New Great Pond Water Treatment Plant
Weymouth, Massachusetts

The 6th International IWA Conference
on Flotation for Water and Wastewater Systems

Session 1 – Drinking Water Treatment
Monday, October 29, 2012

Presenter: Stephen C. Olson, P.E.
Presentation Overview

- New Great Pond WTP
- Background Information
  - Weymouth Water System
  - Raw Water Quality
- Pilot Studies
- Design
- Construction
- Operations
- Performance
New Great Pond WTP Project

Original Great Pond WTP constructed in 1935
The facility had exceeded its useful service life and was not projected to comply with future drinking water regulations

**Project Scope:**
Replace existing 8 MGD Great Pond WTP

<table>
<thead>
<tr>
<th>Project Phasing</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Project Planning</td>
<td>October 2004 – December 2004</td>
</tr>
<tr>
<td>Conceptual Design &amp; Planning</td>
<td>March 2006 – August 2006</td>
</tr>
<tr>
<td>Procurement (Prequalification of Bidders)</td>
<td>September 2007 – March 2008</td>
</tr>
<tr>
<td>Construction</td>
<td>July 2008 – September 2010</td>
</tr>
<tr>
<td>Facilities Placed On-Line</td>
<td>September 2010</td>
</tr>
</tbody>
</table>
**Background Information**

**Town of Weymouth**
- Eastern Shore of Massachusetts
- Water Customers - 5,970
- Service Population – 53,700
- Average Demand – 4.2 MGD
- 2 Water Treatment Plants
- 3 Distribution Pressure Zones
- 4 Water Storage Tanks
Background Information

Great Pond Water Supply

- Surface Water
- 1.2 Billion Gallons
- Safe Yield (3.63 MGD)
- Treated at Great Pond WTP
- Provides ~85% Town’s Drinking Water
Great Pond Source Water Quality

“Great Pond is a seasonally variable surface water supply with low turbidity (1 NTU), low pH (5.5 to 6.5), low alkalinity (2 to 10 mg/L CaCO₃), moderate to high levels of natural organic matter (TOC: 4 to 15 mg/L), seasonally high levels of iron and manganese (Fe > 0.3, Mn > 0.1), and seasonal episodes of algal blooms.”
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>Range</th>
<th>Historic</th>
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<tbody>
<tr>
<td>Temperature (°C)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>14.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>3.5 - 28.5</td>
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</tr>
<tr>
<td>pH (s.u.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>5.5 - 6.9</td>
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<tr>
<td>Alkalinity (mg/L CaCO3)</td>
<td>Average</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>2 - 11</td>
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<tr>
<td>Turbidity (NTU)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>1.0</td>
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</tr>
<tr>
<td></td>
<td>Range</td>
<td>0.4 - 4.3</td>
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<tr>
<td>Color (s.u.)</td>
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<td></td>
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<tr>
<td></td>
<td>Average</td>
<td>57</td>
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<tr>
<td></td>
<td>Range</td>
<td>26 - 105</td>
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<tr>
<td>UV-254 (1/cm)</td>
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<tr>
<td></td>
<td>Average</td>
<td>0.27</td>
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<tr>
<td></td>
<td>Range</td>
<td>0.18 - 0.33</td>
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<tr>
<td>TOC (mg/L)</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Average</td>
<td>8.13</td>
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</tr>
<tr>
<td></td>
<td>Range</td>
<td>3.5 - 15</td>
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<td>Fe (total) (mg/L)</td>
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<tr>
<td></td>
<td>Average</td>
<td>0.19</td>
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<td></td>
<td>Range</td>
<td>ND - 0.51</td>
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<tr>
<td>Mn (total) (mg/L)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Average</td>
<td>0.07</td>
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<tr>
<td></td>
<td>Range</td>
<td>ND - 0.78</td>
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<tr>
<td>Algae (cells/L)</td>
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<tr>
<td></td>
<td>Average</td>
<td>300,000</td>
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<tr>
<td></td>
<td>Range</td>
<td>150,000 – 1,200,000</td>
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Great Pond Pilot Studies

