Village of Twin Lakes Process Upgrades for Bio-P Removal

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Overview

- What is phosphorus and why do we care?
- How can you remove phosphorus?
- Biological phosphorus removal
- Twin Lakes operations

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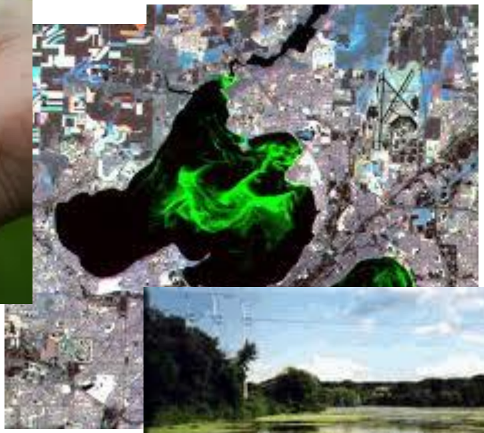
Phosphorus



Phosphorus Regulation

- Technology based effluent limits
  - Typical = 1.0 mg/L
  - Alternative phosphorus limits (APL)
    - Biological – maximum 2.0 mg/L
    - Economics - variance
- Water quality-based effluent limits
  - Based upon target concentration in receiving water
  - Total Maximum Daily Load (TMDL)
  - As low as 0.100 - 0.075 mg/L for streams

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Chemical Phosphorus Removal

- Coagulant
  - Alum
  - Ferric Chloride
  - Ferric Sulfate
  - Poly aluminum chloride (PAC)
- Advantages
  - Simple
  - Lower capital cost (sometimes)
- Disadvantages
  - Sludge production
  - Operational costs
  - Chemical handling

Biological Phosphorus Removal (BPR)

- Create an environment to select for organisms that will store phosphorus
- Requirements
  - Phosphorus
  - Readily biodegradable BOD in the form of volatile fatty acids
  - Cycling between anaerobic and aerobic environments

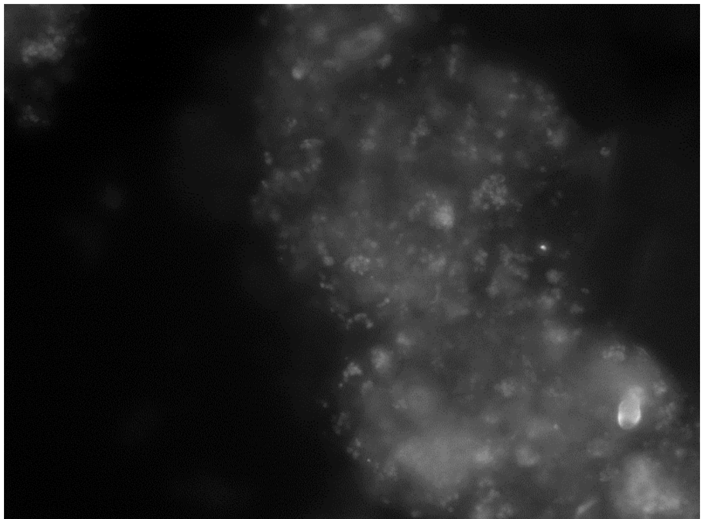
Biological Phosphorus Removal (BPR)

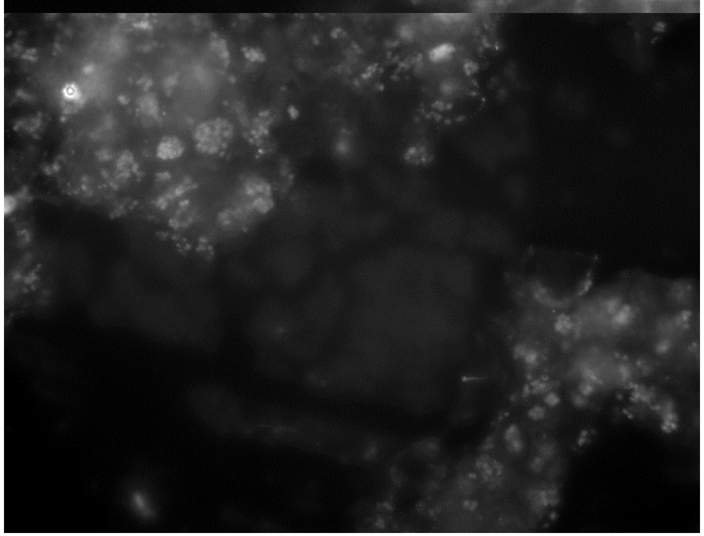
- Advantages
  - Low operational costs
  - Improved treatment performance
- Disadvantages
  - Capital cost
  - More complicated treatment
  - Temperamental

