PINEVIEW RESERVOIR & ITS LOW ELEVATION WATERSHED

Water Quality Planning & Management Considerations

UtahStateUniversity

Utah Water Research Laboratory

Background

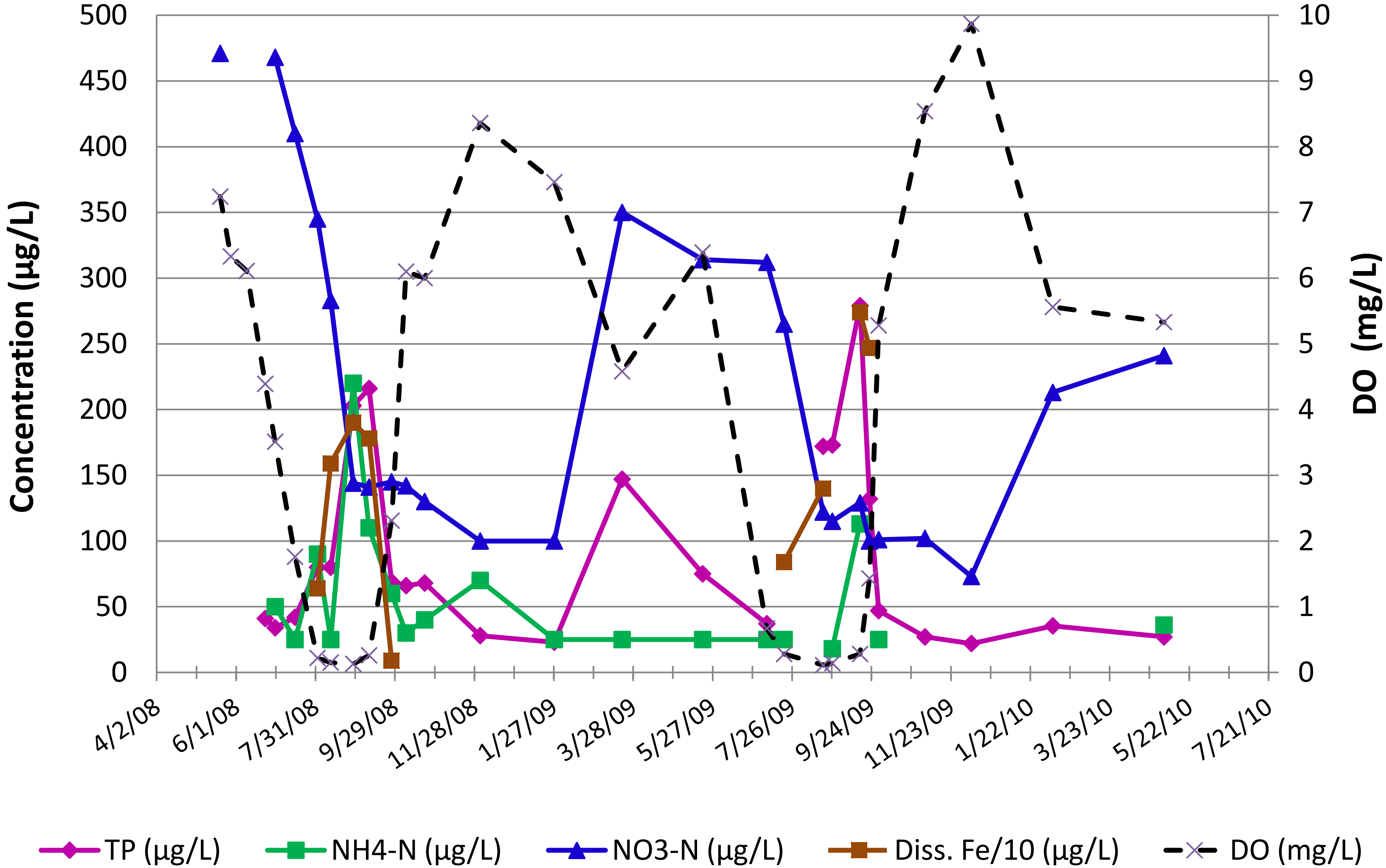
- 6 years of water quality research in and around Pineview Reservoir
- Response to concerns over inaccuracies in the Pineview Total Maximum Daily Load (TMDL) study
  - Ineffective actions with high monetary and societal costs
  - A need for more data

Things we studied

1. In-reservoir processes
2. Surface water nutrient export to the South Fork of the Ogden River
3. Nitrogen & phosphorus loads from groundwater
4. Processes & mechanisms affecting phosphorus mobility in groundwater

