CDM

UpstateRoundtable

# Wastewater Nutrient Removal

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**Presented to: Upstate Roundtable Technical Committee**

***Western Carolina Regional Sewer Authority***
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# The Excess Nutrient Problem

- Depletion of Dissolved Oxygen
  - Ammonia (4.6 mg $O_2$ used per 1.0 mg N nitrified)
- Toxicity to Aquatic Life
  - Ammonia (< 1 mg/L as NH3)
- Human Health
  - Nitrate (<10 mg/L nitrate N)
- Fertilizing Effect (eutrophication)
  - Total Phosphorus
  - Total Nitrogen
  - TMDLs

# Principles of Nutrient Removal

- What comes in must go out
  - Air
  - Water
  - Solids
- Transform to an acceptable or removable form
  - Air ($N_2$ gas)
  - Water (effluent, e.g. nitrate)
  - Solid (biosolids, precipitate)
- Remove solids
  - Sedimentation
  - Filtration
  - Membrane Separation

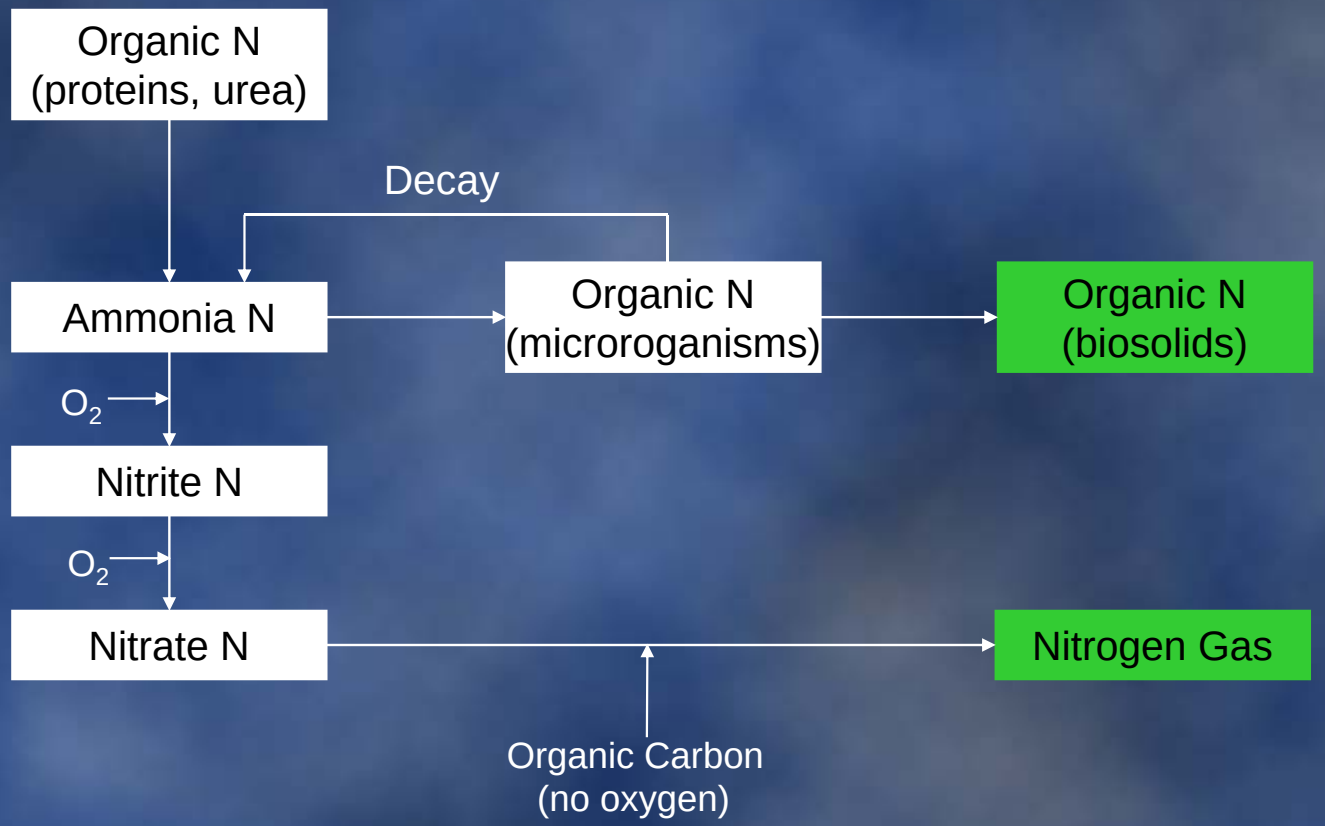
# Nitrogen Removal Processes

- Breakpoint Chlorination
- Air Stripping
- Ion Exchange
- Reverse Osmosis
- Biological
  - Nitrification (ammonia to nitrate)
    - < 1 mg/L ammonia N
  - Denitrification (nitrate to nitrogen gas)
    - Combined Process (< 5 mg/L nitrate N)

      Internal Recycle Required
    - Separate Process (< 1 mg/L nitrate N)

      Carbon Addition Required

# Biological Nitrogen Removal



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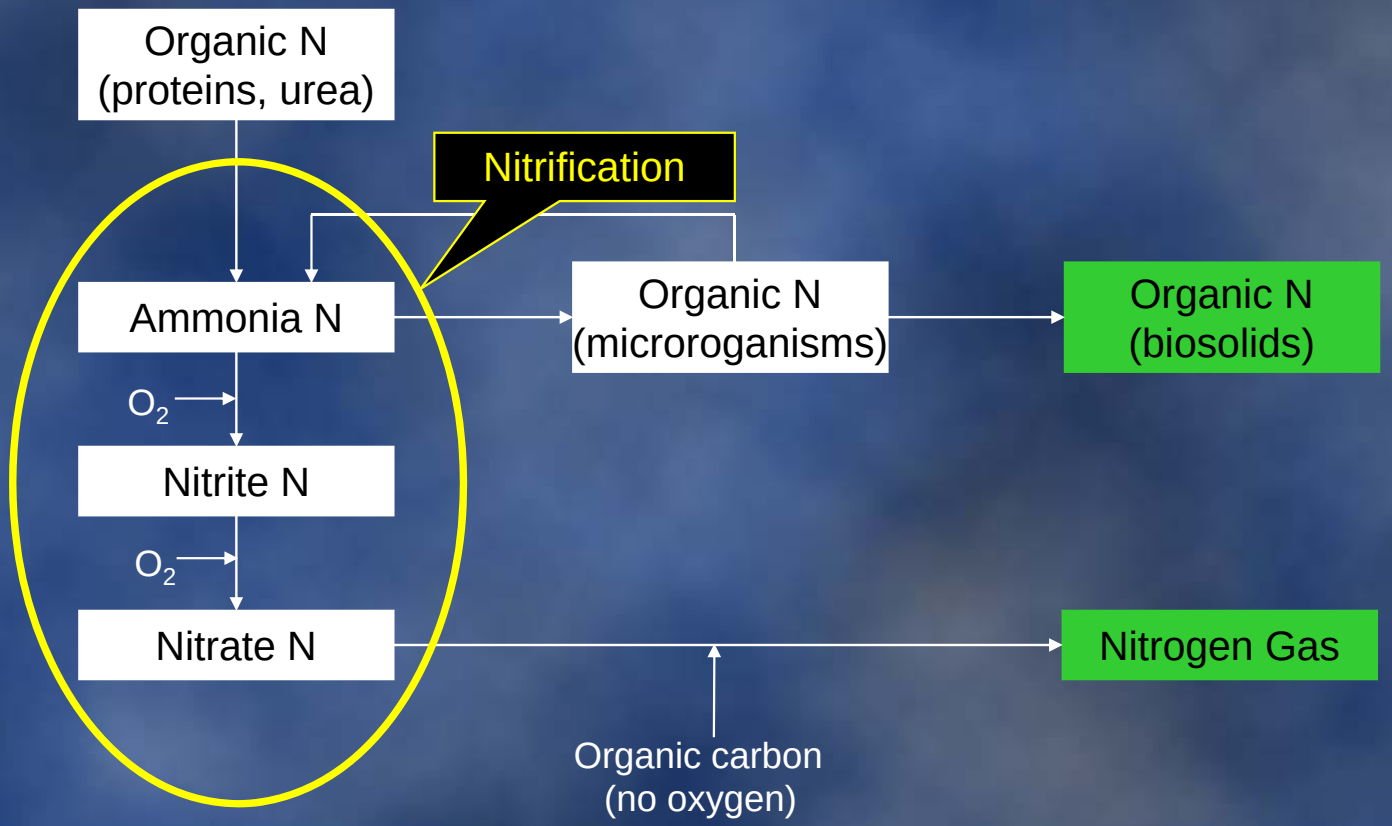

