# A Presentation of the 2013 Drainage Research Forum

November 14, 2013
SDSU Extension Regional Center
Sioux Falls, SD

IOWA STATE UNIVERSITY
University Extension

SDSU
Extension

# Saturating Riparian Buffers In Tile Drained Landscapes for Nitrate Removal.

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and

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USDA

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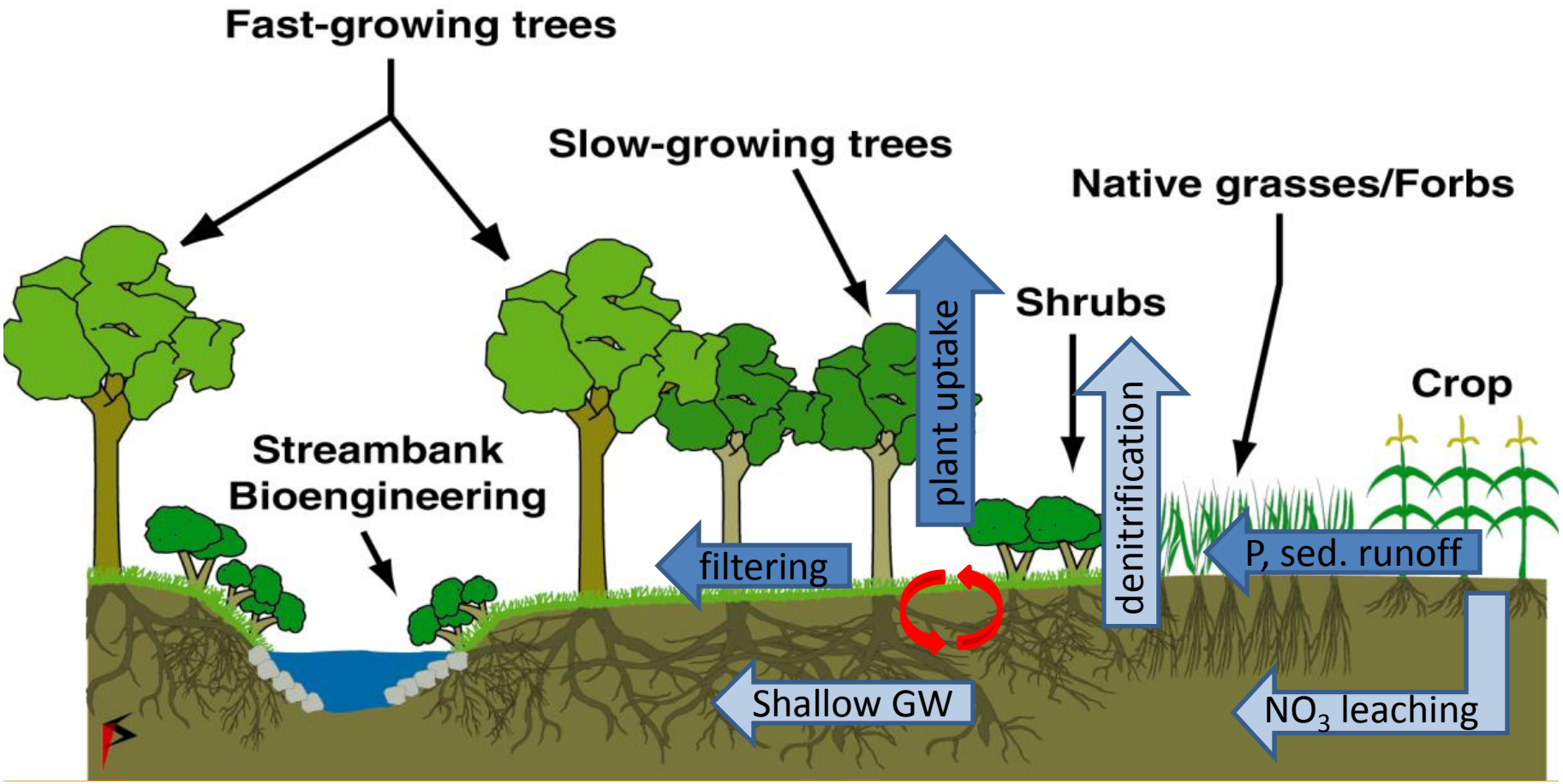
IOWA STATE UNIVERSITY

College of Agriculture and Life Sciences

LEOPOLD CENTER

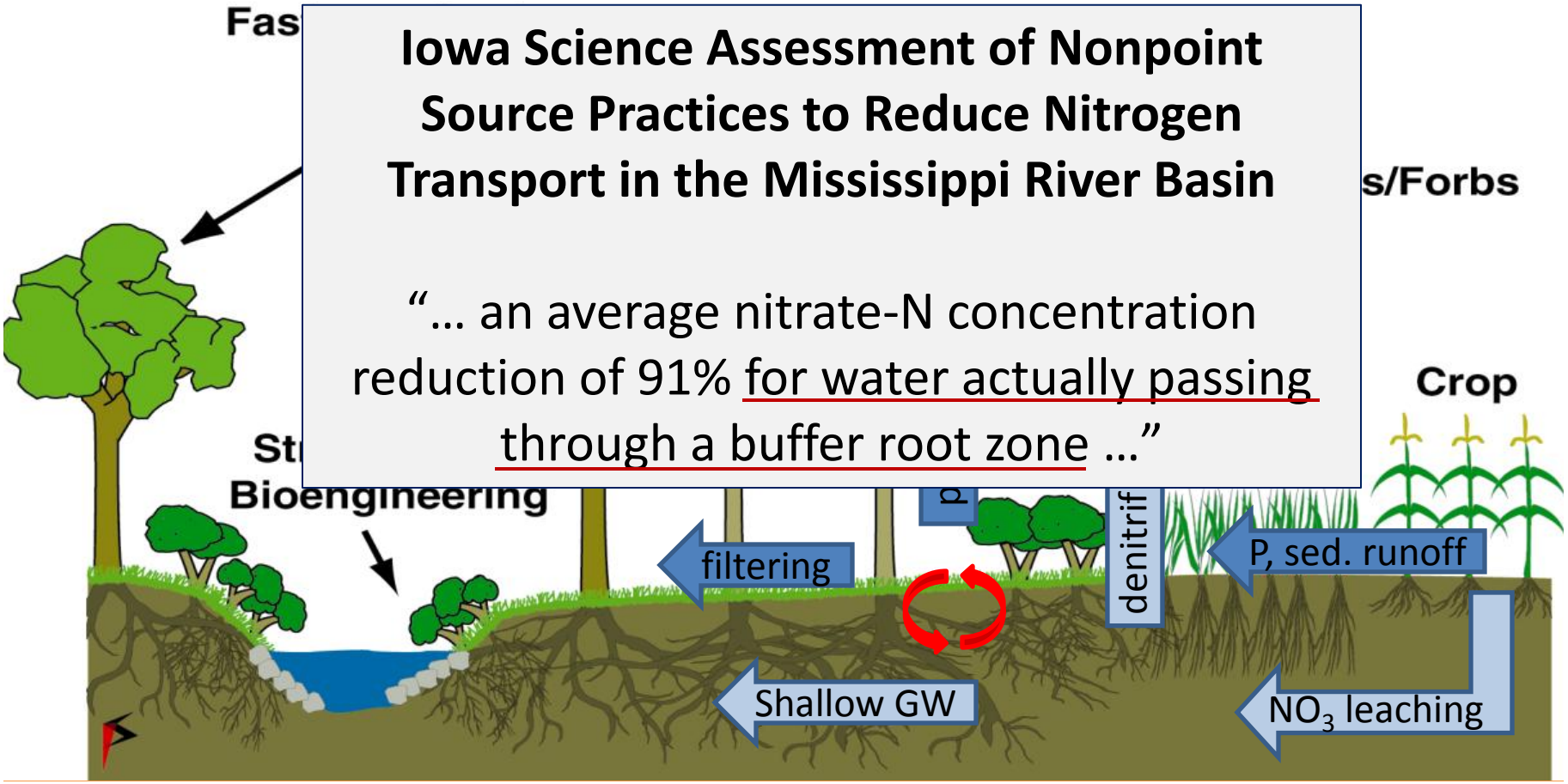
# Schematic of nutrient retention in a riparian buffer.



