A Presentation of the

December 2, 2008

IOWA STATE UNIVERSITY
University Extension

UNIVERSITY OF MINNESOTA
EXTENSION

A Pilot Program for Integrated Drainage and Wetland Landscape Systems

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Situation

- To reduce the size of the Gulf of Mexico Hypoxic Zone - at least 45% reductions in both riverine total nitrogen flux and riverine total phosphorus flux are needed
- To achieve these reductions as well as local water quality goals will require a combination of practices implemented at the watershed scale
- Nitrate removal wetlands are a watershed scale practice that have been shown to be effective in removing nitrate
- Optimal drainage capacity has the potential to reduce surface runoff, phosphorus & other SRO contaminants
- Market driven, public/private partnerships will be essential to achieve these nutrient reductions at full

Current Conditions

- Deteriorating drainage infrastructure that will need replacement in next 10-30 years
- Farmed wetlands provide lowered crop production and little wetland function compared to original state
- Most farmed wetlands have drainage installed, but the drainage system capacity is too low to provide adequate drainage for good crop growth
- Farmed wetlands result in high losses of nitrogen fertilizer as result of denitrification
- “Worst of both worlds”- Poor crop production- Little wetland function

Future Vision

- “Engineer” the watershed for better drainage and wetland function
- Set aside areas where wetlands can be established at the discharge end of the watershed for better wetland function as well as water quality renovation
- Allow these wetlands to be used for mitigation of farmed wetlands in the watershed
- Allow higher capacity outlet systems to be installed to provide better crop production
- “Best of both worlds”- a win-win situation

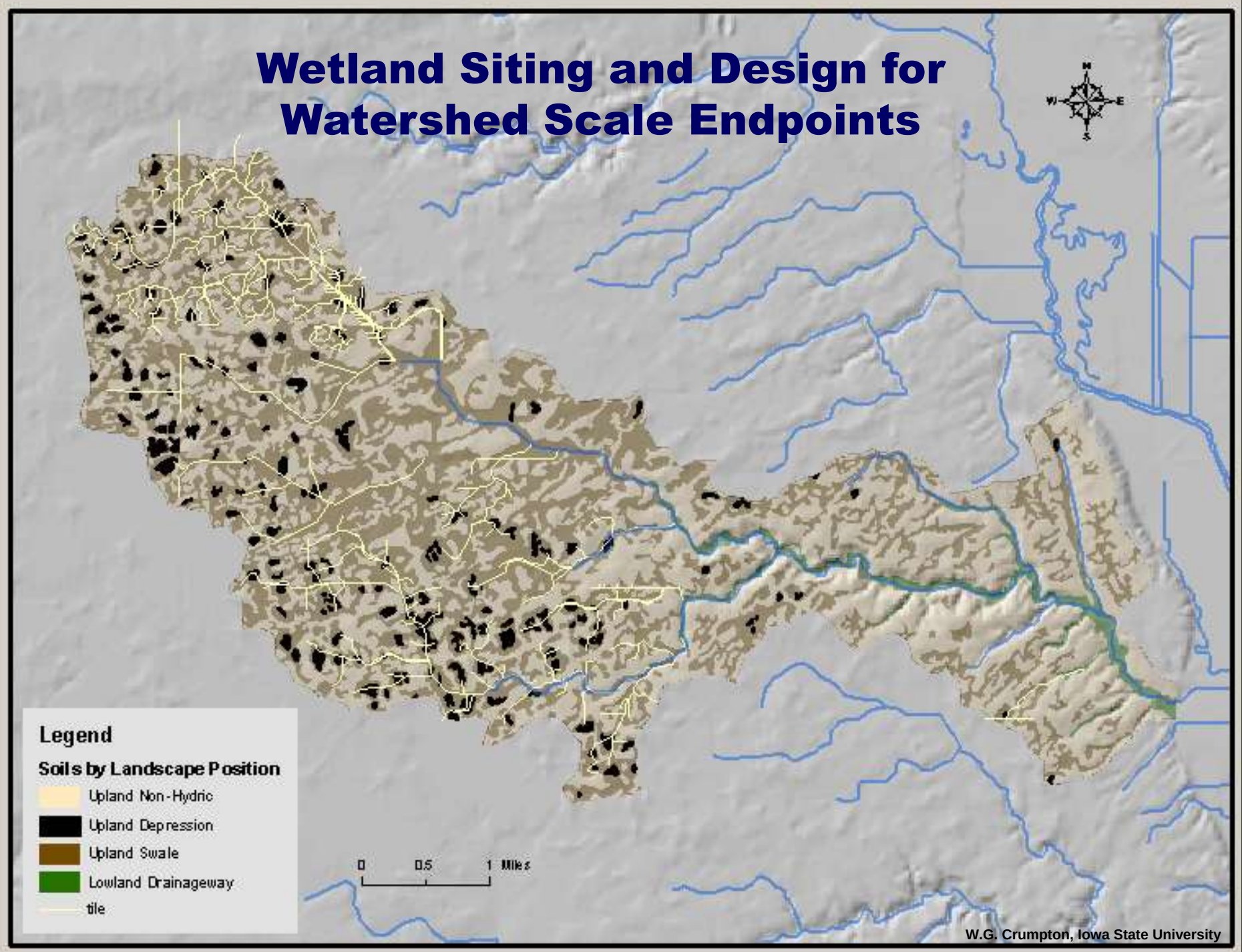
Goals

- Reduce the loss of subsurface flow contaminants (primarily nitrate)
- Reduce surface runoff and loss of surface runoff contaminants (e.g. phosphorus, pesticides, sediment, and micro-organisms)
- Optimize crop production, yield, and profitability
- Increase habitat and ecological functions of the landscape
- Reduce N_2O greenhouse gas emissions

Goals

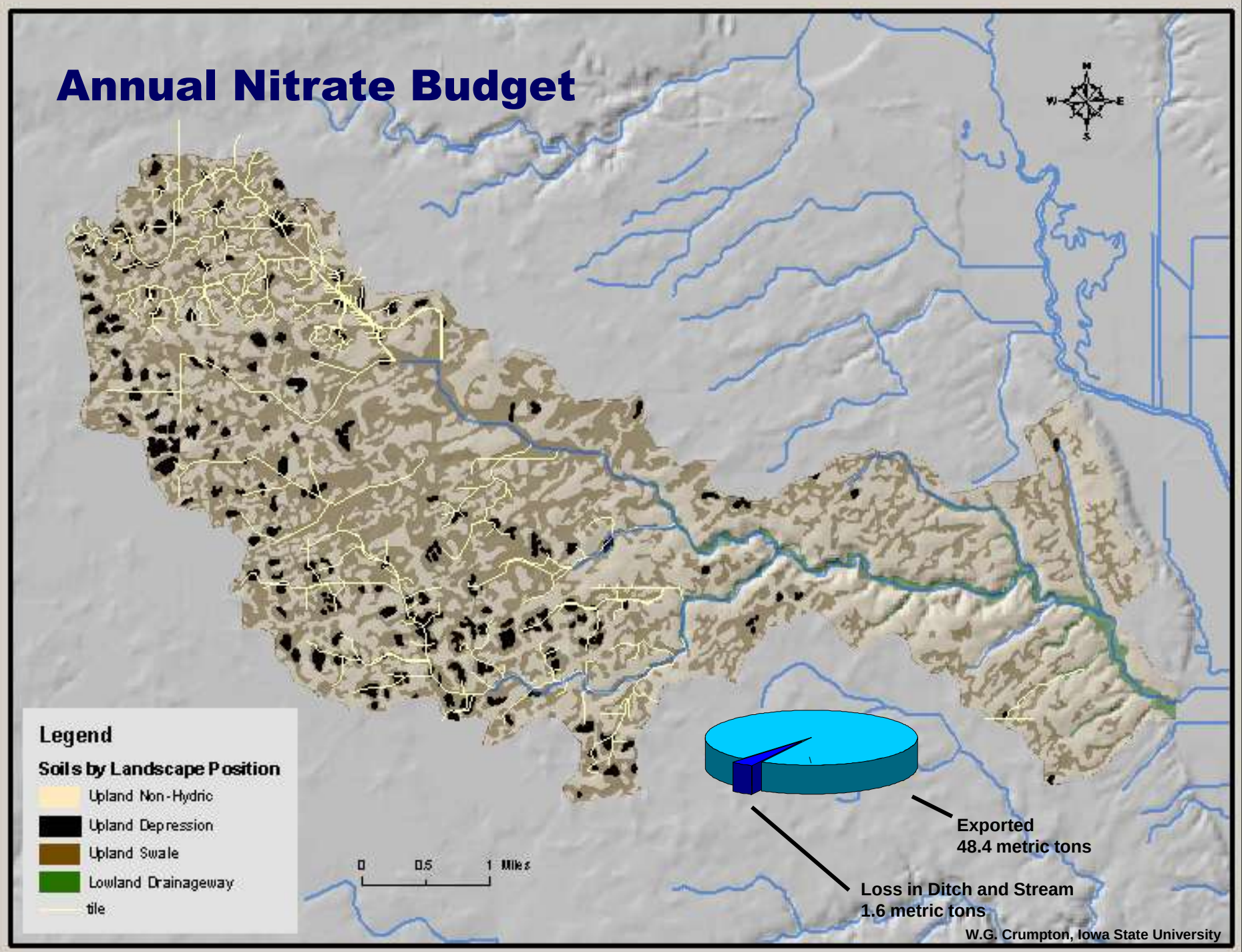
- Reduce the loss of subsurface flow contaminants (primarily nitrate)

