Potassium Persulfate Oxidation vs. Photo Oxidation

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Purpose

- Determine whether photo oxidation or chemical oxidation is the best method to **breakdown** dissolved ***organic*** materials into ***inorganic*** materials
  - **Nitrogen** and **Phosphorus**

- Meet EPA and DOH standards
  - Are tenants polluting?

Nutrient Breakdown

Total Nutrient
(Unfiltered)

Particulate Nutrient
(does not pass through filter)

Total Dissolved Nutrient
(0.2 micron filtered)

Total Dissolved Nutrient

(0.2 micron filtered)

Total Dissolved Nutrient

(0.2 micron filtered)

Dissolved *Inorganic* Nutrient

Dissolved *Organic* Nutrient

Organic

Organic N and P Compounds

Oxidation Methods

Photo Oxidation

Chemical Oxidation

Inorganic

NO3/NO2, NH3, PO4

Nutrient Concentrations Determined

Segmented Flow Auto-analyzer

What is Oxidation?

- Oxidation: loss of electrons
- Excess oxygen in hydrogen peroxide (H_2O_2) and potassium persulfate ($K_2S_2O_8$)
- Converts all ***organic*** N and P compound to ***inorganic*** forms

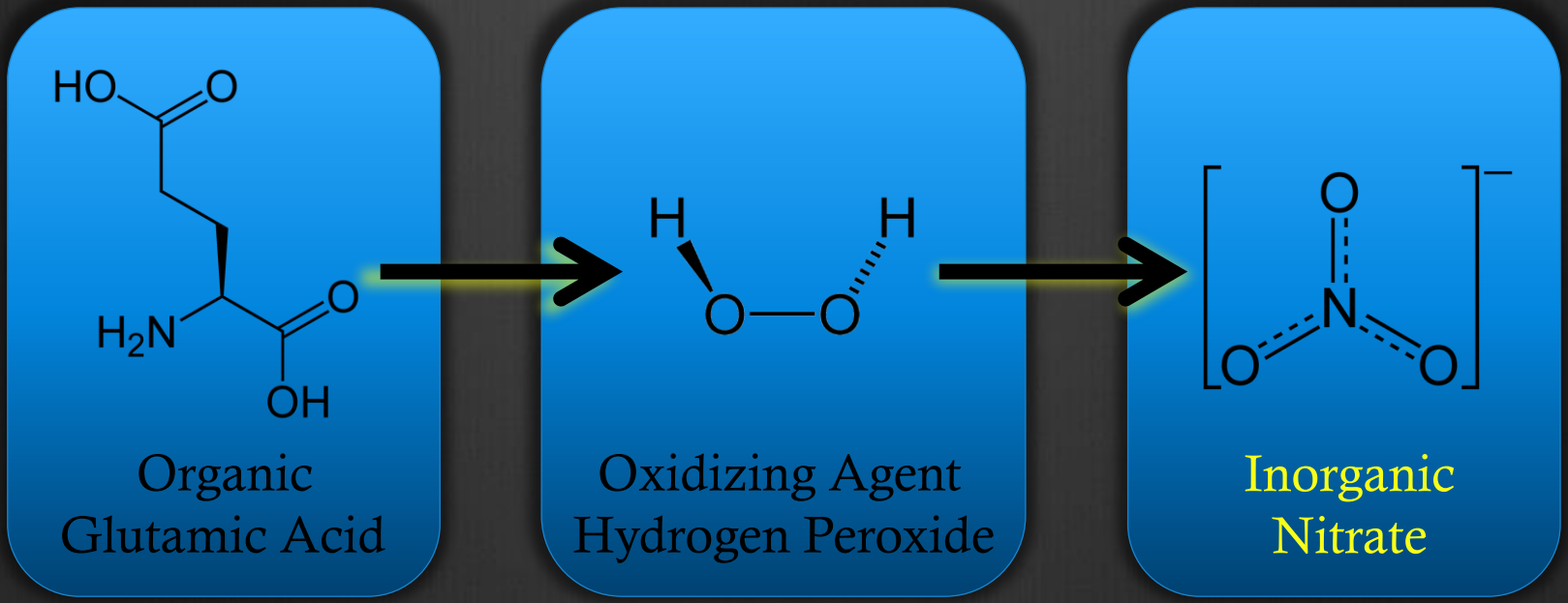
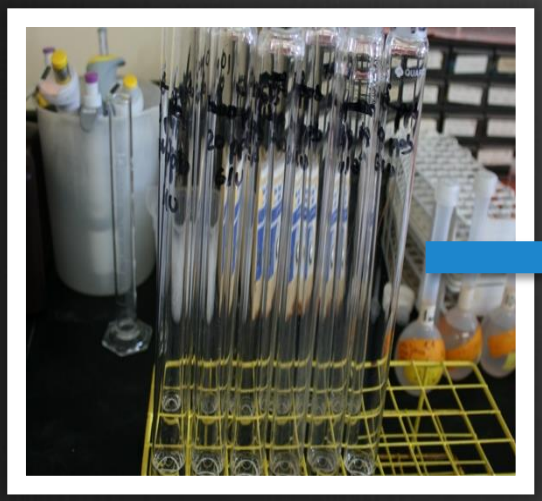