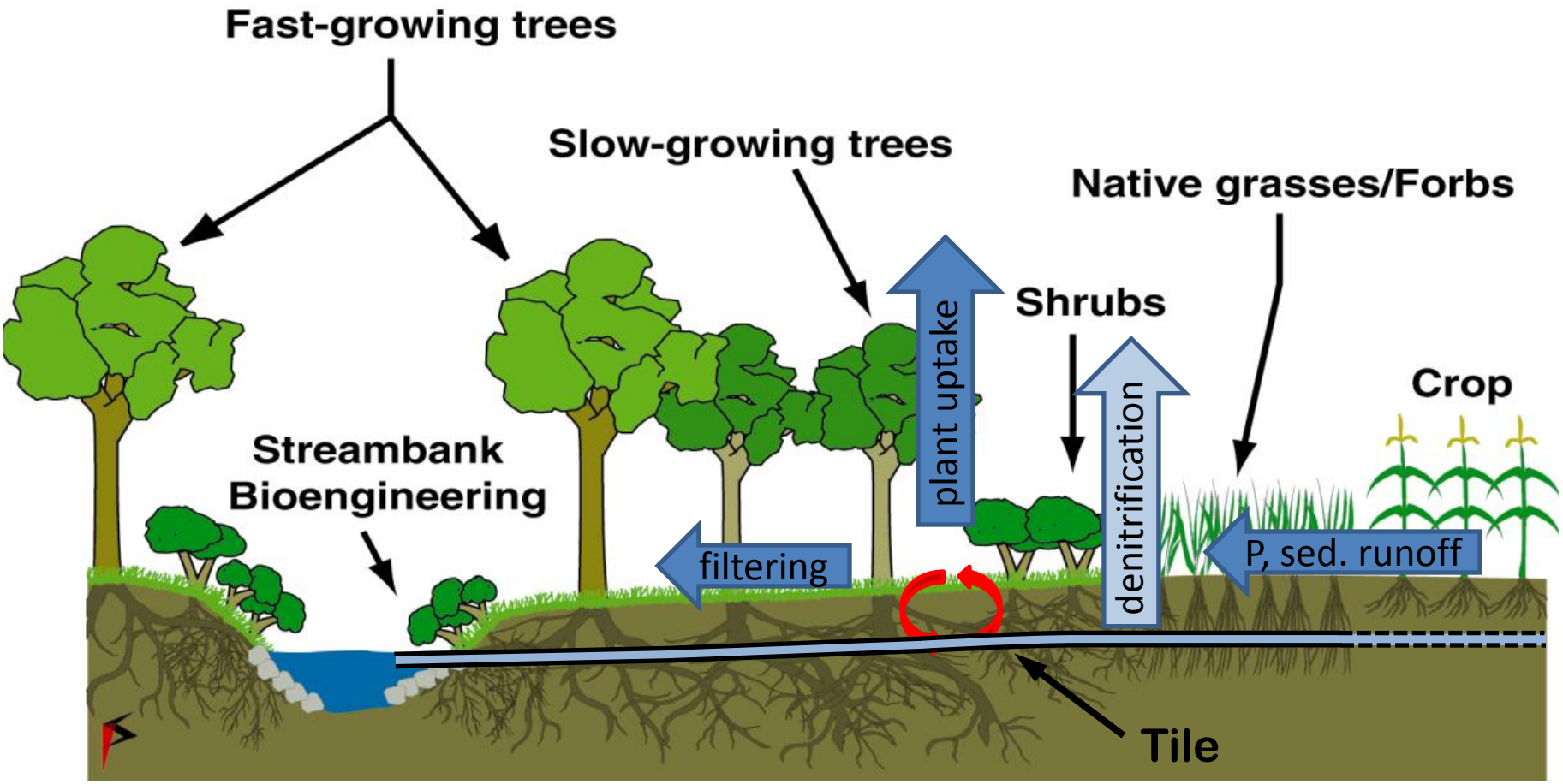
# Schematic of nutrient retention in a riparian buffer.

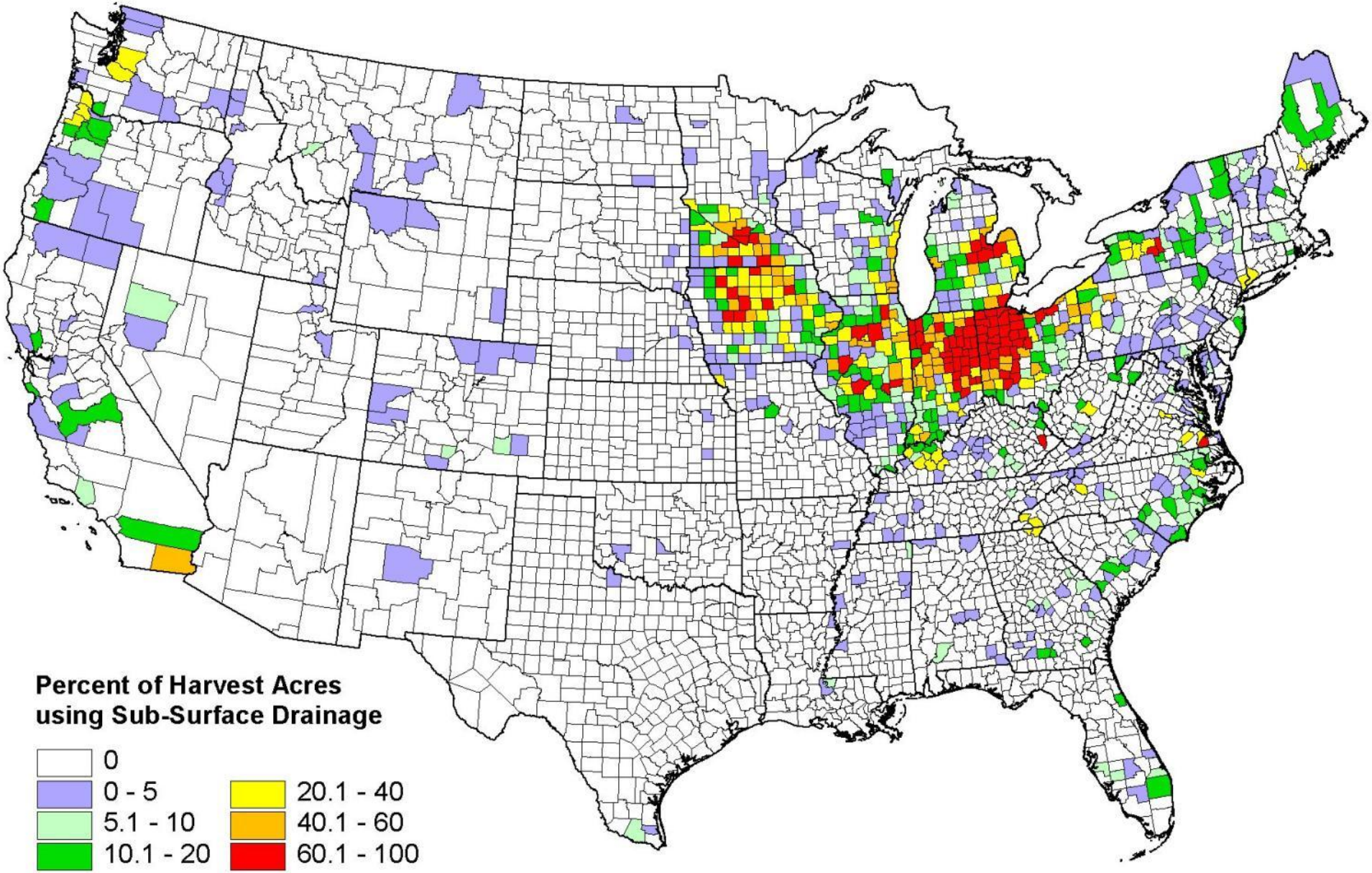
**Iowa Science Assessment of Nonpoint Source Practices to Reduce Nitrogen Transport in the Mississippi River Basin**

"… an average nitrate-N concentration reduction of 91% for water actually passing through a buffer root zone …"



