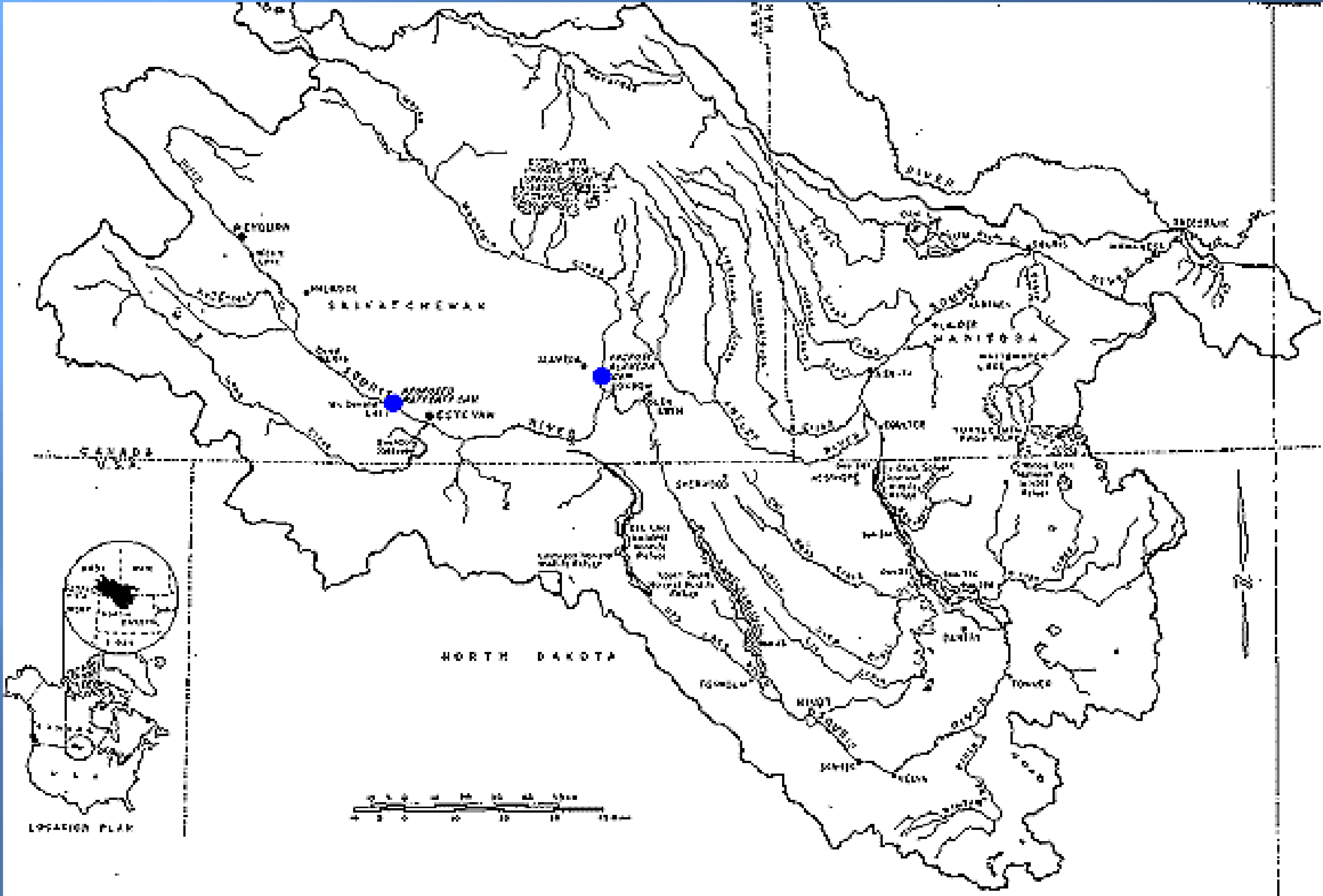


# LINKING NUTRIENTS AND SOD

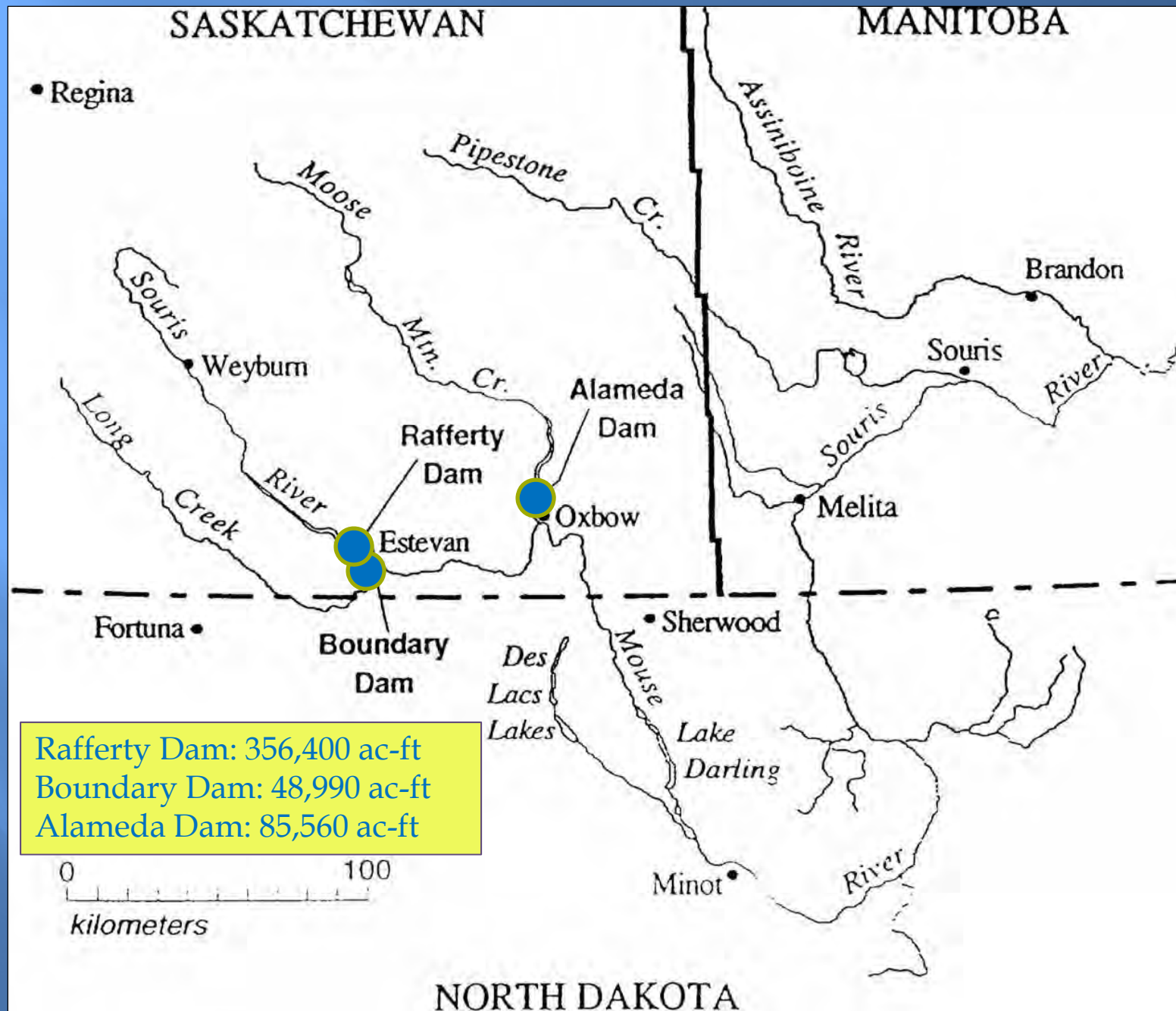
Souris River TMDL

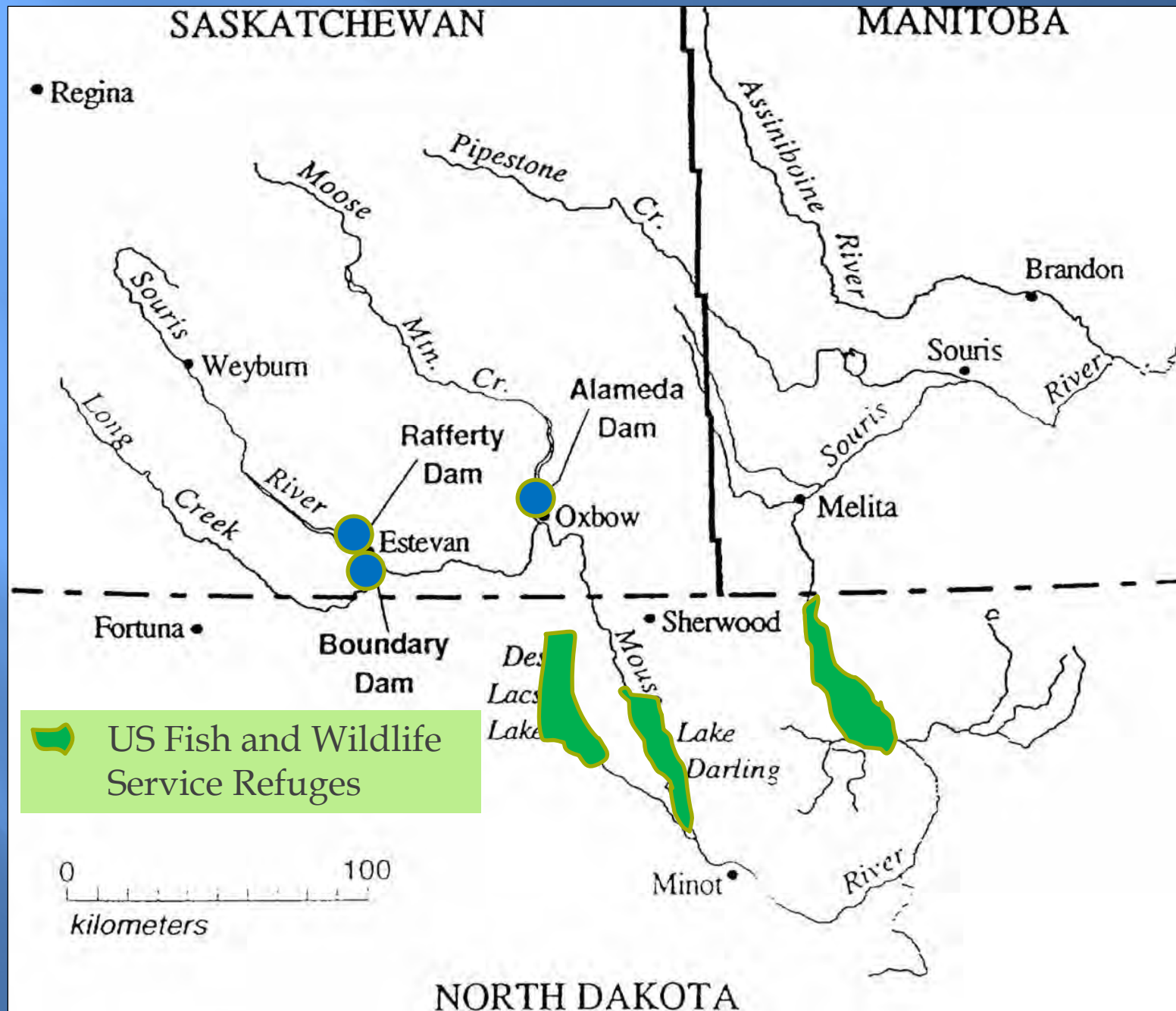
North Dakota Dept. of Health  
Division of Water Quality

# Where Are We





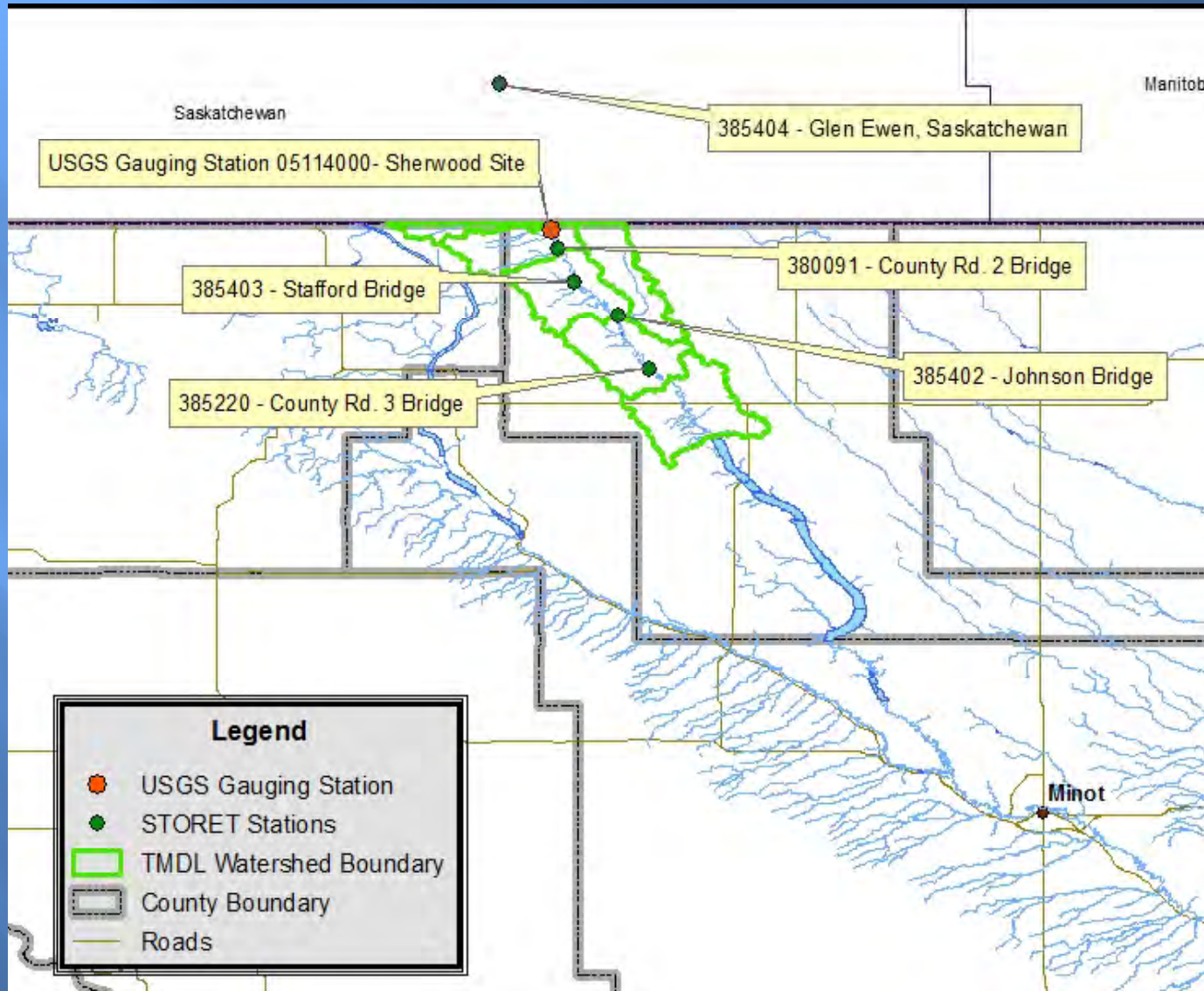




# International Souris River Board

- Under the International Joint Commission was initially formed to govern water quantity
  - Amount and timing of releases to meet minimum at ND border and again at Manitoba border
  
- Finally moving towards water quality
  - Aquatic Ecosystem Committee to review guidelines including Phosphorus
  
