



STRATEGIES FOR UPGRADING EXISTING WWTPs TO MEET NEW NITROGEN AND PHOSPHORUS LIMITS

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**Ed Kobylinski, Chris deBarbadillo,
Bob Willet, James Barnard and Mark
Steichen**

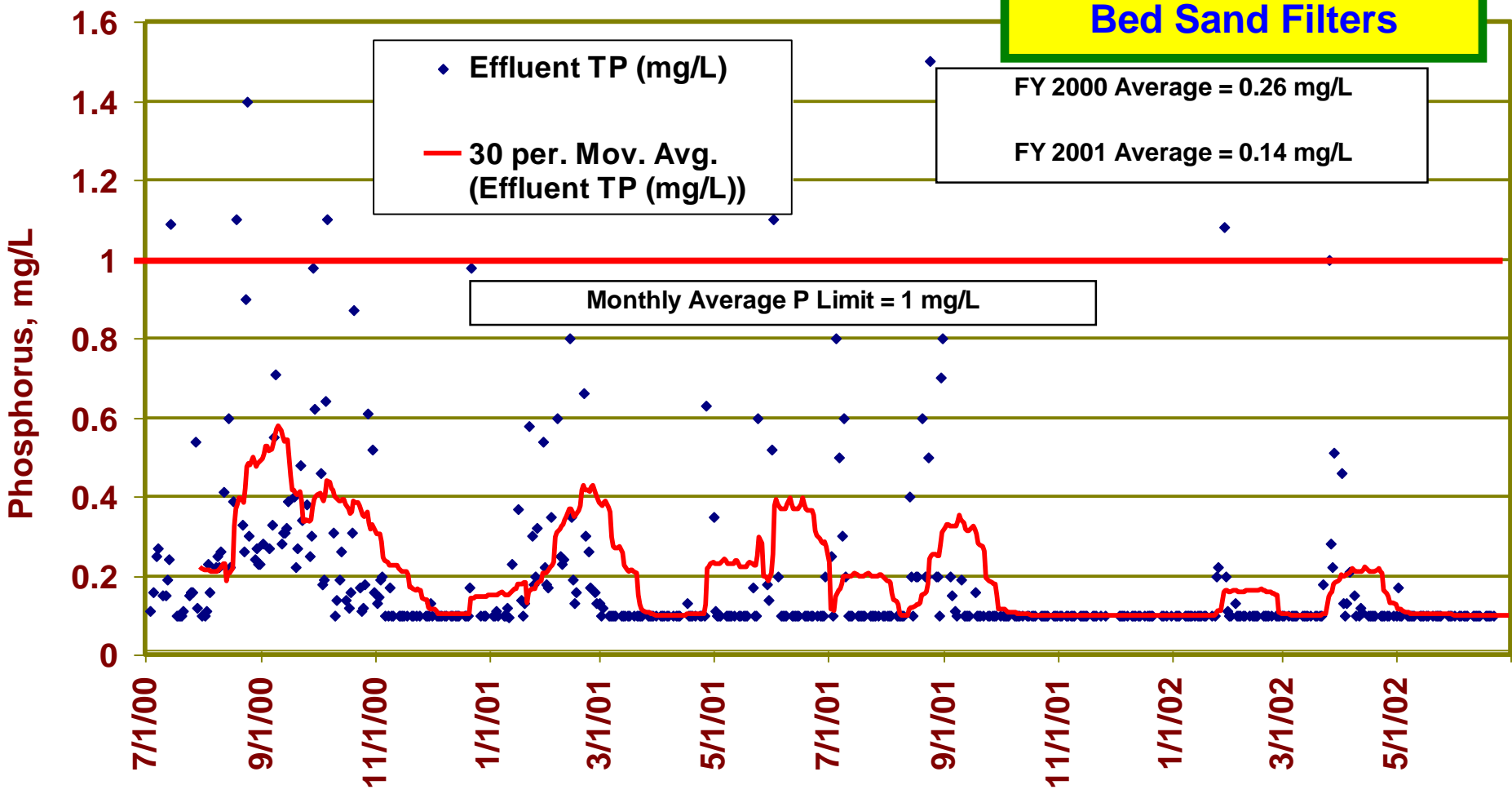
Why Do Some BPR Plants Work Better at Different Times of the Year?

