Massachusetts Water Resources Authority

Struvite: The Deer Island Experience

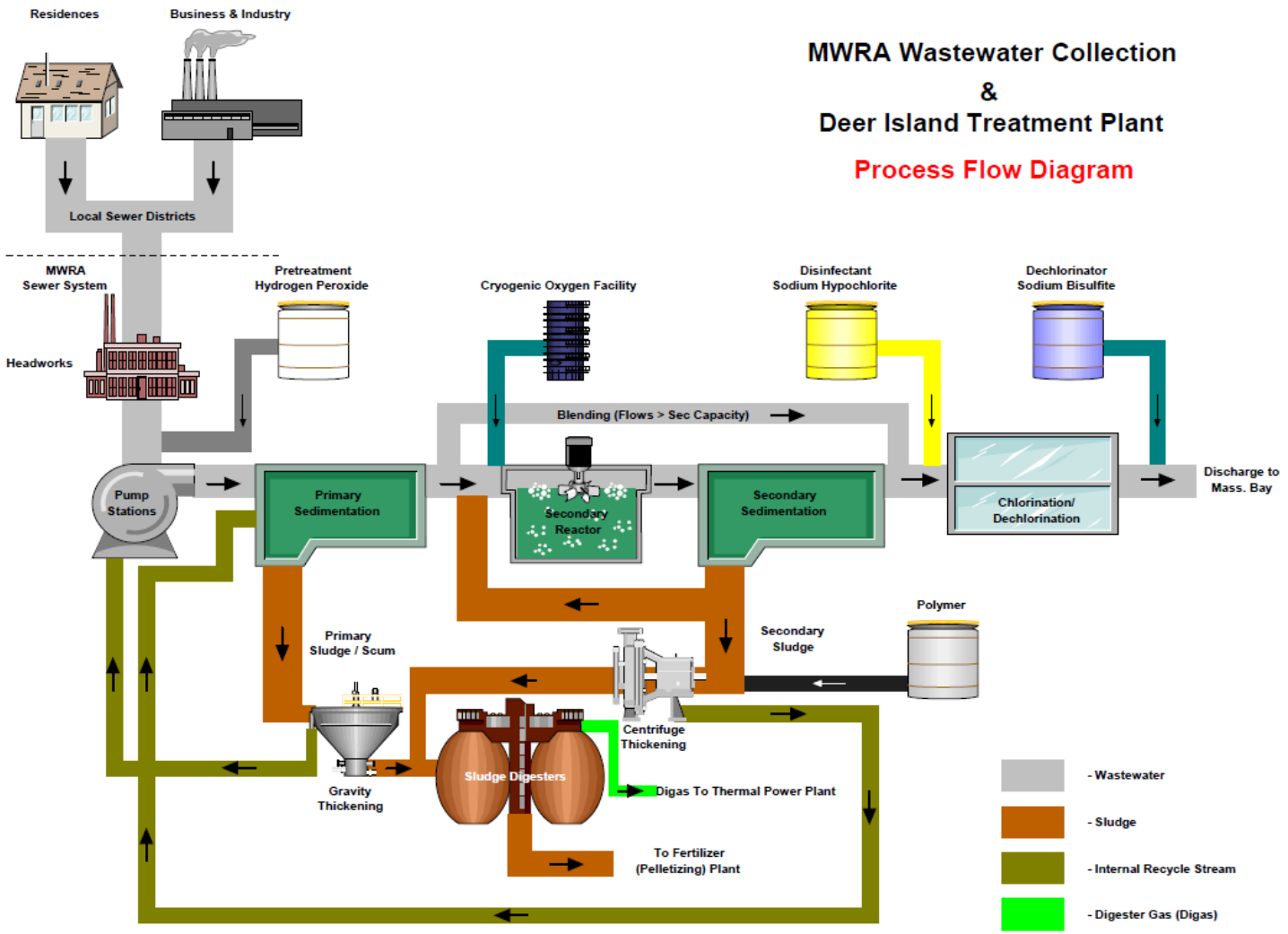
Ethan Wenger
Manager, Process Control
MWRA Deer Island Treatment Plant