Wetland Siting and Design for Watershed Scale Endpoints



W.G. Crumpton, Iowa State University

Annual Nitrate Budget



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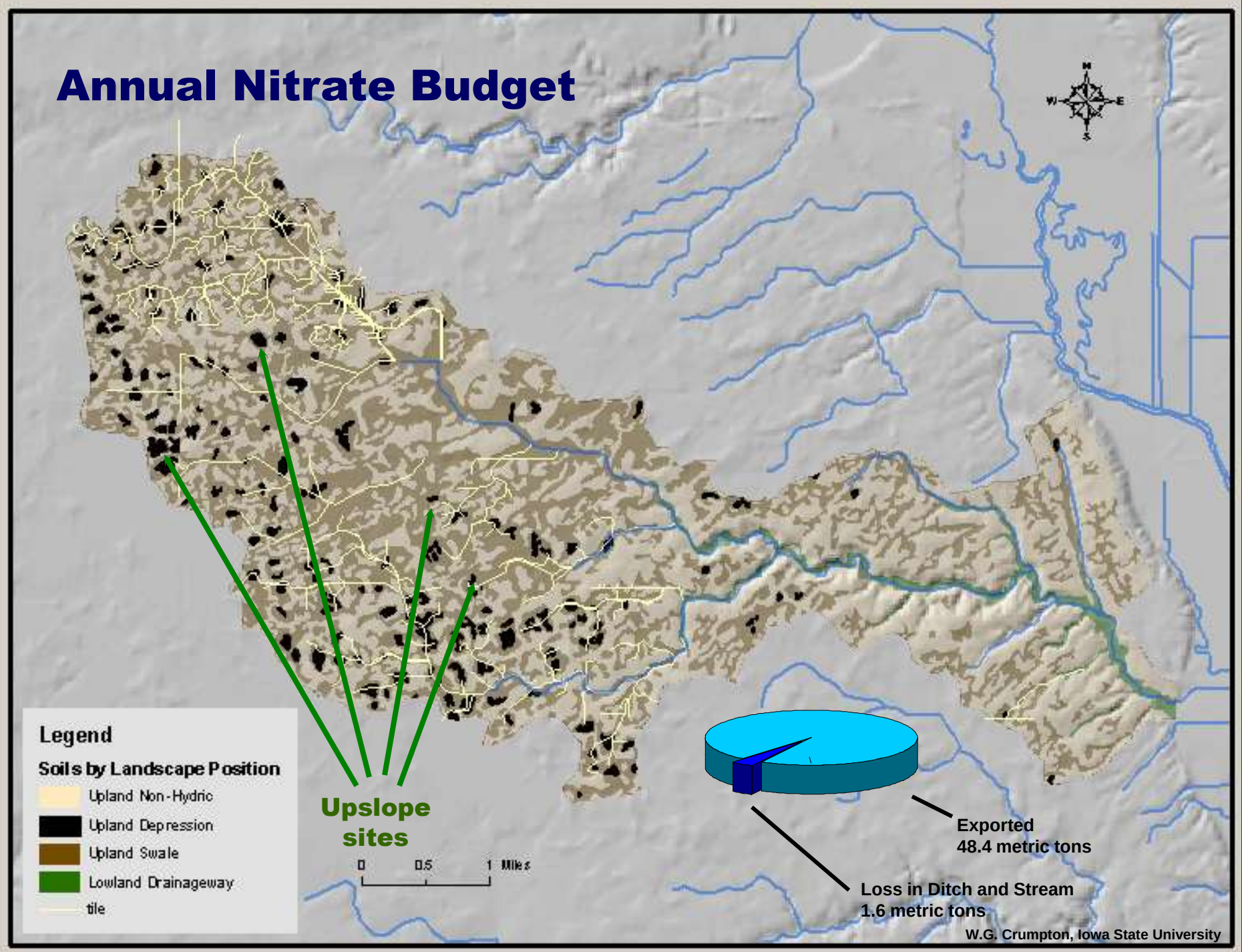

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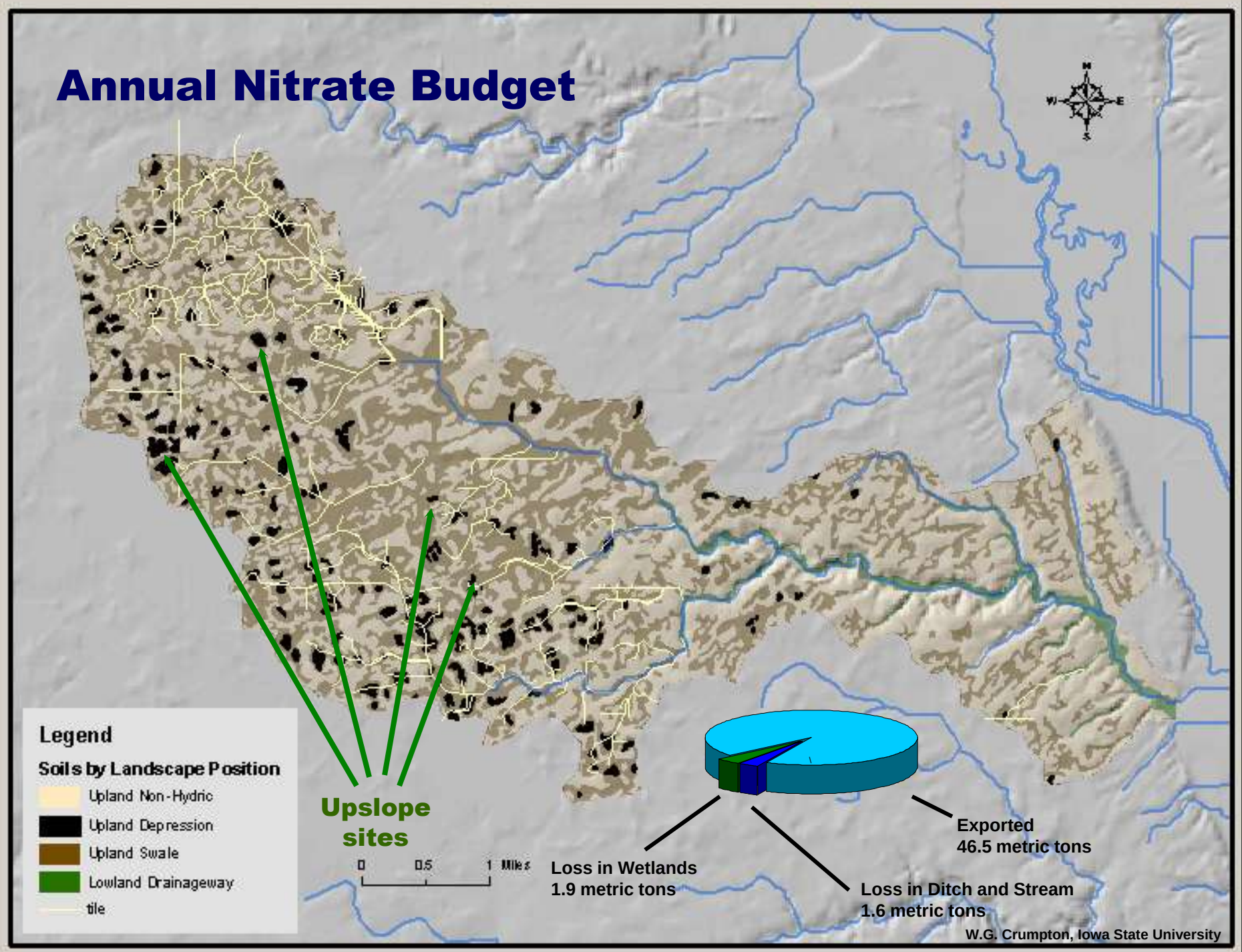