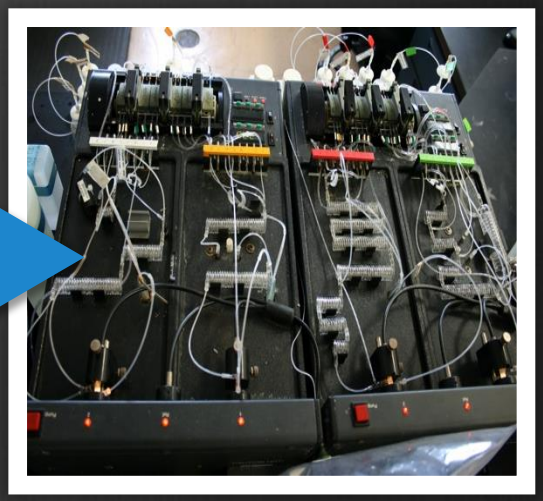
Photo Oxidation Method

Photo Oxidation Apparatus Function: Oxidize organic N and P using UV radiation



30 mL sample + 0.3 mL Hydrogen Peroxide

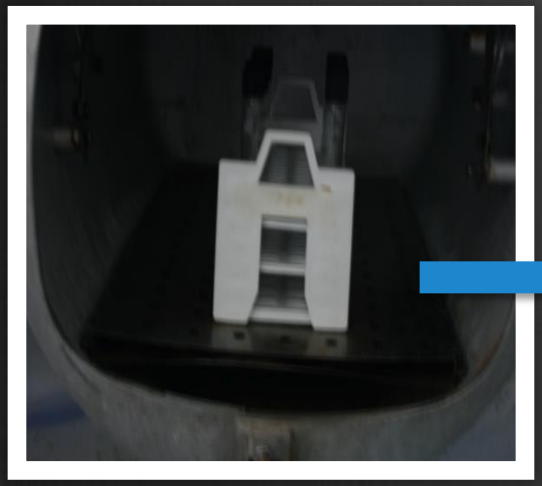
Samples oxidized for 2.5 hours



Nutrient concentrations analyzed via segmented flow auto-analyzer

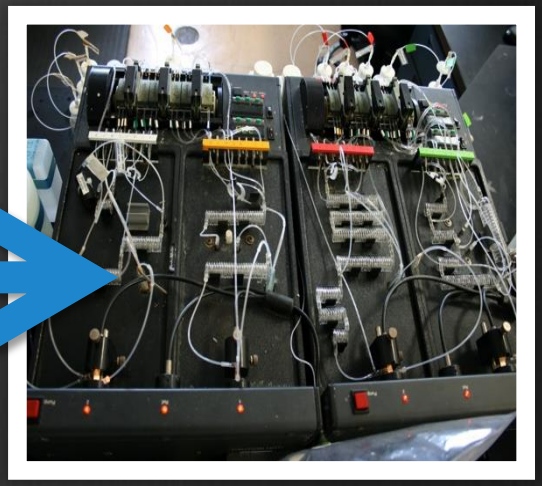
Chemical Oxidation Method

Autoclave Function: Vessel used to cause chemical reactions to occur under high temperature and pressure