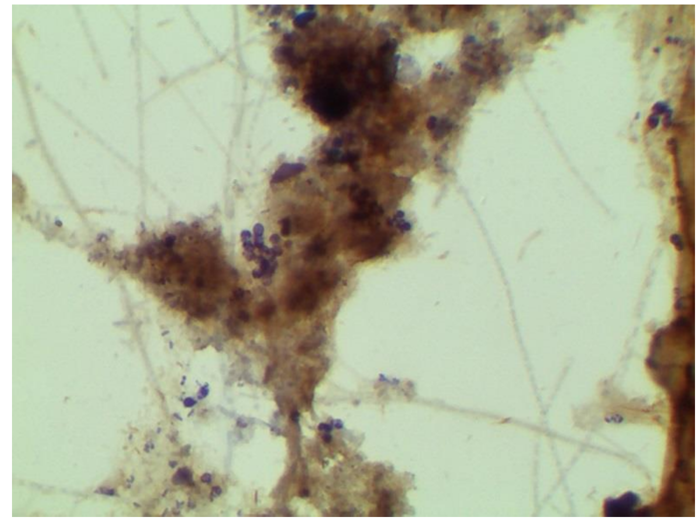
BPR Microbiology

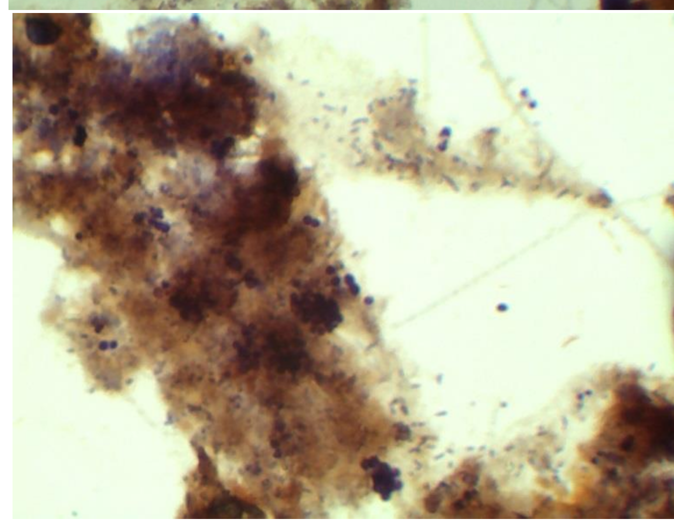
- Phosphorus accumulating organisms (PAOs)
  - Store excess phosphorus inside cells
  - Release phosphorus for energy in anaerobic environment
  - Take in phosphorus in aerobic environment
- Identifying PAOs and biological phosphorus removal
  - Anaerobic batch testing
  - Staining techniques
  - DAPI
  - Florescence In-Situ Hybridization (FISH)
  - DNA sequencing

BPR Microbiology









Influent Considerations

- BOD and phosphorus required for biological phosphorus removal to work
- BOD should be in readily biodegradable form
- Nitrate inhibits biological phosphorus removal
  - High influent ammonia will be converted to nitrate if nitrification occurs
- Frequency and quantity of inflow and infiltration (I&I)

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Selector Basins

- Anaerobic environment
- VFA's formed through fermentation
- Organisms take in VFA's and store VFA's as PHB
- Phosphorus released to give PAO energy

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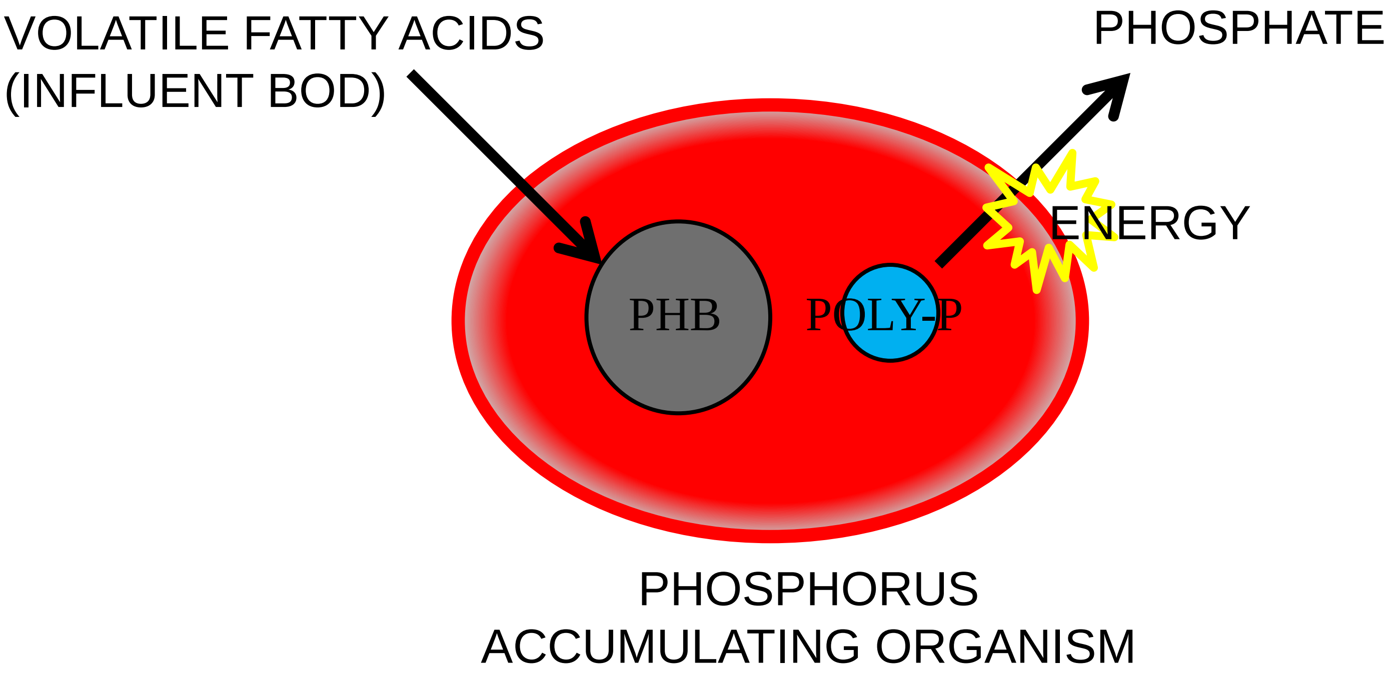
Anaerobic Environment



