The Challenges of Change: From RBCs to BNR Activated Sludge at Whitewater

Tom Crouse & Bill Marten

Tim Reel
Outline

- Review Background & Upgrade Project
- Nutrient Removal Configuration/Facilities
- Startup/Initial Operations
- Results to Date
Existing Whitewater WWTF (Circa 2009)
Existing WWTF Processes

- Screening and Grit Removal
- RWW Pumping
- Secondary Clarifiers and SSD Pumping
- Rotating Biological Contactors (RBCs)
- Tertiary Filters
- UV Disinfection
- Primary Clarifiers and PSD Pumping
- Screening and Grit Removal
- Anaerobic Digestion and Biosolids Storage
- RWW Pumping
Whitewater WWTF

- Average flow 1.5 MGD, service population ~15,000
- Key challenges:
  - Future design flow (max month 3.8 MGD; peak hour 11 MGD)
  - UW-Whitewater impacts on flows and loadings (in/out of session)
  - Aging infrastructure (35 years old)
  - Code compliance issues (RWW pump station, digester complex & tunnel)
  - RBC shaft failures
  - Nutrient removal performance
    - Nitrification
    - P Removal
Aging Infrastructure
RBCs – Limited Nutrient Removal Capability...
...Along With Loading & Shaft Failure Issues
Upgrade Project: 2014 FP to 2018 S/U

- New activated sludge system
  - New Aeration basins with BPR
  - Conversion of one existing clarifier to an aeration basin
  - Construction of two new secondary clarifiers

- New process building:
  - RAS and WAS pumping
  - Sludge thickening WAS/DSD
  - Aeration blowers
  - Electrical switchgear
  - Relocated generators

- Control Building renovation
- Storage building

- MCC replacements
- NFPA 820 upgrades
- Fiber optic network
- Septage receiving
- 6mm Screen
- Primary sludge pumps
- Filter Building HVAC
- Post aeration blowers
- Filter bypass control
- Digester 2 mixing system
- Digester/building heat boiler system
### Upgrade Element

<table>
<thead>
<tr>
<th>Upgrade Element</th>
<th>Total Project Cost</th>
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<tbody>
<tr>
<td>BNR Activated Sludge</td>
<td>$10.3M</td>
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<tr>
<td>Electrical Systems</td>
<td>$3.5 M</td>
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<tr>
<td>Fire and Safety Guidelines</td>
<td>$0.4 M</td>
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<tr>
<td>HVAC and Lab QC Areas</td>
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<td>Lab Expansion/Space Use</td>
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<td>Aging Site Infrastructure</td>
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<td>Hydraulics, Controls, Aging Equipment</td>
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<tr>
<td>Digestion Complex Improvements</td>
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<tr>
<td>Total Project</td>
<td>$20.7M</td>
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</tbody>
</table>

The Upgrade Encompassed Entire Plant.
Bio-P Configuration with Nitrifying Activated Sludge: Modified UCT’
Key Challenge: UW-Whitewater Loadings

New Aeration Tanks

New Volume  0.64 MG
Selectors    0.24 MG
Aeration     0.40 MG

Re-purpose Volume  0.40 MG

Flexible Bioreactor Volume While
Minimizing New Construction

Circular Aeration Tank

To F.C.
Circular Aeration Tank A5: Aeration & Mixing

- Avoids Over-Aeration Due to Mixing Limited Condition
MUCT’ Configuration Provides Efficient Bio-P
Key Challenge:
Ave Flow 1.5 MGD/Peak Flow 11+ MGD

Approach:
- Peak Flow Step Feed
Maintains Higher MLSS in Rectangular Basins
- Optimize BNR

Aerated Circular Bioreactor Ensures Full Treatment & Nitrification

Clarifier Solids Loading Rates are Minimized to Ensure Effective Clarifier Performance
Instrumentation Provides Key Process Control Supplement
New, Optimized Activated Sludge Secondary Clarifiers

Secondary Clarifiers 1 & 2
80 ft diameter
14.75 ft side water depth
As With Such Projects, Kudos to Plant Staff for Maintaining Operations & Compliance of Their Facility During Upgrades
Let’s Get to Some Results

