OWEA TECHNICAL CONFERENCE & EXPO - 2019
Modeling Saves City of Youngstown $$$ by Rethinking LTCP Strategy

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AGENDA

Introduction
Health & Safety Moment
WWTP History and the LTCP
Process and Hydraulic System Modeling
Impact on Cost and Operations
Modifications to the LTCP
Q&A
Heat Related Illness (HRI) Prevention

RECOGNIZE the 4 stages of Heat Illness

1. Heat Cramps (Discomfort)
2. Heat Syncope AKA “Heat Stress” (Fainting)
3. Heat Exhaustion (Will become life threatening if not addressed quickly)
4. Heat Stroke (Life Threatening – call 911)

Hazard controls start with effective management:

✔ Read and know your company’s H&S Standard.
✔ Being hydrated in advance is critical.
✔ Have water onsite and require folks to routinely hydrate & replenish electrolytes.
✔ Provide adequate shade.
✔ Schedule and require routine breaks

Need Heat Index Support? Get the NIOSH (Formerly OSHA) Heat Tool app. Look for this icon.

Effective hazard controls involve ensuring water, shade, & breaks.
Hazard controls start with effective planning of work. PPE is your last option.

Heat Related Illness (HRI) Prevention

Monitor conditions

(NIOSH Heat App)

&

Take cooling breaks

Eat light

Hydrate

3:1 waters to electrolyte drinks
Hydrate w/ 8 oz. water every 15 minutes

Replenish

Cooling Vest

Cooling Towels

Misting Fan

Portable shade
WWTP History

• Original WWTP was built in 1957 with preliminary treatment, primary flocculation, clarification and disinfection. Sludge processing included digestion and dewatering on vacuum filters.

• In 1984 construction began on the modifications to the existing WWTP primary treatment systems and sludge handling processes.

• In 1985 construction on the secondary treatment improvements was started

• WWTP is rated for 35 MGD ADDF and 90 MGD PDF

• Total Project Cost $50 million
Long Term Control Plan (LTCP)

Expected Improvements Needed to Maintain Service

- Control Combined Sewer Overflows (CSO)
- Upgrade the WWTP to Handle 80 MGD Wet Weather Flow
- Construct 100 MGD High Rate Treatment Wet Weather Facility
- Other System Improvements
Long Term Control Plan (LTCP) 2014 Report

WWTP Improvements:
• Cost: $37+ million
• Finalize by March 27, 2020

Wet Weather Facility Improvements:
• Cost: $62+ million
• Finalize by April 20, 2029
Affordability Burden Is a Challenge to LTCP Implementation

LTCP Planned and Required Rate Hikes
Affordability Burden Is a Challenge to LTCP Implementation

LTCP Planned and Required Rate Hikes

Cost as a Percentage of Income

- $22,000
- $27,000
WWTP Design Approach

WWTP Secondary Treatment Process Improvements:

1. Hydraulic Model to determine the WWTP hydraulic profile/flow capacity/conveyance modifications
2. Process Model to verify treatment needs and potential upgrades
3. Design of Secondary Treatment Improvements:
   • Trickling Filters
   • Aeration Tanks
   • Final Clarifiers
   • RAS/WAS
WWTP Primary Effluent Pumping Station and Microscreen System Improvements:

1. Pumping of Primary Effluent to Secondary Treatment
   • Upgrade Primary Effluent Pumping Station (PEPS)
   • Construct a new Auxiliary Primary Effluent Pumping Station (APEPS)

2. Improvements to the Microscreen System
   • Not Implemented and Replaced With Disk Filters

3. Aeration Tanks Diversion Box
WWTP Design Approach

Other WWTP Improvements:

• LTCP Phase 1 - Electrical Improvements Contract A - Substation
• LTCP Phase 1 - Electrical Improvements Contract B – Electrical Distribution
• UV Disinfection Improvements Project
• Primary Settling Tanks Improvements Project
Hydraulic WWTP Model