- Has agreed upon set of goals for water quality at border

# TMDL Listed Reach

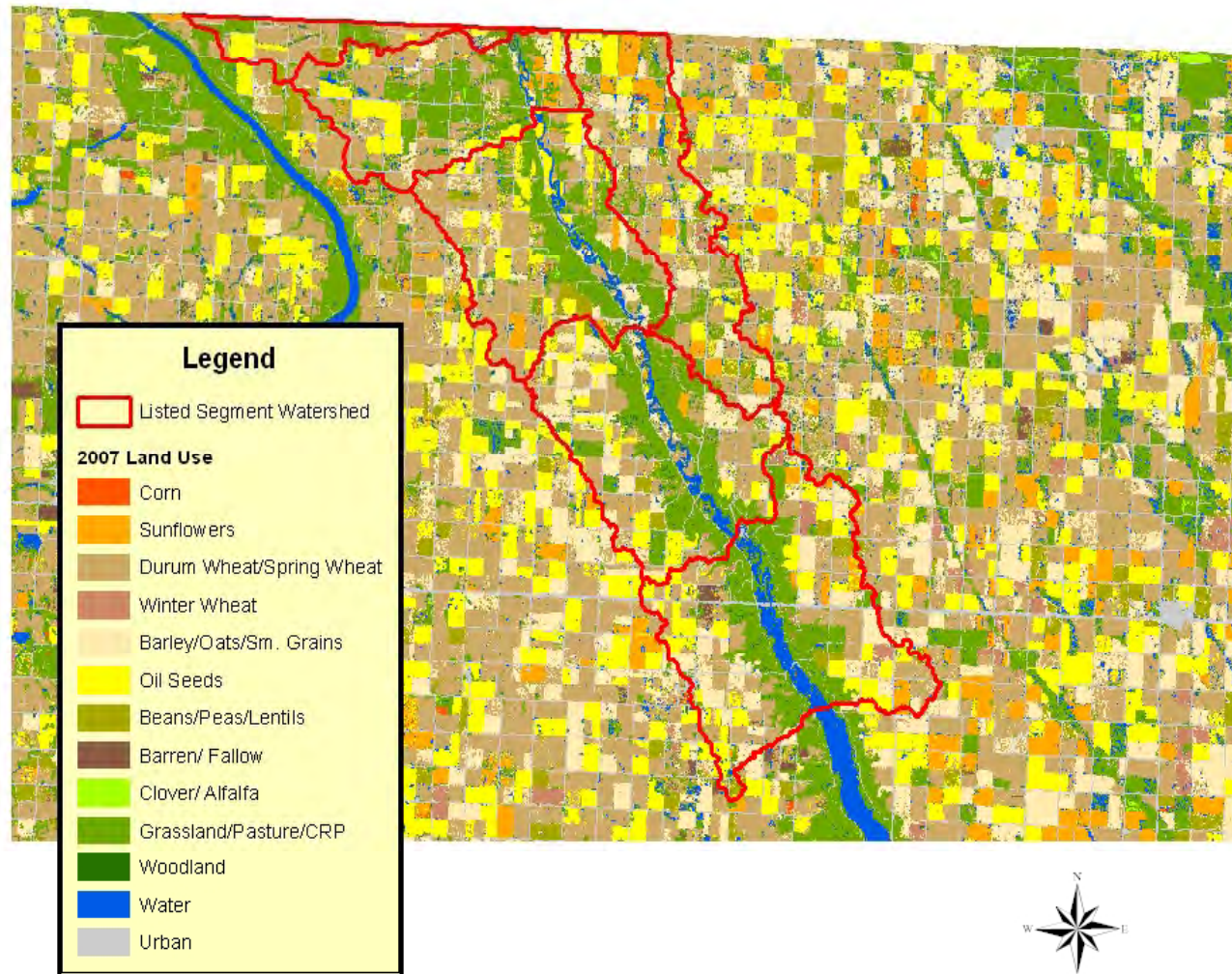


# Area Background

- ▣ Low Population
  - North Dakota total pop. ~650,000
  - NW North Dakota lowest pop. in state
  - Primarily Agriculture
    - ▣ TMDL watershed is 49% Cropped, 21% Pasture/Range



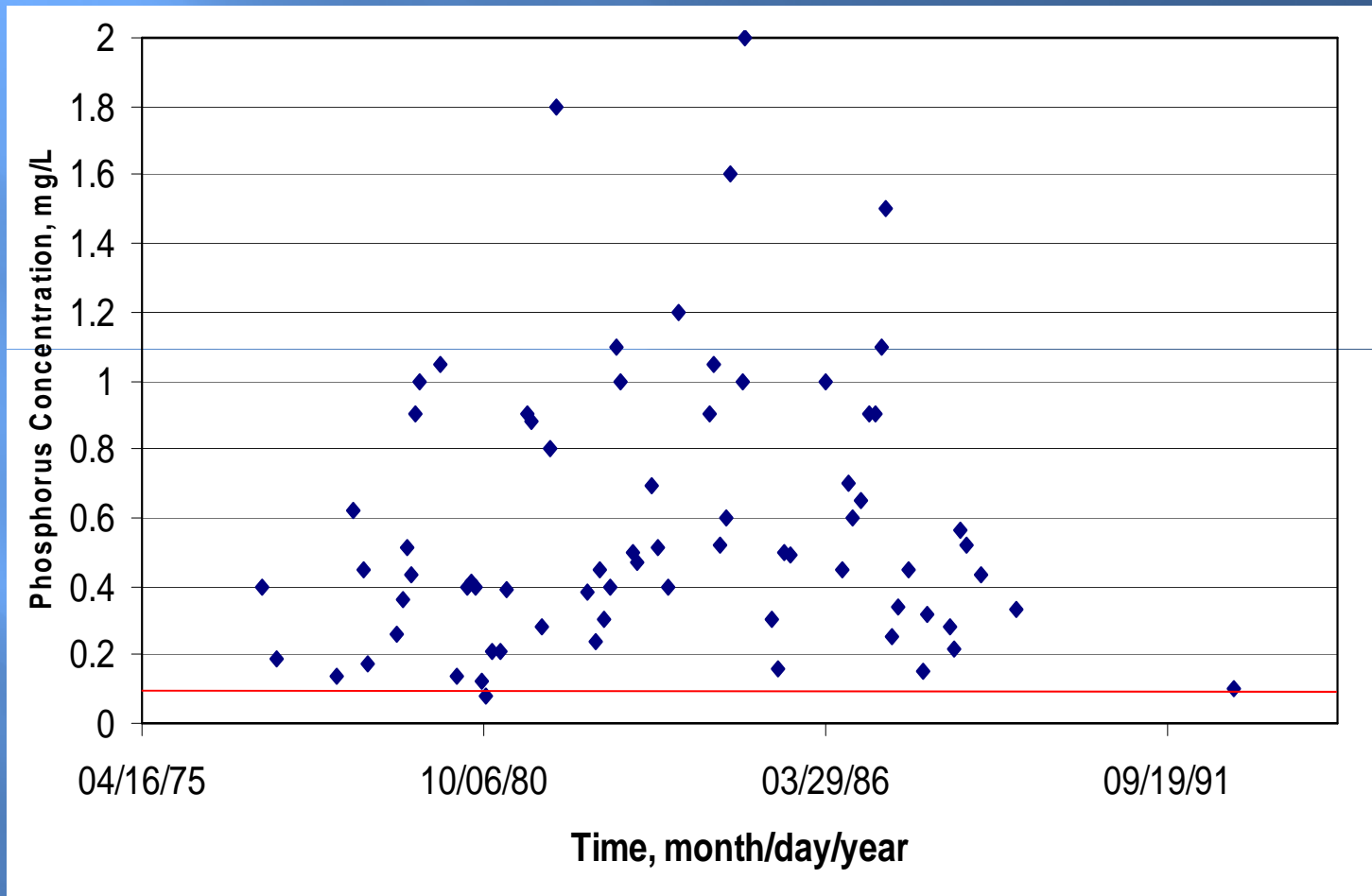
# Landuse



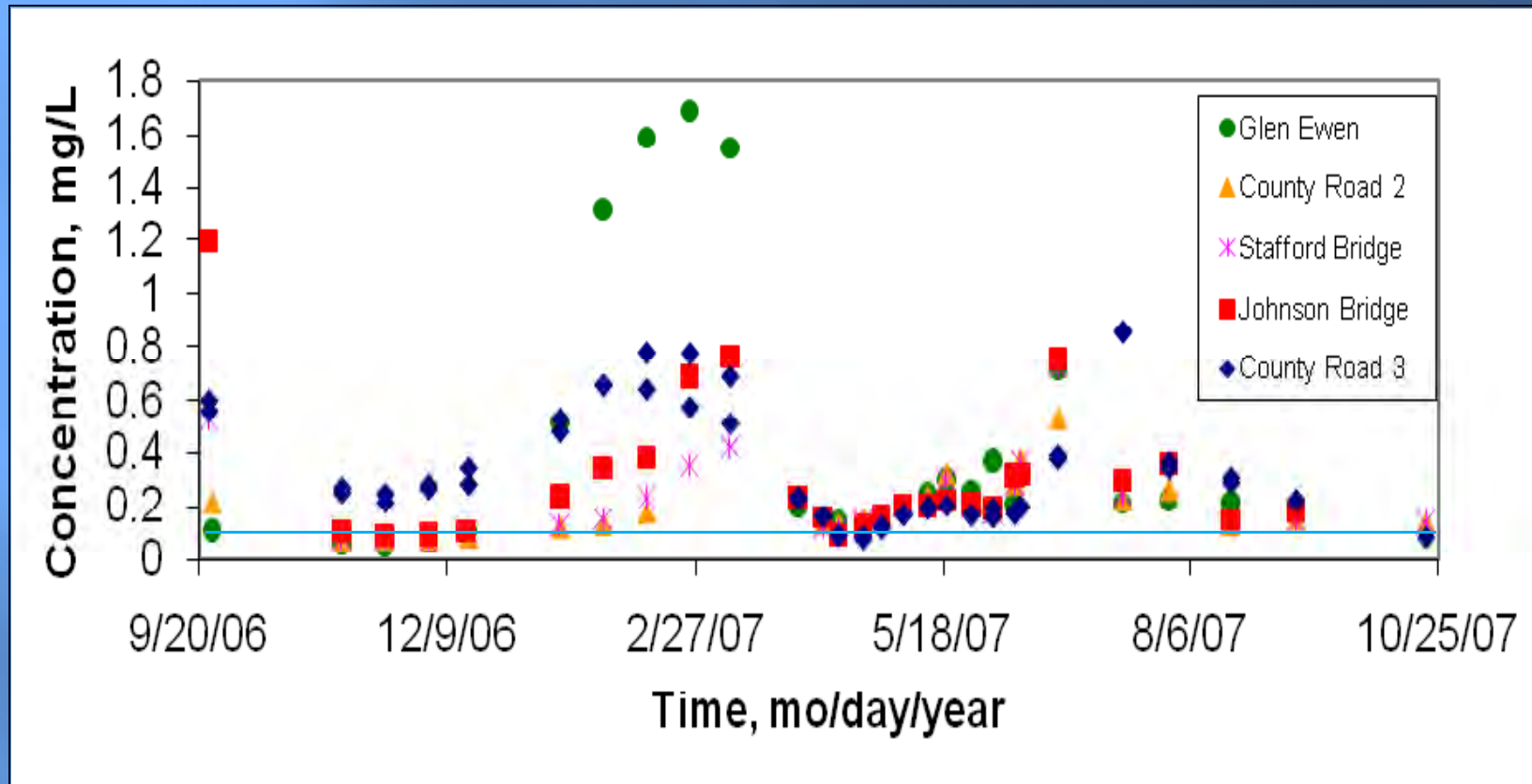
# Problem

- ▣ Local residents complained of bad smell in spring, lots of algae in summer, and fish kills
  - Suggests nutrient related problem
  - Fish kills noted in 1999, 2002, 2003, and 2004
  
