

Red River Valley Subsurface Drainage Water Quality Assessment Phase I & II, 2008 to 2013



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Acknowledgements

- US EPA 319 Program
- ND Department of Health
 - WQ Division - Mike Ell and Greg Sandness
 - Division of Laboratory Services – Chemistry
 - Analyzed over 1000 water samples
- Soil Conservation District Watershed Coordinators in Cass, Richland, Sargent, Walsh, Steele, Traill, Ransom and Grand Forks Counties



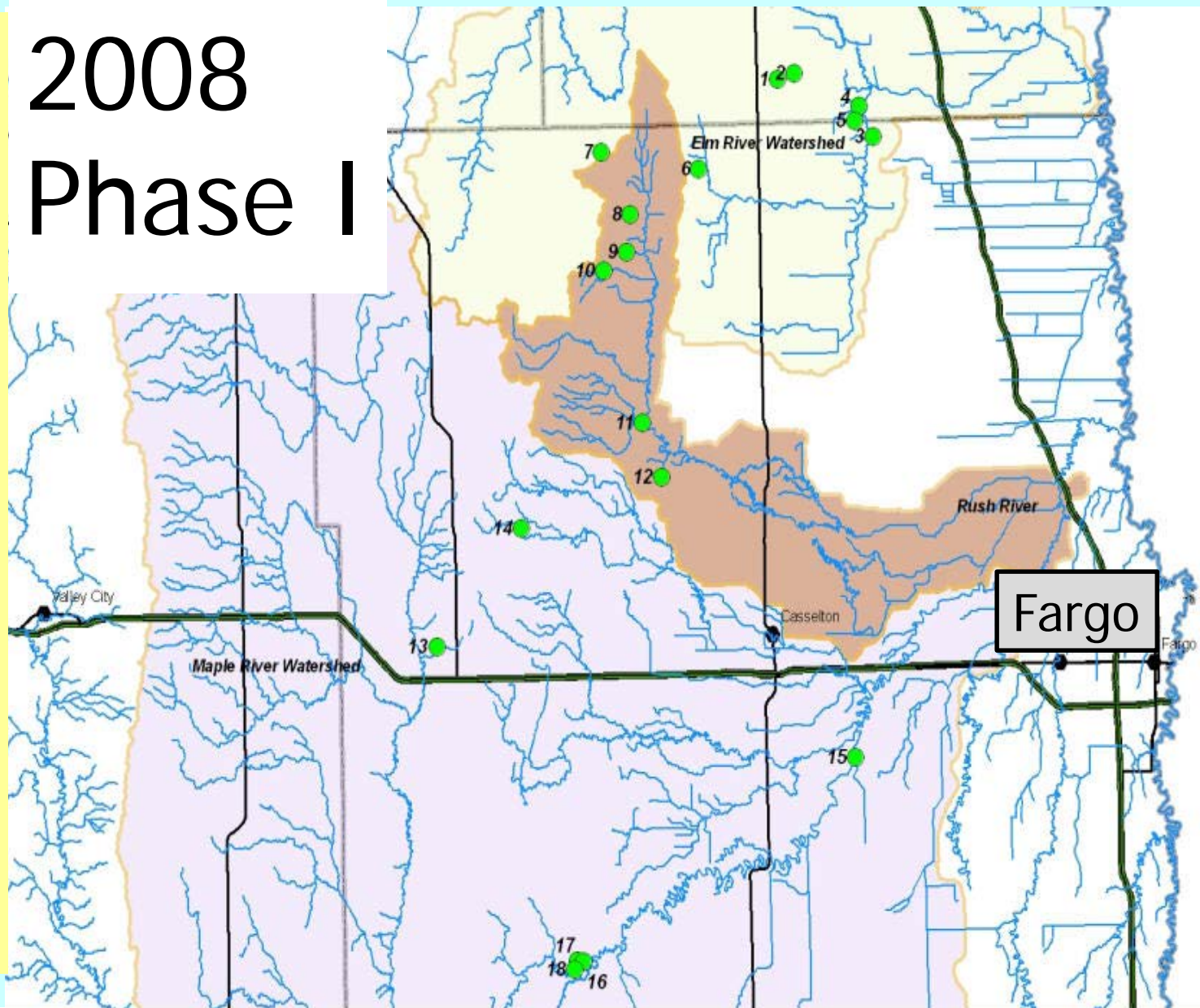
Watersheds:
Elm River
Maple River
Rush River

18 Sites:
16 gravity and
2 lift stations

Weekly
samples from
April to
December

Roxanne
Lori Clark
Darin Eisinger

2008 Phase I



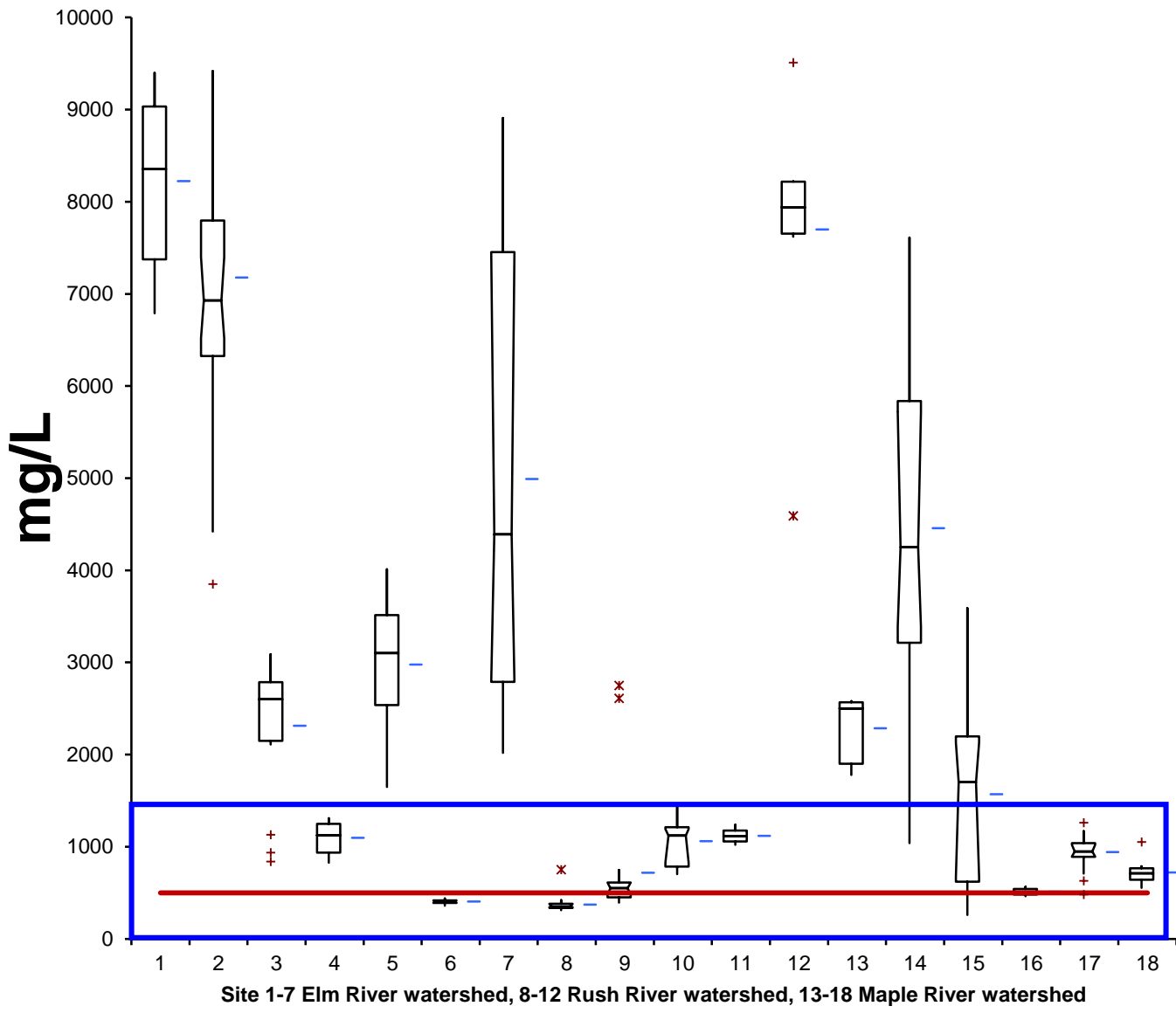


Water Quality Parameters Measured in Subsurface Drainage Water

- Each Sample – 40 analyses
- Total Dissolve Salts (TDS)
 - Major minerals
 - Minor minerals
 - Heavy metals
- pH
- No Bacteria or Organic Matter Testing