Peak Flow Capacity 80 MGD

<table>
<thead>
<tr>
<th>Wastewater Treatment Process</th>
<th>Existing Wet Weather Flow Rating, MGD</th>
<th>Planned Wet Weather Flow Capacity, MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Pump Station and Grit Tanks</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Mechanical Bar Screen (Channel Monster)</td>
<td>65 + (15) = 80</td>
<td>65 + (15) = 80</td>
</tr>
<tr>
<td>Primary Clarifiers (recycle)</td>
<td>80 + (10) = 90</td>
<td>80 + (10) = 90</td>
</tr>
<tr>
<td>Primary Effluent Pump Station (recycle)</td>
<td>~70</td>
<td>~70</td>
</tr>
<tr>
<td>Primary Bypass to Chlorine</td>
<td>~20</td>
<td>0</td>
</tr>
<tr>
<td>Trickling Filters (recycle)</td>
<td>~70</td>
<td>80 + (10) = 90</td>
</tr>
<tr>
<td>Aeration (RAS)</td>
<td>35 + (20) = 55</td>
<td>50 + (30) = 80</td>
</tr>
<tr>
<td>Secondary Clarifiers</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Microscreens (Backwash)</td>
<td>35 + (10) = 45</td>
<td>30 + (10) = 40</td>
</tr>
<tr>
<td>Chlorine Contact Tank</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

Software: InfoWorks Integrated Catchment Model (ICM)
Over 700 Nodes and 1000 Conduits / Flap Valves / Flumes / Pumps / Screens / Sluice Gates, etc.

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Hydraulic WWTP Model Benefits

- Evaluate existing conditions, optimize plant performance, and review proposed plant improvements.
- Simulate open channel and pressure flow conditions for both steady and unsteady flow conditions.
- Real time controls to simulate various operational controls (automatically opening/closing gates, throttling valves, variable crest weirs, etc.).
- Dynamically routing hydrographs with potential to incorporate the collection system model.
## Hydraulic Issues Identified

<table>
<thead>
<tr>
<th>Hydraulic Issue Identified</th>
<th>Proposed Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulically limiting inlet configuration at the Trickling Filter Effluent Pipe (Inlet Controlled) causing surcharging at the Trickling Filters</td>
<td>Modified effluent structure increased inlet capacity for 54-in Effluent Pipe and reduced turbulence</td>
</tr>
<tr>
<td>Aeration Leopold Flume depth sensor “deadbands” above 35 MGD and has a high headloss making it difficult to control wet weather flow splitting between aeration tanks and microscreens</td>
<td>Replace the Leopold Flume unit with a lower headloss measuring device with more dependable flow measurements</td>
</tr>
<tr>
<td>Desire increased processing capacity</td>
<td>Determined that increasing the Aeration effluent weir elevation would provide greater retention time / capacity without impacting influent &amp; RAS water surface elevations</td>
</tr>
</tbody>
</table>
Process Model Objectives

1. Develop a BioWin® model of the YWWTP

2. Evaluate alternative process configurations and operating scenarios to treat up to 80 MGD peak wet weather plant influent flow and meet the existing WWTP permit limits

3. Develop estimated oxygen demands for the evaluated scenarios for use in the design of the aeration system and blower upgrades
**Process Model Approach**

- **Parameter** | **Plant Influent** | **Final Effluent**
- Flow | Not Reported | Daily
- Temperature | Not Reported | Daily
- Total Suspended Solids | 5/week | 5/week
- Ammonia Nitrogen | Not Reported | 5/week
- pH, Daily Max and Min | Daily | Daily
- CBOD5 | 5/week | 5/week
- Total Phosphorus | Not Reported | 2/week
- Total Kjeldahl Nitrogen | Not Reported | 1/week
- Nitrate + Nitrite | Not Reported | 1/week

**Used Historical Data and Supplemented with Additional Field Sampling**

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### Process Model Approach

<table>
<thead>
<tr>
<th></th>
<th>Flow</th>
<th>TSS</th>
<th>CBOD5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MGD</td>
<td>mg/L</td>
<td>lb/d</td>
</tr>
<tr>
<td>Min Day</td>
<td>16.5</td>
<td>119</td>
<td>16,400</td>
</tr>
<tr>
<td>Min Week (7-d)</td>
<td>17.0</td>
<td></td>
<td>20,700</td>
</tr>
<tr>
<td>Min Month (30-d)</td>
<td>19.2</td>
<td></td>
<td>25,300</td>
</tr>
<tr>
<td>Average Day</td>
<td>29.2</td>
<td>134</td>
<td>32,800</td>
</tr>
<tr>
<td>Max Month (30-d)</td>
<td>46.9</td>
<td></td>
<td>43,300</td>
</tr>
<tr>
<td>Max Week (7-d)</td>
<td>58.9</td>
<td></td>
<td>57,700</td>
</tr>
<tr>
<td>Peak Day</td>
<td>68.2</td>
<td>134</td>
<td>76,300</td>
</tr>
<tr>
<td>2014 Annual Average</td>
<td>29.9</td>
<td>137</td>
<td>32,300</td>
</tr>
<tr>
<td>2015 Annual Average</td>
<td>28.5</td>
<td>152</td>
<td>33,400</td>
</tr>
</tbody>
</table>

