What's your plant of the future look like? Visioning the Morris Forman WQTC

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NC AWWA/WEA ‘17
Morris Forman Water Quality Treatment Center

- Largest Treatment Center in the Louisville & Jefferson County (KY) Metropolitan Sewer District (MSD)

- Designed to treat 120 mgd (Annual Avg) with peak capacity up to 350 mgd.

- Treatment consists of
  - Screening and Grit Removal
  - Primary Sedimentation
  - Biotowers (Trickling Filters) Roughing
  - HPO Activated Sludge
  - Discharge to Ohio River
    - Gravity or Pump
  - Sludge Thickening
  - Anaerobic Digestion
  - Dewatering/Drying

Image courtesy of Google Maps (2017) – Altered by CH2M
Morris Forman WQTC

Image courtesy of Google Earth (2017) – Altered by CH2M
Spring 2015: Rain, Rain Go Away....

• Extreme weather caused effluent pump station to fail
  – 3rd wettest April in Louisville History (~11”)
  – Thunderstorms cause power surge and destroy circuit breaker (fire)
  – Significant power outage
  – Plant Flood
  – Time to Restore:
    • April 8 – April 30
Epiphany Time....

• MFWQTC has its issues...
  – Site Topography is effectively a ‘bowl’ which traps water onsite
  – Expansions have grown to occupy nearly the entire site!
  – Little to no room for expansion

• Perhaps its time to think about a new MFWQTC...

Image courtesy of Google Earth (2017) – Altered by CH2M
BOGO?

• MSD was already in the midst of a Facility Plan
• Opportunity to add a visioning study for the MFWQTC
  – 50-yr timeframe within interim stages for progression
    • MFWQTC designed/constructed in the 70s. And after ~40 yrs, facility is landlocked.
    • Look really long term to not make the same mistake twice...
  – Flow and Load Projections
  – Revisit Site Constraints...relocation?
  – Projections of Future Regulations
  – Future Technologies
  – Costs
  – Roadmap
MFWQTC Visioning Study

• What is 50-yrs in the future going to look like?
  – What regulations could be expected?
    • Look to Reclaimed Water Treatment Standards!
  – When are they going to happen?
  – What technologies will be available?
    • Today vs Tomorrow
    • Site Requirements
  – Facility Capacity
    • Flows & Loads based on pop projections
    • 600 mgd of total wet weather
    • 82 mgd (‘dry’ weather)
    • 160 mgd (‘wet’ capacity thru biological)
Future Treatment Goals/Regulations

• Conducted a workshop to develop major categories
  – Nutrient Standards
  – Secondary Bypass Reduction
  – Residuals Management
  – Emerging Constituents (Micro-constituents)
  – Prohibition of Chlorine Disinfection
Future Treatment Goals/Regulations

• Nutrient Standards
  – Already happening across the Nation
  – MFWQTC currently has no nutrient removal per its discharge permit
  – Nutrient Reduction Strategy under development for Ohio River Watershed
    • Extension of Mississippi River/Gulf of Mexico Watershed Nutrient (Hypoxia) Task Force in response to the USEPA 2008 Gulf Hypoxia Action Plan
    • KY Milestone to develop criteria by end of 2019

<table>
<thead>
<tr>
<th>Year</th>
<th>Discharge Limit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Ammonia-Nitrogen to 1 mg/L</td>
<td>To Prevent Aquatic Toxicity. Requires Nitrification</td>
</tr>
<tr>
<td>20</td>
<td>Total Nitrogen Reduction to 10 mg/L Total Phosphorus Reduction to 1 mg/L</td>
<td>Similar Nutrient Removal Criteria for Ohio River Watershed - BNR</td>
</tr>
<tr>
<td>40</td>
<td>Total Nitrogen Reduction to 3 mg/L Total Phosphorus Reduction to 0.2 mg/L</td>
<td>Future ‘stringent’ criteria – High level BNR or MBR, Carbon Capture and Anammox, Sidestream Treatment (N &amp; P)</td>
</tr>
</tbody>
</table>
Future Treatment Goals/Regulations

- Secondary Bypass Reduction
  - Protect Public Watersheds and Health during wet weather
  - Reduce/Eliminate CSO/SSO
  - Disinfection is the biggest driver

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<tr>
<td>10-15</td>
<td>Increase wet weather treatment (lower particulates: BOD₅/TSS)</td>
<td>Could implement Chemically Enhanced Primary Treatment (CEPT) or a ballasted flocculation type wet weather treatment technology</td>
</tr>
<tr>
<td>40</td>
<td>Full Secondary Treatment of Wet Weather Flows (lower soluble pollutants: BOD₅/NH₃)</td>
<td>Could implement step feed or a biological ballasted flocculation treatment technology</td>
</tr>
</tbody>
</table>
Future Treatment Goals/Regulations

