Using Risk Based Criteria for Rehabilitation Decisions

City of Sugar Land

Howard Christian
Assistant Director of Water Utilities
Agenda

- System Summary
- Wastewater Collection Rehabilitation
  - GIS Based Infrastructure Risk Determination
  - Asset Management Tool
- Water Distribution System Replacement
- TCEQ SSOI Program
City of Sugar Land

- 395 miles wastewater lines
  - 31.3 % over 25 years old
  - 2.3 % over 40 years old
  - 1986 Design Standards Adoption

- 421 miles water distribution lines
  - 33.4 % over 25 years old
  - 1.9 % over 40 years old
Asset Management

- Need rating criteria for asset management
- No industry standard for condition assessment
- No standard for useful life –
  - soil type / conditions play a key role
- Wastewater lines - rehab or replace
  - Gravity and force mains
- Water lines – replace - pressurized
Asset Management System

- Well developed GIS database
- Focused on gravity sewer system
- Five factors used to determine risk
  - Material
  - Age
  - Remaining useful life
  - Diameter
  - Depth
- Developed Point Rating for each factor
## Pipe Material

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Life (yrs)</th>
<th>Value</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>50</td>
<td>1</td>
<td>137.5</td>
</tr>
<tr>
<td>PEP</td>
<td>50</td>
<td>1</td>
<td>9.6</td>
</tr>
<tr>
<td>CIPP</td>
<td>50</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>DIP</td>
<td>30</td>
<td>10</td>
<td>7.3</td>
</tr>
<tr>
<td>Other</td>
<td>30</td>
<td>13</td>
<td>2.5</td>
</tr>
<tr>
<td>Truss</td>
<td>30</td>
<td>18</td>
<td>114.1</td>
</tr>
<tr>
<td>Clay</td>
<td>40</td>
<td>18</td>
<td>21.3</td>
</tr>
<tr>
<td>Concrete</td>
<td>30</td>
<td>20</td>
<td>19.1</td>
</tr>
</tbody>
</table>
## Remaining Useful Life

<table>
<thead>
<tr>
<th>Remaining Useful Life</th>
<th>Miles</th>
<th>% of Total Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.1-50</td>
<td>136.96</td>
<td>45.80</td>
</tr>
<tr>
<td>10.1-25</td>
<td>13.42</td>
<td>4.49</td>
</tr>
<tr>
<td>5.1-10</td>
<td>15.72</td>
<td>5.25</td>
</tr>
<tr>
<td>.01-5</td>
<td>78.70</td>
<td>26.31</td>
</tr>
<tr>
<td>-20-0</td>
<td>52.59</td>
<td>17.58</td>
</tr>
</tbody>
</table>
## Pipe Diameter

<table>
<thead>
<tr>
<th>Size pipe</th>
<th>Value</th>
<th>Miles</th>
<th>% of Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-10</td>
<td>3</td>
<td>257.62</td>
<td>86.14</td>
</tr>
<tr>
<td>12-18</td>
<td>6</td>
<td>25.14</td>
<td>8.41</td>
</tr>
<tr>
<td>21-30</td>
<td>12</td>
<td>8.87</td>
<td>2.96</td>
</tr>
<tr>
<td>36-48</td>
<td>20</td>
<td>7.27</td>
<td>2.43</td>
</tr>
</tbody>
</table>
### Age of Pipe

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>Value</th>
<th>Miles</th>
<th>% of Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2</td>
<td>1.0</td>
<td>3.37</td>
<td>1.13</td>
</tr>
<tr>
<td>2.01-5</td>
<td>2.0</td>
<td>32.44</td>
<td>10.85</td>
</tr>
<tr>
<td>5.01-15</td>
<td>5.0</td>
<td>68.26</td>
<td>22.82</td>
</tr>
<tr>
<td>15.01-25</td>
<td>8.0</td>
<td>101.37</td>
<td>33.89</td>
</tr>
<tr>
<td>25.01-40</td>
<td>12.0</td>
<td>86.59</td>
<td>28.95</td>
</tr>
<tr>
<td>&gt;40.01</td>
<td>15.0</td>
<td>7.06</td>
<td>2.36</td>
</tr>
</tbody>
</table>
Depth of Line

