Nutrient Analyzers for Process Control and Monitoring

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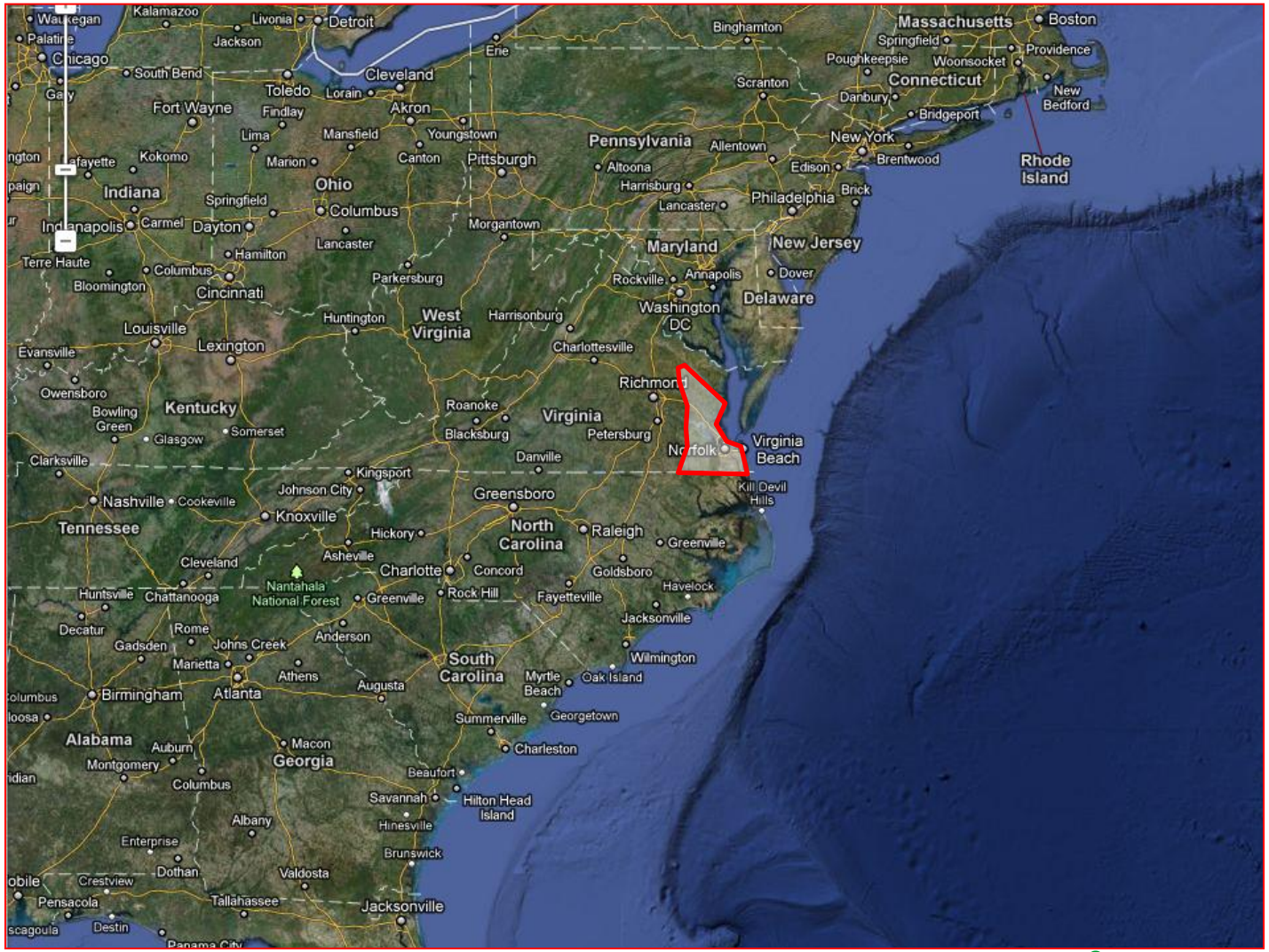
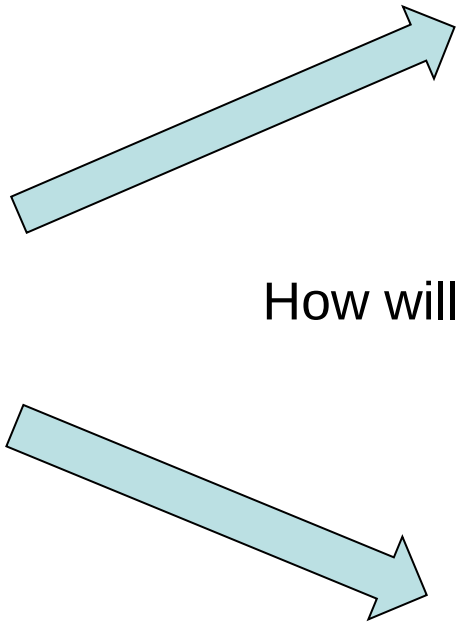
VT PhD Candidate

HRSD



- Provide wastewater treatment for 17+ localities (250 mgd treatment capacity)
- Serve 1.7 million people (20% of all Virginians)
- “Bubble” and individual permits drive nutrient removal targets
- SWIFT – Future implementation of indirect potable reuse via aquifer recharge driving advancement in process control



Primary Purpose

Monitoring

Effluent Phosphorus for bio-P monitoring and chemical dosing

How will the data produced influence or change operation?

Risk Tolerance?

Active Control

Ammonia Based Aeration Control (ABAC) for energy and chemical savings

SCADA

Cleaning

hach.com

YSI.com

Controller/
Transmitter

Analyzer

Ex-situ
Accuracy
Points of Failure

hach.com

YSI Ammonia
ISE Probe

YSI.com

Hach Nitratax
Optical

hach.com

Probe

In-situ
Responsive
Fouling

hach.com

Filtration
module

Observations from HRSD's Experience with Probes

- Ion Selective Electrodes
  - Electrode life is unpredictable (2 weeks to 1 year)
  - Drift is consistent but unpredictable
  - Some compensation cartridges aren't required. (ex. K^+)
  - Don't clean with DI water!

- Optical Probes
  - Measuring Path Length is important
  - With appropriate maintenance/cleaning, calibration/adjustment is rarely required.