Used Historical Data and Supplemented with Additional Field Sampling
Process Model Approach

Rainfall and Plant Flows During the April 2016 Sampling Events

1-d (Apr 21-22)  2-d (Apr 24-26)  2-d (Apr 27-29)

Flow, MGD

Daily Rain Depth, in

Plant Influent Flow  Composite Sampling  Plant Effluent  Daily Cumulative Rain  24 per. Mov. Avg. (Plant Influent Flow)
Process Model Approach

WWTP Flow and Influent TSS and CBOD Load Trends for April-May of 2014 2015 and 2016
Two Trickling Filter Operations
Initial Proposal

Two Trickling Filter Dry Weather Operation

Two Trickling Filter Peak Wet Weather Operation
Process Model Developed to Represent Current and Proposed WWTP Operations
Actual Wet Weather Influent Flow and Concentrations Provide Realistic Model Input
## Proposed Modification – Process Modeling Results

Modeling compared operation and predicted performance of proposed strategy with two trickling filters vs. LTCP with four trickling filters.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>AT Flow</th>
<th>TSS</th>
<th>CBOD5</th>
<th>NH3-N</th>
<th>FC SLR</th>
<th>FC SOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max</td>
<td>7d</td>
<td>30d</td>
<td>7d</td>
<td>30d</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td>MGD</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>lb/d/sf</td>
</tr>
<tr>
<td>4TFs Plug Flow</td>
<td>35</td>
<td>13</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>1.7</td>
</tr>
<tr>
<td>2 TFs Step Feed</td>
<td>50</td>
<td>21</td>
<td>18</td>
<td>7</td>
<td>5</td>
<td>1.4</td>
</tr>
<tr>
<td>Permit/Operating Limits</td>
<td>-</td>
<td>30</td>
<td>20</td>
<td>17</td>
<td>10</td>
<td>4.5</td>
</tr>
</tbody>
</table>

**Predicted Combined Effluent Quality and Clarifier Loading Rates**
Secondary Treatment Design & Operation Aspects Reviewed and Supported Through Process Modeling

<table>
<thead>
<tr>
<th>LTCP</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeration System</td>
<td>Upgrade in kind</td>
</tr>
<tr>
<td></td>
<td>Step Feed Aeration:</td>
</tr>
<tr>
<td></td>
<td>• Higher peak flow treated in ATs</td>
</tr>
<tr>
<td></td>
<td>• Longer SRT for improved nitrification reliability</td>
</tr>
<tr>
<td></td>
<td>• Operational Flexibility</td>
</tr>
<tr>
<td></td>
<td>• More robust, improved post-storm recovery</td>
</tr>
<tr>
<td></td>
<td>• Allows reduced peak clarifier solids loading</td>
</tr>
<tr>
<td>Final Clarification</td>
<td>Upgrade in kind</td>
</tr>
<tr>
<td></td>
<td>• Extended surface area</td>
</tr>
<tr>
<td></td>
<td>• Increased capacity</td>
</tr>
<tr>
<td></td>
<td>• Improved solids withdrawal</td>
</tr>
<tr>
<td>Microscreens</td>
<td>Upgrade in kind</td>
</tr>
<tr>
<td></td>
<td>• Replaced with Disk Filters</td>
</tr>
</tbody>
</table>
WWTP Current Operations

- **Primary Effluent** ≤ 70 MGD
- **Trickling Filters (4)**
- **Aeration**
- **Secondary Clarification**
- **Microscreens**
- **Disinfection**
- **Non-Potable Water Supply (10 MGD)**

Max 35 MGD

0-35 MGD

Up to 35 MGD
Proposed Modification 2 TFs
Process Flow Diagram – Dry Weather 0-35 MGD