# Schematic of nutrient retention in a riparian buffer.

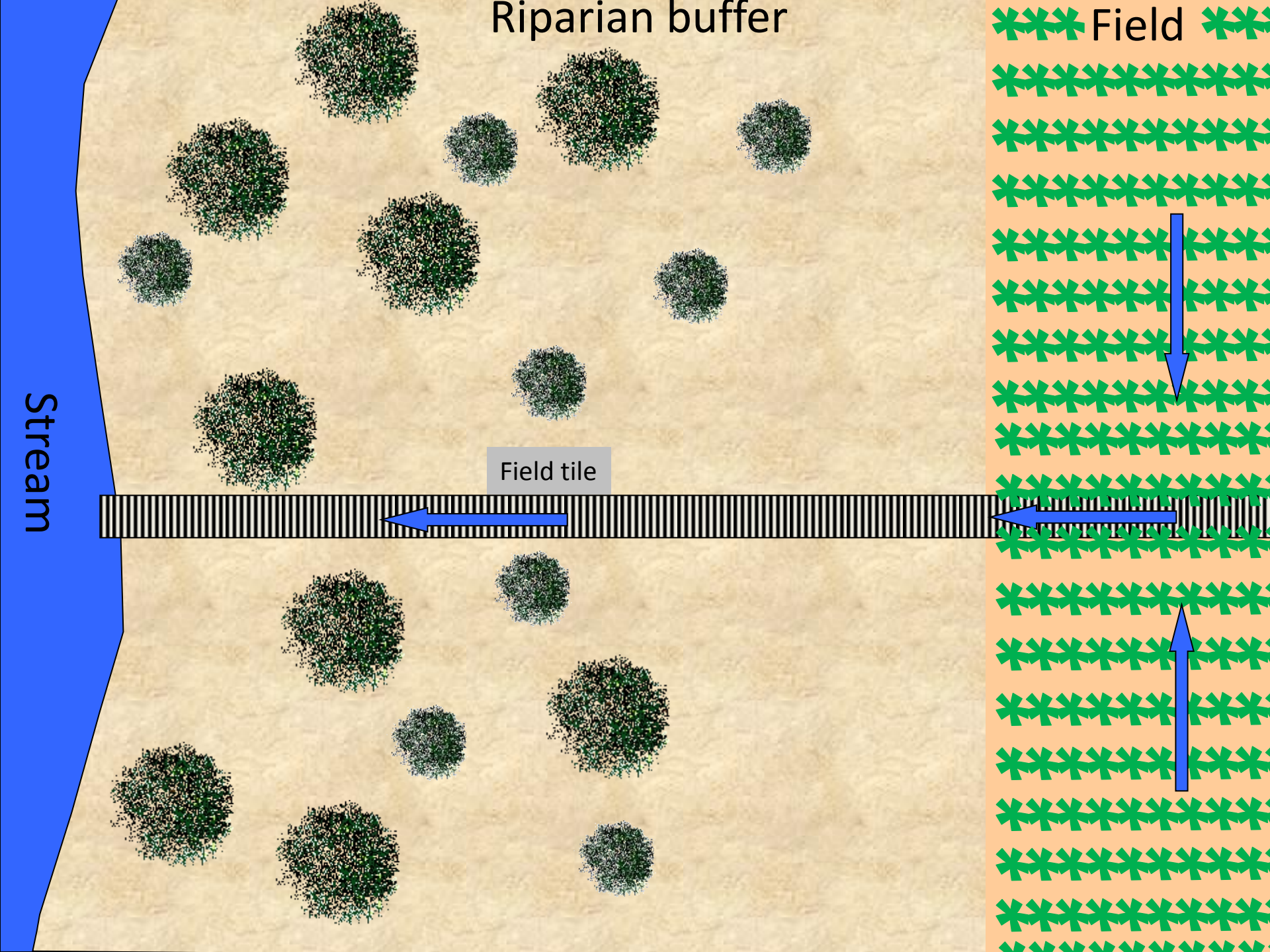


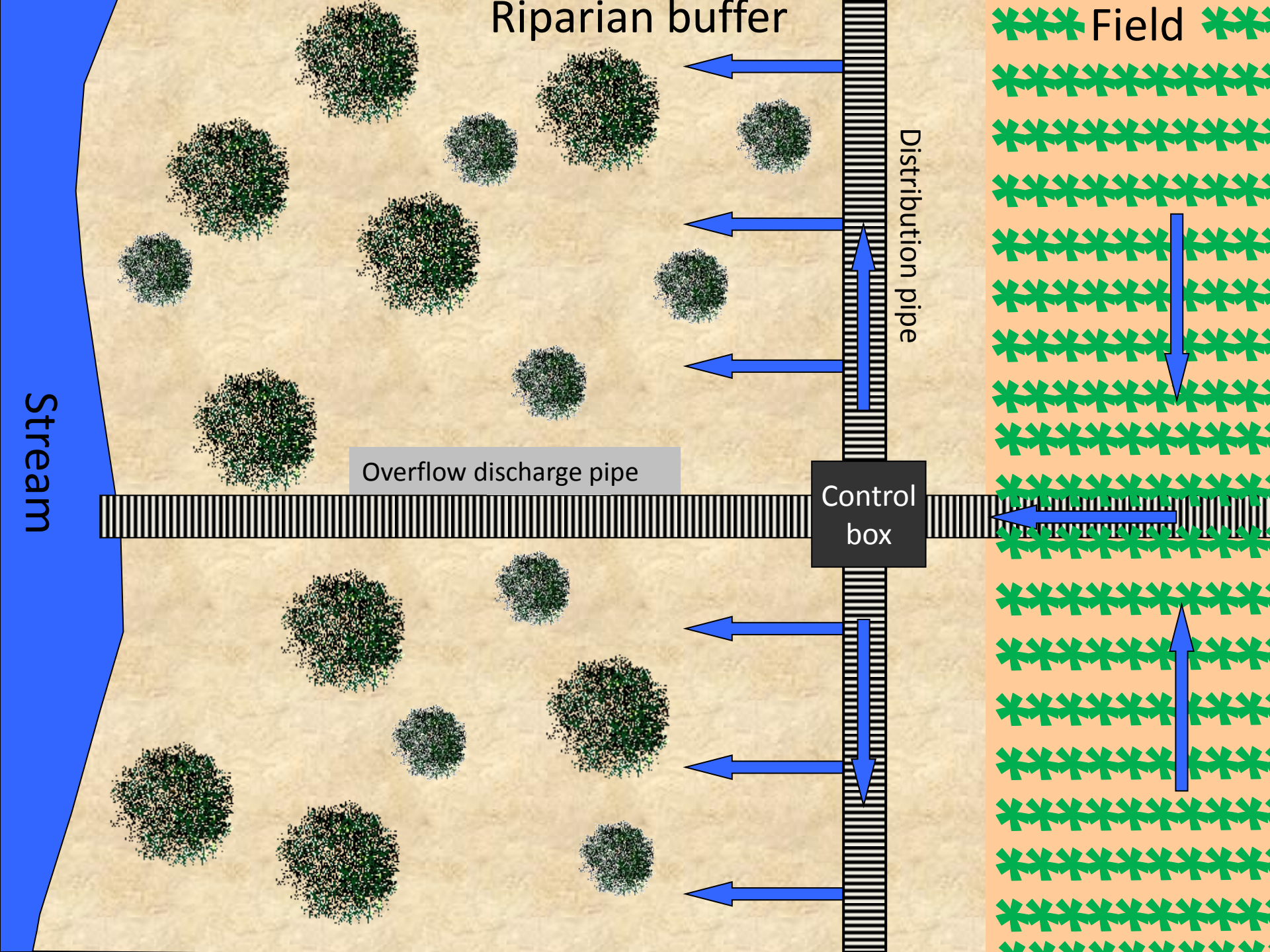



Source: 1992 NRI; 1992 Census of Agriculture

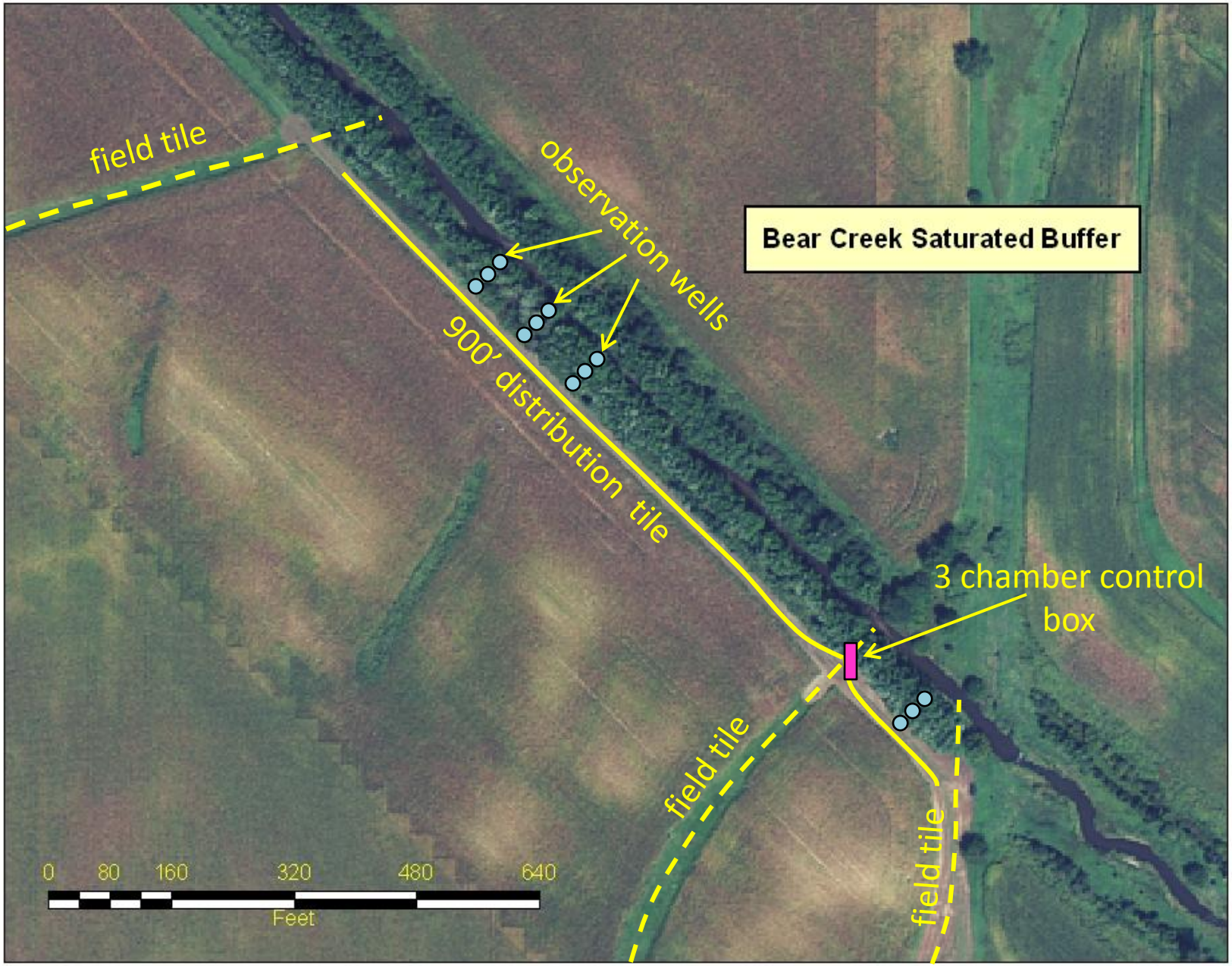
# Question:

