Preliminary Investigations into the Adverse Effects of Low Phosphorous Levels on Settleability at the GLWA WRRF

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Introduction

This presentation will:
• Provide background information for the GLWA WRRF
• Discuss background on phosphorous removal at the GLWA WRRF
• Present data on settleability issues
• Show a preliminary correlation between settleability issues and phosphorous concentrations
• And, as any good research paper does, discuss the need for additional study
GLWA Background
GLWA Background
Wastewater System

Collection System

Combined Sewage

Treated Combined Sewage Overflow
9 Facilities

Untreated Combined Sewage Overflow
56 Untreated CSO Outfalls
1,550 MG

Treatment System

165,000 Tons (Solids)
237,250 MG (Treated)
GLWA Background
GLWA Wastewater System

Serves 35% of Michigan’s population
~3.1 million people in 77 communities
over a 946 sq. mile service area

Only one GLWA WRRF in system
Treatment Capacity: 1,700 MGD primary
930 MGD secondary treatment
686 MGD average flow

Solids Disposal Requirements
• Average day - 450 dry tons
• Peak day – 850 dry tons
GLWA Background
Primary Treatment Process

[Diagram showing the primary treatment process with泵站1 and pump station 2 connected through primary clarifiers, leading to Rouge River, Detroit River, North Intercept East Arm, and an input to the aeration basin followed by sludge processing complex A.]

Ferric Chloride
GLWA Background
Secondary Treatment Process
GLWA Background
Solids Processing

Sludge Processing & Solids Handling Processes

- Sludge Processing Complex A
- Blenders
- Storage Facility
- Dewatering Process
  - Complex 1 BFPs
  - Complex 2 ULBFPs
  - Complex 2 Westralia
  - Complex 2 Sharple

- Central Off-Loading Facility
- Truck to Off Site
- Cake Production to Incineration

- BDF
  - Dried Pellets
  - Trucked to Off Site
GLWA Background

• GLWA is a newly formed authority operating many of the assets of the old DWSD
• One of the critical assets is the Water Resource Recovery Facility (WRRF)
• The GLWA WRRF has a firm pumping and primary treatment capacity of 1,700 mgd
• Secondary capacity is 930 mgd
Phosphorous Removal
Background
Phosphorous Removal

- One of the permit requirements for the GLWA WRRF is Total Phosphorous (TP)
- The previous permit limit (Pre-2015) for secondary effluent was 1.0 mg/l
- The current limit for secondary effluent is 0.7 mg/l with a seasonal limit of 0.6 mg/l from April – September
- Can anyone guess where future limits are heading???? (hint – they are not going up)
Phosphorous Removal

- As most folks know phosphorous is a key nutrient for biological growth
- Sometimes this is good and sometimes this is bad
- Good – human growth, crops, green lawns
- Bad – eutrophication, algal growth
- Many examples of eutrophication issues – Chesapeake Bay, Long Island Sound, Gulf of Mexico, Great Lakes, etc.
Phosphorous Removal

TP can be removed in several ways:

• Standard biological uptake – usually in the 0.1-0.3 mg/l as part of the normal biological treatment of BOD in a secondary system
• Enhanced biological uptake – BNR which can remove several mg/l
• Chemical removal – Chemical precipitation by addition of iron salts, alum, etc.

GLWA uses chemical removal at the primary clarifiers (iron salts) and natural biological uptake in the secondary treatment process
Phosphorous Removal

- Based upon current removal requirements (0.6-0.7 mg/l), GLWA generally sets a target below the limit to provide a buffer
- In recent years, GLWA has achieved an average annual secondary effluent concentration of 0.3 – 0.4 mg/l
- If some removal is good, more removal must be better
- That is not necessarily true!!!!!!!!!!
Phosphorous Removal

Annual Average Secondary TP (mg/l)

- Pre-2015 NPDES Permit Limit 1.0 mg/l
- January 2015 NPDES Permit Limit 0.7 mg/l
Settleability Issues
Settleability Issues

• GLWA began to experience some settleability issues in 2013
• Definitive peaks in effluent TSS in 2013, 2014 and 2015. These were intermittent and not long term issues.
• During this time, the TP levels were being reduced to consistently below 0.4 mg/l – but these are annual average concentrations
• Low TP levels causing settleability issues was discussed among GLWA O&M staff
Settleability Issues

C2E – 10 Day Moving Average
TSS vs. Time

Peaks after 2011 indicating potential settling problems
Settleability Issues

Many variables can affect settleability:
• Temperature
• Oil & Grease
• Nocardia
• Sludge Age

Based upon discussions with GLWA staff, it was decided to investigate low phosphorous levels.
Settleability Issues

A literature search was conducted and basically supported the thinking that low phosphorous levels can result in poor settleability.

Review of the literature indicated:

- Sludge bulking
- Settleability issues
- Carbon:Nitrogen:Phosphorous ratios should be about 100:5:1
- Some of the literature actually recommends adding Phosphorous to address settleability issues
Settleability Issues

- Based upon high effluent TSS, discussions amongst Operations Staff, and a preliminary literature search, GLWA decided to do a preliminary review of past plant data to see if there is a correlation between low Phosphorous levels and poor settleability/high effluent TSS.
- Combined Secondary Effluent (C2E) TSP (Total Soluble Phosphorous) and SVI (Sludge Volume Index) data were readily available so it was evaluated first.
- The focus of the time frame was for the three defined peaks identified in the figure (2013, 2014, and 2015).
Correlation Between TSP and Settleability
Correlation Between TSP and Settleability

A-1 Deck – 10 Day Moving Average
SVI & C2E TSP vs. Time

Upward trend of SVI data

Downward trend of C2E TSP concentrations
Correlation Between TSP and Settleability

• Previous graph shows a general correlation between trend of increases in SVI and general trend in decreases in TSP in the effluent
• Preliminary data indicated a correlation between TSP and settleability
• Data were reviewed for TSS and PEAS Total Soluble Phosphorous (TSP)
• The Aeration Deck influent (PEAS) TSP was evaluated against Effluent TSS
• The two peaks in effluent TSS appear to correlate with two distinct drops in TSP to the aeration tank
• While this is an indicator, it is not a definitive correlation. Some low TSP levels do not result in settleability issues.
Correlation Between TSP and Settleability
Correlation Between TSP and Settleability

- To smooth the data, 10-day moving averages were used.
- Graph on the previous slide shows two periods of generally stable TSP levels above 0.4 mg/l.
- The corresponding effluent TSS is generally stable.
- There are also two periods when the effluent TSS appears to peak above 20 mg/l.
- These periods correlate to periods of TSP dipping below 0.4 mg/l.
Summary and Conclusions
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• GLWA effectively removes Phosphorous
• Some settleability issues have been detected
• Investigations into the relationship between low phosphorus levels at secondary treatment and high effluent TSS were initiated
• While not completely conclusive, some preliminary correlation between low TSP and settleability issues has been detected
Questions?