Using Green Infrastructure to Mitigate Combined Sewer Overflows

Kentucky Association of Mitigation Managers Conference
Kentucky Dam Village 2017

Jason Dempster, Project Manager | Louisville MSD
Jason.Dempster@louisvillemsd.org
(502) 540-6386

Patrick Dominik, President | Sabak, Wilson and Lingo, Inc.
patrick.dominik@swlinc.com
(502) 584-6271
Presentation Agenda

• Items Covered
  – Background Information
  – MSD’s previous use of Green Infrastructure
  – CSO 130 Project (Lessons Learned)
  – CSO 190 Project
    • Goals and Objectives
    • Project Planning, Phasing and Construction
  – Results and Lessons Learned
Louisville MSD’s Combined Sewer System
MSD Combined Sewer System

- 99 Combined Sewer Overflows
- Smallest CSO Area 2 Acres
- Largest CSO Area 7,496 Acres
- Total Area of 22,730 Acres
- Impervious Percentage 52.0%
Why Green Infrastructure?

**LTCP Projects**
- 7 Inline Storage Projects
- 7 Storage Basins
- Ohio River Tunnel Project
- 1 Upgraded Pump Station
- 1 High-Rate Wet Weather Treatment Facility
- 6 CSO structure modifications
- 3 Conveyance Projects
- 2 Storage Basins replaced with Green Infrastructure
- $47,000,000 to be spent on Green Infrastructure

**Green Infrastructure:**
- Improved Sidewalks and Roads
- More Vegetation
- Water that doesn’t enter the system never needs to be stored, pumped or treated
- Community is more accepting of Green Infrastructure in their neighborhood
MSD’s Green Infrastructure Implementation
## CSO130 Drainage Area

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Impervious Area</th>
<th>Downstream Infrastructure Cost</th>
<th>Percentage Reduction Needed</th>
<th>Impervious Area Needed for Capture</th>
<th>Impervious Area Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,237,540 SF (28.4 acres)</td>
<td>895,702 SF (20.5 acres)</td>
<td>$1,576,476</td>
<td>33.4%</td>
<td>300,038SF</td>
<td>$5.33</td>
</tr>
</tbody>
</table>
Lessons Learned

• Pavers are high maintenance in areas with a lot of tree cover
• It is important to meet with the public and communicate the goals of the project early and often.
• Infiltration strategies
  • Trench Strategy was lower cost option
• Precast Tree Boxes were more expensive cf of Storage
• Sandy soils allow plants near the inlet to survive but plants further away may suffer.
CSO 190 Green Infrastructure Project
Project Background

- 142 Acres
- 96 Acres Impervious
- Capture 63 Impervious Acres with Green Infrastructure
- 32.27 Million Gallons of Overflow Reduction in a typical year
- Streetscape Improvements, Bioswales, Treewells, and Infiltration Galleries
- Construction will be completed in 3 phases began November 2015
- Need to Reduce Overflows from 42 to 8 in a Typical Year
Watershed Analysis

Watershed Area   142ac.

Impervious Area Summary:
Buildings        32ac.
Roads            24ac.
Lots & Sidewalks 34ac.
TOTAL IMPERVIOUS: 90ac.