• Residuals Management
  – Too many to list (could be a separate discussion)
  – Chose 2 most notable limits
    • Nutrient Management
    • Restrictions on land application

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<tr>
<td>20</td>
<td>P limits in biosolids land application products to prevent eutrophication of lakes and streams</td>
<td>Use Nutrient Recovery</td>
</tr>
<tr>
<td>30</td>
<td>Prohibition of Class B land application.</td>
<td>Move to Class A</td>
</tr>
</tbody>
</table>
Future Treatment Goals/Regulations

• Emerging Constituents
  – Currently being regulated in drinking water, but could move to wastewater in foreseeable future
  – Generalized as
    • Biodegradable and absorbable
    • Non-biodegradable and non-adsorbable

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<tr>
<td>20</td>
<td>Treatment of Biodegradable and Absorbable MCs</td>
<td>Use of advanced biological treatment coupled with enhanced solids removal/capture</td>
</tr>
<tr>
<td>30</td>
<td>Treatment of Biodegradable, non-biodegradable, Absorbable MCs</td>
<td>Integrate organic carbon conversion and advanced adsorption</td>
</tr>
<tr>
<td>50</td>
<td>Treatment of all MCs</td>
<td>Include RO and Advanced Oxidation</td>
</tr>
</tbody>
</table>
Future Treatment Goals/Regulations

- Disinfection (Prohibition of Chlorine)
  - Driven by safety concerns (gaseous chlorine) and disinfection byproducts
  - Multiple alternatives based on footprint and hydraulic requirements

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<tr>
<td>20</td>
<td>Restrict Disinfection Byproduct Formation</td>
<td>Enhance organic carbon capture. Change to alternative chlorine disinfection technique such as chloramines to reduce formation.</td>
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<tr>
<td>30</td>
<td>Change indicator organism for disinfection requiring higher dosages</td>
<td>Increase dosage and utilize CT time for requirements.</td>
</tr>
<tr>
<td>50</td>
<td>Disinfection system includes MC destruction</td>
<td>Include Advanced Oxidation</td>
</tr>
</tbody>
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## Treatment Goal Staging - Regulations

<table>
<thead>
<tr>
<th>Planning Horizon (years)</th>
<th>Nutrient Standards</th>
<th>Secondary Bypass Reduction</th>
<th>Residuals Management Trends</th>
<th>Emerging (Micro) Constituent Regulations</th>
<th>Prohibition of Chlorine Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td>+15</td>
<td></td>
<td>Wet weather TSS removal</td>
<td>NA</td>
<td></td>
<td></td>
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<tr>
<td>+20</td>
<td>Low-Level BNR</td>
<td></td>
<td>Phosphorous and/or Micro Constituent limits for land application</td>
<td>Treat Biodegradable and absorbable MCs (i.e. higher SRT)</td>
<td>Reduce Disinfection byproduct formation</td>
</tr>
<tr>
<td></td>
<td>TN to 10 mg/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TP to 1 mg/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+30</td>
<td></td>
<td></td>
<td></td>
<td>Treat Bio- &amp; non-biodegradable and absorbable MCs</td>
<td>Increased dosages for stricter indicator organism</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+40</td>
<td>High-Level BNR</td>
<td>Full secondary treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TN to 3 mg/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TP to 0.2 mg/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+50</td>
<td></td>
<td></td>
<td></td>
<td>Treat all MCs</td>
<td>Disinfection plus MC destruction</td>
</tr>
</tbody>
</table>
## Treatment Goal Staging - Processes

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<thead>
<tr>
<th>Planning Horizon (years)</th>
<th>Nutrient Standards</th>
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<th>Residuals Management Trends</th>
<th>Emerging (Micro) Constituent Regulations</th>
<th>Prohibition of Chlorine Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 (+/-2032)</td>
<td></td>
<td>CEPT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 2 (+/-2037)</td>
<td>New WWTP: Low-Level BNR TN to 10 mg/L TP to 1 mg/L</td>
<td>P-Recovery, Class A Product, Sidestream N</td>
<td>Treated with BNR Higher SRT and Filtration</td>
<td>Alternative Disinfection (UV? Ozone?)</td>
<td></td>
</tr>
<tr>
<td>Phase 3 (+/-2047)</td>
<td></td>
<td></td>
<td></td>
<td>Ozone and BAC</td>
<td>Achieved with Ozone + Alt Disinfection</td>
</tr>
<tr>
<td>Phase 4 (+/-2057)</td>
<td>Operate WWTP as High-Level BNR TN to 3 mg/L TP to 0.2 mg/L (Swing Zone to Post- ANX zone, Suppl C)</td>
<td>Bio-Actiflo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 5 (+/-2067)</td>
<td></td>
<td></td>
<td></td>
<td>UVAOP</td>
<td>Ozone + UVAOP</td>
</tr>
</tbody>
</table>