In-Reservoir Processes Effecting N & P Cycling

In-Reservoir, Near-Bottom Processes Effecting N & P Cycling



In-Reservoir Conclusions

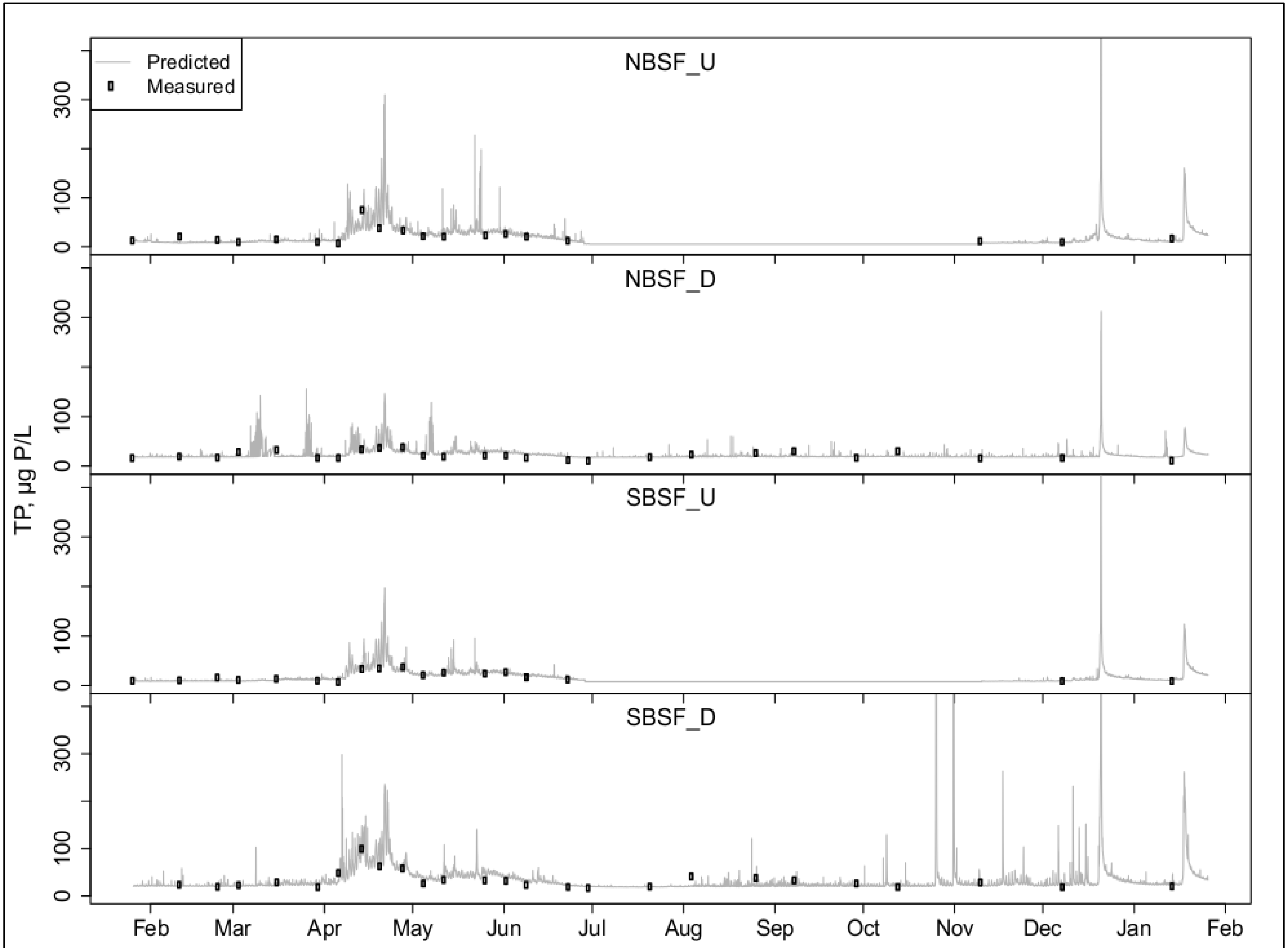
- Approximately 98% of the total phosphorus and 80% of the nitrate-N entering the reservoir comes with surface runoff
- Internal cycling of N & P from the sediments leads to summer/fall cyanobacteria & algae (phytoplankton) blooms
- During most of the winter, spring & summer phytoplankton concentrations are in the low to medium range
- P export in anaerobic, bottom water during the irrigation season is slowing the eutrophication of Pineview Reservoir

In-Reservoir Recommendations

- Pineview Reservoir water quality is better than expected—worth protecting
- Reduce nitrogen and phosphorus loads to Pineview Reservoir wherever practicable
- Controlling internal nutrient cycling is probably not economically feasible
- Export nutrients with the reservoir effluent when possible

Nutrient Export to Streams

Nutrient Export to Streams



Export to Streams: Conclusions

- Soil & stream bank erosion are the principal sources of stream suspended solids & associated phosphorus
- Loads of nitrogen & phosphorus were highest during spring runoff
- High-frequency turbidity measurements revealed intense, short duration, snowmelt-associated phosphorus loads

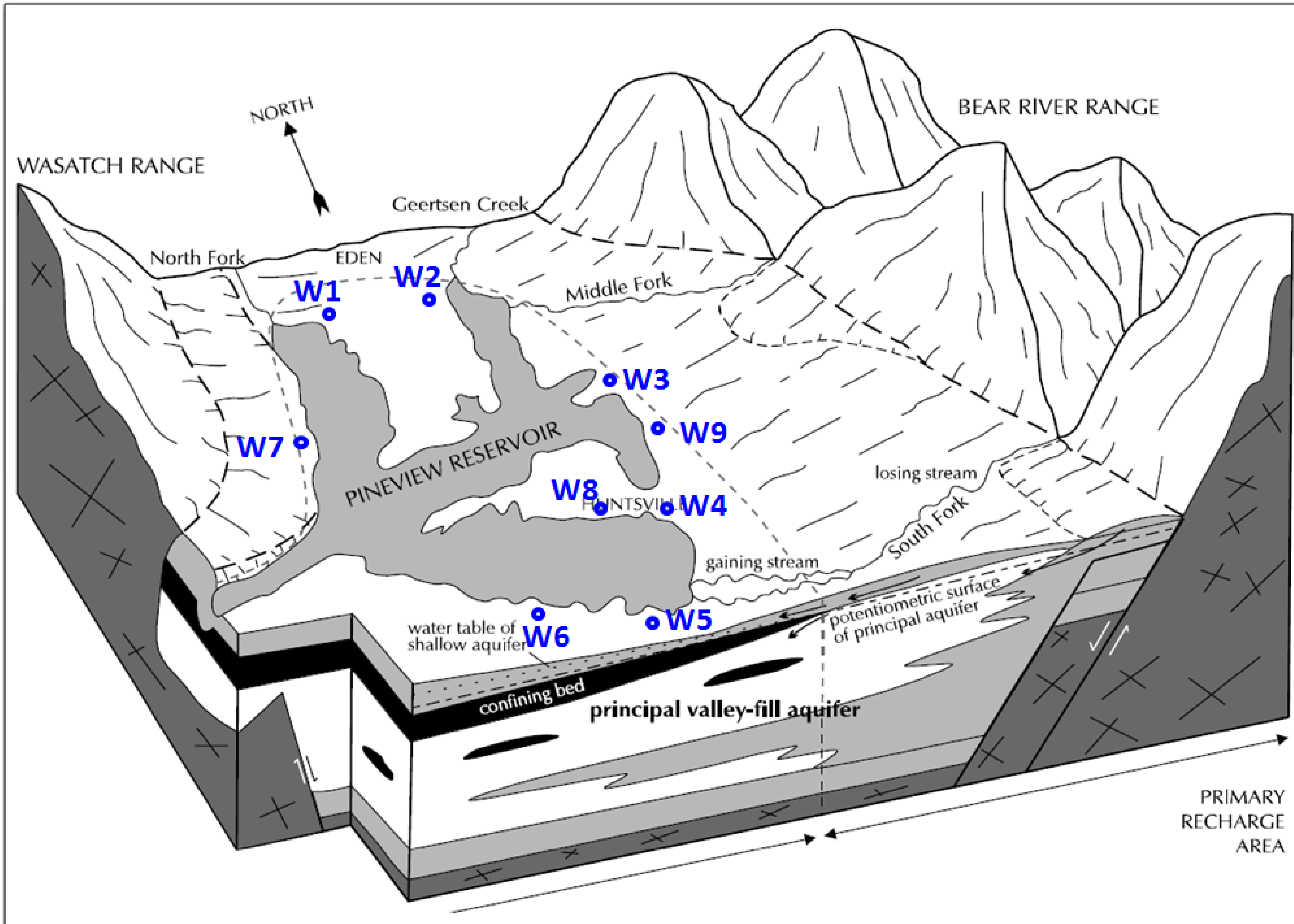
Export to Streams: Recommendations

- Implement NRCS soil erosion control practices in agriculture
- Implement construction site erosion control practices
- Minimize manure application on snow & frozen ground
- Implement stream bank erosion control practices

