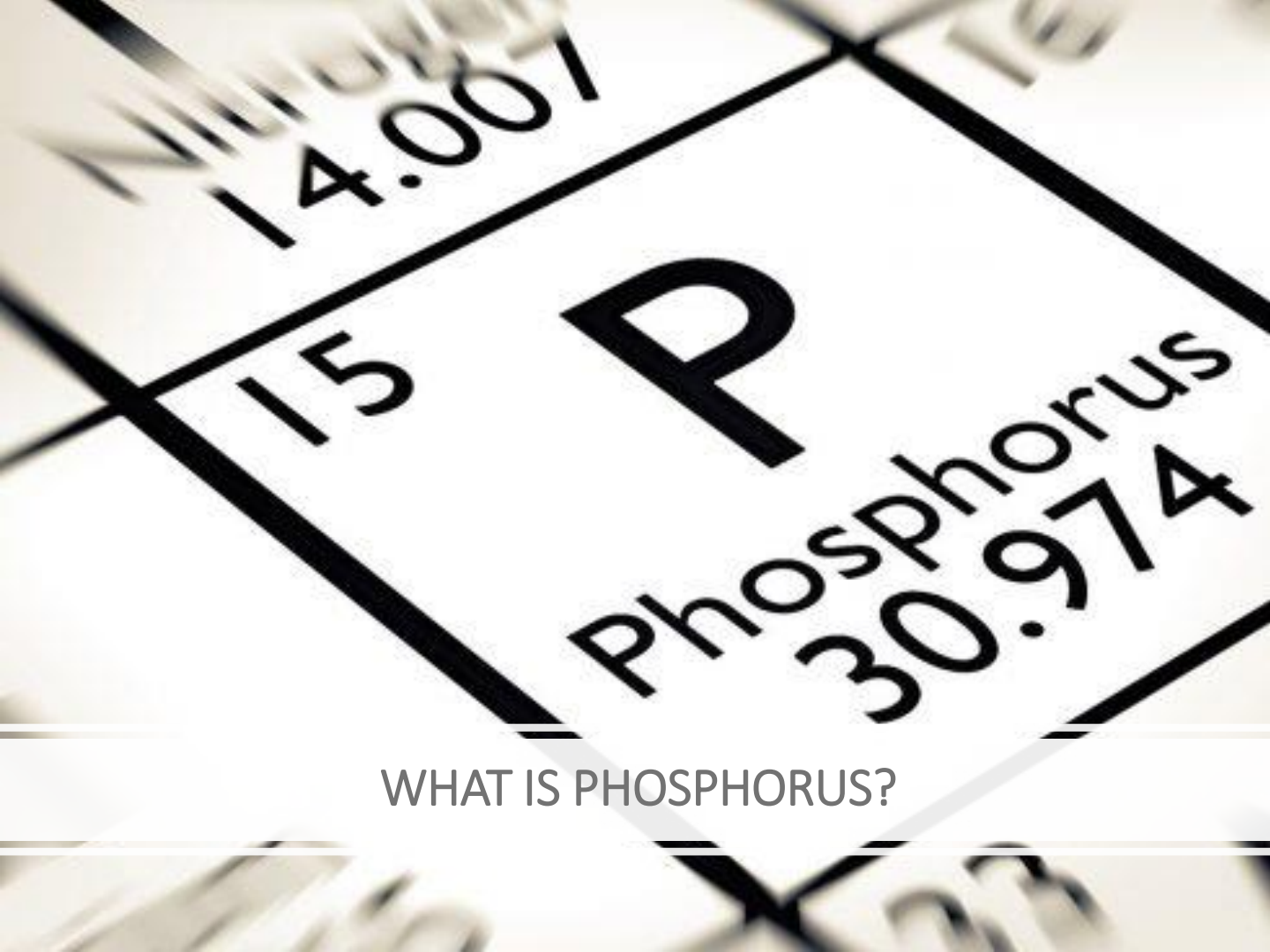
PHOSPHORUS REMOVAL

Tom Tedrick

TECHNICAL APPLICATIONS SPECIALIST

HAWKINS WTG



WHAT IS PHOSPHORUS?

