LOOKING INTO THE CRYSTAL BALL

WHERE IS THE WATER AND WASTEWATER INDUSTRY HEADED?

2019 Central West Texas Regional School

Joshua L. Berryhill, P.E.
Enprotec / Hibbs & Todd, Inc. (eHT)

Presentation Topics

- **Water Discussion**
  - Current Major Water Regulations
  - Anticipated Updates to Current Water Rules
  - Anticipated New Water Rules Coming
  - Current Water Treatment Technology Options
  - Future Water Tech

- **Wastewater Discussion**
  - Current Major Wastewater Regulations
  - Anticipated Updates to Current Wastewater Rules
  - Anticipated New Wastewater Rules Coming
  - Current Wastewater Treatment Technology Options
  - Future Wastewater Tech

Current Major Water Regulations

- LT2 – Long Term Stage 2 Enhanced Surface Water Treatment Rule
  - <= 0.3 Nephelometric Turbidity Units (NTU) 95% of the time
  - <= 1.0 NTU 100% of the time
- DB2 – Stage 2 Disinfectants and Disinfection Byproducts Rule
  - Locational Running Annual Average (LRAA) for Total Trihalomethanes (TTHM) of 80 parts per billion (ppb)
  - LRAA for Haloacetic Acids (HAA5) of 60 ppb

Anticipated Updates to Current Water Rules

- LT3?
  - Long Term 3 Enhanced Surface Water Treatment Rule
  - Turbidity is an indirect indicator of potential for pathogen exposure risk – SWTR focuses on reduction of finished water turbidity
  - Anticipated within the next 5-10 years

- History of ESWTR
  - Original SWTR – 1989
    - Interim Enhanced SWTR – 1998
      - Long Term 1 ESWTR – 2002
        - » Long Term 2 ESWTR – 2006
          - Long Term 3….?

Anticipated Updates to Current Water Rules

- Why is LT3 a concern?
  - Current filter requirements
    - < 0.3 Nephelometric Turbidity Units (NTU) 95% of the time
    - < 1.0 NTU 100% of the time
    - These limits can be met by 99+% of the water utilities in Texas
  - Original version of LT2 proposed by EPA
    - < 0.1 NTU 95% of the time
    - < 0.3 NTU 100% of the time
    - These lower limits can only be met consistently with the use of membrane filtration technology

Anticipated Updates to Current Water Rules

- DB3?
  - Stage 3 Disinfectants and Disinfection Byproducts Rule
  - Disinfection of water can create carcinogenic compounds – Focus is on reducing the potential for carcinogen exposure risk
  - Anticipated within the next 2-3 years

- History of DBP
  - Original DBP Rule – 1998
    - Stage 1 DBP Rule Revisions – 2001
      - Stage 2 DBP Rule – 2006
        - Stage 3….?

Anticipated Updates to Current Water Rules

- Why is DB3 a concern?
  - Current DBP requirements
    - < 80 parts per billion (ppb) Total Trihalomethanes (TTHM)
    - < 60 ppb Haloacetic Acids (HAA5)
    - These limits can be met by most of the water utilities in Texas, with most utilities switching from free chlorine to chloramine use
  - Growing concerns about chloramination byproducts (not currently regulated…yet)
  - Potential changes in the future (if still focusing on just free chlorine based DBPs)
    - < 40-60 ppb TTHM
    - < 30-40 ppb HAA5
    - These limits will be difficult to meet consistently without major treatment changes

Anticipated New Water Rules Coming

- Perchlorate
- Strontium
- PFAS
- NDMA
- Additional TTHMs
- Additional HAA5s

Anticipated New Water Rules Coming

- Perchlorate
  - Active ingredient in many different types of rocket booster fuel, explosives, ordinance – previously thought to be focused around military bases, now found worldwide
  - Concern as potential carcinogen

- Strontium
  - Commonly found in brackish water supplies
  - Concern on impacts to growth and development of children

Anticipated New Water Rules Coming

- PFAS – Per- and Polyfluoroalkyl Substances
  - A “wonder chemical” used since 1940, primarily used in cookware – it does not break down naturally, so is now found worldwide
  - Concern as potential carcinogen, both with mutagenic and teratogenic impacts (cancer for you, impacts to your children and grandchildren)

- NDMA – N-Nitrosodimethylamine
  - Found in some industrial processes, most commonly produced through chloramination of drinking water and wastewater
  - Concern as potential carcinogen

Anticipated New Water Rules Coming

- Additional TTHMs
  - Current regulations are based on free chlorine formed TTHMs – Additional TTHMs are formed through chloramination as well, just not currently regulated
  - Concern as potential carcinogen

- Additional HAA5s
  - Current regulations are based on free chlorine formed HAA5 – Additional HAA5 are formed through chloramination as well, just not currently regulated
  - Concern as potential carcinogen

Current Water Treatment Technology Options

- Meet Lower Turbidity Requirements
  - Implement membrane filtration technology, either in the form of microfiltration or ultrafiltration
  - Can operate in pressure or submerged vacuum mode
  - Multiple proven systems in Texas, with the oldest almost 20 years old

Current Water Treatment Technology Options

- Meet Reduced DBP Limits

  - Can treat before disinfection, after disinfection, or both

  - Before Disinfection
    - Reduce formation potential before reacting with chlorine
    - Reduce TOC with enhanced coagulation, GAC, chlorine dioxide, ozone, peroxide, permanganate, UV-AOP, RO, NF

  - After Disinfection
    - “Strip” formed DBPs from finished water
    - Clearwell mixing, air addition, forced ventilation

Current Water Treatment Technology Options

- Meet Strontium Limit
  - Implement desalination type technology
    - Reverse Osmosis (RO)
    - Nanofiltration (NF)
    - Electrodialysis (ED)
    - Electrodialysis Reversal (EDR)
    - Electrodistillation (EDI)

Current Water Treatment Technology Options

- Meet PFAS Limit
  - Implement RO or GAC
    - Reverse Osmosis – Effective large-scale, and limited effectiveness for POU units
    - Granular Activated Carbon – Effective large-scale, short operating life for POU units