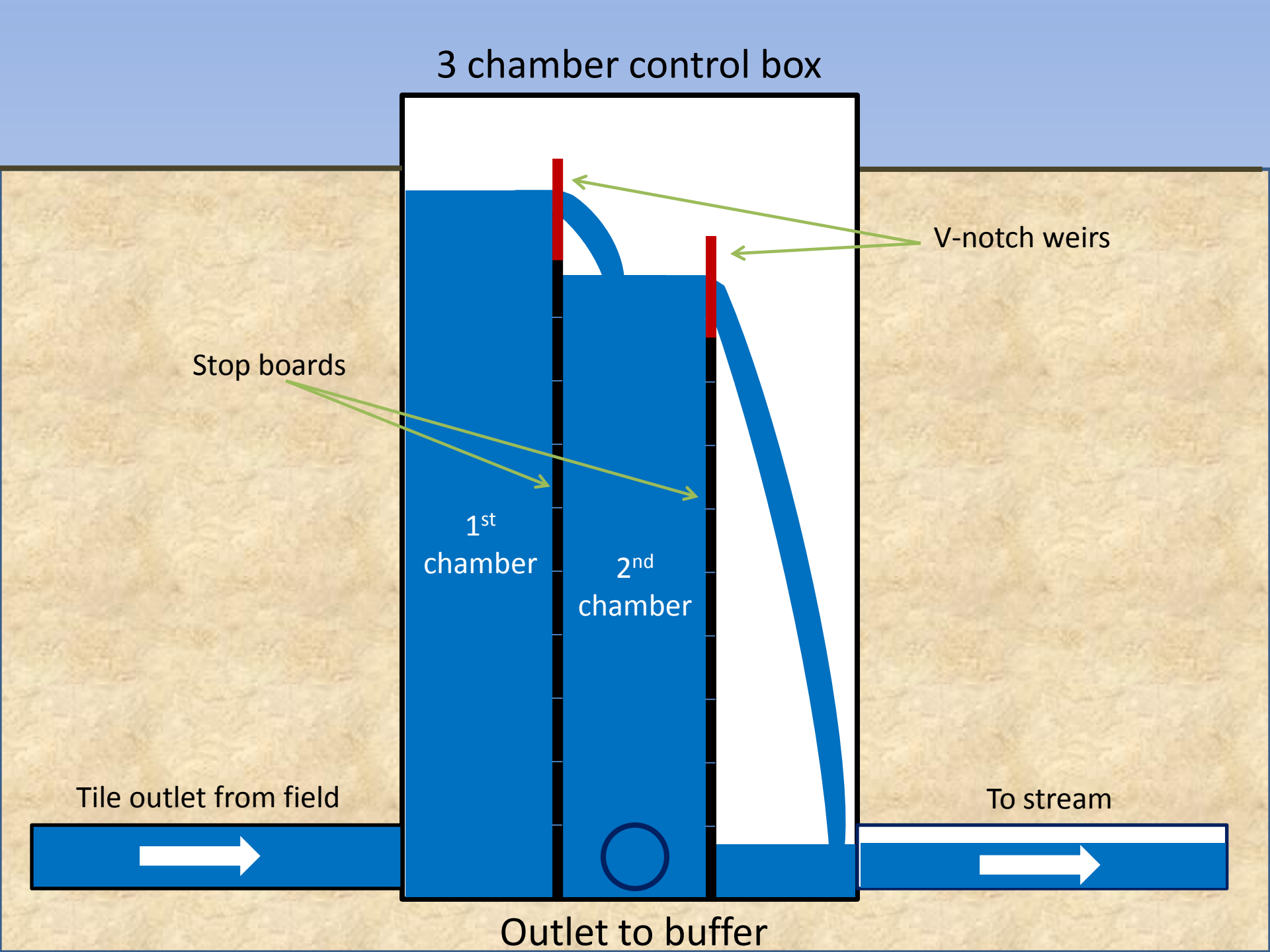
- Could reconnecting tile flow to riparian buffers remove substantial amounts of nitrate before it reaches surface waters?


Riparian buffer
Field
Stream
Field tile

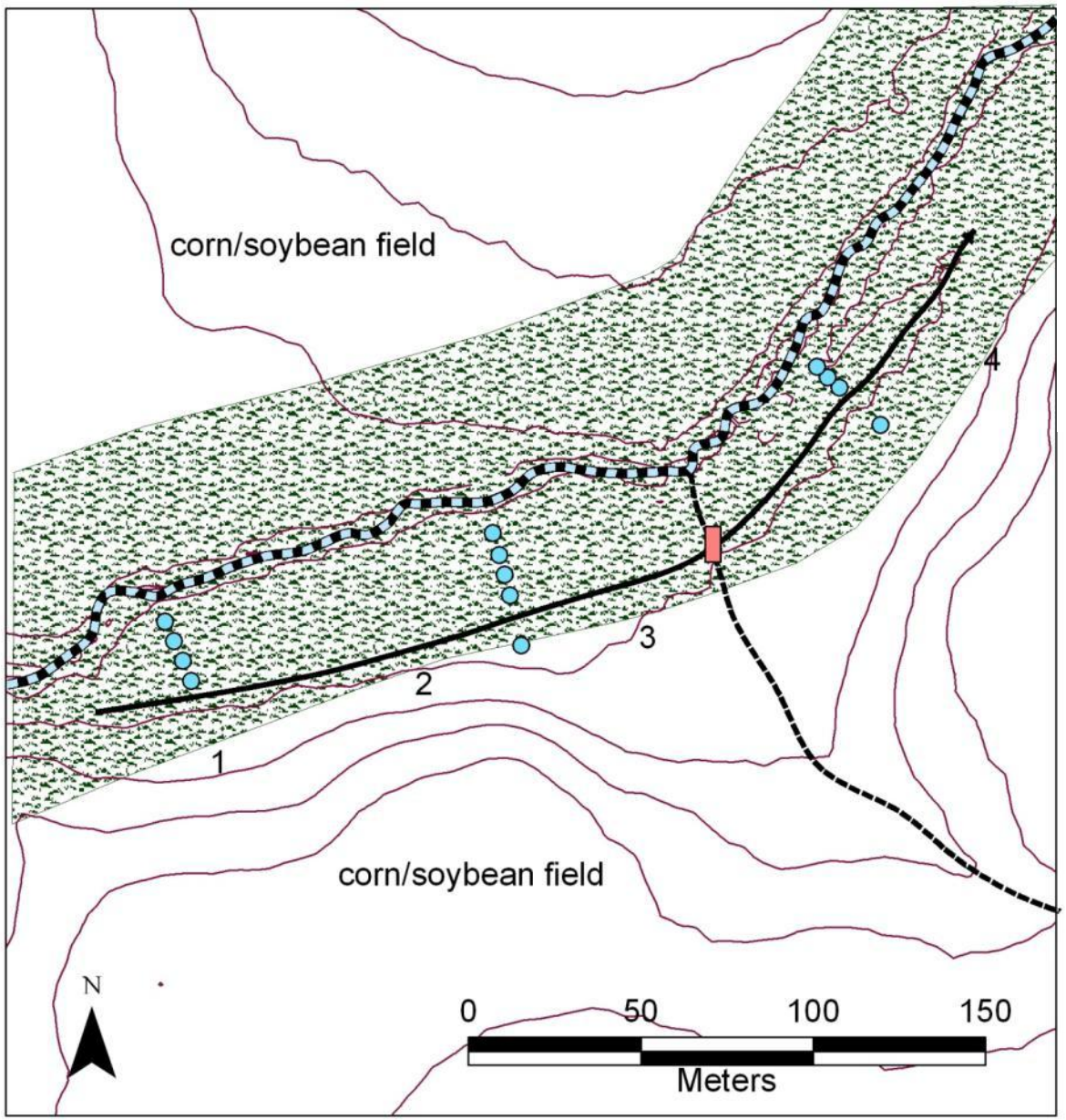

Riparian buffer
Field
Stream
Distribution pipe
Overflow discharge pipe
Control box

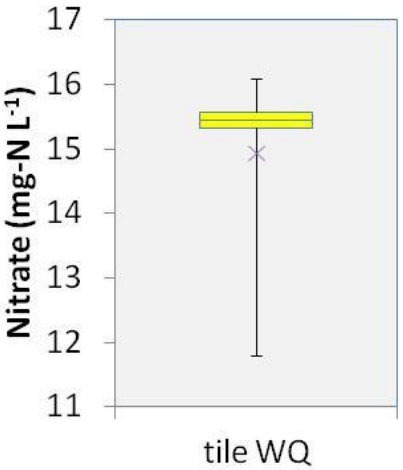
# How is it working?


