Analysis of Green Infrastructure Performance Data in the Streets of Philadelphia

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PHILADELPHIA WATER DEPARTMENT

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Program and Regulatory Background

2009:
CSO Long Term Control Plan Update

2011:
Consent Order & Agreement

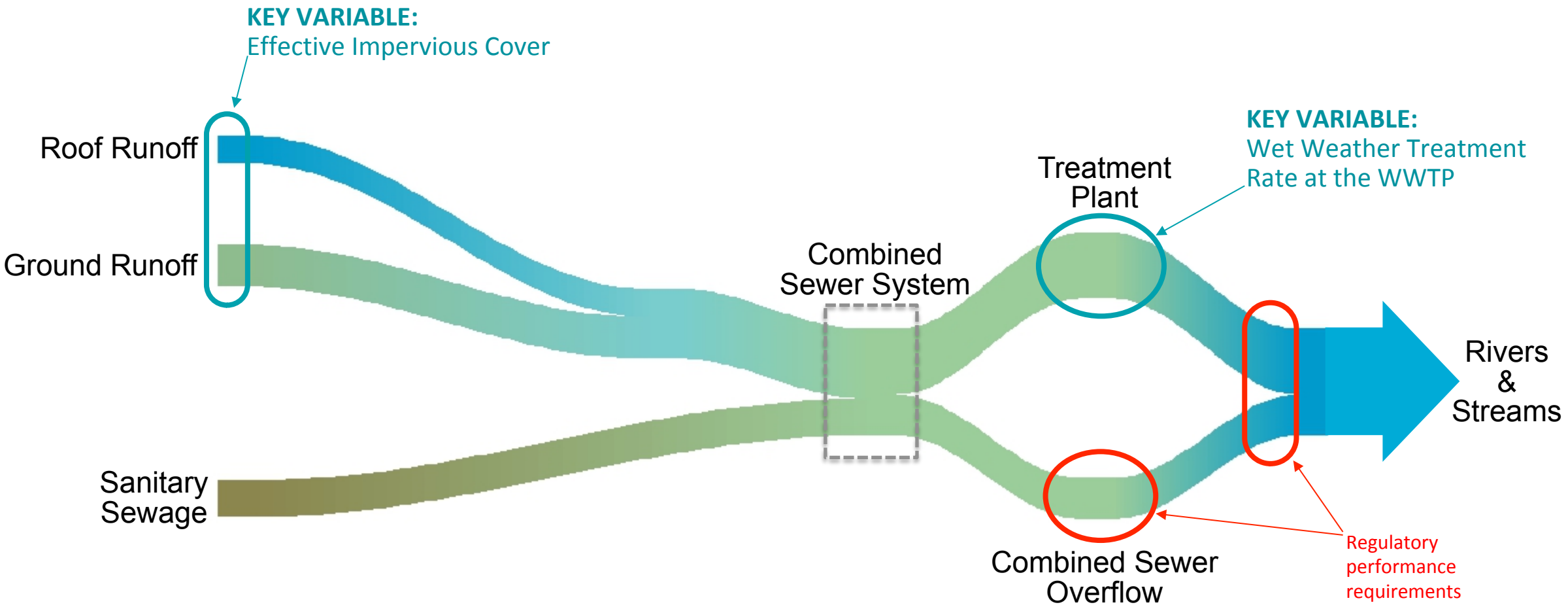
2012:
Partnership Agreement and Administrative Order for Compliance on Consent

- CSO reduction
- Pollutant removal
- Green and traditional infrastructure
- Monitoring and proof of concept program
- Adaptive management

Service Area and Collection System Key Performance Objectives

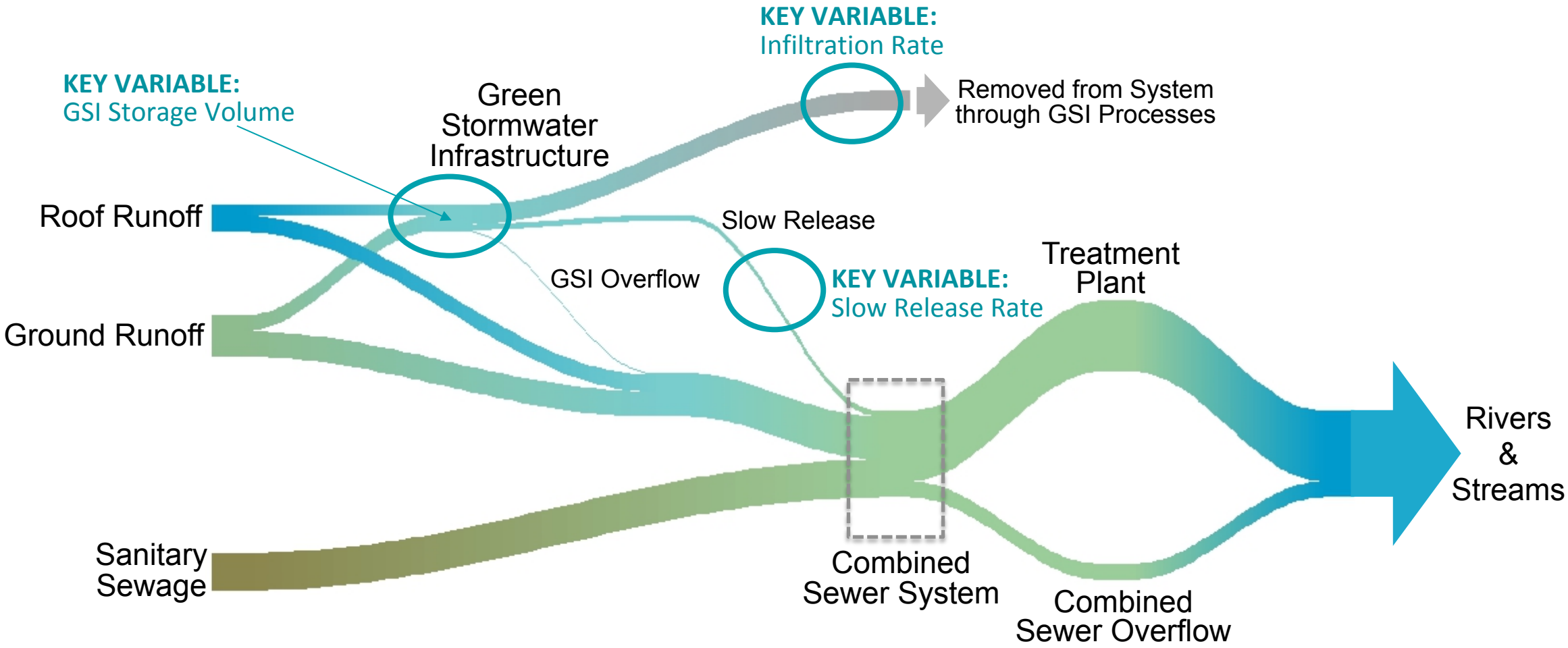
- CSO Volume Reduction: ~8 billion fewer gallons combined sewer overflow per year compared to today
- Pollutant Load Reduction: Capture and treat pollutants from 85% of wet weather flow
- Green Infrastructure: ~9,600 ac-in of storage/stormwater treatment capacity distributed throughout the landscape

