Neshaminy Water Treatment Plant Design and Construction

Mark A. Tompeck, PE, DBIA
## Acknowledgements

<table>
<thead>
<tr>
<th>Aqua PA</th>
<th>Marc Lucca – VP Production</th>
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<tbody>
<tr>
<td></td>
<td>Dave Hughes – Manager of Construction</td>
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<td></td>
<td>Curt Steffy – Operations Manager</td>
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<td></td>
<td>Tom Walton – Neshaminy WTP Superintendent</td>
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<td></td>
<td>Jeff Bickel – Neshaminy WTP Asst. Superintendent</td>
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<tr>
<td>Hatch Mott MacDonald</td>
<td>John Civardi – Lead Process Engineer</td>
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<td></td>
<td>Mike Polito – Project Engineer</td>
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<tr>
<td></td>
<td>Margie Gray – Process Designer</td>
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<tr>
<td></td>
<td>Joe Procopio – Resident Engineer</td>
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<td></td>
<td>Chris Evans – Design Engineer</td>
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<tr>
<td>Michael F. Ronca</td>
<td>David Ronca – President</td>
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<td>Phil Ruggiero – Construction Superintendent</td>
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Presentation Outline

- Background on Aqua PA and the Neshaminy WTP
- Project components and phasing
- Project Design
- Water Quality Issues and Concerns
- Project Construction
- Project Challenges
- Summary
Overview of Aqua PA

- Subsidiary of Aqua America
  - Publically traded (NYSE: WTR)
  - Operations in 14-states serving 3-million people.

- Aqua PA – SE Operations
  - Serves 350,000 customers in portions of the 5 counties surrounding the City of Philadelphia
  - 8 Surface WTPs and 70 Wells
  - Total Delivered Water: 100-140 MGD
Neshaminy Water Treatment Plant

- Located in Middletown Twp., Bucks County
- Source is the Neshaminy Creek
- 15 MGD Conventional WTP consisting of raw water pumping, coagulation/sedimentation, gravity filtration, chemical storage and feed systems, and high lift pumping
Neshaminy Water Treatment Plant

Intake
Sedimentation Basin
Clearwell
Filter Building
Raw Water PS and Chemical Storage
Raw Water Transmission Mains
Intake
Existing Schematic

Neshaminy Creek

Intake, Screening & Raw Water Pumping

Mixing Basins

Coagulation Basin

Low Lift Pumps

8 Hrs. Detention

Pumps to Distribution

Clearwell

Washwater Transfer Pit

Washwater Drying Lagoons (Lagoons Nos. 2 & 3)

Sedimentation Sludge Lagoon (Lagoon No. 1)

Sludge Transfer Pit

Mixing Basins

8 Gravity Filters & Clearwell

Coagulation Basin

Low Lift Pumps
Project Needs

- Insufficient firm intake piping capacity
- Aging clarification system that has reached the end of its useful life and is labor intensive to clean
- Raw water pumping and screening systems that are inefficient and in need of replacement
- Aging chemical storage and feed systems
- Intermittent Taste & Odor problems
- Inefficient and labor intensive Residuals Disposal Systems
## Project Components & Phasing

<table>
<thead>
<tr>
<th>Phase</th>
<th>Facility Components</th>
<th>Construction Timing</th>
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</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Raw Water Transmission Main Rehabilitation</td>
<td>Jan 2009 – April 2009</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Taste &amp; Odor Treatment Facility and Office Renovations</td>
<td>Jan 2010 – July 2010 (Equipment pre-purchased in 2009)</td>
</tr>
<tr>
<td>Phase 3a</td>
<td>Raw Water PS, Pretreatment and Chemical Storage/Feed Facilities</td>
<td>Jan 2011 – Sep 2012</td>
</tr>
<tr>
<td>Phase 3b</td>
<td>Mechanical Dewatering Facilities</td>
<td>Oct 2012 – Dec 2013</td>
</tr>
</tbody>
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Upgraded Neshaminy Water Treatment Plant

- Residuals Treatment
- UV Facility
- Filter Building
- Clearwell
- Sedimentation Basin
- Raw Water PS and Chemical Storage
- New Pretreatment
- Raw Water Transmission Mains
- Intake
Upgraded System Process Schematic

Neshaminy Creek
Intake, Screening & Raw Water Pumping

In-Line Mixers (Typ. of 2)
2-Stage Flocculation (Typ. of 3)
Plate Settler Unit w/ Chain & Flight Sludge Collectors (Typ. of 3)

Washwater Transfer Pit

Washwater Drying Lagoons (Lagoons Nos. 2 & 3)

8 Gravity Filters & Clearwell

Hydrogen Peroxide
UV Reactors

Sulfur Dioxide
Chlorine

Clearwell

Pumps to Distribution

To Mechanical Dewatering
Raw Water Transmission Main Improvements

- 24” CI pipe constructed in 1908 (C = 83)
- 24” steel pipe constructed in the 1947 (C = 90)
- Combined capacity about 15 MGD
- Need firm capacity > 12 MGD
Raw Water Transmission Main Rehabilitation

- Decision made to clean and cement line both mains to increase capacity
- Each main removed from service and individually cleaned and lined (no bypass piping required)
- Subsequent hydraulic testing showed increased C values to greater than 110 and individual line capacity greater than 12 MGD
Neshaminy Creek Taste and Odor Issues

- T&O occurs seasonally generally between May and September with episodes ranging from a few days to several weeks.