- ▣ No State numeric water quality standards for nutrients
  
- ▣ Listed on ND 303(d) list as fully supporting but threatened for aquatic life beneficial use due to low dissolved oxygen

- ▣ Total phosphorus concentrations above ISRB guideline limit of 0.1 mg/L at border



# Total Phosphorus Concentrations



Data from study period

**How to write a Dissolved  
Oxygen TMDL (what will be  
the loading value), believing  
nutrients are a cause, without  
nutrient WQ standards**

(Linkage Analysis)

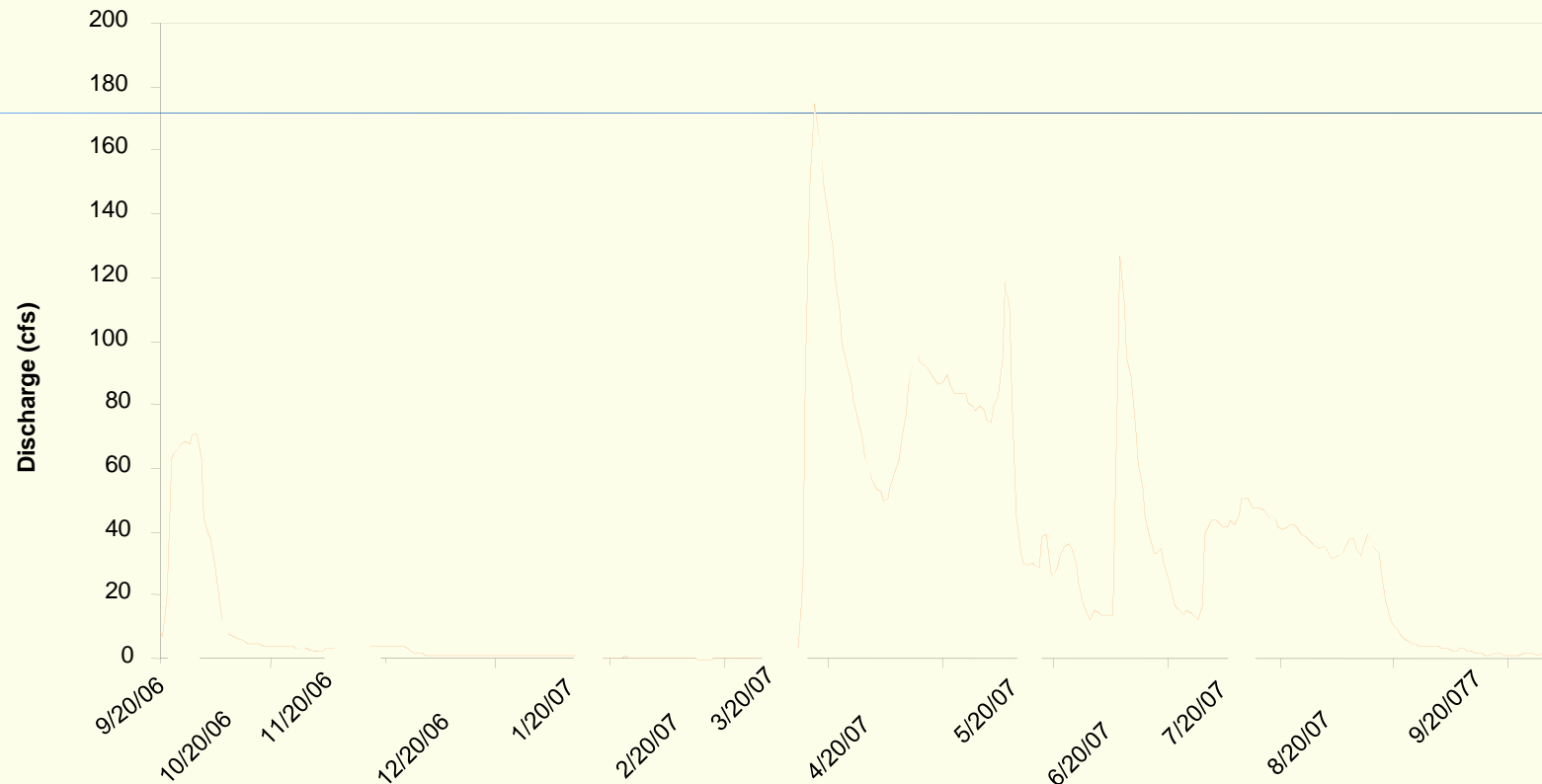
# Investigation

- ▣ **Lots of historical data**
  - Do we need something additional?
  
- ▣ **Big Picture approach**
  - Try to understand all processes involved
  
- ▣ **Limited staff**
  - Four full time staff to write TMDLs for entire state, also responsible for 319 program, developing watershed assessments, information and education programs, and spills, kills and complaints
  
  - My area is approx. 38,500 mi<sup>2</sup> (more if you include my work in Saskatchewan)
  
  - Contracted with North Dakota State University for Grad student to conduct historical data analysis and any additional sampling