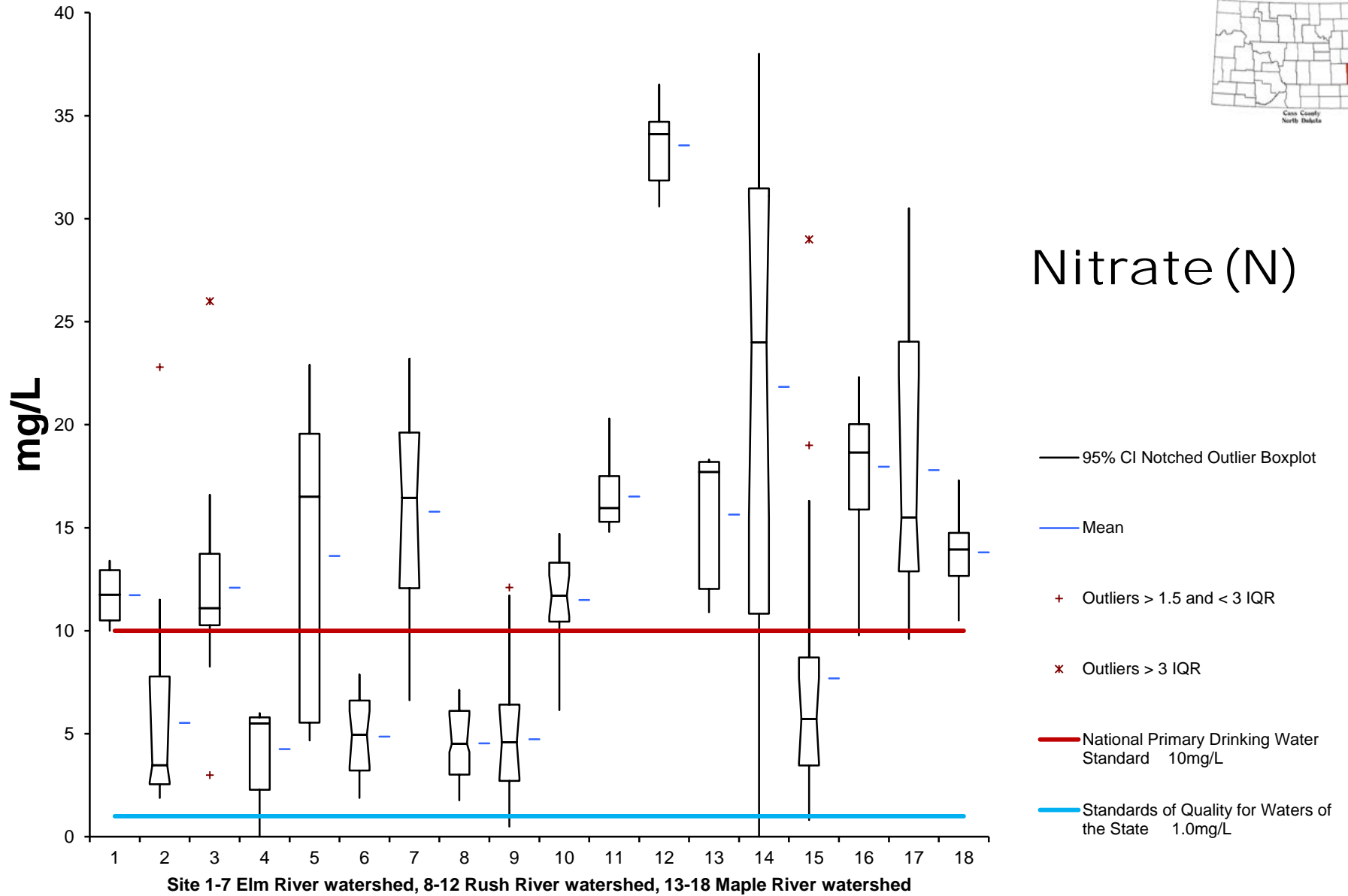
Total Dissolved Salts

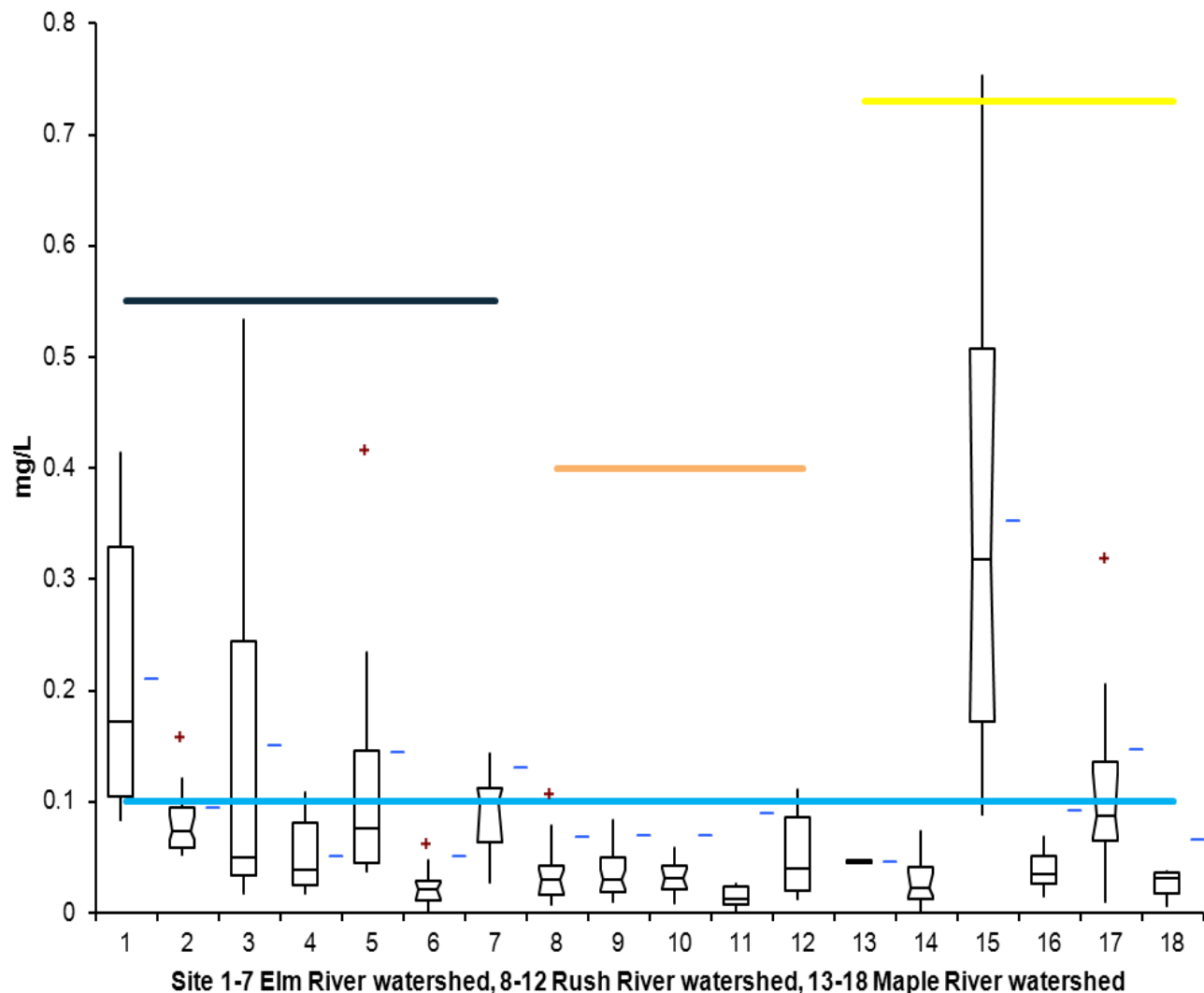


- 95% CI Notched Outlier Boxplot
- Mean
- + Outliers > 1.5 and < 3 IQR
- * Outliers > 3 IQR
- National Secondary Drinking Water Standards 500mg/L



Nitrate (N)