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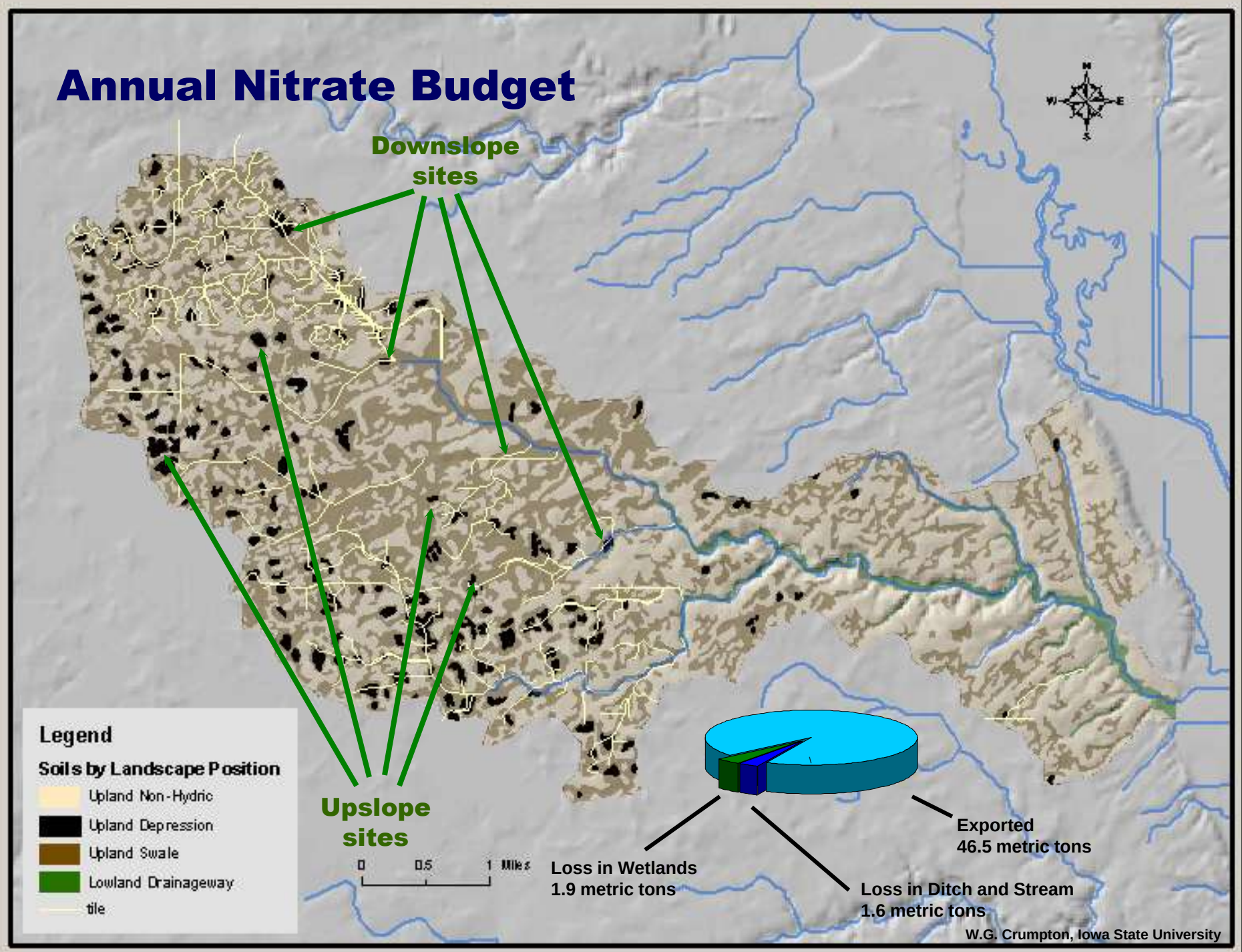

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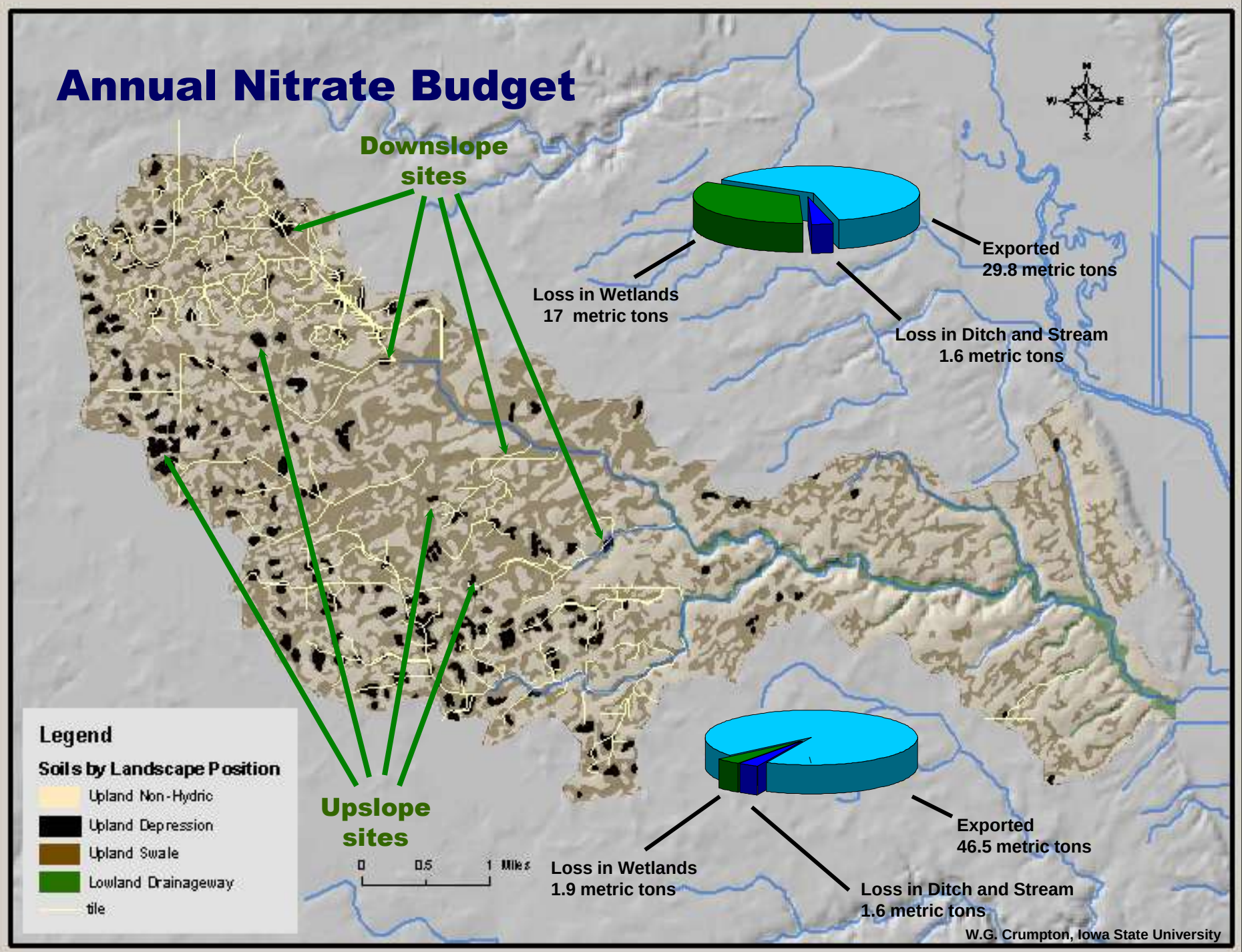