<table>
<thead>
<tr>
<th>Pilot Period</th>
<th>Piloting Duration</th>
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<tbody>
<tr>
<td>Pilot Study #1</td>
<td>January 2005 – March 2005</td>
</tr>
<tr>
<td>Cold Water</td>
<td></td>
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<tr>
<td>Pilot Study #1</td>
<td>July 2005 – September 2005</td>
</tr>
<tr>
<td>Warm Water</td>
<td></td>
</tr>
<tr>
<td>Pilot Study #2</td>
<td>August 2005 – October 2005</td>
</tr>
<tr>
<td>Warm Water</td>
<td></td>
</tr>
<tr>
<td>Pilot Study #2</td>
<td>December 2005 – January 2006</td>
</tr>
<tr>
<td>Cold Water</td>
<td></td>
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</tbody>
</table>
Pilot Study #1 Technologies

1A
- GREAT POND
- KMnO4, KOH
- PRE-OXIDATION
- COAGULATION / FLOCCULATION
- INCLINED PLATE SETTLING
- OZONE
- GAC MEDIA

1B
- GREAT POND
- KMnO4, KOH
- PRE-OXIDATION
- COAGULATION / FLOCCULATION
- INCLINED PLATE SETTLING
- OZONE
- DUAL MEDIA

2A
- GREAT POND
- KMnO4, KOH
- PRE-OXIDATION
- COAGULATION / FLOCCULATION
- DISSOLVED AIR FLOTATION
- OZONE
- GAC MEDIA

2B
- GREAT POND
- KMnO4, KOH
- CONTACT TANK
- COAGULATION/FLOCCULATION
- DISSOLVED AIR FLOTATION
- OZONE
- DUAL MEDIA
Pilot Study #2 Technologies
Pilot Study #2 Technologies

10
- GREAT POND
- PRE-OXIDATION
- COAGULATION/FLOCCULATION
- ZENON ZEEWEED-500
- MEMBRANE ULTRAFILTRATION
- OZONE
- BAC FILTER

11
- GREAT POND
- PRE-OXIDATION
- COAGULATION/FLOCCULATION
- US FILTER MEMCOR CMF-S
- MEMBRANE MICROFILTRATION
- OZONE
- BAC FILTER

12
- GREAT POND
- PRE-OXIDATION
- COAGULATION/FLOCCULATION
- PALL MICROZA WPM-1
- MEMBRANE MICROFILTRATION
- OZONE
- BAC FILTER
1. DAF Vendors: Leopold (Clari-DAF) and Infilco Degremont (AquaDAF)

2. Coagulation – Polyaluminum Chloride, product dosage 75 mg/L, pH 6.5 to 6.9

3. Flocculation – 8 to 20 minutes

4. Loading Rates (Calculation Comparison)
   - Leopold: 4 to 8 gpm/sf
   - Infilco Degremont: 4 to 18 gpm/sf

<table>
<thead>
<tr>
<th>Leopold Loading Rates</th>
<th>IDI Loading Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Total Area*)</td>
<td>(Float Area)</td>
</tr>
<tr>
<td>(gpm/sf)*</td>
<td>(gpm/sf)</td>
</tr>
<tr>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>6</td>
<td>8.2</td>
</tr>
<tr>
<td>8</td>
<td>10.9</td>
</tr>
<tr>
<td>10</td>
<td>13.6</td>
</tr>
<tr>
<td>12</td>
<td>16.4</td>
</tr>
</tbody>
</table>

*reported vendor rates

5. Recycle Rates
   - Leopold: 6% to 12%
   - Infilco Degremont: 10% to 16%
Comparison of DAF Systems

Design Comparison
- Both use 2-stage flocculation
- Both use inclined baffle wall
- Both use dual laterals for air dispersion/injection
- Leopold collection laterals, IDI false floor
- Leopold packed saturator, IDI un-packed saturator
- Both have option for either mechanical or hydraulic sludge collection/removal
## DAF Pilot Turbidity Results