YSI Ammonia ISE Probe

YSI.com

Unreliable measuring to low concentrations <1 mg/L

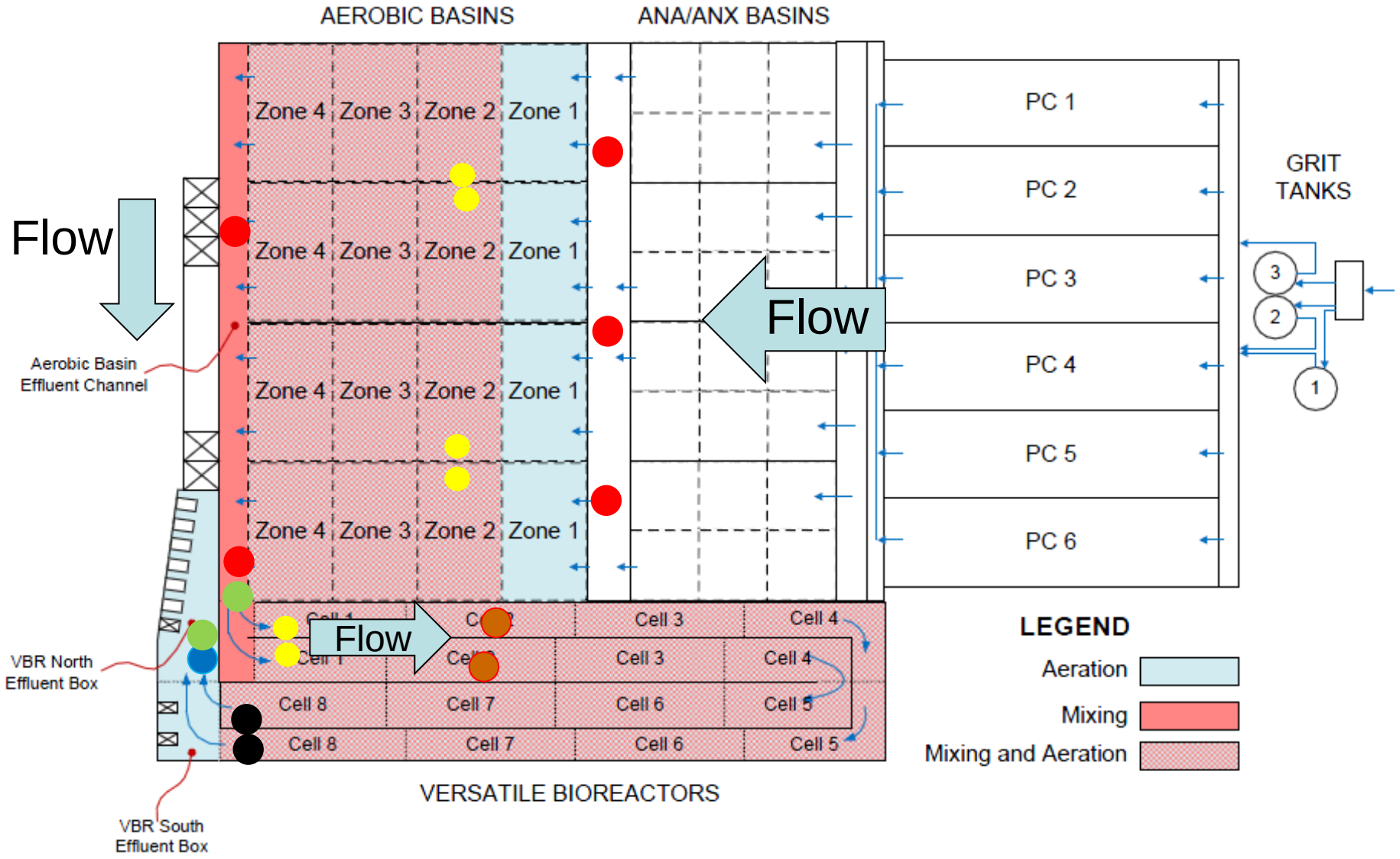
Hach Nitratax Optical

hach.com

HRSD

Installation: Location, Location, Location

- Nitrate/Nitrite
- Ammonia
- Nitrate + Nitrite
- Ammonia
- Phosphorus
- DO



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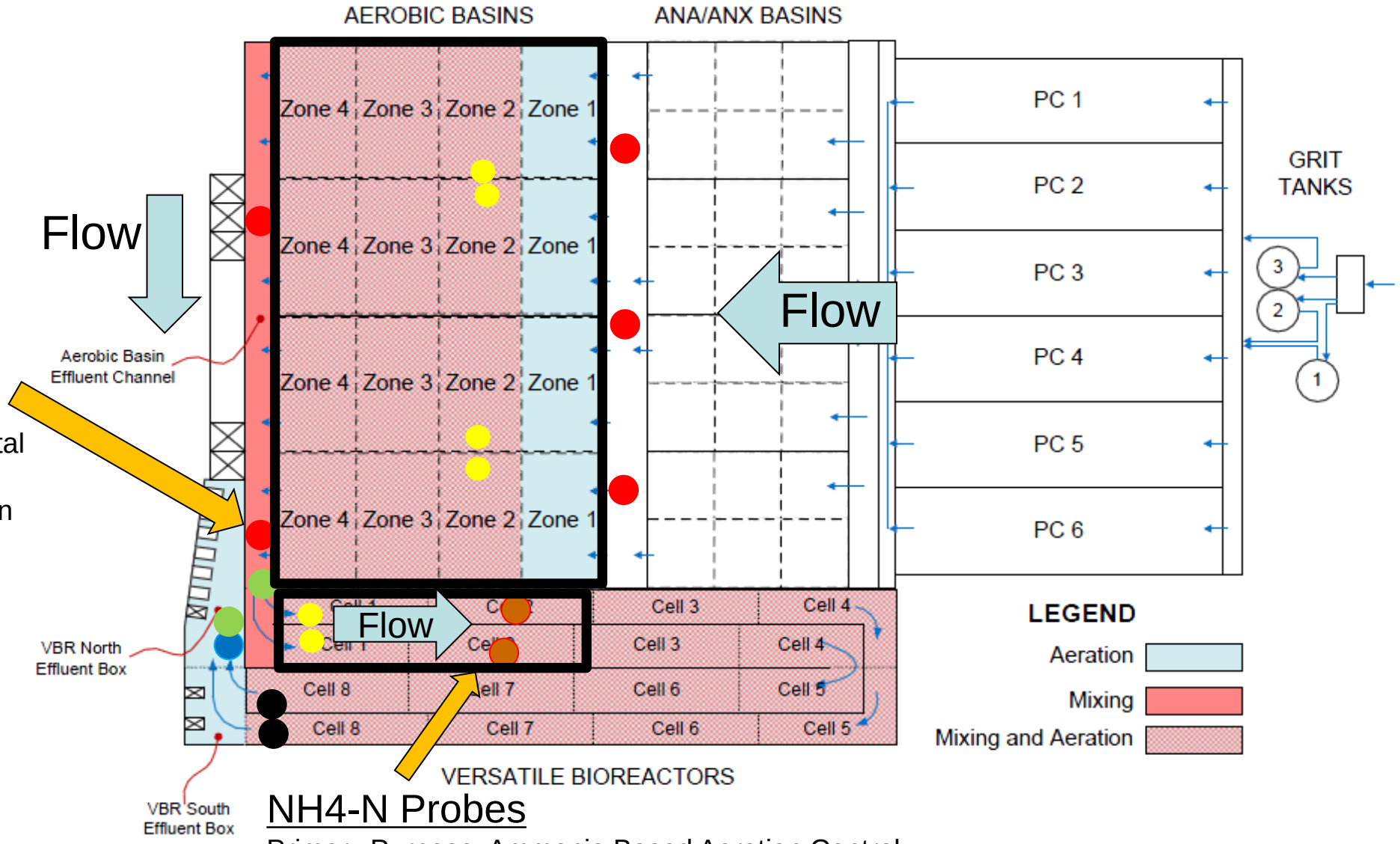