● THREE BASIC CONDITIONS

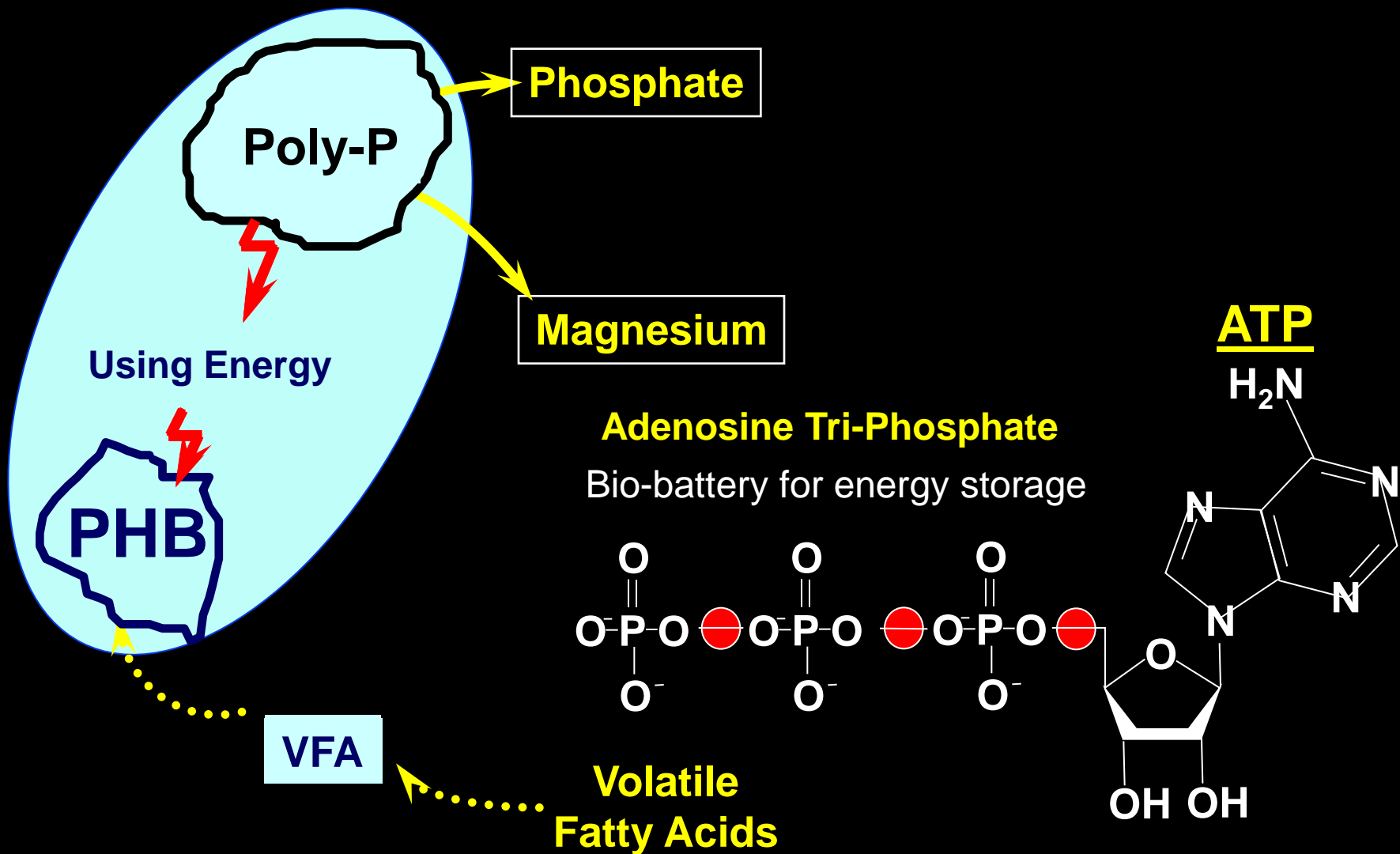
- There is plenty of VFA in the WWTP influent
 - ***Bio P works Great!***
- There is plenty of soluble food but little VFA in influent
 - ***Bio P works Great!***
- Incoming wastewater is anemic and has little to no VFA and little soluble food
 - ***Bio P Performance is not as good as it should be***