The Urban Hydrologic System ***without*** Green Infrastructure*



*average annual hydrologic conditions, during wet weather events

The Urban Hydrologic System ***with*** Green Infrastructure*



*average annual hydrologic conditions, during wet weather events

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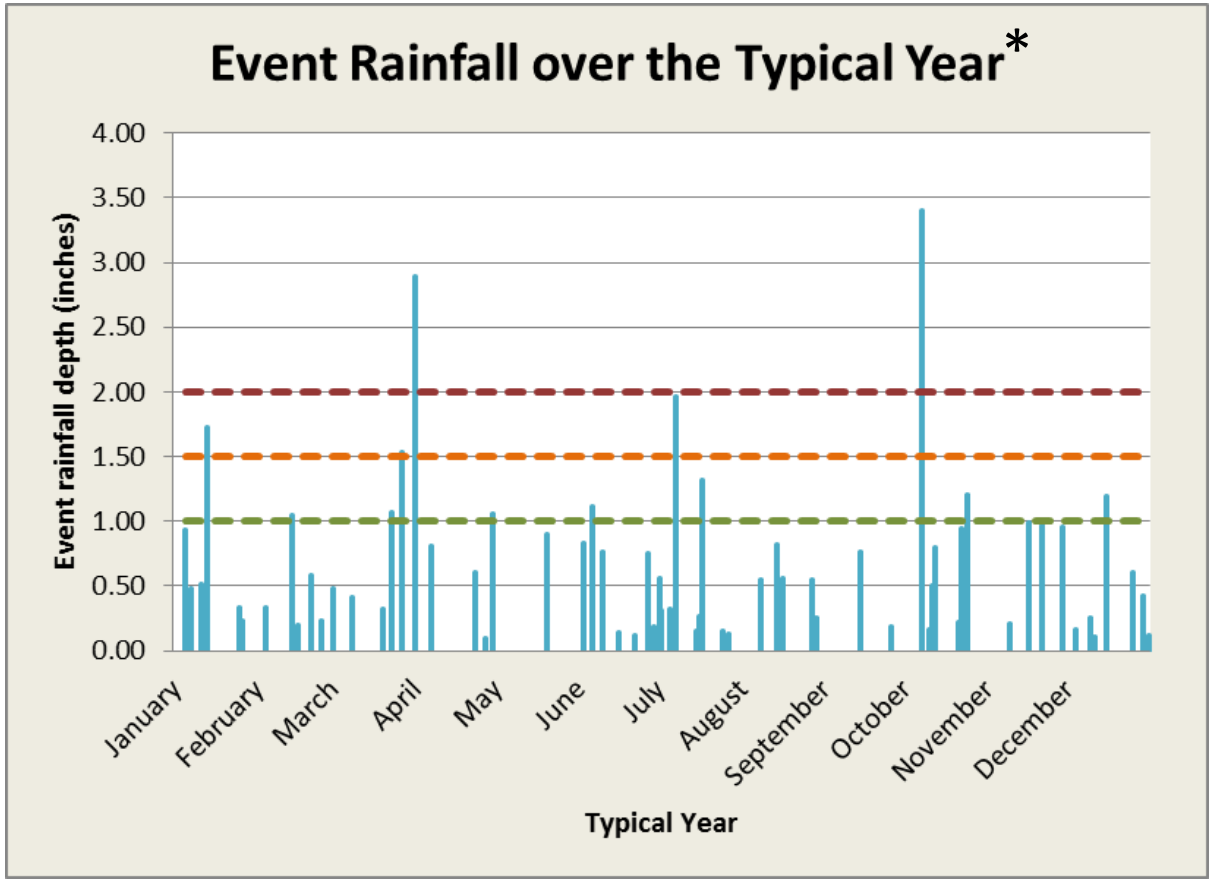
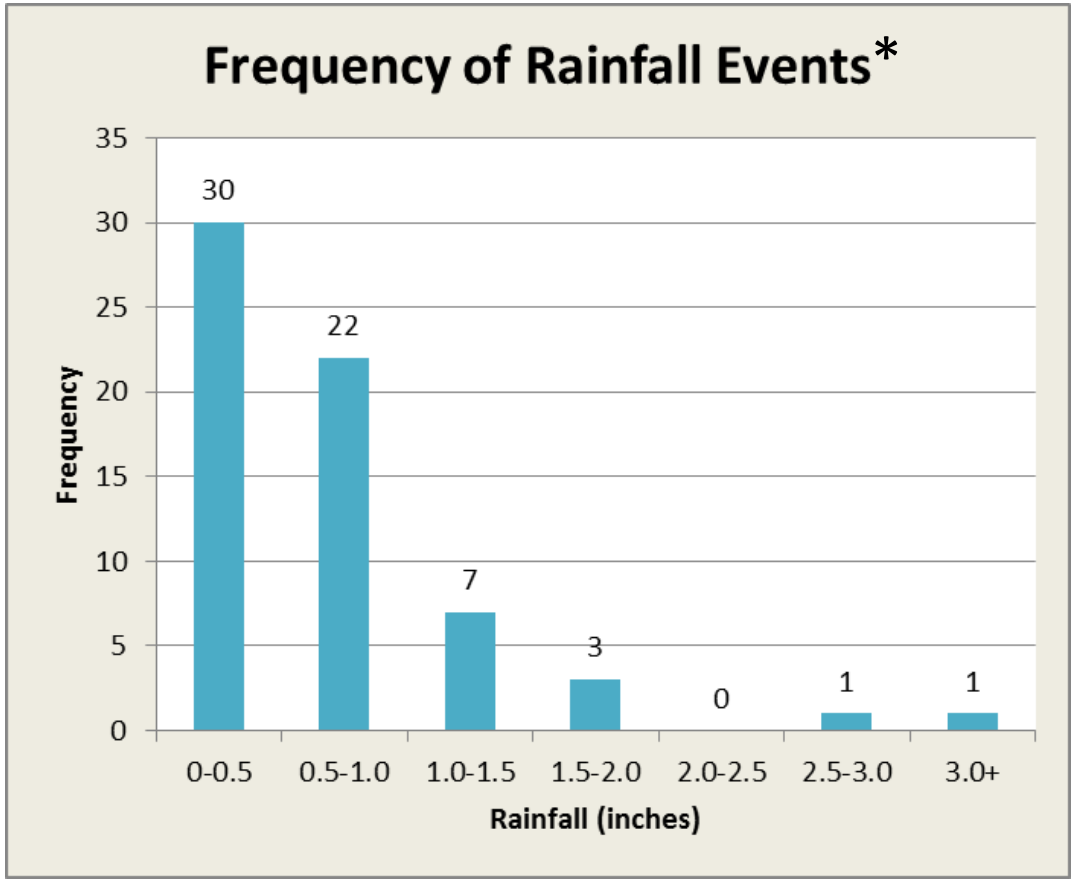
Typical Hydrologic Year for Wet Weather Planning