PHOSPHORUS IN WASTEWATER

Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest in inorganic.

The individual contribution tends to increase, because phosphorous is one of the main constituent of synthetic detergents.

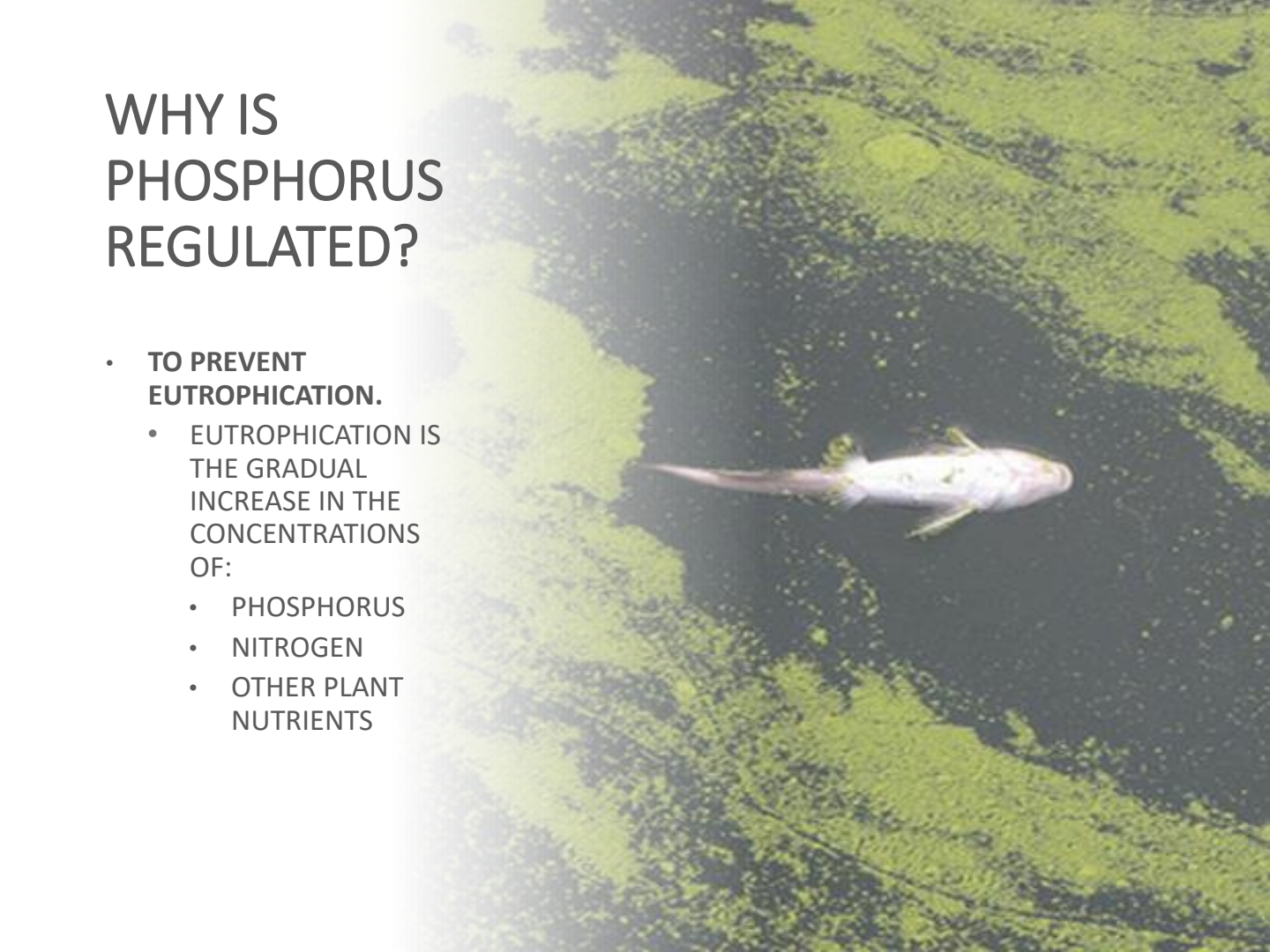
Phosphorus is also a component of phosphate, a commonly used base for corrosion inhibitors used at water treatment facilities.

