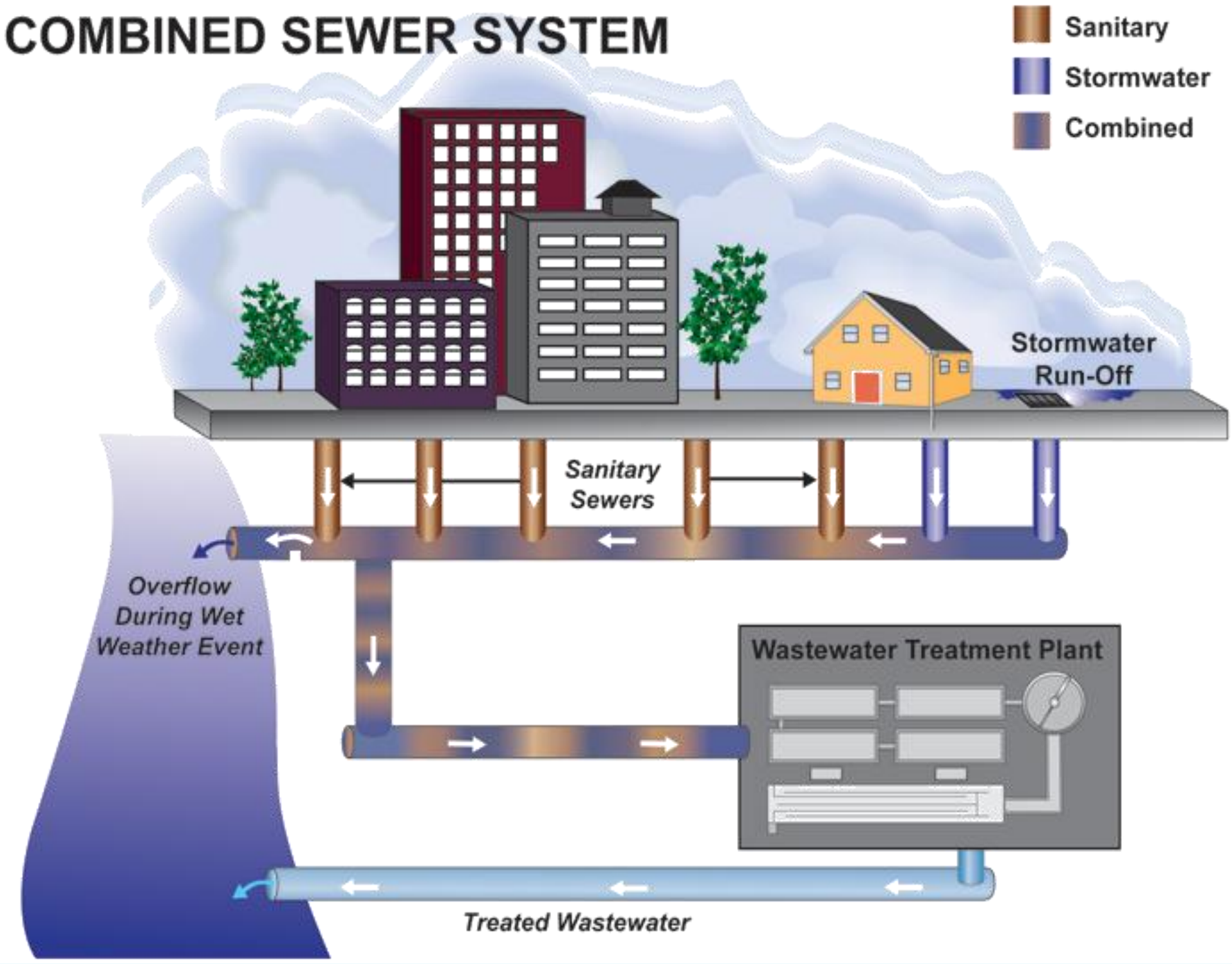
Green Infrastructure Impact Assessment Collaboration

Overview

- MSD is responsible for clean water in our community
- MSD has an $850 million EPA consent decree obligation
- Green infrastructure is a component of this consent decree
- Green programs are only successful if the entire community is involved

Traditional (Gray) Infrastructure



System Overview

- 385 sq. miles
- Pop. 700,000
- Ohio River Flood Protection System
  - 16 Flood Pump Stations
  - 29 miles of Floodwall
- 6 Regional WQTCs
- 14 Small WQTCs
- 286 Pump Stations
- 3,200 miles of Sewers