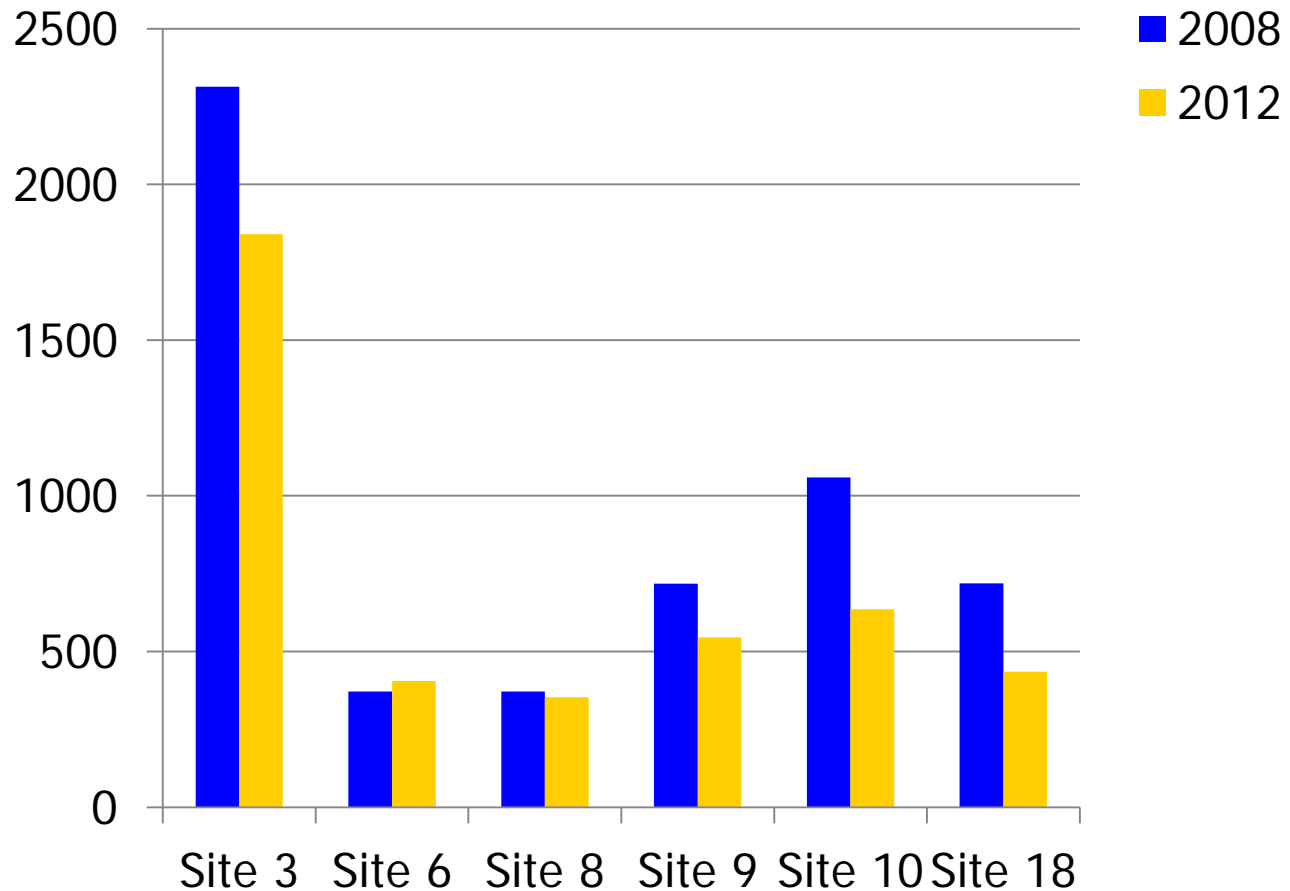




Phosphorus

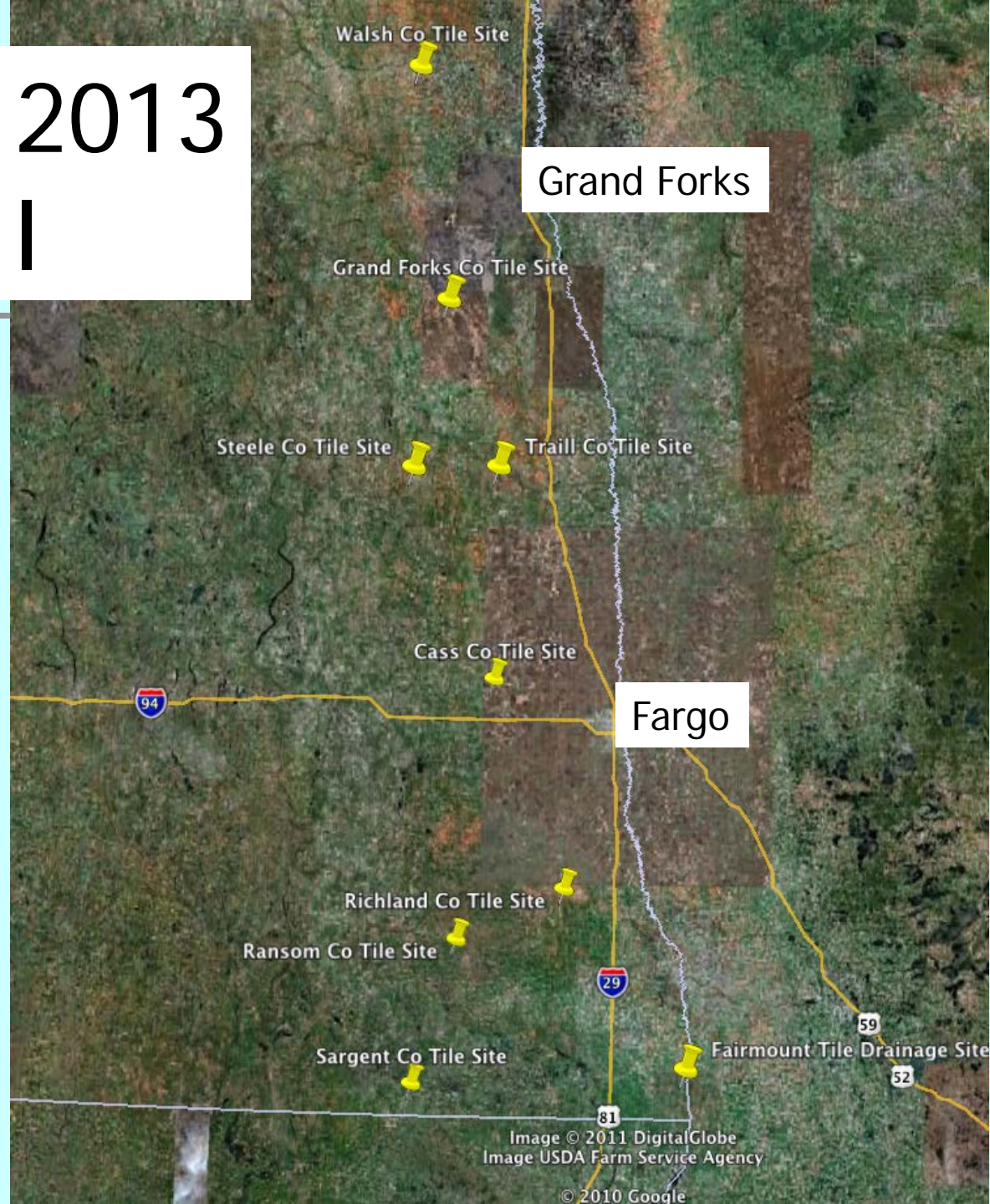
- 95% CI Notched Outlier Boxplot
- Mean
- + Outliers > 1.5 and < 3 IQR
- Average in 2004-05 study on Rush River 0.4mg/L
- Average in 2007 study on Maple River 0.73mg/L
- Standards of Quality for Waters of the State 0.1mg/L
- Average in 1993 study on Elm River 0.55mg/L

Total Dissolved Salts 2008 and 2012



2009 – 2013 Phase II

Tile Water Quality
Monitoring Sites:
- Recently
Installed Tile
- Salt Affected
Soils



Rain Measurement

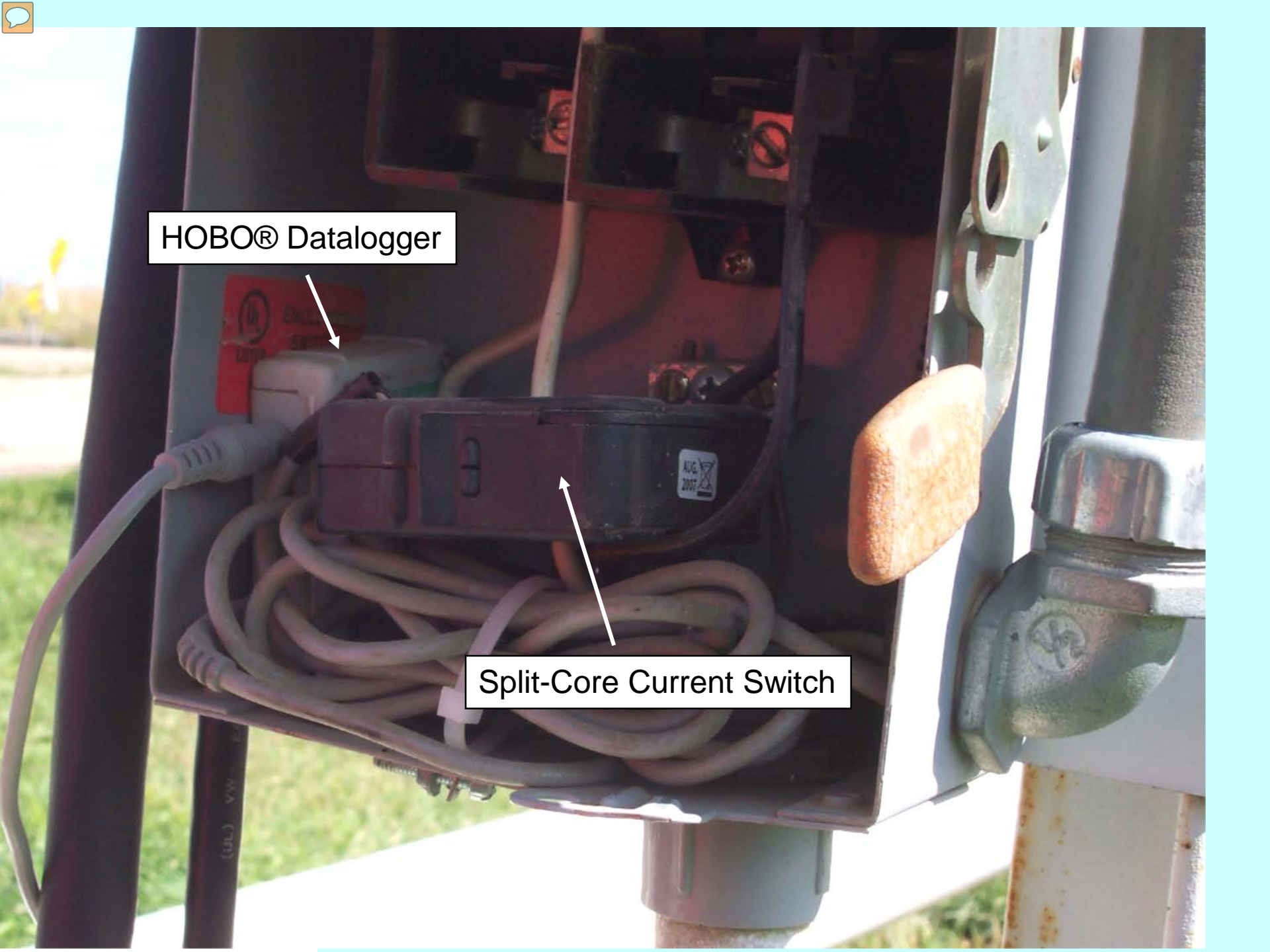


Flow Measurement at the 5 Pump Stations



HOBO® Datalogger

Split-Core Current Switch







GREYLINE
instruments inc.

Stingray
Level Velocity Logger

INSTRUCTIONS
• Press switch to power variable
• Double press to (re)start display
• Display returns to 00 seconds
• Logging begins when battery is installed
• Monitor for green when power is restored
• Operating temperature: -20° to +50°C

ENCLOSURE
• Rapid IP67 Weatherproof Enclosure
• Wash Service Compatible (Wash and Dry)

DO NOT SHIP WITH

BATTERIES
• Use premium Alkaline B Cells (MinigAA CEE or Duracell MX2300)
• Insert proper orientation
• Replace when low-charge alarm is on
• Operate at -20°C without battery life

IN HAZARDOUS LOCATIONS
• Do not disconnect the battery
• Do not connect to AC (via USB cable)
• Do not remove batteries

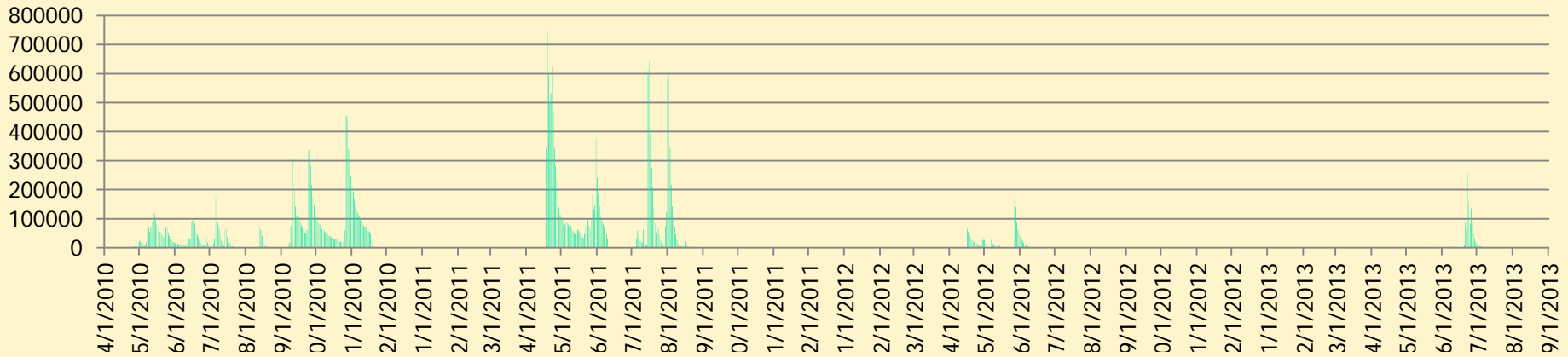
BATTERIES INSTALLED

Circular Flume – Grand Forks

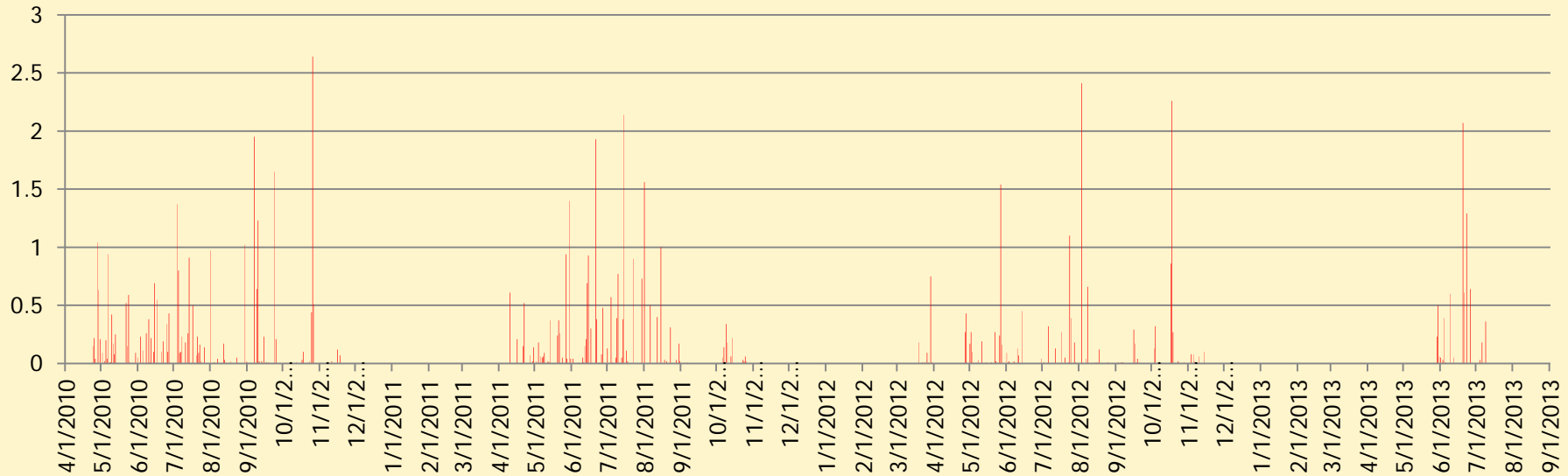


Richland Site (2010 to 2013)