Current Water Treatment Technology Options

- Meet NDMA or Tightened TTHM/HAA5 Limits
  - Need to focus on treatment prior to disinfection
    - Reduce formation potential before reacting with chlorine
      - Need to consider alternate disinfection options – no more chlorine?
    - Reduce TOC with enhanced coagulation, GAC, chlorine dioxide, ozone, peroxide, permanganate, UV-AOP, RO, NF

Future Water Tech

- Upcoming Technologies
  - Electrocoagulation
    - Can minimize or eliminate the need for coagulant while completing enhanced coagulation of TOC
  - Forward Osmosis
    - Performance is similar to RO, but at a fraction of energy use
    - Currently in prototype testing in UAE
  - Ozone/BAF
    - Ozonation combined with Biologically Active Filters
    - Concerns about Bromate formation
    - Current being tested in Dallas, TX

Wastewater Discussion

Current Major Wastewater Regulations

- What are typical current permit limits in Texas?
  - Natural Treatment (Lagoon) Systems
    - BOD – 30 mg/L
    - TSS – 90mg/L
  - Mechanical Treatment WWTPs
    - BOD (or cBOD) – 5-15 mg/L
    - TSS – 7-15 mg/L
    - NH_3 – 2-3 mg/L
  - Reuse
    - Type II Non-Potable Reuse
      - BOD (or cBOD) – 20 mg/L
    - Type I Non-Potable Reuse
      - BOD (or cBOD) – 5 mg/L
      - Turbidity – 3 NTU

Anticipated Updates to Current Wastewater Rules

- What changes are anticipated to current permit limits in Texas?
  - Changes are site specific to a given receiving stream, but changes are occurring throughout Texas
  - BOD or cBOD
    - 5-15 mg/L -> 5-7 mg/L
  - TSS
    - 7-15 mg/L -> 5-7 mg/L
  - Ammonia (NH_3)
    - 2-3 mg/L -> 1-2 mg/L
  - E. Coli
    - 126 CFU / 100 ml -> 63 CFU / 100 ml

Anticipated New Wastewater Rules Coming

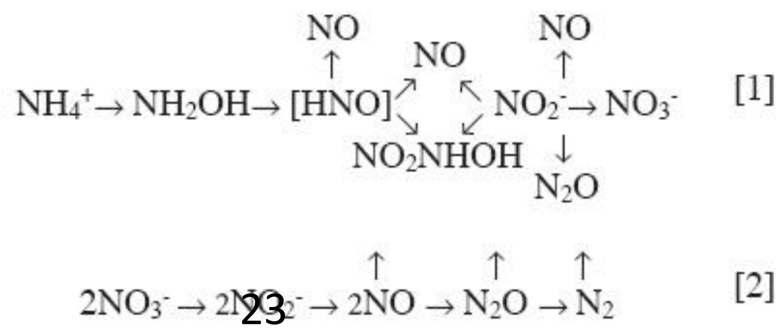
- What changes may be coming to permitting?
  - Numeric Nutrient Criteria Development Plan
    - WAS anticipated to become active in 2016
    - Intended to evaluate WWTPs for the potential of adding a total phosphorus (TP) and/or total nitrogen (TN) limit to permits
    - Triggers for further evaluation:
      - WWTP permit rating >= 0.5 MGD
      - TP in effluent >= 3.5 mg/L
      - TN in effluent >= 15 mg/L (primarily in coastal areas)
      - Discharge stream segment is impaired for anything

Current Wastewater Treatment Technology Options

- What if I get a nutrient limit added to my permit?
  - Total Nitrogen
    - Need to start planning for adding a nitrogen removal step
      - Biological Removal of Ammonia/Nitrate/Nitrite
  - Total Phosphorus
    - Need to start planning for adding a phosphorus removal step
      - Chemical Removal?
      - Biological Removal?
      - Filtration Removal?

Current Wastewater Treatment Technology Options

- Advanced Nitrogen Reduction
  - Biological Removal
    - Ammonia (NH_3)
      - Removal via nitrification step in aerobic selector zone, conversion to nitrate (NO_3)
    - Nitrate (NO_3) and Nitrite (NO_2)
      - Addition of an anoxic (zero free dissolved oxygen) selector zone upstream of the aerobic selector zone



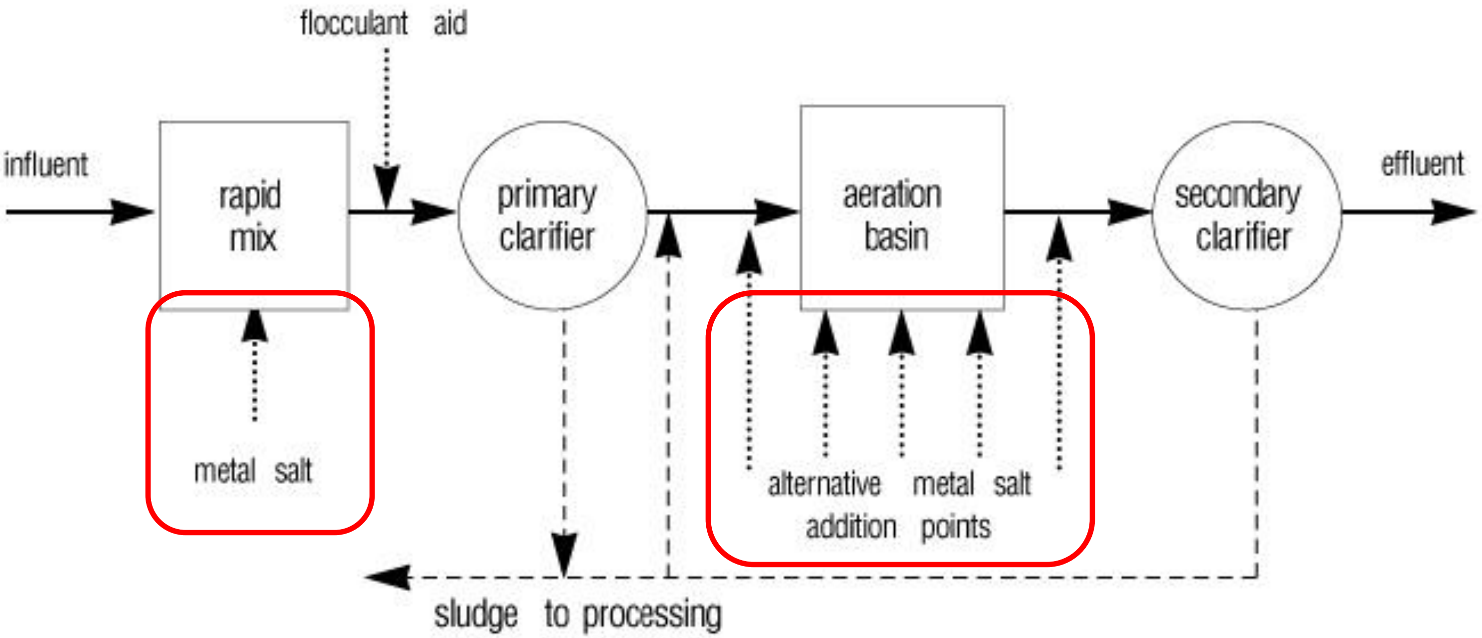
Current Wastewater Treatment Technology Options