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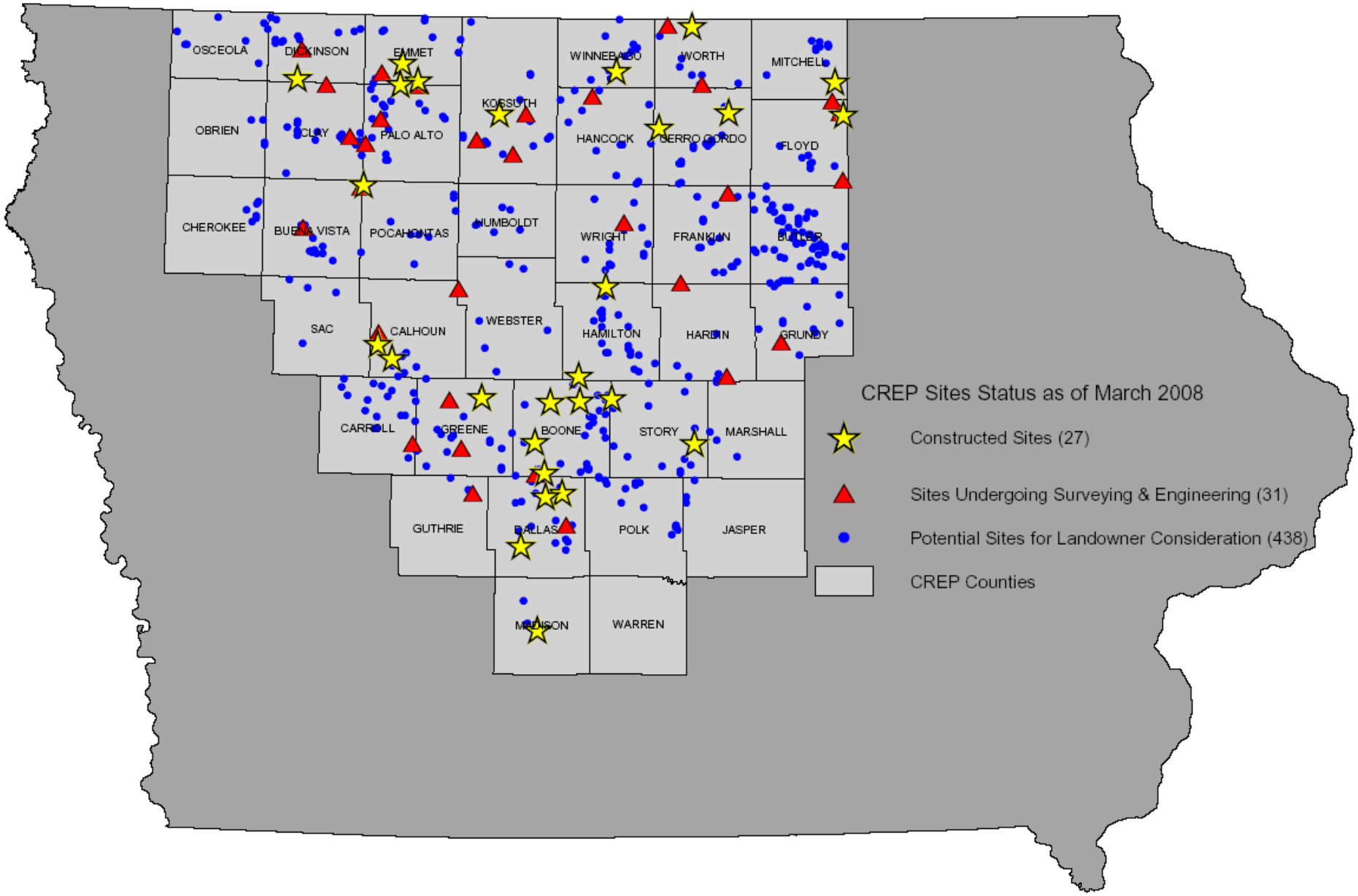
Current Iowa CREP - Nitrate Removal Wetlands



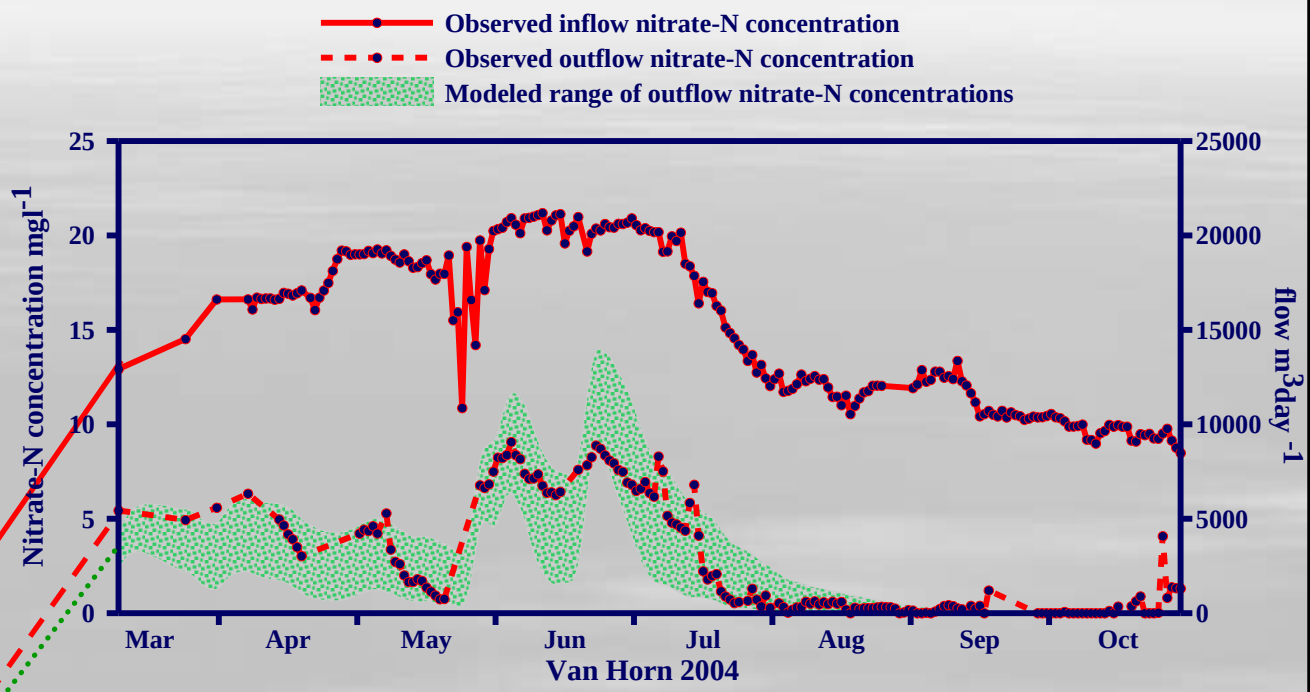
Iowa CREP – Current Status

- 35 wetlands restored/constructed
- Currently ‘waiting list’ of landowners for enrolling
- 72 wetlands restored, under construction or design
  - 715 acres total wetland pool
  - Remove 40-90% of nitrate from 86,100 acres
  - Estimated nitrate removal over practice lifetime is 53,600 tons
  - Nitrogen removal cost $0.23/lb, below current cost of fertilizer N

Iowa Department of Agriculture & Land Stewardship
Iowa Farm Service Agency
A Partnership of Iowa Agriculture for
Reducing Nutrients to the Gulf - Des Moines, Iowa
Gulf Guardian Award
Partnership
2008

Model validation and illustration of wetland performance

Van Horn Wetland



Measured and modeled nitrate concentrations for Van Horn Wetland in 2004.