Results from Charlotte NC

**BNR Plant with Deep
Bed Sand Filters**

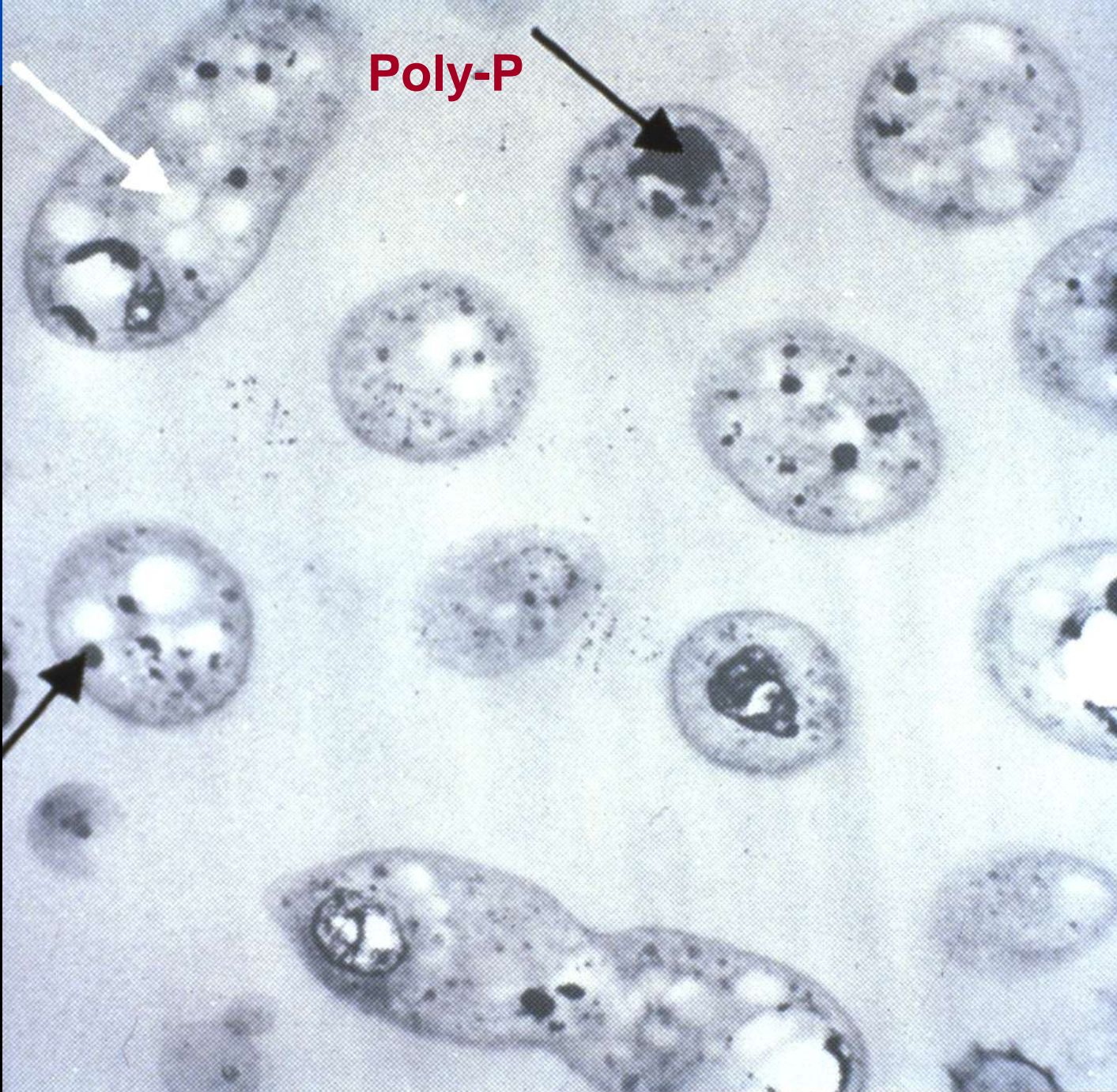


Under Anaerobic Conditions – ATP Depletion



PHB

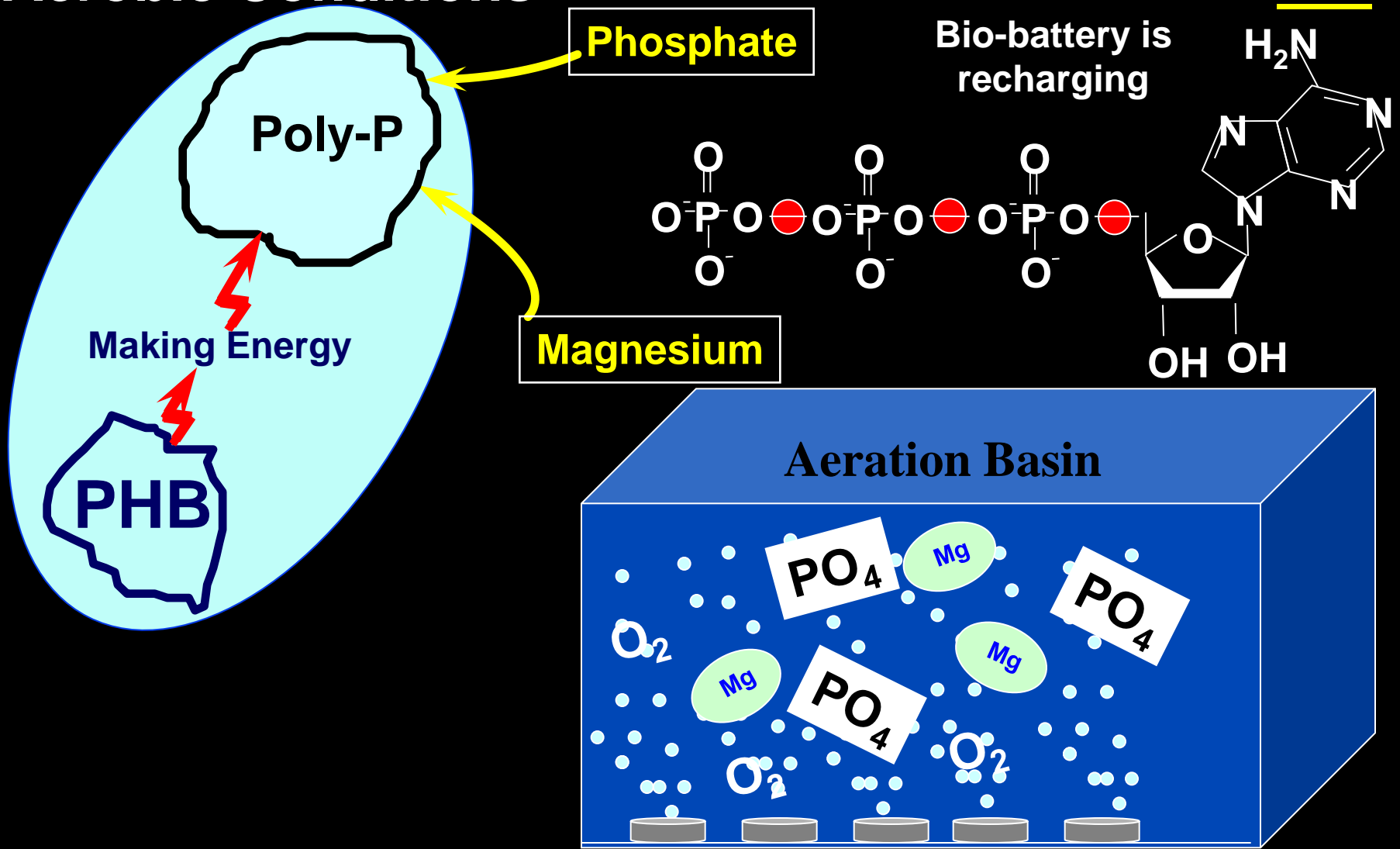
Poly-P



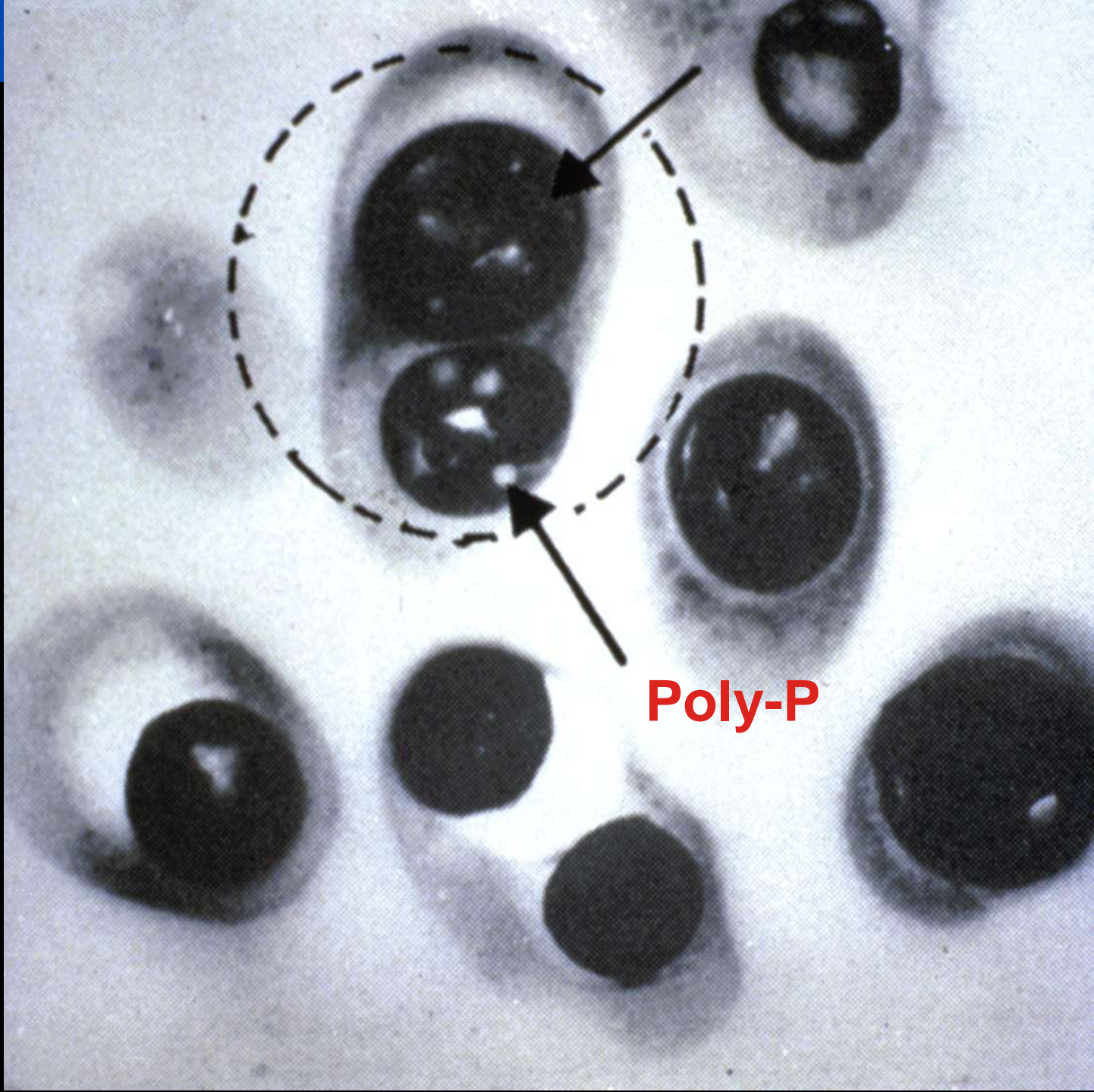
Electron microscope
– Poly stains black,