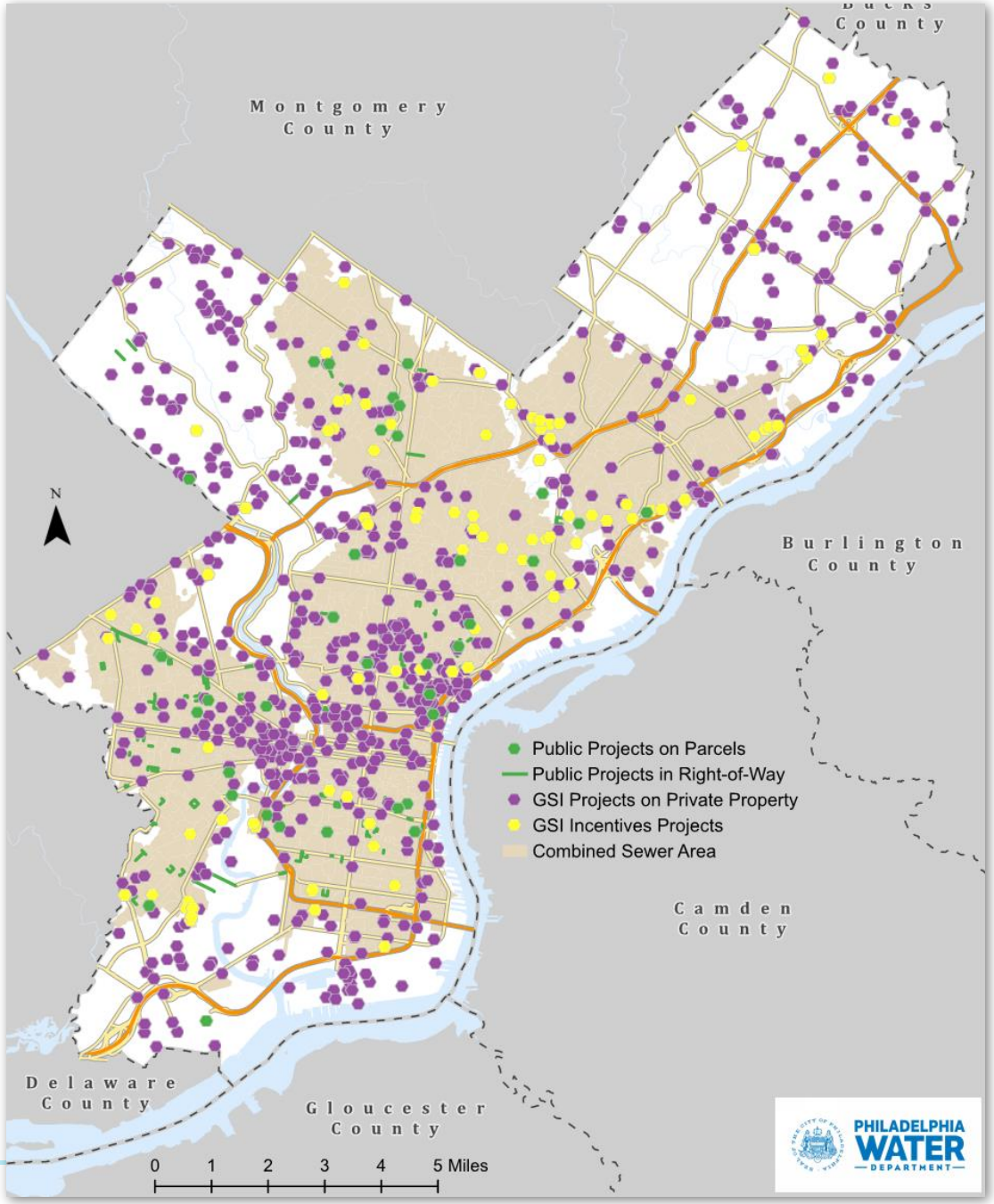


* Events of 0.1 in. or greater depth shown

Green Stormwater Infrastructure Design Criteria

- **Water quality volume** informed by long-term rainfall patterns (1-2 inches of runoff for most public and private designs)
- **Maximize infiltration** into underlying soil (unless unstable geotechnical conditions or contamination are present)
- If infiltration is insufficient to manage all runoff, **controlled release** to the combined sewer system at a rate that can be conveyed and treated at a wastewater treatment plant (~0.05 cfs per acre of impervious drainage area)
- **Reduce pollutants**
- Additional **stream channel protection and peak flow** requirements in some areas