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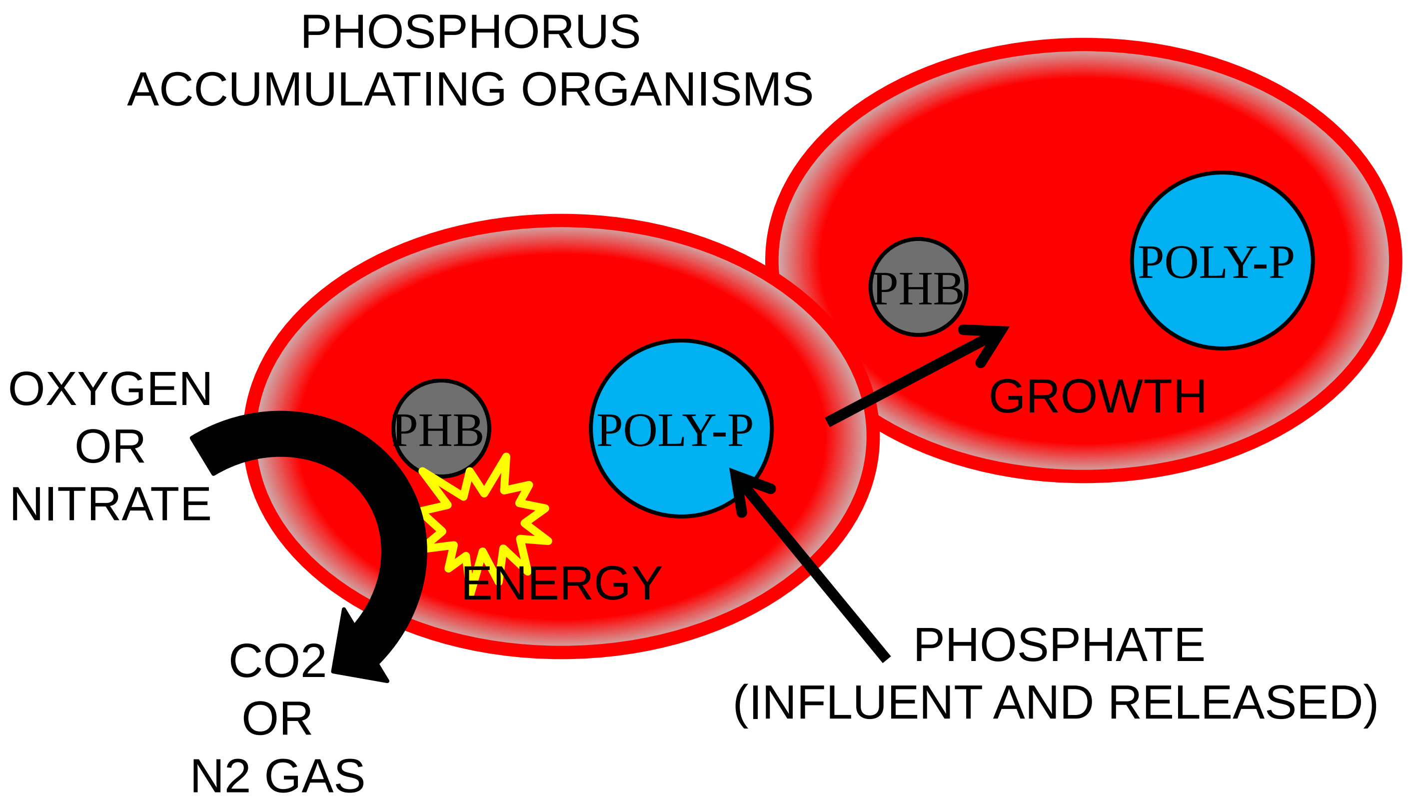
Aeration Basins