Nutrient Contribution of the Shallow Unconfined Aquifer to Pineview Reservoir

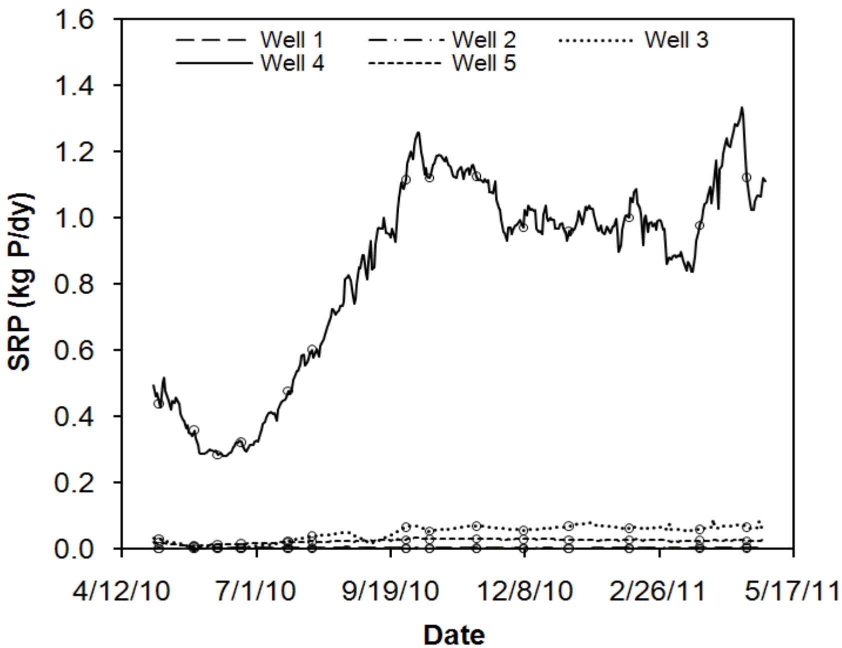
Thomas Nyanda Reuben

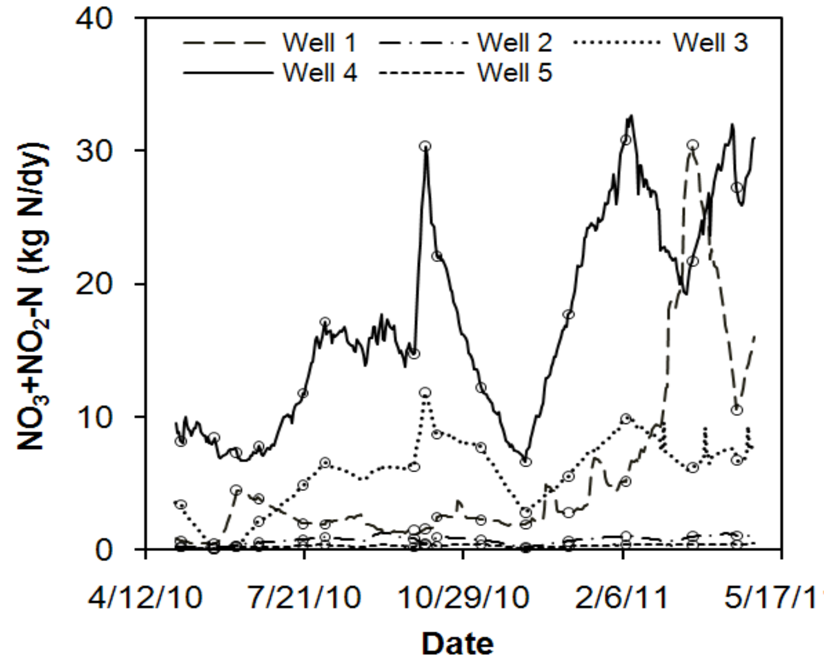
Groundwater in Ogden Valley



Groundwater contributes ~2% of the water to the reservoir yearly but ~20% of the nitrate-N

Ground Water Soluble Reactive Phosphorus (SRP) and Nitrate-N





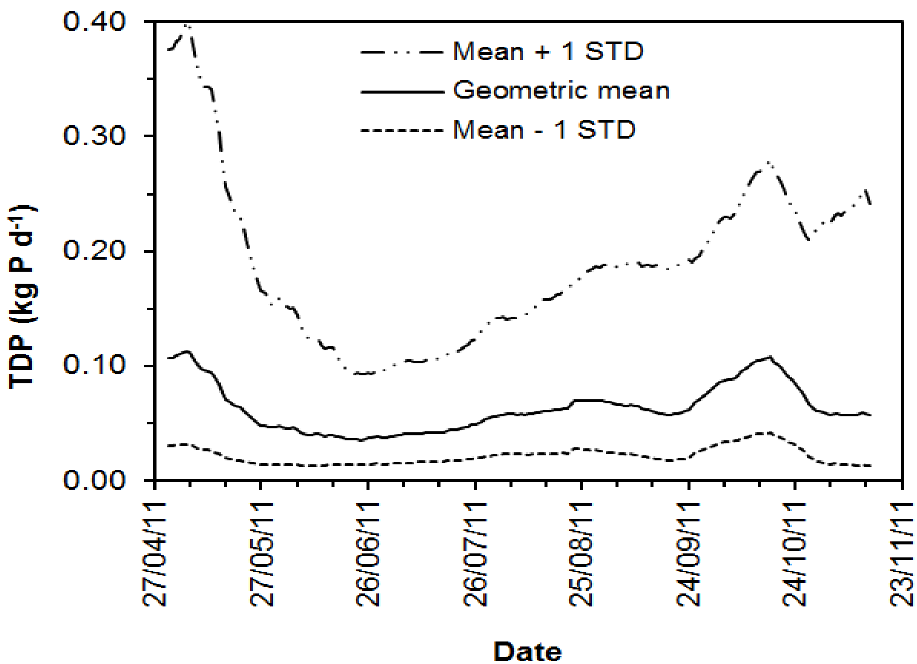
TDP and Nitrate-N Concentrations (05/01 – 11/14, 2011)

