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Protecting Puget Sound from CSOs by retrofitting Urban Neighborhoods with Green Stormwater Infrastructure

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Protecting Puget Sound from CSOs by retrofitting Urban Neighborhoods with Green Stormwater Infrastructure

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Salish Sea Ecosystem Conference, Vancouver BC
April 13, 2016, 3:30-5pm, SW3F session

www.svrdesign.com
Barton CSO Control with Green Stormwater Infrastructure (GSI)

- King County Wastewater Treatment Division (WTD) led project within the public right-of-way of the City of Seattle
Regulatory Requirements

- Ecology requires no more than 1 CSO event per year over a 20-year rolling average
- Consent decree: *United States of America and the State of Washington v. King County* (USDC Civil Action No. 2:13-cv-677 lodged on April 16, 2013)
- In 2008, average 4 CSOs per year, 4 MG
Project Team – Design & Construction

• Developer/Owner of Facility:
  – King County Wastewater Treatment Division

• Consultant Design Team
  – MIG I SvR (Prime – civil & landscape)
  – Associated Earth Sciences Inc. (Hydrogeologist/Geotechnical)
  – Aqualyze Inc (GSI & Basin modeling)
  – ILM, Bill Lucas (GSI modeling support)
  – PRR (Community outreach)
  – Sue Nicol (Arborist)
  – Pacific Geomatic Services (Surveyor)

• Permitting through Seattle Department of Transportation and Washington State Department of Ecology

• Community Involvement

• Contractor
  – Goodfellow Bros., Inc. (Prime)
  – T. Yorozu Gardening Co. (bioretention soil & plantings)
  – Aquatech Well Drilling & Pumps

• CM support - MWH
Why GSI was chosen for CSO Control by King County in 2011 for Barton CSS

• Facility Plan evaluated green & grey alternatives
• GSI allows for adaptive management over time
• Lifecycle costs less than gray infrastructure
  – Pump station cost reduction
  – Treatment plant cost reduction
  – Greenhouse emissions reduced
Barton CSS Basin Description

• 1,111 acres (450 ha)

• Five sub-basins

• CSS pipes convey flows to the Barton Pump station then on to West Point Treatment Plant
Why this area?

- 45% of stormwater flows entering CSS come from the project area. Streets drain to CSS.
- 72 streets in project area
- 151 acres (61 ha)
- Available space in street right of way planting strip
Challenges at start of Design Phase

- Approved Facility Plan scope: shallow infiltration on the blocks
- Shallow infiltration was not feasible
- On the heels of another not-so-successful roadside rain garden project
- Community fears and concerns
- New City ROW permitting process
- Federal consent decree schedule
- New technology for WTD in addressing CSOs
King County Approach

- Take the time to study existing conditions
- Geotechnical & Hydrogeological Testing
- Understand street surface flows and use of flow model
- Design for individual streets and site context
- Careful and rigorous construction
- Early and on-going community involvement from planning through O&M
Design Process

- Survey
- Geotechnical Testing
- Modeling
- Field Recon.
- Public Feedback
- Agencies

Design & Permitting
Public Outreach During Design

- 6 community meetings
- 24 block level meetings
- 2 neighborhood surveys
- 4 association briefings
- 2 rounds of neighborhood canvassing
- 6 project update newsletters
- 10 small group neighborhood meetings
- Nearly 700 email, phone or street conversations with more than 500 residents and stakeholders.
Future (summer)
Future (winter)
What We Heard from Neighborhood

• Existing Drainage Concerns
• Pests
• Parking
• Access
• Vegetation and Trees
• Maintenance
• Minimize Construction Impacts
• Define agency roles
• Be consistent with terminology
Field Reconnaissance

- Above- and Below-Ground Infrastructure and features
- Within ROW & Adjacent
Project Area Geology

- Soil layers
- How and where water flows underground
- Water table
- Deep infiltration borings
- Monitoring wells
- Infiltration test pits

Map & photo shown provided by Associated Earth Sciences, Inc.
LEGEND:
BMW - GROUNDWATER MONITORING WELLS TO MEASURE SHALLOW GROUNDWATER LEVELS (20 FT. DEEP)
MW - GROUNDWATER MONITORING WELLS TO MEASURE DEEP GROUNDWATER LEVELS (45-205 FT.)
IB - DEEP INFILTRATION BORINGS TO FIND OUT THE RATE WATER FLOWS THROUGH THE UNSATURATED VASHON SOIL LAYER (BEIGE LAYER)
▽ - WATER LEVELS, AS MEASURED BY WELLS
TD - TOTAL DEPTH OF WELL UNDERGROUND

NOTE: SLOPE SHOWN IS NOT TO SCALE (STEEPER THAN ACTUAL)
GSI with Deep Infiltration Design Elements for Barton

- Bioretention swales
- Underdrains
- Underground Injection Control (UIC) screen wells
Describing Street Selection to the Public

- Factors below helped select the most effective streets in the project area for bioretention in the right-of-way
- Selection criteria are guides, not set in stone