10 mL of sample + 5 mL of potassium persulfate digestion reagent

Samples oxidized for 1 hour



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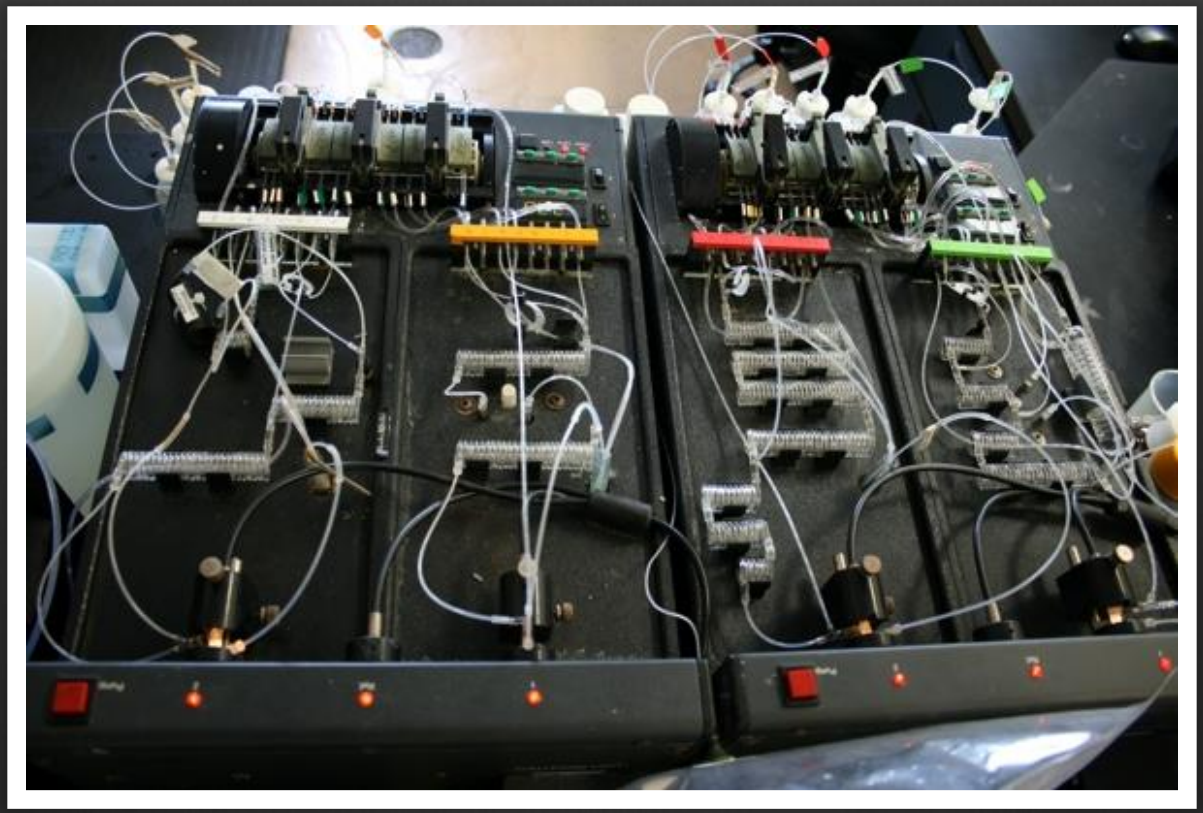
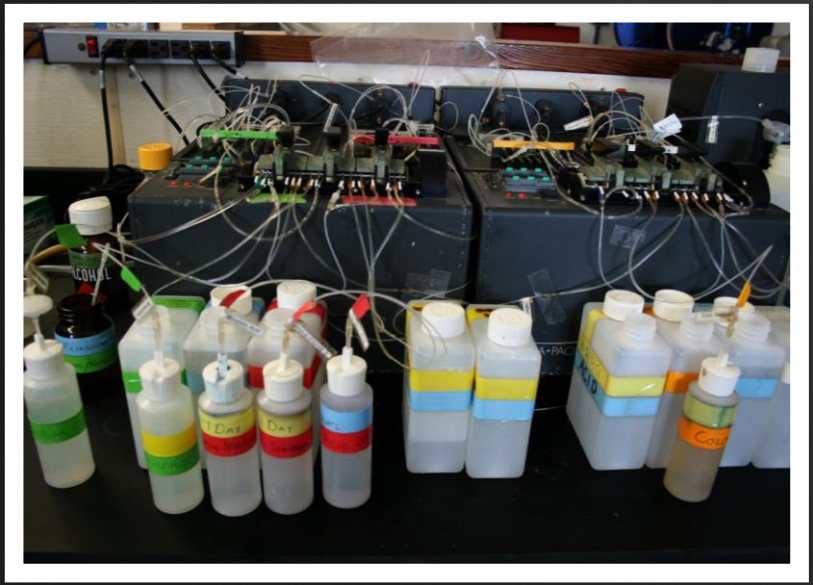
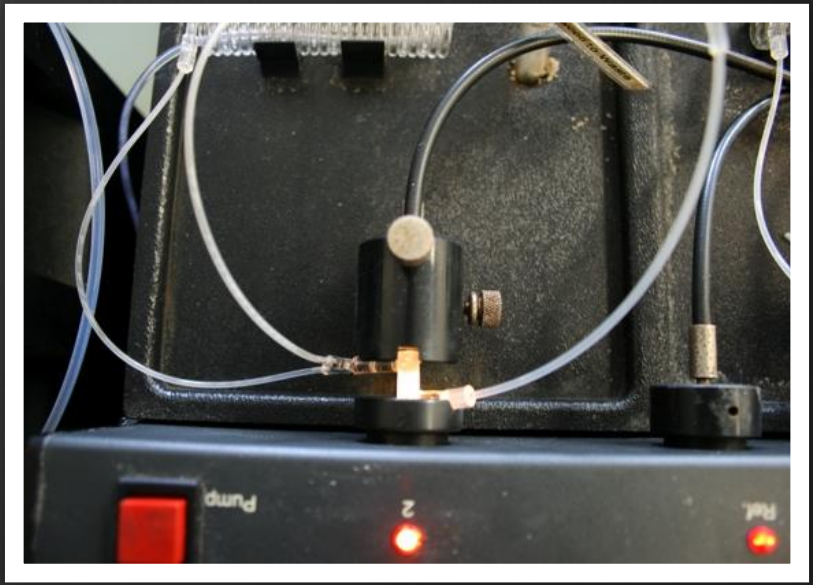