# Data

## Flow: River Managed for Flood Control

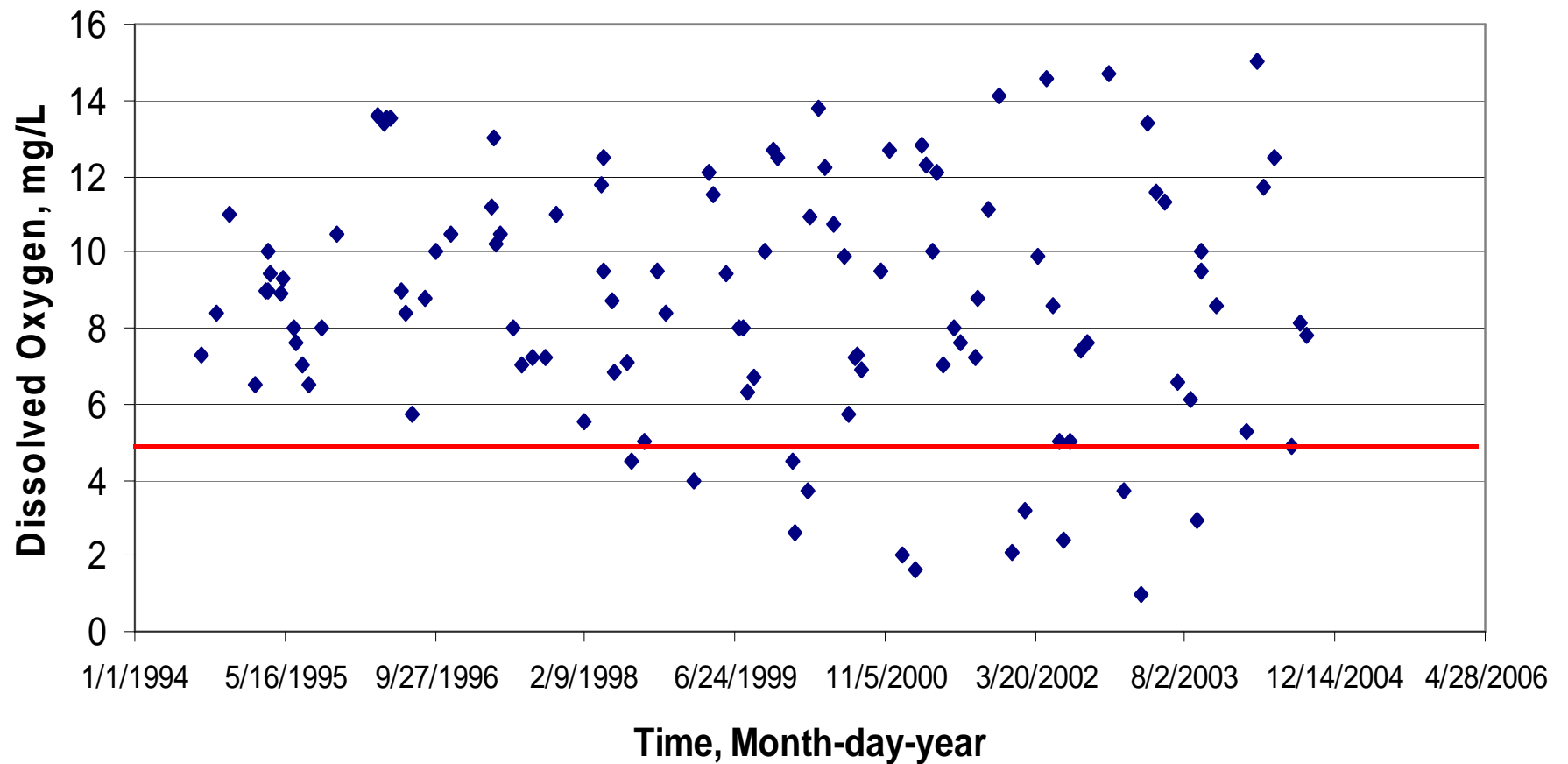
USGS Gauging Station at Sherwood, ND



# Dissolved Oxygen

Historic Data: 1994 – 2004

\*Canadian Reservoirs Constructed in 1991



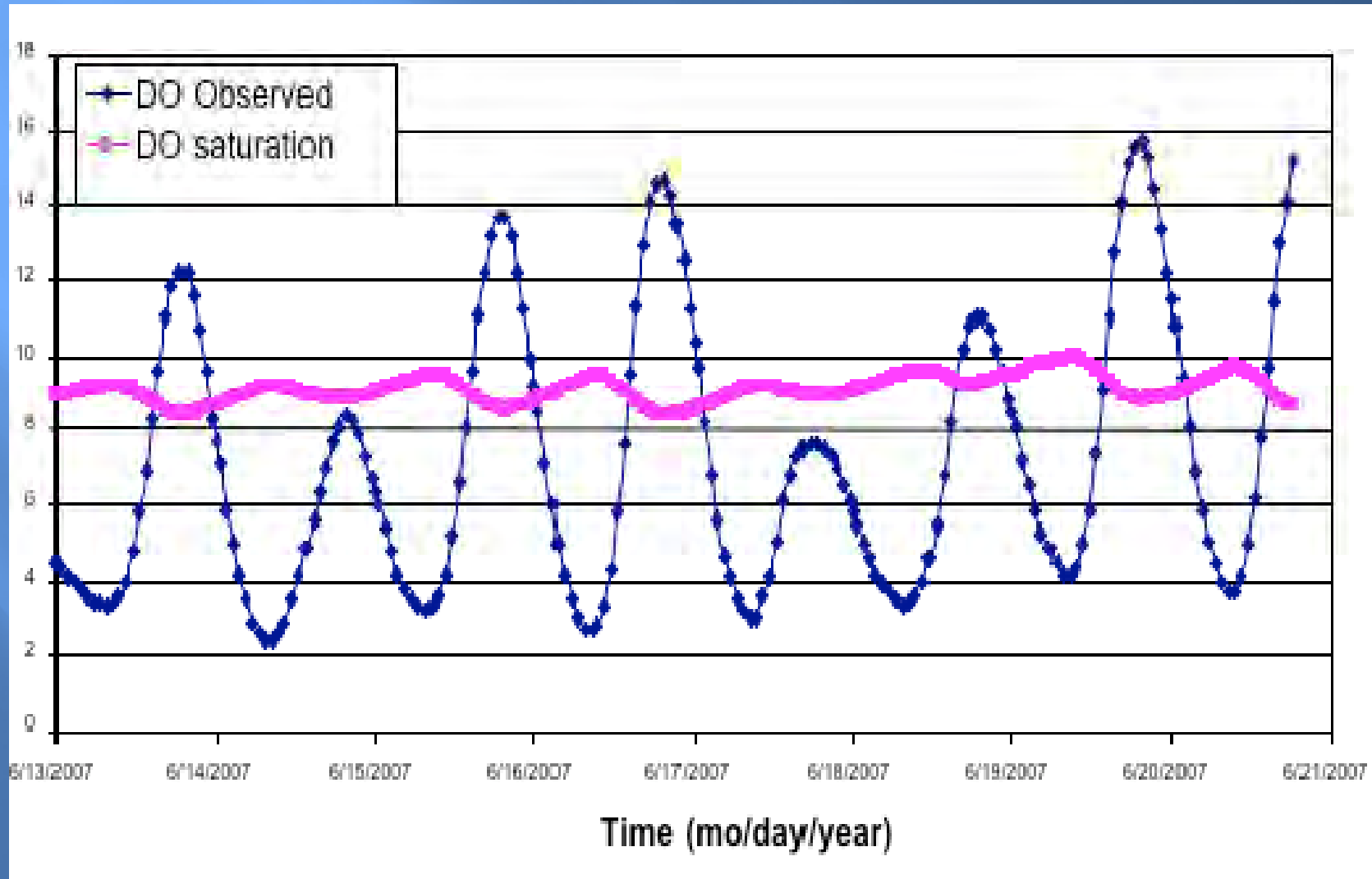






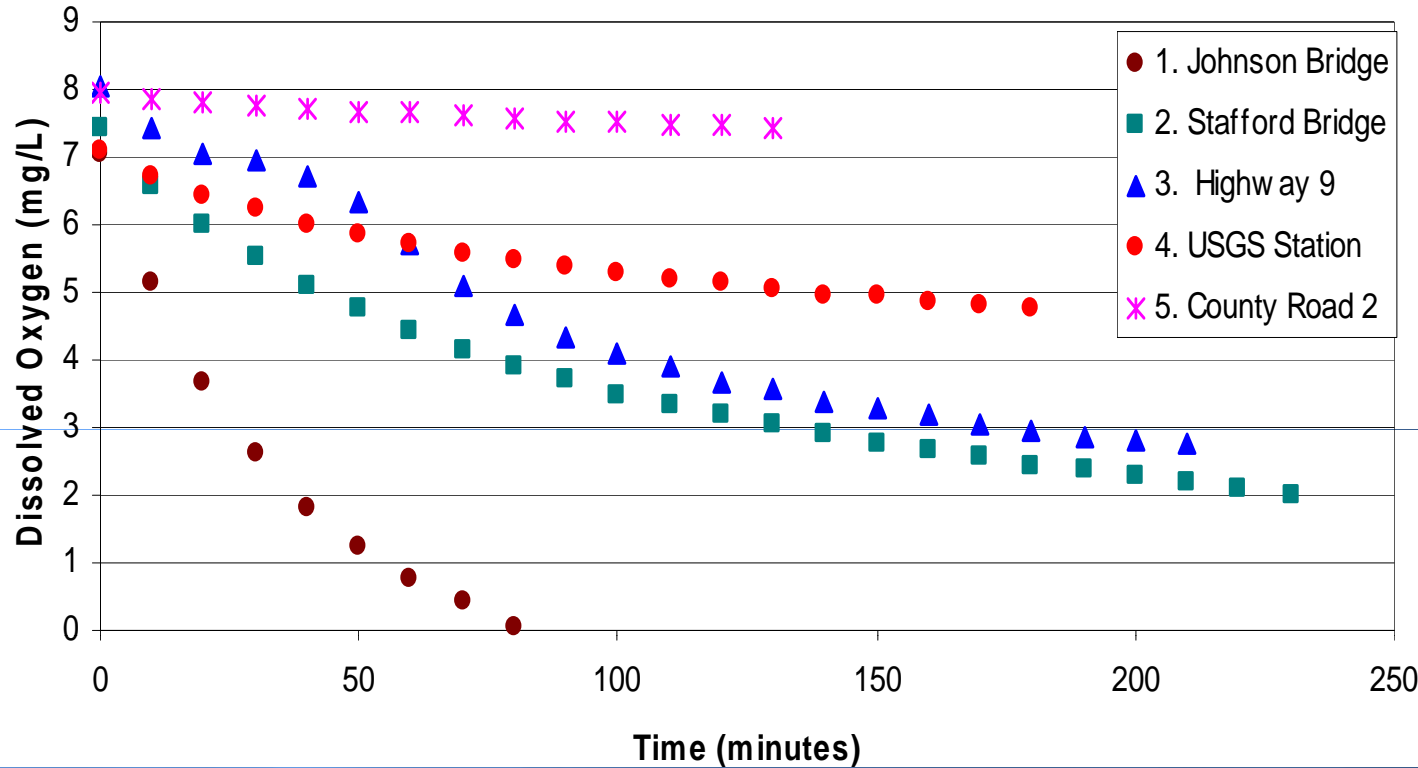
# Dissolved Oxygen

## Diurnal Swings



# Sediment Samples

Sediment analysis conducted by NDSU grad. student Matt Baker



Oxygen Depletion from Sediment in Completely Mixed Reactors

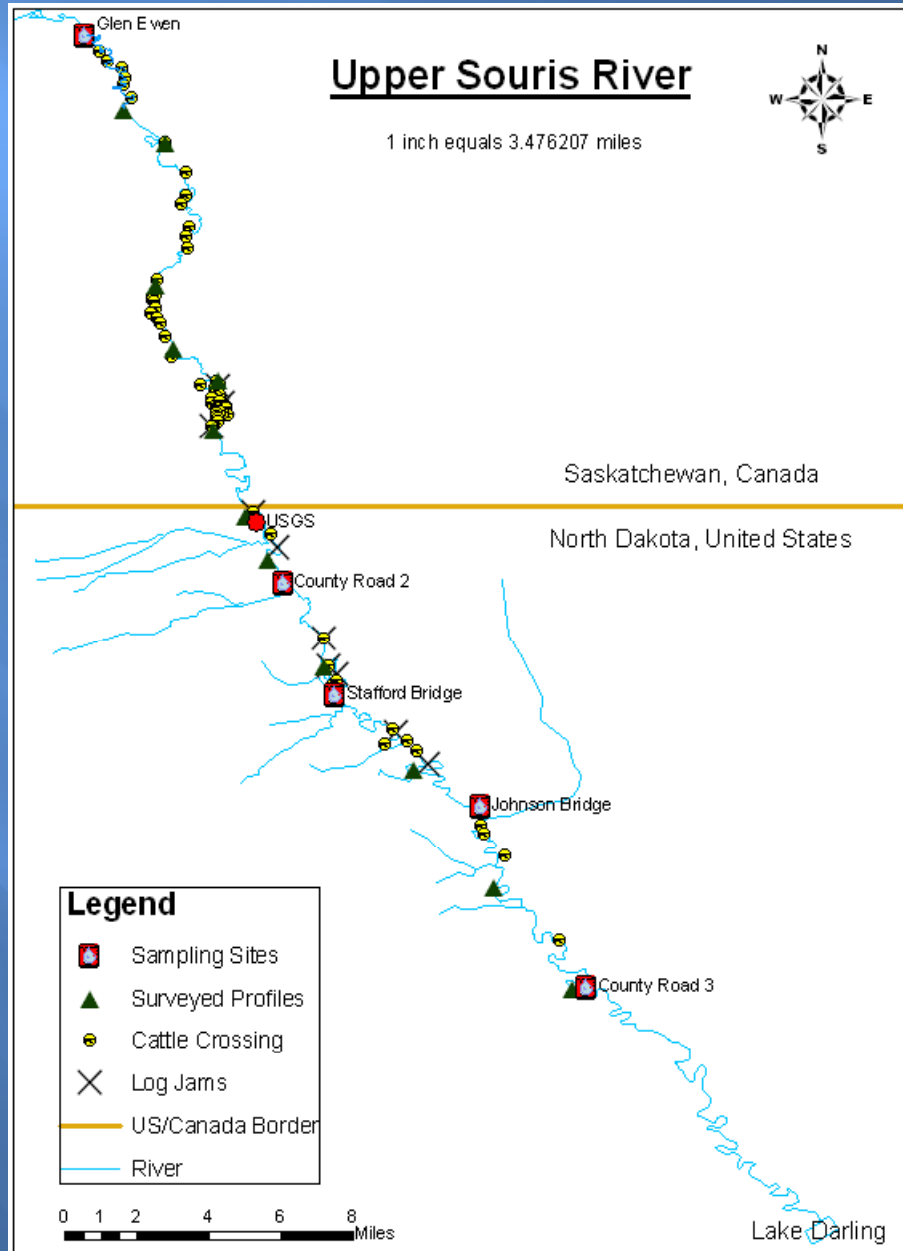
Characteristics of Sediment Samples:  
Composition and % Organic Matter

Site	Site Location	% Organic	Coarse Composition Observed
Hwy 9	Upstream	9.45	Very Little Coarse (twigs)
USGS	↓	6.1	Some Coarse Retained
County 2		2.61	Mostly Coarse Aggregate
Stafford		13.23	Little to no Coarse
Johnson	Downstream	14.91	Algae and Plant remains

# Additional Data

- ▣ BOD concentrations remained below detection limits at all sites throughout entire sampling period (Aug. 2006 through Nov. 2007)
- ▣ Ammonia concentrations were below water quality standards for period as well

