Asset Management in the Water/Wastewater Industries:

A Case Study from the Upper Occoquan Service Authority (UOSA) in Centreville, VA

Mike Matichich
FTA State of Good Repair Roundtable
Chicago, Illinois
July 22, 2010
Agenda

- Overview of approaches to asset management in the water industry
- UOSA Case Study
  - How it was conducted
  - Results
  - How it’s been used
- Concluding Thoughts
Water and wastewater industry associations have sponsored a number of studies and guidance documents related to asset management in the past ten years.

*Managing Public Infrastructure Assets to Minimize Costs and Maximize Performance*
Association of Metropolitan Sewerage Agencies, Association of Metropolitan Water Agencies, American Water Works Association, Water Environment Federation, 2002

*Implementing Asset Management – A Practical Guide*
Asset management is an integrated set of processes to:

- Minimize the life-cycle costs of owning, operating and maintaining infrastructure assets
- Continuously deliver established levels of service...
- At an acceptable level of risk
Risk is quantified using the classic risk equation

\[ \text{Risk} = f(\text{consequence} \times \text{likelihood}) \]

How severe are the consequences of asset failure?  
How likely is it for the asset to fail?
Quantify consequence of failure using established levels of service

\[ \text{Risk} = (\text{consequence} \times \text{likelihood}) \]

**How severe are the consequences of asset failure?**

- Health, Safety & Security implications
- Financial impact
- Regulatory/code compliance
- Public confidence/image
- Service delivery

**How likely is it for the asset to fail?**
Quantify likelihood of failure

Risk = (consequence x likelihood)

- How severe are the consequences of asset failure?
- How likely is it for the asset to fail?
  - Condition of asset
  - Performance of asset
  - Effectiveness of O&M protocols
  - Maintenance history
Top-down/risk-based approach provides best value for resource investment

- Develop asset hierarchy
- Conduct Top-Down Risk Assessment
- Prioritize field condition assessments based on initial risk assessment
- Conduct field condition assessments and refine risk scores and rankings
- Develop risk-mitigation measures
Understanding the risk of asset failure provides the basis for:

- Objective, informed decision-making
- Optimizing O&M
- Investing in condition assessments
- Prioritizing capital investments for Renewal & Replacement (R&R)
Risk reduction opportunities are often a key factor in overall CIP prioritization where R&R projects compete with other projects for funding.
UPPER OCCOQUAN SERVICE AUTHORITY (UOSA) CASE EXAMPLE
Context for UOSA

- Major suburban Washington DC area wastewater utility
  - 54 million gallons per day treatment capacity
  - 275,000 service area population
Context for UOSA

- Formed in the 1970s, with major expansions at several intervals, so
  - Facilities of varying age
  - Facilities of varying condition
- Substantial capital needs
  - $437 M capital budget through 2021
  - Need to prioritize investments
The ‘top-down’ approach was used to identify 1,912 assets that merited detailed field assessments

- Existing studies and data
- Staff knowledge of operating history and maintenance
- Preliminary consideration of criticality
Condition assessments were conducted using a step-by-step process that can be sustained

1. Asset data and history were gathered
2. Assessment criteria were developed with UOSA for each type of asset
3. Information was uploaded to CH2M HILL’s Asset Condition Evaluation System (ACES) tool
4. Field condition assessments were conducted
5. Risk results were calculated
This example illustrates specific questions by asset type and how answers were documented.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>NA</th>
<th>Flag</th>
<th>Answer Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration Measurement</td>
<td>2</td>
<td></td>
<td></td>
<td>Good .039 - .15 inches/sec / sec</td>
</tr>
<tr>
<td>Mounting</td>
<td>2</td>
<td></td>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>All Safety Guards Present</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Acceptable Noise</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Absence of Pump Cavitations</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Absence of Leaks</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>All Components</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Lubrication OK at Inspection</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>No Mechanical Seal Leakage</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Operating at Inspection</td>
<td>1</td>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Corrosion - Structural Metals</td>
<td>2</td>
<td></td>
<td></td>
<td>Slight staining/small chips</td>
</tr>
<tr>
<td>Infrared</td>
<td>1</td>
<td></td>
<td></td>
<td>Negligible Ambient</td>
</tr>
<tr>
<td>Packing Gland/Seals</td>
<td>2</td>
<td></td>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>Pipe Alignment</td>
<td>1</td>
<td></td>
<td></td>
<td>Straight</td>
</tr>
<tr>
<td>Belt/Direct Drive/Couplings</td>
<td>2</td>
<td></td>
<td></td>
<td>Minor Wear</td>
</tr>
<tr>
<td>Gauges Operational</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obsolescence</td>
<td>1</td>
<td></td>
<td></td>
<td>Currently supported</td>
</tr>
</tbody>
</table>

Condition Score: 1.429  Condition Category: Very Good No corrective maintenance needed
Tools and Methods

- Three non-destructive tests were used for the condition assessments
  - Vibration (inches/sec) horizontal, vertical, and axial
  - Thermography
  - Oil analysis
- No invasive techniques were used
UOSA-specific factors were used to define the elements of the risk equation.