PHB stains white

Poly-P

Phosphate Uptake/ ATP Production - Under Aerobic Conditions



**Poly-phosphate
stored in the
aerobic zone.
Phosphorus is
removed with
the WAS.**



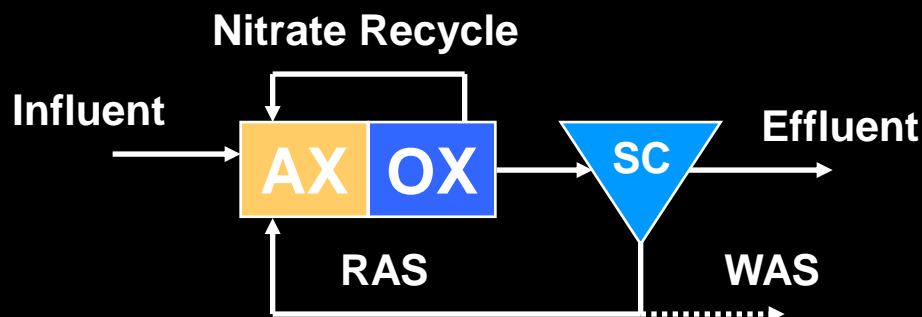
Poly-P

Upgrade or Optimize Process Without Increasing Tank Volume to Meet Nutrient Limits