Capture Required 63ac
### Controlled Runoff Calculations

<table>
<thead>
<tr>
<th>INLET</th>
<th>LOCATION</th>
<th>DRAINAGE AREA (S.F.)</th>
<th>IMPERVIOUS AREA (S.F.)</th>
<th>RUNOFF (C.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-120</td>
<td>17th St. @ Bank St.</td>
<td>10,148</td>
<td>4,016</td>
<td>365</td>
</tr>
<tr>
<td>A-130</td>
<td>17th St. @ Bank St.</td>
<td>45,027</td>
<td>13,642</td>
<td>1,240</td>
</tr>
<tr>
<td>A-140</td>
<td>Bank St. @ 17th St.</td>
<td>26,155</td>
<td>17,765</td>
<td>1,614</td>
</tr>
<tr>
<td>A-150</td>
<td>Bank St. @ 17th St.</td>
<td>23,492</td>
<td>15,492</td>
<td>1,408</td>
</tr>
<tr>
<td>A-160</td>
<td>17th St. @ Bank St.</td>
<td>8,452</td>
<td>5,979</td>
<td>544</td>
</tr>
<tr>
<td>A-170</td>
<td>Bank St. @ 17th St.</td>
<td>6,513</td>
<td>4,761</td>
<td>433</td>
</tr>
<tr>
<td>A-180</td>
<td>17th St. @ Bank St.</td>
<td>4,657</td>
<td>3,374</td>
<td>307</td>
</tr>
<tr>
<td>A-190</td>
<td>Duncan St. @ 17th St.</td>
<td>3,936</td>
<td>1,445</td>
<td>132</td>
</tr>
<tr>
<td>A-200</td>
<td>Duncan St. @ 17th St.</td>
<td>4,207</td>
<td>2,844</td>
<td>259</td>
</tr>
</tbody>
</table>

### Drainage Inlet Inventory & Area Mapping
• Required Stormwater Capture Parameters:
  ✓ 63 Acs Impervious Surface
  ✓ 255,000 cu ft of Stormwater
  ✓ 1.09” Rainfall Event

• Optimize Drainage Areas for Max. Efficiency

• Focus on Street Intersections – Max. Intercept Opportunities

• Analyze / Avoid Utility Conflicts & Re-locations

• Enhance Neighborhood w/Streetscape Improvements

• Ease of Maintenance
Overall Project Concept

210 Storm Inlets – Intercept Storm Drainage
27 Intersections.
255,550 C.F. Storage Provided.
64.6 Acs Impervious Captured.
Overall Phase Map

Phase 1 - 66,843 C.F. Captured (26%)
Phase 2 - 106,230 C.F. Captured (42%)
Phase 3 - 82,477 C.F. Captured (32%)
PHASE 1 SUMMARY

- 17th Street
- 7 Intersections
- 37 Existing Inlets
- 17 +/- Acres Impervious Surface
- Captures 60,627 C.F. of Storm Water Runoff
Existing Conditions: S 17th Street

- Minimize Overhead and Underground Utility Conflicts.
- Few property service connections
- Grass verge strip between sidewalk and curb
- Construction on west side of street
Phase 1 GMP’s Selected

Infiltration Pipe Arches

Water Quality Units as Cleanout Structures / Pre-Treatment

Infiltration Planters
Phase 1 Concept Plan

Landscape enhancement/"Gateway" opportunity at Market St

New curbs, sidewalks and Street trees

Storm sewer intercepts surface drainage into underground pipes/arches
Phase 1 Construction Photos
Phase 1 – Demonstration of Cost Effectiveness

<table>
<thead>
<tr>
<th>Green Infrastructure Project</th>
<th>Cost Per CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnolia - Right of Way Infiltration Trench</td>
<td>$20</td>
</tr>
<tr>
<td>Adams St - Pavers</td>
<td>$20</td>
</tr>
<tr>
<td>German Paristown - Rain Garden</td>
<td>$26</td>
</tr>
<tr>
<td>CSO 190 – Phase 1</td>
<td><strong>$28.96</strong></td>
</tr>
<tr>
<td>CSO 130 - Pavers</td>
<td>$31</td>
</tr>
<tr>
<td>Office of Employment - Bioswales</td>
<td>$35</td>
</tr>
<tr>
<td>Office of Employment - Pavers</td>
<td>$38</td>
</tr>
<tr>
<td>CSO 130 - Tree Wells</td>
<td>$41</td>
</tr>
</tbody>
</table>
Phase 2 - 2016 Project Area

PROJECT SUMMARY

- 11 Intersections
- 26.86 acres Impervious Surface
- 84,775 C.F. of Storage
Phase 2 – Challenges / Opportunities

- More utility conflicts within the public right-of-way.
- Truck traffic may demand preserving/widening pavement sections.
- Railroad crossing.
- Non-contiguous project area.
- Minimize construction disruption to ex. businesses.
- Incentivize downspout disconnection for large business rooftops to maximize GMP efficiency.
- Seek private partnering opportunities, where practical.
Downspout Disconnection– Improved GMP Performance