Phosphorus in Plants

- Phosphorus in fertilizers are essential in plant growth factors, including:
  - Stimulating root development
  - Increasing stalk and stem strength
  - Improving flower formation and seed production
  - Promoting more uniform and earlier crop maturity
  - Improving crop quality
  - Increasing resistance to plant diseases

WHY IS PHOSPHORUS REGULATED?

- **TO PREVENT EUTROPHICATION.**
  - EUTROPHICATION IS THE GRADUAL INCREASE IN THE CONCENTRATIONS OF:
    - PHOSPHORUS
    - NITROGEN
    - OTHER PLANT NUTRIENTS



CAUSES OF EUTROPHICATION

Nutrient Pollution

- **Agricultural Runoff:** Fertilizers (NPK)
- **Wastewater Discharges:** Untreated or partially treated sewage and industrial effluents often contain significant amounts of nutrients.
- **Stormwater Runoff:** Urban areas with impervious surfaces (like roads and pavements)
- **Atmospheric Deposition:** Nutrients, particularly nitrogen, can be deposited into water bodies from the atmosphere due to industrial emissions and vehicle exhaust.

IMPACTS OF EUTROPHICATION

Ecological Impacts:

- - Loss of Biodiversity: Sensitive species may decline or disappear, reducing overall biodiversity.
- - Changes in Species Composition: Dominance of tolerant species (e.g., certain algae and bacteria) over sensitive species (e.g., fish and aquatic plants).
- - Habitat Degradation: Loss of critical habitats like seagrass beds and coral reefs due to lack of light and oxygen.

Water Quality Impacts:

- Reduced Water Clarity: Algal blooms reduce water transparency, affecting the aesthetic and recreational value of water bodies.
- Odor and Taste Issues: Decomposing algae can produce foul odors and unpleasant tastes in drinking water.
- Toxin Production: Some algal species produce toxins (e.g., cyanotoxins) that can be harmful to humans and animals.

