Defiance CSO Program

Cost Effective Sewer Separation – Part 1

By

Mark Lehnert, Defiance WPC Superintendent
Michael Frommer, P.E., URS Corporation
CITY OF DEFIANCE

- Population – 16,465
- Large Industrial Customer Base
- “College Town” – Defiance College
- Auglaize River – Runs North/South
- Maumee River – Runs East/West
- 7 Major League Baseball Pitchers
DEFIANCE WASTEWATER SYSTEM

• WWTP - ADF 6.0 MGD
   PHF 12.0 MGD

• Collection System –
  93 miles (8” to 54”)

• 2,600 Manholes

• 21 Pump Stations

• 44 CSO’s

• 4 River Siphons
DEFIANCE CSO PROGRAM

- 44 CSO’s – Maumee & Auglaize Rivers
- Combined Sewers in Central Part of Town
- Separate Sewers along Perimeter of Town
- Consent Order Finalized in 2010
- CSO Elimination and 0 Events per year
- Sewer Separation and River Water Intrusion Elimination
DEFIANCE CSO PROGRAM

• Sewer Separation in 20 Groups over 20 Years
  - New Sanitary Sewers (Parallel to Existing Combined Sewers)
  - Conversion of Combined Sewers to Storm Sewers
  - Footer Drain Disconnection/New Sanitary Lateral

• River Water Intrusion – 4 Projects along Maumee & Auglaize Interceptors
  - Rehabilitation of Existing Interceptors
CSO PROGRAM INITIAL RESULTS

• **Sewer Separation Costs were 185% Higher than LTCP Estimates**
  - First 6 Groups – $24.8M Actual / $13.4M Planned
  - Extensive Pavement Replacement/Restoration Costs
  - Rehabilitation of Combined Sewers not Planned for Conversion
  - Utility Conflicts/Relocation – Gas, Water Mains, Telephone, etc.
  - New Sanitary Excavation Depth

• **Private Property Footer Drain Disconnection/New Lateral Costs were 490% Higher than LTCP Estimates**
  - First 6 Groups – $3.8M Actual / $780K Planned
  - Most Properties Required Disconnection (>95%)
  - Dummy Tap Locations – Increased Lateral Footage and Pavement Restoration Costs
  - No Cost Control Mechanism over Contractor Quotes
PART 1 – SEWER SEPARATION

• Single Method of Sewer Separation/New Sanitary Sewers Parallel to Combined Sewers (Typically 0 – 5 feet)

• Conversion of Combined Sewers for Use as Storm Sewers

• Full Width Pavement Replacement because of “in street” Existing Sewer Locations and Lateral Connections; Also Trench Caving Issues

• Dummy Tap Lateral Locations at R/W; Find Private Property Lateral and Connect to Dummy Tap

• SSES Did Not Locate Lateral/Footer Drain Connection Point and No Coordination with Sewer Separation Design

• SSES Did Not Evaluate Additional Collection System Controls
SEWER SEPARATION COSTS

- Increased Cost in Dense Residential and Commercial Areas with Curbs, Sidewalks, Pavement Restoration, and Utility Conflicts
- Sanitary Sewers Deepest Utility in Developed Area
- New Sanitary Sewers and Dummy Taps – Increase Sewer Footage (Mains and Laterals)

<table>
<thead>
<tr>
<th>Project</th>
<th>Construction Completion</th>
<th>Estimated* Cost</th>
<th>Actual** Cost</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 2 Sewer Improvements</td>
<td>December 31, 2007</td>
<td>$3,698,000</td>
<td>$4,856,222</td>
<td>131%</td>
</tr>
<tr>
<td>Groups 1 &amp; 3 Sewer Separation</td>
<td>December 31, 2008</td>
<td>$2,207,000</td>
<td>$4,203,275</td>
<td>190%</td>
</tr>
<tr>
<td>Group 4 Sewer Separation/ 31B River Water Intrusion</td>
<td>November 30, 2009</td>
<td>$2,843,000</td>
<td>$6,894,710</td>
<td>243%</td>
</tr>
<tr>
<td>Group 6 Sewer Separation</td>
<td>May 31, 2010</td>
<td>$2,508,000</td>
<td>$5,234,946</td>
<td>209%</td>
</tr>
<tr>
<td>Group 5 Sewer Separation</td>
<td>December 31, 2010</td>
<td>$2,162,000</td>
<td>$3,596,600</td>
<td>166%</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$13,418,000</strong></td>
<td><strong>$24,785,753</strong></td>
<td><strong>185%</strong></td>
<td></td>
</tr>
</tbody>
</table>