NO3-N Probes

Primary Purpose: Supplemental Carbon Control

Secondary Purpose: Interest in monitoring nitrate recycled to first anoxic zone

NH4-N Probes

Primary Purpose: Ammonia Based Aeration Control

Installation: Location, Location, Location

- **Nitrate/Nitrite**
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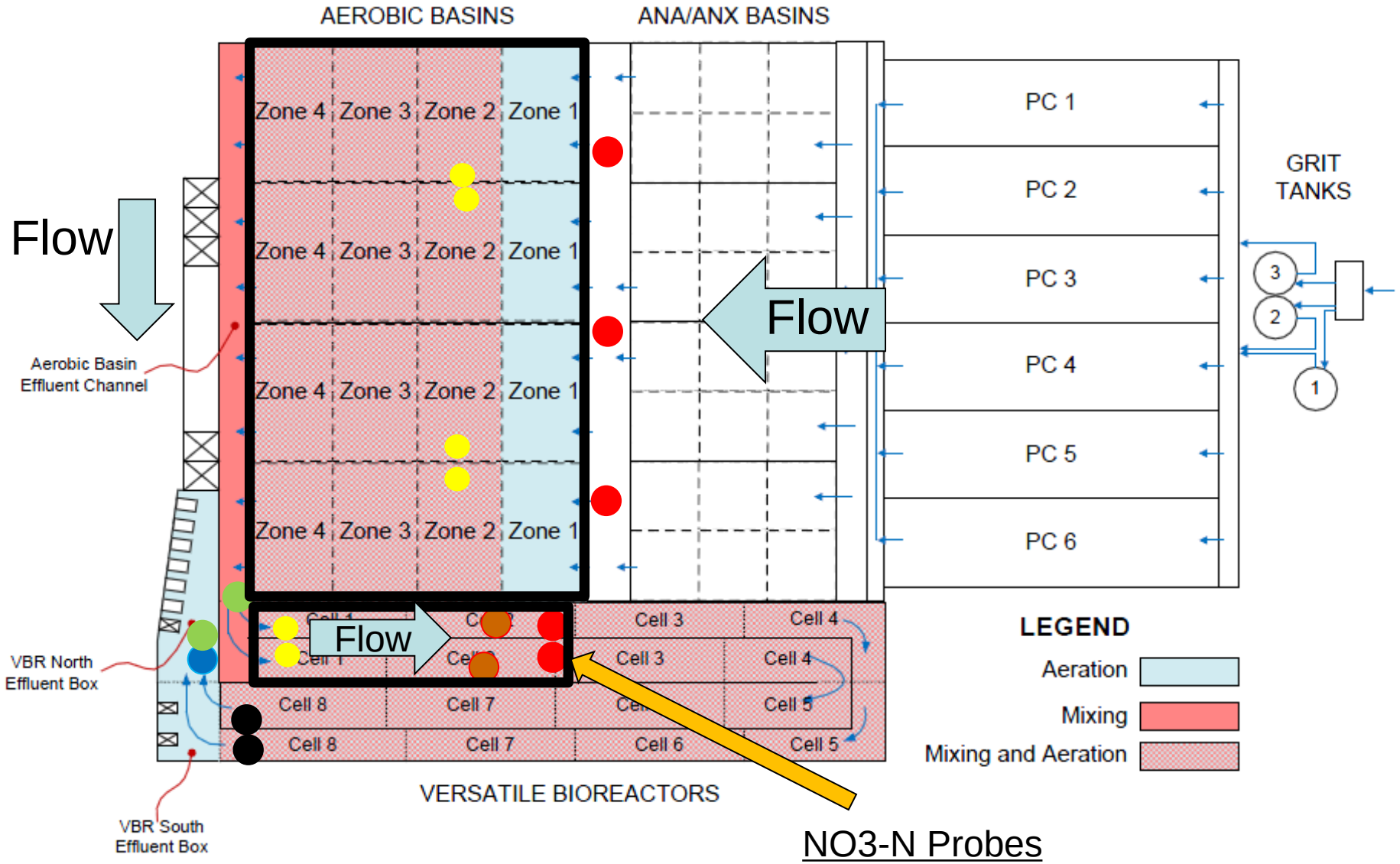
- **Phosphorus**
- **DO**

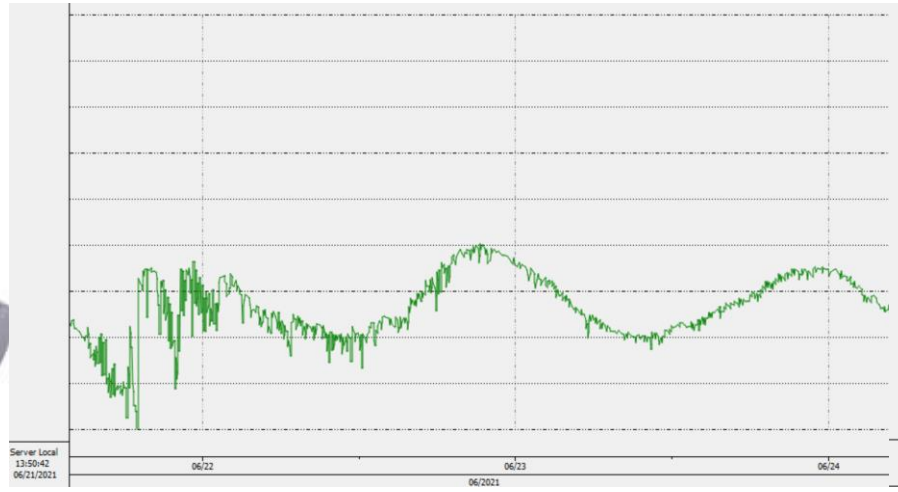
Nitrate probes were moved to ensure accurate and time appropriate measurement for supplemental carbon control.