1. Residential streets
2. Flatter roads (under 5% grade)
3. Minimal driveways
4. Open areas without mature trees
5. Wider planter strips (9’ or greater)
6. Minimal public & private utility conflicts
7. Cross slope of road
8. Minimal impact to on-street parking
Street Selection: Wide Planter Strips

- Wide planter strips with a minimum width of 5' are preferred.
- Narrower strips with a width less than 5' are not recommended.
Street Selection: Flatter Streets

- <2%
- 2-5%
- >5%
Street Selection: Lower Portion of Blocks
Site Considerations: Where to Locate GSI

- Each street is unique
  - Locations of trees (556 trees reviewed)
  - Above & below ground utilities
  - Parking patterns
  - Accessibility
  - Driveway access
  - Cross Slope
- Maximum temporary ponding depth – 12 inches (~30 cm)
- Swales drain within 24 hours
- Access & Drainage: Bottom length ~15 - 30 feet (4.5 – 9 m)
  Top Length ~25 - 40 feet (7.6 – 12.1 m)
GSI Design – more details

• Swale side slopes 2.5:1
• Minimum bottom width 12 in (30 cm)
• Planting Infrastructure
• 18 in (46 cm) bioretention soil
• 6 in (15 cm) sand
• Filter drain rock & underdrain
• Partial & fully lined sections
GSI Design – Curb Cuts & Presettling
GSI Design - UIC Screen Well & MH

- One per block (~660 feet, 200m)
- Design depth varied at each location due to soil conditions
- Total Depth 65 – 100 feet (~19.7 - 30.3m)
- Well Screen 20 – 40 feet (~6 - 12m) of 8 inch (~20 cm) diameter
## Bioretention: Planting Overview

<table>
<thead>
<tr>
<th>ZONE</th>
<th>PLANT TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Emergents</td>
</tr>
<tr>
<td>2</td>
<td>Steppables</td>
</tr>
<tr>
<td>3</td>
<td>Groundcovers</td>
</tr>
<tr>
<td>4</td>
<td>Low Shrubs</td>
</tr>
<tr>
<td>4</td>
<td>Accent Shrubs / Small Trees</td>
</tr>
<tr>
<td>2, 4</td>
<td>Tree</td>
</tr>
</tbody>
</table>
Plant Palettes – Designed for the Varying Existing Street Character

<table>
<thead>
<tr>
<th>Street Character Image</th>
<th>Type of Street</th>
<th>Street Character Description</th>
<th>Recommended Plant Palette</th>
<th>Plant Character</th>
</tr>
</thead>
</table>
| ![Open Street](image)  | Open           | None to few physical object/boundaries Views | **Framed**          | • Dark green foliage
                                |                |                               |               | • Broadleaf evergreens
                                |                |                               |               | • Cool and hot colored flowers |
| ![Enclosed Street](image) | Enclosed       | Tall walls, fences and vegetation | **Airy**             | • Light foliage
                                |                |                               |               | • Medium sized leaves
                                |                |                               |               | • Light colored flowers |
| ![Semi-Open Street](image) | Semi-Open      | Low walls, fences and vegetation | **Blended**           | • Medium dark green foliage
                                |                |                               |               | • Needle-leaf evergreens
                                |                |                               |               | • Warm colored flowers |
| ![Bulbs & Intersections](image) | Bulbs & Intersections | No Parking Zones | **Bulb & Intersection** | • Bright foliage
                                |                |                               |               | • Medium sized leaves
                                |                |                               |               | • Vibrant colored flowers
                                |                |                               |               | • Low for visibility |

PLANT CONCEPTS IN RESPONSE TO STREET CHARACTERISTICS
Modeling

- Subcatchment delineation
- Barton Pump Station upgrade 33mgd
- Continuous Model (EPA SWMM) over last 30 years
- COS Bioretention Soil Design Infiltration Rate of 6 in/hr (15 cm/hr)
- Flow monitoring of CSS
- Rain gauge in project area
- 151 acres in Project Area

Figures provided by Aqualyze
Modeling

- 15 streets with GSI
- ROW Area = 11.6 acres (4.7 ha)
- Parcel Area (including disconnected downspouts) = 20.2 acres (8.1 ha)
- Parcels 43% +/- Impervious
- ROW 64% +/- Impervious

Top figure from Aqualyze. Routing of flows.
Procurement, Cost & Construction

• Public Competitive Bid
• Engineer’s Estimate $5.06 Million
• Low responsive responsible bidder $5.10 Million
• Milestones & Constraints in Contract
  – Two construction seasons 2014 & 2015 (8 and 7)
• Lump Sum bid with select unit prices for items more likely to change (e.g. depth of well screen)
Pre-Construction

- Gas relocates done before main contract
- Tree removal
- Construction Staff Training
Construction

• Checklists for Inspectors
• Mockups
• Flow Tests
• Community Outreach
Construction – Bioretention