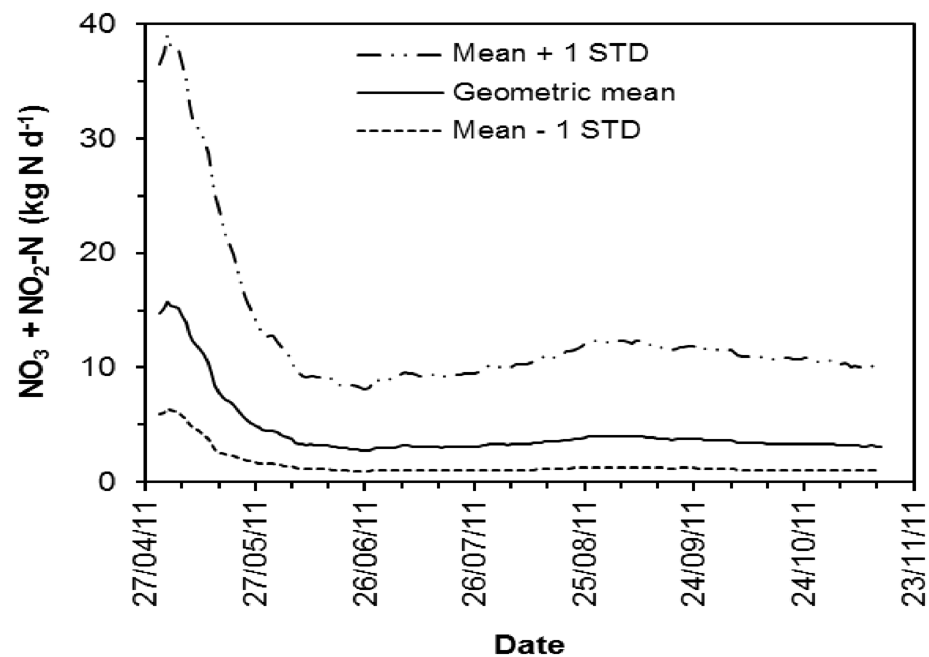
	Total Dissolved P (µg/L)			Nitrate-N (mg N/L)		
Well	Min.	Med.	Max.	Min.	Med.	Max.
1	9	12	17	3.6	7.0	28
4	226	249	443	5.3	6.6	7.2
5	247	304	318	1.2	4.6	8.8
8	64	107	947	0.1	4.2	4.9
9	424	673	1265	2.0	2.9	13

The number of sampling events was six.

NB: TMDL study: TDP = 20 µg P/L; Dissolved N = 0.75 mg N/L

Spatial variations of ground water loadings of TDP & NO_3-N

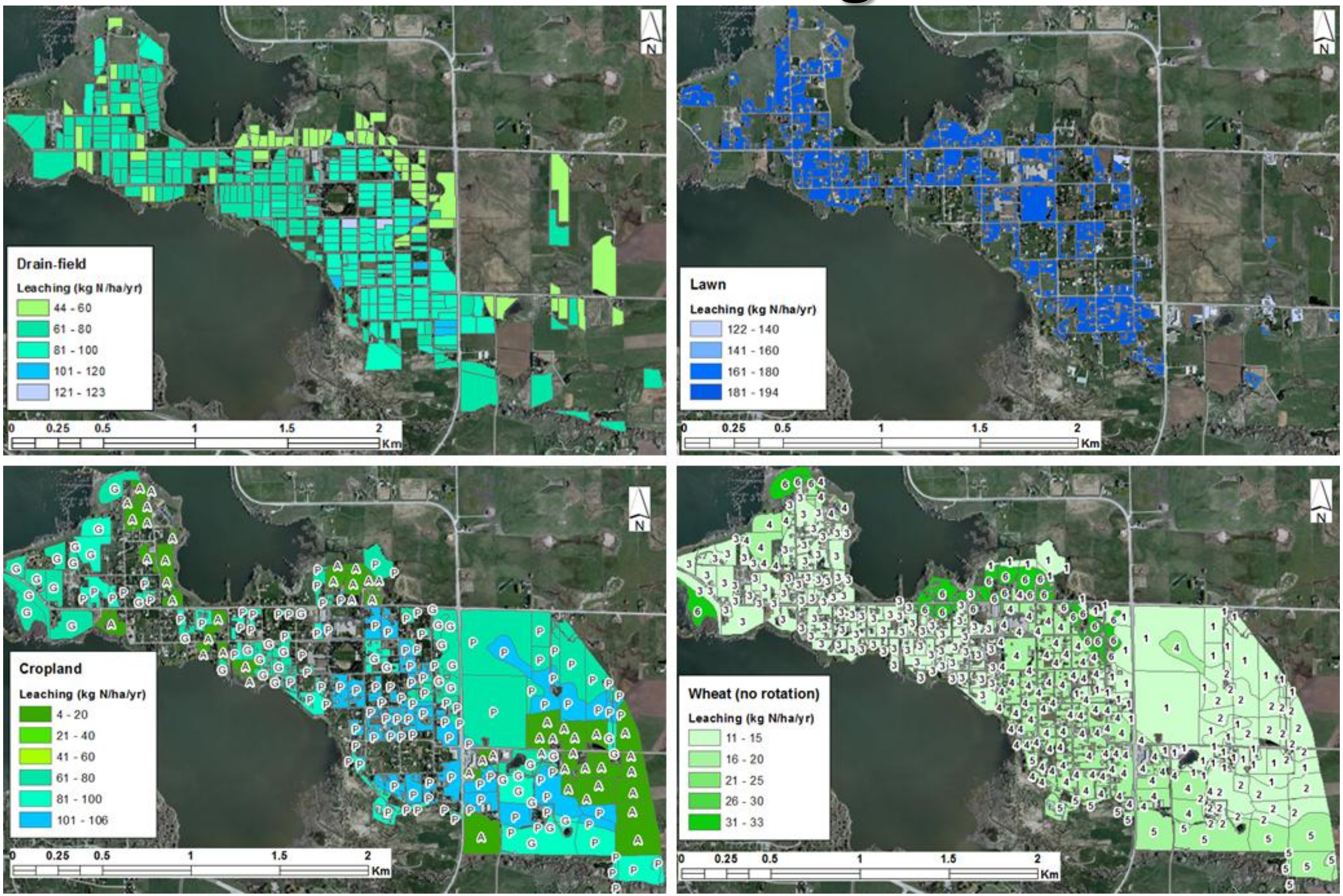




NLEAP-GIS Results and Discussion

Management scenario	Nitrate-N leaching (kg N ha^{-1} yr^{-1})				
	Minimum	Maximum	Median	Mean	SD
Grass hay	70	96	80	82	9
Grass pasture	76	106	95	93	12
Alfalfa/wheat	4	10	4	5	2
Lawn turf	122	194	191	184	21
Drain-fields	44	123	71	76	16
Wheat monoculture	11	33	12	15	6