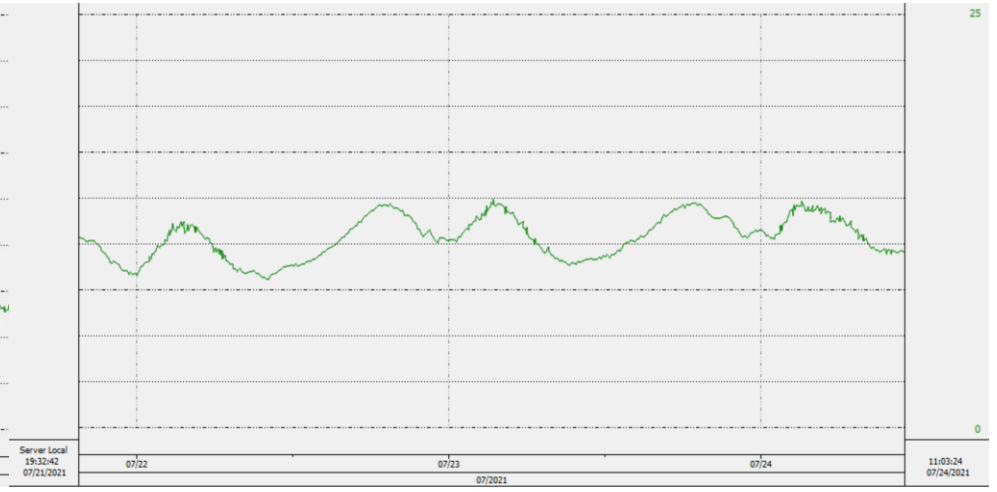


Installation: How is important too!

Hach Nitratax Optical

hach.com

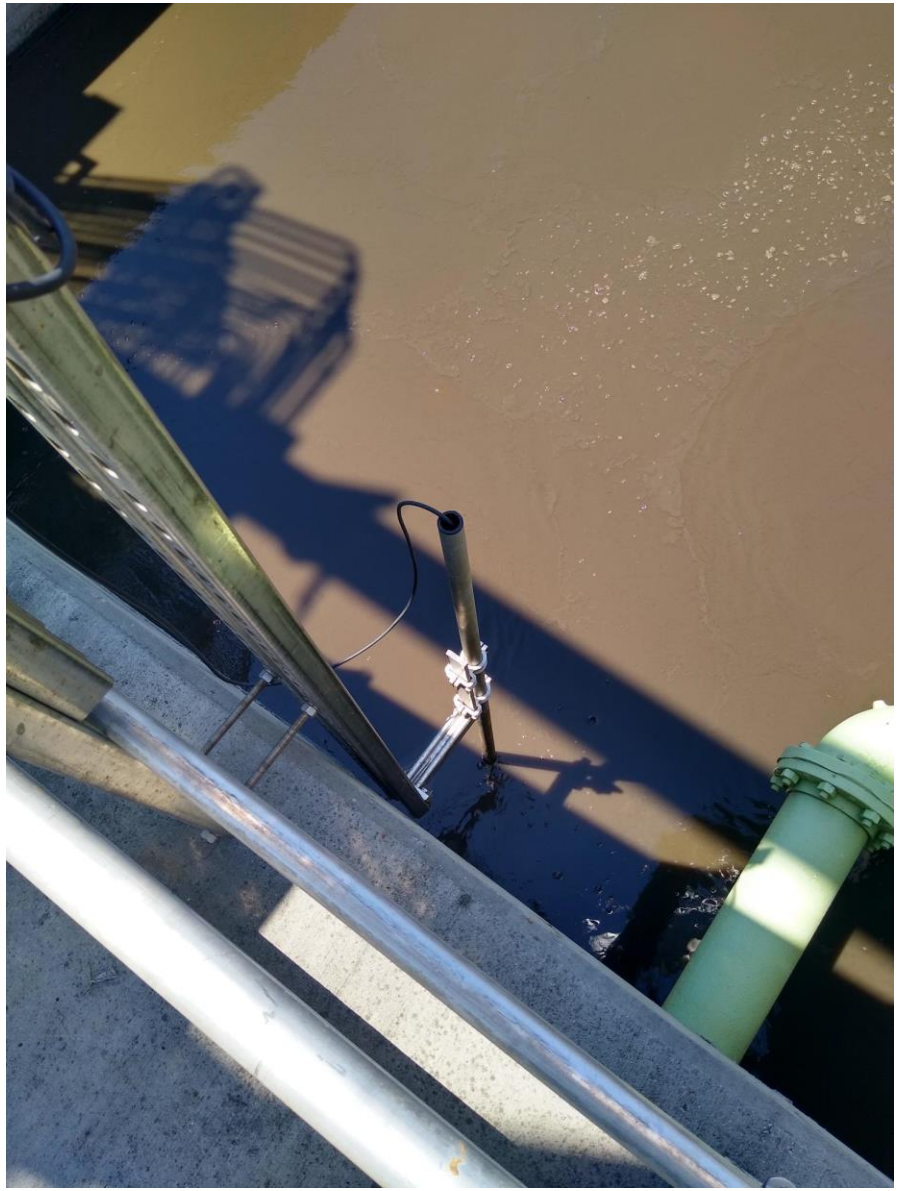




Nitrate probe installed in sink with flow pumped from influent of tank

Nitrate probe moved to influent of tank

Installation: Accessibility

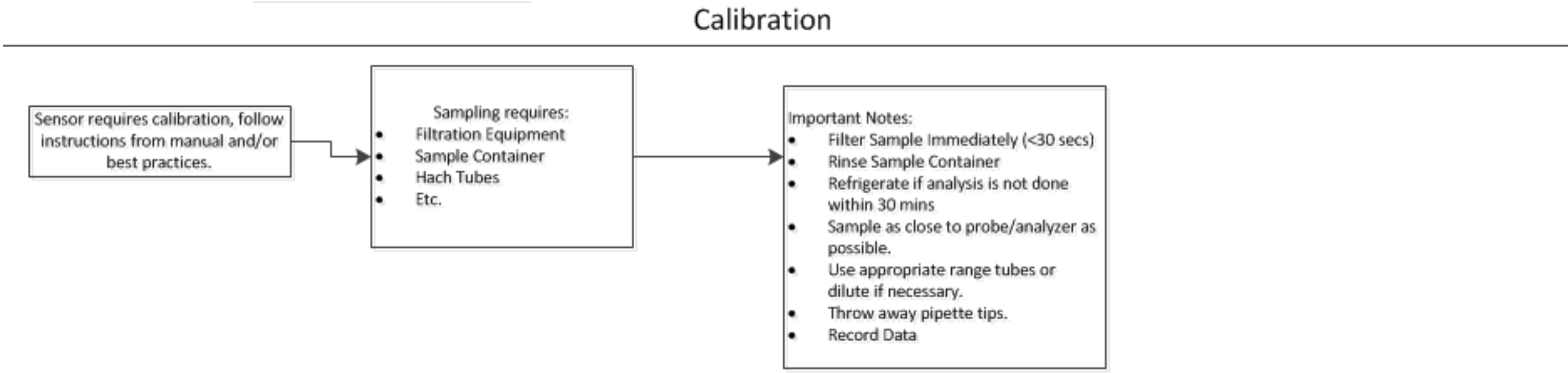


Using Manufacturer's recommendation as jumping off points

How often should I calibrate the sensor? How often should I clean the sensor? How often should I replace the consumables?

