The OWASA – UNC Reclaimed Water System: A Progress Review

2016 NC WRRI Conference
March 17, 2016

Pat Davis

Orange Water and Sewer Authority

A public, non-profit agency providing water, sewer & reclaimed water services to the Carrboro-Chapel Hill community.
Objectives

- Provide overview of:
  - OWASA and UNC’s pursuit of water reuse
  - Operating experience
  - Actual vs. projected demands
  - Some lessons learned
  - Future challenges and opportunities

- Answer your questions

Pursuing Water Reuse

- 1995 OWASA Reuse Feasibility Study
  - Not economically feasible at that time

- Water supply capacity projected to be adequate for many years to come

- But then things changed…
Pursuing Water Reuse

- Record Drought of 2001-2002
- UNC’s 2001 campus expansion/redevelopment plan, and plans for Carolina North satellite campus
- OWASA planning major upgrade and expansion of Mason Farm WWTP
- OWASA facing long-term water supply and treatment facility expansion needs
- Community giving greater attention to sustainability and “living within our means”

Collaborative Study

- Jointly funded RCW system feasibility study
- Extensive follow-up pilot-scale testing
- Undertook microbiological study
- Follow-up economic feasibility analyses
Is It Feasible?

• Demand Analysis
  • What are the potential RCW customers?
  • Where are they located?
  • How would they use the RCW?
  • How much RCW would they use?
  • When would they use it?

Is It Feasible?

• Technical Feasibility
  • Can we provide RCW that meets standards?
    • Pilot-scale testing – WWTP processes/performance
  
  • Can we meet UNC’s quality and quantity requirements?
    • More complex the uses, more complex the analysis
    • Pilot-scale testing – RCW in cooling tower operations
    • Got water? (Is WWTP discharge volume > demands?)
  
  • Can we build it? (Co-design and construct?)
Is It Feasible?

- Economic Feasibility
  - How much will it cost?
    - UNC?
      - Direct and indirect costs?
      - Will it cost them less? When do they get a payback?
    - OWASA’s customers?
      - Will they have to subsidize costs of RCW system?
      - How will drinking water rates be affected by drop in sales?
  - Can we afford it?
  - Can we afford not to?
  - Can we get Federal and/or State funding?

Is It Safe?

- Microbiological Study (Dr. Mark Sobsey – UNC)
  - Used microbiological indicators/surrogates
    - Bacteria/Protozoa/Viruses
  - Evaluated reductions from treatment
    - Influent vs. effluent and expected RCW levels
    - Had to “seed” organisms to measure removal
  - Included chlorine demand study and recommendations for disinfection
  - Supported planned multiple barrier disinfection strategy

Pilot filter and UV disinfection system installed to support studies
Key to RCW System Feasibility:

Suitability of RCW for use as cooling tower make-up water

UNC Chilled Water System (200 mgy)

- (5) Interconnected Central Plants
- 50,000 tons installed capacity
- Serving 145 research and academic buildings
- UNC Hospitals – two additional Chiller Plants (90 mgy)
Daily Make-up Water Use at UNC Chillers
January – June 2008 (not including UNC Hospitals Chillers)

Average Daily Use 1/1/08 - 6/20/08

Monthly Demand Ratios for University’s Heating and Cooling Facility Water Demands, 2000 and 2002
As Compared to OWASA’s System-Wide Monthly Demand Ratios

Peak demand ratios for UNC heating and cooling facilities are much higher than system-wide peaking ratios.
Cooling Tower Water Quality

<table>
<thead>
<tr>
<th>Concern</th>
<th>Contributing Constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaling</td>
<td>Silica, Aluminum, Hardness, Magnesium, Calcium, Phosphorus, Iron</td>
</tr>
<tr>
<td>Deposition</td>
<td>Calcium, Magnesium, Suspended Solids</td>
</tr>
<tr>
<td>Microbial Growth</td>
<td>Residual Organics, Ammonia, Phosphorus</td>
</tr>
<tr>
<td>Corrosion</td>
<td>Silica, Aluminum, Hardness, Bicarbonate Alkalinity, Ammonia</td>
</tr>
<tr>
<td>Foaming</td>
<td>Alkalinity, Residual Organics</td>
</tr>
</tbody>
</table>