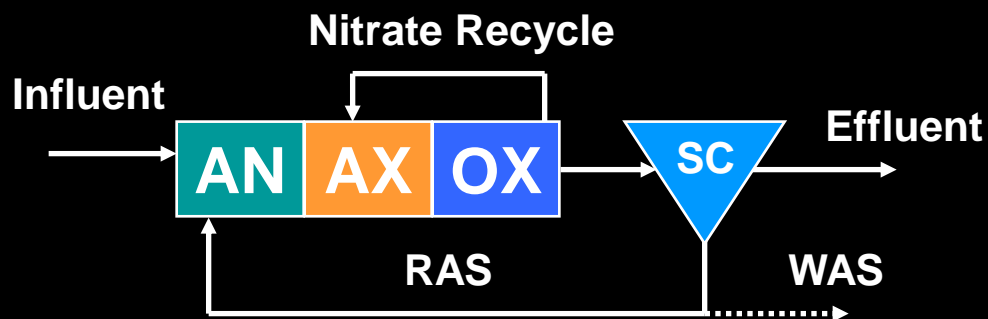
- Convert from low rate to higher rate process
- Convert from two-stage biological process to single stage
- Retrofit plug flow activated sludge to step-feed
- Add selectors

Some BNR Configurations (Effluent TN = 6 to 10 mg/L)

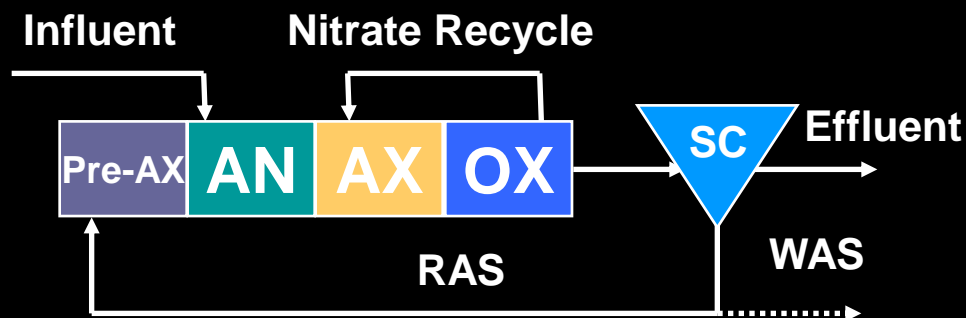
**MLE – Nitrogen
only**



**A2/O – Both N
and P**



**Johannesburg –
Both N and P**



Convert Process From Low Rate to High Rate

- Low rate
 - F/M ratio 0.05 to 0.3
 - SRT > 20 days
 - HRT > 24 hours
 - Large aeration tanks
 - Fewer clarifiers
- Low-rate processes
 - Extended aeration
 - Oxidation ditch
- Higher rate
 - F/M ratio 0.2 to 0.5
 - SRT < 20 days
 - HRT < 12 hours
 - Smaller aeration tanks
 - May need larger clarifier area
- Higher-rate processes
 - Conventional activated sludge
 - Step-feed activated sludge
 - Single-stage nitrification