- Program would Increase from $48.8M to over $118M
SEWER SEPARATION PROGRAM REVISIONS

• SSES for Each Group Area to Include:
  - Evaluation of Additional Collection System Controls
  - Locate Laterals and Eliminate Dummy Tap Locations
  - Sewer Main/Manhole Condition Assessment

• Collection System Controls Considered
  - Sewer Separation with New Storm Sewers
  - Combination Sewer Separation – Dependent on Project Area
  - Inflow Redirection through Express Storm Sewers
  - Green Infrastructure/Practices – Dependent on Soils
COLLECTION SYSTEM CONTROLS

• **Sewer Separation with New Storm Sewers**
  - Shallower Excavation/Larger Pipes
  - Maintenance Concern on Oversized “New Sanitary Sewers”
  - Reduced Pipe Lengths; No need to Parallel Combined Sewers
  - I/I Contribution from Footer/Foundation Drains

• **Combination Sewer Separation (New Storm and Sanitary)**
  - Existing Combined Sewers are Key; More Engineering during SSES Phase
  - Can Utilize Benefits of Both Types of Separation

• **Inflow Redirection**
  - Based on Flow Monitoring and Modeling Results
  - Good Alternative to deal with a “Smoking Gun”
  - I/I Contribution from Footer/Foundation Drains
  - More Rehabilitation of Combined Sewers for Conversion to Sanitary
  - No Lateral Costs (Public and Private)
CASE STUDY – GROUPS 14/15

- Dense Residential Area with Commercial Corridor on Clinton Street
FLOW MONITORING ANALYSIS

- Significant Volume in Regulator A-1; On-site Storm Retention is Suppressing Peak Flow
- Significant Volume/Peak Flow from Regulators A-5 and A-6

<table>
<thead>
<tr>
<th>Group</th>
<th>Flow Meter Site Number</th>
<th>Regulator</th>
<th>Description</th>
<th>Average DWF (MGD)</th>
<th>Peak WWF (MGD)</th>
<th>WWF/DWF</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>FM-07</td>
<td>A-01</td>
<td>Up-Stream Regulator</td>
<td>0.078</td>
<td>2.71</td>
<td>34.79</td>
</tr>
<tr>
<td></td>
<td>FM-08</td>
<td>A-02a_20&quot;</td>
<td>Up-Stream Regulator</td>
<td>0.039</td>
<td>1.03</td>
<td>26.68</td>
</tr>
<tr>
<td></td>
<td>FM-09</td>
<td>A-02b_15&quot;</td>
<td>Up-Stream Regulator</td>
<td>0.004</td>
<td>0.60</td>
<td>171.43</td>
</tr>
<tr>
<td></td>
<td>FM-06</td>
<td>A-03</td>
<td>Up-Stream Regulator</td>
<td>0.021</td>
<td>0.95</td>
<td>45.02</td>
</tr>
<tr>
<td>15</td>
<td>FM-17</td>
<td>A-04</td>
<td>Up-Stream Regulator</td>
<td>0.007</td>
<td>0.50</td>
<td>67.99</td>
</tr>
<tr>
<td></td>
<td>FM-18</td>
<td>A-05</td>
<td>Up-Stream Regulator</td>
<td>0.018</td>
<td>1.90</td>
<td>104.12</td>
</tr>
<tr>
<td></td>
<td>FM-19</td>
<td>A-06</td>
<td>Up-Stream Regulator</td>
<td>0.057</td>
<td>6.25</td>
<td>109.77</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>0.224</strong></td>
<td><strong>13.94</strong></td>
<td><strong>79.97</strong></td>
</tr>
</tbody>
</table>
CASE STUDY – GROUPS 14/15

• Viaduct, On-Site Retention, and Separate Storm Connections
GROUP 14/15 ALTERNATIVES

Alternative #1 – New Storm Sewers and Rehabilitation of Sanitary Sewers

Alternative #2 – Combination of New Storm and Sanitary Sewers including Inflow Redirection at the Viaduct Area and New Storm Outlet for Washington Street

Alternative #3 – New Sanitary Sewers and Rehabilitation of Combined Sewers

Alternative #1 was eliminated because of Topography in Project Area
# SEWER SEPARATION – SEWER SIZING