Study Findings

- Feasible
  - RCW suitable for use as cooling tower make-up water; irrigation; and toilet flushing
  - Substantial demands for RCW
  - Positive ROI for UNC

- Safe
  - Multiple-barrier disinfection system

- Financial impact on OWASA customers
  - Rates would need to go up (initially 3-4%)
  - System would provide long-term cost savings
Financial Feasibility

- UNC projected to incur:
  - additional cost of $0.45 - $1.00/1,000 gallons to treat RCW for use as cooling tower make-up water
  - higher sewer charges for increased volumes of discharge associated with use of RCW
  - internal capital cost of about $2.25 to $4.30/1,000 gallons to pay for RCW system infrastructure

- Positive ROI for UNC in about 4 to 10 years

RCW System Could Help Defer Costs
RCW System Could Help Defer Costs

Benefits of Reclaimed Water

- More sustainable management of our water resources
- Drought risk reduction
- Long-term H₂O savings
- Reduced pollutant loads
- Reliability and redundancy
- Cost savings & deferrals
- Reduced energy use
- Reduced C footprint
It’s the Right Thing to Do

OWASA-UNC RCW System Contract
April 2006

Key Principles of Agreement

- RCW Contract With UNC
  - Funding
    - UNC pays to build
    - Cost of service rates
    - No subsidy from OWASA’s customers
    - No cost reimbursement to UNC
  - OWASA owns and controls system - can extend system to serve other customers
  - RCW water quality specifications for UNC
  - Assurance of drinking water as back-up supply
- Move Ahead to Design and Build It Together
Making It Happen

- UNC Funding – more than $10 million
- Grant Funding
  - ~$1.6 million CWMTF grant
  - $625,500 grant from EPA
- Began construction in 2008
  - 600,000 gallon RCW storage tank with integrated RCW pump station
- Began RCW service to UNC in April 2009

RCW FACILITIES
Extensive On-Line Monitoring and Control Systems with 2-Way Data Transfer

- 2 Turbidimeters
- 2 pH meters
- 2 Chlorine residual meters
- Ammonia analyzer
- Alkalinity analyzer
- 2-way data link with UNC

<table>
<thead>
<tr>
<th>Sensor Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIT_5009W_pH</td>
<td>6.77 pH</td>
</tr>
<tr>
<td>AIT_5010W_Turbidity</td>
<td>0.92 NTU</td>
</tr>
<tr>
<td>AIT_5012W_CL2</td>
<td>3.44 ppm</td>
</tr>
<tr>
<td>AIT_5017W_Alkalinity</td>
<td>28.90 mg/l</td>
</tr>
<tr>
<td>FIT_5005A_Flow_A</td>
<td>656.90 gpm</td>
</tr>
<tr>
<td>FIT_5005B_Flow_B</td>
<td>672.45 gpm</td>
</tr>
<tr>
<td>LIT_5003W_Tank_A</td>
<td>7.85 ft</td>
</tr>
<tr>
<td>LIT_5004W_Tank_B</td>
<td>7.44 ft</td>
</tr>
<tr>
<td>PIT_5007W_Pump_Psig</td>
<td>122.95 psi</td>
</tr>
</tbody>
</table>
East Chiller
Experience to Date

- Minimum RCW demands lower than originally projected
  - longer residence time during winter presents challenge

- Average-day demands lower than originally projected
  - UNC’s energy efficiency investments have reduced campus cooling loads – less make-up water is needed
  - UNC has invested in more water-efficient chiller plant technology

- Energy savings lower than expected due to lower demands
Average-Day RCW Demands

RCW Sales

RCW Sales (MGD)

0
0.2
0.4
0.6
0.8
1
1.2
1.4

RCW Sales
Original Projection

RCW Sales (1,000s of Gallons per Day)


CT Makeup
Irrigation & Toilets
Reclaimed Water Demands* vs. Drinking Water Demands