- Stored PHB is consumed (BOD)
- Influent and released phosphorus is taken up to provide energy for future reactions
- Micro organisms grow and reproduce
- Higher phosphorus content in cells (>4% vs. 1% - 2%)

Aerobic Environment



Final Clarifiers, RAS, and WAS

- Phosphorus laden organisms settle
- Rapid sludge removal (avoid secondary release)
- Sludge wasting removes organisms & phosphorus from the system

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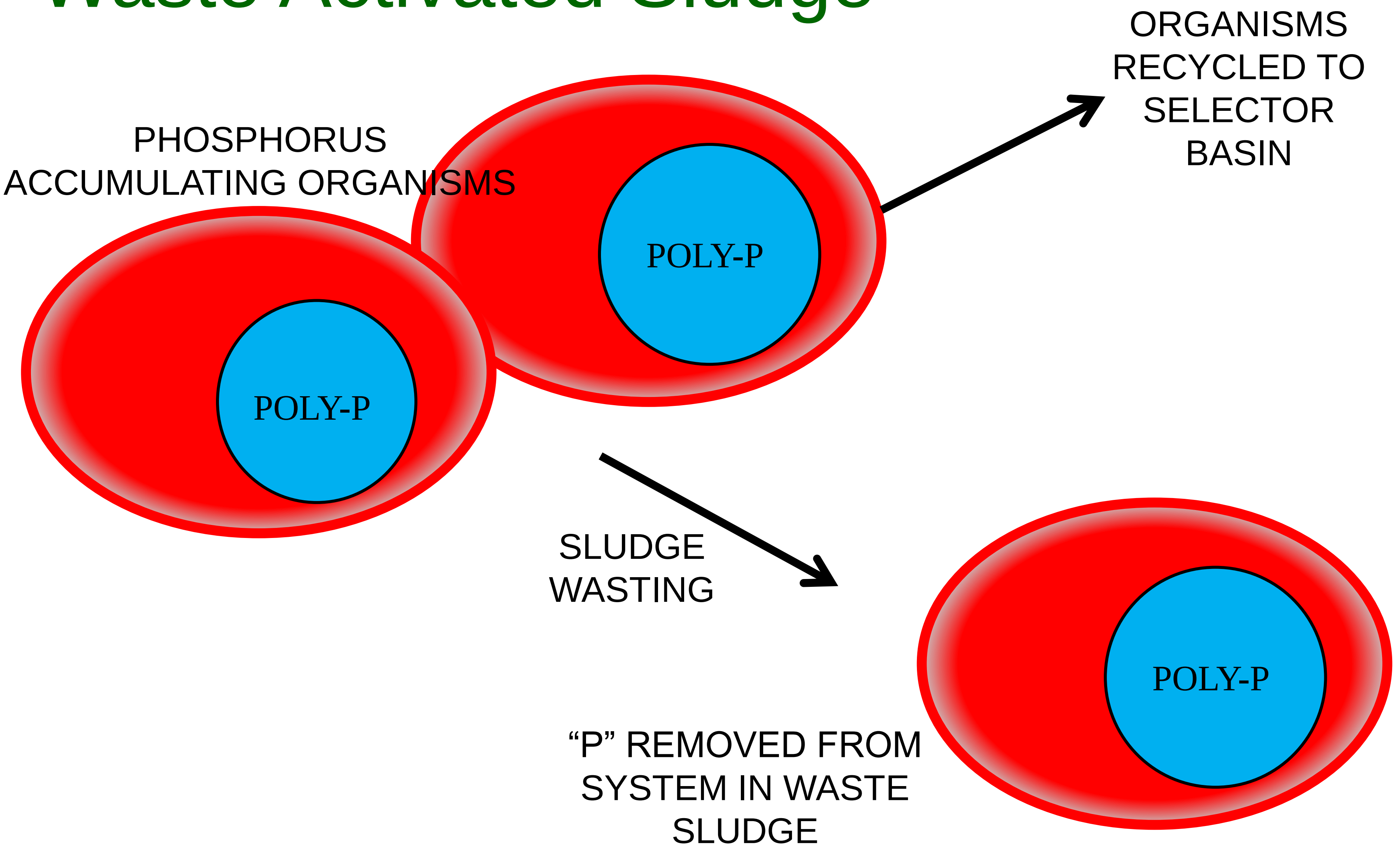
Waste Activated Sludge



Special Considerations for BPR

- Secondary release – selector basins and clarifiers
- Nitrates – RAS
- Recycle streams – especially from digesters and sludge thickening
- ORP and DO control

Twin Lakes WWTF

• Design Flow	1.076 MGD
• Peak Hourly	4.161 MGD
• BOD	2,710 lbs/day
• TSS	3,188 lbs/day
• NH3	320 lbs/day
• Phosphorus	64 lbs/day