<table>
<thead>
<tr>
<th>Depth Feet</th>
<th>Ratio</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>1</td>
<td>72.15</td>
</tr>
<tr>
<td>5-10</td>
<td>1.15</td>
<td>168.00</td>
</tr>
<tr>
<td>10-15</td>
<td>1.4</td>
<td>43.67</td>
</tr>
<tr>
<td>15-20</td>
<td>1.6</td>
<td>13.87</td>
</tr>
<tr>
<td>&gt;20</td>
<td>1.8</td>
<td>1.40</td>
</tr>
</tbody>
</table>
Risk Rating Criteria
Wastewater

- 5 factors used to create three categories
  - Impact, Condition, Criticality

Impact (pipe size)

- Assumed the larger the pipe diameter the more customers it serves
- Consequently line failure impacts more customers
<table>
<thead>
<tr>
<th>Size pipe inches</th>
<th>Replacement Cost per foot</th>
<th>Ratio</th>
<th>Value</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-10</td>
<td>$ 41.00</td>
<td>1.00</td>
<td>4</td>
<td>257.62</td>
</tr>
<tr>
<td>12-18</td>
<td>$ 61.00</td>
<td>1.49</td>
<td>6</td>
<td>25.14</td>
</tr>
<tr>
<td>21-30</td>
<td>$ 120.00</td>
<td>2.93</td>
<td>12</td>
<td>8.87</td>
</tr>
<tr>
<td>36-48</td>
<td>$ 220.00</td>
<td>5.37</td>
<td>20</td>
<td>7.27</td>
</tr>
</tbody>
</table>
Risk Rating Category
Wastewater

Condition (Material and Age)

- Determined by assigning points based on pipe material and age of the pipe including historical performance of the pipe type
  - PVC rank high vs. concrete pipe rank low
  - Points assigned for age assumed all pipe material deteriorates over time
Risk Rating Category

Criticality (depth)

- Used to determine feasibility of repair
- Used a ratio / multiplier - deep but small PVC line lower impact than deep large concrete line
- Deep line failures difficult and expensive to repair, especially as an emergency
  - Track hoe, well pointing, backyards etc.
  - City staff repairs lines that do not require a track hoe, contract for deep repairs
Risk Rating Formula

- \((\text{size value} + \text{material value} + \text{age value}) \times \text{Depth Ratio}\)
- Risk rating on individual line segment varies from 1 to 100
- Higher risk rating the more immediate the line segment needs to be evaluated for replacement
- Risk rating per segment mapped on City GIS
- Also overlaid repair history and sewer backup history onto risk rating map
- Combination of information determined what areas to target for further analysis
## Risk Ranking

<table>
<thead>
<tr>
<th>Risk-Rating</th>
<th>Miles</th>
<th>% of Total Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-15</td>
<td>123.27</td>
<td>41.22</td>
</tr>
<tr>
<td>15-30</td>
<td>26.36</td>
<td>8.81</td>
</tr>
<tr>
<td>30-45.25</td>
<td>119.54</td>
<td>39.97</td>
</tr>
<tr>
<td>45.25-60.2</td>
<td>24.47</td>
<td>8.18</td>
</tr>
<tr>
<td>60.2-83.2</td>
<td>4.87</td>
<td>1.63</td>
</tr>
</tbody>
</table>
Risk Based Rating Tool

- Higher score
  - greater risk of failure
  - significant consequence of failure
- Scores used to define what areas need further investigation
  - Smoke testing & televising
- Review data used to develop CIP rehab/replacement projects
GIS – Based Risk Rating System

- Average Rating: 25
- < 5 Years Useful Life: 31.3%
- > 45 Risk ranking: 9.8%
Asset Management Tool
Wastewater