- Phosphorus Reduction
  - Chemical Removal
    - Can remove orthophosphate (PO_4, HPO_4, H_2PO_4) via chemical bonding and precipitation
    - Addition of a metal salt such as alum (aluminum sulfate) or ferric (ferric sulfate) can bond with phosphorus
    - Can typically remove down to 0.5-1.0 mg/L

    - $Al + PO_4 \Rightarrow AlPO_4$
      - Works best at a pH range of 5-7
      - Potential nitrification impacts
    - $Fe + PO_4 \Rightarrow FePO_4$
      - Works best at a pH range of 6.5-7.5

Current Wastewater Treatment Technology Options

Fig. 1: **Multiple point application flow diagram**

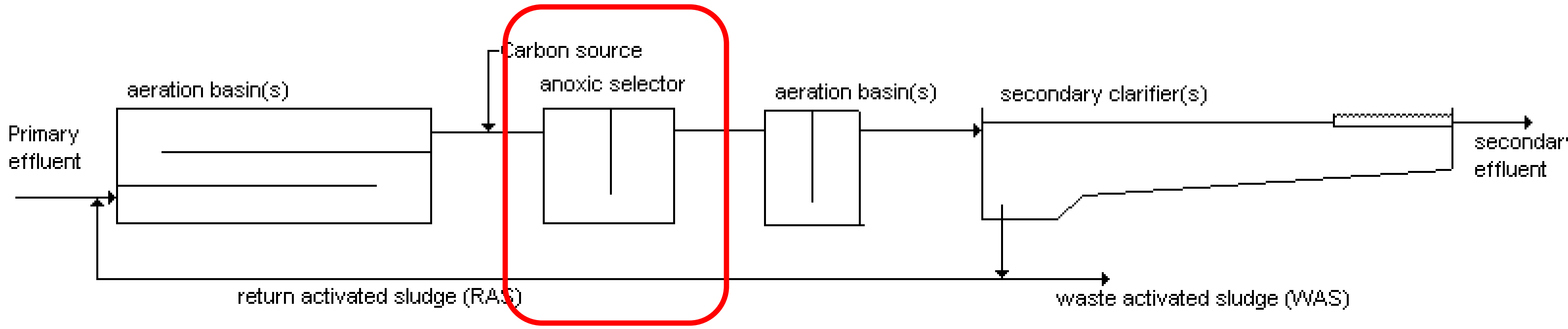


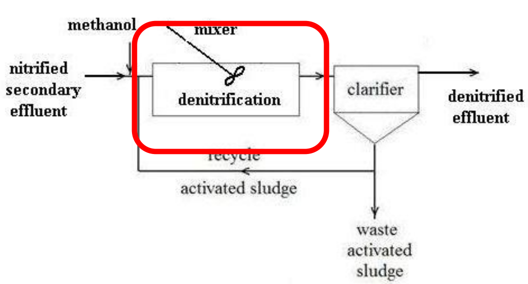
Source: Bowker and Stensel (1990)

Current Wastewater Treatment Technology Options

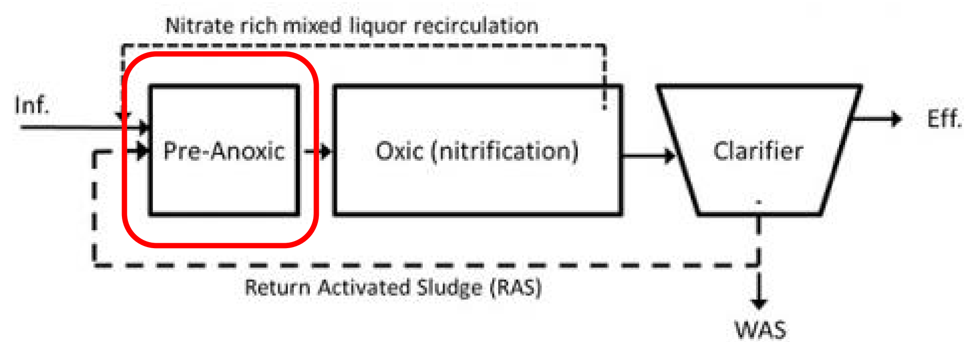
- How can phosphorus be removed at a WWTP?
  - Biological Removal
    - Orthophosphate
      - Biomass does not readily absorb orthophosphate, the orthophosphate must be converted to polyphosphate for uptake
      - Conversion occurs via breakdown in an anaerobic selector zone (no presence of oxygen), along with the production of volatile fatty acids (VFAs)
    - Polyphosphate
      - Biomass in the aerobic selector zone called phosphorus accumulating organisms (PAOs) absorb excess phosphorus while consuming VFAs
    - Can typically remove phosphorus down to 0.5 mg/L