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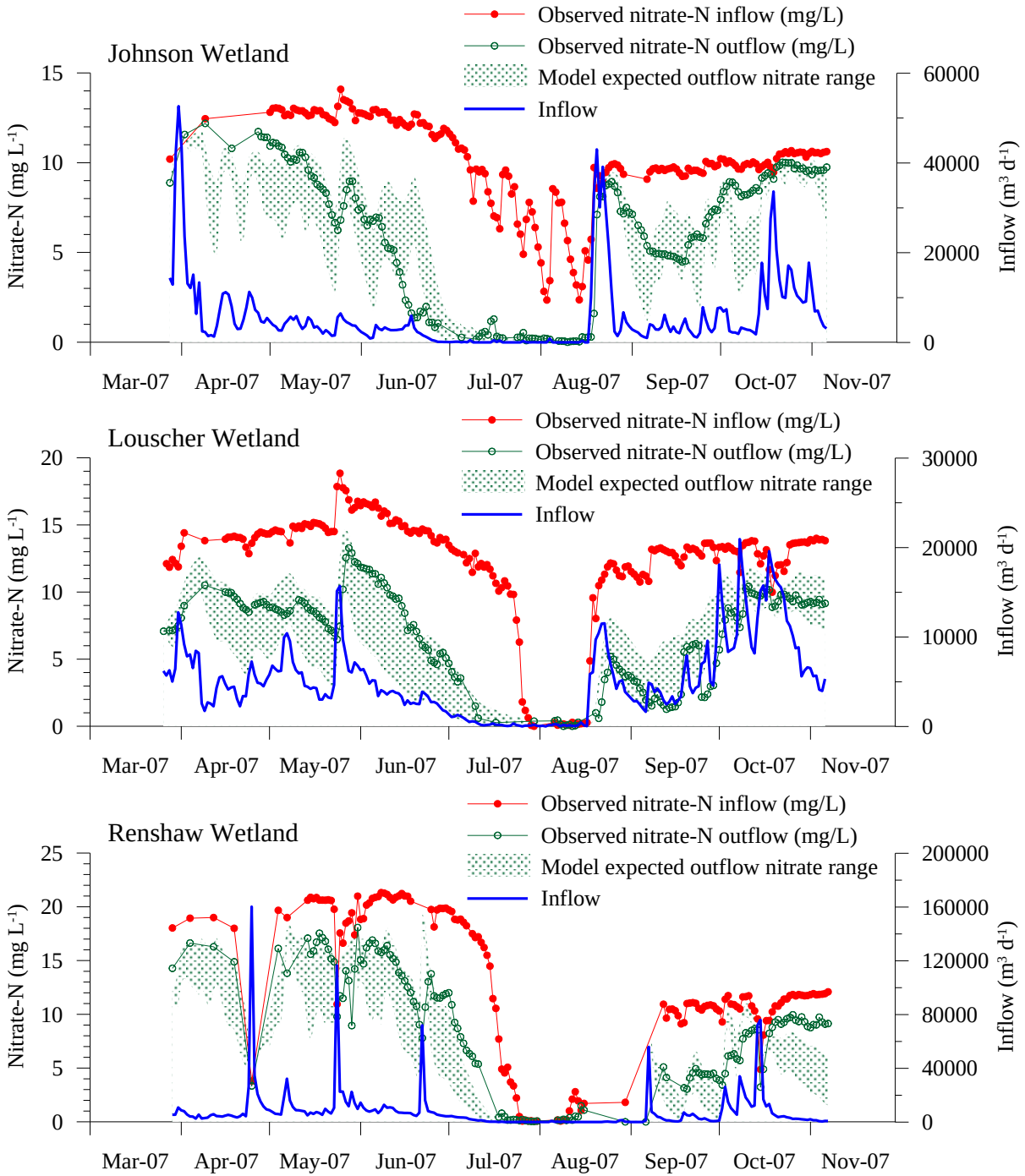
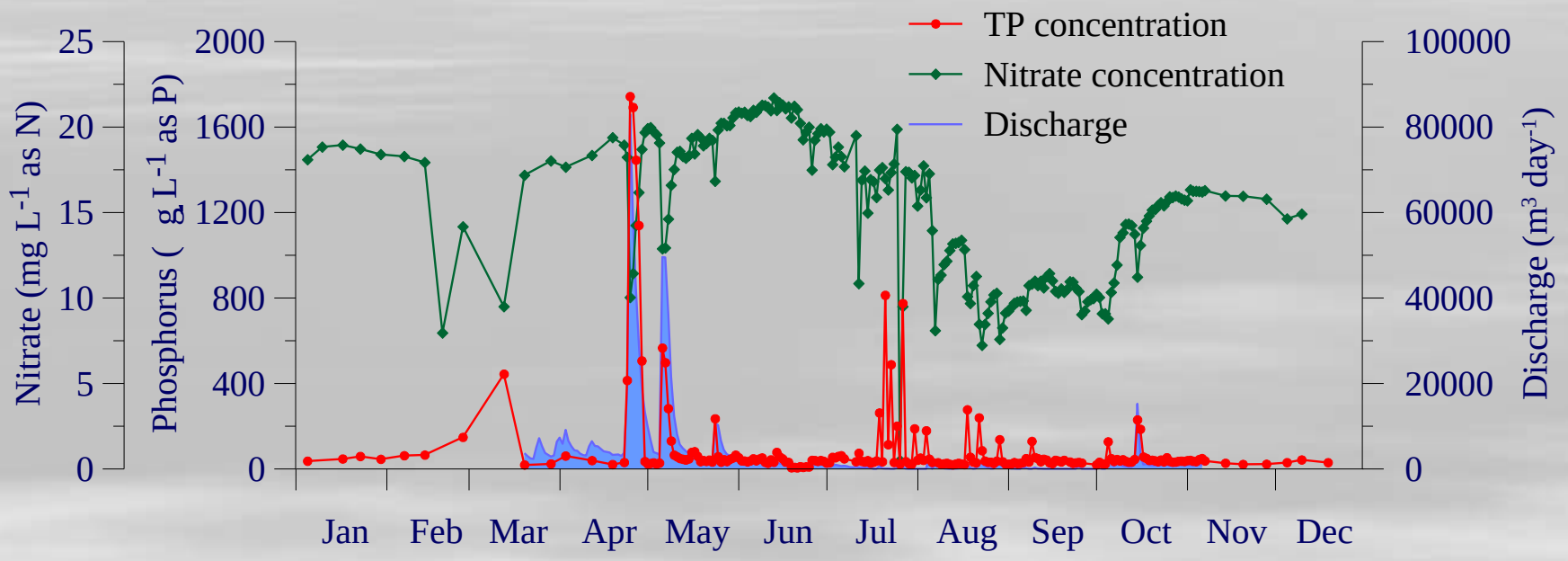

Johnson Wetland
Observed nitrate-N inflow (mg/L)
Observed nitrate-N outflow (mg/L)
Model expected outflow nitrate range
Inflow
Nitrate-N (mg L-1)
Inflow (m3 d-1)
0
5
10
15
0
20000
40000
60000
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Louscher Wetland
Observed nitrate-N inflow (mg/L)
Observed nitrate-N outflow (mg/L)
Model expected outflow nitrate range
Inflow
Nitrate-N (mg L-1)
Inflow (m3 d-1)
0
5
10
15
20
0
10000
20000
30000
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Renshaw Wetland
Observed nitrate-N inflow (mg/L)
Observed nitrate-N outflow (mg/L)
Model expected outflow nitrate range
Inflow
Nitrate-N (mg L-1)
Inflow (m3 d-1)
0
5
10
15
20
25
0
40000
80000
120000
160000
200000
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07

Goals

- Reduce the loss of subsurface flow contaminants (primarily nitrate)
- Reduce surface runoff and loss of surface runoff contaminants (e.g. phosphorus, pesticides, sediment, and micro-organisms)

