Enhanced Biological Phosphorus Removal at the Marquette Area WWTP

2012 MWEA Administrators Conference

Frankenmuth, Michigan
Outline

- the City and the plant
- Tankage, a good candidate.
- Process Specifics and Control
- Conditions to watch for
- Performance Summary: Chapter 1 and Chapter 2
The real Marquette...
Marquette Area WWTP

- Original construction 1953
- Secondary Treatment upgrade 1978
- Second, Secondary Treatment upgrade 2008
- Discharge
- Flow Rate
## Selected Permit Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus</td>
<td>1.0 mg/L</td>
</tr>
<tr>
<td>Ammonia (seasonal)</td>
<td>10 mg/L daily max</td>
</tr>
<tr>
<td>CBOD5 / TSS (varies seasonally)</td>
<td>17 mg/L / 30 mg/L</td>
</tr>
<tr>
<td>D.O.</td>
<td>4.0 mg/L</td>
</tr>
</tbody>
</table>
History of the Bio-P Tanks

- Original construction 1953: primary clarifiers, 2 x 115,000 gallons
- New Purpose: modified UCT bio-P tanks
- Cartoon illustrations
Started with this...

Primary Clarifier #1

Primary Clarifier #2
- 6 Baffled zones
- 3 RAS addition points
- Cut a RCR hole in the wall
- 1 High Volume Submersible pump
- 6 Mixers
- 1 ORP probe
UCT Enhanced Bio-P system

To aeration basins

Mixer

Z-4

Z-5

Z-6

Pump

RAS

Z-3

Z-2

Z-1

Primary Effluent

Mixer

Mixer

Mixer

Mixer
Bio-P Configuration Min Anaerobic, Max Anox.

**Anaerobic Zone, Anoxic Zone**
Flow Diagram

- Anaerobic Condition
  - P Release

- Anoxic Condition
  - Denitrification

- Bio-P Process

- Aerobic Condition
  - Phosphorus Uptake
Marquette Area Wastewater Treatment Plant
Biological Phosphorus Removal Process
Average of Values Based on 23 days of an 11 point data set
Soluble P Conditions Across Bio-P Tank Zones 1 - 6 and Aeration Basins
February and March 2010

Primary Clar.
Bio-P Tanks Zone 1 - 6
Aeration Basin, Inlet, mid, outlet

Soluble Phosphorus Concentration, mg/L

Poor performance Day
ORP Remained Consistent at -383 mV.

Is there anaerobic zone phosphorus release? Aerobic zone uptake?
**ORP**

**Oxidizers**
- Free elemental oxygen, O2
- NO3
- ...any other type of oxidant

**Reducers**
- Biomass, ML bacteria

<table>
<thead>
<tr>
<th>Oxygen Condition</th>
<th>0 – ~8 mg/L DO</th>
<th>ORP, -500 mV To +1000 mV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobic Condition</td>
<td>0 mg/L DO Concentration</td>
<td>Aerobic Condition</td>
</tr>
<tr>
<td>Anoxic Condition</td>
<td>0 mg/L DO Concentration</td>
<td>Aerobic Condition</td>
</tr>
</tbody>
</table>
What ORP tells us

- Denitrification is complete
- Anaerobic conditions will exist, phosphorus will be released.

Assumptions
- Influent strength sufficient to support release
- AS aerobic conditions will uptake
Precautions
Phosphorus Removal Mechanisms

• Chemical coagulation
  – Chemical sludge
  – Bound up, dead end

• Biological uptake
  – Phosphorus rich W.A.S.
    • This can come back to haunt you!
328 mg/L
Problematic Encounters

- Clarifier Collector Failures
- WAS tank aeration diffuser failure
- Root control
Marquette Area wastewater Treatment Plant
Impact of Root Control on
Final Effluent Phosphorus and Ammonia Concentrations

Concentration, mg/L

Total-P
NH3-N
Root Control 6/22 - 6/25
Averages for 6 Months

- 0.50 mg/L phosphorus
- 41 gallons per day for ferric
Summary

- Incredibly powerful biological tool…but
  - Beware of non aerated ML sludge potential
  - Be wary of keeping any excess WAS
  - Added complexity: Increased likelihood of permit violation
  - Have a Hair Trigger response with chemical addition

- Sidestream load equalization and ferric chloride addition to the process

- Layperson understanding of process.
The End