Current Wastewater Treatment Technology Options





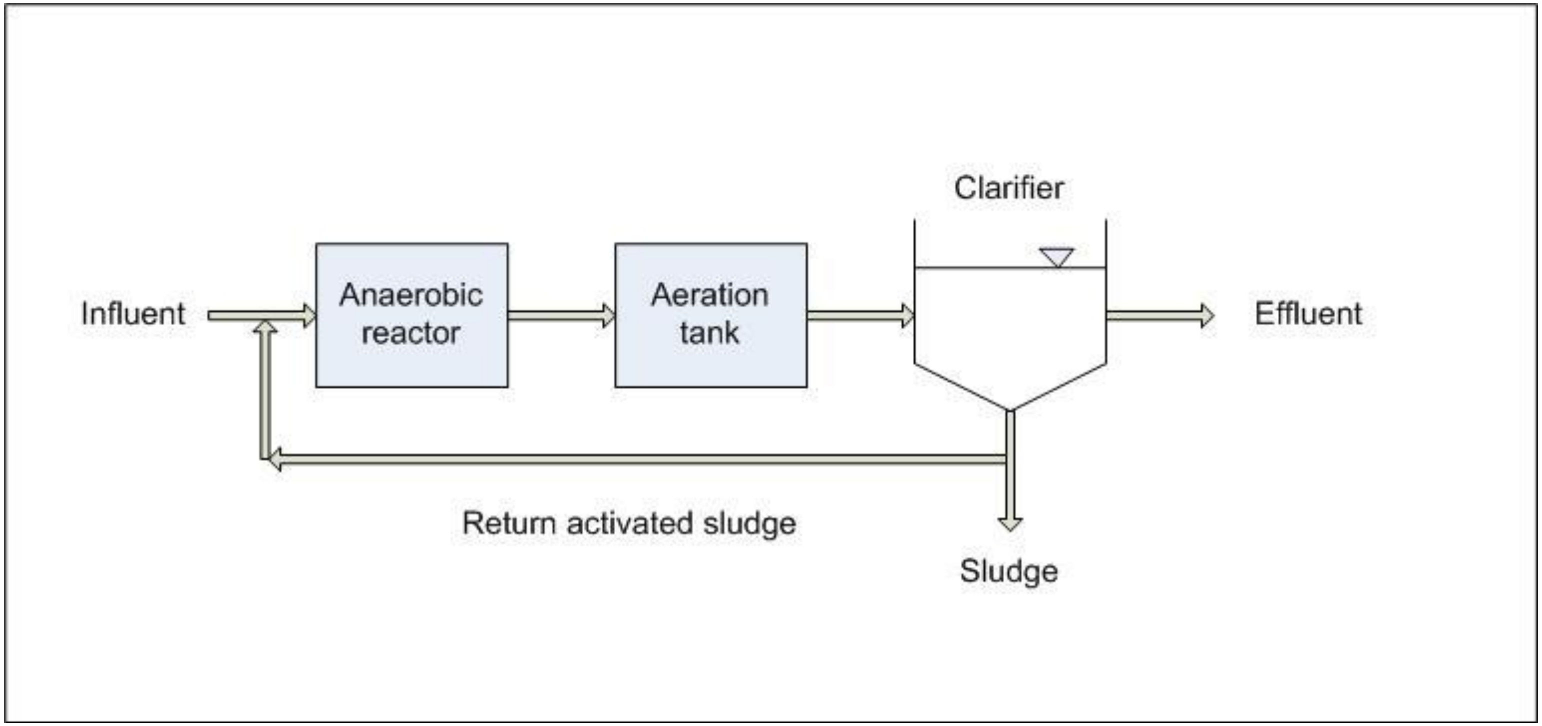
Denitrification Process Flow Diagram



Modified Ludzack-Ettinger (MLE) Process

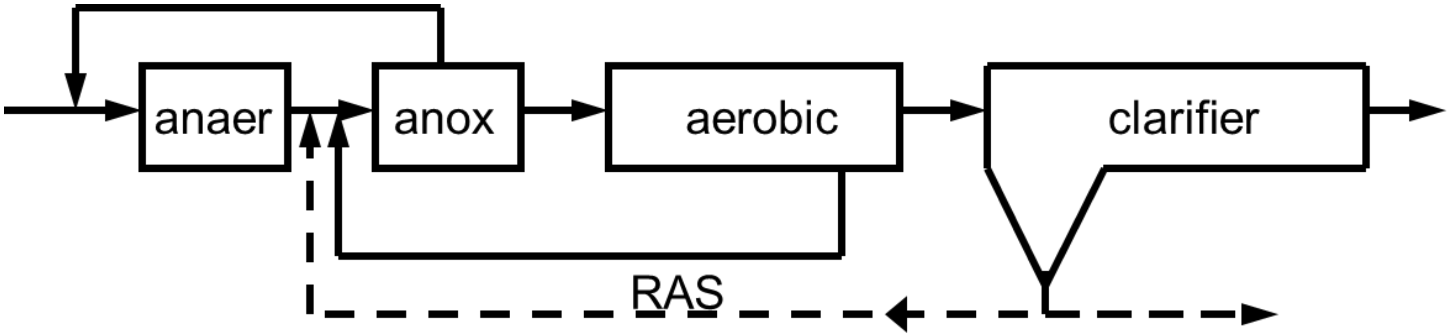
Current Wastewater Treatment Technology Options

- Anaerobic-Oxic (AO) Process



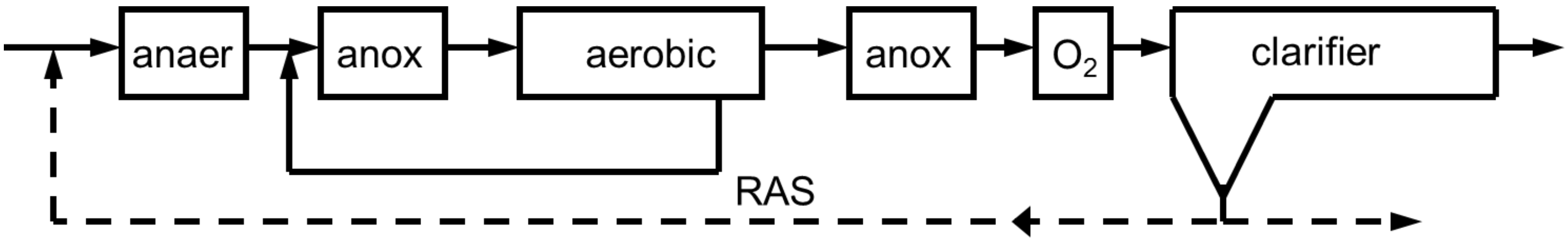
Current Wastewater Treatment Technology Options