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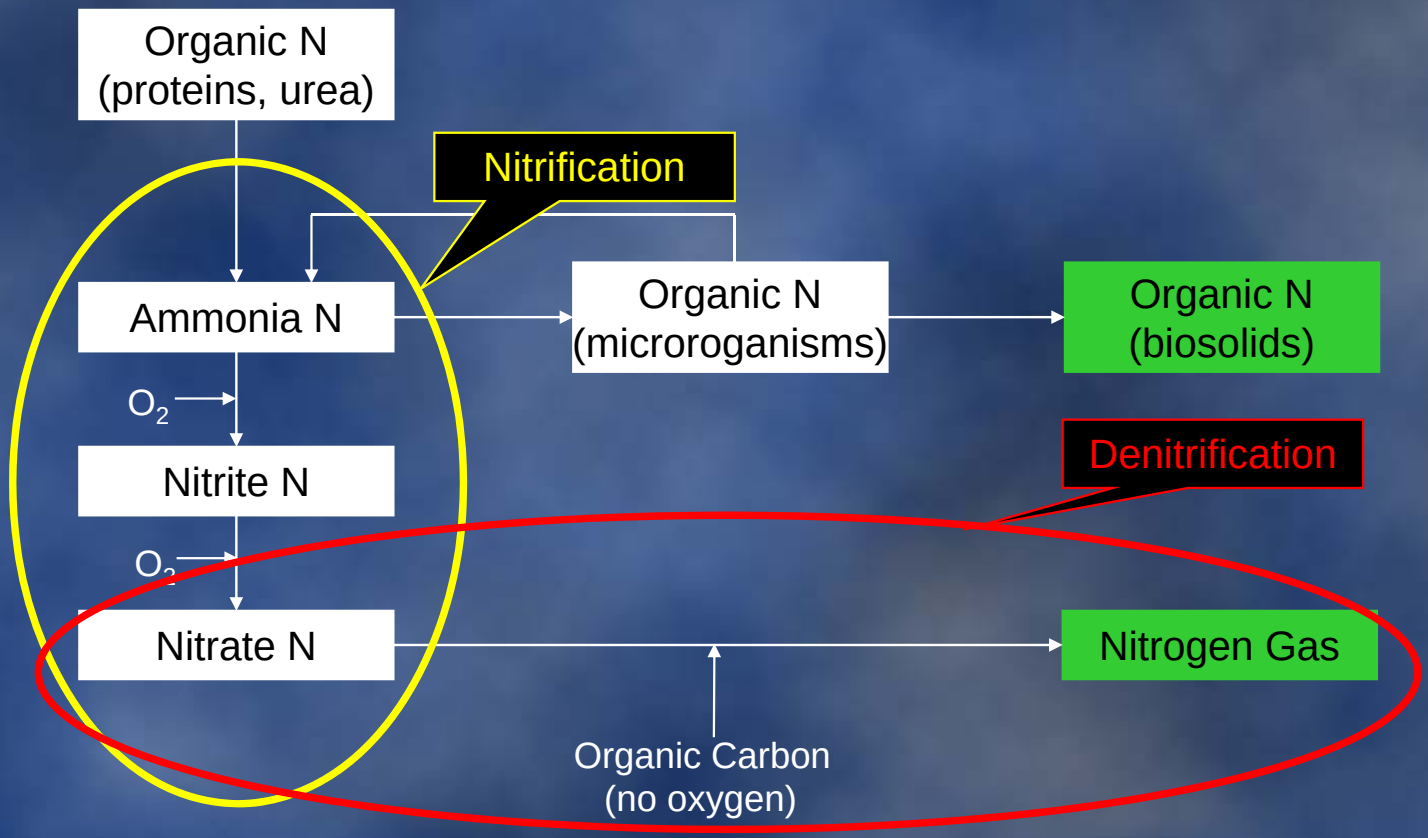