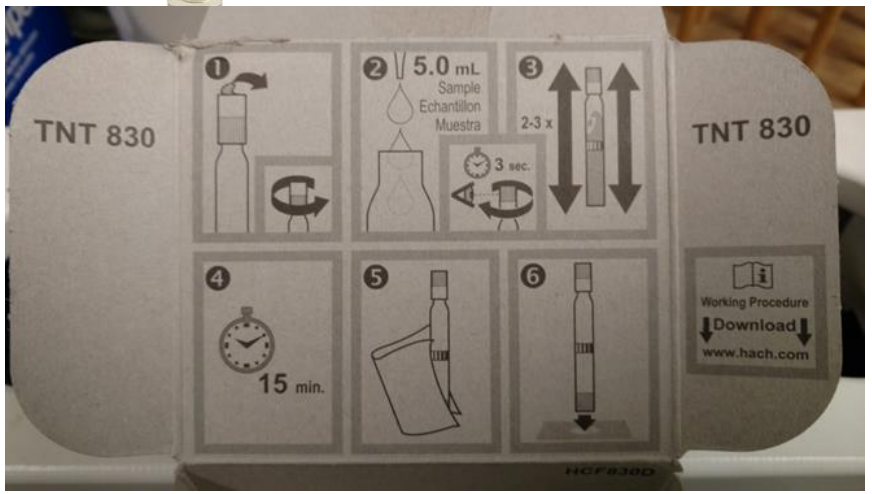
- It really depends on a few different factors!

Sensor Action Flow Chart

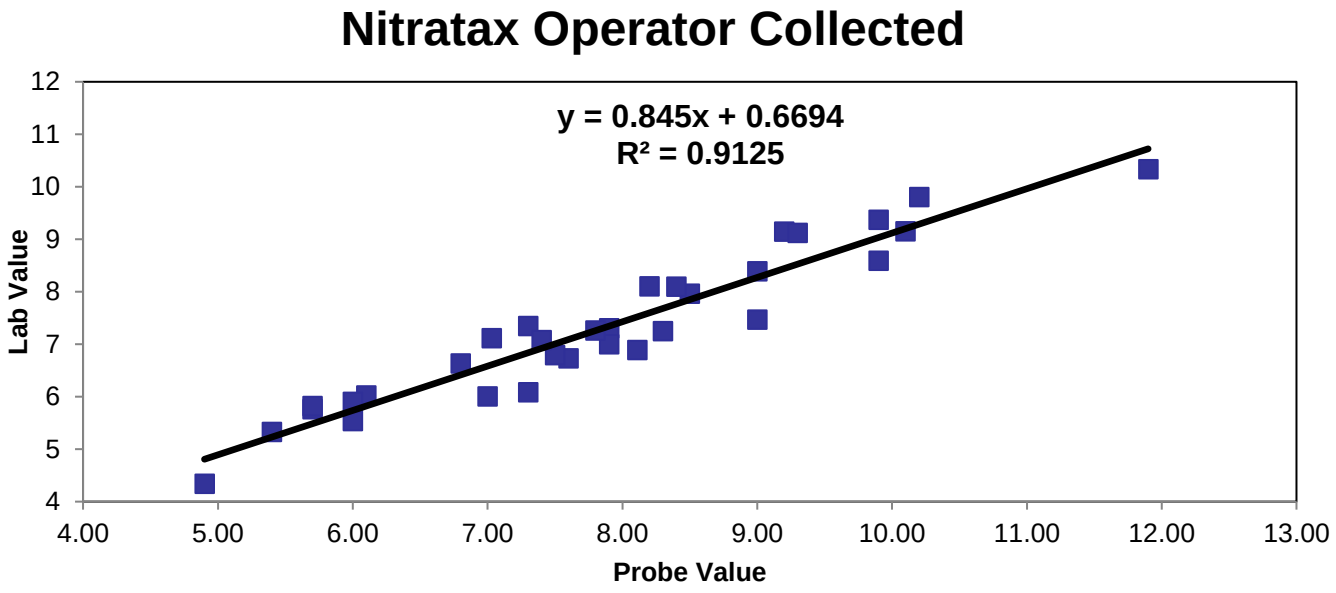


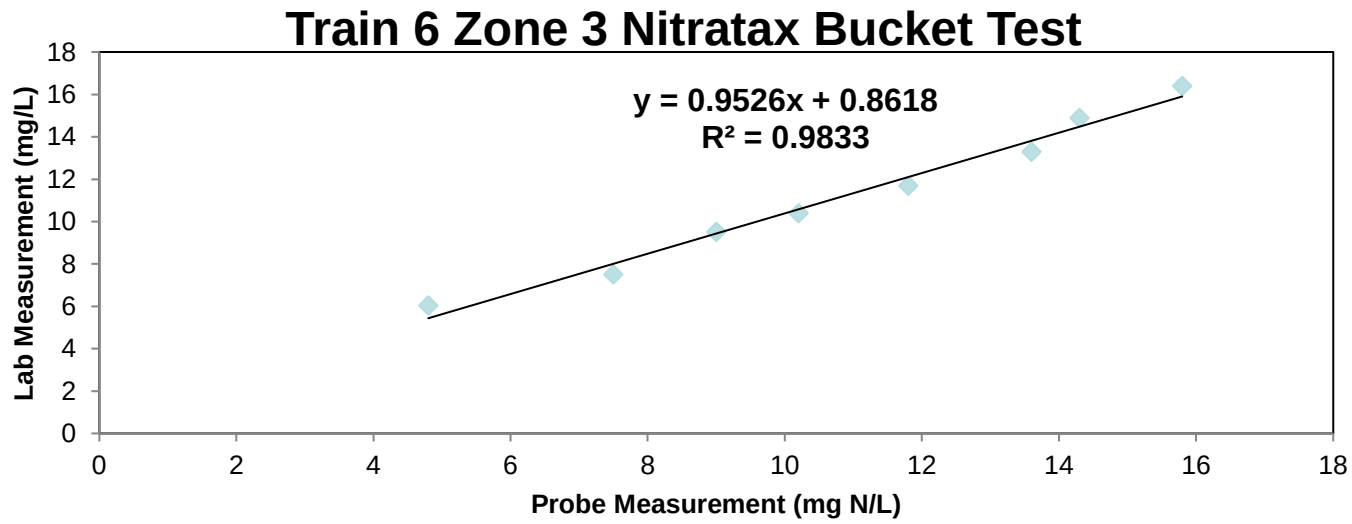
Sensor Validation – Sample Collection & Analysis

Sample collected as close to probe as possible and immediately filtered! Probe measurement recorded.