Pumped Volume (gallons)



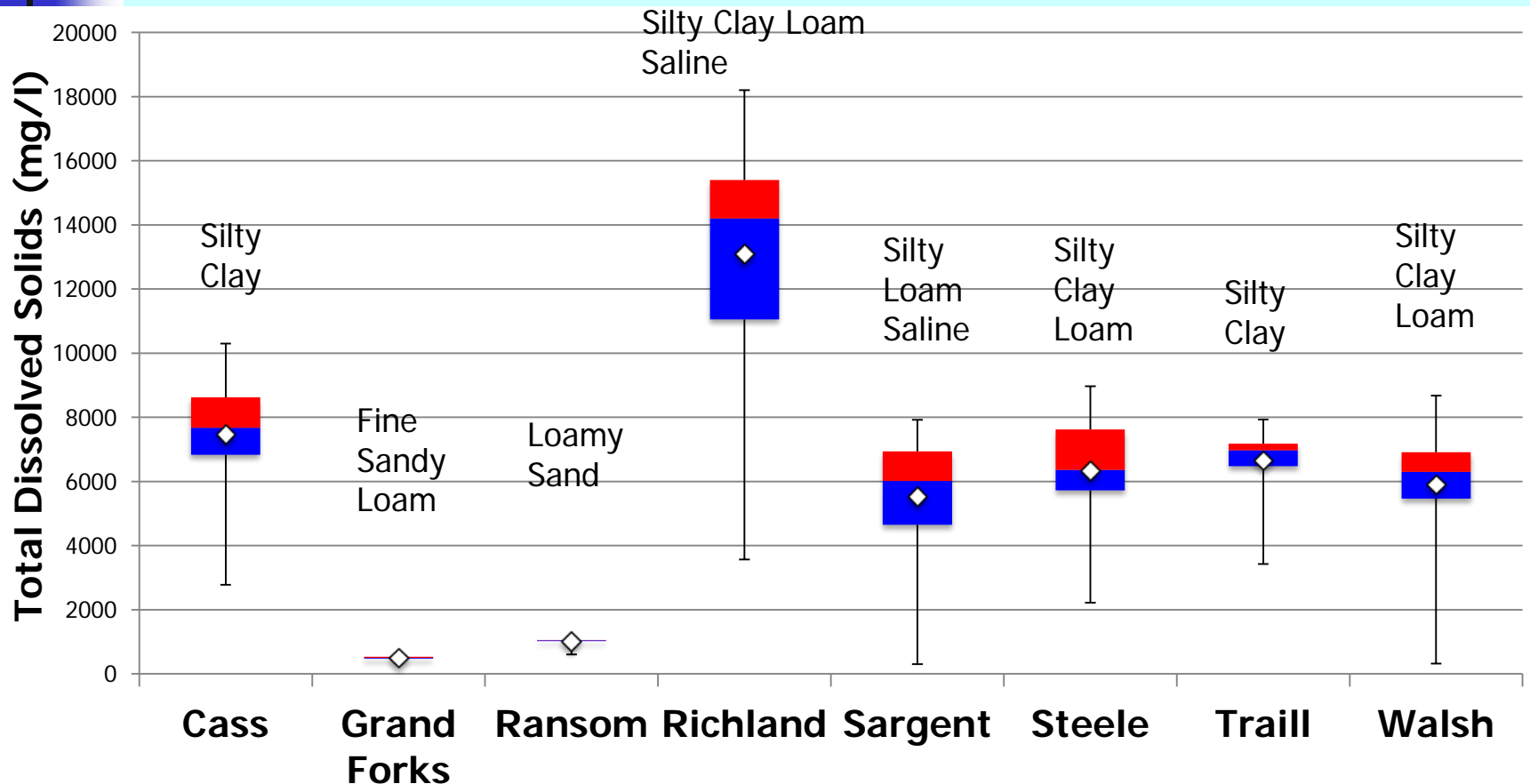
Rain Total (inches)



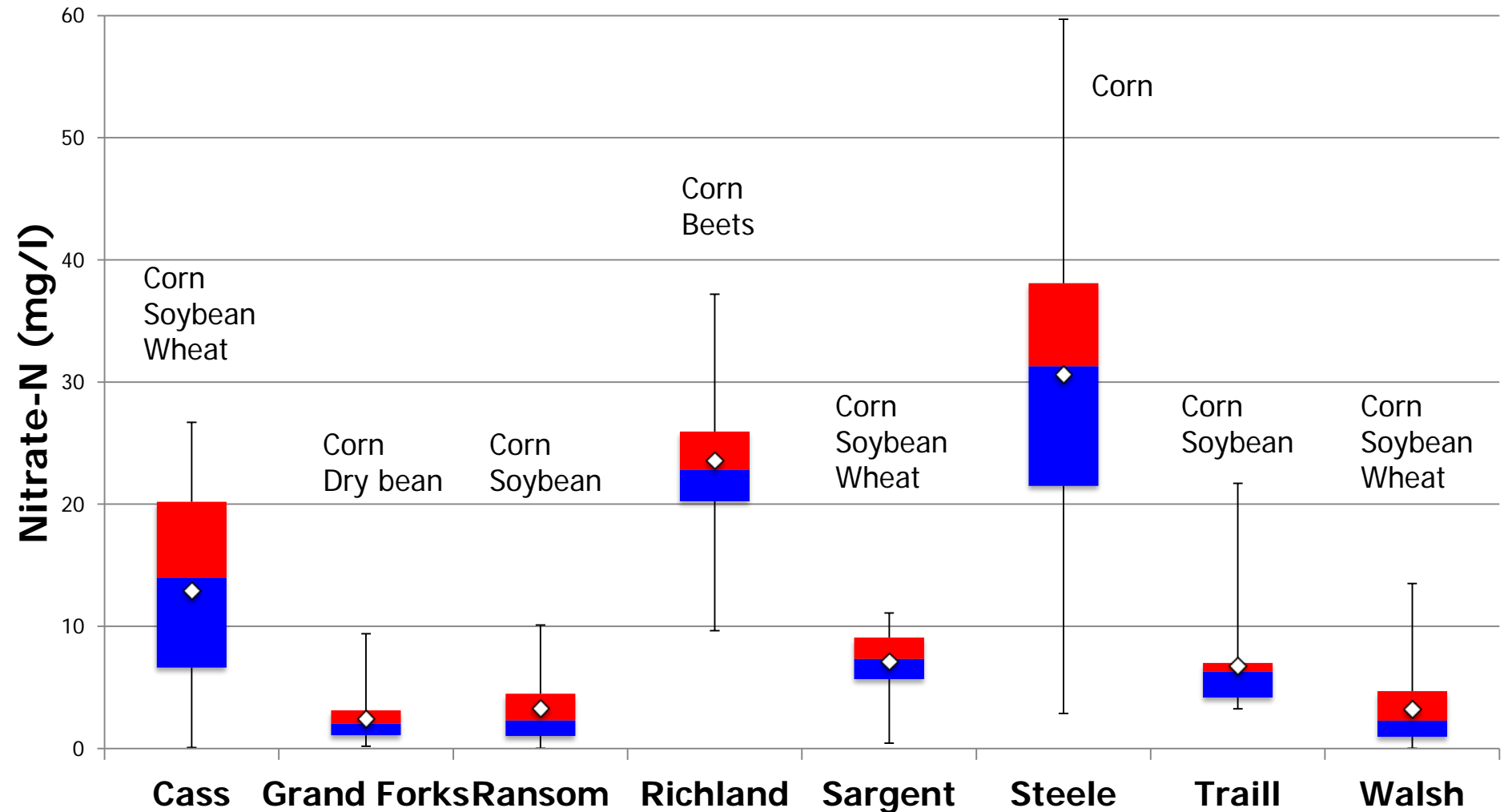
What's in Tile Water?