Constructed GSI Projects



Green Infrastructure Examples

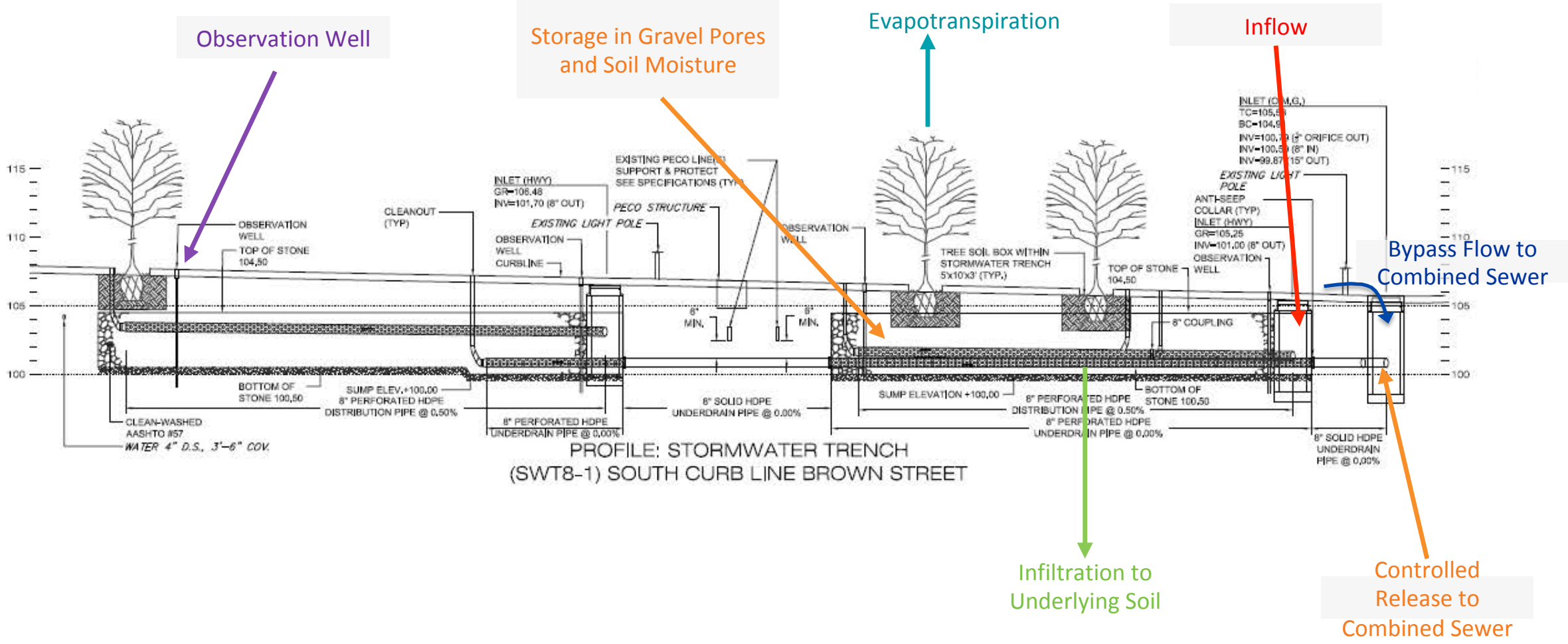
Columbus Square Rain Garden

Columbus Square Planter Trench

Front Street Tree Trench

Green Infrastructure Example – Design and Monitoring Results

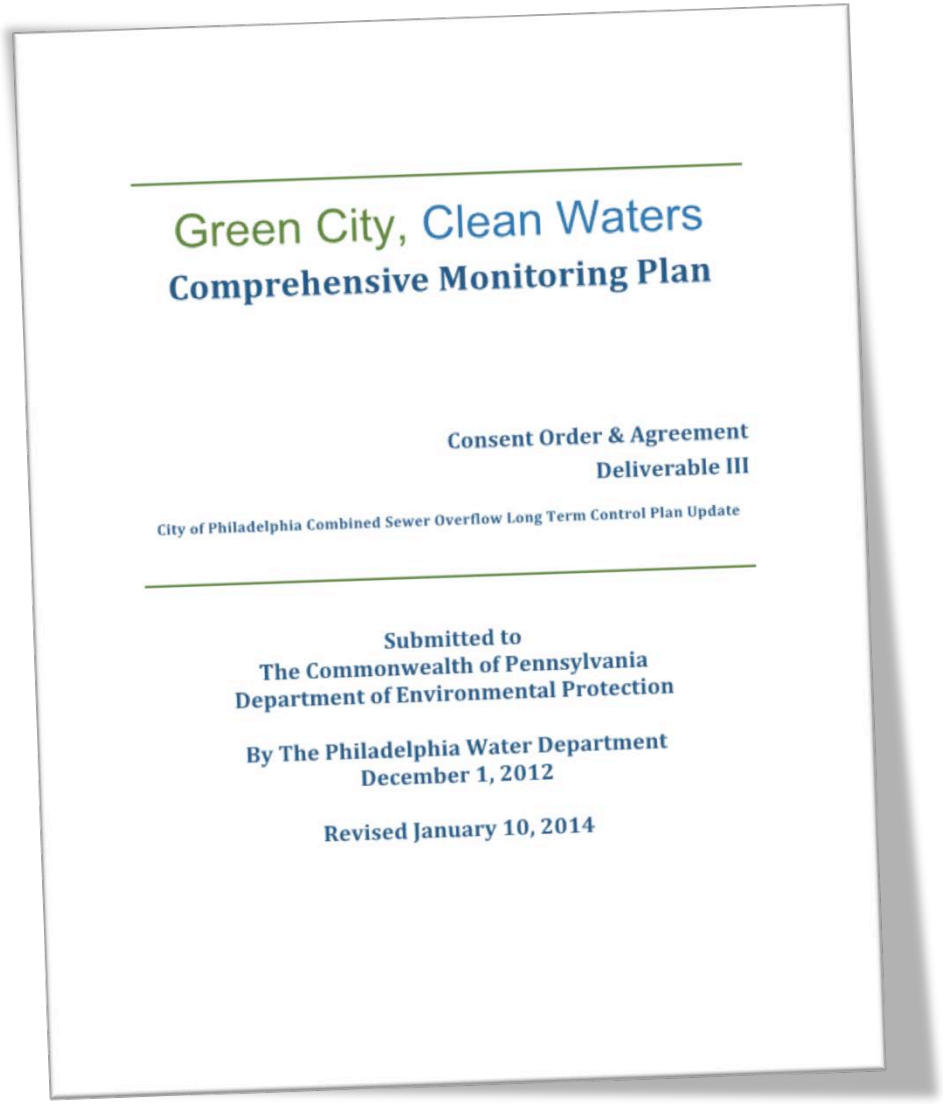
Green Infrastructure Example – Design and Monitoring Results