<table>
<thead>
<tr>
<th>Consequence of Failure</th>
<th>Factor</th>
<th>Wt</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Negligible</td>
<td>Minor</td>
<td>Moderate</td>
<td>Major</td>
<td>Severe</td>
</tr>
<tr>
<td>Permit compliance</td>
<td>23%</td>
<td>Permit conditions met</td>
<td>Above target on an individual day but no impact on monthly standard</td>
<td>Above target on week but no impact on monthly standard</td>
<td>Violated monthly standard</td>
<td>Chronic permit violation; pending enforcement action.</td>
<td></td>
</tr>
<tr>
<td>Impact on process</td>
<td>15%</td>
<td>Individual equipment level. Can still meet all flow demands with excess capacity available</td>
<td>Multiple equipment level. Can still meet all flow demands with firm capacity still available</td>
<td>System level or major equipment. Inability to meet peak flow. Pond available.</td>
<td>System level. Inability to meet peak flow. Bypass of unit process</td>
<td>Major process upset with recovery uncertain</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No impact on process</td>
<td>Routine adjustment on process</td>
<td>Significant adjustment in process necessary requiring significant labor effort</td>
<td>Significant adjustment in process necessary with uncertainty as to recovery</td>
<td>Cannot be down beyond a week</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be out of service for several months</td>
<td>Can be down more than a month</td>
<td>Cannot be down beyond a week</td>
<td>Cannot be down for more than a couple of days</td>
<td>Cannot be down more than several hours</td>
<td></td>
</tr>
<tr>
<td>Financial impact</td>
<td>18%</td>
<td>Within budget line item; cost effective</td>
<td>Exceeds O&amp;M budget line item</td>
<td>Requires reserve maintenance funds in excess of expectations</td>
<td>Requires deferral of other reserve expenditures</td>
<td>New money needed. Board action required.</td>
<td></td>
</tr>
<tr>
<td>(repair, loss of revenue, claims, etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety</td>
<td>25%</td>
<td>No injuries or adverse health effects</td>
<td></td>
<td>Minor injury with no lost time; no public health effects</td>
<td>Minor injury with lost time; no public health effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community and public</td>
<td>20%</td>
<td>No complaints. No third-party damage No media coverage.</td>
<td>Small number of complaints. No third-party damage Neutral or no coverage in media</td>
<td>Many complaints. Minor third-party damage Adverse media coverage</td>
<td>Widespread complaints Major third-party damage Minor short-term impact on environment Widespread adverse media coverage</td>
<td>Extensive complaints National adverse media coverage. Political opposition Environmental impact reversible in 6 months or more</td>
<td></td>
</tr>
<tr>
<td>image and media coverage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
UOSA-specific factors were used to define the elements of the risk equation.

<table>
<thead>
<tr>
<th>Description</th>
<th>Wt</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Condition</td>
<td>53%</td>
<td>Very Good No corrective maintenance needed</td>
<td>Good Few minor deficiencies. Some corrective maintenance needed</td>
<td>Fair Several minor deficiencies. Requires corrective maintenance</td>
<td>Poor Major deficiencies. Requires significant repair or rehabilitation</td>
<td>Very Poor Rehabilitation or replacement necessary. May be unserviceable</td>
</tr>
<tr>
<td>Performance</td>
<td>32%</td>
<td>Exceeds performance expectations</td>
<td>Meets performance expectations</td>
<td>Barely meets current expectations. Room for performance improvement</td>
<td>Does not meet current performance expectations</td>
<td>Inefficient performance, bottleneck, obsolete</td>
</tr>
<tr>
<td>Repair History</td>
<td>16%</td>
<td>Repair history does not suggest problems</td>
<td>Repair history suggests occasional minor problems</td>
<td>Repair history indicates frequent minor problems</td>
<td>Repair history suggests occasional major problems</td>
<td>Repair history indicates frequent major problems</td>
</tr>
</tbody>
</table>
Outputs at UOSA Include an Overall Condition Ranking of the Assets.....

UOSA Asset Condition Spread (ALL)

- Good: 51%
- Very Good: 24%
- Fair: 13%
- Poor: 3%
- Very Poor: 9%
...and a Detailed Risk and Condition Ranking for Each Key Asset