- Cost data is used to assign estimated replacement cost for each line segment
- Based on available funding we targeted areas for additional review through smoke testing and televising
- Able to match funding available for repair / replacement with critical need
- End Result 6 million in targeted rehab and replacement
Asset Management

Water

- Replace water lines when they reach useful life -
- Determined by a combination of:
  - Age
  - Material type
    - PVC vs asbestos cement
  - Repair history
  - Criticality of failure
    - # of customers out of service
## Water Pipe Age

<table>
<thead>
<tr>
<th>AGE</th>
<th>MILES</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 to 2011</td>
<td>43.8</td>
<td>10.4%</td>
</tr>
<tr>
<td>2005 to 1985</td>
<td>194.5</td>
<td>46.2%</td>
</tr>
<tr>
<td>Older 1984</td>
<td>182.7</td>
<td>43.4%</td>
</tr>
</tbody>
</table>
## Water Pipe Material

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>MILES</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>243.4</td>
<td>58%</td>
</tr>
<tr>
<td>Ductile Iron</td>
<td>2.1</td>
<td>0%</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>13.7</td>
<td>3%</td>
</tr>
<tr>
<td>Steel</td>
<td>0.3</td>
<td>0%</td>
</tr>
<tr>
<td>As. Cement</td>
<td>160.8</td>
<td>38%</td>
</tr>
</tbody>
</table>

![Map of City of Sugar Land Water Network Pipe Material](image)
**Water Pipe Diameter**

<table>
<thead>
<tr>
<th>DIAMETER</th>
<th>MILES</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 8 INCH</td>
<td>284.7</td>
<td>67.6%</td>
</tr>
<tr>
<td>10 - 16 INCH</td>
<td>126.4</td>
<td>30.0%</td>
</tr>
<tr>
<td>&gt; 18 INCH</td>
<td>9.9</td>
<td>2.4%</td>
</tr>
</tbody>
</table>
Map of Repairs

- Use all the criteria to determine which areas to replace
- Oval 2012
- Square 2008-11
Asset Management  
“Inside the Fence”

- GST and EST ~ recoated every 12 years
- Water Well ~ rehab every 9 years
- Chemical feed ~ Yearly PM, 20 years
- Lift Station ~ rehab every 25 years
- Fences, SCADA, booster pumps, motor control centers, HPT, lift pumps generators, auxiliary drive units, etc.
- And the list goes on ....
Challenges

■ Keeping the data fresh
  ■ Update GIS to reflect rehab
  ■ Updating assumptions and information
■ Always more needs than $$
■ Unanticipated failures changing priority
  ■ Early force main failure
    ■ 15 year – Ductile Iron
■ Refocus capital on critical failure

■ Sustainability
TCEQ SSOI Program

- Sanitary Sewer Overflow Initiative
- Allow entity to identify needed improvements or programs to reduce overflows
- 180 days - System assessment
  - Causes of the overflows
  - Specific corrective actions & milestones
  - Timeline for completing actions
  - Budgetary funding commitments
  - Effectiveness evaluation
Sugar Land SSOI Program

- Unauthorized Discharges - Averaged 25 a year

- SSOI initiative approval in October 2009
  - City Council approval – CIP commitment

- Program Commitment - both WWTP
  - Televise 15,000 LF a year
  - Improved grease trap inspection program
  - Customer FOG education and local drop off place
  - Rehab east and west interceptors
  - Rehab 4 lift stations
  - WWTP rehab projects: SCADA upgrade, upgrade blowers, replace airline, re-laminate screw augers
  - Install generators and auto switch gear at both WWTP
  - System I/I evaluation and resulting Rehab
Results

- City Committed to spend $24,325,000
- Actually spent $29,754,000

Unauthorized Discharges

- 2010 – 22
- 2011 – 17
- 2012 – 34

  - 2012 - No significant discharges
  - No consistent reason for increase

SSOI Program

- City Council funding support
- TCEQ support for improvements
Risk Based Asset Management
Rating Tools

Sanitary Sewer Overflow Program

Questions??