PROFILE: STORMWATER TRENCH
(SWT8-1) SOUTH CURB LINE BROWN STREET

Monitoring Objectives

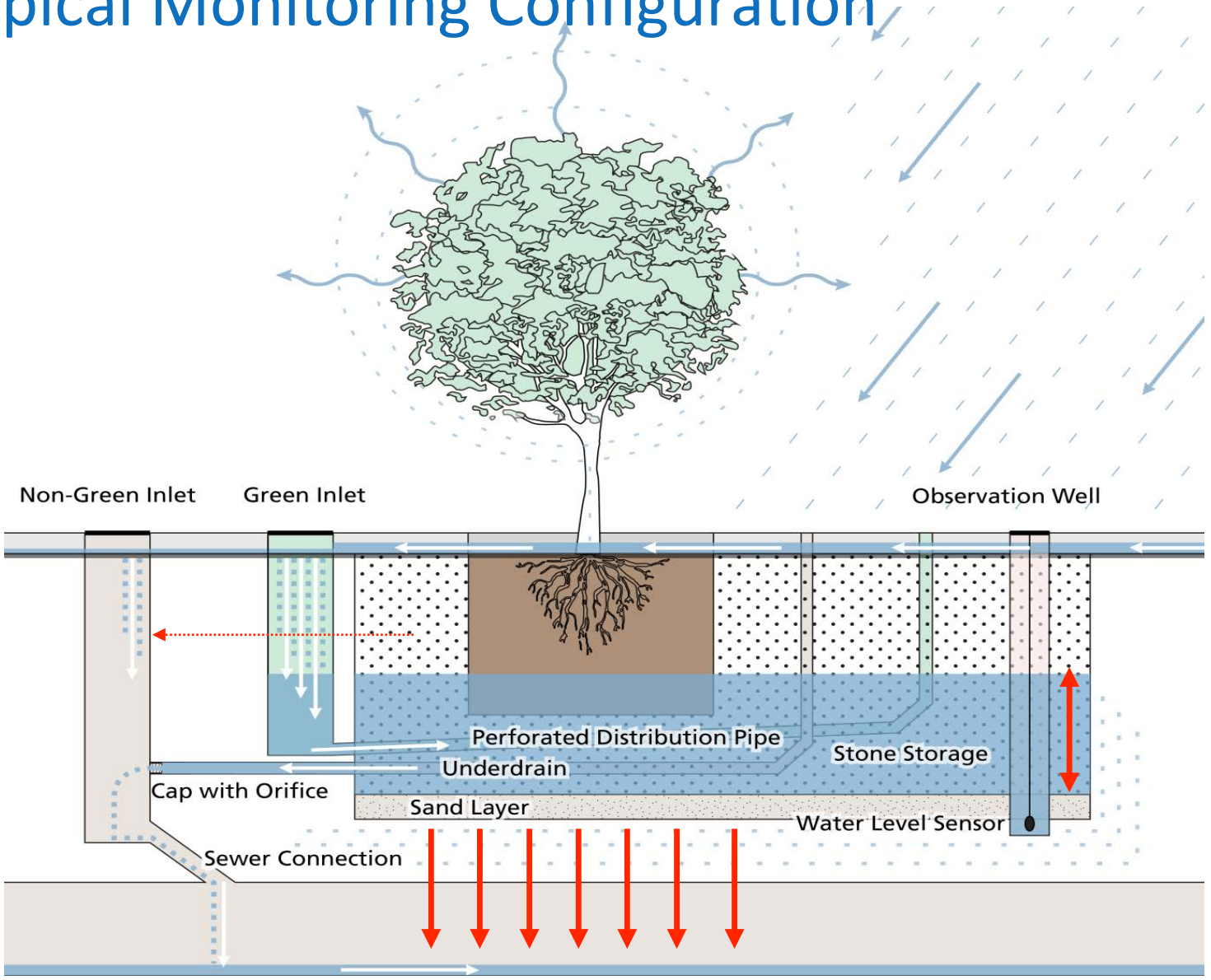
- **Regulatory reporting**
- **Confirm performance as designed**
- Identify field troubleshooting/retrofit needs
- Inform design criteria and regulations
- Inform maintenance and monitoring practices
- Validate computer models
- Inform adaptive management decisions
- Contribute to the state of knowledge

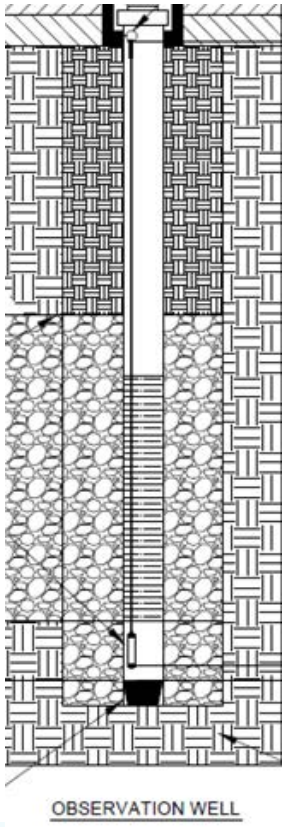


Monitoring Approaches

- Verification that the site was built as designed
- Visual assessment
- Planting media infiltration testing
- **Simulated runoff testing**
- **Rainfall monitoring**
- **Water level logging**
- Inflow and Outflow Measurement Research with academic partners
- Combined Sewer System Flow Monitoring Used in computer model calibration
- Pollutant Concentration Monitoring Research with academic partners

Typical Monitoring Configuration





Wet Weather Events in the WQV* Range (February-June 2017)

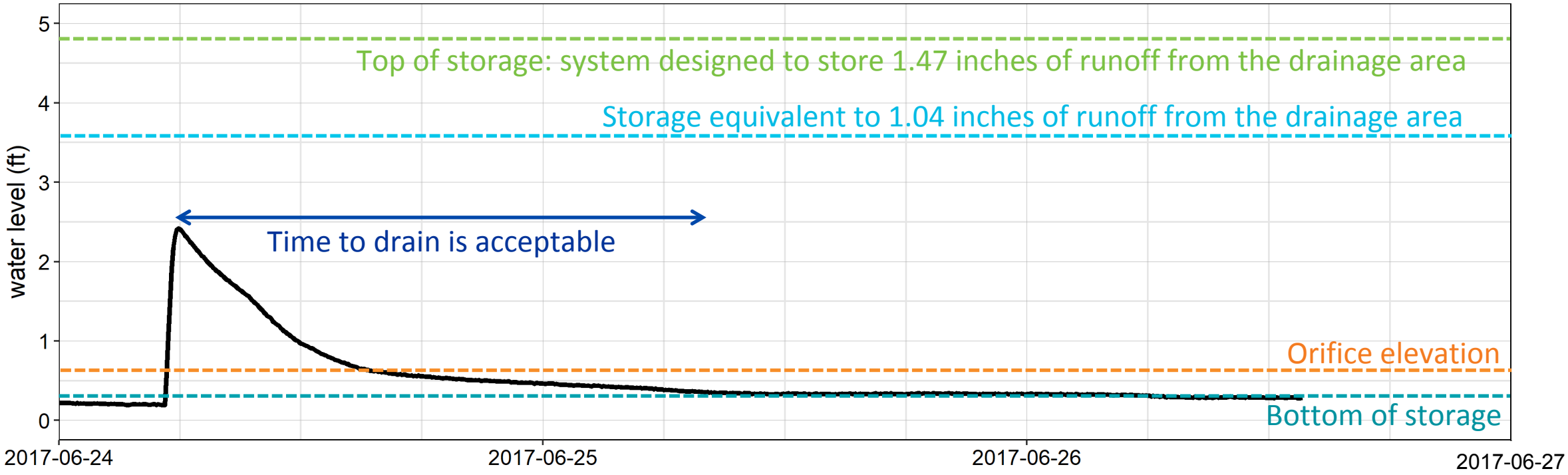
Event #	Dates	Depth (inches)	Duration (hrs)	Peak Intensity (in/hr)**
6	March 13-14, 2017	1.51	12.25	0.37
9	March 30-31, 2017	1.61	31.25	0.35
11	April 6, 2017	1.46	12.50	1.39
17	May 4-5, 2017	1.33	13.75	0.79
18	May 12-13, 2017	1.85	24.00	0.32
26	June 24, 2017	1.04	3.75	1.92