Van Horn 2007



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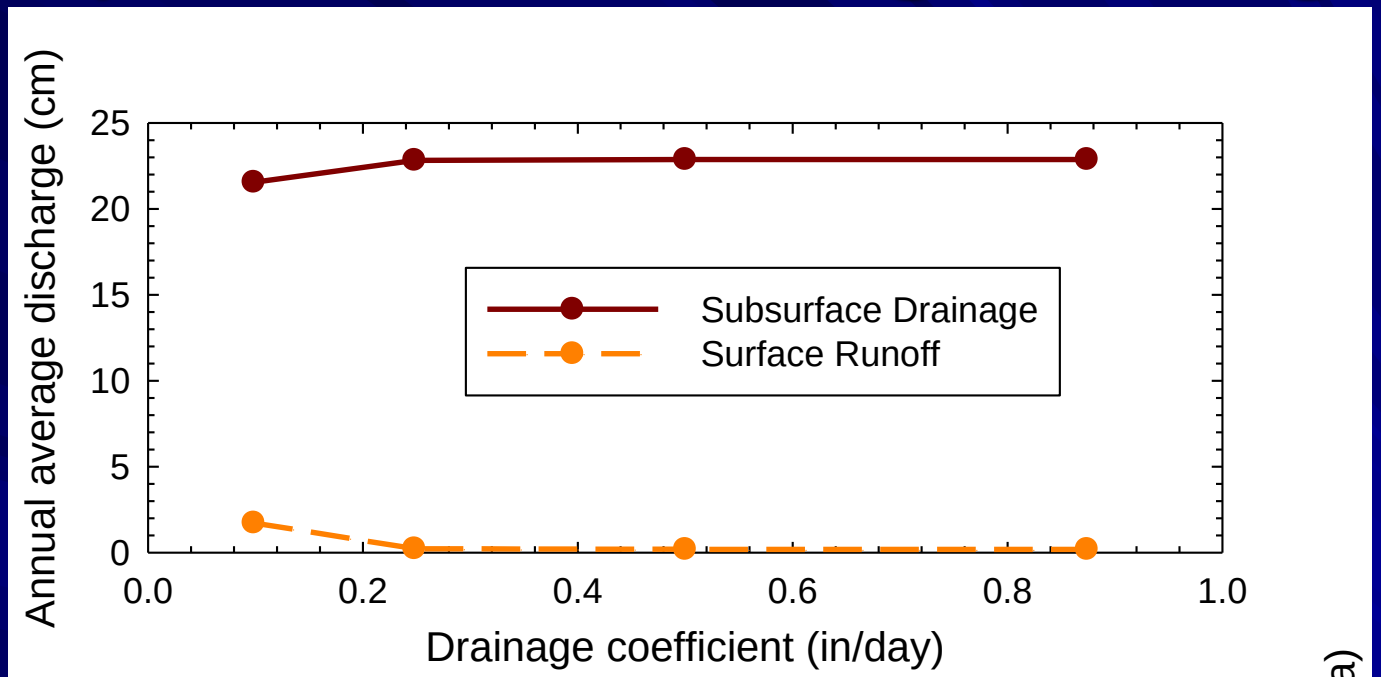
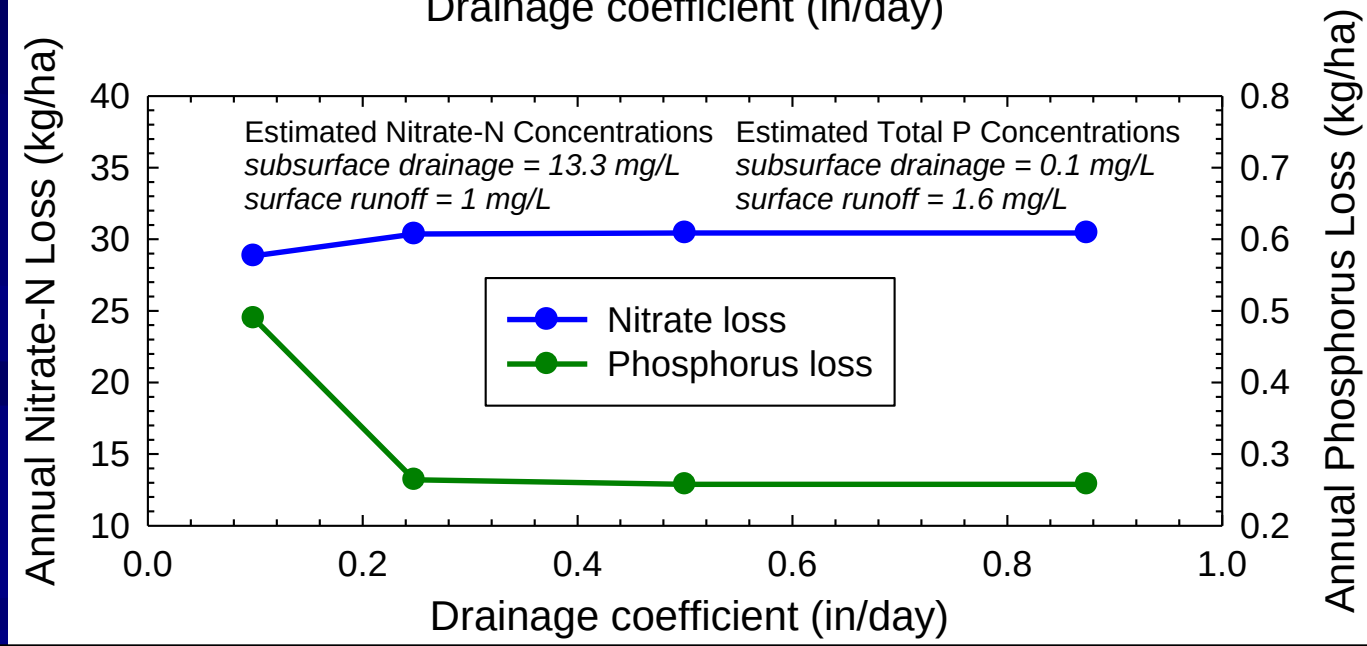
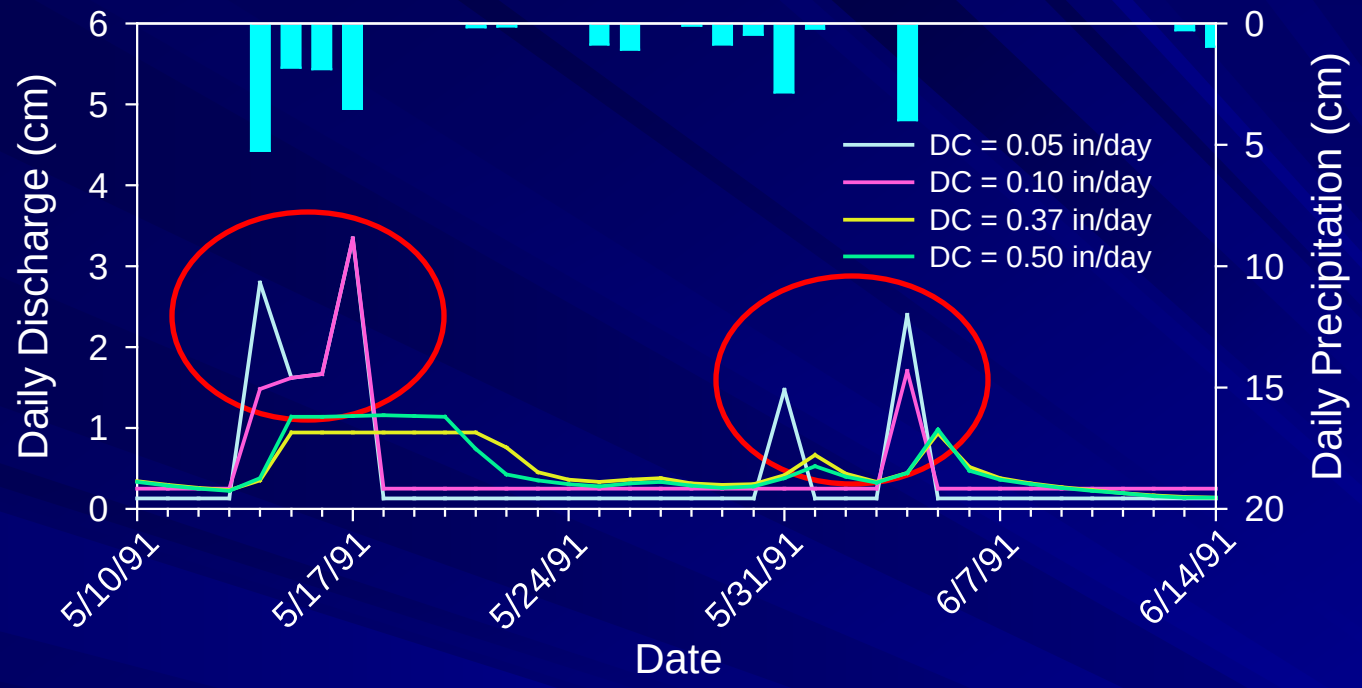
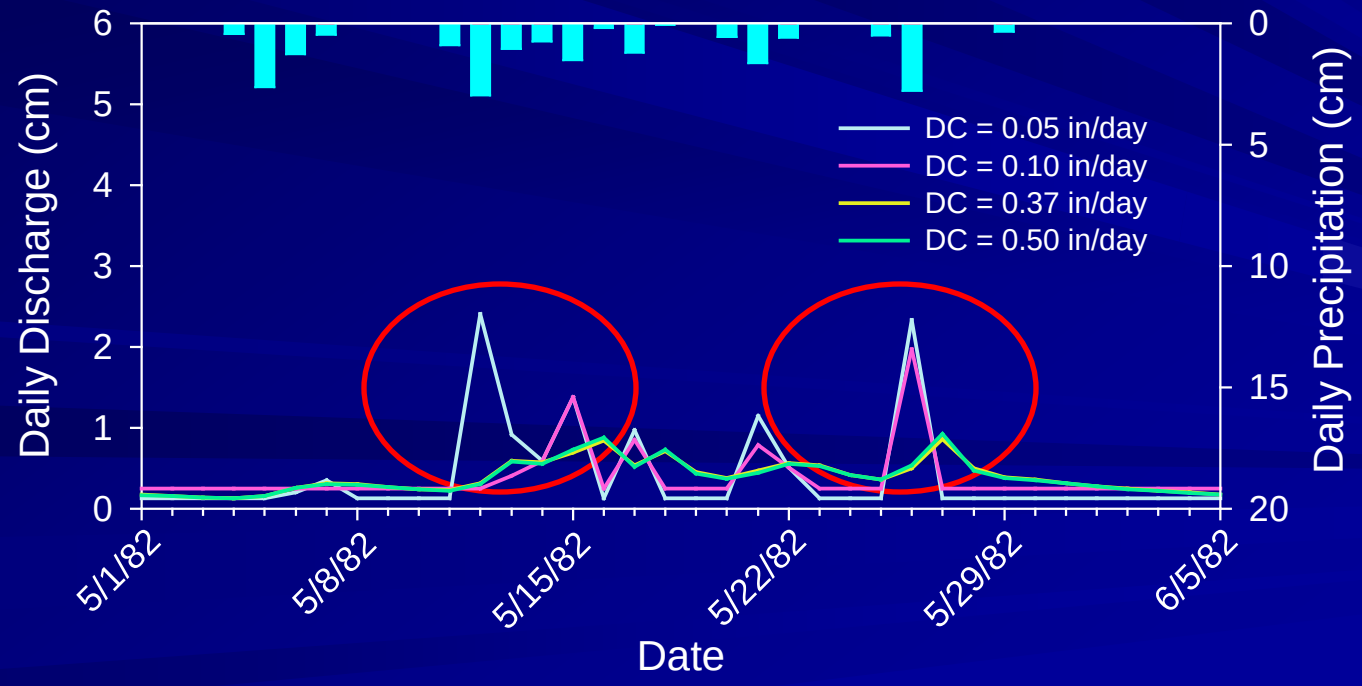
Impacts of Drainage Design





