Street Alternatives: Seattle Public Utilities Natural Drainage System Program

Urbanization of Puget Sound

1972 1986 1996


Endangered and threatened species of Puget Sound – orca, chinook (steelhead, chum, coho, etc.)

Natural Drainage Systems

Tries to make this... ...function like this.
Seattle’s Natural Drainage System Program

City Right-of-Way
- Residential Neighborhood – NDS Grids
  - SEA Street Prototype
  - Cascade Prototype
  - Lessons Learned through projects
- High density Neighborhood– High Point
- Commercial Area – Swale on Yale

Private Property
- Private Parking Lots – Northgate Mall
- Stormwater Code Revisions to encourage LID
- Lakewood Pilot Project
- Private Incentives – RainWise Program

Tracy Tackett, Low Impact Development Program Manager
Who to Involve

Street Design, Landscape Architects, Other Utilities, …

SEA Street monitoring results for two years:

99% reduction in total runoff volume

NW110th Carkeek Cascade
Existing Systems

Carkeek Cascade at NW 110th
Combined with flow through water quality channel
Different from SEA Street – lots more water, steeper slopes

Major Lesson Learned, Street Guidelines
Major Lesson Learned, Soil Wrap Wall specs

Water Quantity and Quality Monitoring by UW (Cameron Chapman) – great performance

Major Lesson Learned, modeling
- Less runoff than anticipated
- Higher average annual infiltration rate

Broadview Green Grid

Sub-basin drainage area = 32 acres
SEA Streets and Cascades

Major Design Change

Sidewalk adjacent street
Sub-basin drainage area = 32 acres

Major Lesson Learned, Native Soils

Native Soil Infiltration Rates
Modified Full Scale Field Testing (PIT)

Field flexibility - Subsurface Pipe

Major Lesson Learned, Bioretention Soils
Major Lesson Learned, need better modeling

November 11?, 2004

Pinehurst Project Area

- Kramer drainage = 134 acres
- Pinehurst project = 49 acres

Offset Template

Block Scale Template Cost/Benefit Comparison

- Potential Infiltration Surface Area (SF/Block)
  - $141,000: 863 SF
  - $139,000: 1465 SF
  - $109,000: 440 SF
Major impact to residents during construction!

Construction Costs

$280,000 for 660’ block
42% Stormwater elements (including soil)
45% Street improvements (road, curb, sidewalk)
13% Landscaping
Note: correlates to approximate $200/ LF for stormwater elements
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More Project Information:

http://www.ci.seattle.wa.us/util/naturalsystems/

Natural System Program

High Priority Watersheds

North: Piper’s Creek Watershed

South: Longfellow Creek Watershed

Longfellow Creek Watershed

High Point Redevelopment

- 130-acre site
- new right-of-way
- 1,600 units
- 65% impervious area
- 9% of watershed
High Point Natural Drainage Strategies
Housing: Block-level Design

High Point Neighborhood

Case Study: High Point Redevelopment, Seattle, WA

Comparison of Flow Duration

<table>
<thead>
<tr>
<th>Condition</th>
<th>Duration that 2-year peak flow rate, based on past conditions, is exceeded (hours/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td></td>
</tr>
<tr>
<td>Pasture</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td></td>
</tr>
<tr>
<td>Redeveloped, no NSS</td>
<td></td>
</tr>
<tr>
<td>Redeveloped, with NSS</td>
<td></td>
</tr>
</tbody>
</table>

Bar chart showing:
- Peaks
- Rainfall
- Current Condition
- Redeveloped (no NSS)
- Redeveloped (with NSS)
Porous Concrete Roadway Demonstration
Who to work with – Permitting and enforcement procedures in place prior to construction
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Right-of-Way - Commercial Neighborhood
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Private Property: parking lots

Rainwise Incentives Program
• Rainwater cisterns
• Green roofs
• Biortention
• Bioswales
  – Peak reduction
  – Peak and volume reduction
• Compost amended soil
• Porous pavement
• Reduction of impervious surface area
More Project Information:

http://www.ci.seattle.wa.us/util/naturalsystems/

Major Lesson Learned, Stewardship

Water Quality Monitoring by UW

Results: runoff retention

- System retains at least 48% of all inflows
Results: outlet hydrology

- Discharge in only 49 of 235 storms
- Fully retains storms up to 1” in dry conditions
- Fully retains storms up to 0.3” in any condition

Rainfall thresholds for discharge of 110th Cascade

Minimum rain needed for discharge

Maximum potential rain depth without discharge

Results – peak flow reduction

Water Quality Results:

Conservative estimates of percent reduction in mass loading

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Method 1</th>
<th>Method 2, 3*</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>84 (72-92)</td>
<td>89, 86*</td>
</tr>
<tr>
<td>TN</td>
<td>63 (53-74)</td>
<td>67</td>
</tr>
<tr>
<td>TP</td>
<td>63 (49-74)</td>
<td>73</td>
</tr>
<tr>
<td>Copper</td>
<td>83 (77-88)</td>
<td>83</td>
</tr>
<tr>
<td>Zinc</td>
<td>76 (46-85)</td>
<td>84</td>
</tr>
<tr>
<td>Lead</td>
<td>90 (84-94)</td>
<td>89</td>
</tr>
<tr>
<td>Motor oil</td>
<td>92 (86-97)</td>
<td>93</td>
</tr>
</tbody>
</table>

Results: typical outflow quality from 110th Cascade (mg/L)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Range</th>
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<tbody>
<tr>
<td>TSS</td>
<td>10 – 40</td>
</tr>
<tr>
<td>TN</td>
<td>0.6 – 1.4</td>
</tr>
<tr>
<td>TP</td>
<td>0.09 – 0.23</td>
</tr>
<tr>
<td>SRP</td>
<td>0.02 – 0.05</td>
</tr>
<tr>
<td>Total copper</td>
<td>0.004 – 0.008</td>
</tr>
<tr>
<td>Dissolved copper</td>
<td>0.002 – 0.005</td>
</tr>
<tr>
<td>Total zinc</td>
<td>0.04 – 0.11</td>
</tr>
<tr>
<td>Dissolved zinc</td>
<td>0.02 – 0.06</td>
</tr>
<tr>
<td>Total lead</td>
<td>0.002 – 0.007</td>
</tr>
<tr>
<td>Dissolved lead</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Motor oil</td>
<td>0.11 – 0.33</td>
</tr>
</tbody>
</table>
High Point Neighborhood

Swale Cross Sections

- Vegetated swale
  - 10” ponding
  - 18” deep

- Grass-lined swale
  - 2” ponding
  - 8” deep