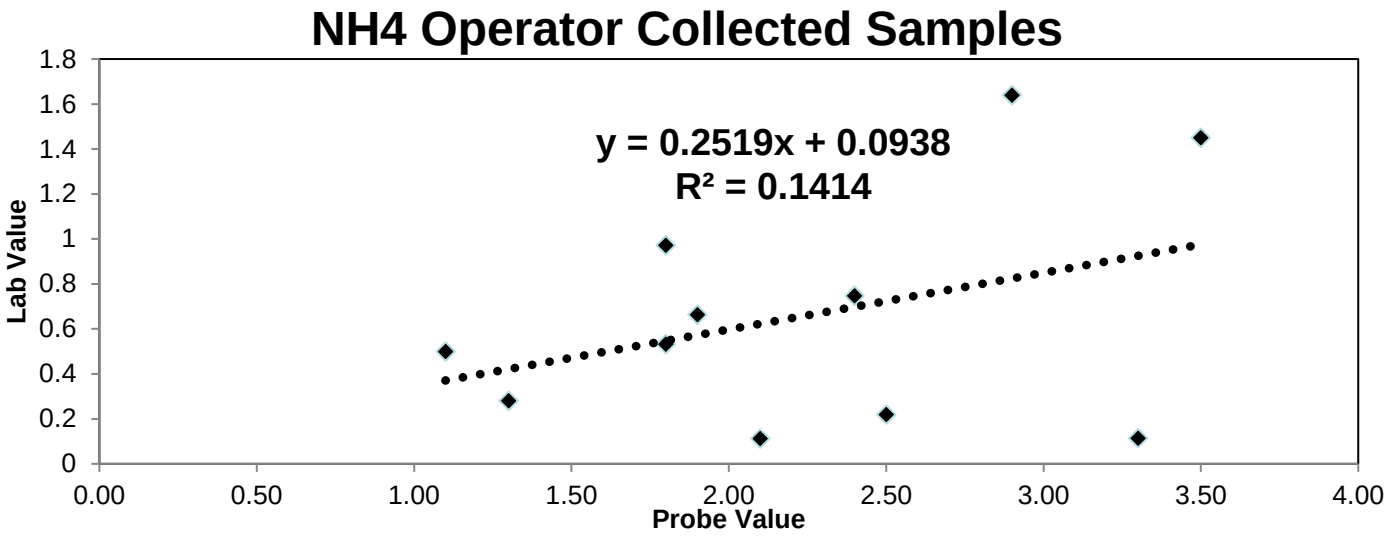
Sensor Validation: Data Collection

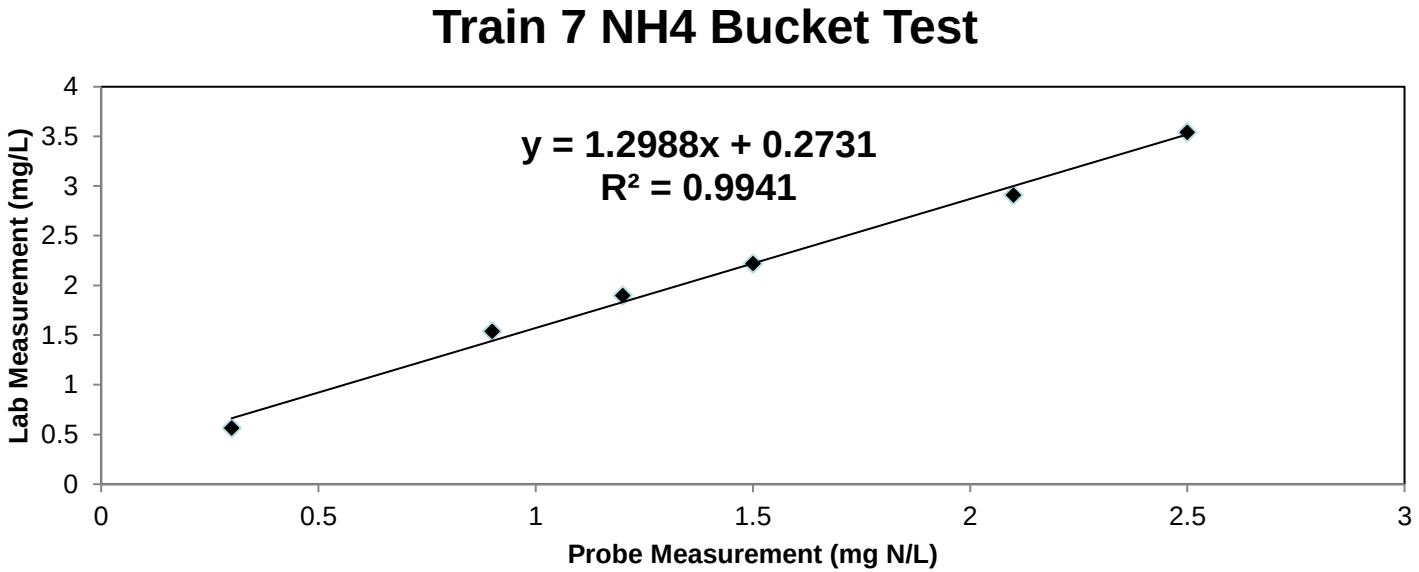




- Tracking sensor and lab data overtime allows for assessment of performance, monitoring of drift, outlier detection,etc.
- Bucket testing can assist with determining probe accuracy