Segmented Flow Auto-Analyzer

Function: evaluate nutrient concentrations by measuring the absorbance of solutions at different wavelengths of light

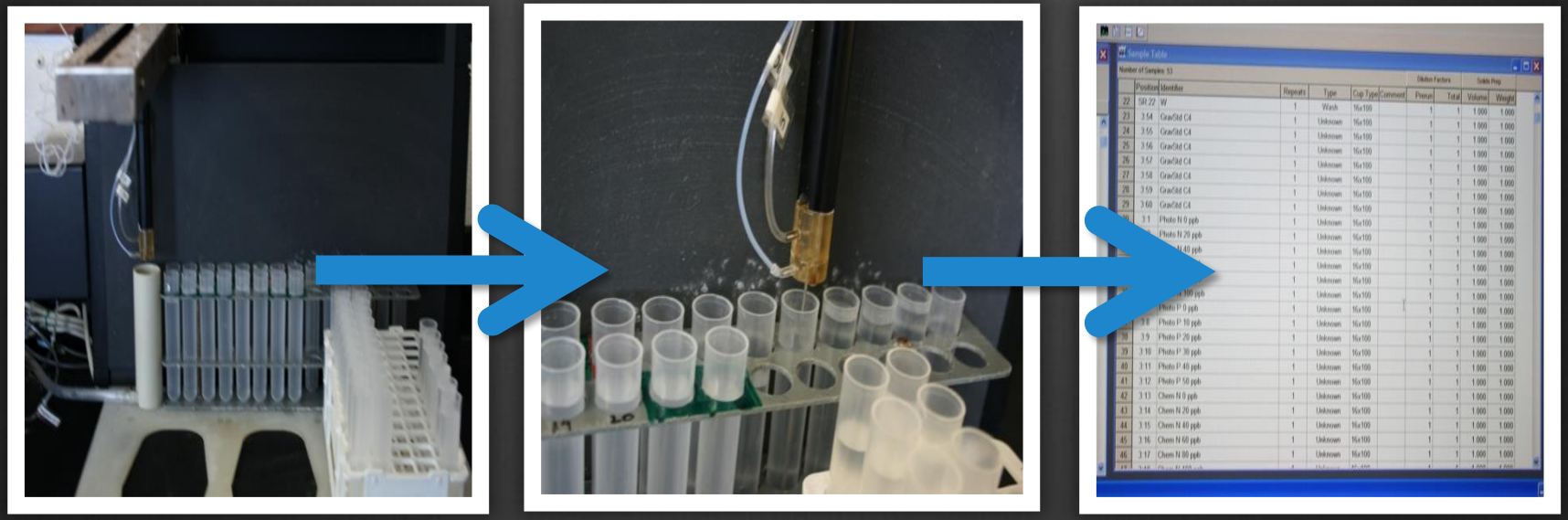
- Specific reagents used to react with oxidized sample to create various colored solutions
- Spectrometer reads 4 nutrient channels
  - **Orthophosphate – 880 nm**
  - **Nitrate/Nitrate – 540 nm**
  - Ammonia - 640 nm
  - Silicate – 820 nm