Simulated Leaching Losses



Nitrate pathways and residual

Nitrate-N pool/loss	Cropland (kg N yr^{-1}) *(209 ha)*	Lawns (kg N yr^{-1}) *(53 ha)*	Drain-fields (kg N yr^{-1}) *(3 ha)*	Baseline scenario (kg N yr^{-1}) *(262 ha)*
Leaching	14,150	10,030	200	3,800
Denitrification	2,050	1,720	30	1,850
Emissions	460	680	5	760
Runoff	40	10	0	40
Volatilization	980	3,960	5	3,270
Residual	9,170	13,690	180	3,570

- 50% reduction in irrigation: -18 ± 6 leaching; 31 ± 44 residual
- 50% reduction in fertilizer: -36 ± 8 leaching; -40 ± 11 residual

Recommendations

- Large spatial variations in ground water flow and nutrient loading exist
- Site and land use-specific (e.g. lawns & croplands) management practices are needed:
  - Increase irrigation application efficiency
  - Base fertilizer application on crop need & soil residual N
- Develop and implement a ground water monitoring plan
- Include ground water pollutant loads in all pollution control programs

Septic System Recommendations

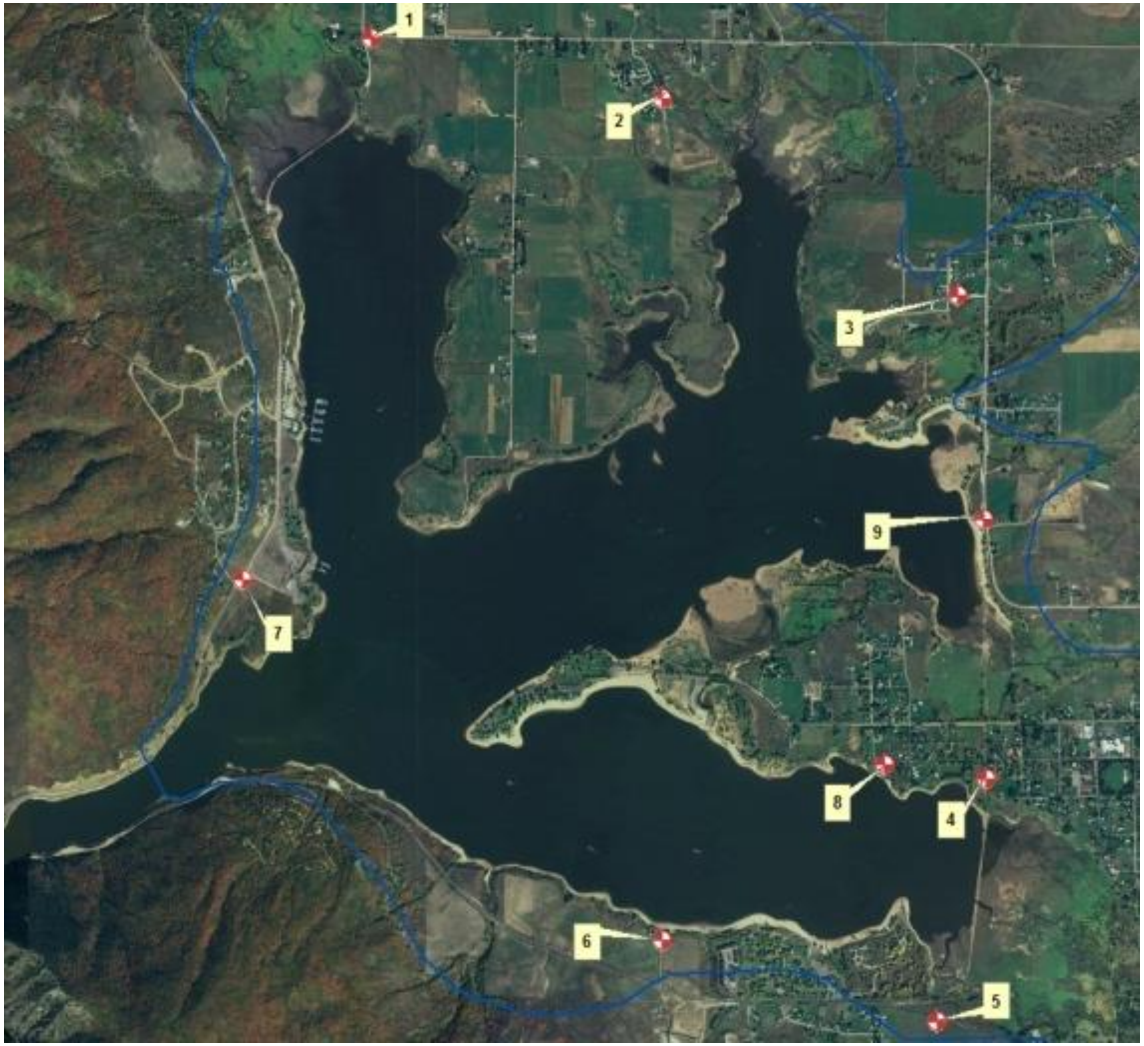
- Control onsite wastewater discharge to groundwater—quantity & quality
  - Implement wastewater management including regular on-site wastewater treatment system checks
  - Control system density
  - Continue considering wastewater collection & treatment with nutrient control