Starting Year 2017
Liquid Treatment Processes

- Raw wastewater pumping
- Preliminary treatment – grit & screening
- Primary treatment
- Secondary/Advanced treatment
- Disinfection
- Removal of micro-constituents (CEC)
- Wet weather treatment – to secondary level
- Intermediate pumping – for blended site alternatives
- Sidestream treatment – solids recycles
Secondary/Advanced Treatment

• Conventional (well-established) BNR
  – 5-Stage Treatment to achieve P and N removal
  – Large Footprint
  – Secondary Clarification and Deep Bed Filtration

• BNR MBR
  – Smallest Footprint, most robust
  – Membranes in lieu of clarifiers and filters

• Carbon Capture and Deammonification
  – 2-Stage Treatment
    • High rate Bio-P followed by 2\textsuperscript{nd} stage deammonification
  – Deep Bed Filtration
Micro-Constituent (CECs) Treatment

- Multiple barriers based on type of CEC
- Biodegradable CECs
  - Min 10-day SRT
- Absorbable CECs
  - Enhanced Solids Capture (Filtration)
  - Advanced Absorption with Biological Activated Carbon
- Refractory CECs
  - Carbon conversion using Ozone
  - Advanced Absorption with Biological Activated Carbon
  - Advanced Oxidation with UV and Peroxide (UVAOP)
  - Doubles as Disinfection
Micro-Constituent Schematic

Tertiary Effluent → OZONE CONTACTOR → BIOLOGICAL ACTIVATED CARBON → UVAOP → DISCHARGE
Wet Weather Treatment

• Separate wet weather treatment facility
  – Impact: Prevent over-design of the biological and CEC treatment systems
• Chemically enhanced primary treatment (interim for max reuse)
  – Add one rectangular clarifier
• High rate biological ballasted flocculation system
  – Example: Bio-Actiflo
  – 440 mgd of wet weather capacity (600 mgd – 160 mgd through biological)
  – 90-95% TSS Removal (TSS < 10 mg/L)
  – 90% BOD5 Removal (BOD5 < 10 mg/L)
  – TP <0.1 mg/L

• Disinfection assumes using chemical oxidation
  – Assume contact time of 10 min required
Wet Weather Schematic with Full Secondary Treatment
Solids Processes

Major alternatives
• Thermal hydrolysis process (THP)
• Pre-drying & incineration (max extraction)
• Drying

Common components
• Thickening – primary & secondary
• Anaerobic digestion with energy recovery
• Dewatering
• Sidestream treatment & Recovery (N and P)
• Final Product
MFWQTC Plant of the Future - Treatment Flow Diagram

Ex. MF Site

Energy, Nutrients, Class A Product
How much space do we need?

- Existing MF site is ~40 acres
- 9 potential sites identified
  - ~20 to ~225 acres
- Need ~40 to 100 acres
- Could reuse MF site for HW, PCs, Wet Weather, and Residuals
  - Reduces land needed by ~20-40 acres
  - Would need pumping to/from new site
Conclusions

• It’s anticipated the MFWQTC ‘Plant of the Future’ will...
  – Provide treatment for all captured water (dry and wet weather)
  – Include a high level of nutrient removal
  – Treat Micro-constituents
  – Produce a Class A product
  – Maximize capture and recovery (Energy, Water, Nutrients, etc.)

• The next steps taken...
  – Combining liquids and solids for alternatives analysis
    • Reviewing facility footprints and land requirements
    • Financial Life Cycle Evaluation
    • Non Cost Evaluation: Environmental, Sustainable, Economic Vitality
    • Multi-Attribute Evaluation (Cost-Benefit)
    • ‘Roadmap’ to the future
What’s your plant of the future look like? Visioning the Morris Forman WQTC

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Thank you to EVERYONE who worked on this project!

Alex N – MSD
Gary S, Nick W, Jim G, Mugdha M, Daniel T, John B - CH2M
Glen D – Univ of Michigan
Strand Assoc, JTL Engineering, HDR