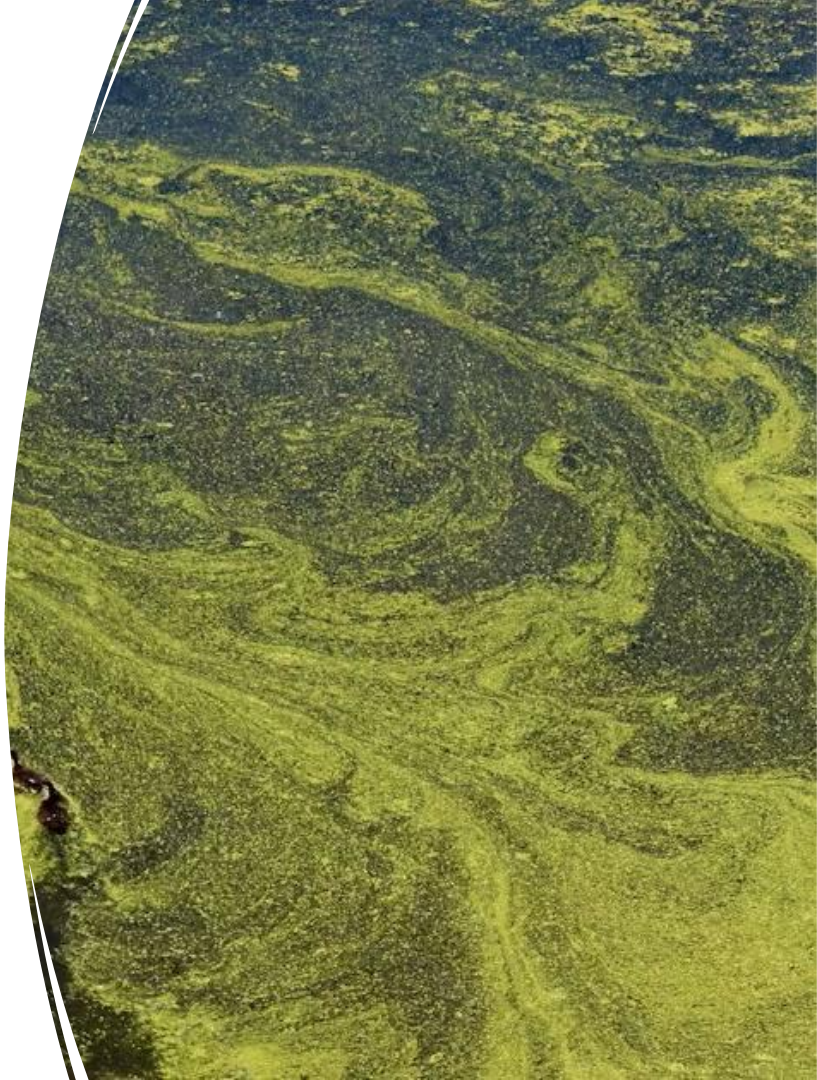
WHY REMOVE PHOSPHORUS FROM WASTEWATER

- **PHOSPHOROUS PROVIDES A FOOD SOURCE FOR ALGAE**
- **WHICH CAN LEAD TO HARMFUL ALGAE BLOOMS (HABS).**

- **HARMFUL ALGAE BLOOMS CAN…**
  - …REDUCE DISSOLVED OXYGEN LEVELS AS THEY DECAY
  - …PRODUCE METABOLIC TOXINS
  - …ODOR ISSUES IF THE SYSTEM GOES ANAEROBIC

PHOSPHORUS IS A NUTRIENT FOR ALGAE

- **ALGAE (BLOOMS) WILL CONSUME PHOSPHORUS AS FOOD THEN RELEASE EXCESS PHOSPHORUS AS IT BREAKS DOWN THROUGH PHOTOSYNTHESIS.**



IMPACT OF ALGAE BLOOMS ON PLANT EFFLUENT

CBOD5 (CHEMICAL BIOLOGICAL OXYGEN DEMAND) LIMITS MAY BECOME UNACHIEVABLE.

(<25 MG/L)

TSS (TOTAL SUSPENDED SOLIDS) CAN EXCEED LIMTS

(<45 MG/L)

POTENTIAL FOR INEFFECTIVE UV LIGHT TRANSMITTANCE

HEAVY ALGAL MATTING CAN DIMINISH UV LIGHT TRANSMITTANCE.

COMMON ALGAE CONTROL METHODS

- **COPPER SULFATE**
  - DRY OR LIQUID FORM
- **SODIUM PERMANGANATE**
  - 20% ACTIVE
- **POTASSIUM PERMANGANATE**
  - 2 – 4% ACTIVE
- **SODIUM PERCARBONATE**
  - 32.5% ACTIVE
- **BIOAUGMENTATION**