# Phosphorus Removal Basics

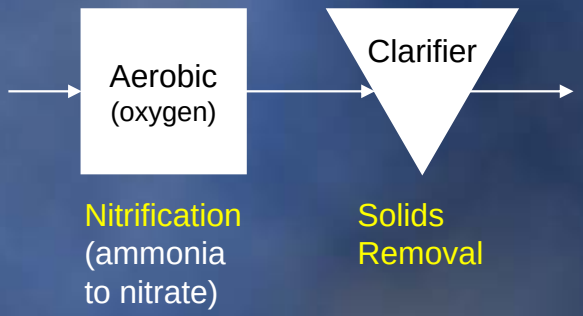
- No Gas Form of P
- Effluent Limits usually as TP
- Convert to Solid
  - Normal Uptake by Microorganisms
  - Enhanced Biological Phosphorus Removal (EBPR)
  - Precipitation as Insoluble Metal Phosphate ($AlPO_4$, $FePO_4$)
  - Adsorption to Other Solids ($Fe[OH]_3 - PO_4$)
- Remove solids

# Phosphorus Removal Processes

- EBPR (< 1 mg/L P)
  - Need Organic Acid (acetate, propionate)
    - Fermentation of influent organic carbon
  - Need Alternating Anaerobic/Aerobic Environment
  - Remove Biosolids (including stored P)
- Chem P Removal (< 0.1 mg/L P with filtration)
  - Feed Metal (Ferric or Aluminum) salt
  - Produce Metal Precipitate
  - Remove Precipitated Solids