Bear Creek Saturated Buffer
field tile
observation wells
900' distribution tile
3 chamber control box
field tile
field tile
0 80 160 320 480 640
Feet


3 chamber control box
V-notch weirs
Stop boards
1st chamber
2nd chamber
Tile outlet from field
To stream
Outlet to buffer

# Maass farm site



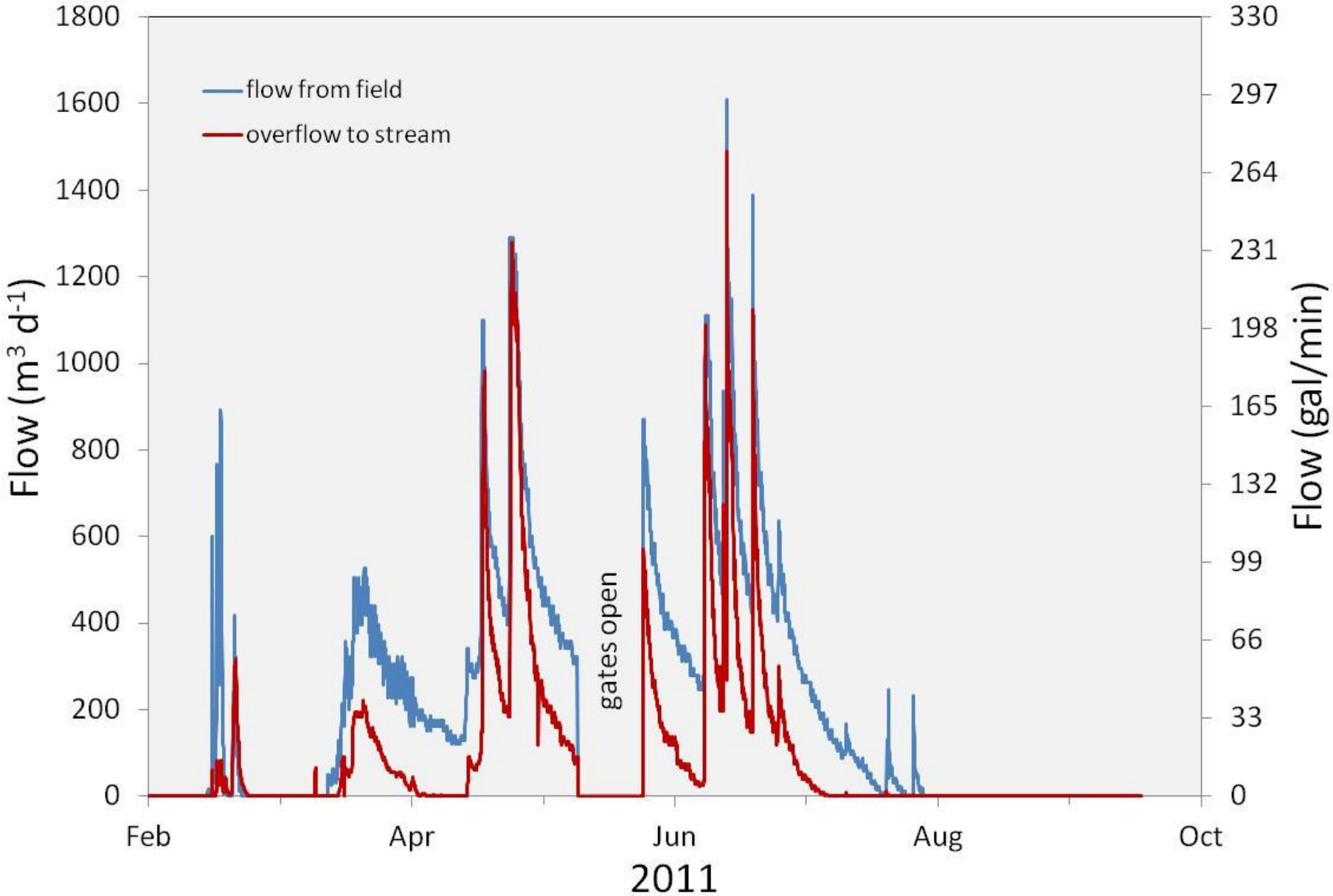




Legend

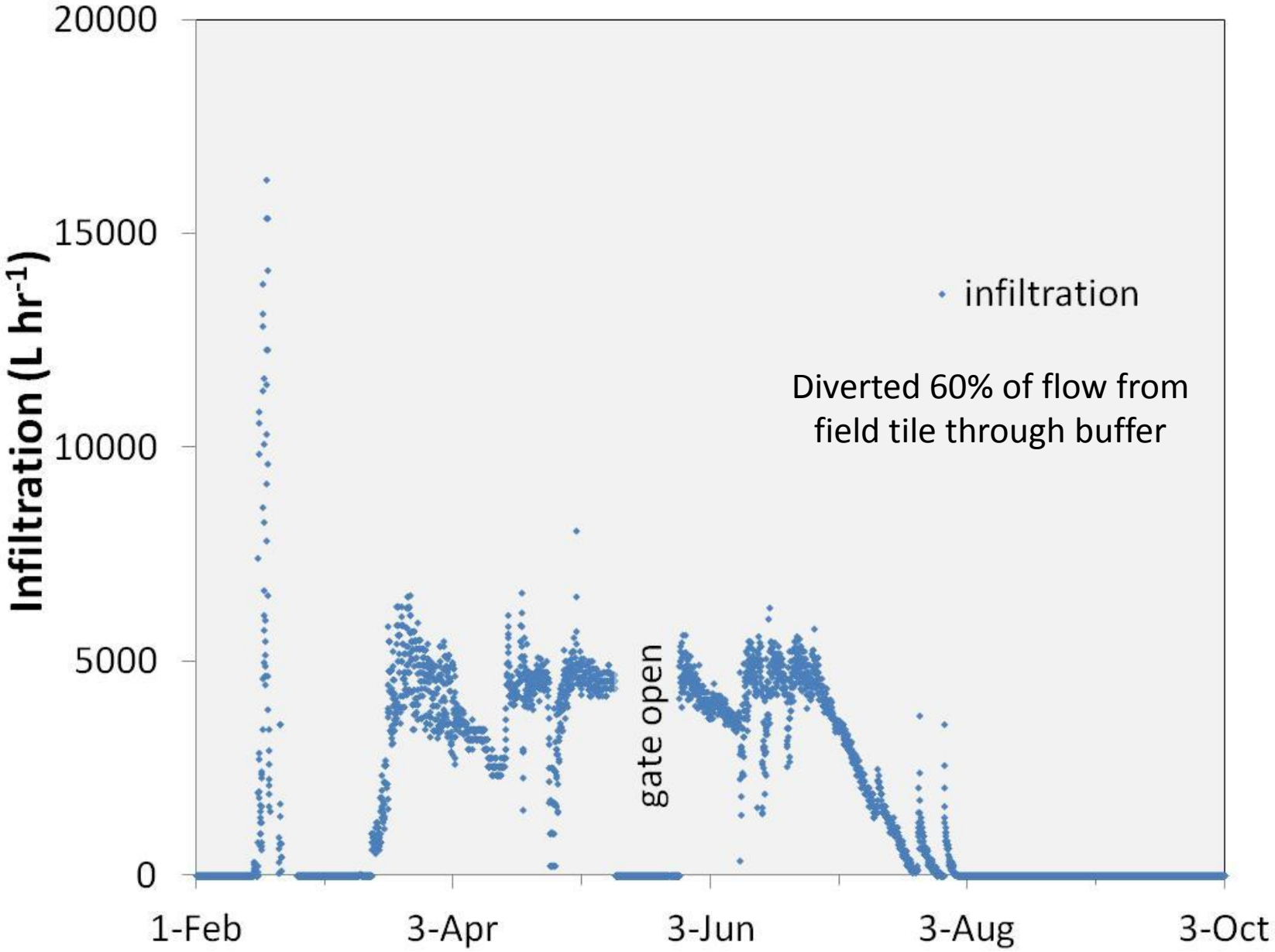
- creek
- riparian buffer
- 1 m contour
- existing tile
- distribution tile
- control box
- observation well