- University of Capetown (UCT) Process

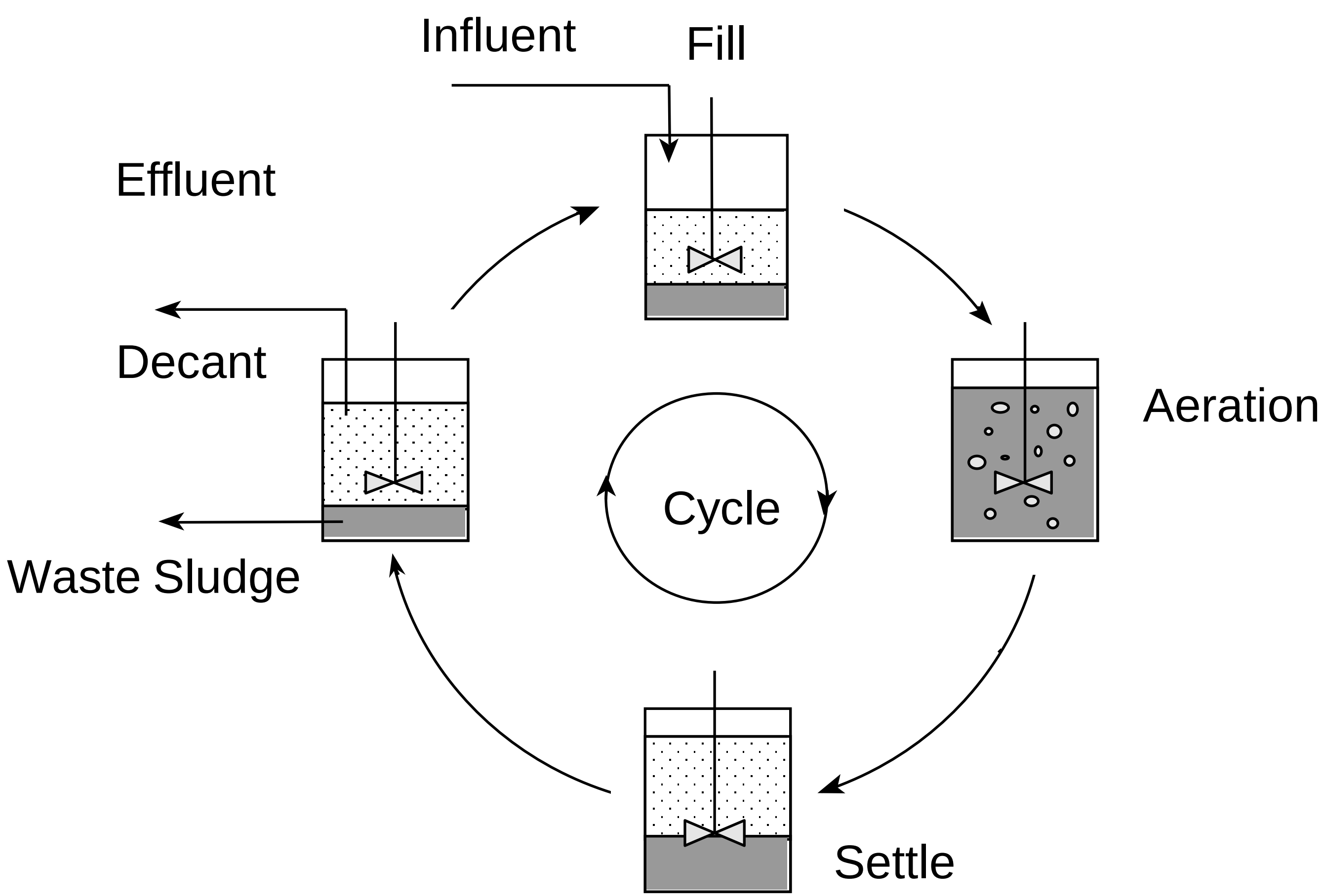


Current Wastewater Treatment Technology Options

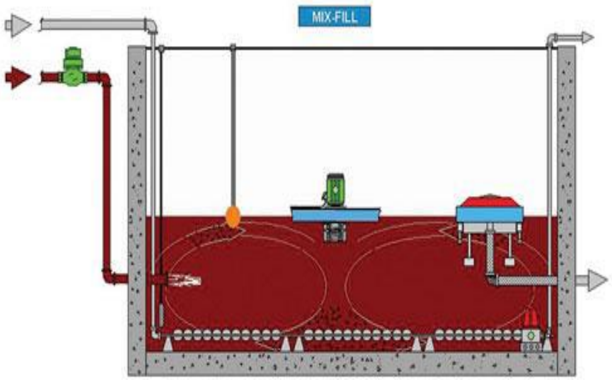
- Bardenpho Process



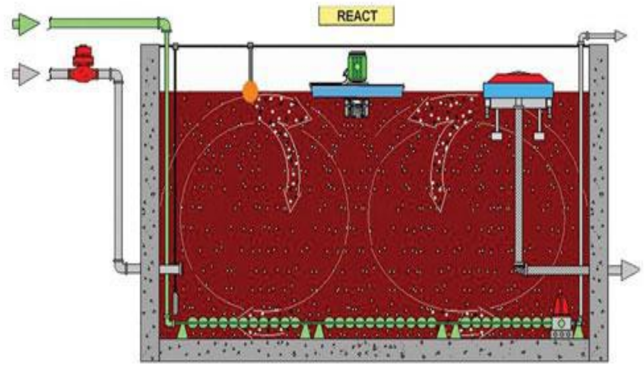
Current Wastewater Treatment Technology Options



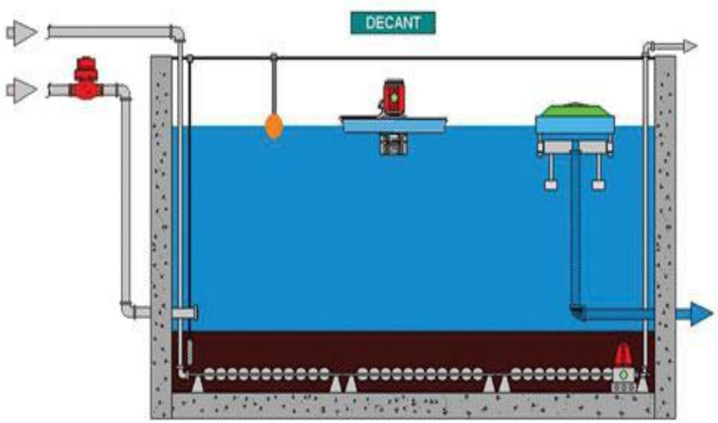
Current Wastewater Treatment Technology Options