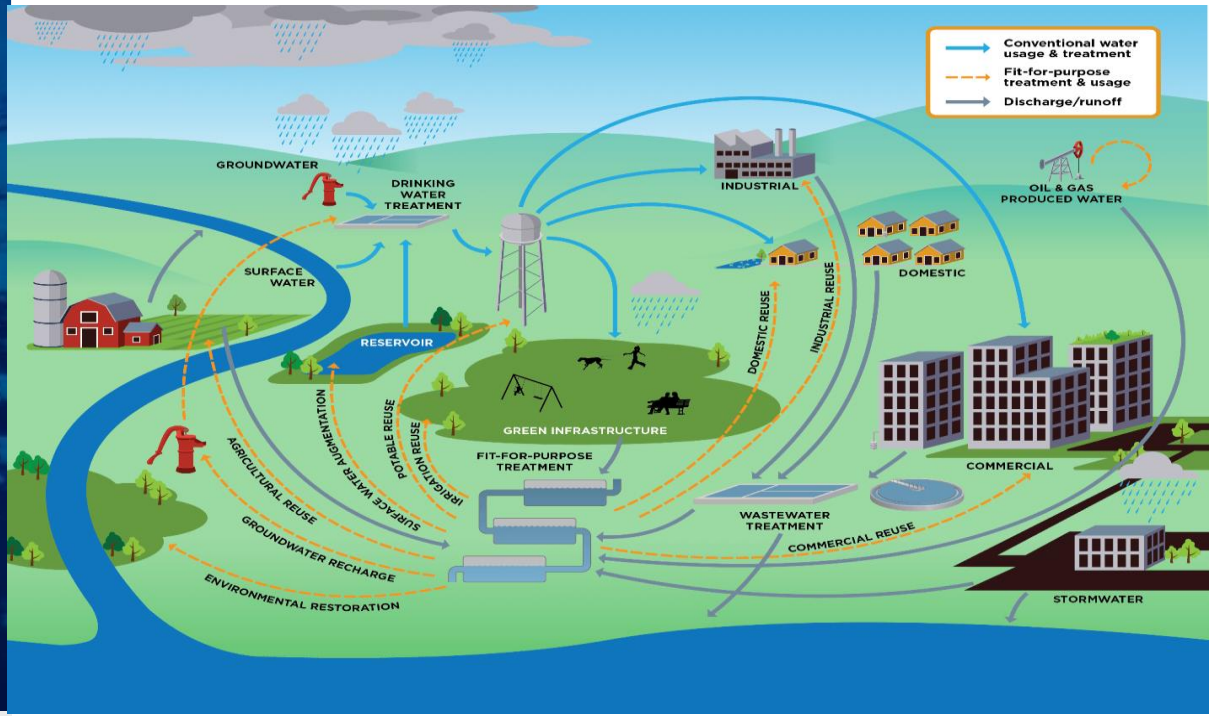
COMMON ALGAE CONTROL PRODUCTS

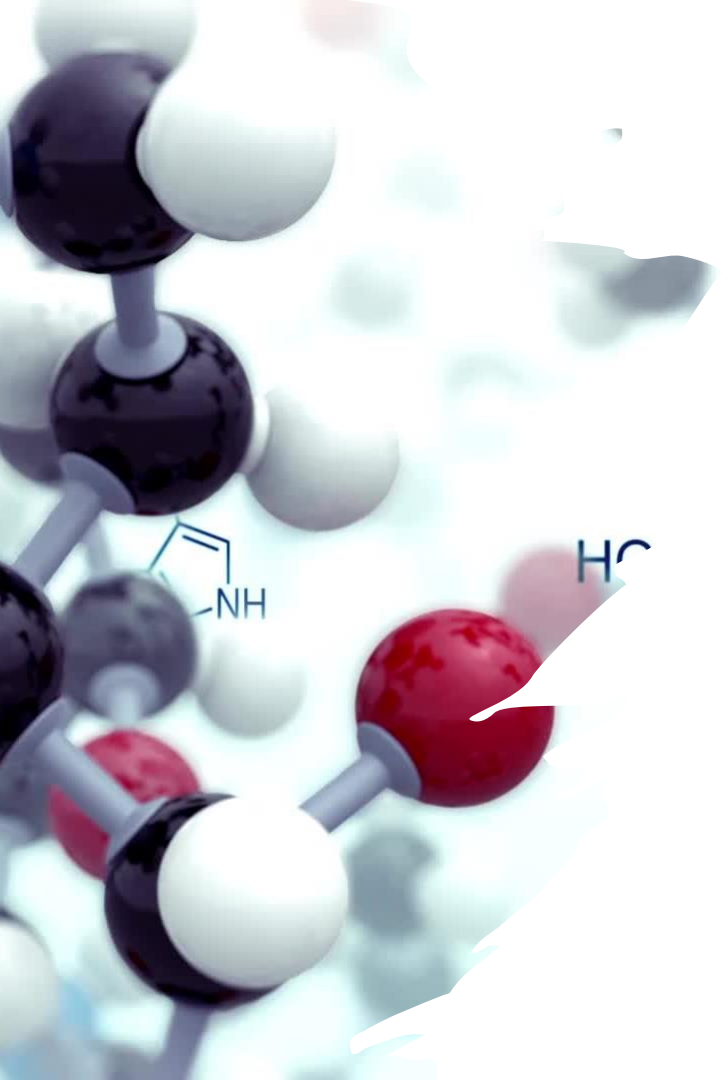
PHOSPHORUS LIMITS

- **MOST STATES ENFORCE**
  - 1 MG/L AS PHOSPHORUS "P"
  - An effluent limitation equal to 1 mg/L total phosphorus as a monthly average shall apply in cases where the discharge of wastewater from all outfalls of a facility other than those subject to change.

ADVANCED WASTEWATER TREATMENT (AWT)

- Nutrient standards set for contaminants in effluent discharge
- Requires annual averages of 5:5:3:1 (CBOD:TSS:N:P)





TESTING FOR PHOSPHORUS

- **PHOSPHORUS IS ONE OF THE PRIMARY COMPONENTS OF THE PHOSPHATE (PO4) MOLECULE.**
- **THE PHOSPHATE MOLECULE CONTAINS ON AVERAGE 32% PHOSPHORUS.**
- **CONVERSION OF PHOSPHATE (PO4) TO PHOSPHORUS (P):**
- **(PO4) X (0.326) = “P”**

COMMON PHOSPHORUS REMOVAL TECHNIQUES

CHEMICAL COAGULATION

ALUM SALTS

FERRIC SALTS

PACs

ACHs

BLENDS (EPIAMINE/DADMAC)