WWTF Site

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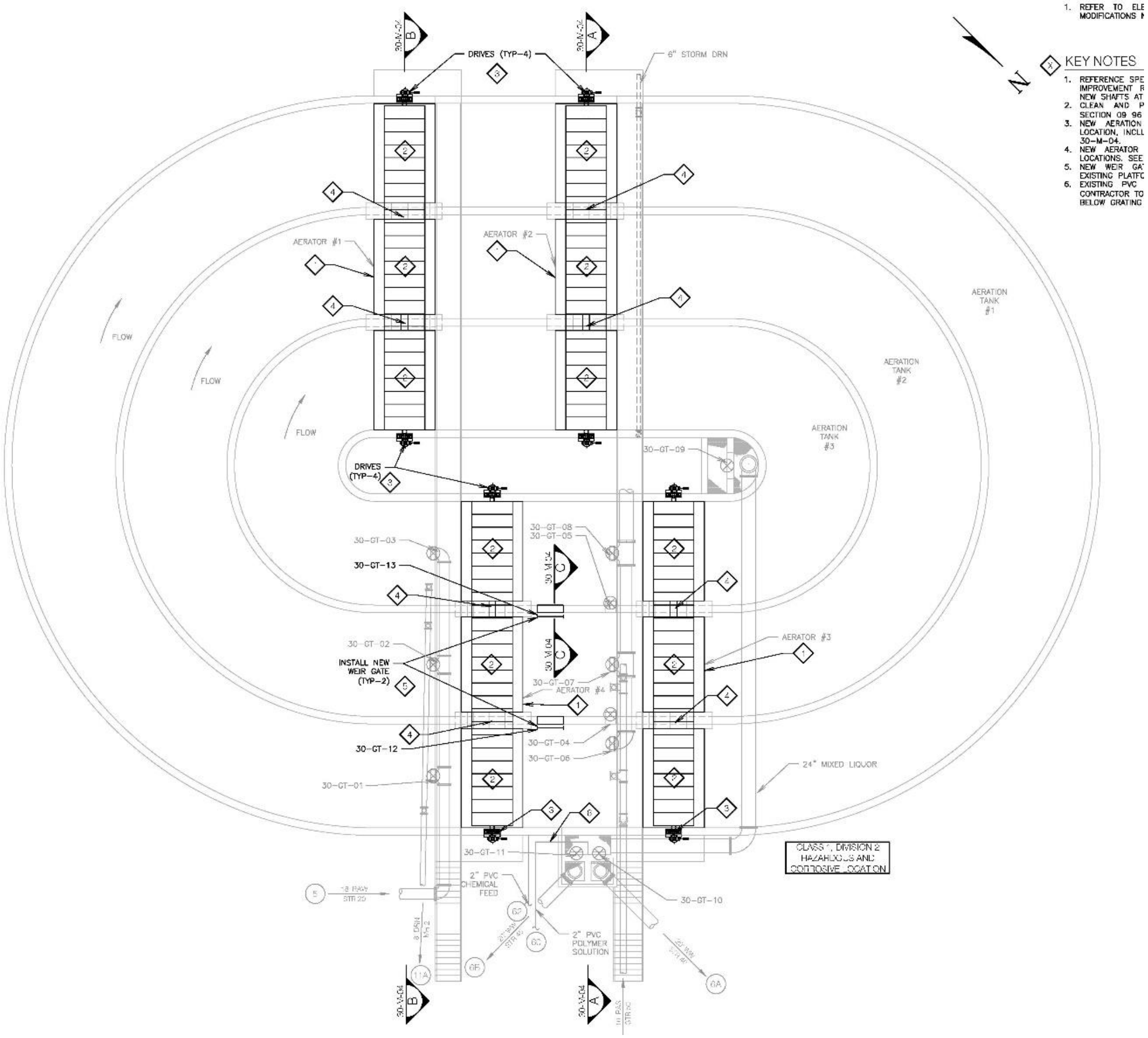
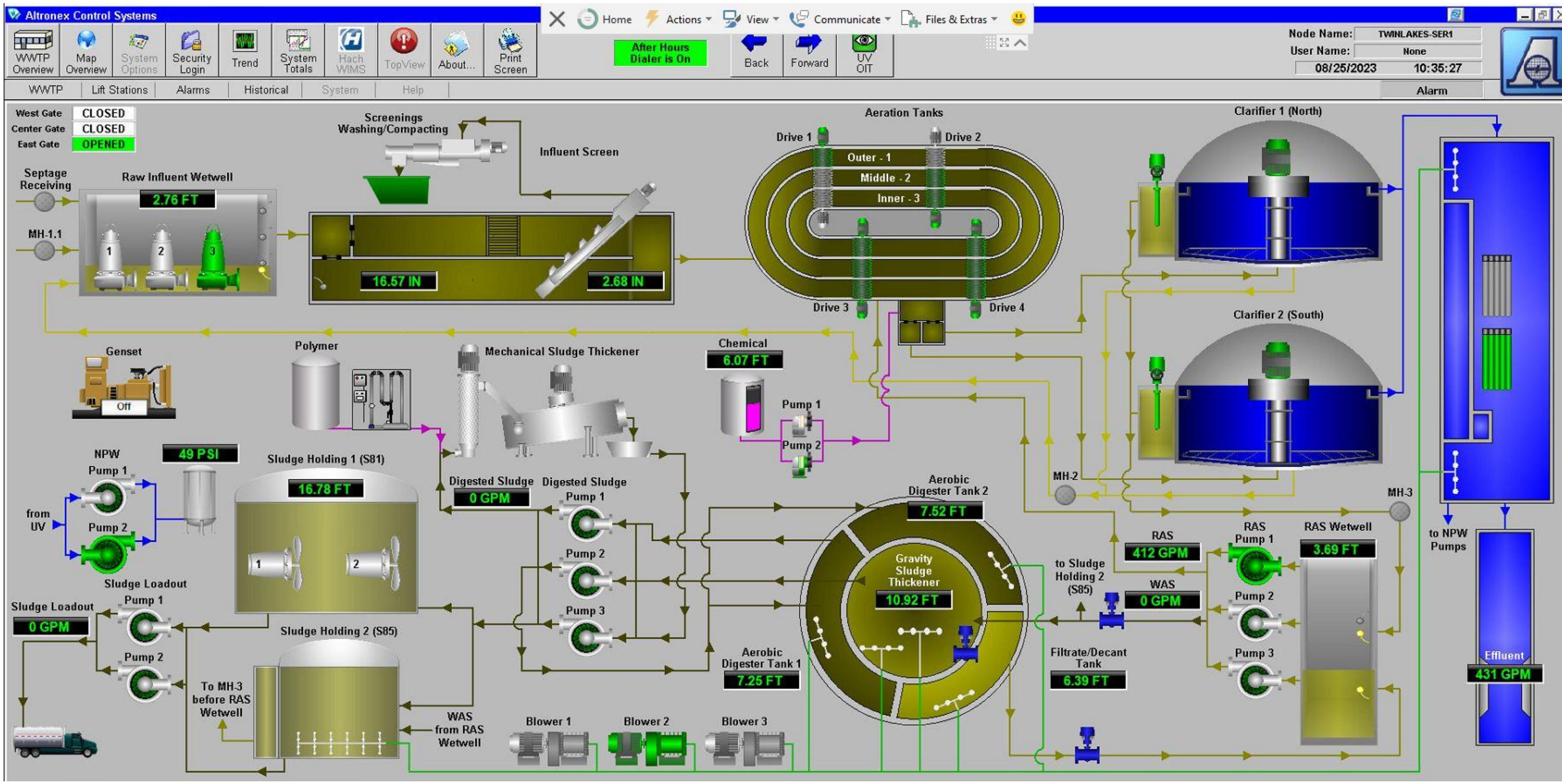
3-Channel Oxidation Ditch