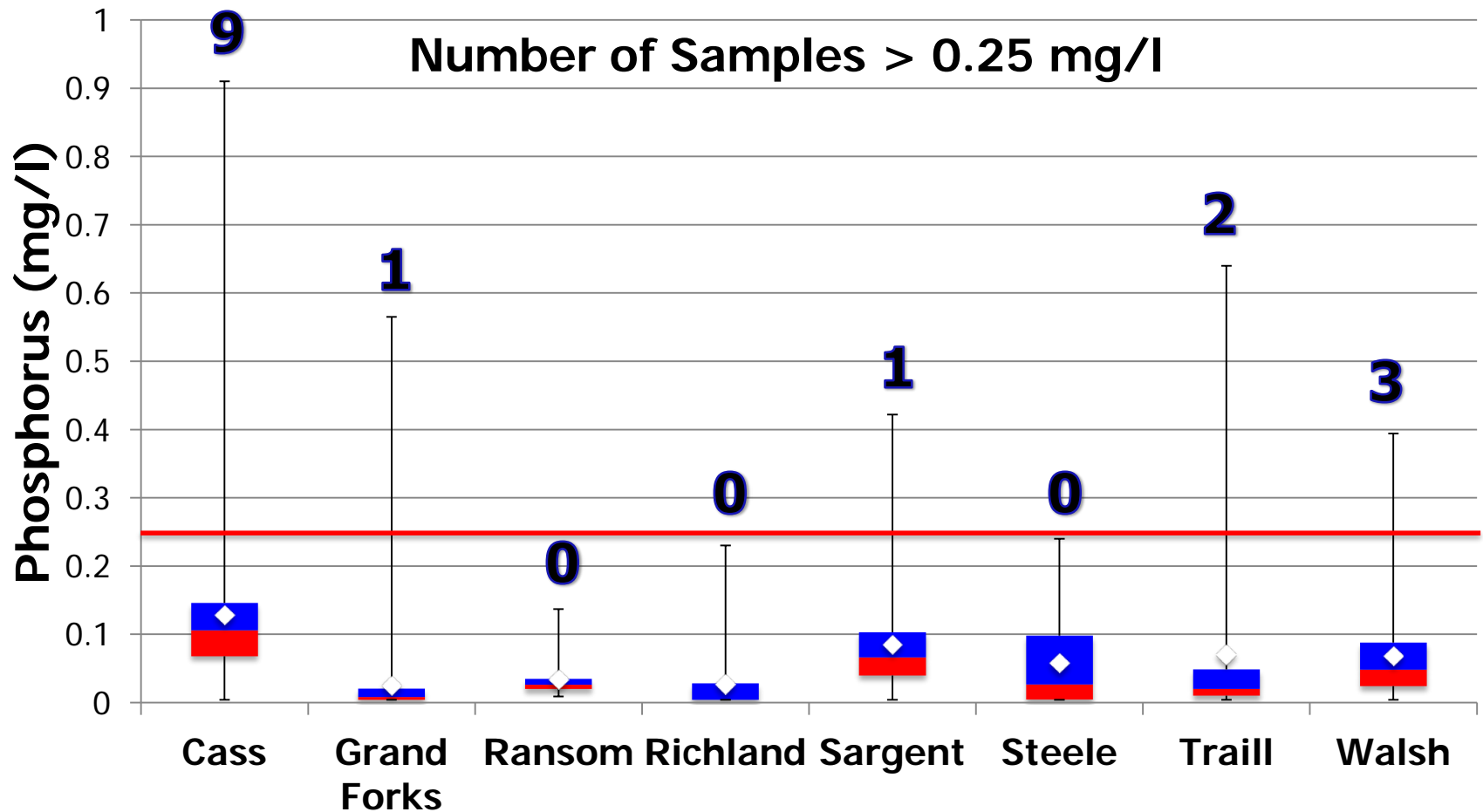
2009-2013 Sampling Total Dissolved Solids



2009-2013 Sampling Nitrate-Nitrogen



2009-2013 Sampling Total Phosphorus



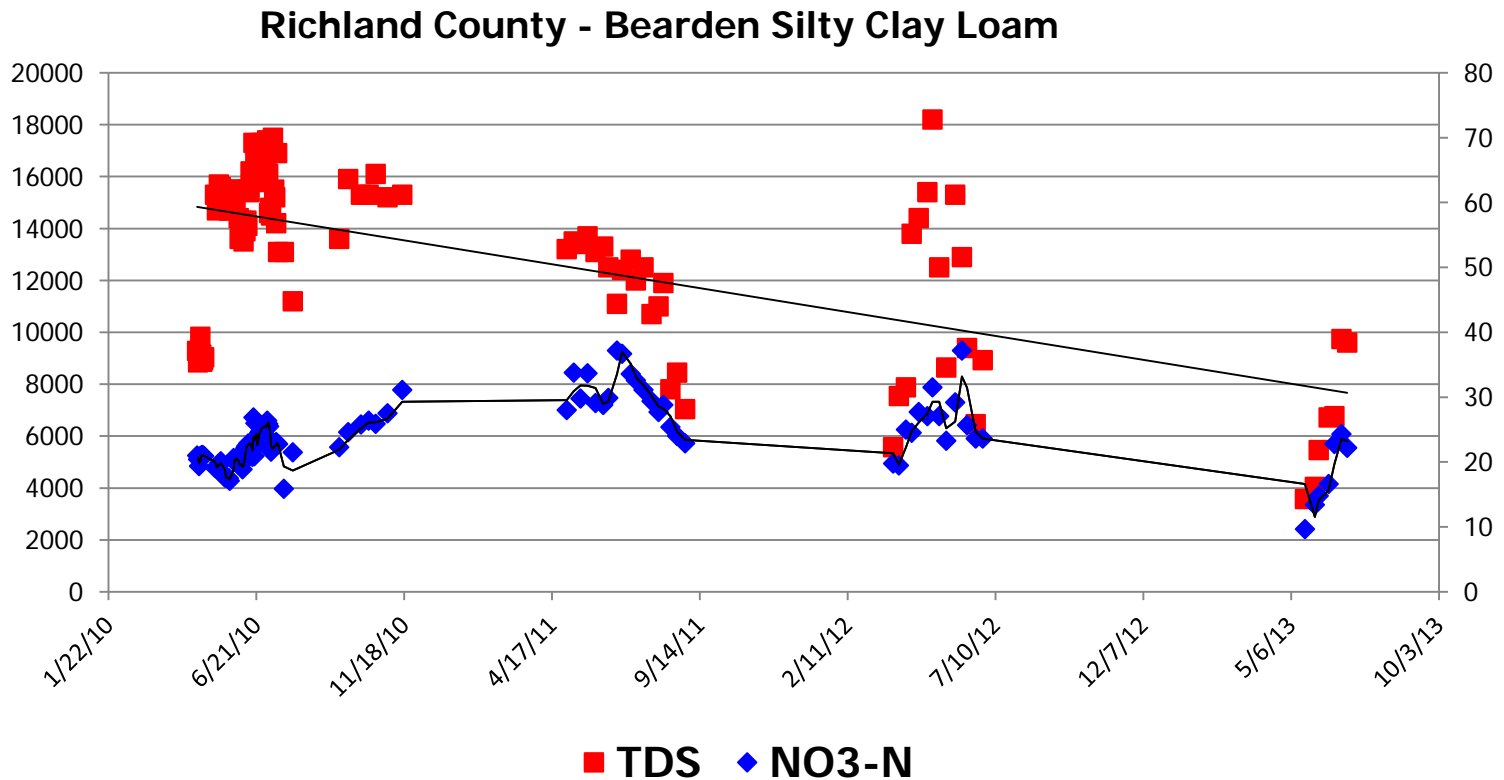
2009-2013 Sampling Sulfates (SO_4)



Sulfate Comprises $> 65\%$ of TDS at 5 sites (higher clay content soils)