# Results for Bear Creek site

# Flow measurement



# Water and cumulative nitrate diverted through buffer in 2011



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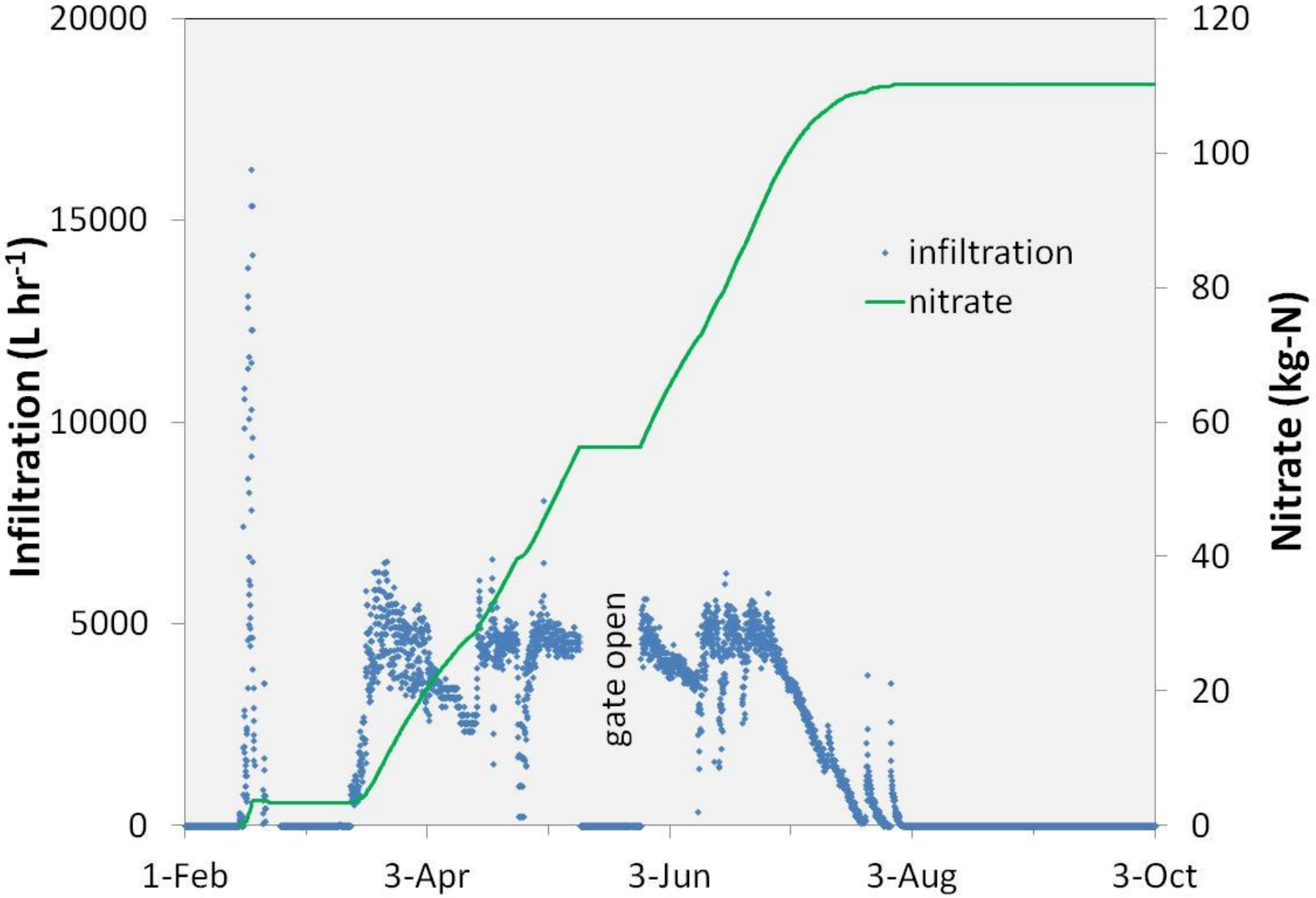
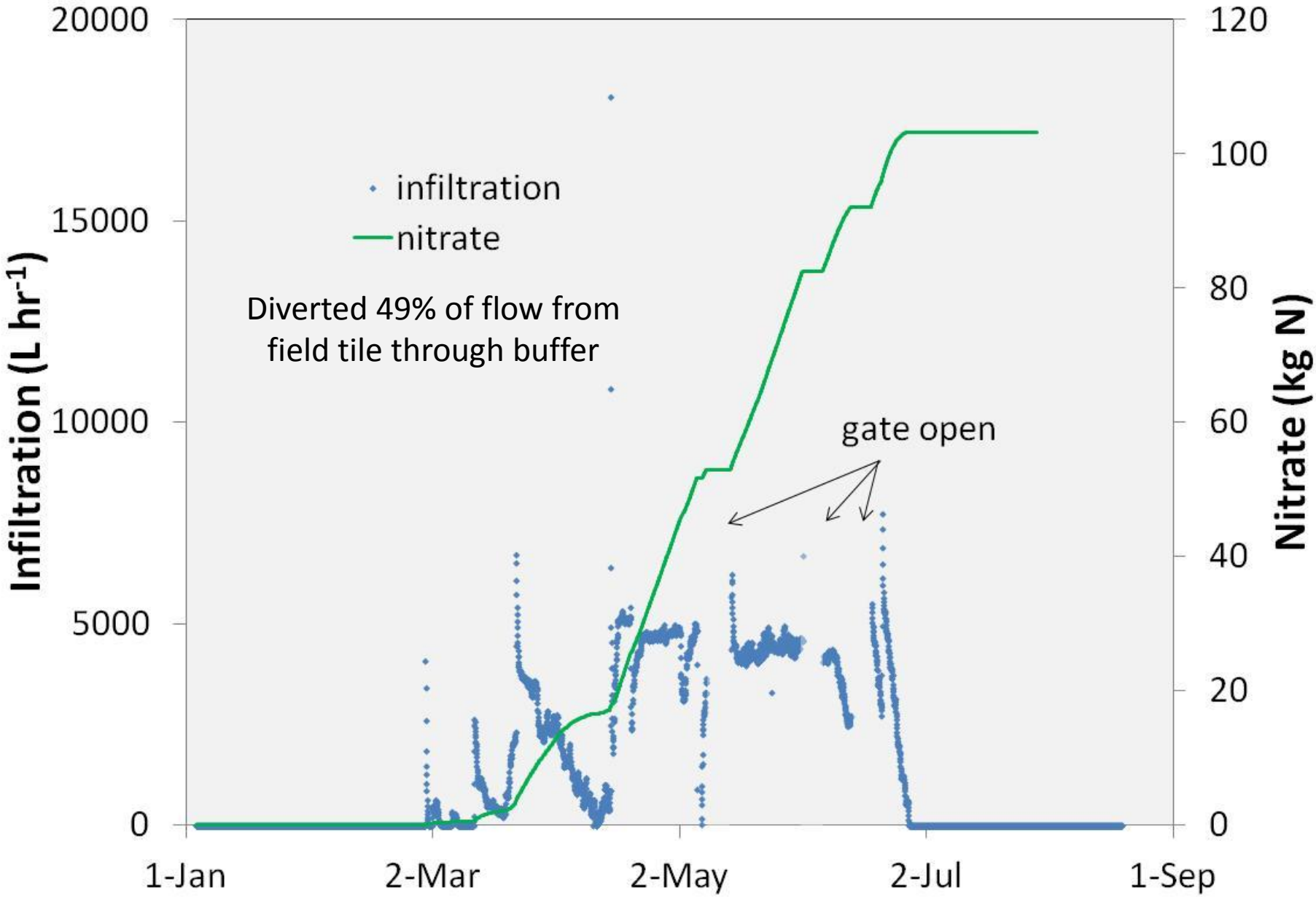