<table>
<thead>
<tr>
<th></th>
<th>Reclaimed Water (mgd)</th>
<th>Drinking Water (mgd)</th>
<th>Total Demand (mgd)</th>
<th>Reclaimed as % of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 (Act.)</td>
<td>0.55</td>
<td>6.2</td>
<td>6.75</td>
<td>8%</td>
</tr>
<tr>
<td>2028</td>
<td>1.07</td>
<td>6.90</td>
<td>7.97</td>
<td>13%</td>
</tr>
</tbody>
</table>

* Demands shown are for UNC cooling tower make-up water, irrigation, and toilet flushing uses, only. Potential demands may be higher if other uses and non-UNC demands are met through reuse. Water reuse may also be a strategy for meeting Carolina North water needs, but that potential is not reflected in the above table.

Experience to Date

- System downtime lower than expected for last three years – *operational challenges have been very manageable*

- RCW more aggressive than anticipated; some pitting and through-wall leaks on carbon steel piping carrying influent RCW – *UNC has installed stainless steel piping*

- UNC’s incremental costs to treat RCW are considerably less than expected (*only about $0.33/1,000 gallons*)
RCW Rates to UNC

- Monthly Fixed Charge to UNC
  - Does not include construction cost recovery since UNC paid to build the system
  - 70% of O&M Costs are Fixed
  - Fixed Monthly Charge: $24,000

- Commodity Rate
  - Uniform Rate of $0.60/1,000 Gallons
  - Includes rehab/replacement and contingency funding

- FY 15 Effective Cost Per 1,000 gallons
  - Study Projection – $1.44  Actual – $2.07
  - Higher because fixed costs are spread over lower demands

Lessons Learned

- Install RCW blow-offs ahead of meters at key demand points
- Strategically locate RCW blow-offs near sanitary sewer system
- Ensure pipes carrying influent RCW are corrosion resistant (stainless steel)
- AMR/AMI meters needed to support reporting requirements for RCW end users
- RCW demands can be influenced by some of same factors affecting drinking water demands
Going Forward

- RCW elevated storage tank could benefit current operations – *UNC has reserved site for future tank*

- No active plans for expansion, but will pursue cost-effective opportunities to serve others

- Study benefits/costs of alternative denitrification strategies to ensure RCW quality *(timing depends on Jordan Lake Nutrient Rules timetable)*

- Evaluate indirect/direct potable reuse as long-term water supply strategy for extreme events

Water Sales and Accounts

![Graph showing water sales and accounts over time with key events marked: Drought 2001/02, Drought 2007/08, Reclaimed Water to UNC begins 2009.](image-url)
Only Possible Because of UNC

- Center of non-potable water demands – close proximity to our WWTP
- Concern about long-term water supply
- Commitment to sustainability
- Recognition of the broader community
- Commitment of capital (more than $10 million from UNC; $2.3 million in grants)

Thanks to Many Partners

- UNC - Institution of the Year (WateReuse Assoc.)
- Hazen & Sawyer (Feasibility study; final design)
- Nalco (UNC’s water treatment services company)
- McKim & Creed (Engineering design work for UNC)
- Burton and Associates and Black & Veatch (Financial reviews for UNC and OWASA, respectively)
- Dr. Mark Sobsey, UNC-ESE (Microbiological study)
- NC Division of Water Quality (Permitting)
- NC Clean Water Management Trust Fund (Grant)
- Congressman David Price and USEPA (Grant)
- …and others
Questions/Discussion

For more information:

John Kiviniemi
OWASA Wastewater Manager
jkiviniemi@owasa.org  919-537-4352

Meg Holton
UNC Water, Wastewater and Stormwater Manager
mdholton@energy.unc.edu  919-843-0364