Impacts of Drainage Design on Daily Discharges





Integrated Drainage & Wetland Systems

	Optimal Drainage	Wetlands	Drainage + Wetlands
N loss	+5%	- 50%	- 50%
SRO & P loss	- 50%	- 5%	- 50%

Goals

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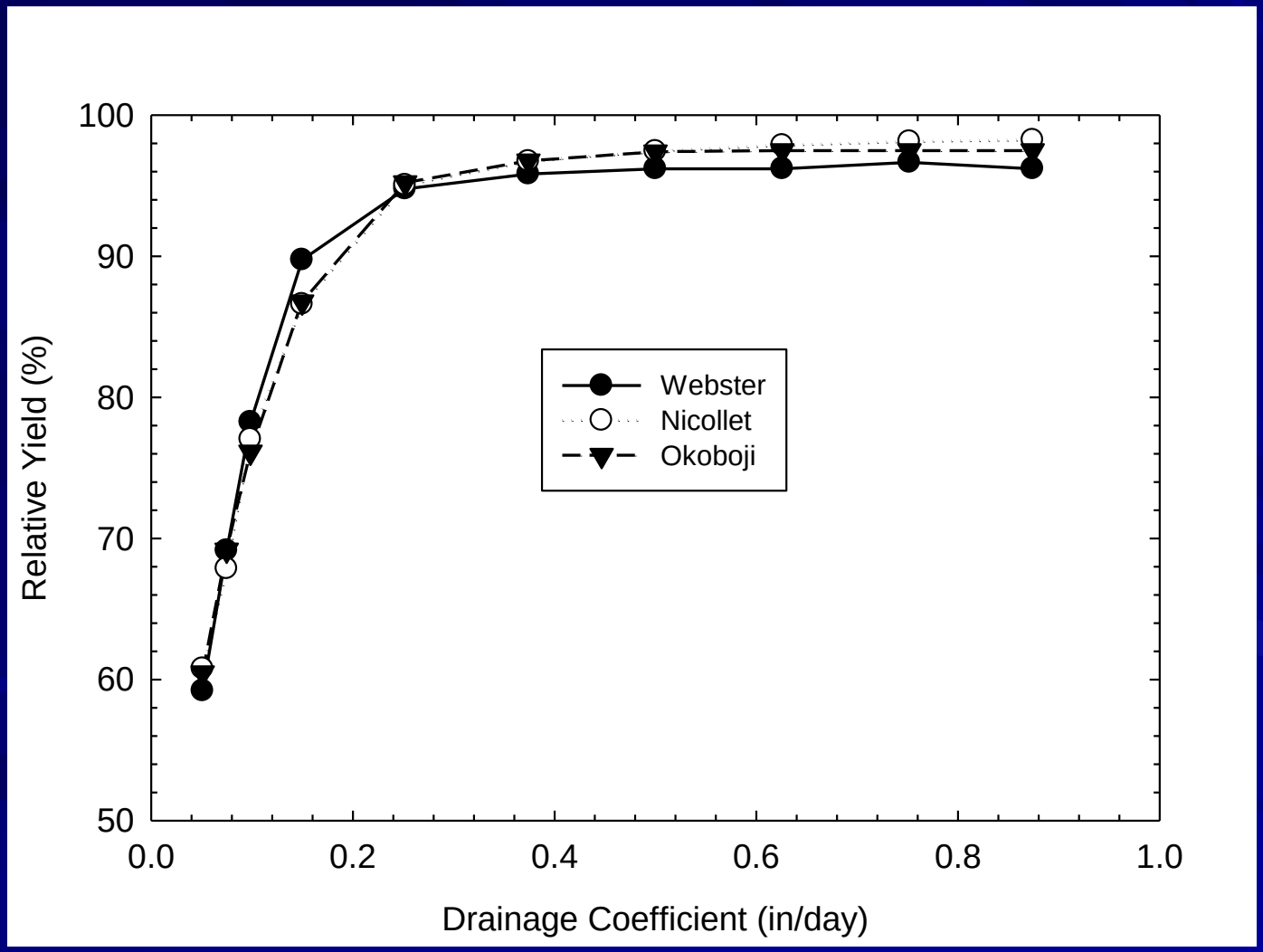
- Reduce surface runoff and loss of surface runoff contaminants (e.g. phosphorus, pesticides, sediment, and micro-organisms)
- Optimize crop production, yield, and profitability

Drainage Design

- Majority of Des Moines Lobe is artificially drained with tile drainage systems installed in early to mid-1900's
- From surveys performed in 1980's many drainage systems have a drainage coefficient of <0.25 in/day (some <0.10 in/day)
- Modern drainage systems will be designed with a drainage coefficient of 0.5-1.0 in/day

How much do Under Designed Systems Impact Yield?



These estimates are likely on the conservative side.

Yield impacts may be greater.

Example Yield Increases

Calhoun

District Size (acres)	Outlet Capacity (in/day)	Relative Yield	Inc in Rel. Yield if 0.5 in/day coefficient
1860	0.22	94	2
1025	0.18	92	4
1920	0.1	79	17
1600	0.09	76	21
2000	0.05	56	41
1920	0.13	86	10
1760	0.11	82	15
1120	0.44	97	0
1120	0.24	95	2
960	0.27	96	1
400	0.25	95	1

What Might $ Impacts of Optimized Drainage Systems be on a County?

Acres in DD	250,411
Yield Increase (%)	7.7
Base Corn Yield	190
Base Soy Yield	55
Corn Price	$4.95
Soy Price	$13.20
Acreage in corn (%)	65
Acreage in Soy (%)	35

Total Annual Increase in Corn Yield (bushels)	2,381,283
Total Annual Increase in Soy Yield (bushels)	371,172
Annual Increase in Income ($)	$16,686,819

What Might $ Payback of Optimized Drainage Systems be to Landowners?

Estimated cost of optimized drainage mains	$600/acre
Estimated cost of “status quo replacement” drains	480/acre
Optimization cost	120/acre
Estimated net income increase*	60/acre/yr
Projected payback for drain optimization**	2-3 yrs

*Basis

7.7% yield increase
190 bu corn @ $5/bu
55 bu soy @ $$10/bu

**Note - does not include wetland mitigation costs

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Pothole
Depression
Typical of Farmed
Wetland
May 2007

Same
Pothole
Depression
June 2007

Kossuth County – 0.4 Acre Farmed Wetland with Crop Loss Spring 2007

Targeted Wetland Restoration: Iowa CREP Wetland

Goals

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Iowa Climate Change Council Policy Options Report

- N_2O reductions
  - Denitrification in targeted wetlands more complete than “downstream” denitrification
  - Reduced emissions from seasonally-wet croplands
- Year 2050
  - ranks 6th of all policy options for ag/foresty/waste in reduced CO_2 equivalence
  - ranks 2nd of options for all policy sectors in cost-effectiveness