Nutrient Concentration Analysis

- FASPAC Software used to determine nutrient concentrations



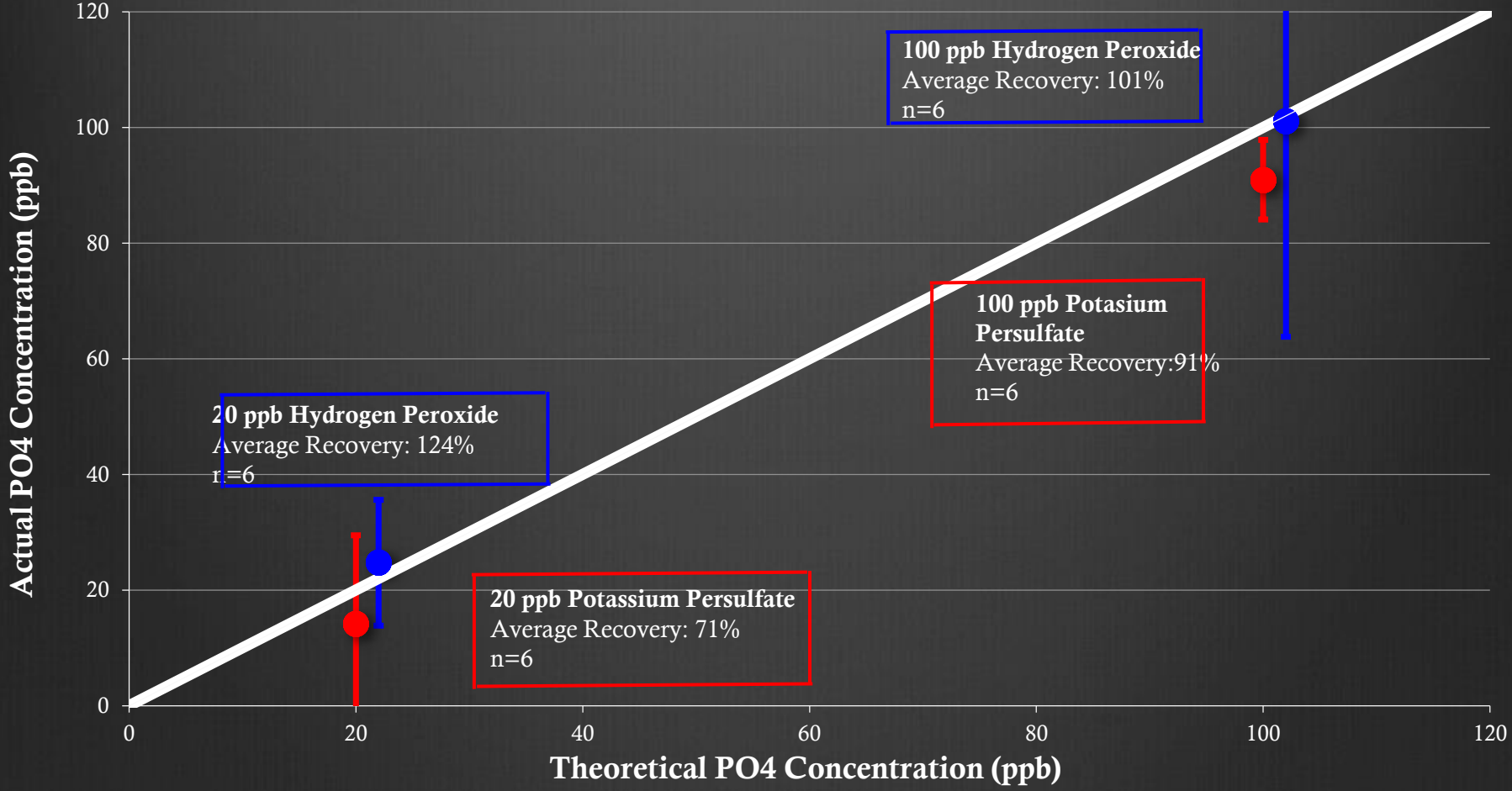
Limitations

- Measuring in parts per billion (precision matters)
  - Human error is a large factor
  - Method Detection Limits above accepted DOH values
    - (ex. NH_3 expected < 2.5 ppb)

Potassium Persulfate

- Potasium Persulfate used as the oxidizing agent in ***photo oxidation*** rather than chemical oxidation

Theoretical vs. Actual PO4 Concentration
Potassium Persulfate vs. Hydrogen Peroxide Oxidizing Reagent Method in Photo Oxidation