# Combined Nutrient Removal

- **Nitrification (ammonia to nitrate)**



# Combined Nutrient Removal

- **Nitrification (ammonia to nitrate)**
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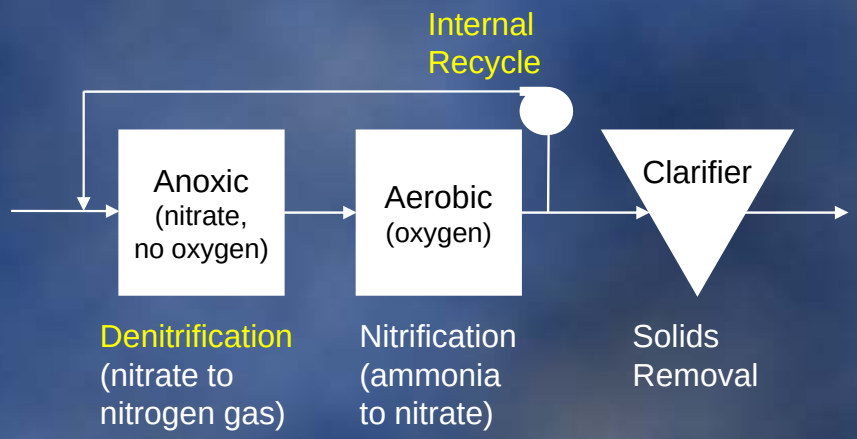
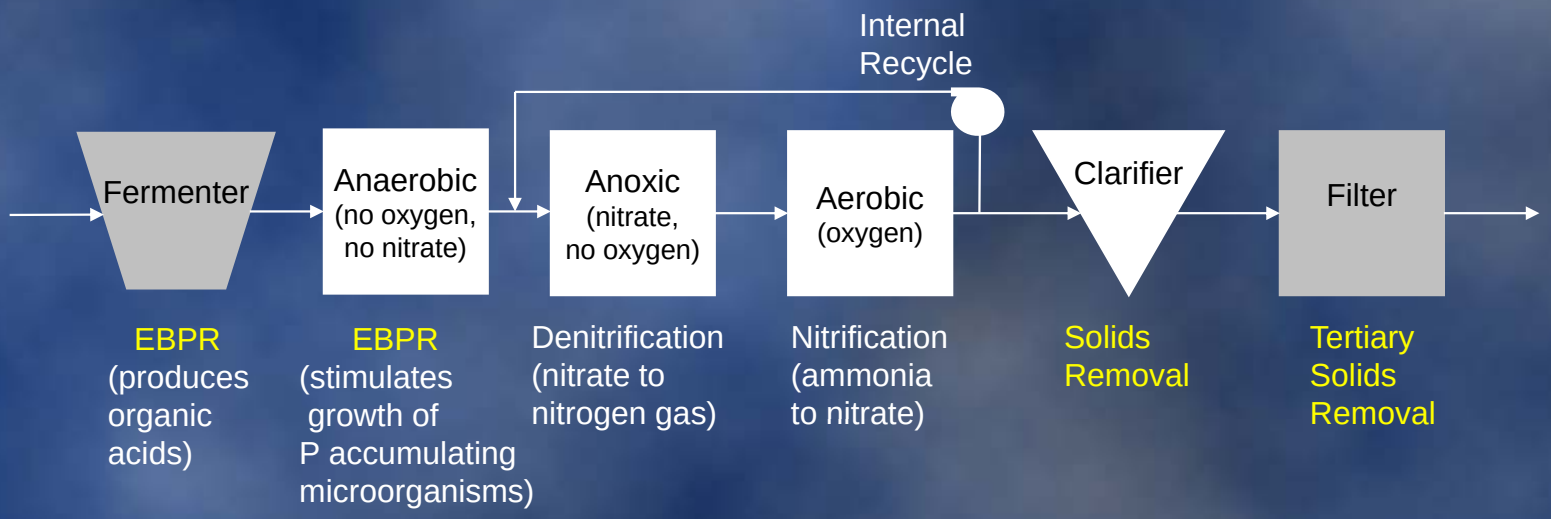