FILL

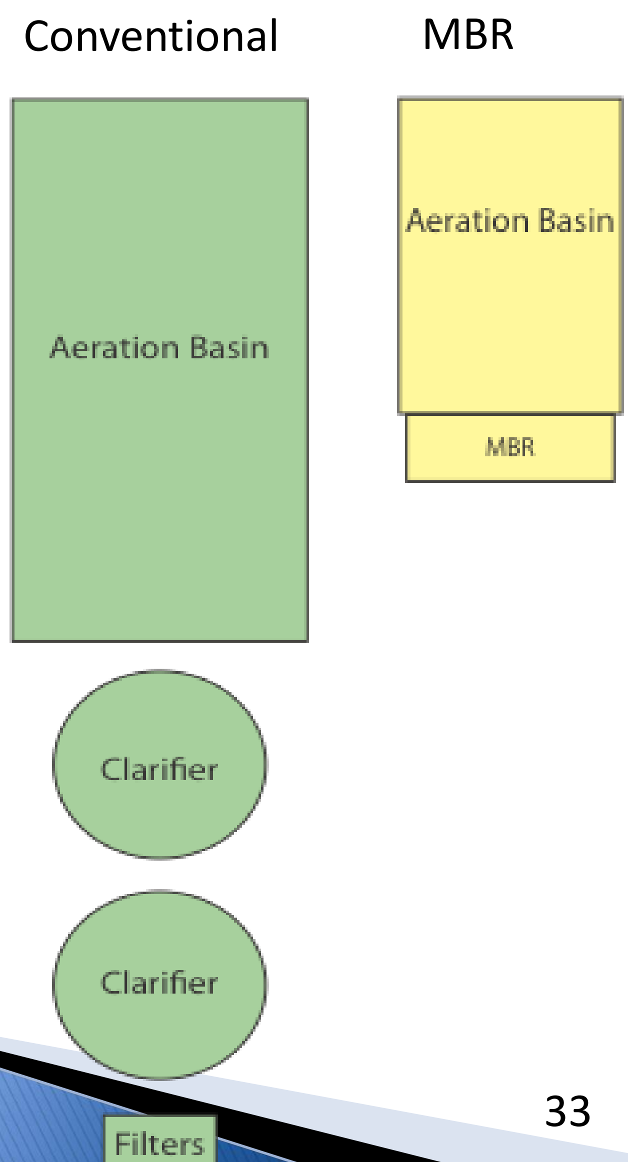


REACT



SETTLE/DECANT

Current Wastewater Treatment Technology Options



MBR Issues

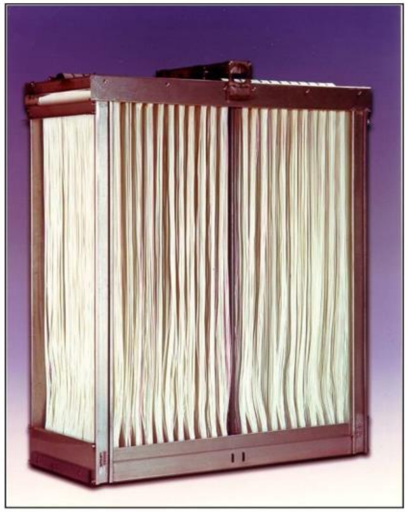
- Scum control
- ***Pretreatment!!!***
- Peak flows
- Air scour (HP)
- Membrane cleaning
- Membrane replacement

Conventional Issues

- Scum control
- Sludge settleability
- Weir cleaning
- Filter cleaning
- Filter replacement/maintenance