- MSD offers $0.40/sf to commercial businesses to “daylight” downspouts into underground infiltration GMP’s.
- 70,603 sf of rooftop captured in Phase 2.
Private Partnering Opportunities

- 44,662 C.F. Runoff Captured (35%)
- Partners get:
  - enhanced streetscape improvements.
  - Compensation for easements and downspout disconnection.
Phase 2 – GMP’s Selected

Infiltration Pipe Arches

Infiltration Planters

Infiltration Beds

Pervious Pavers “Green Alley”
Phase 2 – Construction / As-Built Images

- Underground Infiltration Basin
- Improved Parking & Loading Facilities
Phase 2 – Construction / As-Built Images

Permeable Pavers
Phase 2 – Construction / As-Built Images

Permeable pavers

Underground Infiltration Basin
Phase 2 – Construction / As-Built Images

- Downspout Disconnection
- New Curbs, Sidewalks & Landscaping
Phase 3 - 2017 Project Area

PROJECT SUMMARY

- 5 Intersections
- 14.17 acres Impervious Surface
- 70,877 C.F. of Storage
- Storm Diversion
- Dam Raise
Phase 3 – Challenges / Opportunities

• Updated level of control based on Phase 1 monitoring data.

• More residential land uses, less large impervious area.

• Downstream focus allowed implementing strategic “gray” stormwater controls.
  • *Dam Raise*
  • *Diversion Storm Sewer*

• Modified scope allowed work to be a continuation of Phase 2 contract.
Phase 3 – GMP’s Selected

Infiltration Pipe Arches

Bending Weir

Infiltration Planters

Storm Diversion Plan View
### Phases 2 & 3 – Demonstration of Cost Effectiveness

<table>
<thead>
<tr>
<th>Green Infrastructure Project</th>
<th>Cost Per CF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CSO 190 – Phase 2 &amp; 3</strong></td>
<td>$17.63</td>
</tr>
<tr>
<td>Magnolia- Right of Way Infiltration Trench</td>
<td>$20</td>
</tr>
<tr>
<td>Adams St- Pavers</td>
<td>$20</td>
</tr>
<tr>
<td>German Paristown- Rain Garden</td>
<td>$26</td>
</tr>
<tr>
<td><strong>CSO 190 – Phase 1</strong></td>
<td>$28.96</td>
</tr>
<tr>
<td>CSO 130- Pavers</td>
<td>$31</td>
</tr>
<tr>
<td>Office of Employment- Bioswales</td>
<td>$35</td>
</tr>
<tr>
<td>Office of Employment- Pavers</td>
<td>$38</td>
</tr>
<tr>
<td>CSO 130- Tree Wells</td>
<td>$41</td>
</tr>
</tbody>
</table>
## Total Project Cost Summary

<table>
<thead>
<tr>
<th>Green Infrastructure Project</th>
<th>Cost Per CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnolia- Right of Way Infiltration Trench</td>
<td>$20</td>
</tr>
<tr>
<td>Adams St- Pavers</td>
<td>$20</td>
</tr>
<tr>
<td><strong>CSO 190 – Total Cost</strong></td>
<td><strong>$20.80</strong></td>
</tr>
<tr>
<td>German Paristown- Rain Garden</td>
<td>$26</td>
</tr>
<tr>
<td>CSO 130- Pavers</td>
<td>$31</td>
</tr>
<tr>
<td>Office of Employment- Bioswales</td>
<td>$35</td>
</tr>
<tr>
<td>Office of Employment- Pavers</td>
<td>$38</td>
</tr>
<tr>
<td>CSO 130- Tree Wells</td>
<td>$41</td>
</tr>
</tbody>
</table>
FLOW GOING INTO CSO 190

- 5/16/15 - Depth: 1.13 in - Max Intensity: 2.28 in/hr
- 6/26/15 - Depth: 1.56 in - Max Intensity: 2.28 in/hr
- 11/5/15 - Depth: 0.93 in - Max Intensity: 2.52 in/hr

FLOW (MGD)

Time
Lessons Learned & Questions