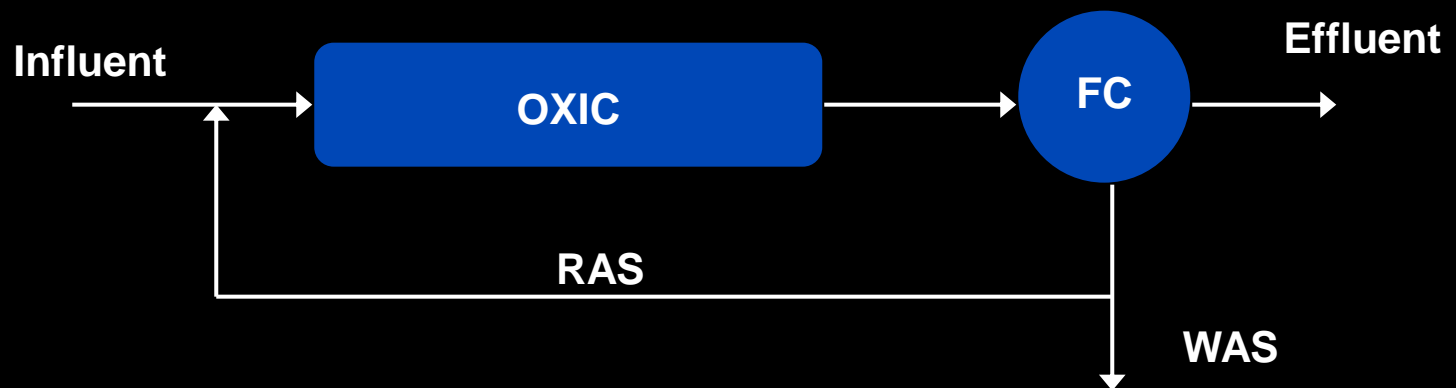
Northside WWTP Kinston, NC

Opportunity to Convert
from lower to higher rate process



Existing Plant Configuration

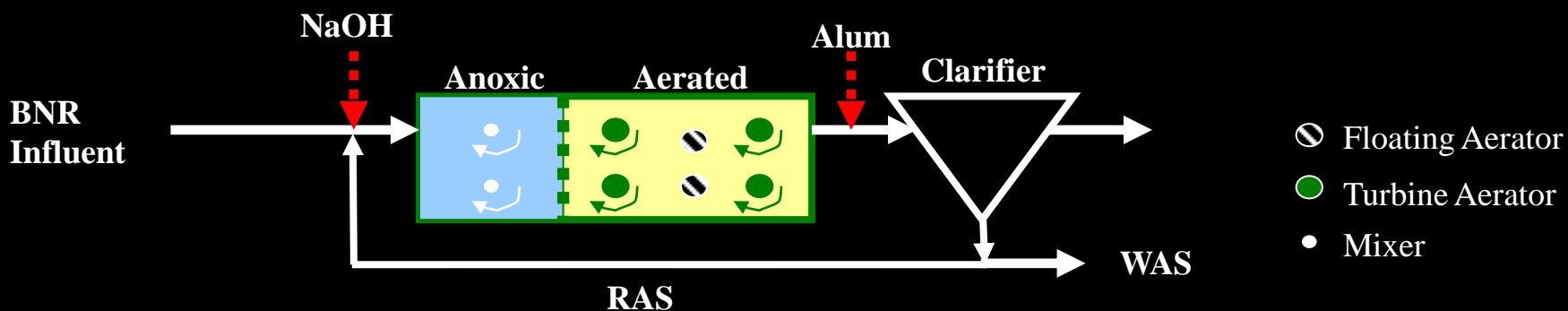
- Two WWTPs --
 - Peachtree and Northside
 - Extended aeration plants with mechanical aerators
 - Peachtree WWTP in flood plain
 - Existing Permit: BOD, TSS, NH₃-N



Phase 1 TN Upgrade Kinston, NC

Low cost TN removal retrofits completed at each plant site to meet Neuse River Rules/TMDL

- Aerators near aeration tank influent modified for use as mixers to form an “anoxic” zone
- \$0.02/gal capital cost
- Mechanical aerator flow patterns serve to “recycle” nitrified flow to the influent
- Effluent TN averages 4 mg/L w/o filters



Northside WWTP Phase 2 Kinston, NC

Convert from lower to higher rate process
Gets Most Use from Existing Facilities !!!

Facility Planning Considerations

- Rerate Northside from 4.5 to 9.25 mgd AAF
- Upgrade to BNR and tertiary denitrification filters
- Additional final clarifiers
- New anaerobic and anoxic basins
- Aeration upgrade for increased flow



Future limits

- 5 mg/L BOD₅
- 3.5 mg/L TN
- 1 mg/L TP

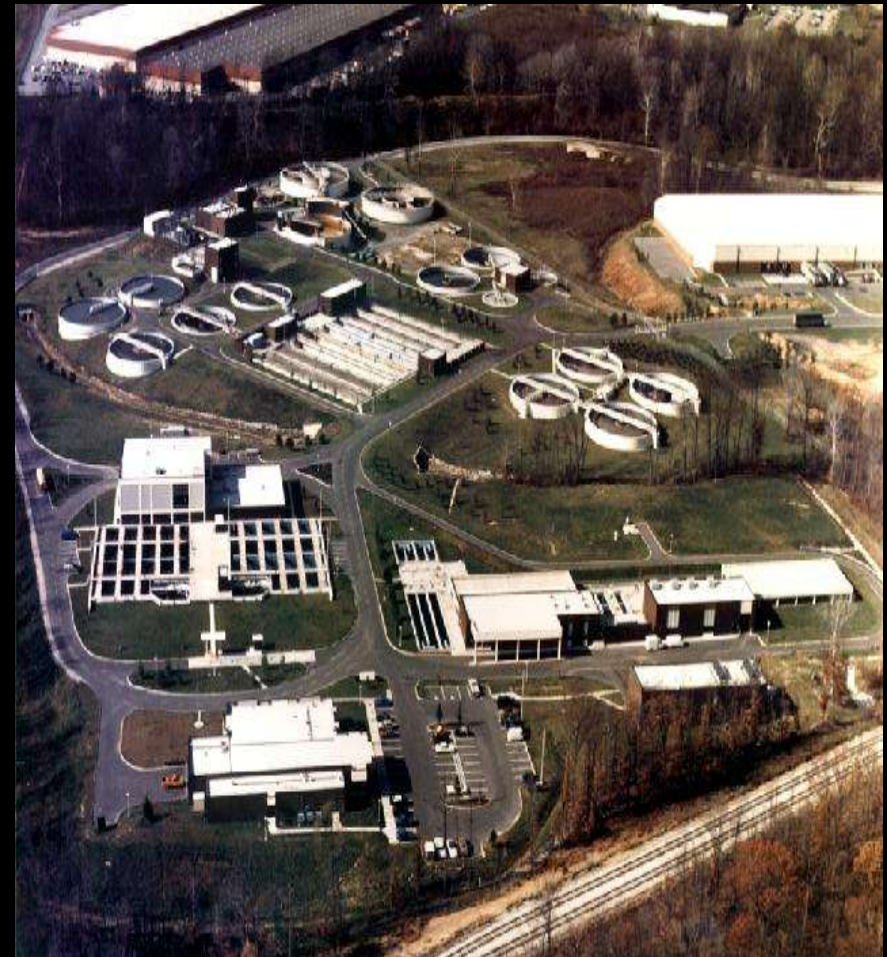
No new aeration tanks required for total nitrogen removal to 8 mg/L – Phase 1