SCADA Control

- The old controls allowed the staff to monitor the basic operations at the plant but lacked any true control of plant operations.
  - Upgrades allow staff to control the aeration rate, RAS & WAS rates, DO & ORP setpoints, and other critical processes
  - Allows the staff to batch or stagger filtrate and supernatant return to avoid slugging the plant
  - Monitor and record these setpoints for future operational adjustments as well

SCADA Control



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RAS Control

- Upgrades Included:
  - 3 new centrifugal dry-pit pumps with VFD control
  - Automated telescopic valves at the final clarifiers
  - SCADA control of the flow rates to allow operators to easily adjust the rates
  - Working flow meters!

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Recycle Flows

- Sludge Thickening
  - Aerate the filtrate to control the ammonia spikes
  - This avoids upsetting the bio-P process

- Aerobic Digesters
  - Slow release of supernatant flow from digesters to avoid P spikes
  - In Twin Lakes, this is comingled with the RAS and other recycle flows

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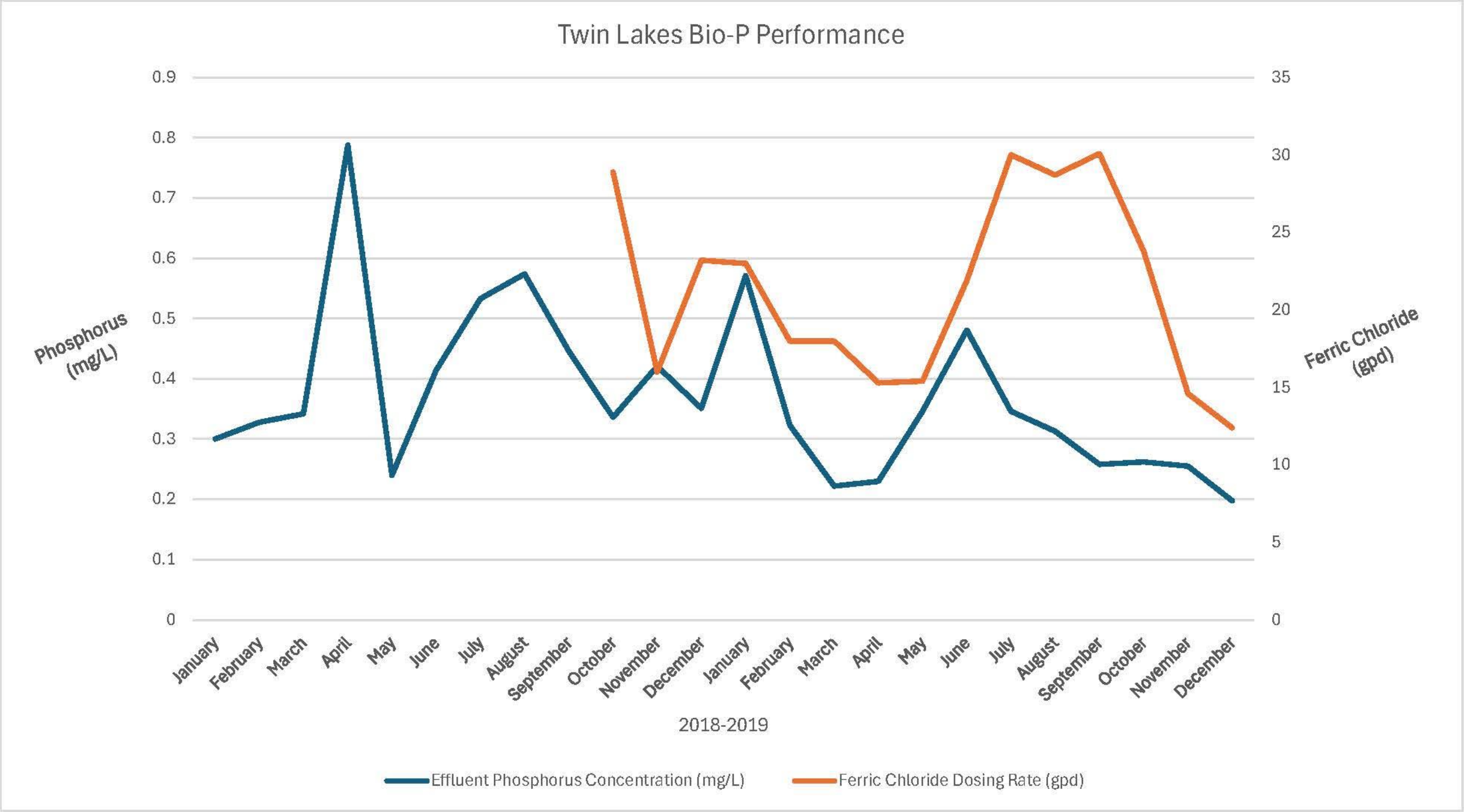
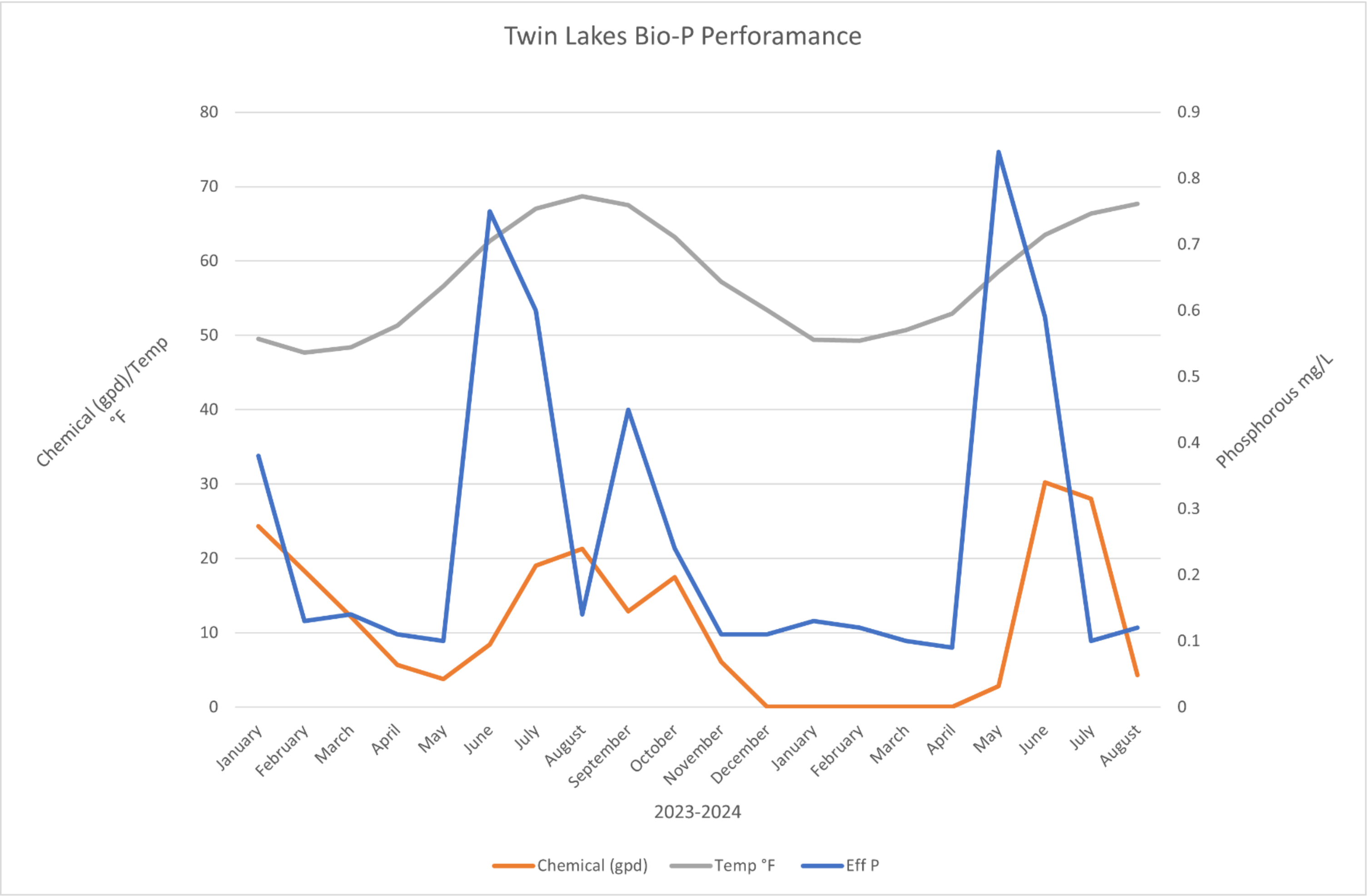
Before the Upgrades