Pat Davis  pdavis4water@gmail.com  919-428-1789

www.owasa.org
## Supporting Slides

### RCW Quality Needs for UNC’s Towers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target Conc.</th>
<th>Reject Conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity, NTU</td>
<td>&lt; 3</td>
<td>&gt; 5</td>
</tr>
<tr>
<td>NH$_3$-N, mg/L</td>
<td>&lt; 0.5</td>
<td>&gt; 2.0</td>
</tr>
<tr>
<td>CBOD</td>
<td>NPDES Permit Limit</td>
<td>NPDES Permit Limit</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>NPDES Permit Limit</td>
<td>NPDES Permit Limit</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 to 7.6</td>
<td>&lt; 6.5 and &gt; 7.6</td>
</tr>
<tr>
<td>Free Chlorine, mg/L</td>
<td>&gt; 0.5 to 2.0</td>
<td>&lt; 0.5 and &gt; 2.0</td>
</tr>
<tr>
<td>TP, mg/L</td>
<td>&lt; 1.0 as PO$_4$</td>
<td>&gt; 3.0 as PO$_4$</td>
</tr>
<tr>
<td>Alkalinity, mg/L</td>
<td>30 to 60 as CaCO$_3$</td>
<td>&gt; 80 as CaCO$_3$</td>
</tr>
<tr>
<td>Sulfate, mg/L</td>
<td>&lt; 150 as SO$_4$</td>
<td>&gt; 170 as SO$_4$</td>
</tr>
<tr>
<td>Conductivity, umhos/cm</td>
<td>&lt; 750</td>
<td>&gt; 1,000</td>
</tr>
</tbody>
</table>
UNC Annual Water Consumption

60% reduction in potable water use per square foot since 2000

POTABLE AND NONPOTABLE WATER USE

Total Water Use (million gallons)

Fiscal Year

2000 '01 '02 '03 '04 '05 '06 '07 '08 '09 '10 '11 '12 '13 '14 '15

450 500 550 600 650 700 750 800
**Energy Use**

- Reduces energy required to meet UNC’s water needs (~35% savings compared to meeting demands with drinking water)

- Reduces GHG emissions / carbon footprint
Water Pumped to System

Importance of Conservation and Reuse
Feasibility of System Expansion?

Expand RCW System?

- Limited opportunities for further demand reduction (0.25 mgd), high capital costs (~$30 million/mgd)

- **Recommendation:** Do not invest OWASA funds to extend the RCW system, but recognize that new non-UNC customers may find RCW extensions or connections to be cost-effective on a case-by-case basis.
## WWTP Effluent Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OWASA Mason Farm WWTP NPDES Limits*</th>
<th>OWASA FY 2008 Monthly Avg.</th>
<th>North Carolina Reuse Water Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow, mgd</td>
<td>14.5</td>
<td>7.6</td>
<td>N/A</td>
</tr>
<tr>
<td>CBOD&lt;sub&gt;5&lt;/sub&gt;, mg/L</td>
<td>4 (8)</td>
<td>&lt; 2.0</td>
<td>10</td>
</tr>
<tr>
<td>NH&lt;sub&gt;3&lt;/sub&gt;-N, mg/L</td>
<td>1 (2)</td>
<td>&lt; 0.1</td>
<td>4</td>
</tr>
<tr>
<td>TSS, mg/L</td>
<td>30</td>
<td>1.0</td>
<td>5</td>
</tr>
<tr>
<td>TP, mg/L</td>
<td>0.25</td>
<td>0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>FCU, No./100 mL</td>
<td>200</td>
<td>&lt; 10</td>
<td>14</td>
</tr>
<tr>
<td>Alkalinity mg/L</td>
<td>NA</td>
<td>50 - 90</td>
<td>NA</td>
</tr>
</tbody>
</table>
## UNC Athletics – Irrigation Demand

<table>
<thead>
<tr>
<th>Facility</th>
<th>Estimated Irrigation Demand (average 48,000 gallons per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Gallons per Year</td>
</tr>
<tr>
<td>Kenan Stadium</td>
<td>12,905,000</td>
</tr>
<tr>
<td>Navy Field/Henry Stadium</td>
<td>15,514,800</td>
</tr>
<tr>
<td>Boshamer Stadium</td>
<td>12,216,000</td>
</tr>
<tr>
<td>Fetzer Field</td>
<td>10,980,000</td>
</tr>
<tr>
<td>Williams Field/Anderson Stadium</td>
<td>24,192,000</td>
</tr>
<tr>
<td>Total Athletics Irrigation Demand</td>
<td>77,100,000</td>
</tr>
</tbody>
</table>