Current Wastewater Treatment Technology Options

- MBR System Type – Hollow Fiber



Current Wastewater Treatment Technology Options

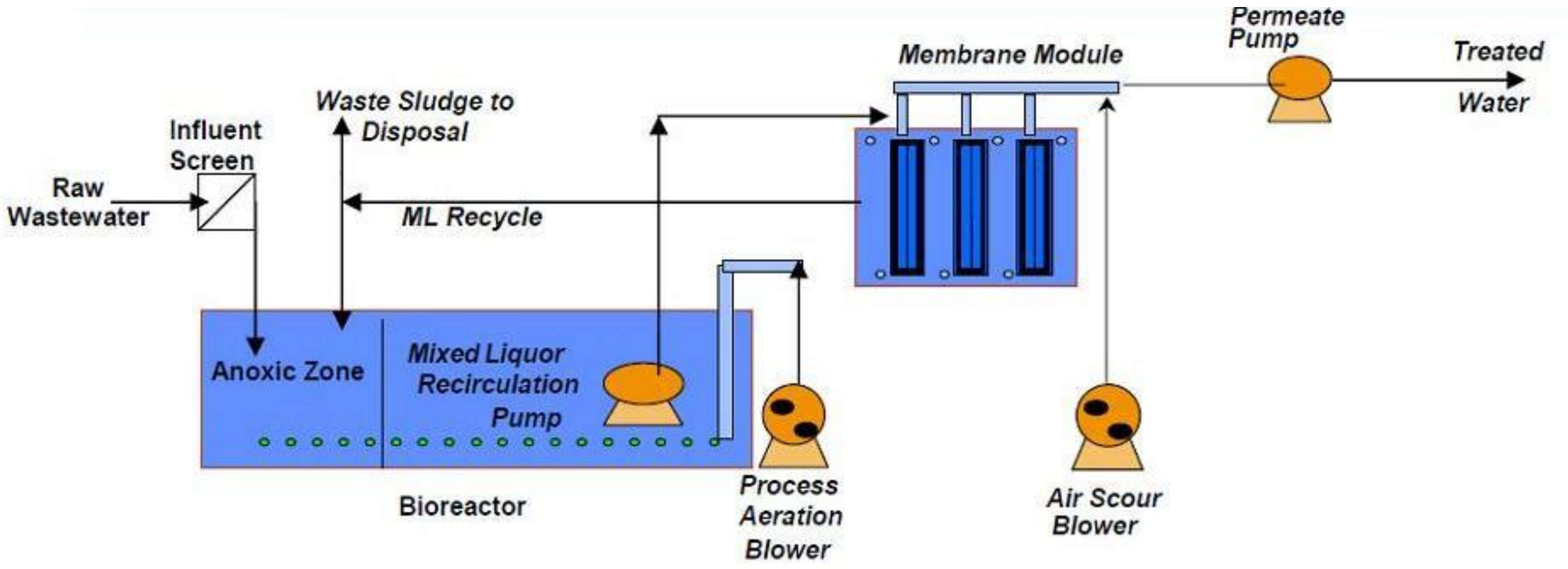
- ➢ MBR System Type – Flat Sheet





Advanced Treatment Technologies - MBR

➢ Historical Custom MBR Design

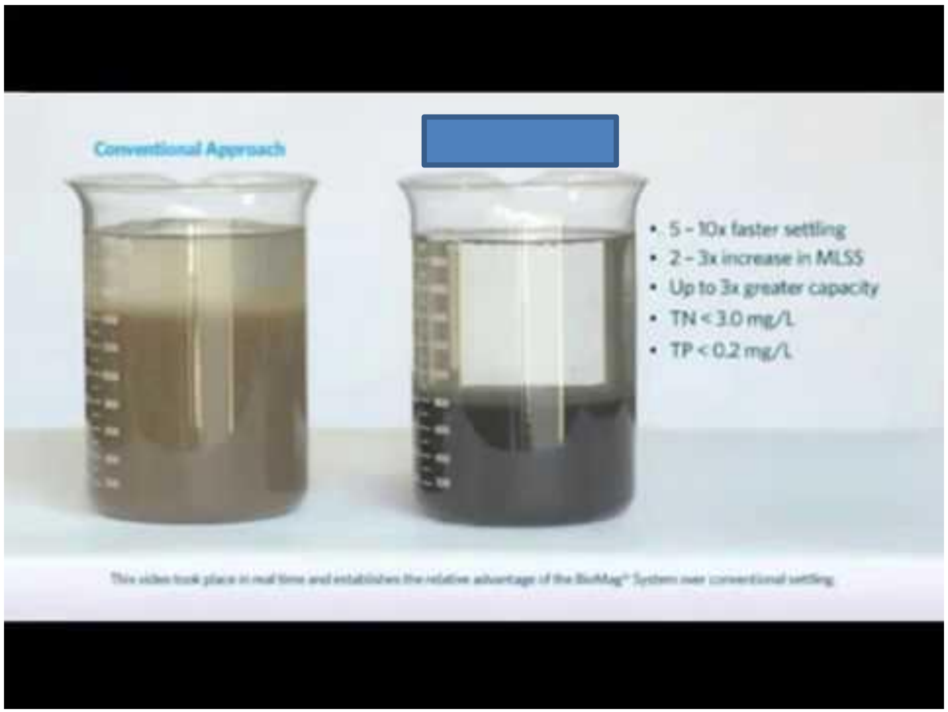


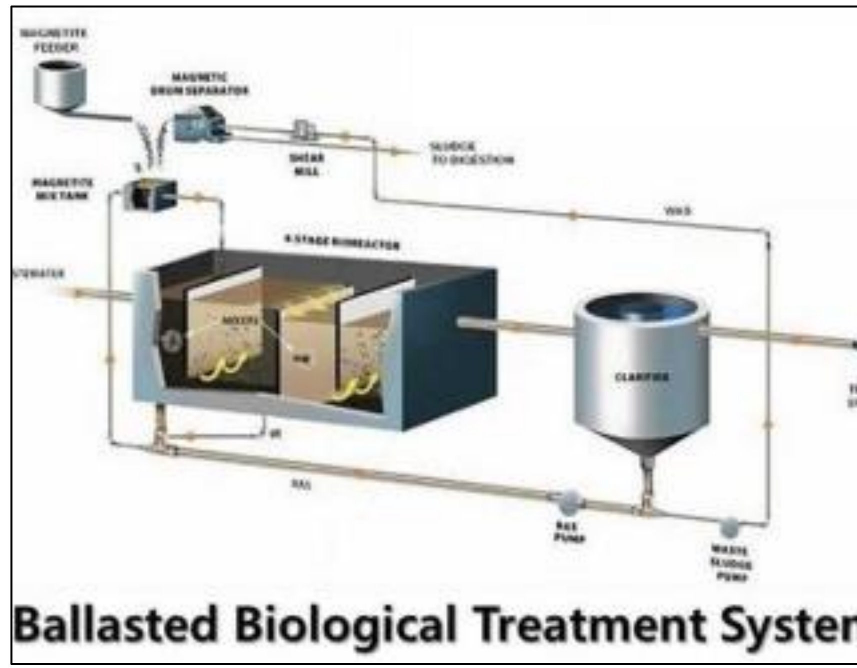
Future Wastewater Tech

- Ceramic MBR Systems

Future Wastewater Tech