PEPS = Primary Effluent Pump Station
APEPS = Auxiliary Primary Effluent Pump Station
Proposed Modification 2 TFs
Process Flow Diagram – Wet Weather 35-50 MGD

PEPS = Primary Effluent Pump Station
APEPS = Auxiliary Primary Effluent Pump Station
Proposed Modification 2 TFs
Process Flow Diagram – Wet Weather 50-80 MGD

Primary Effluent 50-80 MGD

PEPS

APEPS

Trickling Filters (2)

Aeration

Secondary Clarification

Disk Filters

Disinfection

Non-Potable Water Supply

PEPS = Primary Effluent Pump Station
APEPS = Auxiliary Primary Effluent Pump Station
Process Modeling Conclusions

Proposed modifications to LTCP provide:

- Equivalent biological treatment
- Permit compliance (loading and concentration)
- Consent order compliance (schedule)
- More reliable and flexible operations modes
- Opportunities for controlling costs
- Current capital and O&M costs significantly elevated from proposed LTCP estimate
Capital Plan Changes Since LTCP Estimate Present a Cost Challenge for Youngstown

*Estimated Costs of Construction $ Million*

- LTCP planned
- Current Estimate 4 TF
- Current Estimate 2 TF

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Actual Costs 4 Trickling Filters Present Highest Burden on Rates

60% design estimates cost ~$15M over LTCP estimate

Current Planned and Required Rate Hikes with 60% design cost
Actual Costs 2 Trickling Filters Burden on Rates Comparable to LTCP plan

Does not include potential $1M/yr O&M savings
LTCP Implementation Success Relies on the Flexibility to Adopt Latest Technologies

✓ Most LTCPs adopt different technologies than those originally proposed. Approval is typically granted if treatment limits meet permit and CSO policy goals.

✓ New technologies will become available (as was often discussed during LTCP negotiation)

✓ Improvements that reduce O&M cost and increase operational flexibility are more sustainable if population does not grow

✓ Youngstown has an acknowledged “high burden” for existing rates

✓ Costs of required and desired improvements may have been underestimated in LTCP effort
LTCP Modification Process

1. Teleconference to update EPA about findings – June 13, 2016
2. Letter from City requesting a non-material modification to the LTCP
3. December 15, 2016 EPA rejected proposed modification (anti-backsliding provisions)
4. Meeting with EPA in January 25, 2017
5. June 22, 2017 approval was granted
6. Approval included Performance Criteria, Demonstration of Treatment and Schedule
### LTCP Modification Process

#### Youngstown WWTP: Control Measures and Design and Performance Criteria

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>CSOs/SSOs Controlled</th>
<th>Design Criteria</th>
<th>Secondary Effluent Performance Criteria</th>
<th>Critical Milestones</th>
</tr>
</thead>
</table>
| Youngstown WWTP Upgrades | 1. Renovate two Trickling Filters (TFs), 2. Rehabilitate Aeration Basins and convert to step feed, 3. Rehabilitate microscreens. | Increases treatment rate to reduce all CSOs | All flow of 80 MGD undergoes secondary treatment. All Primary Effluent (PE) flows up to 35 MGD shall receive full treatment (primary, TF, then Aeration Basins). At PE flows between 35 MGD and 50 MGD, PE flow to the TFs and then to Aeration shall be 35 MGD, with the remaining PE flow to the Aeration basins. At PE flows between 50 MGD and 80 MGD, TF flow shall remain at 35 MGD, flow through Aeration shall remain at 50 MGD, flow to the microscreens from the TFs shall be (PE flow – 50) MGD, and PE flow direct to Aeration shall be 15 MGD (PE flow – 50) MGD. | Conventional organic loading = 40 lbs CBOD5/d/1000 cfs Daily monitoring requirements: 
1. Nitrogen, Ammonia: 7-day average 
   i. CBOD5 = 17 mg/L  
   ii. NH3 = 4.5 mg/L  
   iii. pH = Within limits of 6.5 and 9  
2. CBOD5: 30-day average 
   i. CBOD5 = 12 mg/L  
   ii. NH3 = 3.0 mg/L  
   iii. pH = Within limits of 6.5 and 9  
3. Total Suspended Solids: 7-day average 
   i. TSS = 30 mg/L  
4. Total Suspended Solids: 30-day average 
   i. TSS = 20 mg/L | 1. Substantial Completion WWTP Improvements, March 27, 2020                                                                 |