Overview of Deer Island Treatment Process

Deer Island Treatment Plant

- $3.8 Billion Construction Project
- One of the Largest Wastewater Treatment Plants in the United States
- Treatment Capacity:
  - Maximum
    - 1.27 Billion Gal/Day combined sewer system
    - Up to 700 MGD by Secondary Treatment
  - Average Daily Flow:
    - 365 Million Gal/Day
- Built on 200 Acres
  - includes 60 acres of public access area

Deer Island Process Flow Diagram



Primary Stacked Clarifiers

Primary Treatment Has 48 Stacked Clarifiers

Each Clarifier: 1.369 MGal (15,252 sq ft)

- Five Chain Collector Mechanisms
- Primary Sludge Pumps (1.5 x 15 hp)
- Primary Scum Pumps (14 per battery)
- 20 Field Monitoring Instruments

Process Requires 42 Out Of 48 Always Available

Challenges:

- Covered & Stacked
- Monitored With I&C Remotely
- All Work Is Confined Space Entry

Secondary Process Area

Biological Treatment - Activated Sludge (Pure O2)

Over 900,000 Square Feet Facilities (1/3 Covered)

Pure Oxygen Generation Facility

Odor Control - Carbon Adsorption

Secondary Clarifiers

Secondary Treatment Has 54 Stacked Clarifiers

Each Clarifier:

1.36 Mgal, 14,350 sqft

Six Collectors

22 Field Instruments

1 x 70HP 3000GPM Return Sludge Pump

Process Requires 50 Out of 54 Always Available

Challenges:

Stacked

Monitored With I&C

Confined Space Entry

Residuals Processing Statistics for Deer Island

- **DITP Influent Solids – 262 dry TPD (94% captured)**
- **Sludge to Digestion – 246 dry TPD**
  - 70% Primary sludge
  - 30% Waste Secondary sludge
  - Time in Anaerobic Digestion:
    - 18 -20 days
  - 62% Volatile Solids destruction
    - (industry avg. is 45-55%)

- **Digas Production – 189 kscfh**
  - 98% beneficially utilized (value: $15-$20 M (heat); & $2.8 M (power))
  - 65% of days Digas meets all DI heating requirements
  - 96.9% of boiler heat attributable to Digas

Methane Utilization At Deer Island

- Deer Island utilizes 98% of the methane generated to power a steam turbine generator and backpressure turbine for plant heat and hot water
- Avoid purchase of about 5MG in fuel oil annually
- Approximately 28M kWh/yr electricity production
- Approximately $3.4M/yr electricity savings and revenue

NEFCO – Dryer Trains and Centrifuges

DITP Struvite Formation

- 140 ft tall egg-shaped digesters
- 3 million gallon volume
- 18-20 day holding time
- Digesters are fed in a sequence
- Contents “overflow” into a discharge line
- Prime struvite formation conditions during overflow

Struvite in Overflow Pipe

Other Struvite Formation Spots

- Digester Mixers
- Valves downstream of digester
- Digested sludge centrifuges (at fertilizer plant)
- Other points of turbulence in the line