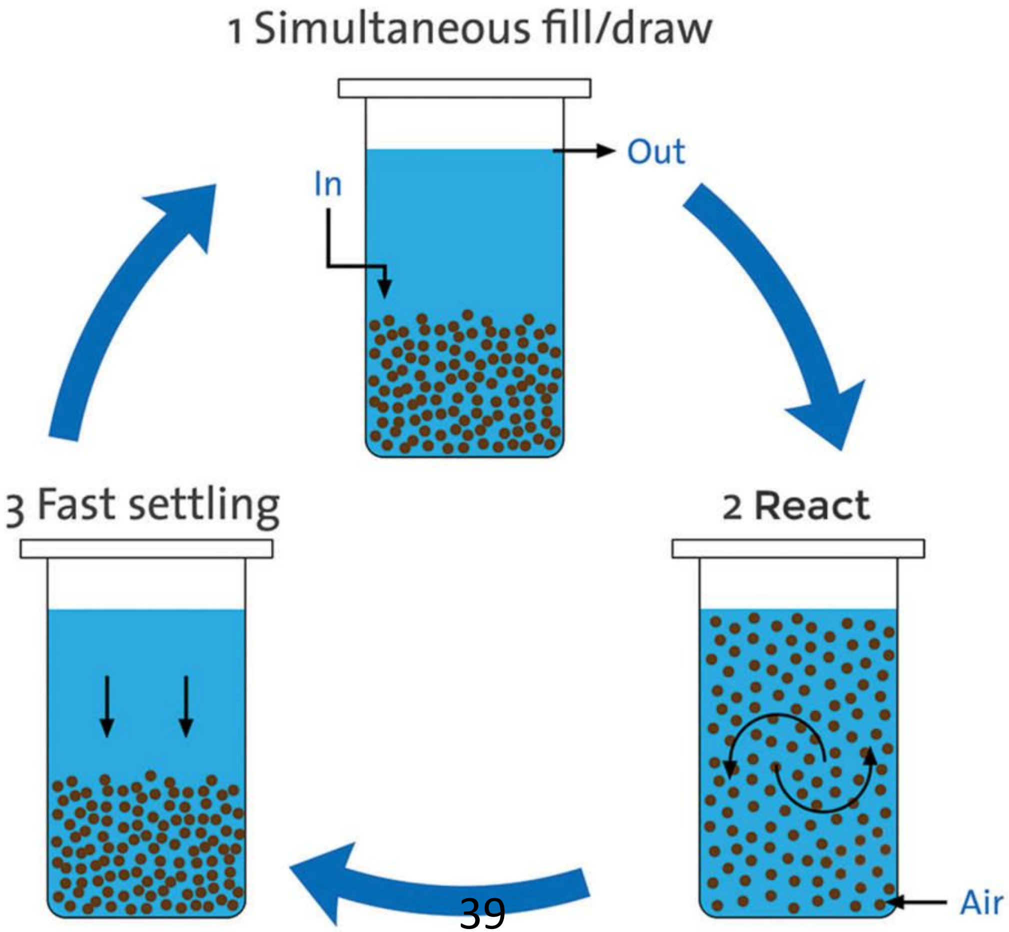
- ➢ Magnetite Ballasted Biological Treatment System





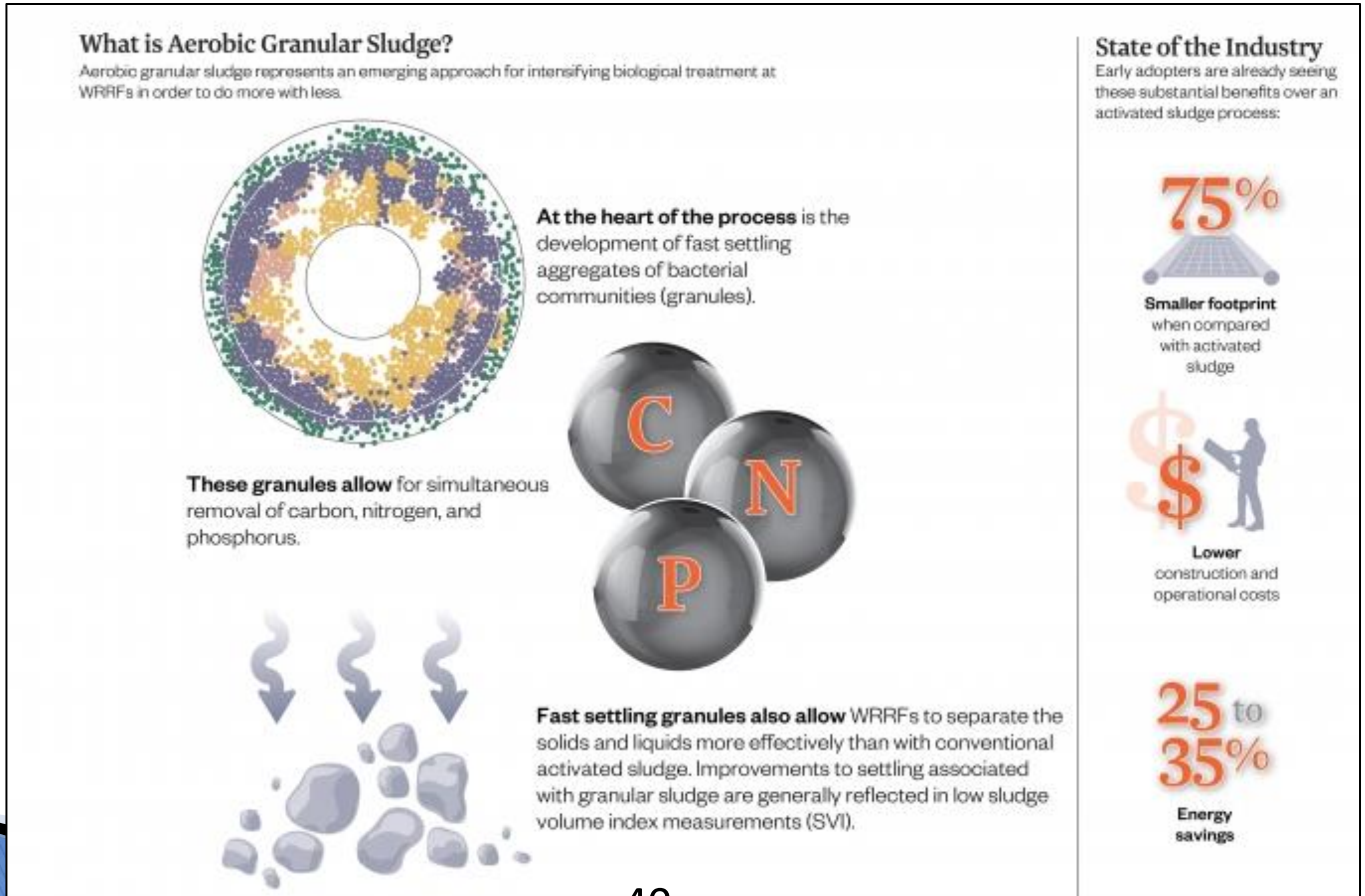
Future Wastewater Tech

- Granular Biological Treatment System



Future Wastewater Tech

- Granular Biological Treatment System



Questions?

Thank you for your time!

For additional information, please contact Joshua Berryhill at
joshua.berryhill@e-ht.com

Joshua Berryhill, P.E.
Enprotec / Hibbs & Todd, Inc. (eHT)