Phosphorus mobility in the shallow unconfined aquifer at pineview reservoir

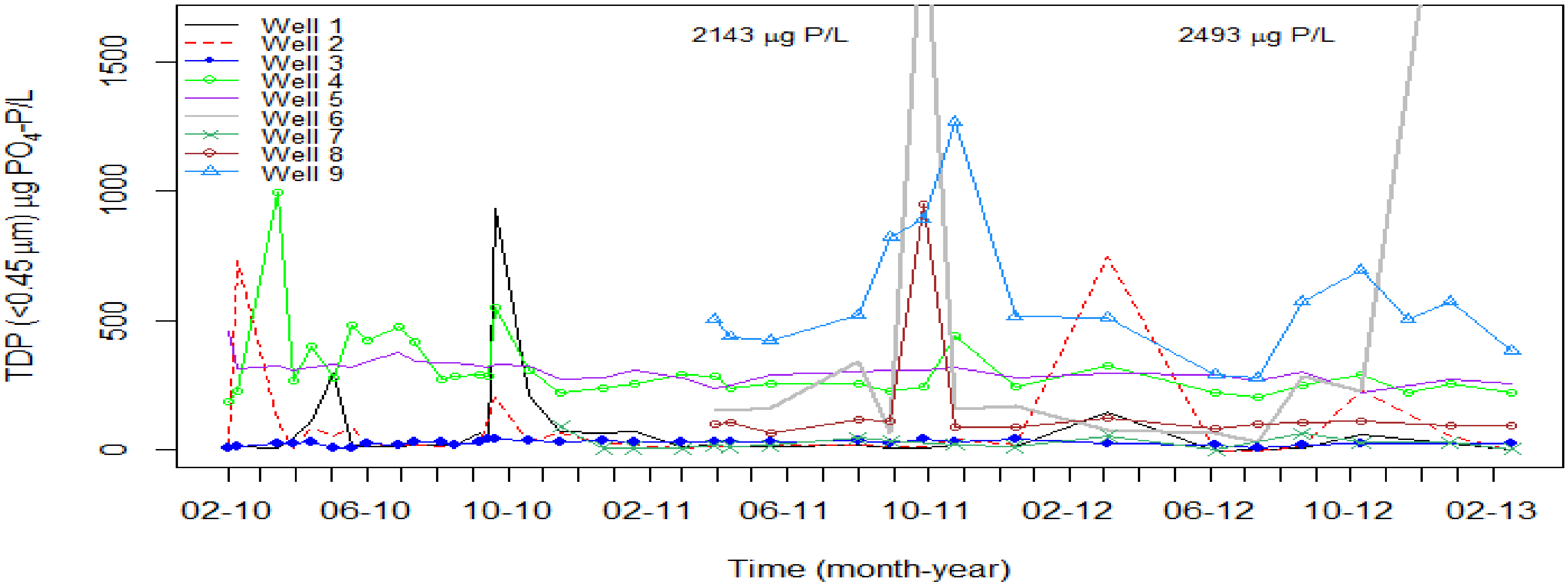
Christine Rumsey

Groundwater monitoring

- Relatively high concentrations of P in groundwater
- Evidence of septic system influence
  - NO_3, DOC, DO, NH_4, Fe, Cl/Br, B

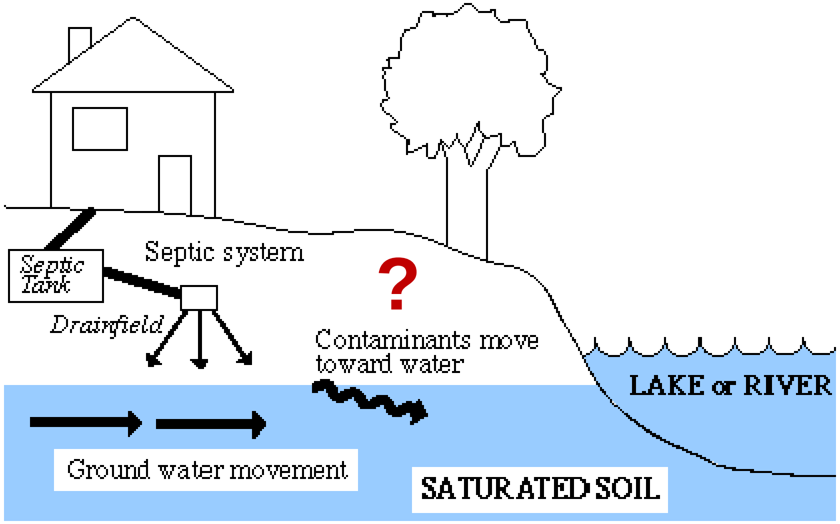


Ground water phosphorus (summary)



Where is the phosphorus coming from?