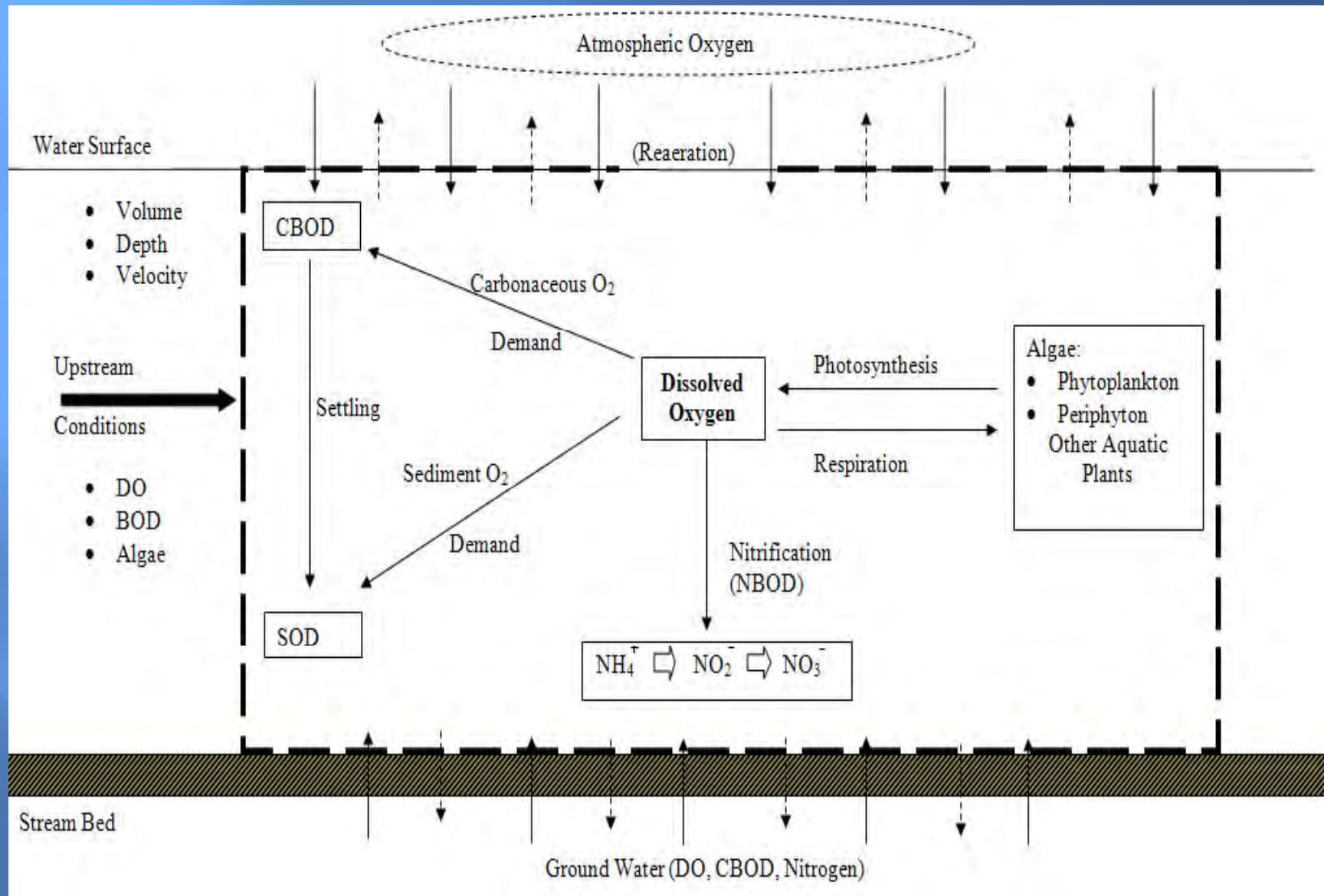
# Visual Survey



May 27<sup>th</sup>, 2007

- Cattle Crossings
- Log Jams

# Conclusions



# How We Got to SOD

- ▣ The amount of DO at any time reflects the contribution of physical, chemical, and biological sources and sinks within the reach
- ▣ No BOD to speak of
- ▣ Sediment oxygen demand (SOD) is defined as the combination of several processes, primarily the aerobic decay of organic material that has settled to the bottom of the streambed.
  - ▣ Ex. Leaf litter, algae or plant biomass, particulate BOD in wastewater
- ▣ Low flow in winter contributing to accumulation of organic matter in sediment
  - ▣ No more spring scours
  - ▣ River channel incised on ND portion of watershed



- ▣ Greatest periods (severity and length) of low DO during ice cover
  - No re-aeration
  - Not a period of plant growth
  
- ▣ Secondary period of low DO during summer algal bloom
  - Contributed to sediment organic matter through decay of plant material
  
- ▣ Dutch Elm Disease and Riparian Grazing contribute to organic matter and nutrient load