Sensor Validation: Data Collection





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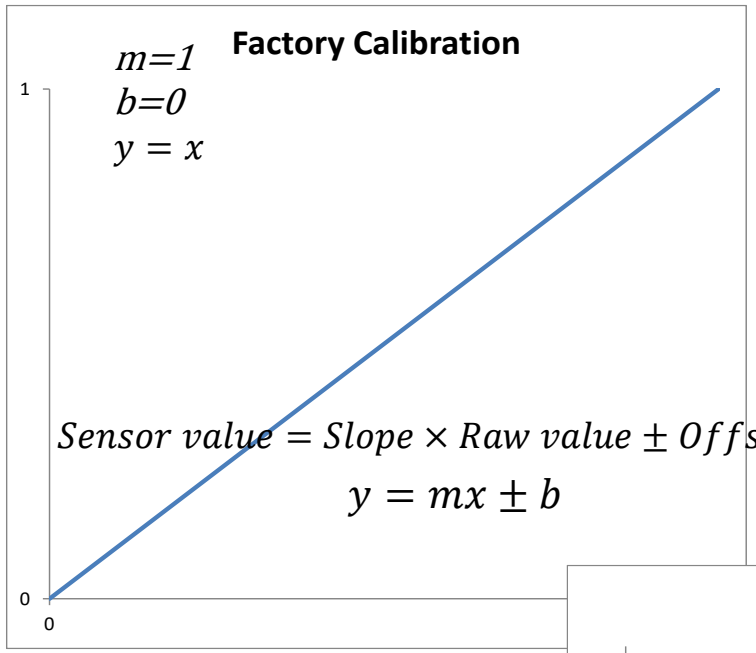
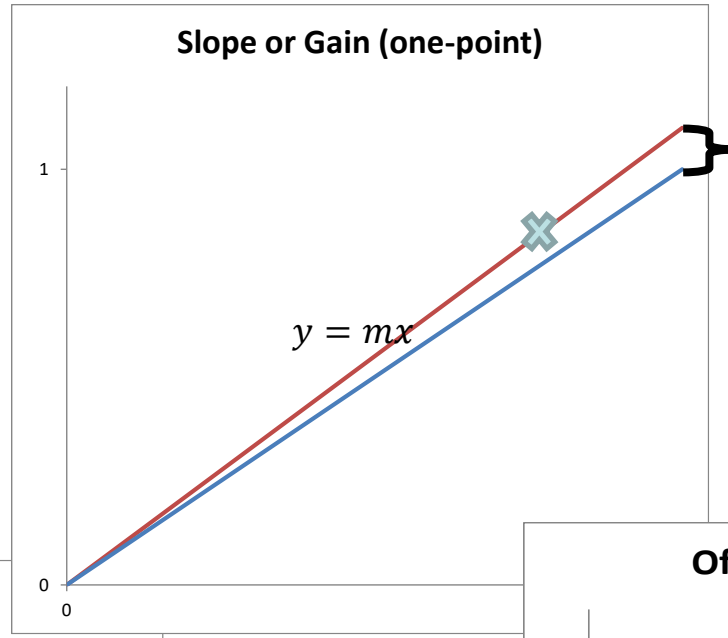
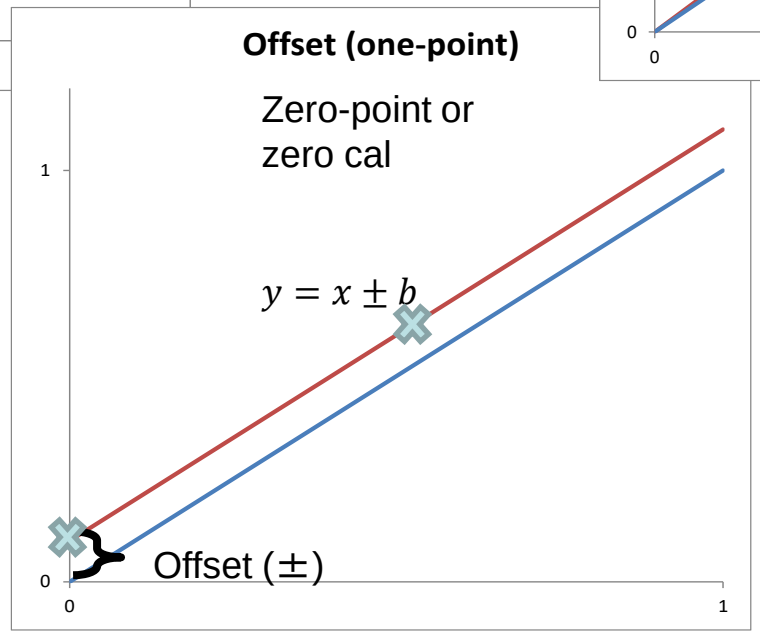
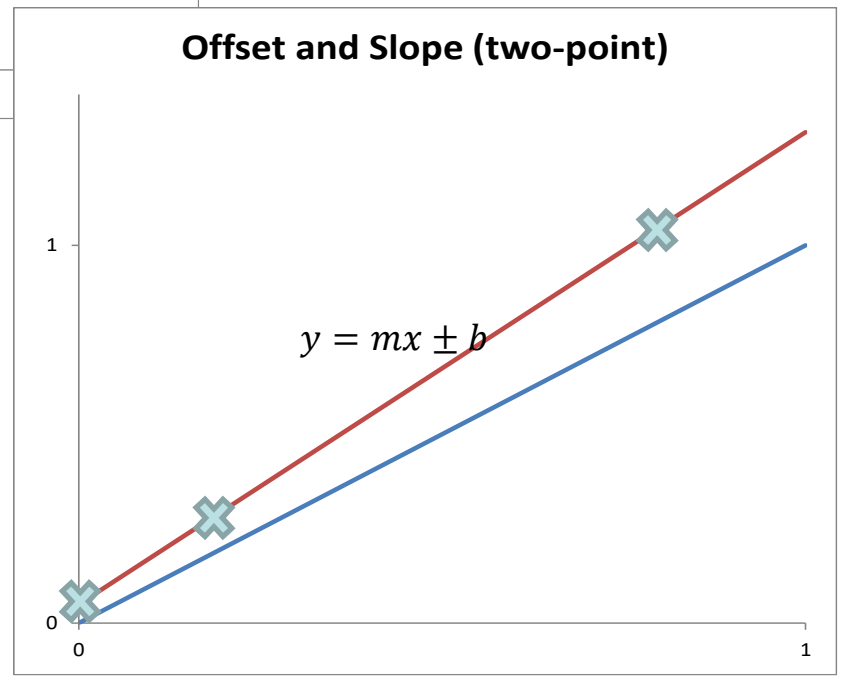
What is happening when you calibrate?



