2019 Villanova University Biennial Symposium

Sizing Green Infrastructure For Today and Tomorrow

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Green Infrastructure

Common GI Components:
1. Inlets
2. Pipes
3. Subsurface Storage
4. Trees/Vegetation
**Storm Size Design Targets**

- Vary across municipal GI programs but typically range between treating 1” to 2” rainfall events

- Limiting Factors:
  - Existing utilities
  - Geological conditions
  - Topography
  - Adjacent properties and structures
  - Existing trees

**When there is room to expand a GI practice, what other things should be considered?**
Impacts of maximizing GI footprint

Examine one GI system location in 3 scenarios

Key Considerations:

1. Design Feasibility
2. Value
3. Constructability
**Scenario 1: 1.0” Storm Depth Managed**

*System contained within sidewalk on one side of city block*

<table>
<thead>
<tr>
<th>Design Metrics</th>
<th>Scenario 1 (1”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Area (SF)</td>
<td>20,074</td>
</tr>
<tr>
<td>GI Footprint (SF)</td>
<td>675</td>
</tr>
<tr>
<td>GI Depth (ft)</td>
<td>6.25</td>
</tr>
</tbody>
</table>
Scenario 2: 1.5” Storm Depth Managed

<table>
<thead>
<tr>
<th>Design Metrics</th>
<th>Scenario 1 (1”)</th>
<th>Scenario 2 (1.5”)</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>Drainage Area (SF)</td>
<td>20,074</td>
<td>20,074</td>
<td>-</td>
</tr>
<tr>
<td>GI Footprint (SF)</td>
<td>675</td>
<td>1008</td>
<td>+49%</td>
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<tr>
<td>GI Depth (ft)</td>
<td>6.25</td>
<td>6.5</td>
<td>+4%</td>
</tr>
</tbody>
</table>

+ 55% increase in excavation & storage media
+ 48% increase in surface restoration
**Scenario 3: 2.0” Storm Depth Managed**

<table>
<thead>
<tr>
<th>Design Metrics</th>
<th>Scenario 1 (1”)</th>
<th>Scenario 3 (2”)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Area (SF)</td>
<td>20,074</td>
<td>20,074</td>
<td>-</td>
</tr>
<tr>
<td>GI Footprint (SF)</td>
<td>675</td>
<td>1,324</td>
<td>+96%</td>
</tr>
<tr>
<td>GI Depth (ft)</td>
<td>6.25</td>
<td>6.5</td>
<td>+4%</td>
</tr>
</tbody>
</table>

+ 104% increase in excavation & storage media
+ 91% increase in surface restoration
How frequently do storms of these sizes occur?

- 10 years of USGS storm gage data: 10/1/09 – 10/1/19
- 3,653 days of record
- 1,236 storms with rainfall depth between 0.01 - 9.00 inches

<table>
<thead>
<tr>
<th>Range of Rainfall Depth (inches)</th>
<th>Storm Count</th>
<th>% of Storms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 – 1.00</td>
<td>1,079</td>
<td>87%</td>
</tr>
<tr>
<td>1.01 – 1.50</td>
<td>84</td>
<td>7%</td>
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<tr>
<td>1.51 – 2.00</td>
<td>36</td>
<td>3%</td>
</tr>
<tr>
<td>&gt; 2.00</td>
<td>37</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>1,236</td>
<td>100%</td>
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</tbody>
</table>
How has precipitation changed locally? Expected Storms vs Observed Storms

From 10/1/09 to 10/1/19

Design Storm Analysis

15-min Duration

30-min Duration

1-hr Duration

2-hr Duration

6-hr Duration

12-hr Duration

24-hr Duration

ARI (yrs)
How has precipitation changed nationally?

(Figure source: adapted from Peterson et al. 2013).
What about storm events in the future?

(Figure source: NOAA NCDC / CICS-NC).

Annual Maximum Precipitation

Rapid Emissions Reductions (RCP 2.6)  
Continued Emissions Increases (RCP 8.5)

(Figure source: NOAA NCDC / CICS-NC).
Scenario 1: 1” Storm Depth Managed

Rainfall Below WQ Depth

76%
Scenario 2: 1.5” Storm Depth Managed

10% more volume captured than Scenario 1
Scenario 3: 2” Storm Depth Managed

16% more volume captured than Scenario 1
Planning GI for today

• Compare the added value of increasing a GI system size to the added design and construction costs

• Over the past 10 years, most storms have been under 1.0” inch in storm depth.

Planning GI for tomorrow

• More intense storms of larger volumes are predicted to occur more frequently in the future.

• When all constraints allow, a larger GI practice today can help cities be resilient in the face of climate change.