Determine septic system influence

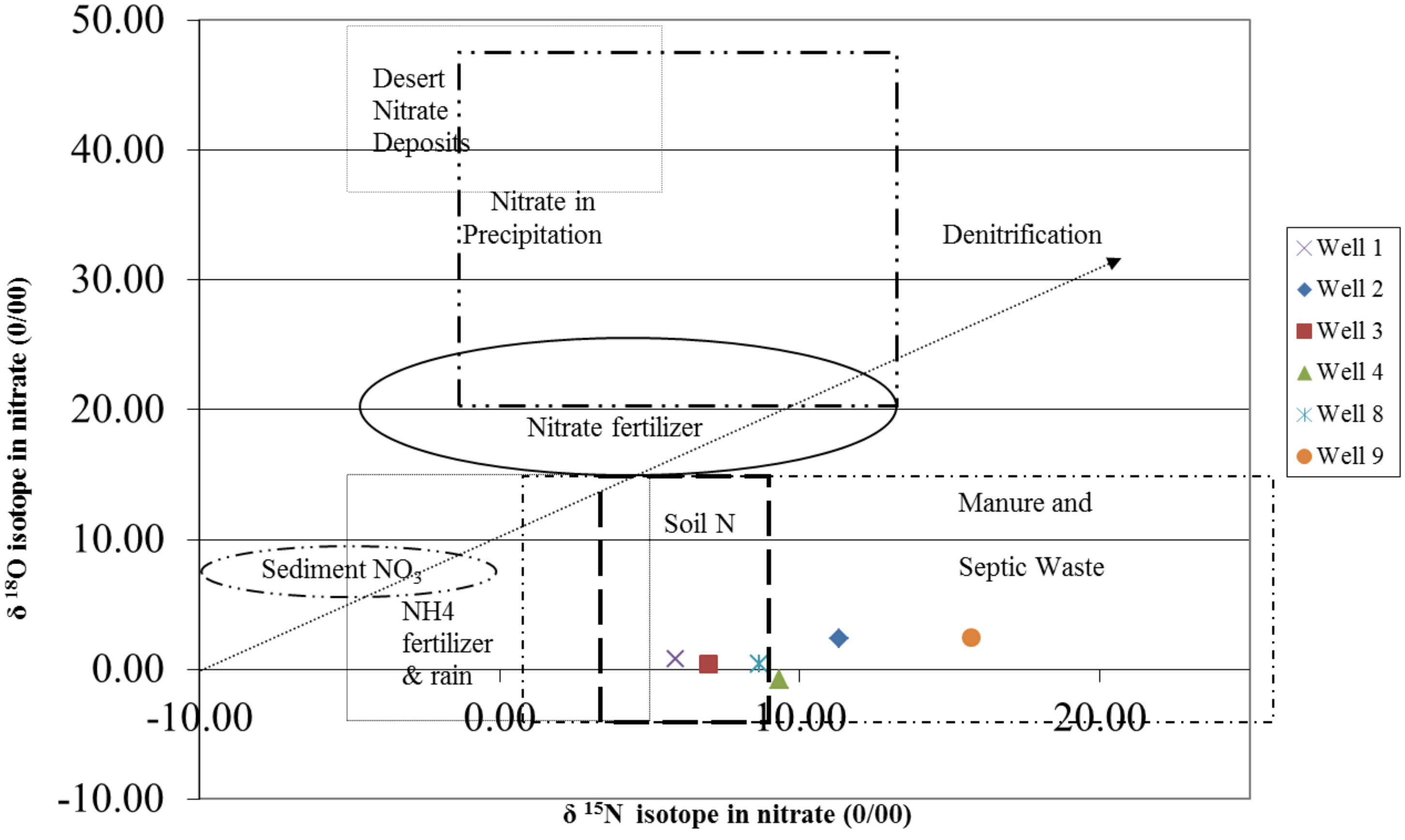


Determine septic system influence

- Groundwater quality monitoring for P source tracking
  - N and O isotope analysis ($\delta^{15}N$ and $\delta^{18}O$ of NO_3^-)
    - N sources often have distinct isotopic characteristics
  - Boron concentrations
    - Found in detergents and household cleaners
  - Cl/Br ratios
    - Used in a variety of anthropogenic products