# Water and cumulative nitrate diverted through buffer in 2012

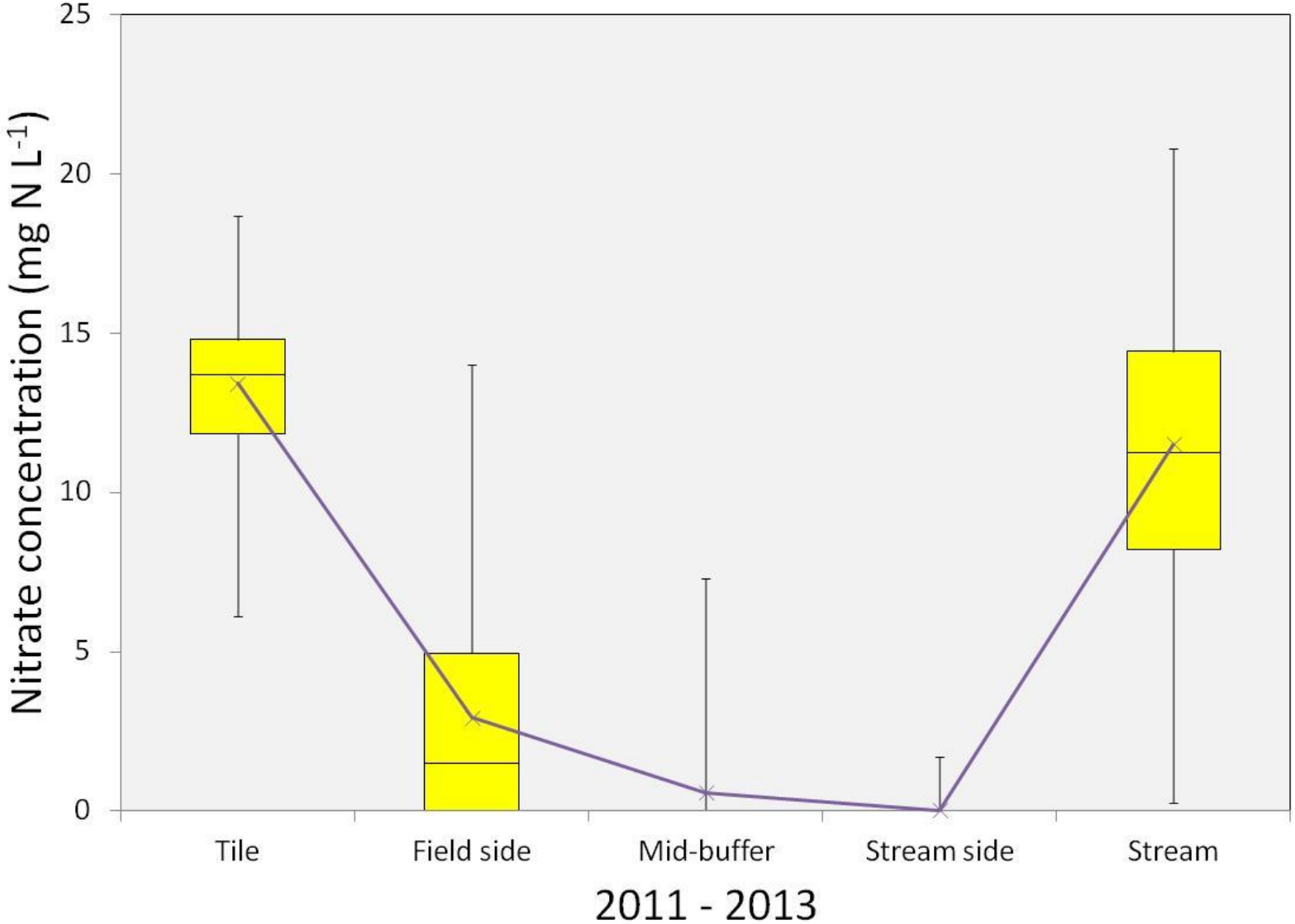


# Fate of Nitrate in Buffer Well Data

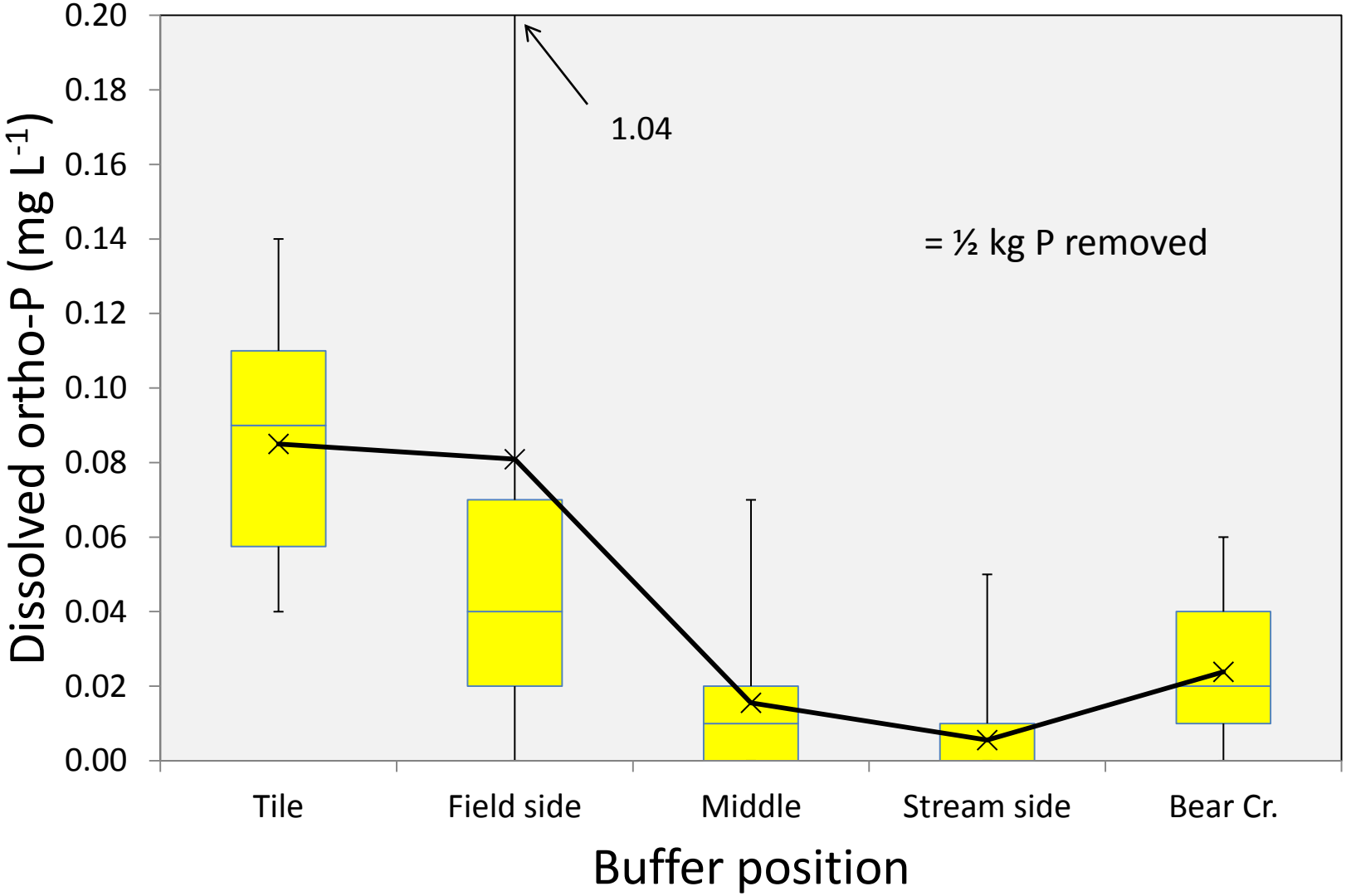
| Transect # | Well # | Distance from tile (m) | Date - 2012 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 27-Mar | 2-Apr | 10-Apr | 16-Apr | 23-Apr | 7-May | 14-May | 21-May | 4-Jun |
| | | | ---------- $NO_3$ (mg N $L^{-1}$) ---------- | | | | | | | | |
| 1 | 01 | 5.7 | 3.8 | 6.9 | 4.6 | 6.1 | 8.4 | 9.7 | 8.4 | 9.8 | 10.6 |
| 1 | 02 | 12.7 | < 0.3 | < 0.3 | 0.8 | 0.9 | 0.5 | 0.5 | 2.4 | 3.1 | 4.7 |
| 1 | 03 | 18.9 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 2 | 04 | 5.7 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 2 | 05 | 12.9 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 2 | 06 | 21.4 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 3 | 07 | 6.6 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | 2.7 |
| 3 | 08 | 14.1 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 3 | 09 | 22.9 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 4 | 10 | 6.0 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | 0.6 | 0.6 | 0.5 | 2.4 |
| 4 | 11 | 14.1 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 4 | 12 | 22.2 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| | Field | | 14.1 | 13.2 | 13.4 | 15.1 | 14.9 | 15.9 | 14.7 | 16.3 | 15.8 |
| | Bear Creek | | 7.3 | 4.8 | 5.5 | 12.6 | 12.7 | 11.0 | 12.6 | 12.7 | 11.5 |