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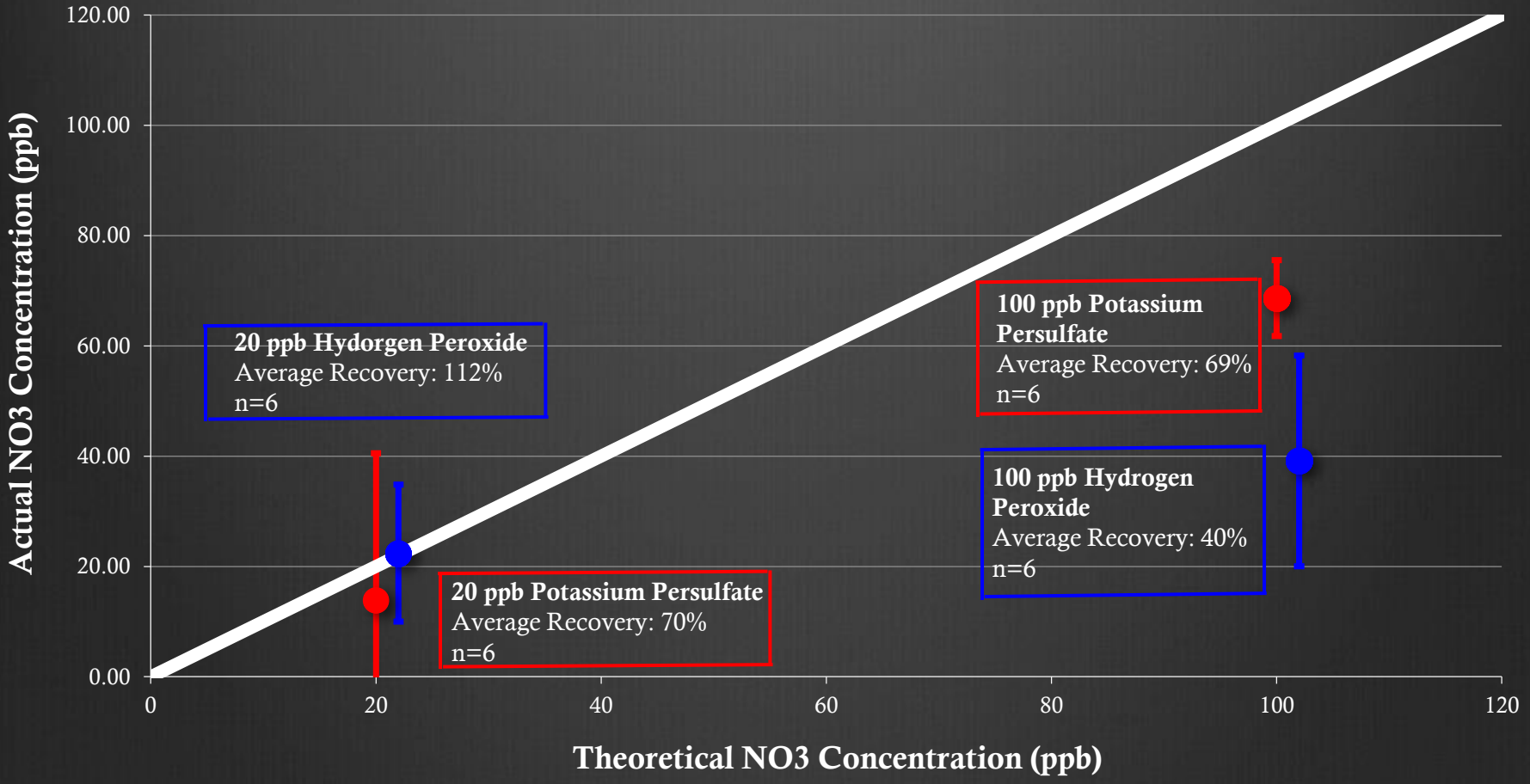
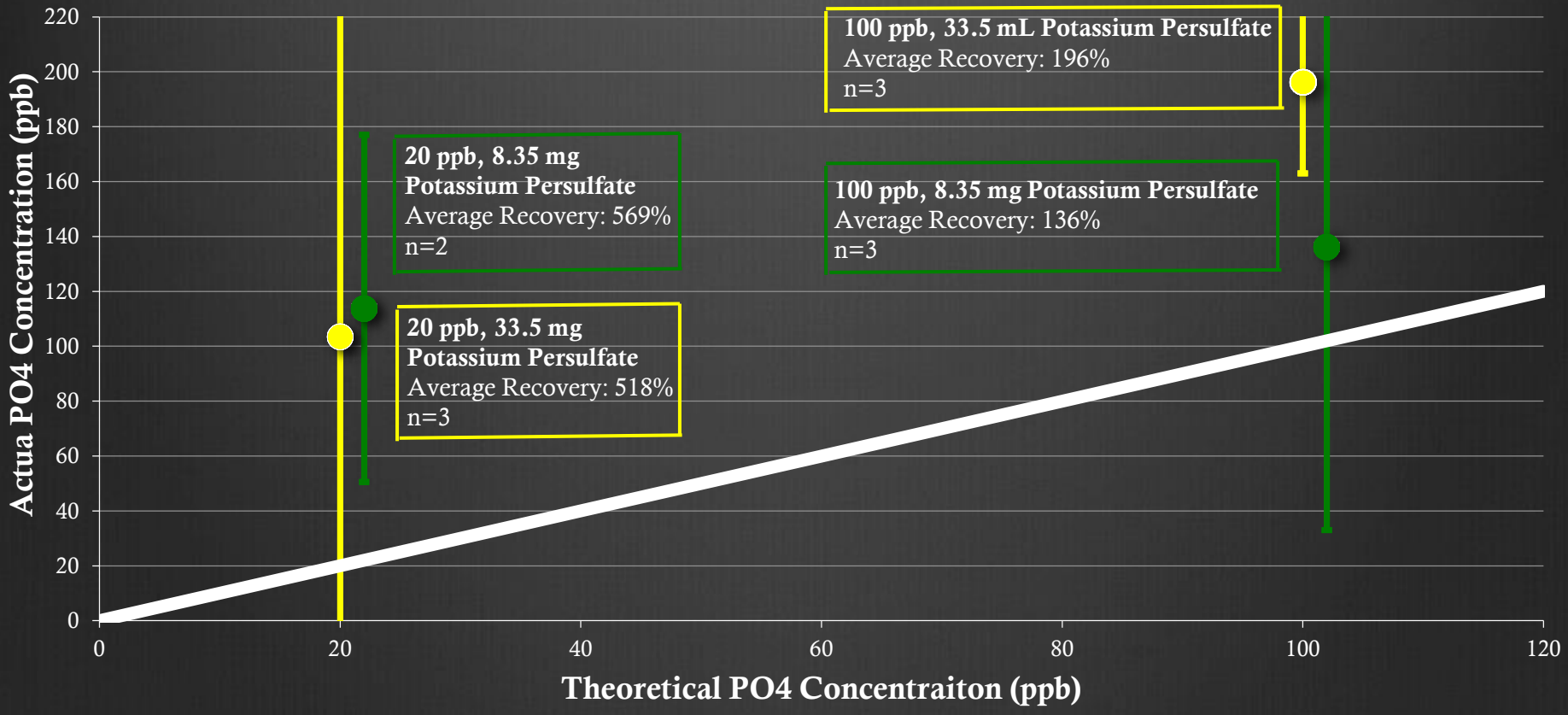