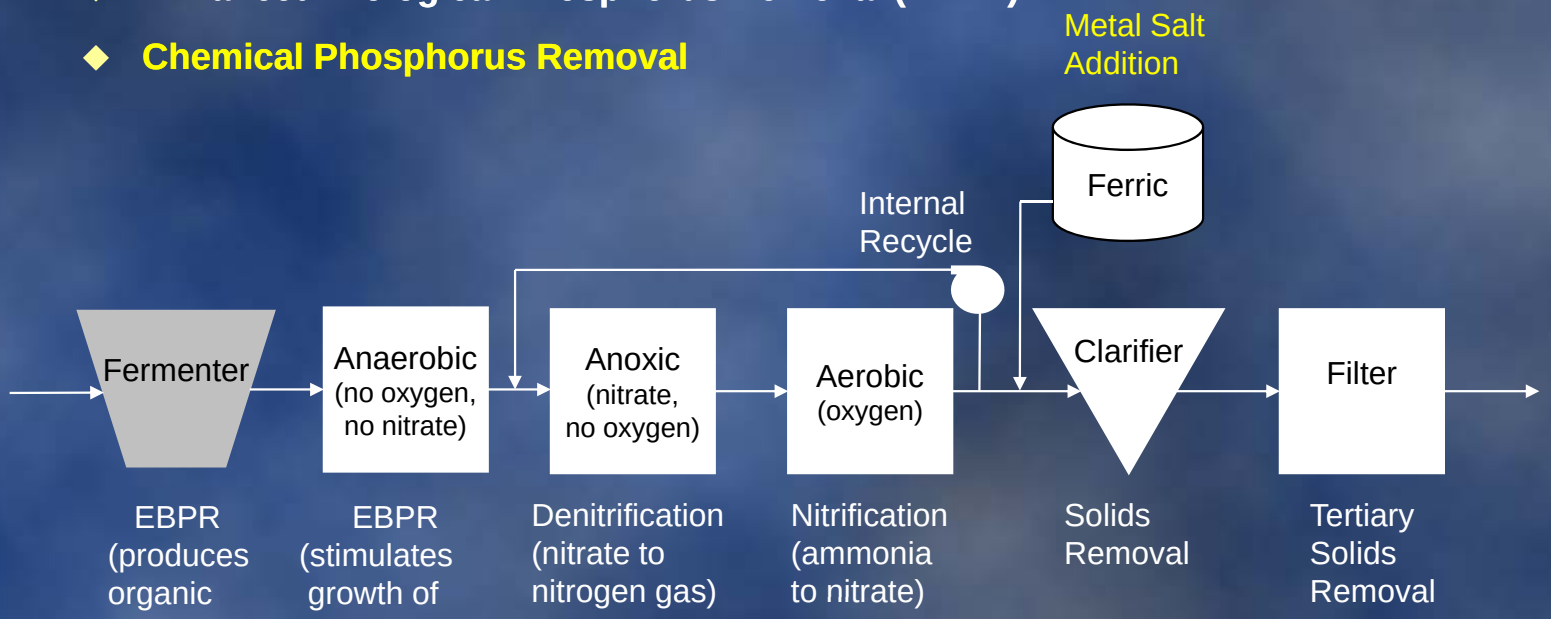
# Combined Nutrient Removal

- **Nitrification (ammonia to nitrate)**
- **Denitrification (nitrate to nitrogen gas)**
- **Enhanced Biological Phosphorus Removal (EBPR)**