- Transitional Startup 2018 Required Key Activated Sludge Elements to Be Finished & Ready for Operation:
  - Rectangular Bioreactor Zones
    - Required Removal of 1 Bank of RBCs
  - New Secondary Clarifiers
  - New RAS/WAS Pump Station
  - Partial Diversion of PE to New System (Seed Bio-P Sludge from Beloit)

- Final Startup
  - Circular Aeration Tank A5 Transformed From RBC Clarifier
    - Required Removal of Second Bank of RBCs
Transitional Startup Required
Temporary Pumping
Transitional Startup Required Temporary Pumping
Ready for Startup...  
Late December 2017
Staff Get an Extra Christmas Present (Winter Startup)
Key Challenges at Startup

- Winter!
- Working in Coordination (& Around) Ongoing Construction
- Phased Startups
- Going From a Process That Runs Itself (RBCs) to a Fairly Complicated Process Requiring Diligent Process Monitoring & Control
Nitrification & Temperature

- The temperature for optimum growth of nitrifying bacteria is between 77-86°F (25-30°C).
- Growth rate is decreased by 50% at 64°F (18°C).
- Growth rate is decreased by 75% at 46-50°F.
- No growth will occur at 39°F (4°C).
- Nitrifying bacteria will die at 32°F (0°C).
- Nitrifying bacteria will die at 120°F (49°C).

Tom Crouse on the Pre-Conference Bike Ride Yesterday!! 😎
Key Process Control (New) Practices

- Clarifier Blankets
- Mixed Liquor Monitoring
  - Bioreactor Conditions
    - D.O., ORP
  - Settleability/SVI
  - Microscopic Exams
- Balancing RAS
  - Clarifiers vs Bio-P
- SRT-Based Wasting
WAS Can Come From RAS Header or MLSS Dropbox

- RAS Secondary Clarifier No. 2
- RAS Secondary Clarifier No. 1
- MLSS from MLSS Dropbox
- RAS to STR 410 RAS Splitter
- WAS Pumps
- Thickened Solids to Digester Complex
- Scum from Secondary Clarifiers
- Solids from Anaerobic Digester Complex
- Centrifuge Air Compressor

Valve (typical)

Drain

RAS Pump

Centrate Tank

Solids to Primary Clarifier for Co-Thickening

Secondary Scum Pump
Results: Effluent $\text{BOD}_5$

![Graph showing Effluent BOD5 over time from 07/03/17 to 08/03/18]
Results: Effluent Ammonia

NH₃-N (mg/L)

Date

07/03/17  08/03/17  09/03/17  10/03/17  11/03/17  12/03/17  01/04/18  02/04/18  03/04/18  04/04/18  05/04/18  06/04/18  07/04/18  08/04/18
Results: Effluent Phosphorus
Facility Prior to Upgrades
Transitional Startup: 2 Down, 1 to Go...

(dated Google Earth image – circa Spring 2018)
Thanks for Being Here!

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Centrifuge for Sludge Thickening

- Dual Use
  - Waste Activated Sludge
  - Digested Sludge
Alum Pumping (STR 200)
Ortho Phosphate Analyzer (STR 600)

Ortho Phosphate Analyzer in Chlorine Room of STR 600 used for control of chemical phosphorus removal using Alum Pumps
Orthophosphate Analyzer (STR 600)
Other Plant Improvements

- Digester Gas Treatment (STR 700)
  - Condensate/Sediment Traps
  - Auto Drip Traps

- Digester Piping (STR 700)
  - Sludge Loadout
  - More flexibility
  - New digester mixing nozzles
Other Plant Improvements

- Natural Gas Boilers (STR 700)
  - Two new natural gas boilers
  - New Boiler and Heating Pumps
- Emergency Generators & Switchgear (STR 800)
  - Relocated engine generators
  - New Switchgear
- Septage Receiving Station (STR 160)
**Anaerobic Processes**
- P release
- Fermentation
- Reclaim Alkalinity

**Anoxic Processes**
- Denitrification
- Reclaim alkalinity

**Aerobic Processes**
- P uptake
- Nitrification
- BOD removal
- Consumes alkalinity

**MUCT process - Modified University of Cape Town Process (South Africa)**
ORP values are relative – every wastewater and wastewater treatment plant is different treatment
First Let’s Focus on the Bioreactors...