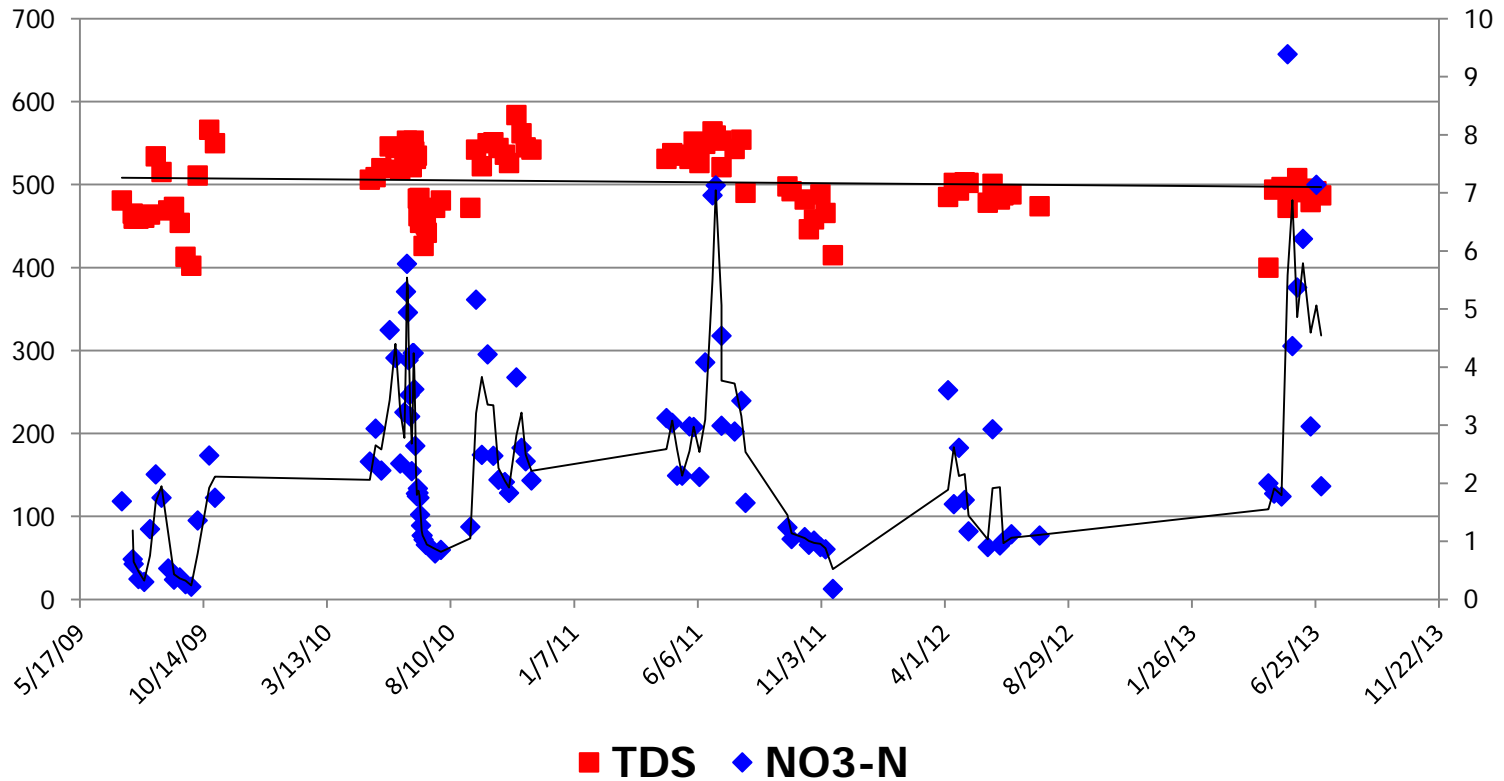
3 other sites: 51, 35 and 20%

2009-2013 Richland County TDS and Nitrate-Nitrogen



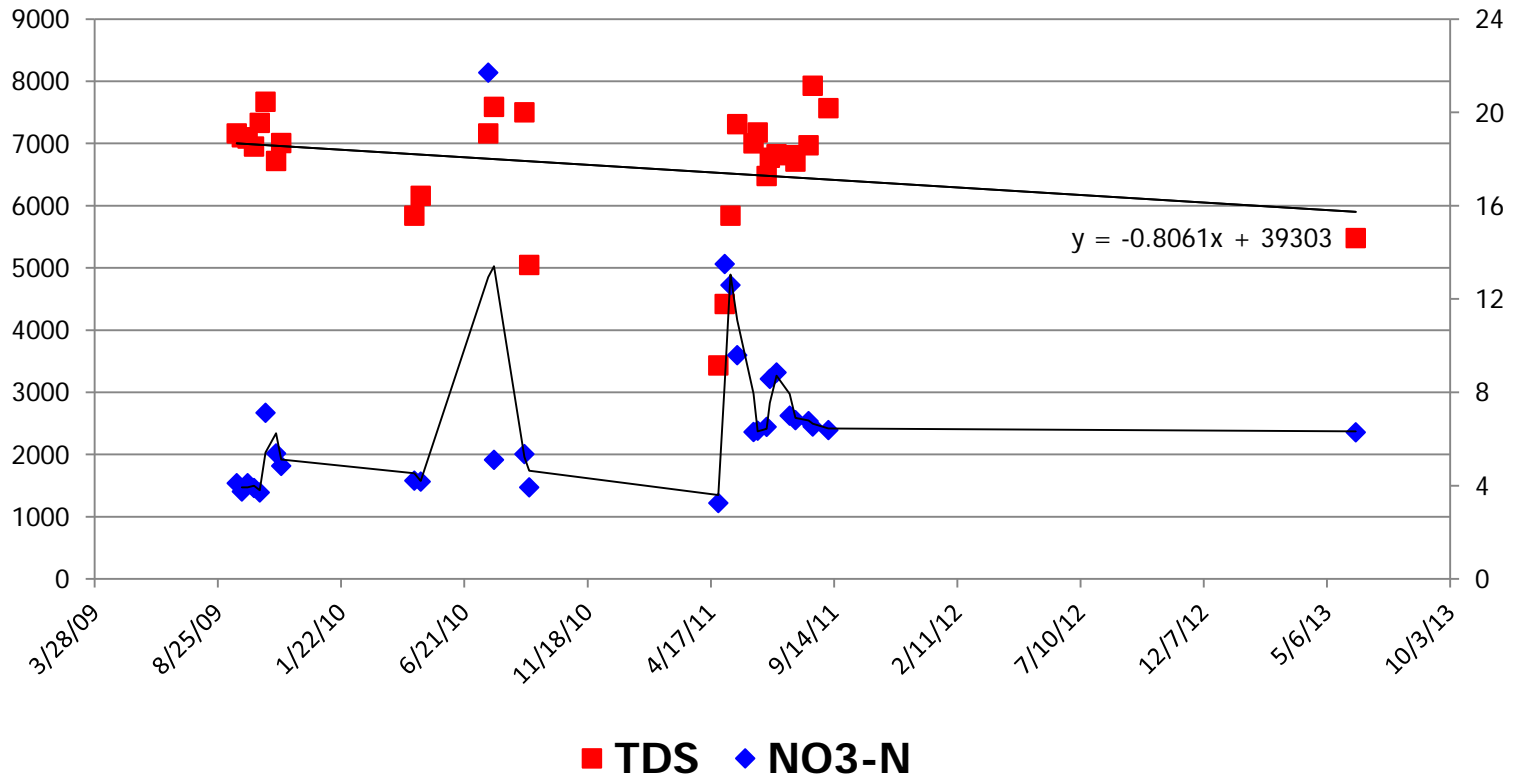
2009-2013 Grand Forks County TDS and Nitrate-Nitrogen

Grand Forks County - Wyndmere/Tiffany Fine Sandy Loam



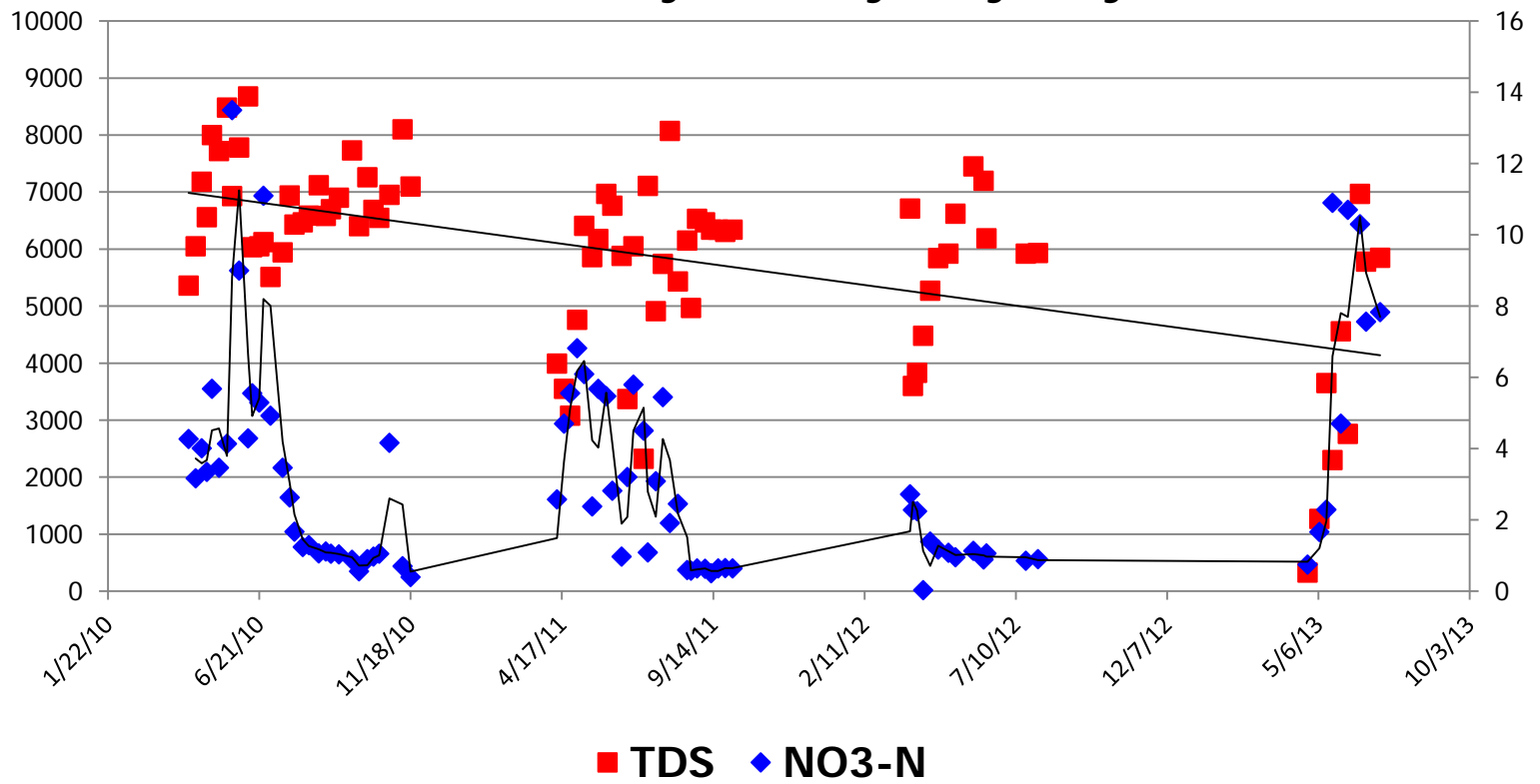
2009-2013 Trail County TDS and Nitrate-Nitrogen

Trail County - Fargo Silty Clay



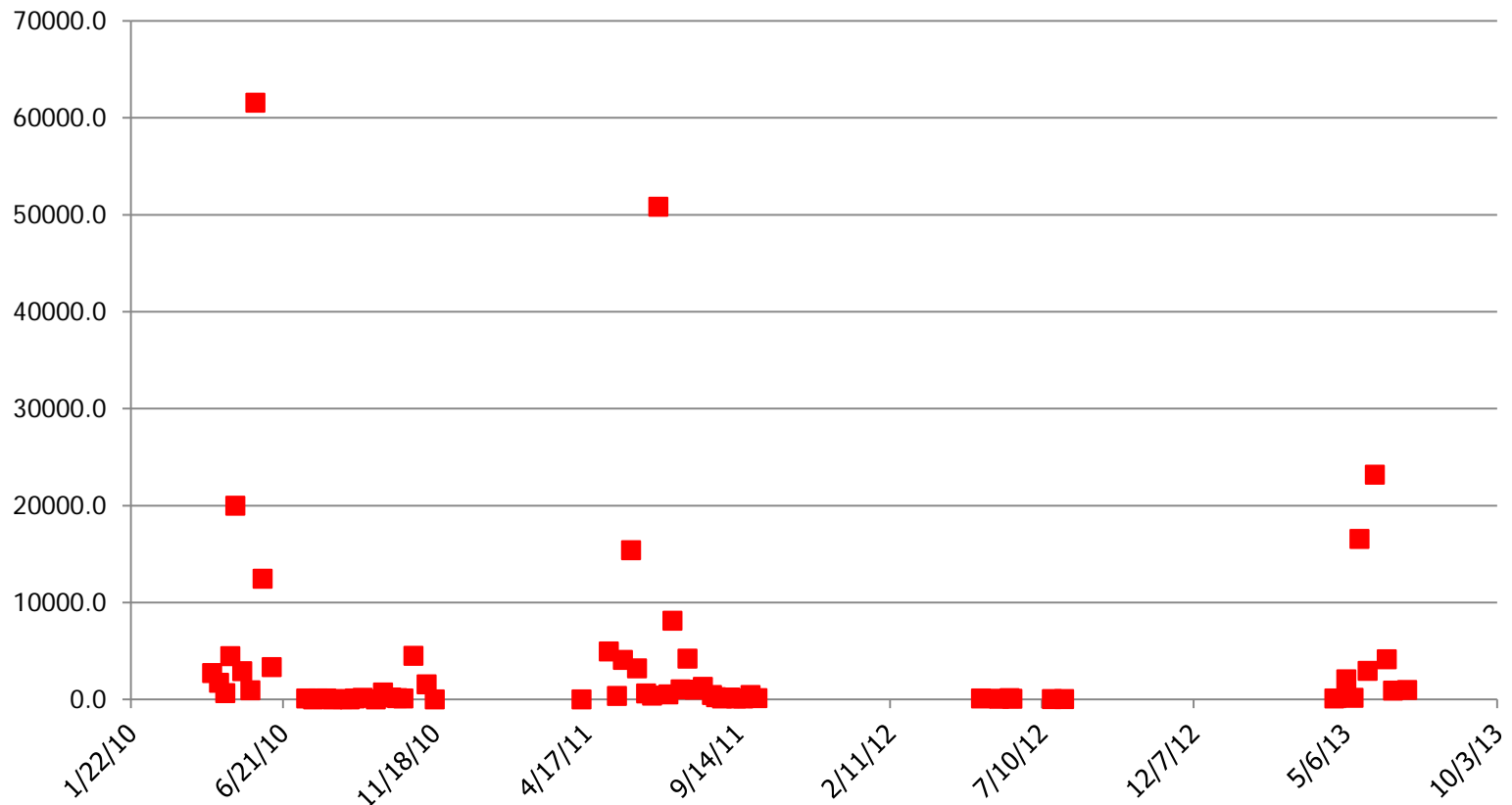
2009-2013 Walsh County TDS and Nitrate-Nitrogen