- Ongoing testing of soil
- Grading mock-up
- Minimize foot traffic
- Curb cuts blocked
- Increase time for wells off line
# Operation and Maintenance

- Maintained by King County as a CSO facility
- O&M Plan

<table>
<thead>
<tr>
<th>Street Name</th>
<th>Date (intersection to intersection):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checked by</td>
<td>Plan:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose of visit:</th>
<th>Routine Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (inches)</td>
<td>2.5 in last 24 hours</td>
</tr>
</tbody>
</table>

### Drain Structure Inlets, Grates, Curb Cuts & Weirs

<table>
<thead>
<tr>
<th>Condition</th>
<th>MODERATE</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility is ready for a storm event:</td>
<td>Facility partially ready for a storm event:</td>
<td>Facility NOT ready for a storm event:</td>
</tr>
<tr>
<td>No blockage from sediment or vegetation, no damaged structures, and no pooling.</td>
<td>Some blockage from sediment or vegetation, some damaged structures, and/or some pooling.</td>
<td>Significant blockage from sediment or vegetation, many damaged structures, and/or pooling.</td>
</tr>
</tbody>
</table>

### Sided Paths & Sidewalks

<table>
<thead>
<tr>
<th>Condition</th>
<th>MODERATE</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 26% of pavement is covered with Miss, debris, leaves and sediment.</td>
<td>Between 26-40% of pavement is covered with Miss, debris, leaves and sediment.</td>
<td>More than 40% of pavement is covered with Miss, debris, leaves and sediment.</td>
</tr>
<tr>
<td>There are no grade changes, cracks or upheaval.</td>
<td>There are slight grade changes, cracks or upheaval.</td>
<td>There are grade changes greater than 1&quot; or significant cracks or upheaval.</td>
</tr>
</tbody>
</table>

### Sidewalk Epoxy in Basalts

<table>
<thead>
<tr>
<th>Condition</th>
<th>MODERATE</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>No erosion, channelization or scouring with less than 1&quot; of water.</td>
<td>Some erosion, channelization or scouring with less than 4&quot; of water.</td>
<td>Significant erosion, channelization or scouring with greater than 4&quot; of water.</td>
</tr>
<tr>
<td>There is very little or no water flowing in basaltic.</td>
<td>Water is slightly compacted and/or signs of slower infiltration.</td>
<td>Water is highly compacted and water is pooling.</td>
</tr>
</tbody>
</table>

### Spill Prevention and Response, and Pest Control

<table>
<thead>
<tr>
<th>Condition</th>
<th>MODERATE</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise spill prevention measures whenever handling or storing potential contaminants. Fertilizers, Herbicides, Fungicides and Insecticides are prohibited.</td>
<td>Clean up spills as soon as possible to prevent contamination of stormwater. See O&amp;M Manual and follow Specification 01590, Environmental Management for spill prevention and response.</td>
<td>No standing water observed in the basins for time periods suitable for insect development (designed to drain in 24 hours).</td>
</tr>
<tr>
<td>Miss: Few or no signs of water are present.</td>
<td>Miss: No standing water observed in the basins for time periods suitable for insect development.</td>
<td>Miss: No standing water observed in the basins for time periods suitable for insect development.</td>
</tr>
</tbody>
</table>

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Photo: King County staff working on a project.
Maintenance – Acceptable vs Unacceptable

Acceptable Maintenance:
- Mostly healthy vegetation with good appearance
- Appearance is good
- Occasional weedy species (6-10%)
- Some erosion and bare spots (0-5%)

Unacceptable Maintenance:
- Debris buildup
- Appearance is poor
- Weedy
- Overgrown

24-hour maintenance hotline: 206-263-3801
King County CSO Control Facility Protecting Our Waters
Monitoring

- Cells and wells are taking all the water that drains to them
- Monitoring flows out of basin.
- Less water flowing to treatment plant = reduction in treatment costs.
- Data loggers in UIC Wells to measure water level
- Adaptive management to be applied if needed. Four more streets design and permitted.
- Stay tuned………. 
Next Steps


• Continuing flow & CSO monitoring within basin

• Compliance reporting in 2017

• King County will be expanding and looking to use GSI for CSO control in more areas within Seattle where feasible.

• Joint GSI Program between King County WTD and Seattle Public Utilities on design standards, policies and procedures for CIP GSI projects. www.700milliongallons.org
THANK YOU!

For more information about the Barton CSO control project with GSI go to:
http://www.kingcounty.gov/environment/wastewater/CSO.aspx
http://www.kingcounty.gov/environment/wastewater/CSO/BeRainwise.aspx

SPU & King County Wastewater Joint GSI program: www.700milliongallons.org

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www.svrdesign.com
Before & After
Before & After
Before & After
Before & After
December 8, 2015 Storm Event
RainWise

- Rebate to homeowners to redirect building downspouts to rain garden/cistern
- So far 82 Installations in Barton ($230,255 in rebates, 121,402 sf roof disconnected)
- Opportunity for residents to take action on their property

www.700milliongallons.org