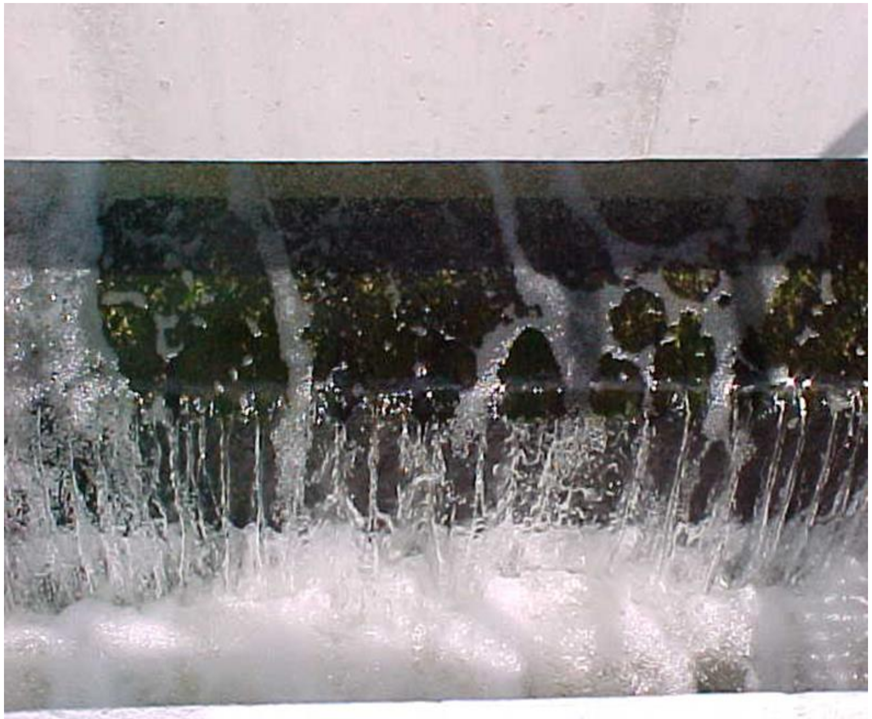
- Effluent P varied from 0.2 to 0.8 mg/L on average
- Dosing 13- 30 gpd of ferric chloride

Bio-P Performance



Twin Lakes - Operating Results

- Effluent Results
  - BOD/SS < 5 mg/L
  - Ammonia < 0.5 mg/L
  - Phosphorus < 0.3 mg/L
- Small / seasonal alum usage for “P” removal
- No control on recycle streaming



Bio-P Lessons Learned

- Water Temperature Matters
  - Bio-P performance stalls when the influent water temp hits about 57^o-59^o
  - < 57^o an ORP setting of -200 to -250 works great, and no alum addition is needed
  - < 59^o an ORP setting of -300 works best

- Heavy phosphorus / nutrient loading hits or high I/I will cause bio-P to stumble, but not fall

Bio-P Lessons Learned

- Mind your plant maintenance
  - ORP / DO sensors to be cleaned
  - Cleaning a clarifier can impact your nutrient management and upset the “status quo”
  - Digesters, sludge dewatering, sludge storage are all potential impacts to the Bio-P health

- Monitor your effluent phosphorus closely as you can lose bio-P quickly

- Data management and trending are great tools for keeping track of all the variables

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Summary

- Biological phosphorus removal can be a reliable alternative for phosphorus removal down to 0.5 mg/L or below
- Designs must incorporate flexibility to ensure systems can be optimized
  - Still need chemical backup for the inevitable upsets that will happen
- Process control allows ease of operation

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Questions / Comments

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