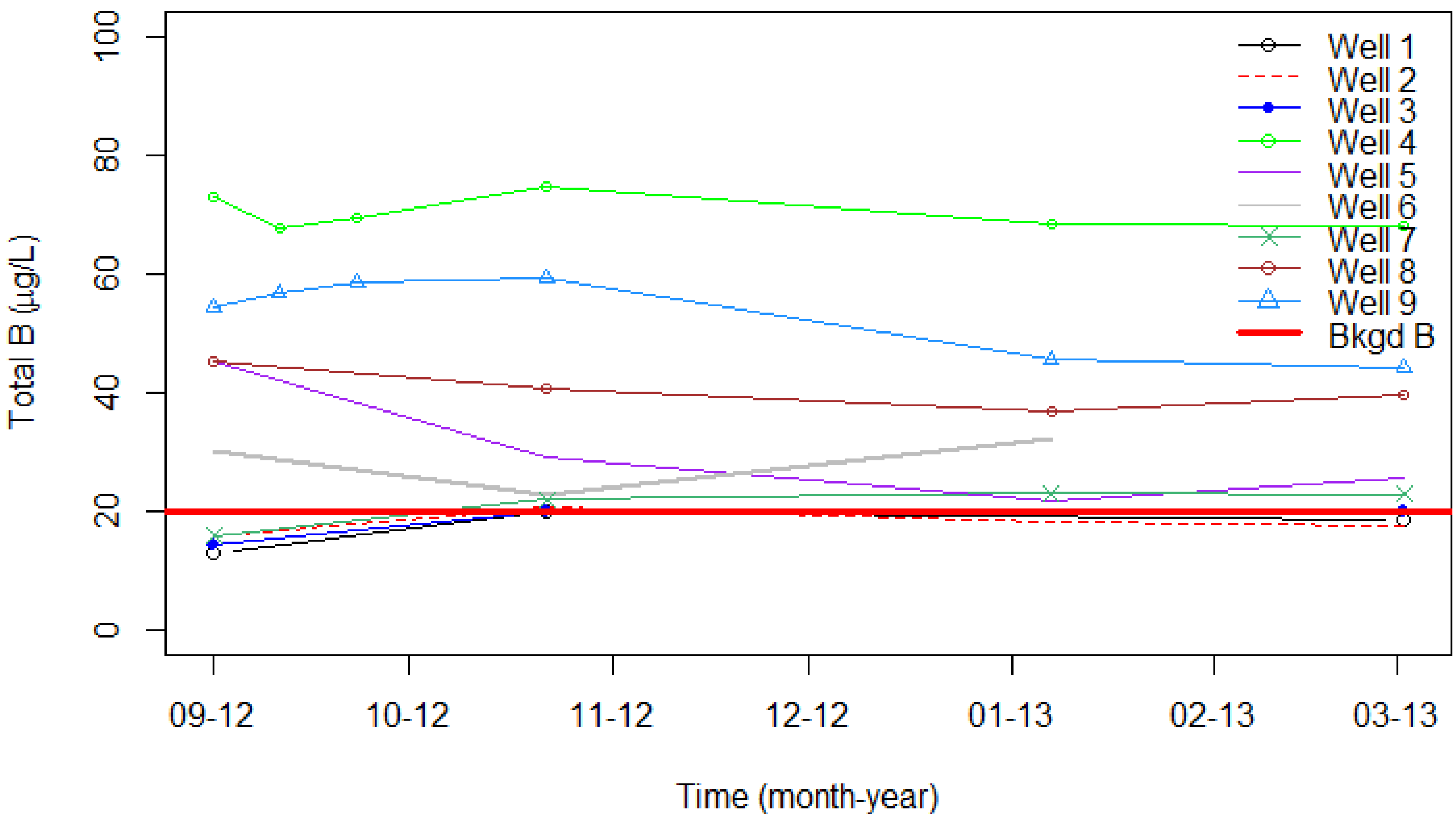
Determine septic system influence

- N and O isotopes of NO_3^-



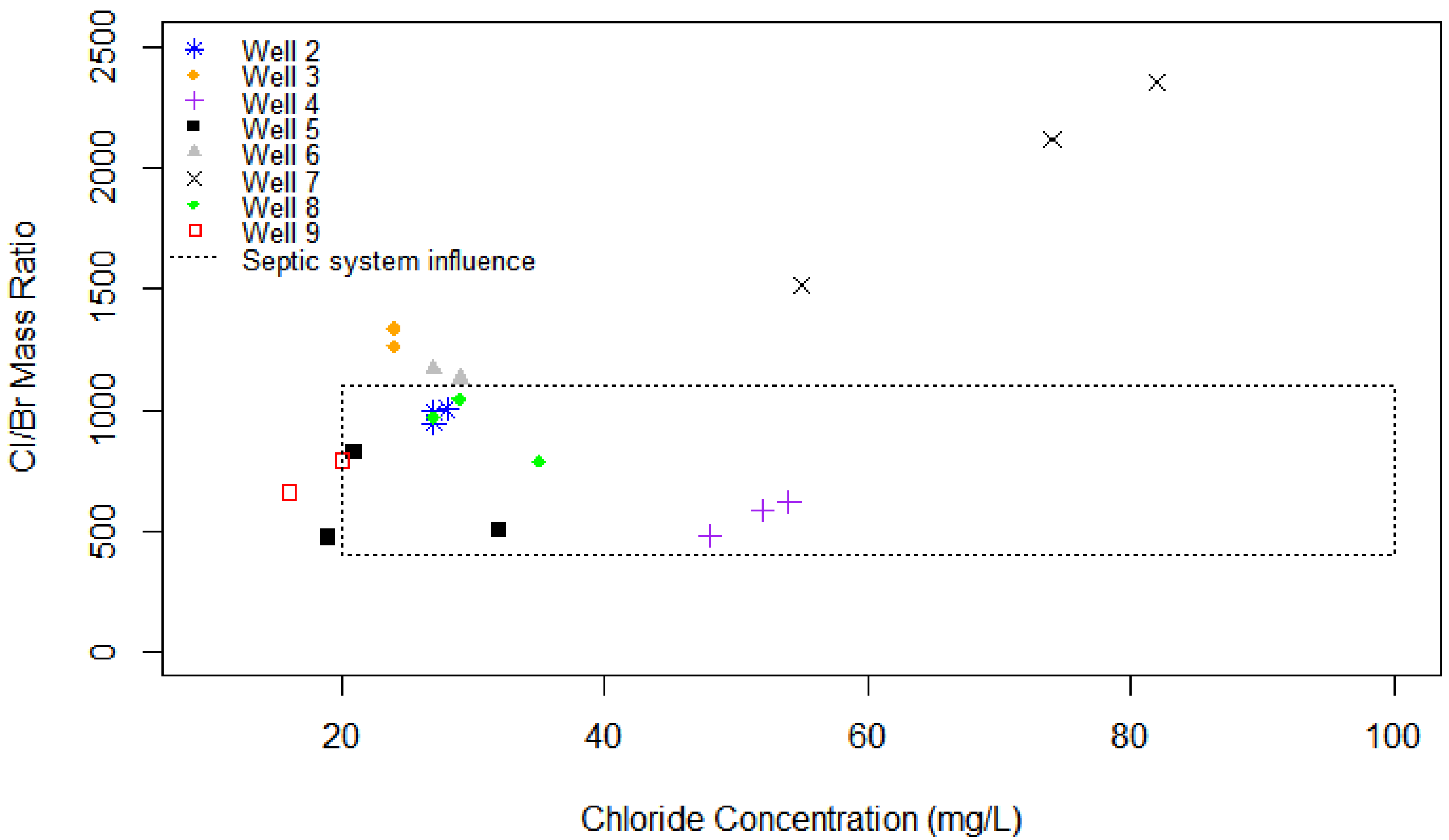
Determine septic system influence

- Boron concentrations



Determine septic system influence

- Cl/Br ratios

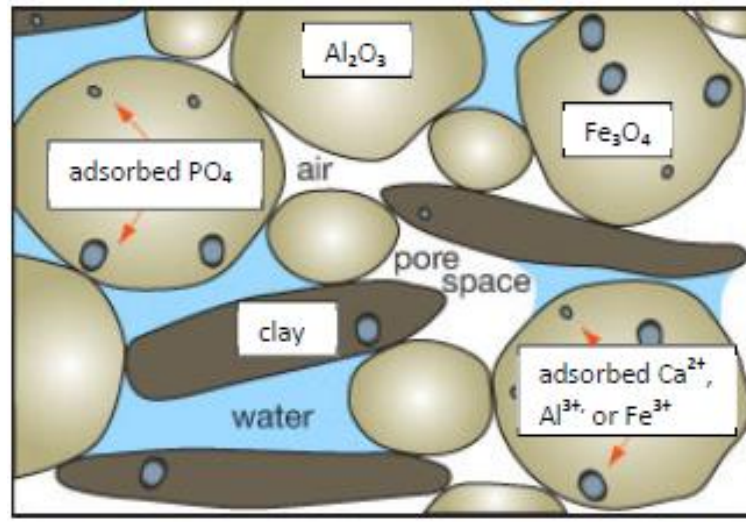


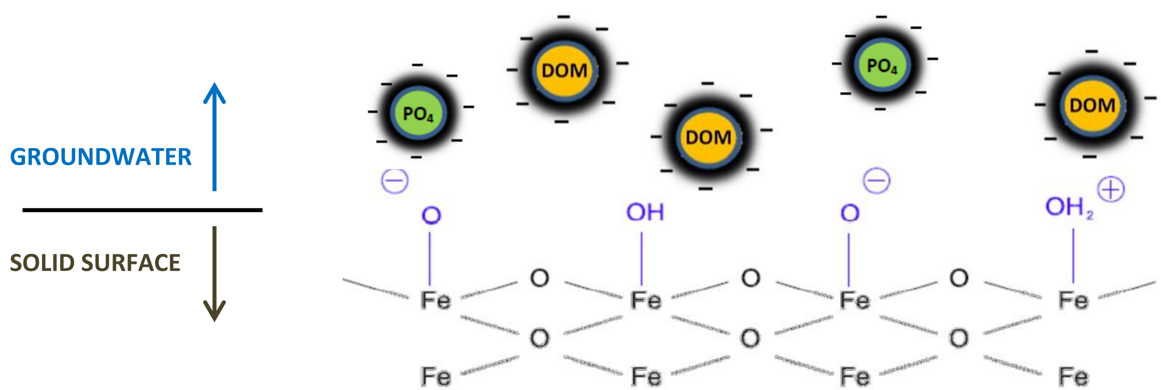
Determine septic system influence

- N and O isotopes, B, and Cl/Br agree that Wells 4 and 9 were influenced by septic system effluent
- Highest concentrations of TDP, SRP, and DOC consistently observed at Wells 4 and 9
- Wells 2, 5, and 8 may also be influenced by septic system effluent

Why doesn't P "stick" to aquifer solids?

- Conducted a series of experiments to investigate why P moves in groundwater





Why doesn't P "stick" to aquifer solids?

- Substantial sorption competition between SRP and dissolved organic matter (DOM) did not occur
  - DOM (from septic systems?) does not explain P mobility in the shallow unconfined aquifer at PVR
- Saturated sorption sites and the effects of historic septic system loading are more likely the reasons soluble P is present at Well 9


Thank You