Theoretical vs. Actual PO4 Concentrations
8.35 mg vs. 33.5 mg Potassium Persulfate Concentration Method In Chemical Oxidation



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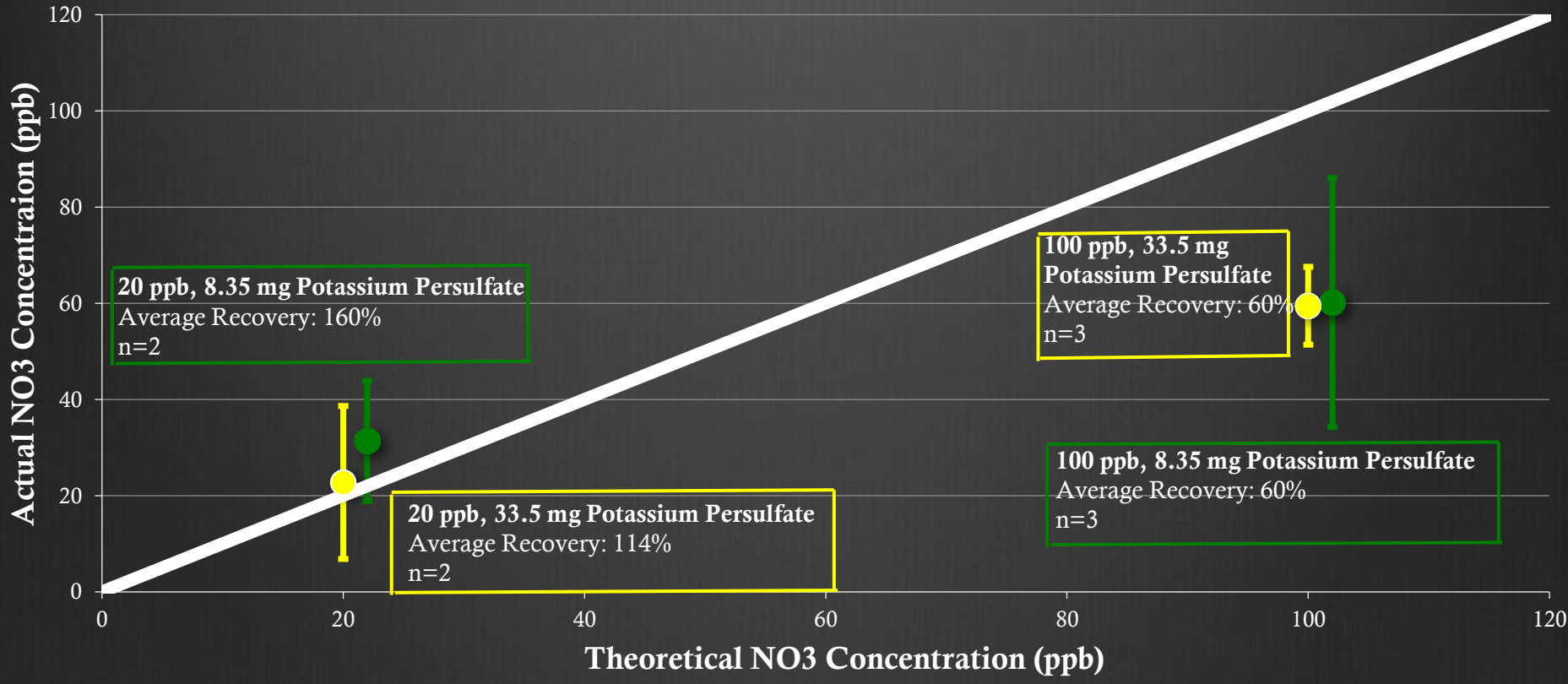
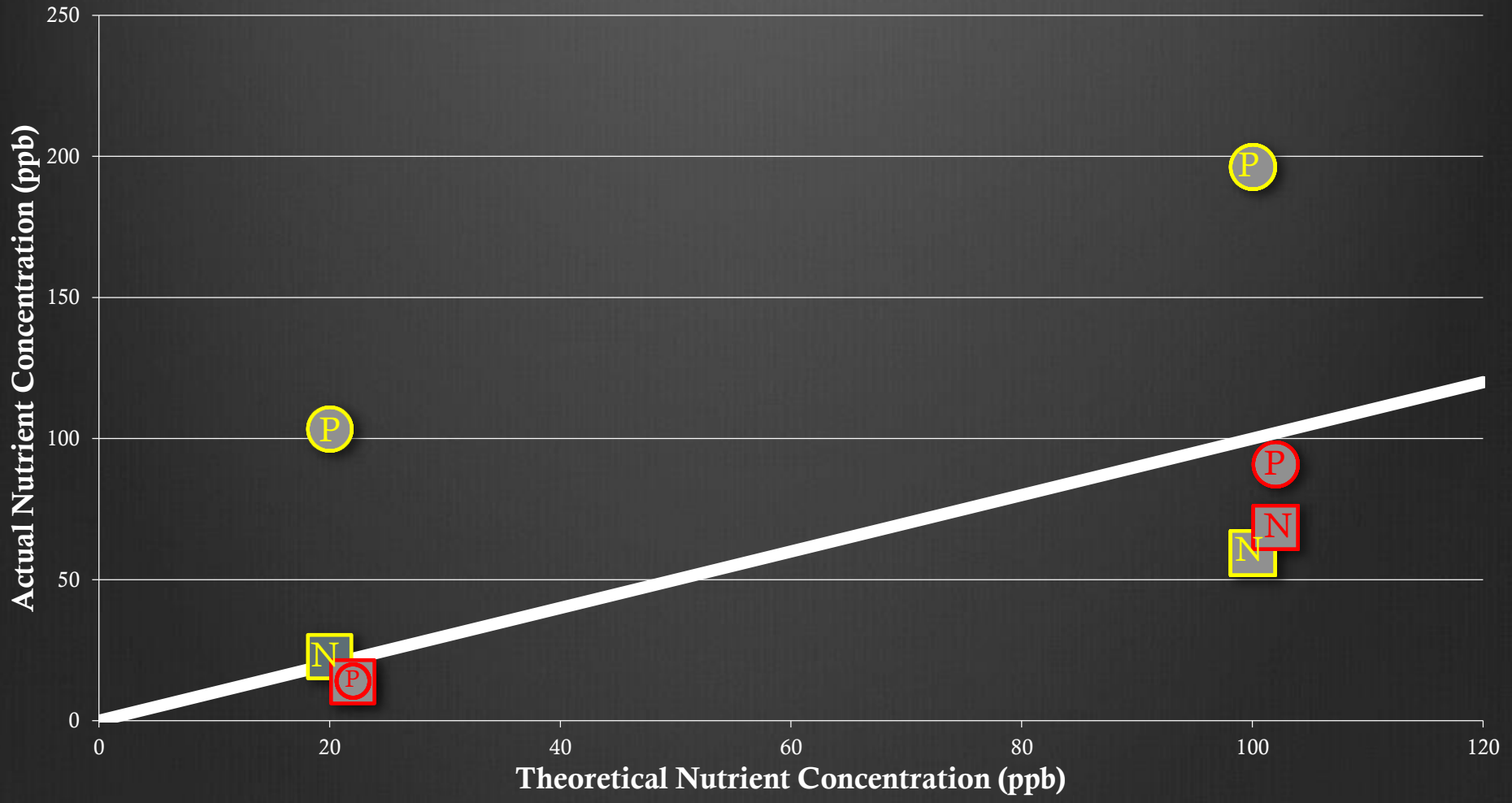


Potassium Persulfate Photo Oxidation vs. 5 mL Potassium Persulfate Chemical Oxidation



Significant Findings

- **Contamination of potassium persulfate**
  - Giving false values of ammonia and nitrogen concentrations
    - Raised values 1-2 **ppm**
    - Measuring on a scale of 0-50 **ppb**
- ***Theoretical*** nutrient standards do not match ***actual*** nutrient standards
- Potassium Persulfate as an oxidizing agent in Photo Oxidation yielded more consistent recovery rates

Future Adjustments

- Develop a standard procedure for chemical oxidation and photo oxidation so both processes can be compared directly
  - Test different standards
- Optimize potassium persulfate as oxidizing reagent in photo oxidation
  - Eventual switch from hydrogen peroxide to potassium persulfate
  - More consistent, accurate results once system optimized

Conclusion

- Photo Oxidation using Potassium Persulfate as the oxidizing agent is better for current testing
  - More accurate recovery rate overall compared to chemical oxidation
- Chemical Oxidation
  - Accurate for Nitrogen

Acknowledgements

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