- ▣ In the summer months, high density of aquatic plants can cause oxygen levels to vary widely.
  - Slow water movement, increased water temp, increased nutrients, increased solar radiation = increased photosynthesis
  - At night, plant respiration decreases oxygen levels
  - High diurnal swings - indicator of excessive nutrient loading

So:

- ▣ Increased nutrients (cropping runoff and livestock)
- ▣ Algae bloom and bust in summer (increased organic matter)
- ▣ Deadfall (increased organic matter)
- ▣ Low winter flows (no re-aeration, no spring scour)

= High SOD, process of most concern

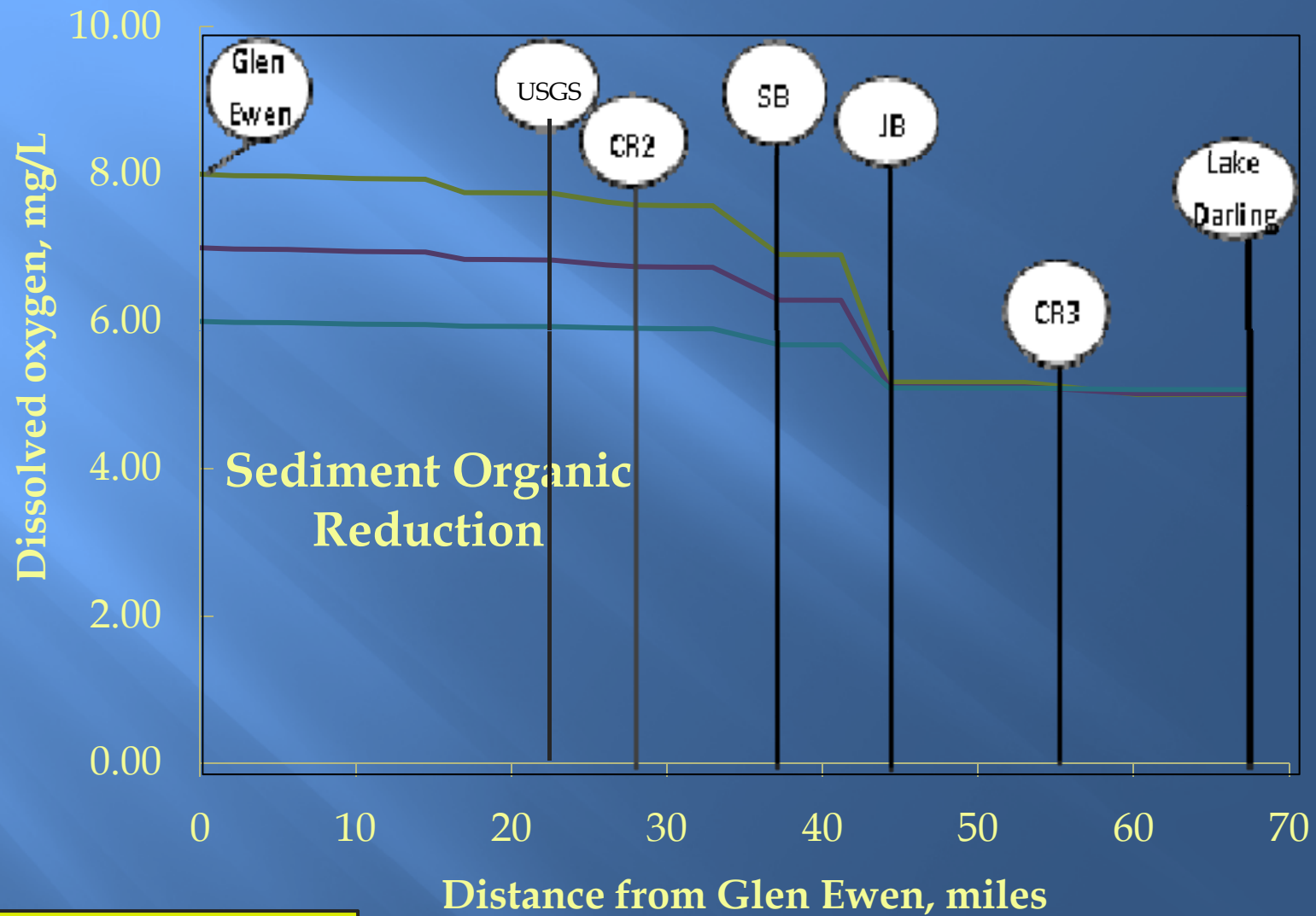
# TMDL Loadings

Since dissolved oxygen levels in the winter were more severe and longer lasting, SOD was chosen for the TMDL load to represent DO in the reach.

# How to Determine Load Reduction

- ▣ Since the organic content of sediment, which is built up over the course of the entire year, drives the SOD, a correlation was determined between SOD and the organic content of the sediment
- ▣ Organic content in the sediment was then modeled using QUAL2K to determine reduction needed
  - Data analysis was conducted by NDSU grad student Joe Super

# QUAL2K Model Results With Different Initial DO Concentrations



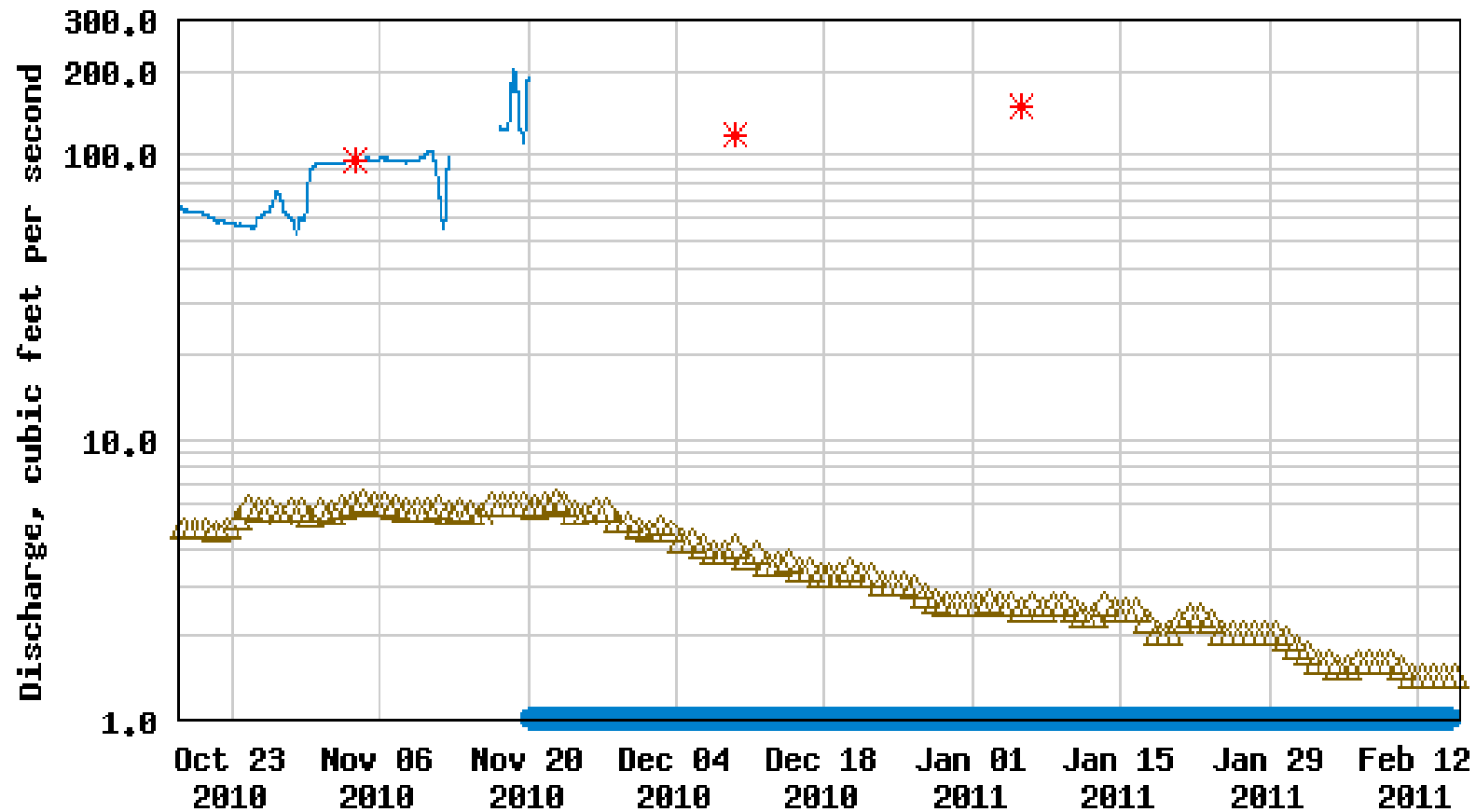
53% Reduction Needed

# Current Questions

- ▣ Flood conditions for over a year
- ▣ All Canadian and US reservoirs releasing all winter long
- ▣ Will this flow remove organic matter and how long will good DO conditions prevail?