* Water Quality Volume

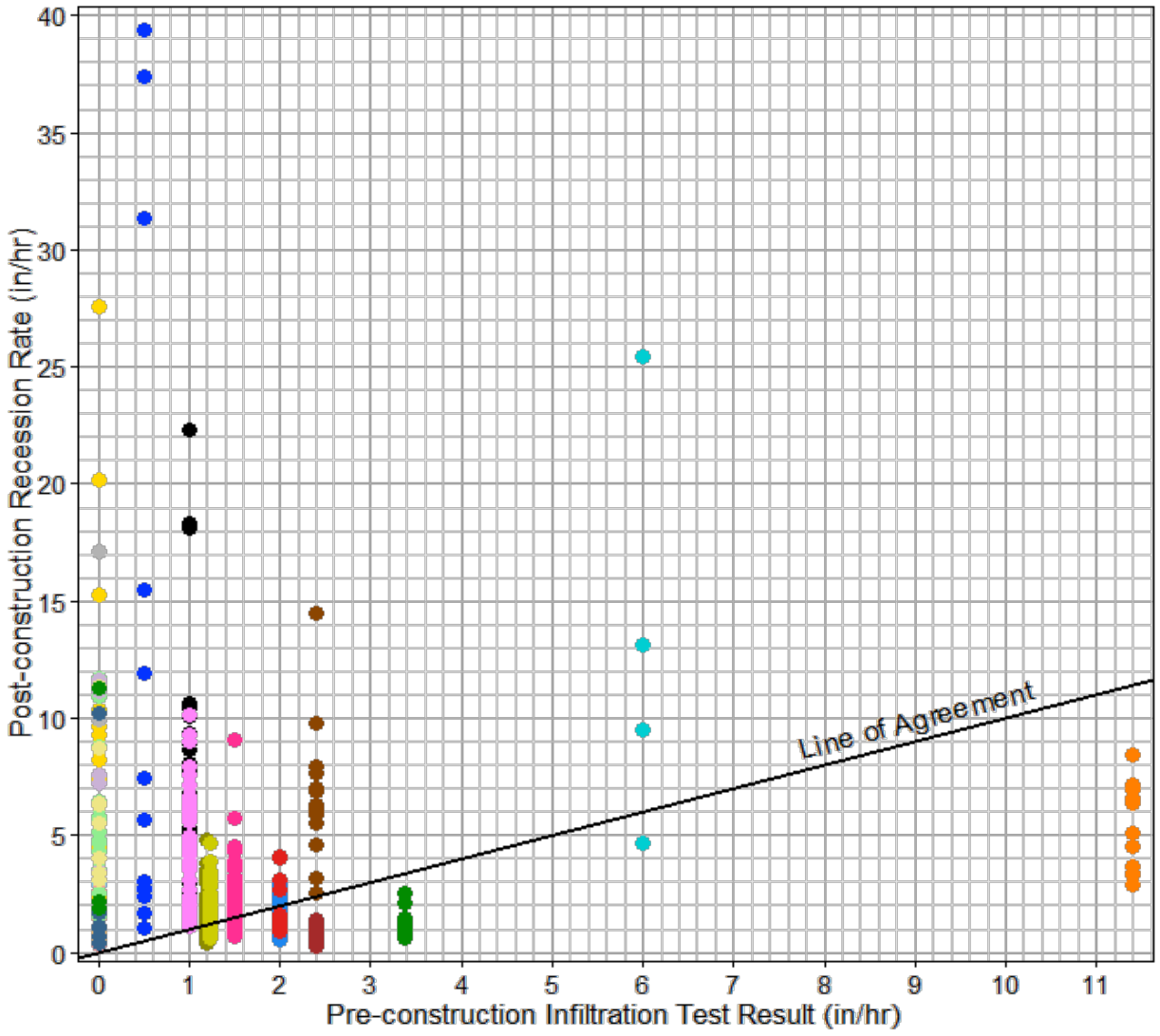
** 15-minute measurement

June 24-25, 2017

- 1.04 inches rainfall depth
- 3.75 hr duration
- 0.28 in/hr average intensity
- 1.92 in/hr peak intensity



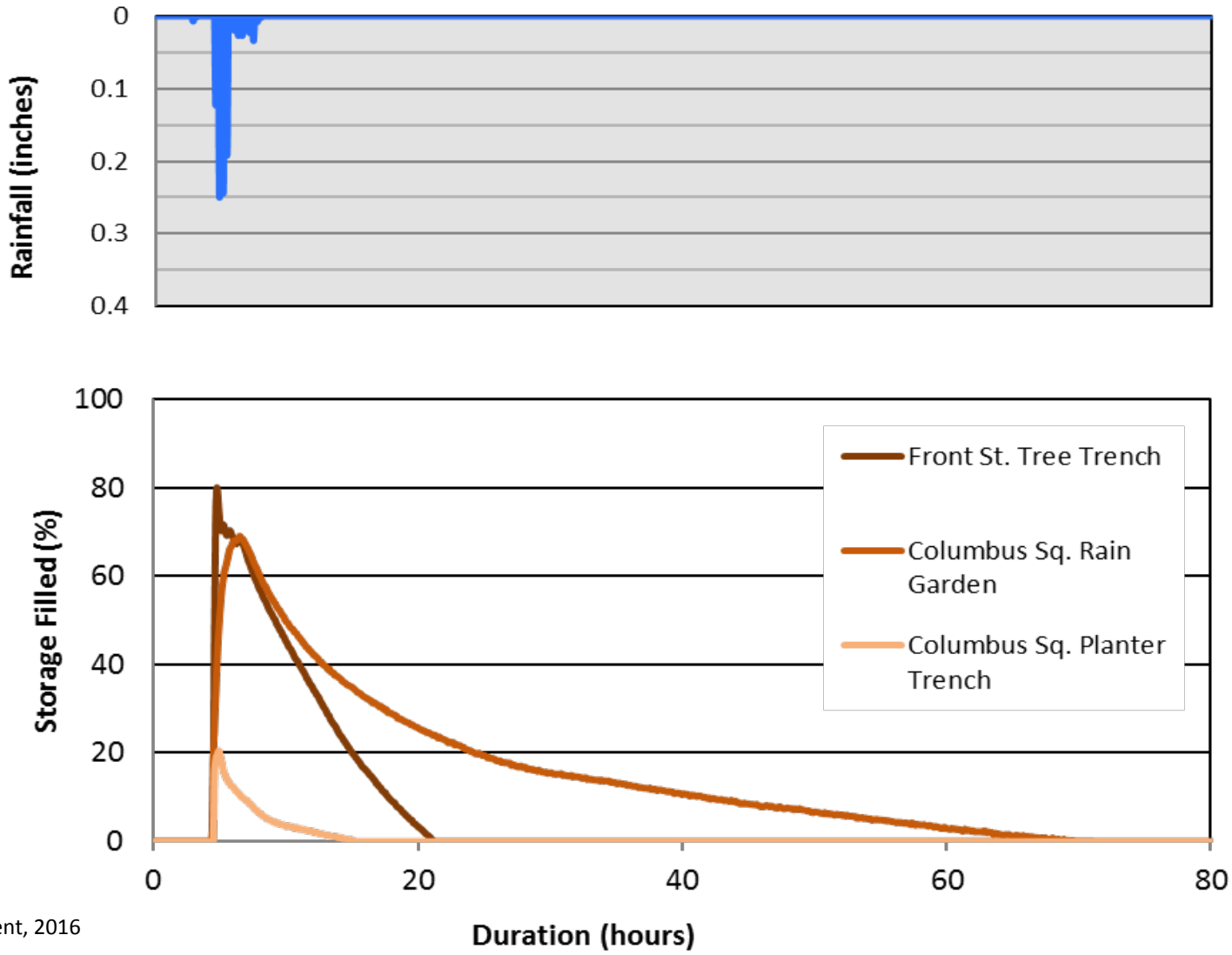
Green Infrastructure Performance Analysis: Infiltration (2012-2015)