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Design Approach/Factors</th>
<th>Supporting Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Storm Sewers</td>
<td>- Delineate tributary areas</td>
<td>Phase 1 New Storm Sewer Design Calculations in Appendix A</td>
</tr>
<tr>
<td></td>
<td>- Rainfall intensity for 2-year storm and 5-year hydraulic grade line</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Runoff coefficient based on project area use designation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Rational method calculation: Q=CIA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Calibration of runoff coefficient based on flow monitoring data in areas with separate storm sewers</td>
<td></td>
</tr>
<tr>
<td>Conversion of Combined Sewers to Storm Sewers</td>
<td>- Delineate tributary areas/eliminate separate storm sewer influencing tributary areas</td>
<td>Existing Combined Sewer Storm Sizing Calculations in Appendix A</td>
</tr>
<tr>
<td></td>
<td>- Rainfall intensity for 2-year storm and 5-year hydraulic grade line</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Runoff coefficient based on project area use designation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Rational method calculation: Q=CIA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Calibration of runoff coefficient with flow monitoring data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Modified runoff coefficient based on existing separate storm infrastructure in Group 14/15 area</td>
<td></td>
</tr>
<tr>
<td>New Sanitary Sewers</td>
<td>- Average daily sanitary flows of 0.00015 cfs/capita and 20 people/acre</td>
<td>Phase 2 Sanitary Sewer Design Calculations in Appendix A</td>
</tr>
<tr>
<td></td>
<td>- I/I allowance of 0.001 cfs/acre</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Calculated peaking factor in accordance with Ten States Standards</td>
<td></td>
</tr>
<tr>
<td>Conversion of Combined Sewers to Sanitary Sewers</td>
<td>- Calculations performed for new sanitary sewers to determine the contributing flow for any combined sewers being converted to sanitary upstream of the new sanitary sewers</td>
<td>Included in Phase 2 Sanitary Sewer Design Calculations in Appendix A</td>
</tr>
<tr>
<td></td>
<td>- Same method of design as new sanitary sewers, except the I/I allowance is 0.05 cfs/acre in existing combined sewers converted to sanitary for the footer/foundation drain allowance</td>
<td></td>
</tr>
</tbody>
</table>
GROUP 14/15 – ALTERNATIVE #3
## COST ANALYSIS

<table>
<thead>
<tr>
<th>Alternative #1</th>
<th>Group 14 Phase 1</th>
<th>Group 15 Phase 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eliminated from Consideration</td>
<td>Eliminated from Consideration</td>
<td></td>
</tr>
<tr>
<td>Alternative #2</td>
<td>$3,265,840</td>
<td>$3,277,690</td>
<td>$6,543,530</td>
</tr>
<tr>
<td>As-Bid Cost (2/2012)</td>
<td>$2,413,129</td>
<td>$3,277,690**</td>
<td>$5,690,819</td>
</tr>
<tr>
<td>Alternative #3*</td>
<td>$4,335,050</td>
<td>$3,312,280</td>
<td>$7,647,330</td>
</tr>
</tbody>
</table>

* New Sanitary Sewers/Separation Method in LTCP

** Planning Cost used for Group 15 phase 2

Combination Alternative is approximately $1,956,500 less in Project Cost than new Sanitary Sewer Separation
COST ANALYSIS

<table>
<thead>
<tr>
<th></th>
<th>Group 14 Phase 1</th>
<th>Group 15 Phase 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative #2</td>
<td>$2,413,129*</td>
<td>$3,277,690</td>
<td>$5,690,819</td>
</tr>
<tr>
<td>LTCP/Addendum No. 1</td>
<td>$2,862,000</td>
<td>$2,013,000</td>
<td>$4,875,000</td>
</tr>
<tr>
<td>% Increase/Decrease</td>
<td>84%</td>
<td>161%</td>
<td>117%</td>
</tr>
</tbody>
</table>

* As-Bid Cost

- Estimated Cost Increase is 117% from the Original LTCP/Addendum No. 1
- Less than Sanitary Only Separation of 185% for Groups 1 - 6
- Cost Reduction was Significant; not enough to Reduce Program to $48.8M
SUMMARY

• Gather data to determine specific site conditions
• Consider and Evaluate Different Controls
• Avoid prescriptive alternatives because they cost more!
• Questions and Answers

Mark Lehnert  
Superintendent, WPC  
City of Defiance  
Phone: 419-782-0841  
Email: mlehnert@CityofDefiance.com

Michael Frommer, P.E.  
Project Manager  
URS Corporation  
Phone: 614-419-0598  
Email: Mike.Frommer@urs.com

Thanks!