## USGS 05114000 SOURIS RIVER NR SHERWOOD, ND



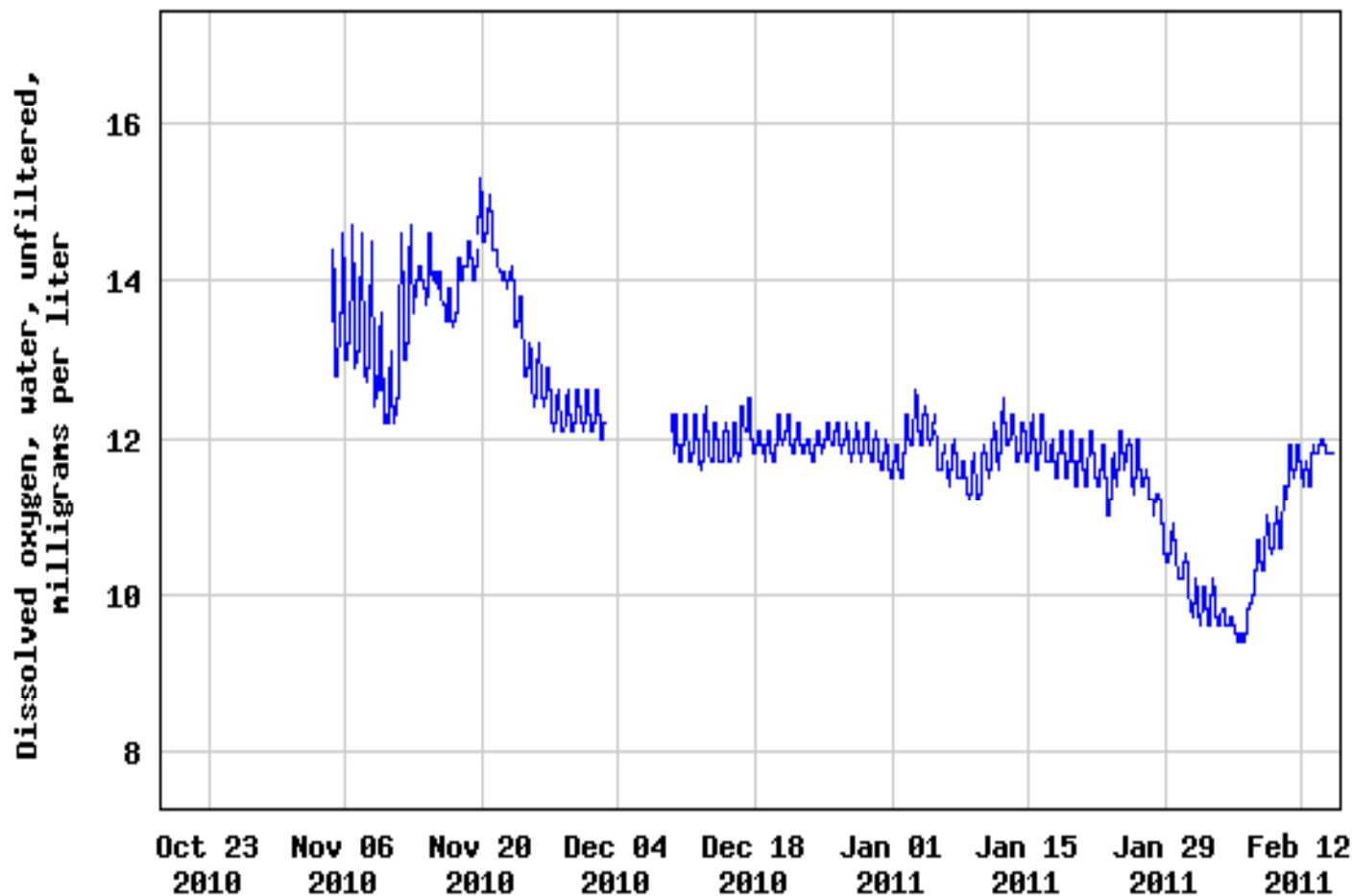
---- Provisional Data Subject to Revision ----

- △ Median daily statistic (80 years)
- Discharge
- \* Measured discharge
- Flow at station affected by ice





### USGS 05114000 SOURIS RIVER NR SHERWOOD, ND



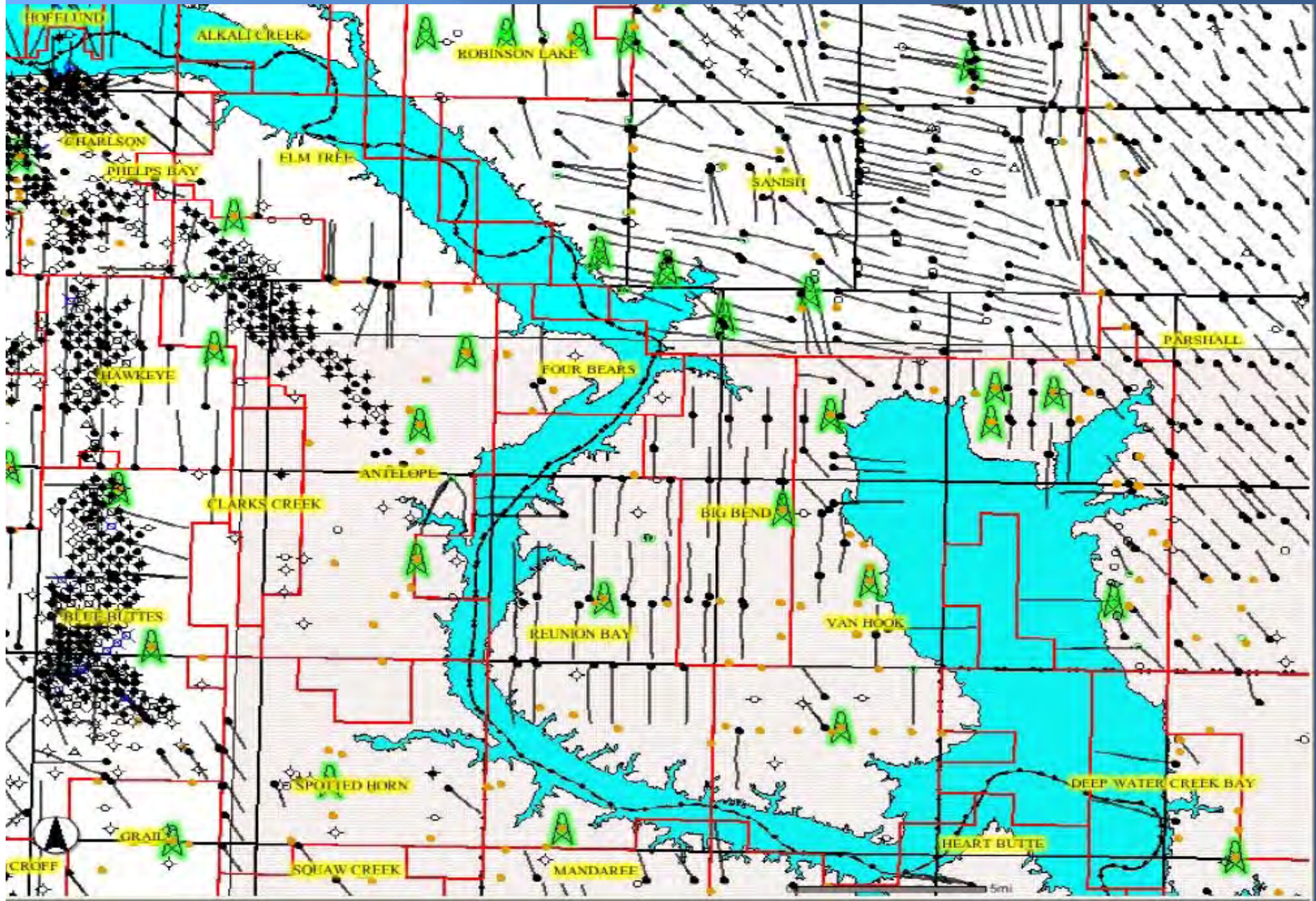
----- Provisional Data Subject to Revision -----

# Future

- ▣ In Saskatchewan, both Upper Souris and Lower Souris watersheds have Watershed Protection Plans in place and are implementing conservation practices
- ▣ Hopefully will get Renville County to submit grant proposal for ND 319 project
- ▣ Nutrient criteria developed for rivers and streams

# Future

- ▣ Extension Service is promoting use of tile drains
- ▣ Oil and Gas development





storm www.fotosearch.com

Cap and trade proposals in congress could reduce activity an estimated 35-40%



storm www.fotosearch.com

Current administration budget contains tax rule changes that could reduce activity an estimated 35-50%



The future looks promising for sustained Bakken/Three Forks development

CoolClips.com



storm www.fotosearch.com

EPA regulation of hydraulic fracturing could halt drilling activity for 18-24 months production decline of 25-30%



storm www.fotosearch.com

Federal regulations require 6 -12 months longer for drilling and surface use approval



# TMDL Website

<http://www.ndhealth.gov/wq/>

Click on TMDL Program link