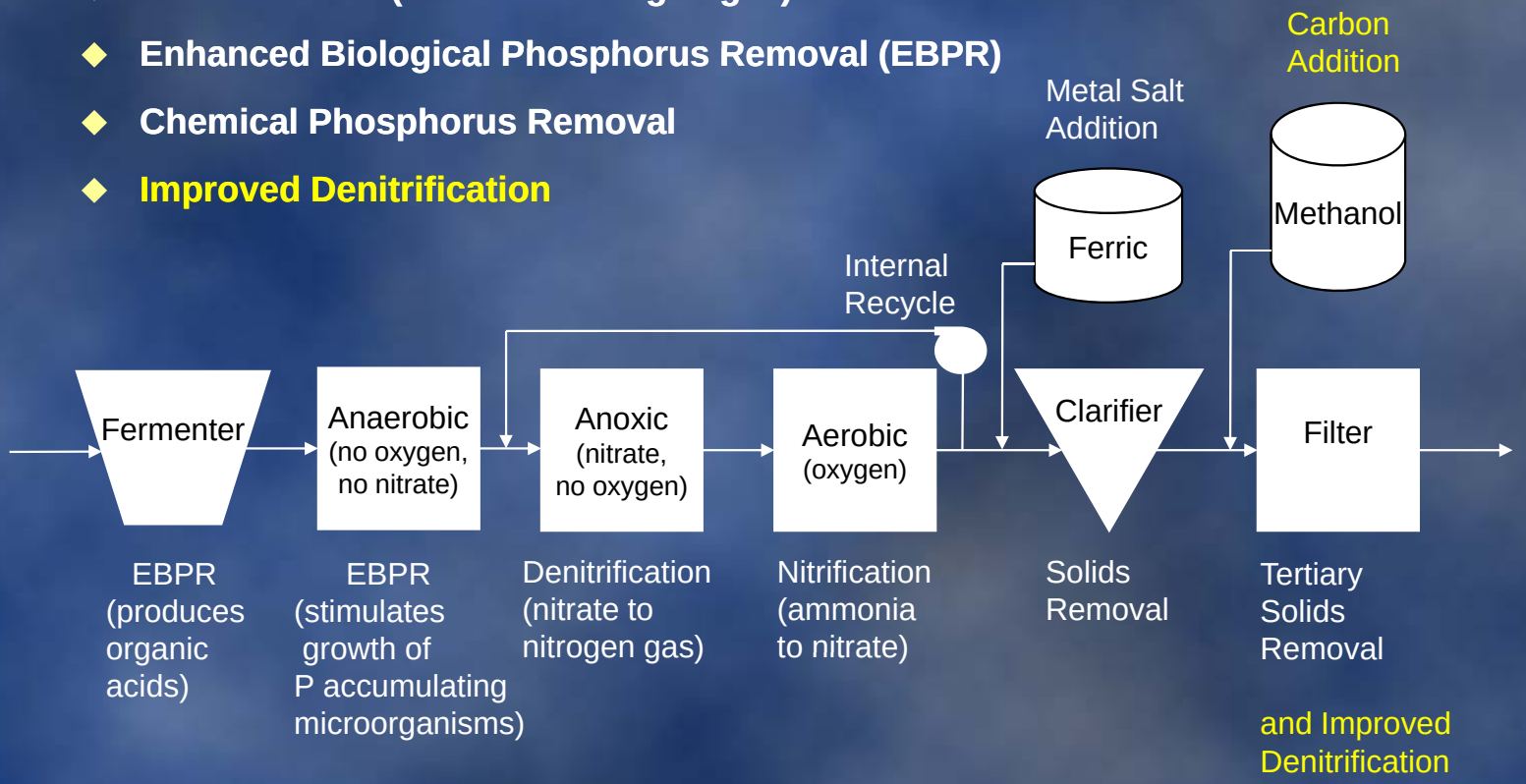
# Combined Nutrient Removal

- **Nitrification (ammonia to nitrate)**
- **Denitrification (nitrate to nitrogen gas)**
- **Enhanced Biological Phosphorus Removal (EBPR)**
- **Chemical Phosphorus Removal**



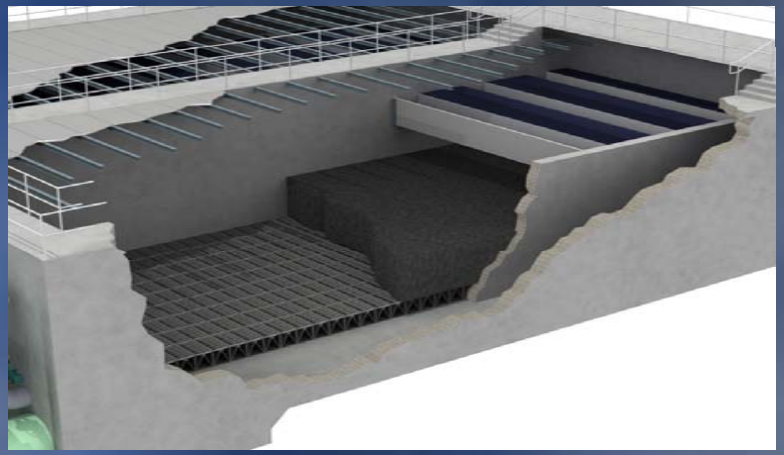
# Combined Nutrient Removal

- **Nitrification (ammonia to nitrate)**
- **Denitrification (nitrate to nitrogen gas)**
- **Enhanced Biological Phosphorus Removal (EBPR)**
- **Chemical Phosphorus Removal**
- **Improved Denitrification**



# Deep Bed Filter

- Removes Biosolids
  - (contain N & P)
- Removes P Solids
- Denitrification Mode
  - Add Carbon Source
    - Methanol
    - Acetate
  - Nitrate to Nitrogen Gas



# Other Advanced Processes

- Ballasted sedimentation
  - Densedeg
  - Comag
- Combined adsorption/ filtration
  - BluePro
- Recycle treatment
  - Anammox
  - Sharon