Plant capacity can be nearly doubled with addition of final clarifiers

Little Patuxent WRP Howard County, MD

Original Plant Configuration

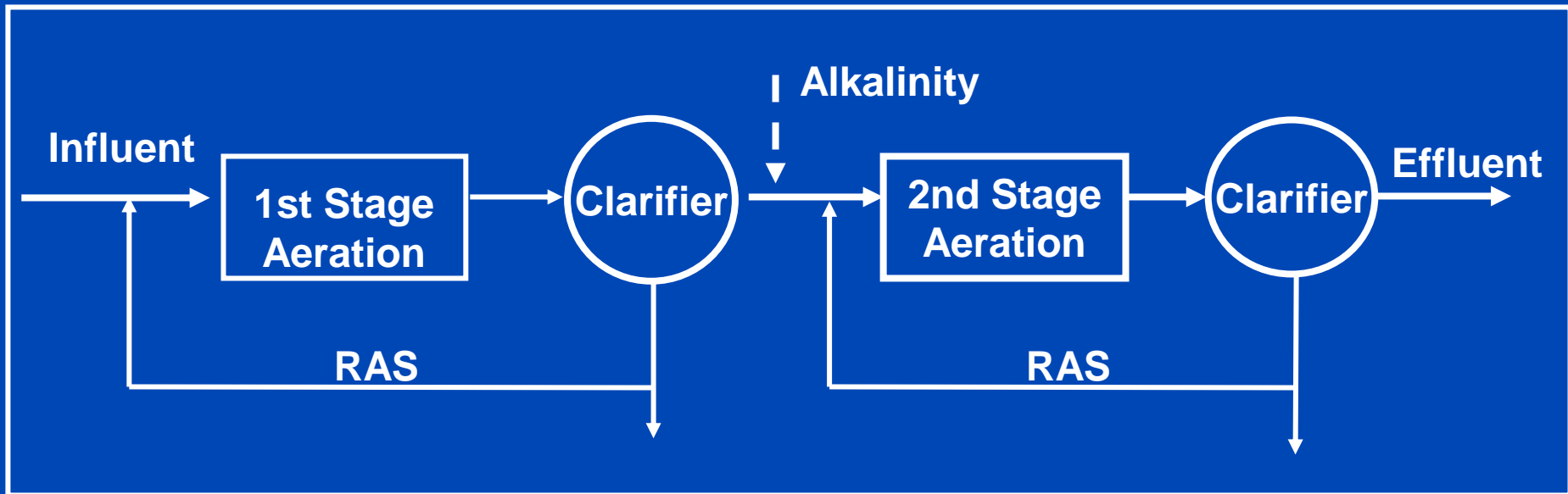
- Two-stage activated sludge system
- 2 double-pass aeration basins for BOD₅ removal and 3 clarifiers
- 4 single-pass nitrification basins and clarifiers
- Supplemental alkalinity required



Old permit limits:
BOD, TSS, TKN, TP

Two Stage Nitrification Process

- First stage BOD₅ removal and clarifiers
- Second-stage nitrification and clarifiers
- Alkalinity addition typically required for nitrification



Plant Upgrade Considerations

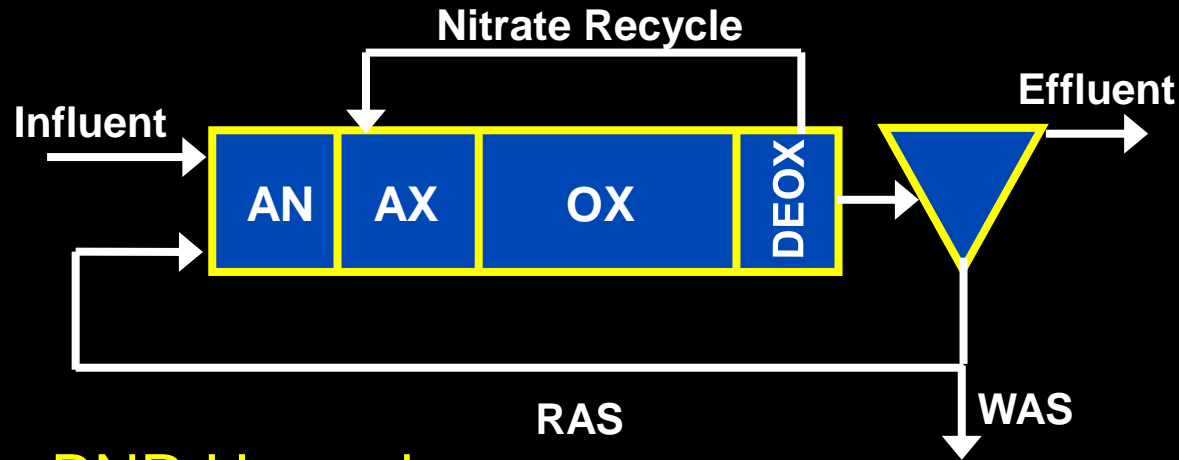
- Plant received nitrogen limits as the result of the Chesapeake Bay Agreement
- Convert to single stage activated sludge aeration basin followed by clarifiers
- “Adding” tanks and clarifiers to first stage allows SRT increase to support nitrification
- Constructing anaerobic and anoxic zones helps reduce BOD₅ load to aerated zone
- May have decrease in total sludge yield