Public/Private Partnership for Achieving Full Landscape Scale

Iowa Drainage Districts

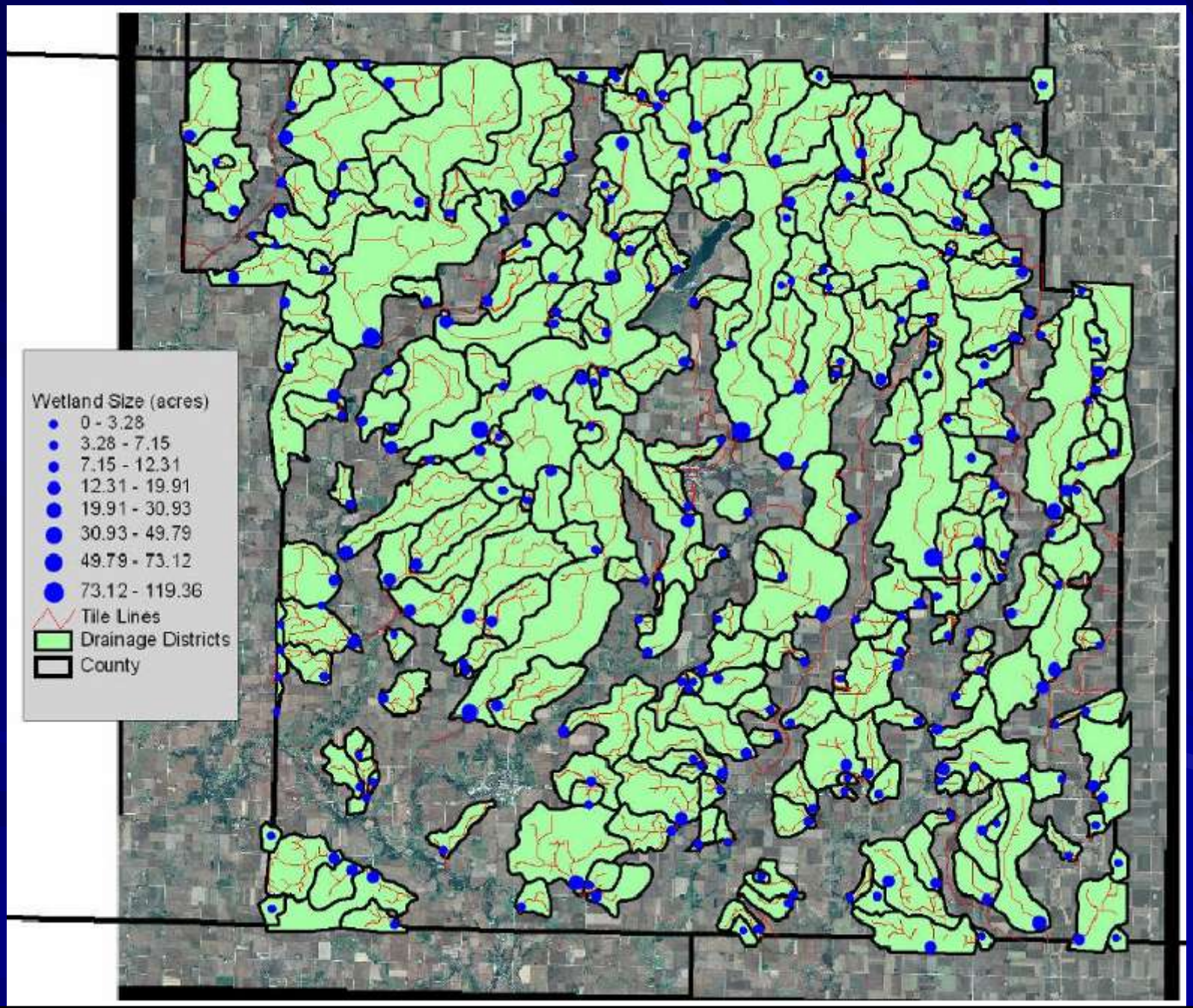
- 3000 drainage districts in Iowa manage common-outlet drains for 6 million acres
- Governing boards of trustees (typically county board of supervisors)
- Extensive statutory & case law base
- Taxing powers
- Power of eminent domain
- Construct and maintain drains

Wetland mitigation with “in-kind farmed wetlands” paid by landowners enhanced to achieve nutrient removal with CREP $

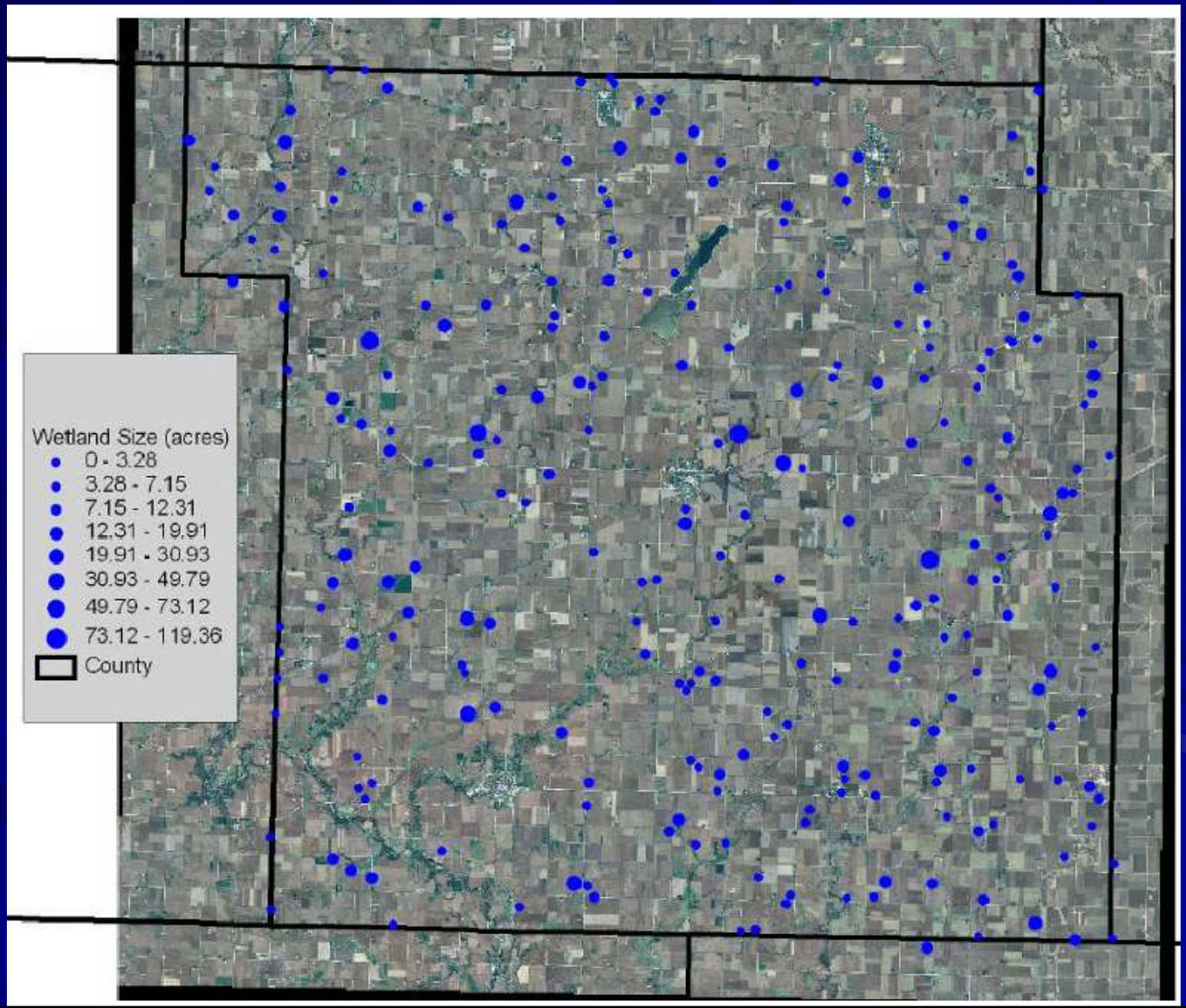
Pilot Demonstrations

- 2012 – 25 pilot demonstrations
  - Study sites to confirm water quality, wetland function, & crop yield benefits
- 2020 – if initial pilots successful & benefits documented, expand to additional 200 pilots
- 2050 – projected target for implementation across 6 million acres of Iowa drainage districts

Calhoun County – Drainage Districts & Potential Nitrate Removal Wetlands



Calhoun County – Potential Nitrate Removal Wetlands



Summary

- Flat, low-erosion drained landscapes are environmentally-preferred for production of row crops
- Over the next decades the existing drainage systems in Iowa's drainage districts will be replaced due to age and structural failures
- Critical Issue – will these replacement systems be designed to maintain the 'status quo' or to optimize these landscapes for both environmental benefits and crop production?