Observed post-construction infiltration rates are higher on balance than pre-construction infiltration test results would suggest.

Pilot Program Final Report,
Philadelphia Water Department, 2016

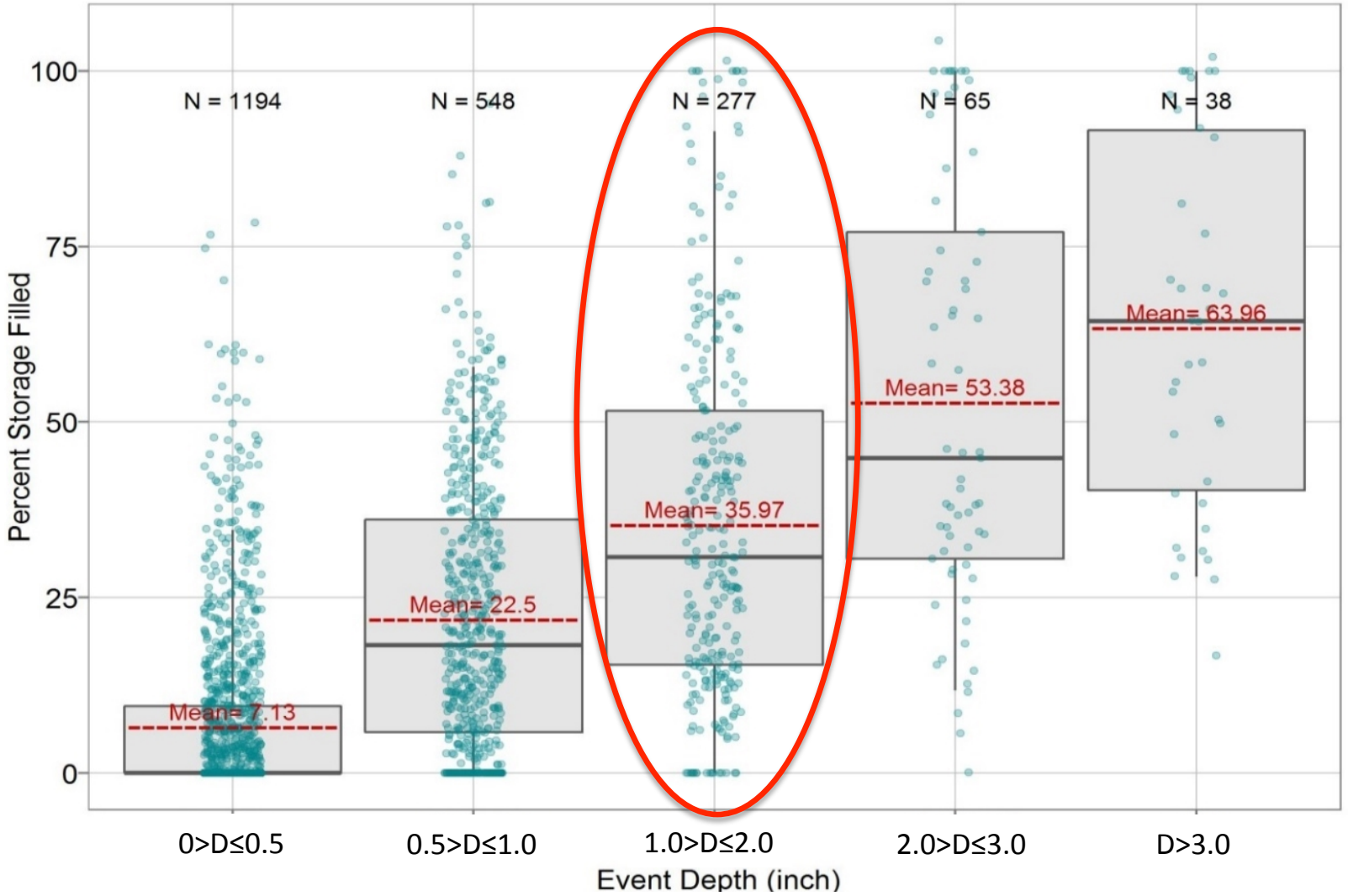
Green Infrastructure Performance Analysis: Draindown (2012-2015)



System Response at Columbus Square and Front Street to a 1 inch Event on June 27, 2014

Pilot Program Final Report, Philadelphia Water Department, 2016

Green Infrastructure Performance Analysis: Storage Utilization (2012-2015)