**I.** Daily monitoring requirements for F/M, SRT, MLSS,MLVSS, and influent BOD5 in Aeration Basin.  
**II.** Continuous monitoring of Dissolved Oxygen in Aeration Basin.  
**III.** Daily monitoring of PE BOD5 and Trickling Filter effluent BOD5 under wet and dry weather conditions.
LTCP Modification Process: Demonstration of Treatment

**Sampling schedule** - The City shall perform sampling from April 1, 2020 through May 30, 2021 when operating its new approved treatment renovations to determine the effectiveness of treating flows during wet weather events. The City shall perform this sampling to demonstrate that it meets Performance Criteria specified in its modification proposal for flows from 35 MGD to 80 MGD prior to discharge from Outfall 001. By February 1, 2021, if the City determines that the sampling period of April 1, 2020 through May 30, 2021 is not sufficient to determine compliance with the Performance Criteria because of inadequate sampling events, the City may request, within 30 days, that EPA and Ohio EPA allow for an additional period of sampling, not to exceed a year. If EPA and Ohio EPA agree that additional sampling is needed, EPA and Ohio EPA shall approve, in writing, an additional period of sampling.

**Effluent quality for WWTP** - Wastewater Treatment Plant Performance Criteria specified in Paragraph 2, is to be sampled as a composite daily, or continuously for pH. Samples shall be collected and analyzed according to 40 CFR Part 136.

a) **7-day average** - The following not to exceed 7-day average values are included in Performance Criteria for total WWTP effluent:
   
i. CBOD$_5$ – 17 mg/liter  
ii. TSS – 30 mg/liter  
iii. NH$_3$ – 4.5 mg/liter  
iv. pH – Within limits of 6.5 and 9

The 7-day average shall apply to any 7 consecutive days of operation.

a) **30-day average** - The following not to exceed 30-day average values are included in Performance Criteria for total WWTP effluent:
   
i. CBOD$_5$ – 12 mg/liter  
ii. TSS – 20 mg/liter  
iii. NH$_3$ – 3.0 mg/liter  
iv. pH – Within limits of 6.5 and 9

The 30-day average shall apply to any 30 consecutive days of operation.
LTCP Modification Process: Demonstration of Treatment

WWTP Operation Monitoring - Youngstown must also monitor and report the following plant parameters to facilitate the evaluation of the modified system’s performance:

a) Primary effluent (PE) flow directed to the trickling filters (TFs). Monitor continuously.
b) TFs effluent flow to the Aeration Basins. Monitor continuously.
c) PE flow direct to the Aeration Basins. Monitor continuously.
d) Activated sludge (final clarifier) effluent flow and microscreen flow. Monitor both continuously.
e) Aeration Basin Mixed Liquor Suspended Solids and Mixed Liquor Volatile Suspended Solids (MLSS/MLVSS) and influent BOD5 to calculate food to microorganism ratio (F/M), organic loading rate (volumetric) and solids retention time (SRT). To be carried out daily.
f) Aeration Basin Dissolved Oxygen (DO) level, monitor continuously.
g) TF effluent BOD5, carried out daily, monitored as a composite sample.

Report - By June 30, 2021, Youngstown shall submit to EPA and Ohio EPA for review, comment, and approval a report that contains the following.

a) The relevant information and supporting documentation that demonstrates that Youngstown sampled and analyzed the values from the WWTP in accordance with Section A paragraphs 2 and 3, above.
b) The results of the sampling, including, but not limited to, the evaluation of whether the sampling results at the WWTP meets all Performance Criteria in section A for treating flows in accordance with the modification proposal.
c) All operational and performance monitoring data collected during sampling pursuant to Section A paragraphs 2 and 3, provided as attachments; and
d) An analysis of additional feasible measures identified during the sampling that can be taken to maximize treatment at the WWTP. The analysis shall: (i) describe in detail such additional or alternative measures to maximize treatment, including the measures’ predicted impact on the WWTP; (ii) estimate the capital and operation and maintenance costs of the additional or alternative measures; and (iii) recommend those additional or alternative control measures for Youngstown to construct or install that will allow Youngstown to maximize treatment.
What’s next
What’s next
What’s next
What’s next
What’s next
Questions/Discussion