Walsh County - Overly Silty Clay Loam

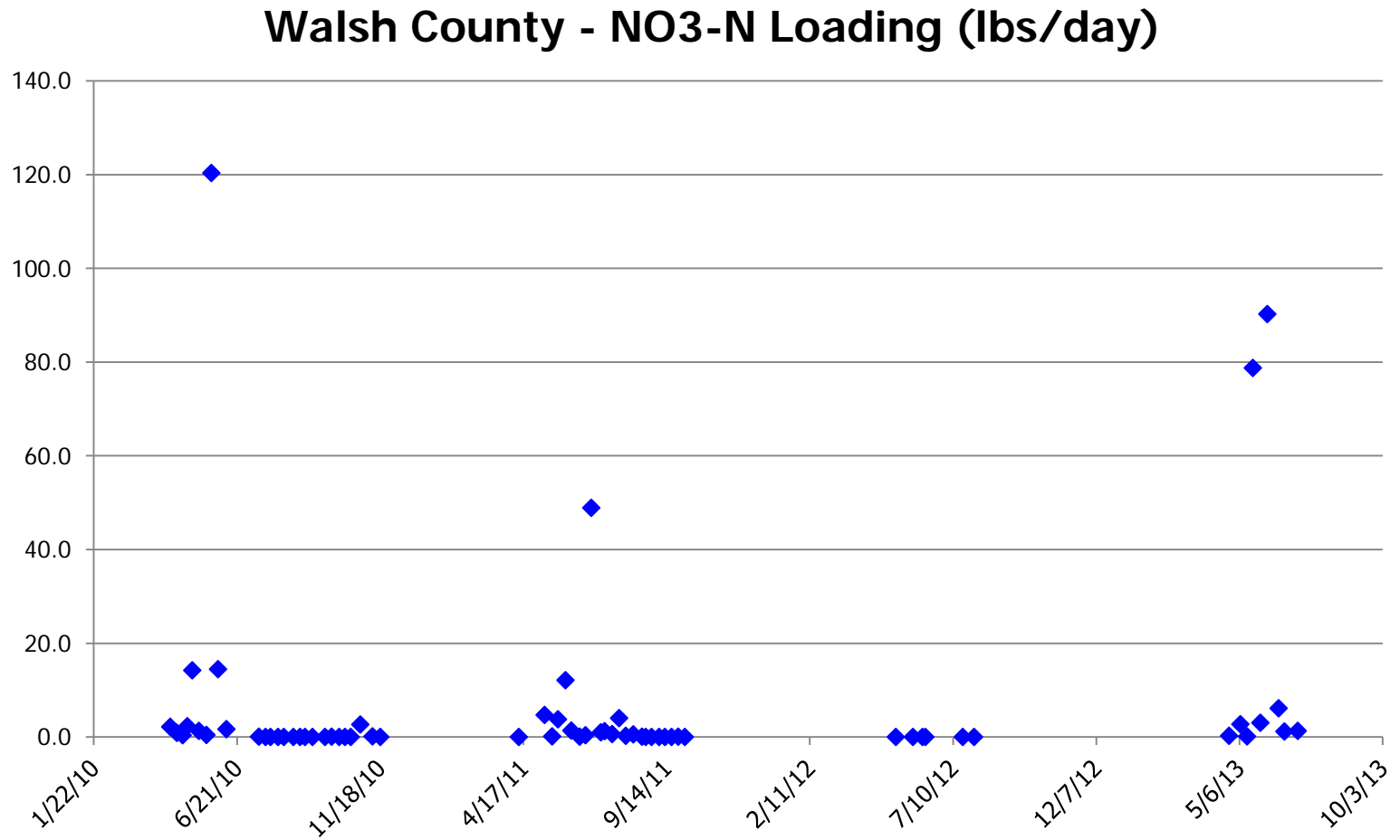


TDS Load at Tile Discharge

Walsh County - TDS Loading (lbs./day)



NO₃-N Load at Tile Discharge





What Did We Learn?

- Tile flows in response to rain events. From 11% to 30% of rain flows through the tile.
- TDS of tile water generally decreased at 6 sites over the 4 year sampling period.
- Sulfate is a dominant mineral in tile water.
- Maximum $\text{NO}_3\text{-N}$ loading and concentrations occurred in April to June time period.
- For 2011 to 2013, the average load for the 8 sites was about 17 pounds per acre per year.



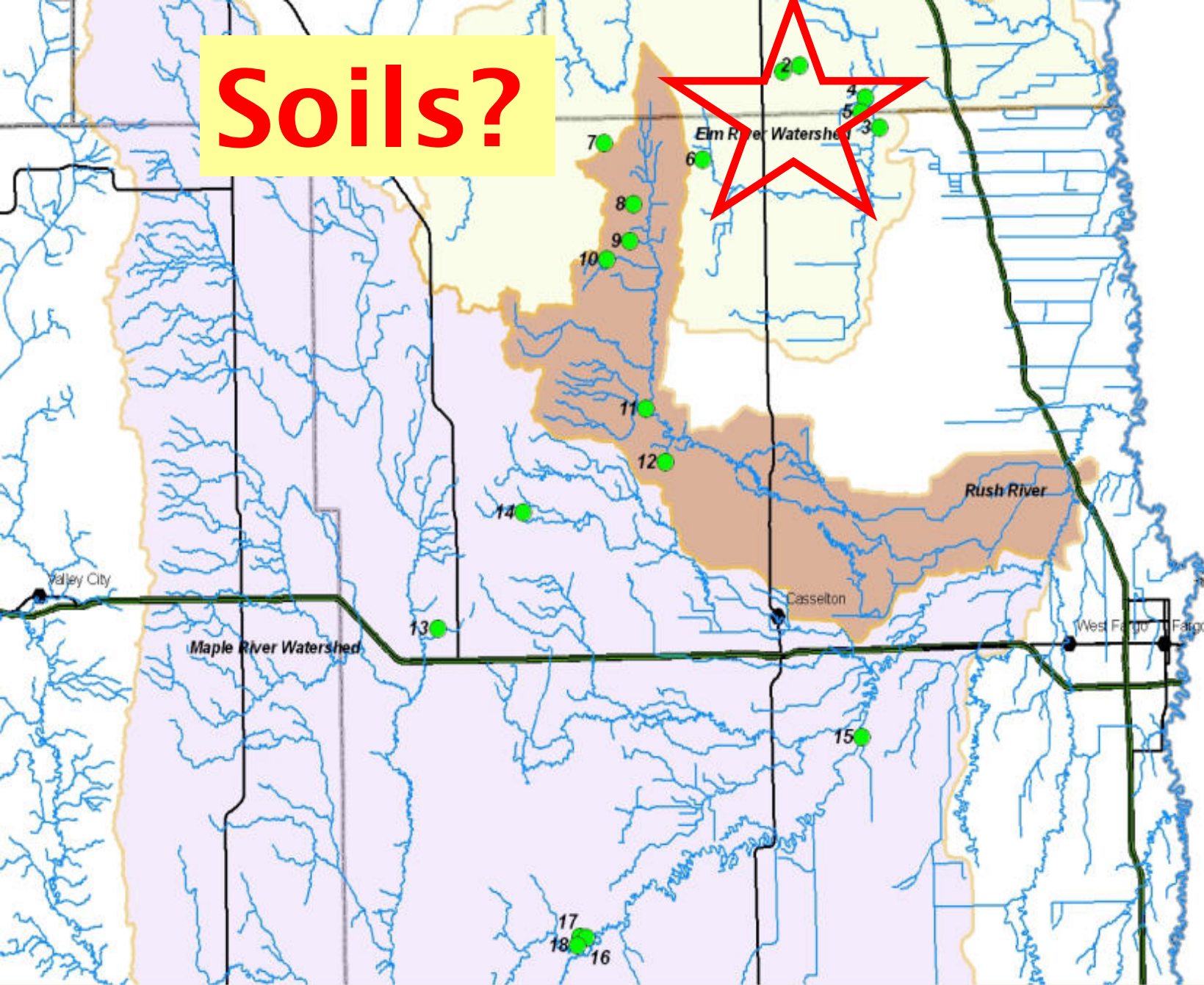
What Did We Learn?

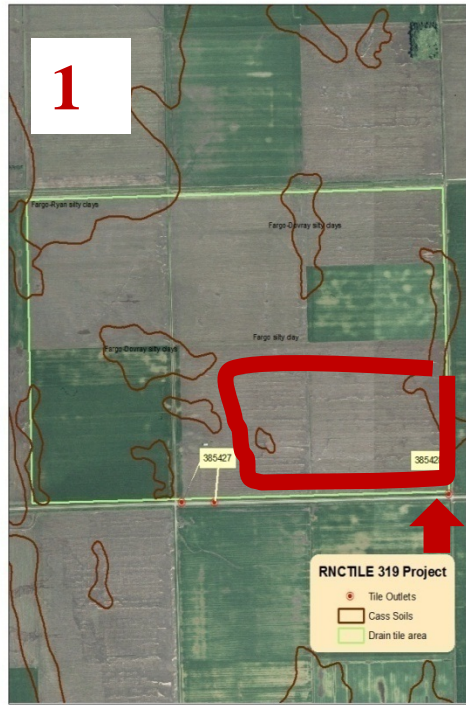
- WQ discharge: each site is statistically unique due to soil formation, geologic deposition, topography and crop mix.
- TDS of tile water has a high correlation with the sodium, sulfate, magnesium, hardness and bicarbonate components.
- Trace metals and other minor minerals often occur in concentrations below the detection limit. Barium was found in all samples – just like Phase I results.

This project was funded through the EPA 319 Program, Grant No. C9-00863309
Copies of the Phase I and Phase II Reports Available at:
<https://www.ag.ndsu.edu/tiledrainage/>

Any Questions?

Soils?