<table>
<thead>
<tr>
<th>Warm Water:</th>
<th>Leopold</th>
<th>Infilco Degremont</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Rate (gpm/sf)</td>
<td>Turbidity (NTU)</td>
<td>Loading Rate (gpm/sf)</td>
</tr>
<tr>
<td>4</td>
<td>0.2</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>0.2</td>
<td>12</td>
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<tr>
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<td></td>
<td>16</td>
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<tr>
<td></td>
<td></td>
<td>18</td>
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</table>

<table>
<thead>
<tr>
<th>Cold Water:</th>
<th>Leopold</th>
<th>Infilco Degremont</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Rate (gpm/sf)</td>
<td>Turbidity (NTU)</td>
<td>Loading Rate (gpm/sf)</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>0.5</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>1.2</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>
Pilot Treatment Performance Assessment

Only 4 process trains were able to meet all of the Pilot Study Water Quality Goals

1. Direct membrane filtration – intermediate ozone – BAC filtration

2. Dissolved air flotation – intermediate ozone – membrane filtration

3. Dissolved air flotation – intermediate ozone – PAC addition – membrane filtration

4. Dissolved air flotation – intermediate ozone – GAC/BAC filtration

Based on an evaluation of capital and O&M costs, DAF – Intermediate ozone – BAC filtration was selected for design.
Schematic Design - DAF Procurement

**DAF Vendor Scope of Supply:**
- Design Drawings (CAD)
- Shop Drawings and O&M Manuals
- PLC Programming
- Furnish and Deliver DAF Equipment
- Installation, Start-up, and Training Services
- Water Quality Performance Warranty
- Delivery Schedule

**Available DAF/Flocculation Area**
Max Dimensions
75’ X 65’
(For Basins, Basin Components, Saturators, and Control Panel)

**Available DAF Equipment Area**
Max Dimensions
26’ X 18’

**Note:**
Proposed Location of DAF Recycle Pump and Compressed Air Systems
DAF Procurement

DAF Vendor Bid Submittal:
Qualifications Statement
Conceptual Design Drawings
Minimum Pass/Fail Criteria
3 Cost Components (Equipment, Concrete, Live Cycle Electrical Costs)
2-Year Process Performance Warranty (Turbidity < 1 NTU, 95% in 24 hours)
Award based on ranking of Qualifications and Costs
DAF Procurement

Award based on Ranking of Qualifications and Costs

F.B. Leopold identified as the lowest responsible and eligible bidder

<table>
<thead>
<tr>
<th>Category</th>
<th>Pass/Fail</th>
<th>Bid</th>
<th>Maximum Points</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>1. DAF system equipment costs</td>
<td>Pass</td>
<td>N/A, based on subtotal</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>2. Post award DAF system submittals</td>
<td>Pass</td>
<td>N/A, based on subtotal</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3. Post award DAF system services</td>
<td>Pass</td>
<td>N/A, based on subtotal</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Subtotal (DAF system costs, 000303, Part I)</td>
<td></td>
<td>$1,146,922</td>
<td>50</td>
<td>50</td>
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<tr>
<td>4. Life cycle electrical costs (000303, Part II)</td>
<td>Pass</td>
<td>$520,610</td>
<td>5</td>
<td>5</td>
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<tr>
<td>5. Equivalent concrete costs (000303, Part III)</td>
<td>Pass</td>
<td>$113,000</td>
<td>5</td>
<td>4.5</td>
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<tr>
<td>6. References</td>
<td>Pass</td>
<td>Refer to Quals</td>
<td>8</td>
<td>6</td>
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<tr>
<td>7. Corporate stability and financial ability</td>
<td>Pass</td>
<td>Refer to Quals</td>
<td>8</td>
<td>8</td>
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<tr>
<td>8. Project Team (Staffing)</td>
<td>Pass</td>
<td>Refer to Quals</td>
<td>8</td>
<td>8</td>
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<tr>
<td>9. Project Work Plan</td>
<td>Pass</td>
<td>Refer to Quals</td>
<td>8</td>
<td>8</td>
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<tr>
<td>10. Equipment maintenance history</td>
<td>Pass</td>
<td>Refer to Quals</td>
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<tr>
<td>Result Total</td>
<td>Pass</td>
<td>N/A</td>
<td>100</td>
<td>97.5</td>
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</table>
Other Design Goals and Objectives

1. Maximize treated water quality effectiveness, operational flexibility, facility reliability/dependability, and cost effectiveness.