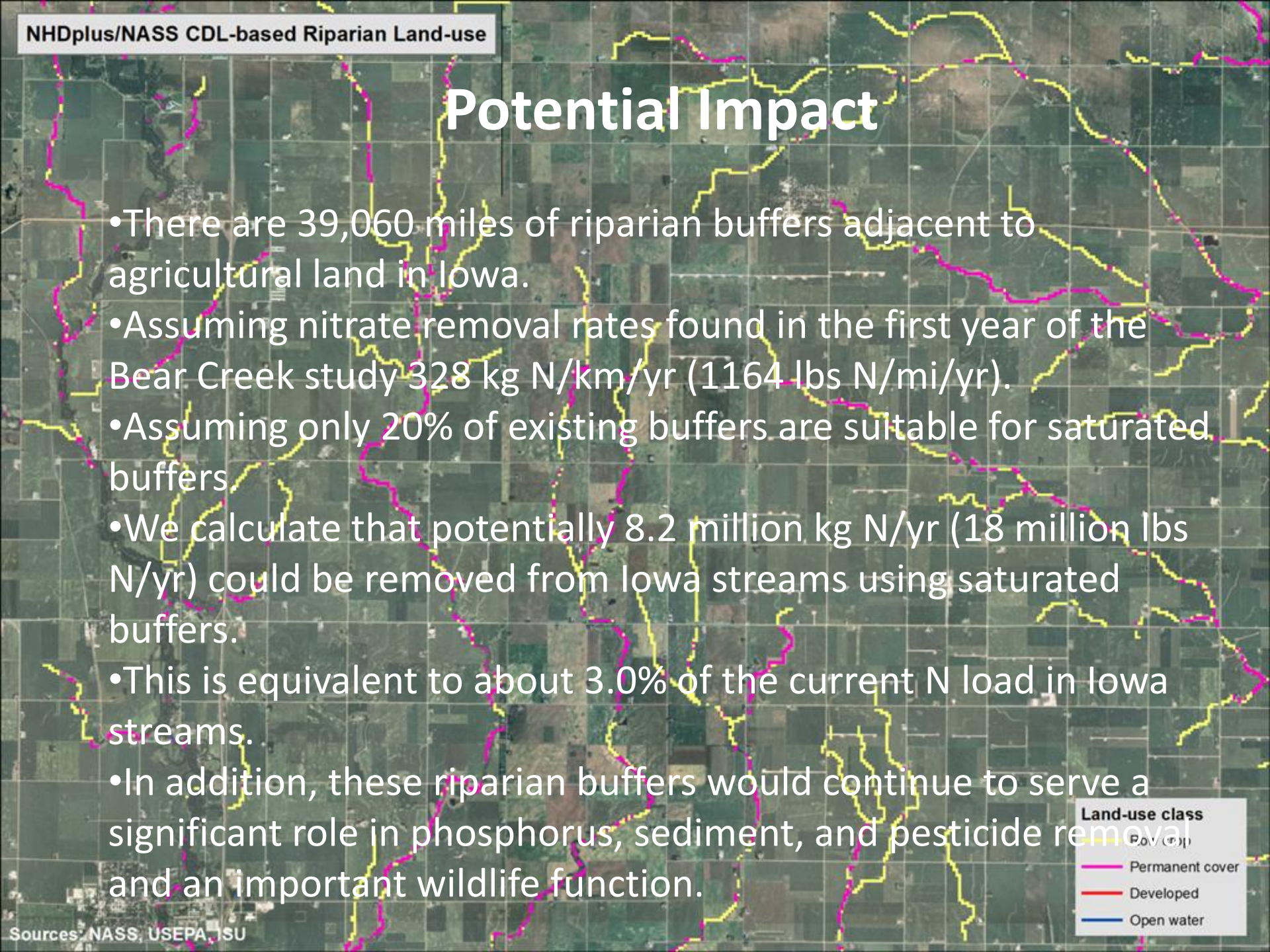
**100% nitrate removal**

# Average $NO_3$ concentration



# P removal in 2012

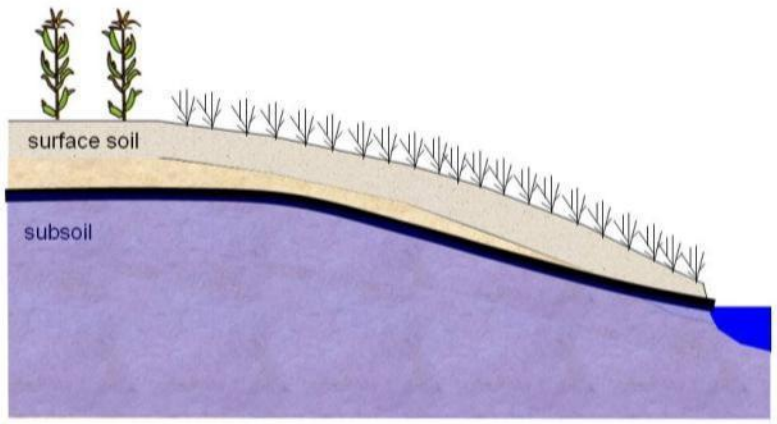




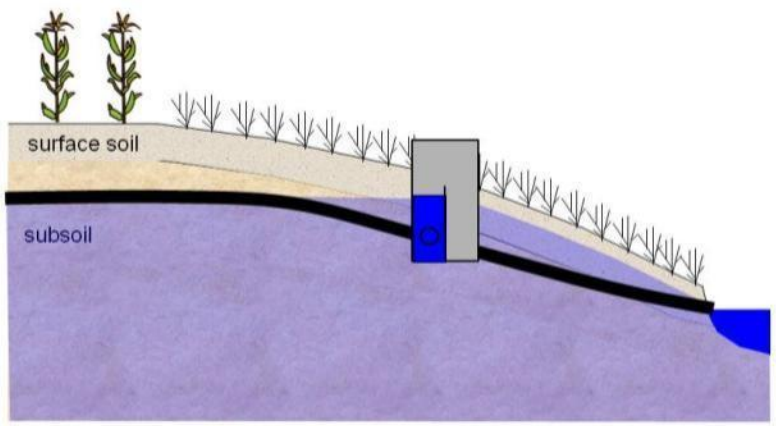

# Potential Impact

- There are 39,060 miles of riparian buffers adjacent to agricultural land in Iowa.
- Assuming nitrate removal rates found in the first year of the Bear Creek study 328 kg N/km/yr (1164 lbs N/mi/yr).
- Assuming only 20% of existing buffers are suitable for saturated buffers.
- We calculate that potentially 8.2 million kg N/yr (18 million lbs N/yr) could be removed from Iowa streams using saturated buffers.
- This is equivalent to about 3.0% of the current N load in Iowa streams.
- In addition, these riparian buffers would continue to serve a significant role in phosphorus, sediment, and pesticide removal and an important wildlife function.

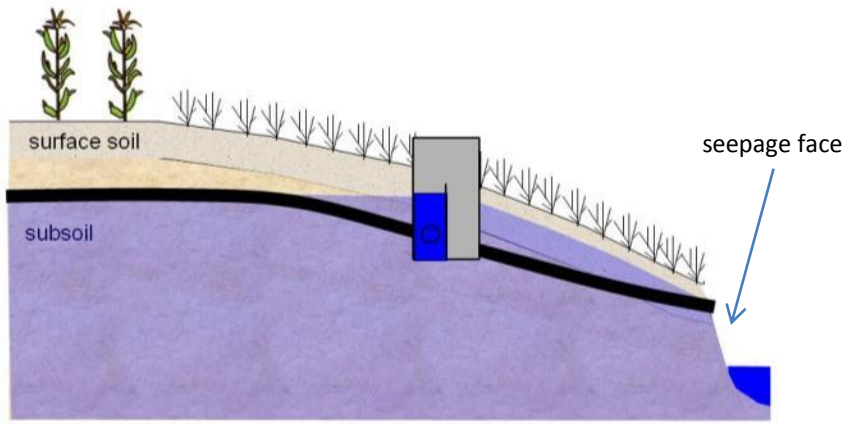
# Placement of Saturated Buffers



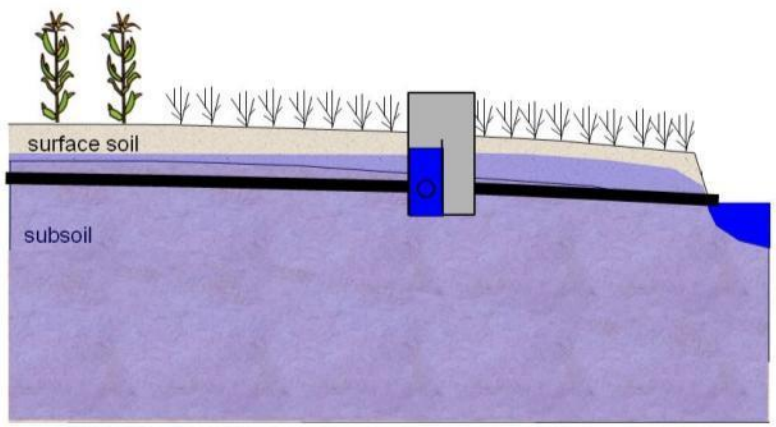

Ideal riparian buffer




Saturated Buffer




Deeply incised channel




Flat landscape

# Economics

- For Bear Creek, we installed 1000 ft of 4 in. tile at a cost of $2280 @ $2.28 per foot installed. The control box was $1120 installed. Another $100 would typically be required for design work for the system.
- Assuming a 20-yr life expectancy for the system at 4% interest would add about $1460. Thus, the total cost of the installation will be $4960 over 20 yr or $248 per year.
- We removed 110 kg (242 lbs) of nitrate-N the first year at Bear Creek.
- Thus, the cost per kg N removed for this prototype system was $2.25/kg ($1.02/lbs) nitrate-N removed.
- This cost is very competitive with estimates for other nitrate removal practices such as constructed wetlands ($2.91/kg) and fall planted cover crops ($6.77/kg).

# Summary

- First 2 years show that diverting tile flow into riparian buffers can remove all the nitrate that is diverted into them
- We diverted 55% of the flow from a field tile draining ~25 ac
- The cost of the practice is comparable to other N removal practices
- Practice shows potential of preventing > 18 million lbs of N from entering IA streams each year
- New Interim Conservation Practice Standard

739 - 1

NATURAL RESOURCES CONSERVATION SERVICE
INTERIM CONSERVATION PRACTICE STANDARD

VEGETATED SUBSURFACE DRAIN OUTLET
(Ft.)
CODE 739

DEFINITION

A water control structure and subsurface distribution pipe capable of diverting drainage system discharge to create an elevated zone of soil saturation.

PURPOSE

The structural measures installed shall be used to achieve one or more of the following purposes:

- To reduce nitrate loading from subsurface drain outlets
- To enhance or restore saturated soil conditions in riverine, lacustrine fringe, slope, or depression hydrogeomorphic (HGM) landscape classes

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable to agricultural lands with subsurface agricultural drainage systems that can be adapted to allow management of drainage discharges.

This practice can be applied where the soils and topography are capable of maintaining a raised water table without adverse effects to channel banks, shorelines, or adjacent land.

This practice shall not be used to treat septic system discharge or animal waste.

CRITERIA

General Criteria Applicable to All Purposes

Geologic and soil investigations shall be conducted to confirm:

- conditions such as a restrictive layer or high water table are present to maintain an elevated water table with water diverted from the subsurface drainage system
- the absence of pockets of high conductivity soil which could provide preferential flow paths

The soil saturation area shall be vegetated to prevent erosion and to utilize nitrogen from the drain water. The minimum width of the vegetated zone for this practice shall be 30 feet.

Design water control structures (diverter box) in accordance with NRCS Conservation Practice Standard Structure for Water Control (587). The water control structure shall be accessible for water table observation and for operation and maintenance.

Design the water control structure to maintain the design water table elevation over the distribution pipe during the management period, based on expected flow rates from the subsurface drainage system.

Design the distribution pipe and overflow pipe in accordance with NRCS Conservation Practice Standard Subsurface Drain (606). The overflow pipe shall be non-perforated for a distance sufficient to avoid draining the saturated soil zone around the water control structure.

Locate and design the system to maximize the amount of subsurface drainage water diverted to the saturated soil zone. Ensure there are no adverse impacts to adjacent lands.

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the electronic Field Office Technical Guide

NRCS, IOWA
July 2012

# Thank you

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http://www.ars.usda.gov/pandp/people/people.htm?personid=2789