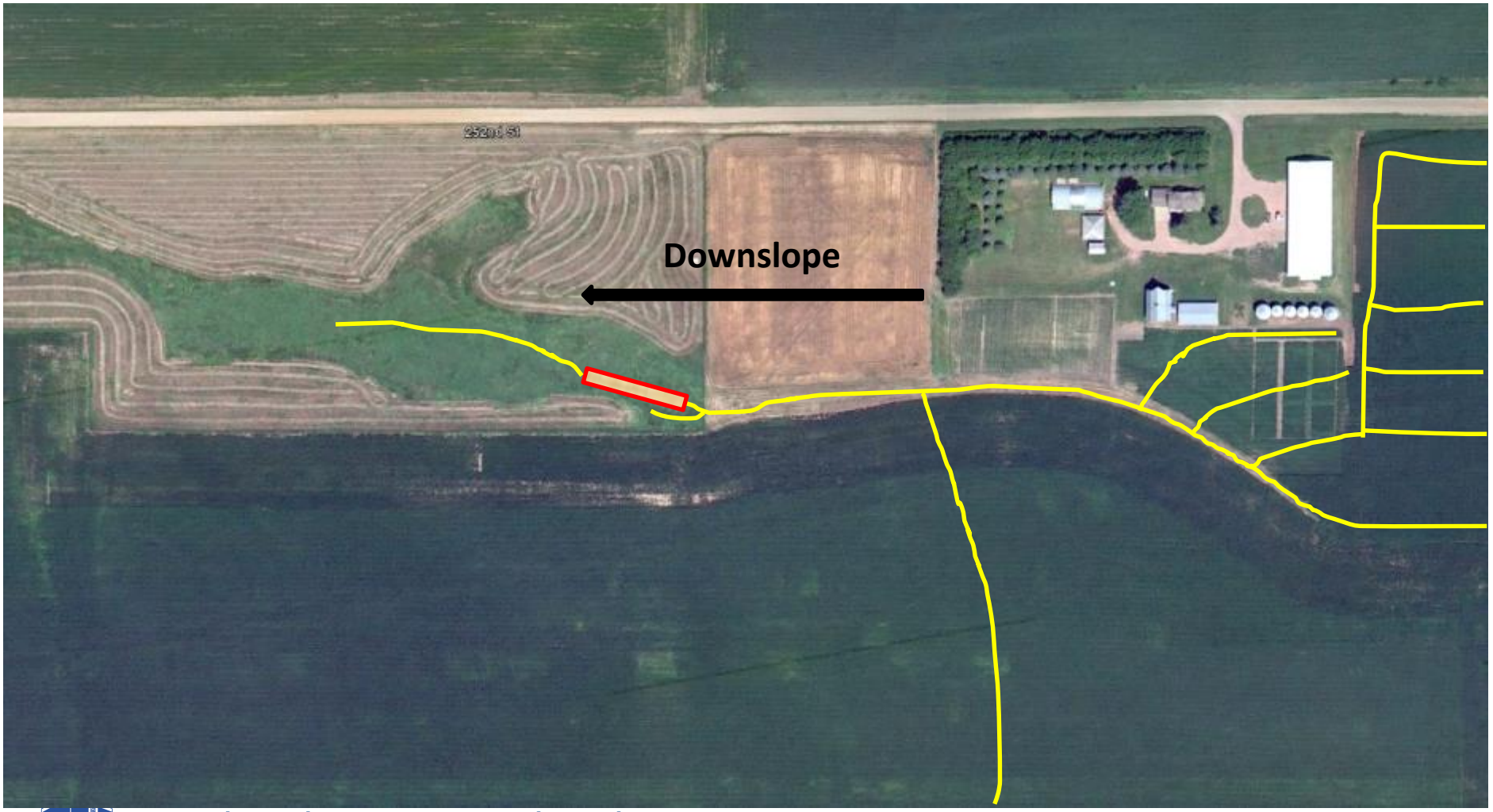
[1]The indicated cost includes a 20% discount from Agridrain Corp.
[2]A liner is not needed if the bioreactor is installed in stable soil (high clay content).
[3]Advanced Drainage System (ADS) donated a roll of 6 inch tile and Hefty Seed donated elbows, tee's, tape etc.
[4]SDSU hourly student labor. Labor costs for local collaborators, SDSU graduate students charged to the project.

Cost per hectare per year

Baltic Bioreactor

Cost category	Cost ($)	Replacement, years	Cost per year
Excavation and back filling	$1,900	20	$95
Woodchips	$3,925	20	$196
Plastic liner	$500	20	$25
Control structure	$1,675	40	$42
Other (personnel transport, labor)	$1,000	40	$25
Stop logs	$14	8	$2
	Total cost one year		$385
	Total drained area (ha)		16
	Cost per treatment area ($/year/ha)		$24
	Cost per treatment area ($/year/ac)		$10

Baltic, SD Bioreactor Installation Site

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Demonstrating the Nitrogen-Removal Effectiveness of Denitrifying Bioreactors for Improved Drainage Water Management

Subsurface (tile) drainage on agricultural land with poor natural drainage allows timelier field operation access and contributes to improved crop yields. While properly designed and installed subsurface drainage typically reduces sediment and phosphorus losses, many studies show that subsurface drainage enhances the movement of nitrate-nitrogen to surface waters.

This creates a critical need for strategies that minimize nitrate losses through subsurface drainage of agricultural land. While improved management of nitrogen fertilizer and animal manure is one important method for reducing nitrate losses, it is often not enough: therefore, water quality goals for nitrate require additional, off-field drainage water and nutrient management methods.

Our long-term goal is investigating, developing, evaluating, and transferring practices that maintain the benefits of agricultural subsurface drainage while minimizing unwanted environmental impacts. The overall objective of this project is demonstrating and evaluating denitrifying bioreactors placed on the edge of fields to reduce nitrate loads from subsurface drainage systems in eastern South Dakota.

We will install 4–6 bioreactor demonstration sites in eastern South Dakota and monitor their performance in removing nitrate. The sites will be open for at field days and the monitoring results will be publically available.

The work involves researchers from the Department of Agricultural and Biosystems Engineering and Water Resources Institute at SDSU and is supported by a grant from the USDA Natural Resources and Conservation Service. Additional support comes from SDSU, East Dakota Water Development District, the South Dakota Farm Bureau, the South Dakota Soybean Research and Promotion Council and the Vermillion Basin Water Development District.

Additional Information:

Project Description

Bioreactors for drainage water treatment – an overview

Project Sponsors

SDSU

Questions?

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