2. Incorporate existing facilities (Intake Structure, Residuals Pump Station, Residuals Lagoons).

- Air Dispersion Headers
- Sludge Removal (brushes, spray water)
- Tank Draining
Construction


3. Demolition: May 2011 – August 2011

Site Preparation
Facility Construction
Facility Construction
Facility Construction

July 2009
Facility Construction
Facility Construction
Construction Challenges
Construction Issues
Demolition
Site Restoration
Operations - Recycle Control

Great Pond WTP

Recycle Flow (%) vs. Plant Flow (MGD)

- 1 Basin
- 2 Basins
DAF Turbidity Performance – October 2011

DAF Loading Rate: 2.75 gpm/sf
Recycle Rate: 13%

Raw UV-254: 0.41
Raw TOC: 9.0 mg/L
Raw Fe: 0.3 mg/L
Raw Mn: 0.08 mg/L

Water Temperature: 19°C
PACl Dose: 85 mg/L
Coagulation pH: 6.3

Turbidity (NTU)
DAF Turbidity Performance – October 2011

Graph showing turbidity (NTU) trends from 9/27/11 to 10/15/11 with three lines:
- DAF 1
- DAF 3
- Raw
DAF Turbidity Performance – January 2012

2 DAF Basins

DAF Loading Rate: 2.4 gpm/sf (1.9 - 2.8)
Recycle Rate: 15.6%

1 DAF Basin

DAF Loading Rate: 5.0 gpm/sf (4.3 - 6.4)
Recycle Rate: 11.3%

Flow = 3.5 MGD

Raw UV-254: 0.42
Raw TOC: 8.1 mg/L
Raw Fe: 0.25 mg/L
Raw Mn: 0.05 mg/L
Water Temperature: 2°C
PACl Dose: 100 mg/L
Coagulation pH: 5.8
DAF Turbidity Performance – July/August 2012

Flow = 3.5 MGD to 6.0 MGD

Raw UV-254: 0.35
Raw TOC: 10.0 mg/L
Raw Fe: 0.35 mg/L
Raw Mn: 0.55 mg/L
Water Temperature: 25°C
PACI Dose: 90 mg/L
Coagulation pH: 6.4
Project Team

- **Weymouth Technical Advisory Committee**
  - Current: Jeff Bina, Al Cowing, Andrew Fontaine, Frank Sheppard
  - Former: Mike Chiasson, Bob O’Connor, Jim Wilson, Scott Bois, Dan Annaccone, Brad Hayes

- **Environmental Partners Group, Inc.**
  - Project Management; Pilot Studies; Design & Construction of Civil/Site, Process Treatment, SCADA, I&C; Bidding/Procurement; Start-up and Training; Operations Assistance

- **Dr. John Tobiason (University of Massachusetts)**
  - Pilot Studies

- **CH2MILL**
  - Pilot Studies; Design and Construction – Architectural, Plumbing, Electrical, HVAC, Ozone, Filters

- **LIN Associates**
  - Design and Construction – Structural

- **Woodard & Curran**
  - PLC and SCADA Programming
Acknowledgements

Mayor’s Office
Town Council
Construction Steering Committee
Technical Advisory Committee
Department of Public Works
Water Department Staff
Water Treatment Facility Staff
Engineering Team

Contractors:
Site Preparation – T. Ford, Inc.
DAF Equipment – F.B. Leopold Inc.
Construction – C.H. Nickerson & Co., Inc.
Demolition – S&R Corporation, Inc.
Site Restoration – E. Watson Excavating, Inc.