<table>
<thead>
<tr>
<th>Asset Description</th>
<th>Rank</th>
<th>Number of Assets</th>
<th>Condition Score</th>
<th>Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPERATIONS BUILDING G (1402000000)</td>
<td>1</td>
<td>1</td>
<td>1.08</td>
<td>28.19</td>
</tr>
<tr>
<td>BALLAST POND PUMP STN #1 (0902000000)</td>
<td>2</td>
<td>13</td>
<td>3.52</td>
<td>24.33</td>
</tr>
<tr>
<td>AUXILIARY POWER BLDG Q (1405000000)</td>
<td>3</td>
<td>52</td>
<td>1.73</td>
<td>24.28</td>
</tr>
<tr>
<td>CHEM STORAGE, FEED AREA BLDG H (0506000000)</td>
<td>4</td>
<td>35</td>
<td>2.35</td>
<td>17.97</td>
</tr>
<tr>
<td>LOAD CENTER #5, BUILDING P (1209000000)</td>
<td>5</td>
<td>20</td>
<td>1.59</td>
<td>17.82</td>
</tr>
<tr>
<td>SOLIDS HANDLING BUILDING (0505000000)</td>
<td>6</td>
<td>169</td>
<td>1.73</td>
<td>17.77</td>
</tr>
<tr>
<td>DIGESTOR COMPLEX (0503000000)</td>
<td>7</td>
<td>116</td>
<td>1.82</td>
<td>17.33</td>
</tr>
<tr>
<td>CHEM SLUDGE DIST STR 18/1-2 (0800000000)</td>
<td>8</td>
<td>10</td>
<td>3.58</td>
<td>16.58</td>
</tr>
<tr>
<td>LOAD CENTER #2, BLDG E/1 (1208000000)</td>
<td>9</td>
<td>25</td>
<td>1.72</td>
<td>16.04</td>
</tr>
<tr>
<td>HYDROCHLORIC GAS BUILDING W (0408000000)</td>
<td>10</td>
<td>7</td>
<td>2.24</td>
<td>15.32</td>
</tr>
<tr>
<td>REGENERATION CHEMICAL BLDG M/1 (1008000000)</td>
<td>11</td>
<td>16</td>
<td>2.23</td>
<td>14.71</td>
</tr>
<tr>
<td>ADVANCED TREATMENT BLDG L/1 (0903000000)</td>
<td>12</td>
<td>176</td>
<td>2.03</td>
<td>14.53</td>
</tr>
<tr>
<td>CHEMICAL CLARIFIER #1-3 (0604000000)</td>
<td>13</td>
<td>15</td>
<td>2.30</td>
<td>14.06</td>
</tr>
<tr>
<td>RECARB SLUDGE PUMPING BLDG N/1 (0704000000)</td>
<td>14</td>
<td>27</td>
<td>3.12</td>
<td>14.03</td>
</tr>
<tr>
<td>RAPID MIX BASINS #1-2 (0602000000)</td>
<td>15</td>
<td>27</td>
<td>2.52</td>
<td>13.71</td>
</tr>
<tr>
<td>1ST STAGE RECARB BASINS #1 &amp; #2 (0701000000)</td>
<td>16</td>
<td>49</td>
<td>3.26</td>
<td>13.65</td>
</tr>
<tr>
<td>PRIMARY CLARIFIERS 4/1-3 (0301000000)</td>
<td>17</td>
<td>18</td>
<td>2.68</td>
<td>13.14</td>
</tr>
<tr>
<td>RAS PUMP STATIONS #1-2 (0403000000)</td>
<td>18</td>
<td>79</td>
<td>2.21</td>
<td>12.76</td>
</tr>
<tr>
<td>SECONDARY CLARIFIERS #1-6 (0401000000)</td>
<td>19</td>
<td>29</td>
<td>2.46</td>
<td>12.76</td>
</tr>
<tr>
<td>RECARBONATION BLDG Y/1 (0706000000)</td>
<td>20</td>
<td>70</td>
<td>2.14</td>
<td>11.64</td>
</tr>
</tbody>
</table>

“The analyses helped us to identify projects that needed to proceed immediately, and projects that could slide back a few years if necessary.”
Chuck Boeppele, Executive Director at UOSA.
Options for addressing the assets with the greatest risks were identified and evaluated to identify the best strategy.

Assess risk reduction for identified options

Rank options by: Risk Reduction Cost

Rehabilitation
Replacement
Operating procedures
Maintenance procedures
Demand management
Reduce LOS & educate
Improve response & recovery

Severe
Very Likely
Likely
Possible
Negligible

Moderate

Low

Negligible
Linking risk results to estimated construction costs helps prioritize CIP spending

Cumulative Construction Cost ($ Millions)

Risk Rank
The results of the condition assessments and risk analyses have been used by UOSA to:

- Guide overall development of the capital renewal program
  - Initial phase includes projects that address many assets with high risk scores
  - Follow-on phase addresses remaining priority needs
- Address specific decisions:
  - Modernization of computer platforms for WWTP control systems was accelerated due to considerable risks identified
  - Rehabilitation of tertiary treatment facilities was pushed back a few years
Additional details of the UOSA case study are available in the June 2010 issue of Public Works

www.pwmag.com
Concluding thoughts

- Much progress has been made in the past dozen years in developing and applying asset management approaches in the water industry.
- Advances in technology have aided this progress.
- **BUT**, there is still much work to be done!
- Risk reduction concepts cut across elements of public works:
  - Many common elements among water, sewer, transportation, public buildings.
  - UOSA’s risk reduction efforts parallel the DOT’s efforts to “identify ‘safety-critical assets’ as a means of establishing priority re-investment decisions”
Thanks for listening!

Mike Matichich
mike.matichich@CH2M.com
202-513-4629