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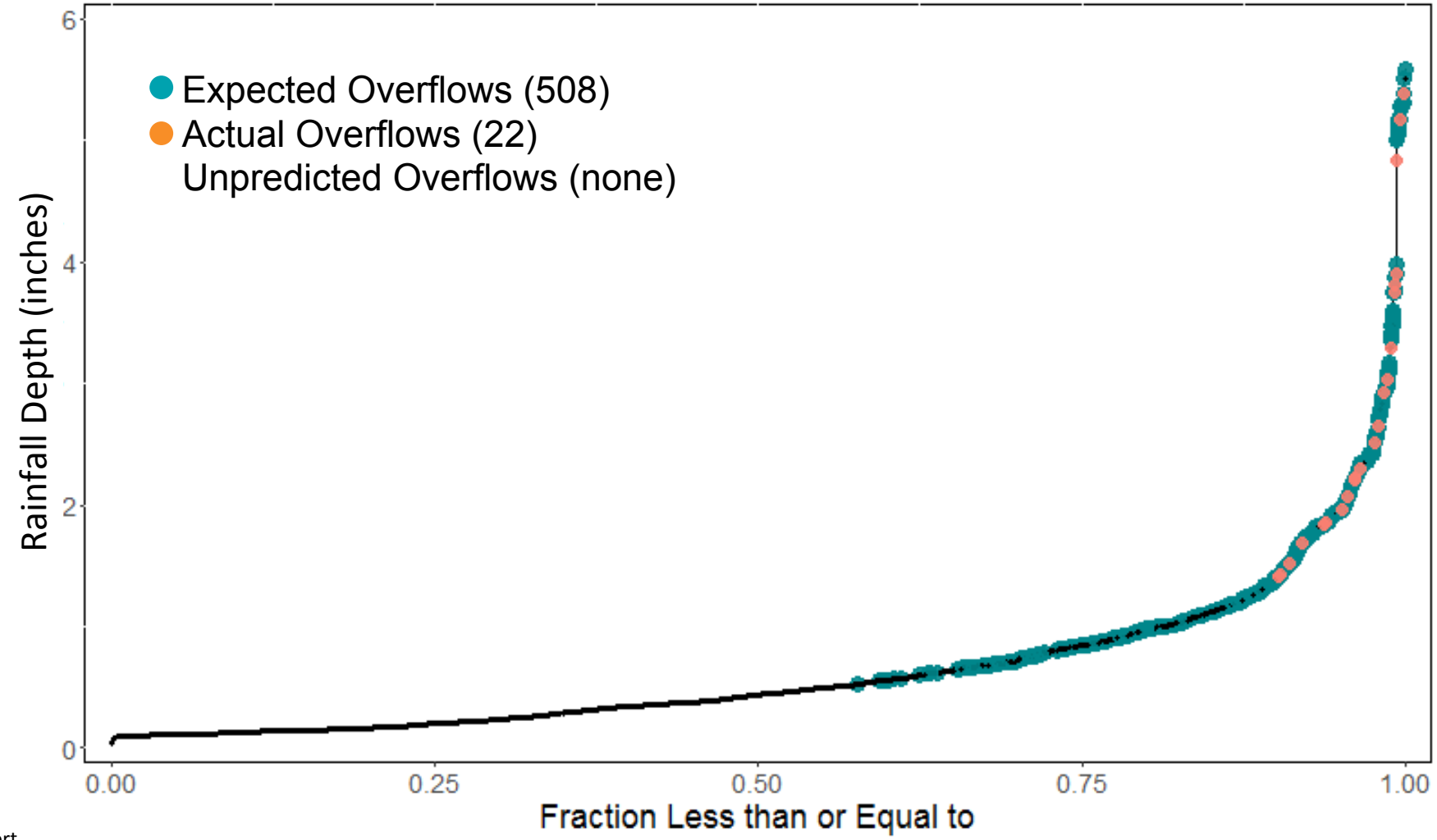

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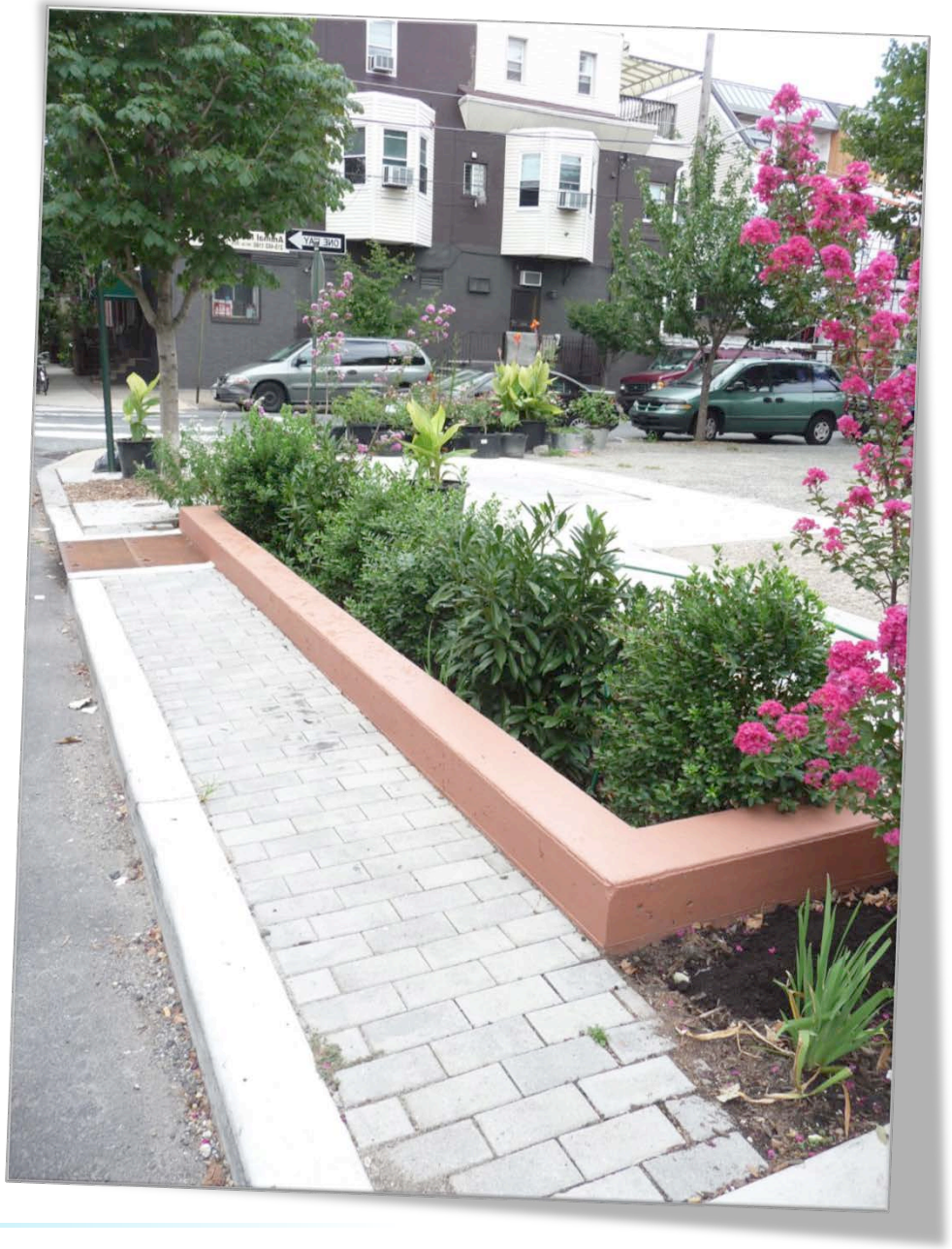
Conclusions

- ✓ Systems generally performing better than predicted under engineering design assumptions
  - Fewer overflows
  - Higher infiltration rates
  - Faster draindown times
  - More excess storage capacity available
- ✓ Site-scale design criteria are tied to collection system performance
- ✓ Green infrastructure is functioning as an effective combined sewer overflow control
- ✓ Results meet regulatory requirements and will inform future monitoring, maintenance, and design practices



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