CHEMICAL PRECIPITATION

HYDRATED LIME

CLC/RARE EARTH

BIOLOGICAL

CERTAIN STRAINS OF BACTERIA WILL FEED ON THE PHOSPHORUS AND TAKE IT UP WITHIN THEIR CELL STRUCTURE

TRADITIONAL SALTS VS PAC/ACH & BLENDS

ALUMS & FERRICS

HIGHER DOSAGE RATES

CONSUMES ALKALINITY

CONSUMES PH

CAN BE CORROSIVE

PRODUCE MORE SLUDGE

STAINING ISSUES WITH FERRIC

PACs, ACHs & BLENDS

TYPICALLY, LOWER DOSAGE RATES✓

CONSUME LESS ALKALINITY✓

LOW IMPACT ON AVAILABLE PH✓

NON-CORROSIVE✓

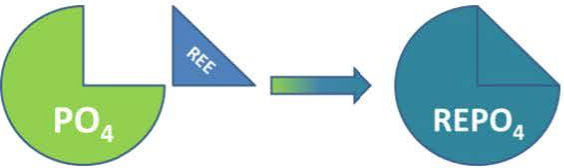
LESS SLUDGE PRODUCED✓

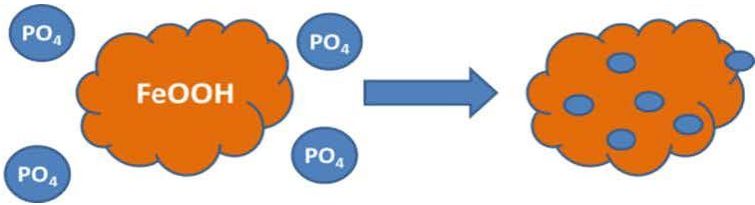
Wt
Water
Treatment

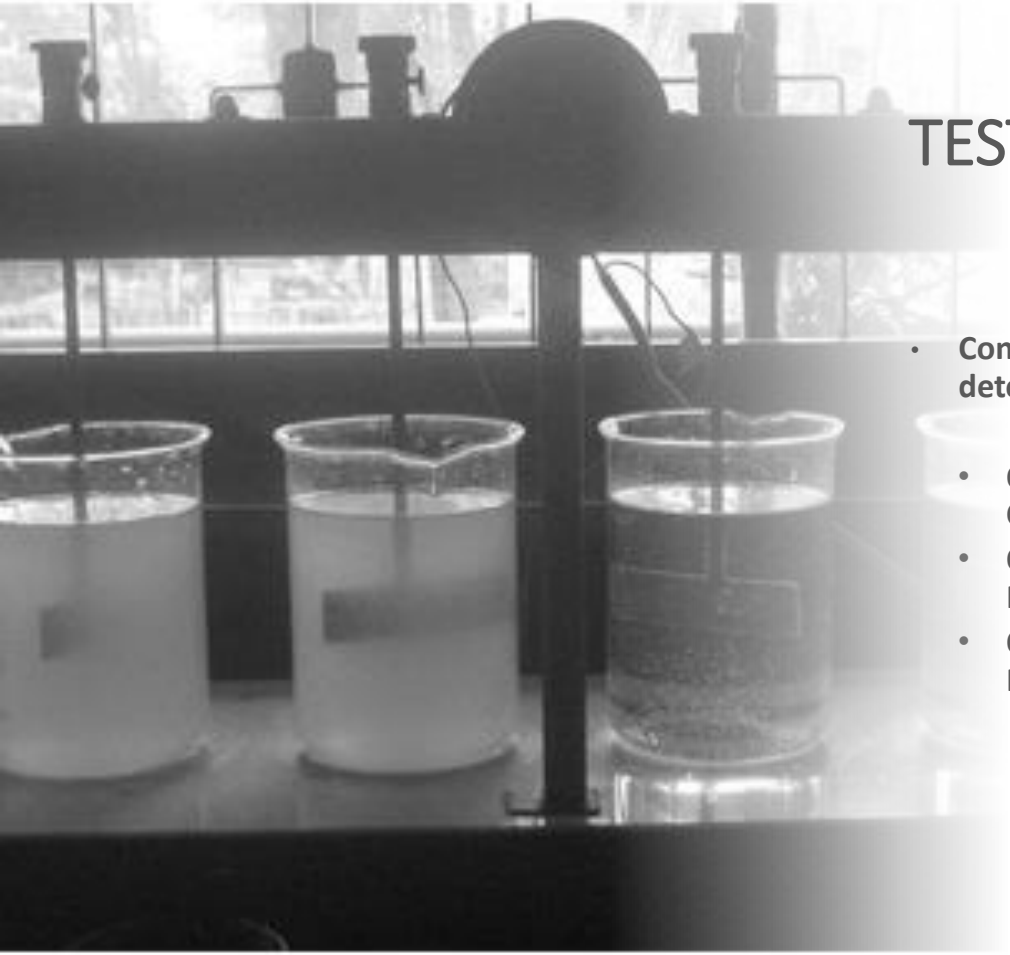
HAWKINS

CERIUM LANTHANUM CHLORIDE (CLC)

- Commonly referred to as “Rare Earth” coagulants (RE)
- Extremely effective at low dose (1:1) when compared to traditional coagulants (~2.5:1)
- Straightforward metal phosphate precipitation, as opposed to adsorption of phosphate onto metal oxide surface
- More efficient than Al/Fe when little P present







TESTING

- **Conduct Jar Testing to determine:**
  - OPTIMAL COAGULANT
  - OPTIMAL DOSAGE RATE
  - OPTIMAL INJECTION POINT