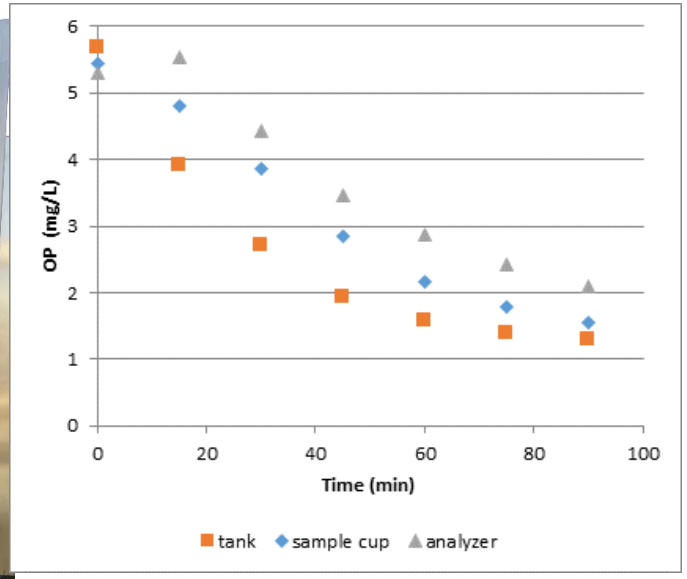




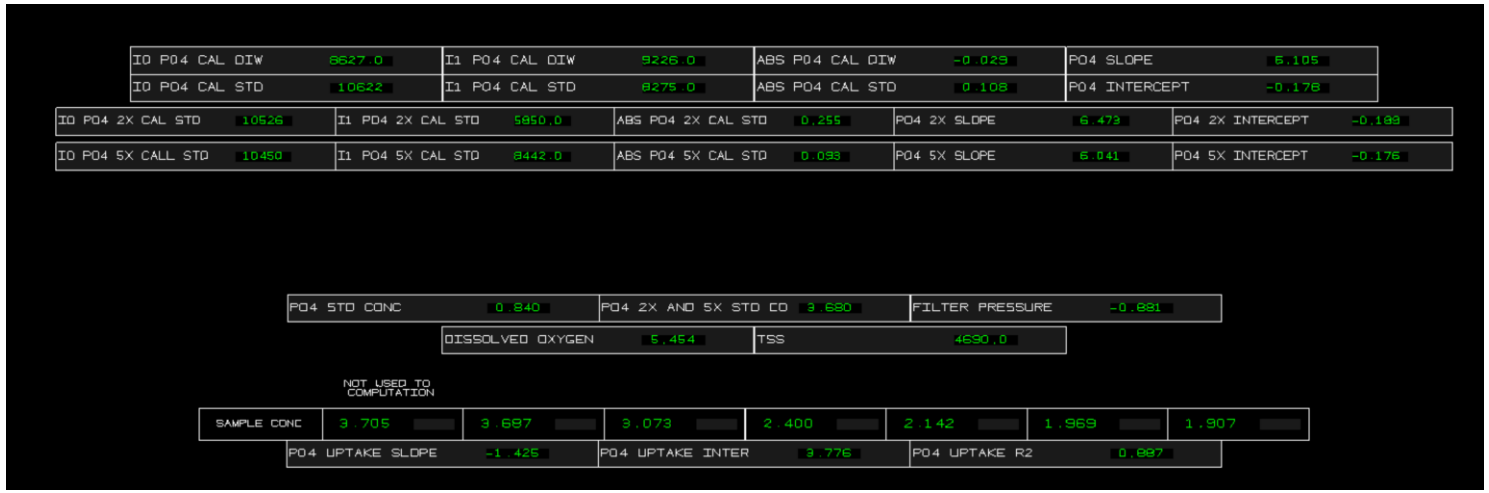


Every time you calibrate, all the data you have collected previously is no longer a valid.

Internal Construction of Wet Chemical Analyzers



- Nutrient Analyzers
  - Phosphorus
  - Ammonia
  - Nitrate
  - Nitrite
- Activity Rate Analyzers
  - P-Uptake Analyzer
  - Oxygen Uptake Rate Analyzer (in construction)



ABAC: Accepting ISE Drift is a fact of Life

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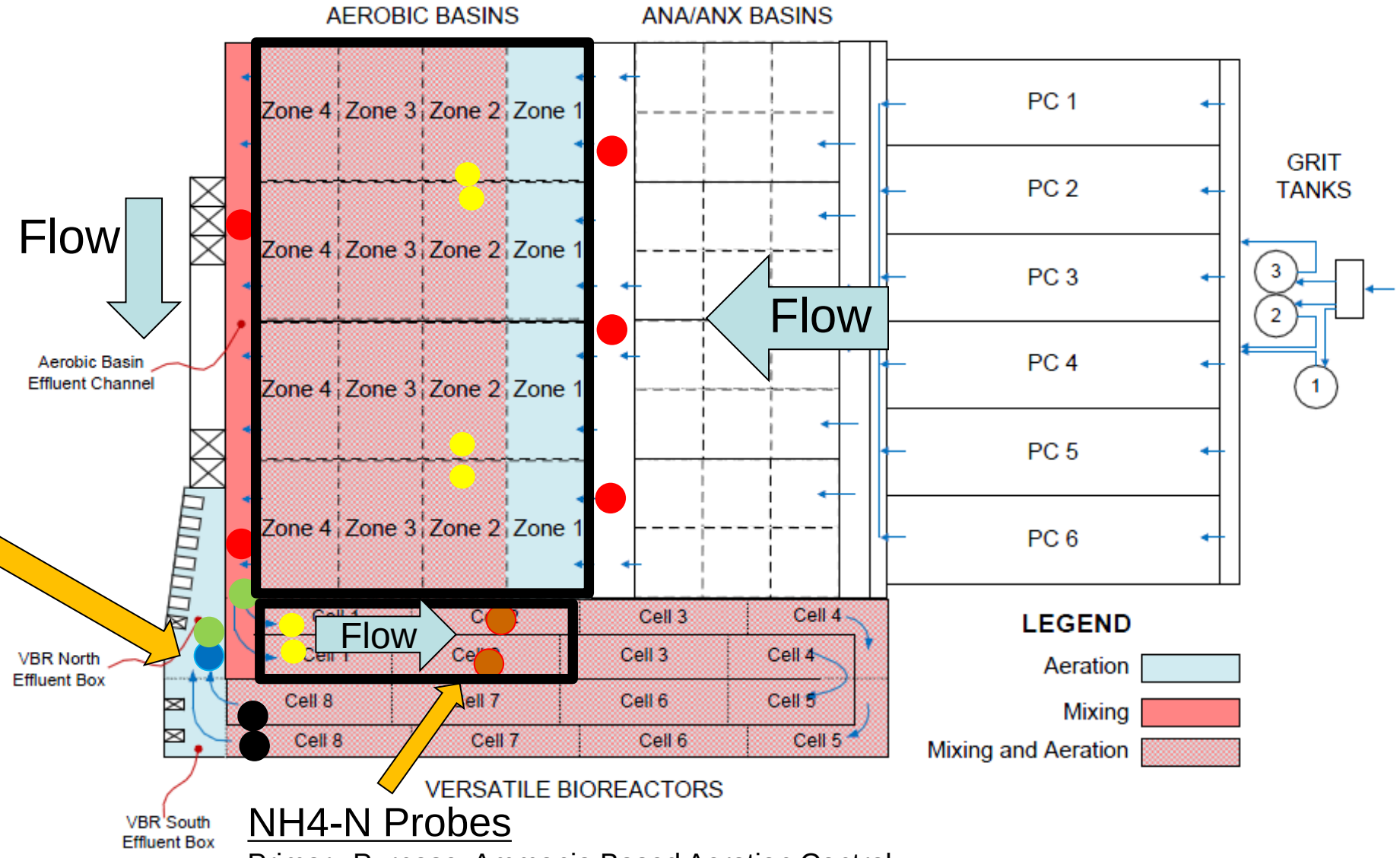

Wet Chemical NH4-N Analyzer:

During stable temperatures increase of ABAC setpoint to account for drift if change increase in auto DO setpoint is observed without other cause.

NH4-N Probes

Primary Purpose: Ammonia Based Aeration Control

Cleaning wastewater every day for a better Bay.

Thank you!