Struvite

Digester Mixer covered with struvite

Remediation Options

Preventative Measures

- Carbon Dioxide Addition (Stickney Plant)
- Ferric Chloride

Remedial Measures

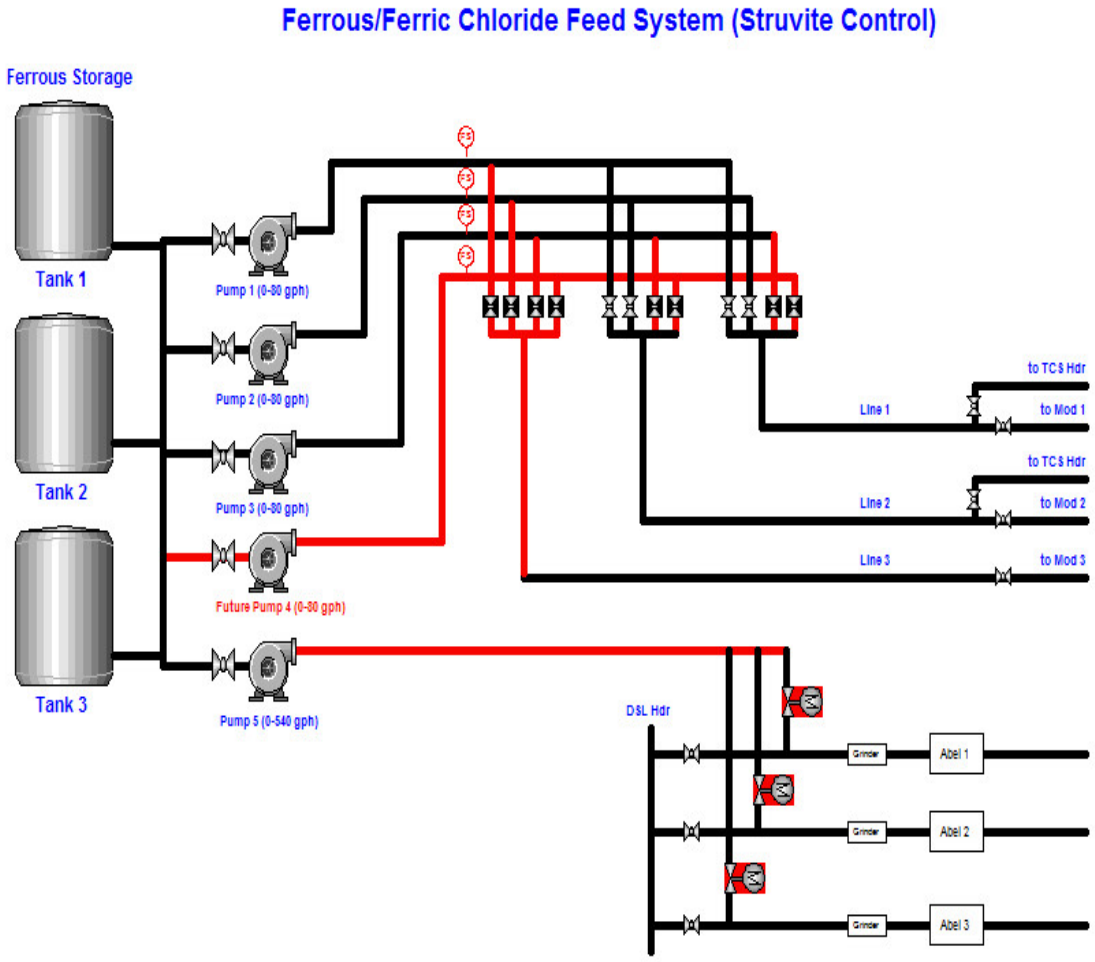
- Sulfuric Acid
- Proprietary Chemicals
- Manual Removal

How Ferric Chloride Works

- Combines with Ortho-Phosphate to Form Vivianite
- Vivianite is $Fe_3(PO_4)_2 \cdot 8\ H_2O$
- Vivianite is a grit-like substance that is less destructive than struvite
- Large amounts of Vivianite can create problems

Vivianite in the Grit Collection System

DITP Ferric Feed Set-up



Ferric Feed pumps

Monitoring Ferric Chloride Effectiveness

- Monitor Orthophospate (PO_4^{3-}) in digested sludge
- DITP samples sludge from each digester every week day
- Analyze for orthophosphate twice per week using colorimetry technology (EPA 353.2, 365.1)
- Target: 50-75 mg/L orthophosphate
- Challenging target to keep: easy to overshoot or undershoot

MWRA Department of Lab Services Autoanalyzer

Costs and Benefits of Ferric Chloride

- Purchasing ferric chloride is expensive
- 1,600,000 lbs budgeted for next year, at $.55 per pound cost is $870,000.
- Limited space to store on-site, only space for seven days supply
- One added benefit, keeps sulfides down in digester gas

Future

- Work on Minimizing Ferric Chloride dose
- Explore Alternatives:
  - Reconfiguring overflow box in digester
  - Precipitate Struvite in side stream process to reduce overall phosphate levels

Thank you!

Questions?