Wt
Water
Treatment

HAWKINS

EVALUATION

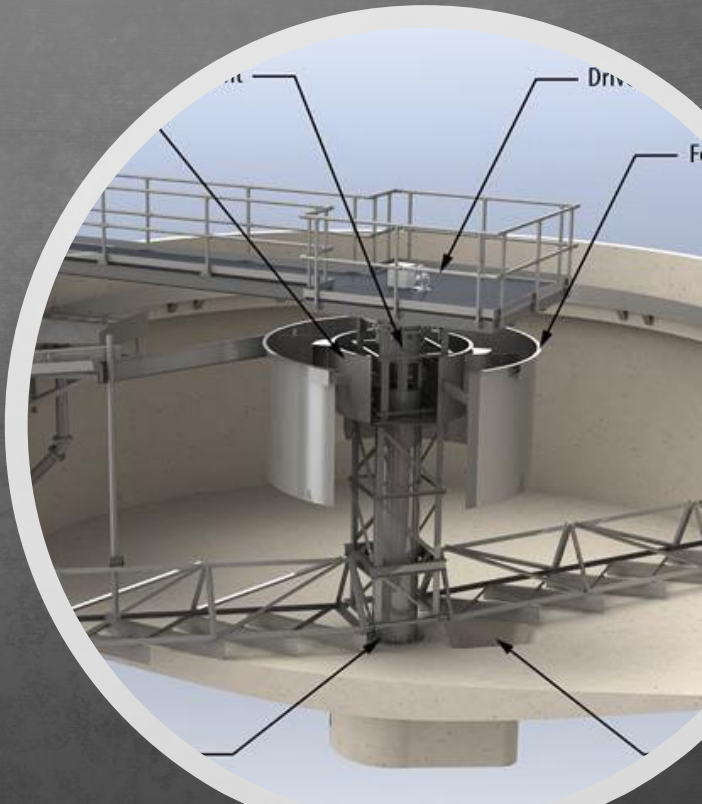
Wt
Water
Treatment

HAWKINS

COAGULANT APPLICATION POINTS

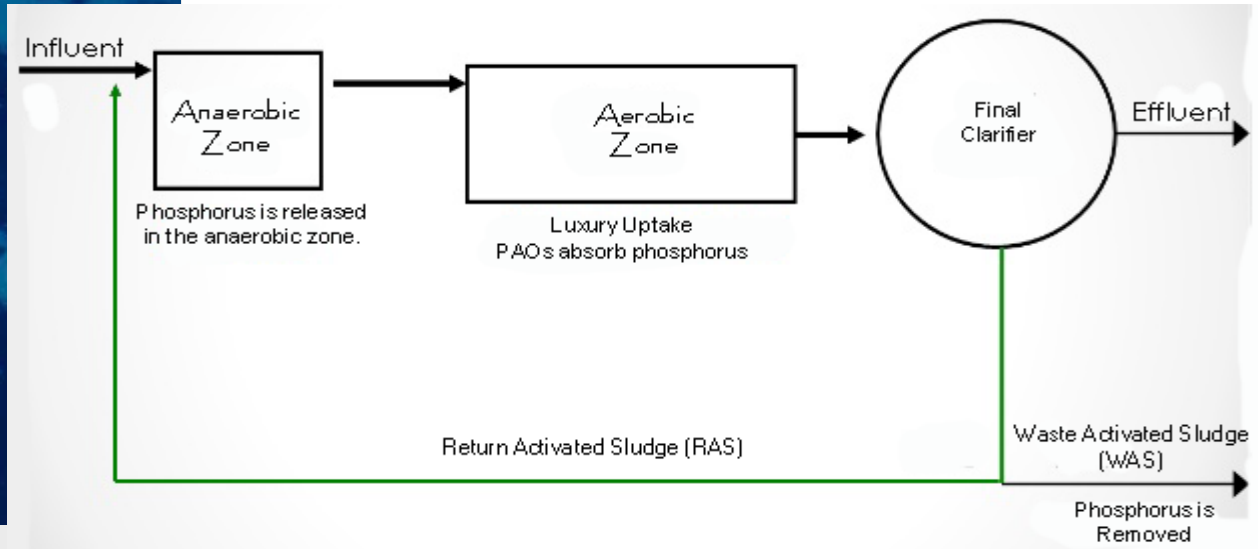
PRIMARY CLARIFIER(S)

SECONDARY CLARIFIER(S)



BIOLOGICAL PHOSPHOROUS REMOVAL

- PAOs (Polyphosphate accumulating organisms)
- P release under anaerobic conditions
- Luxury uptake under aerobic conditions
- Bioaugmentation/Biological supplementation



WASTEWATER LAGOONS

REDUCING PHOSPHORUS FROM LAGOONS

APPLYING COAGULANTS ON LAGOONS

SURFACE APPLICATION

REDUCING PHOSPHORUS AT WASTEWATER TREATMENT PLANTS

Thank you!