Operating Challenge

BOD Limited ----- Must Reduce DO in Anaerobic and Anoxic Zones

- Non-aerated grit removal process
- Reduce free-fall at primary clarifier and splitter box weirs
- Submerged RAS discharge to aeration basins
- DO control in oxic zones
- Deoxygenation zones for nitrate recycle

Little Patuxent WRP



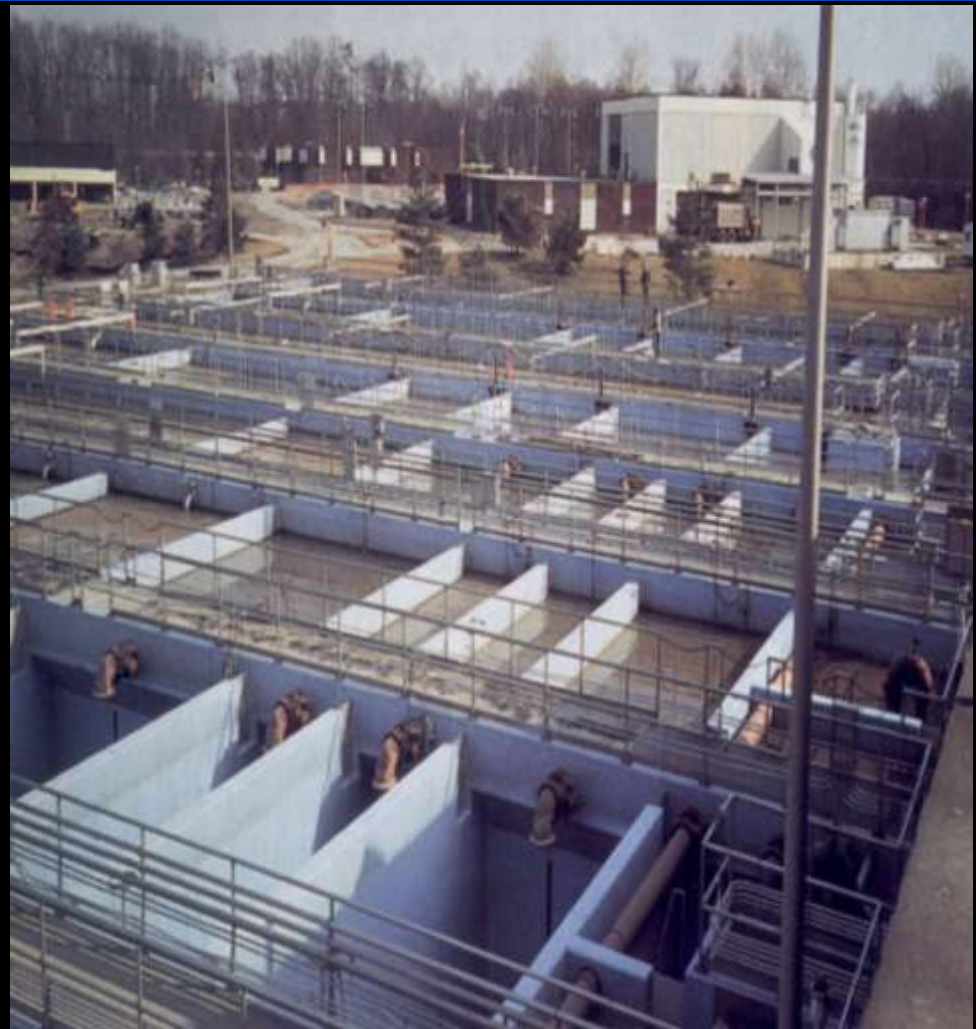
BNR Upgrade

- New permit limit: seasonal TN < 8mg/L
- Existing aeration basins and clarifiers converted to single-stage anaerobic/anoxic/oxic BNR process
- Two single-pass reactors and one clarifier for capacity increase to 18 mgd
- Phostrip system decommissioned

Little Patuxent WRP

The Bottom Line

- No new tanks for upgrade of existing 15-mgd capacity
- Simpler operation
 - No Phostrip process
 - Single vs. multi stage
- Reduction in chemical requirements
 - Phosphorus stripping
 - Supplemental alkalinity



Franklin WWTP

Franklin, TN

- Original Plant with 5.5 mgd capacity
- Two new Carrousel denitR systems with 6.5 mgd capacity



12-mgd Upgrade Franklin, TN

- Re-rate and add third oxidation ditch for expansion to 12 mgd (expected effluent TN is about 5 mg/L)
- Denitrification Filters
 - \$0.29/gal (no building)
- Online monitoring of NO_x-N, NH₃-N, DO, MLSS
- Permit Considerations:
 - Mass limit of approx. 3 mg/L at design flow
 - TN limit computed as seasonal
 - 5 mg/L TN concentration limit
 - NH₃-N limit of 0.4 mg/L



Key Issues

- Site Availability
- Plant Hydraulics
- Influent Wastewater Characteristics – do you have sufficient carbon?
- Permit Limits – Wet Weather and Other Permitting issues
- Future Conditions – permit limits (nutrients) and growth

**Northeast TP limits = 0.1 mg/L – Eco Region
Standards 0.8 mg/L TN and 0.037 mg/L TP – 1.0
mg/L TIN in CA – 0.02 mg/L TP in Canada**

Goals

- Creative use of existing facilities to get the maximum capacity
- Minimize capital costs
- Produce a facility that is “easy” to operate
- Process reliability
- Must meet permit

There are many ways to upgrade for nutrient removal – Which One is Right for You?

QUESTIONS?