Soil Texture:
**Fargo Silty
 Clay**

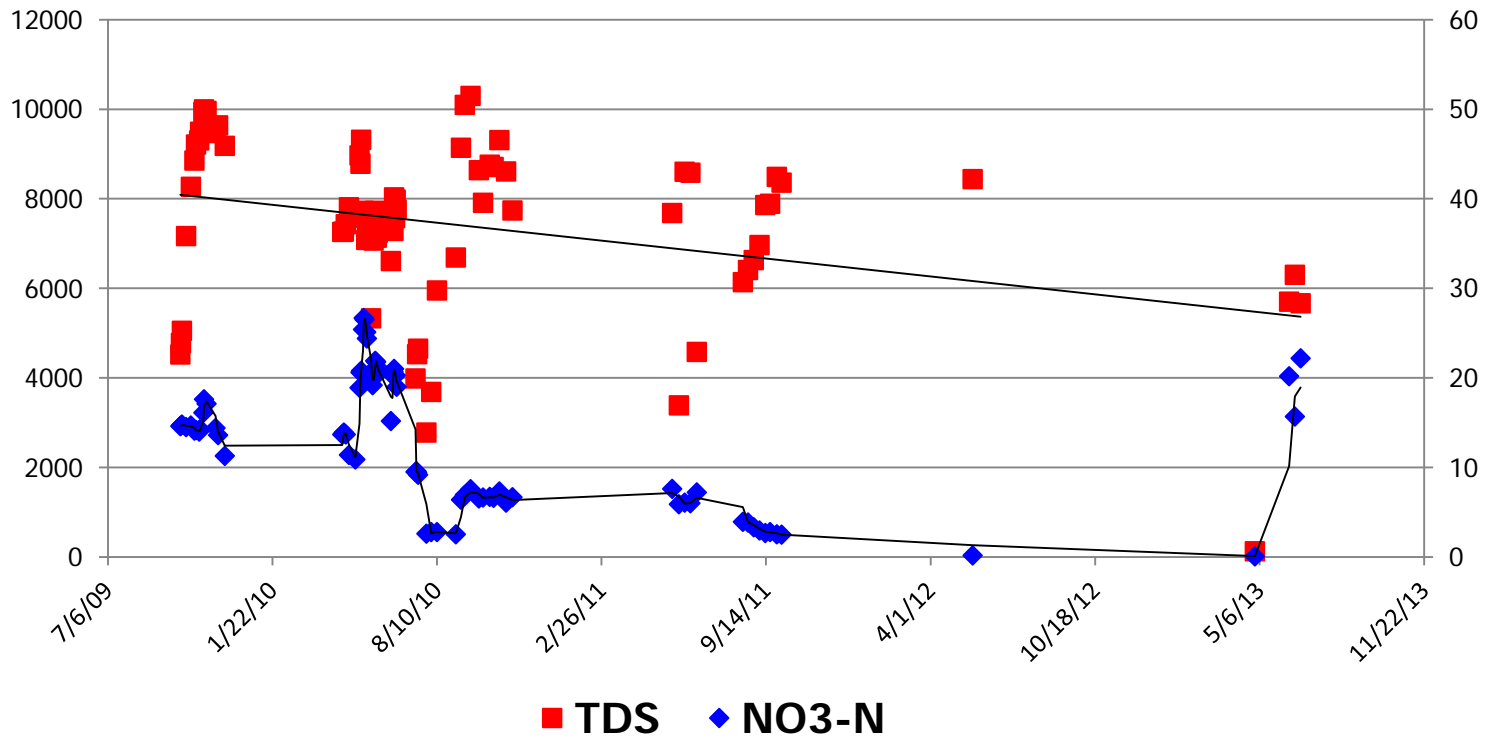


Any Questions?

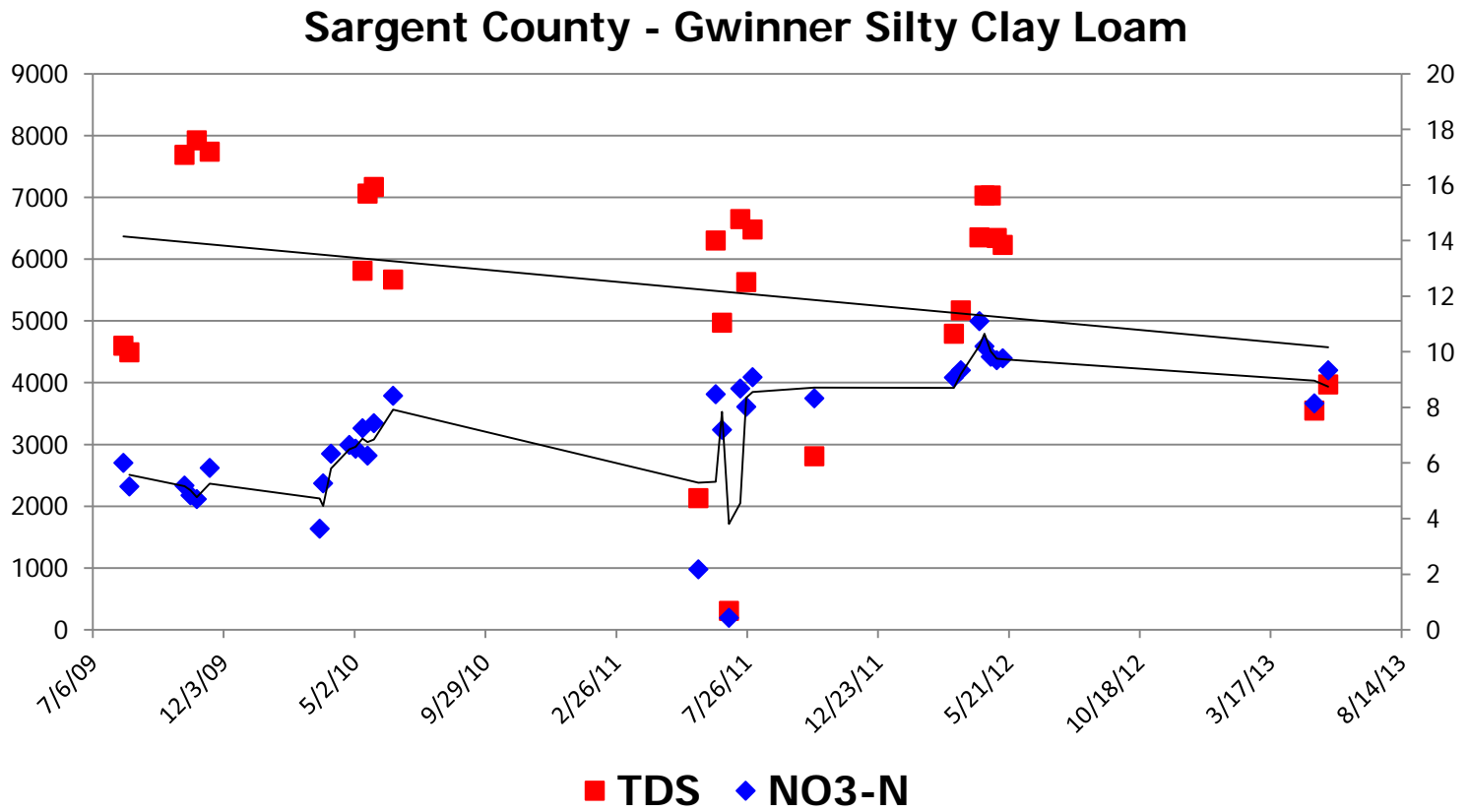


2009-2013 Cass County TDS and Nitrate-Nitrogen

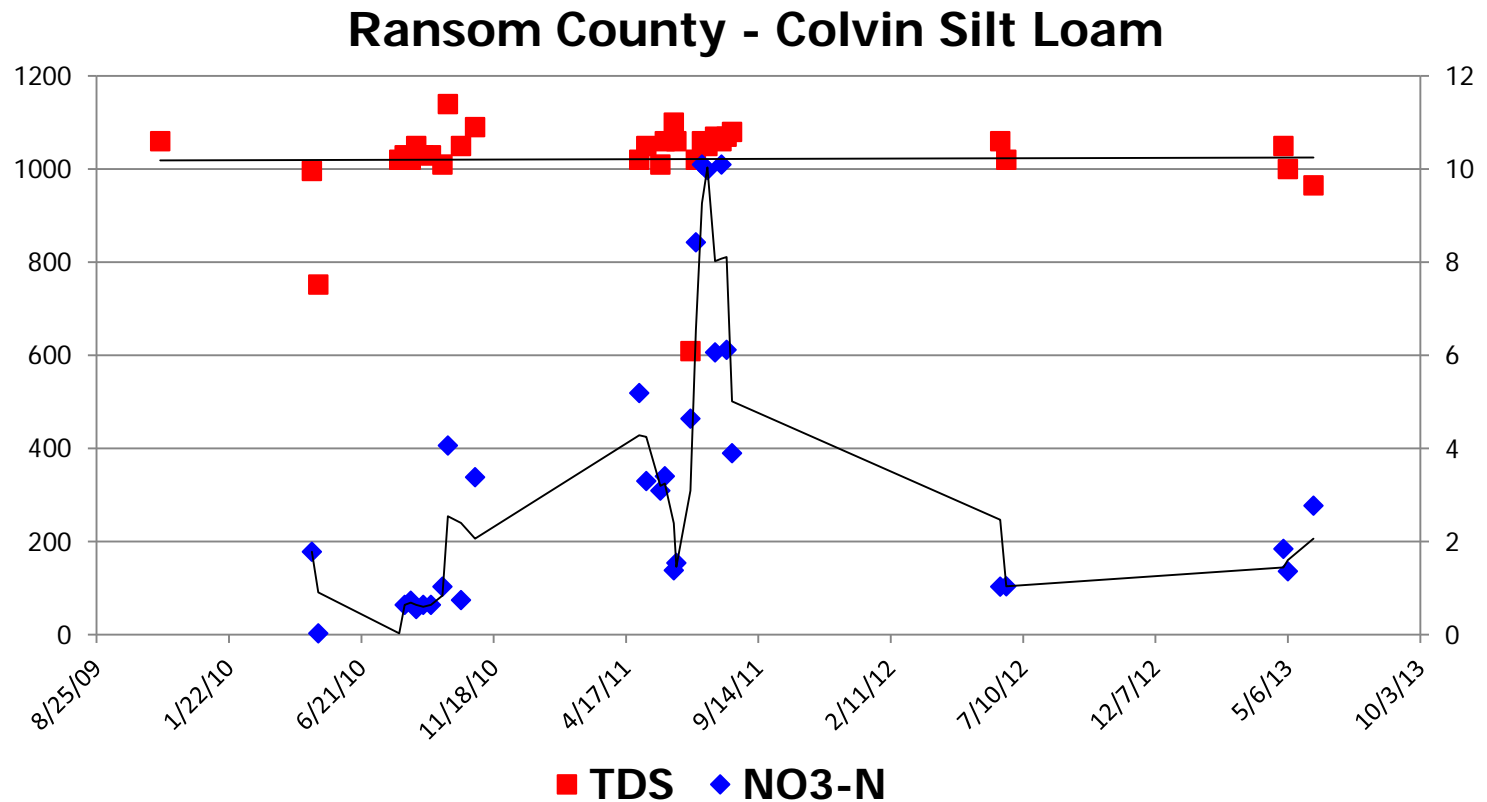
Cass County - Fargo Silty Clay



2009-2013 Sargent County TDS and Nitrate-Nitrogen



2009-2013 Ransom County TDS and Nitrate-Nitrogen



2009-2013 Steele County TDS and Nitrate-Nitrogen