- Taste and odors consist primarily of the odor-causing compounds, 2-methylisoborneol (MIB) and Geosmin.
### T&O at Neshaminy from 2006 – 2008

<table>
<thead>
<tr>
<th></th>
<th>Geosmin</th>
<th>MIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>240</td>
<td>45</td>
</tr>
<tr>
<td>90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>37</td>
<td>8</td>
</tr>
<tr>
<td>95&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>55</td>
<td>11</td>
</tr>
<tr>
<td>Typical Threshold Value</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

All values in ng/l
## Cost Comparison AOP vs PAC

<table>
<thead>
<tr>
<th>Cost</th>
<th>UV-H$_2$O$_2$</th>
<th>PAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>$2.5$ million</td>
<td>$2.2$ million</td>
</tr>
<tr>
<td>O &amp; M</td>
<td>$200,000</td>
<td>$310,000</td>
</tr>
<tr>
<td>Equivalent Uniform Annual Cost</td>
<td>$384,000</td>
<td>$475,000</td>
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</tbody>
</table>
## Comparison of UV-H$_2$O$_2$ and PAC

<table>
<thead>
<tr>
<th></th>
<th>UV-H$_2$O$_2$</th>
<th>PAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Efficiency</td>
<td>Ability to provide 1-log removal</td>
<td>Only 0.5-log removal practical</td>
</tr>
<tr>
<td>Residuals</td>
<td>No residuals</td>
<td>Doubles existing sludge production at the plant</td>
</tr>
<tr>
<td>Facility Sizing</td>
<td>Small footprint</td>
<td>Large tankage</td>
</tr>
<tr>
<td>Operations</td>
<td>Easy to operate/adjust</td>
<td>More difficult to operate</td>
</tr>
<tr>
<td>Value Added</td>
<td>Additional Microbial disinfection</td>
<td></td>
</tr>
<tr>
<td>Carbon Footprint Analysis</td>
<td>25% less carbon footprint over PAC</td>
<td></td>
</tr>
</tbody>
</table>

Pennsylvania Section AWWA Annual Conference
May 8, 2014
Bethlehem, Pennsylvania
Application of UV-Peroxide

- UV System installed post-filtration and before the clearwell where UVT is highest.
- UV-peroxide for T&O requires approx. 4 times the UV dose required for disinfection.
- Actual system use has shown good T & O removals with no statistical impact on increase of TTHM’s.

![Diagram of water treatment process](image-url)
UV Building /Reactor and H$_2$O$_2$ Storage

(From upper left, clockwise)
UV Treatment Building, Hydrogen Peroxide Storage and UV Reactor
# Neshaminy Raw Water Quality (2009)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>Maximum</th>
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</thead>
<tbody>
<tr>
<td>Turbidity (NTU)</td>
<td>14</td>
<td>830</td>
</tr>
<tr>
<td>Raw Water TOC</td>
<td>3.6</td>
<td>8.0</td>
</tr>
<tr>
<td>Filtered Water TOC</td>
<td>2.0</td>
<td>2.8</td>
</tr>
</tbody>
</table>
Pretreatment

- Tapered two stage flocculation
- Plate settlers designed at 0.3 gpm/sf at 80% plate efficiency
- 3 trains @ 6 MGD each
- 46 minutes detention time at 15 MGD
- Automatic solids removal removal
Pretreatment Building
Raw Water Pump Station

- Integrated into new Pretreatment Facility
- Two Traveling Screens
- 3 Raw Water Pumps
  - 2 @ 7.5 MGD w/VFDs
  - 1 @ 6 MGD Constant Speed
- Redundant In-Line Mechanical Mixers and Flow Meters
- Chemical Addition for:
  - Lime
  - Chlorine
  - Sulfuric Acid
  - PAC
  - Alum
Chemical Systems

Alum Day Tank

Chlorine Ton Cylinder Storage

High Density Lime System

Sulfuric Acid and Cl₂ Scrubber
# Water Quality Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Old Basin</th>
<th>New Pretreatment</th>
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</thead>
<tbody>
<tr>
<td>Settled Turbidity (NTU)</td>
<td>0.62</td>
<td>0.54</td>
</tr>
<tr>
<td>Raw Water TOC</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Settled Water TOC</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Settled Water TTHMs</td>
<td>38</td>
<td>29</td>
</tr>
</tbody>
</table>

All values are average
Residuals Treatment Facility

- Two 30 ft. diameter gravity thickeners
- Two TSMEBs
- Two 2 meter belt presses
- 2,750 lbs DS/day (Avg)
- 6,800 lbs DS/day (max mo.)
- and 12,000 lbs DS/day (max week)
- Cake residuals trucked to nearby quarry landfill
Residuals Treatment Facility

Thickeners

Residuals Building

Sludge Pumps

Sludge Conveyor and Belt Press
Project Challenges

• Transition of old/new process
  – Operators somewhat familiar with the new process technology
  – Chemical feed systems not completed and needed to use existing systems
  – Old/New processes run together initially

• What to do with the residuals from the new process until the new RTF is complete?

• High pressure (450 psi) transmission main installation on-site during construction
### Cost Summary

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<th>Facility Components</th>
<th>Total Project Cost</th>
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<td>Phase 1</td>
<td>Raw Water Transmission Main Rehabilitation</td>
<td>$0.3 million</td>
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<td>Phase 2</td>
<td>Taste &amp; Odor Treatment Facility and Office Renovations</td>
<td>$2.5 million</td>
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<tr>
<td>Phase 3a and 3b</td>
<td>Raw Water PS, Pretreatment and Chemical Storage/Feed Facilities and Mechanical Dewatering Facilities</td>
<td>$22.2 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$25 million</strong></td>
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</table>
Summary

- Improved hydraulic capacity of the raw water conveyance system
- Improved pumping operations and efficiency
- High quality pretreatment system
- Improved T & O treatment system
- More efficient/Less Labor Intensive Residuals Treatment System
Thank You and Questions?

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