- 103 Active CSOs
  - 200+ SSOs

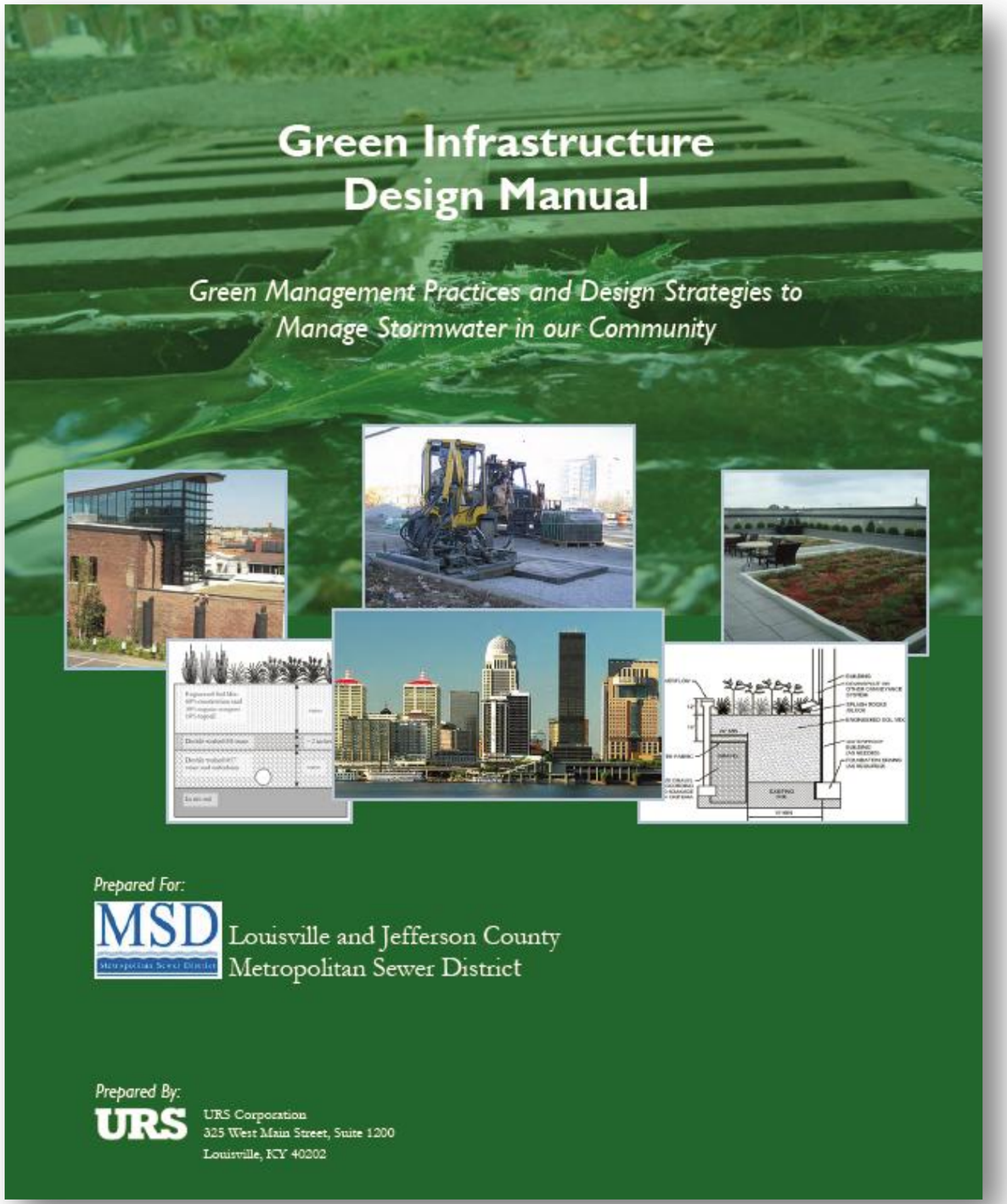
MSD Green Management Approach

- Comprehensive community wide planning
- Practice selection for type and location
- Detailed modeling to determine effectiveness
- State of the art design and construction
- Extensive monitoring of the practice and the system

Green Stormwater Technology

Practice Types

- Downspout disconnection
- Permeable pavement strips
- Tree boxes
- Infiltration trenches
- Bioswales
- Rain gardens
- Urban reforestation
- Underground infiltration/ storage



Green Impact Collaboration –

Answering the Green Infrastructure Questions

First EPA Partnered Community

- Multi-year effort
- EPA monitoring of green management practices
- Evaluate and establish long term trends
- Standardize Design and Maintenance Criteria
- Other Community Benefits
- Partner with University of Louisville

Install/modify monitor locations for combined sewershed calibration

Conduct site feasibility analysis to preliminarily identify GMPs (desktop exercise using aerial imagery and contours)

Confirm preliminary GMP selection (Conduct site visit to assess feasibility of conveying stormwater to GMP, capability to manage stormwater runoff from multiple locations, and if area proposed for GMP is newly constructed/ refurbished)

Assess potential conflicts (KYTC, exst. trees and utilities)

Develop costs for each preliminary GMP based on presumed size, depth and infiltration rate

Use calibrated 2010 Base Model to model each preliminary GMP of combined sewershed for only storm that produces the (y+1)th greatest CSO volume, assuming y is the allowed number of annual CSOs

From model output for each GMP, determine size reduction or elimination of grey if GMP is installed

Using the cost curves for the reduced grey solution, calculate the total project cost (GMP and reduced grey)

Select preliminary GMP and reduced grey combinations that provide less than or equal total project cost as grey solution alone

Perform field measurement of infiltration rate of selected preliminary GMP sites

Are the modeled and field measured infiltration rates >25% different?

Yes

No

Meet with property owners of selected preliminary GMPs to obtain buy in for GMP installation

Yes

Yes

Is grey solution eliminated ?

No

Can the GMPs be modified to reduce their cost/ CSO gallon removed?

No

Using Base Model, model suite of selected GMPs for only storm that produces the (y+1)th greatest CSO volume, assuming y is the allowed number of annual CSOs

Select preliminary suite of GMPs that has lowest cost per CSO gallon removed and is collectively less cost than grey solution alone

From model output, calculate cost/ CSO gallon removed for each GMP

Yes

Using the selected suite of GMPs and reduced/eliminated grey size that are acceptable to the property owners, model entire year using the LTCP Model

Do the model results indicate that the selected suite of GMPs and reduced/ eliminated grey provide the CSO volume and frequency reduction needed to comply with IOAP?

No

Are there other potentially cost effective GMPs to consider?

No

Install monitors to obtain baseline flow data

Conduct design of grey solution

Yes

Install monitors to obtain baseline flow data

Conduct design of selected suite of GMPs and any reduced grey solution

Green Management Practice Placement and Design Process

Gray to Green Right Sizing Trend

Not Cost Effective

Gray Storage Practice

Success

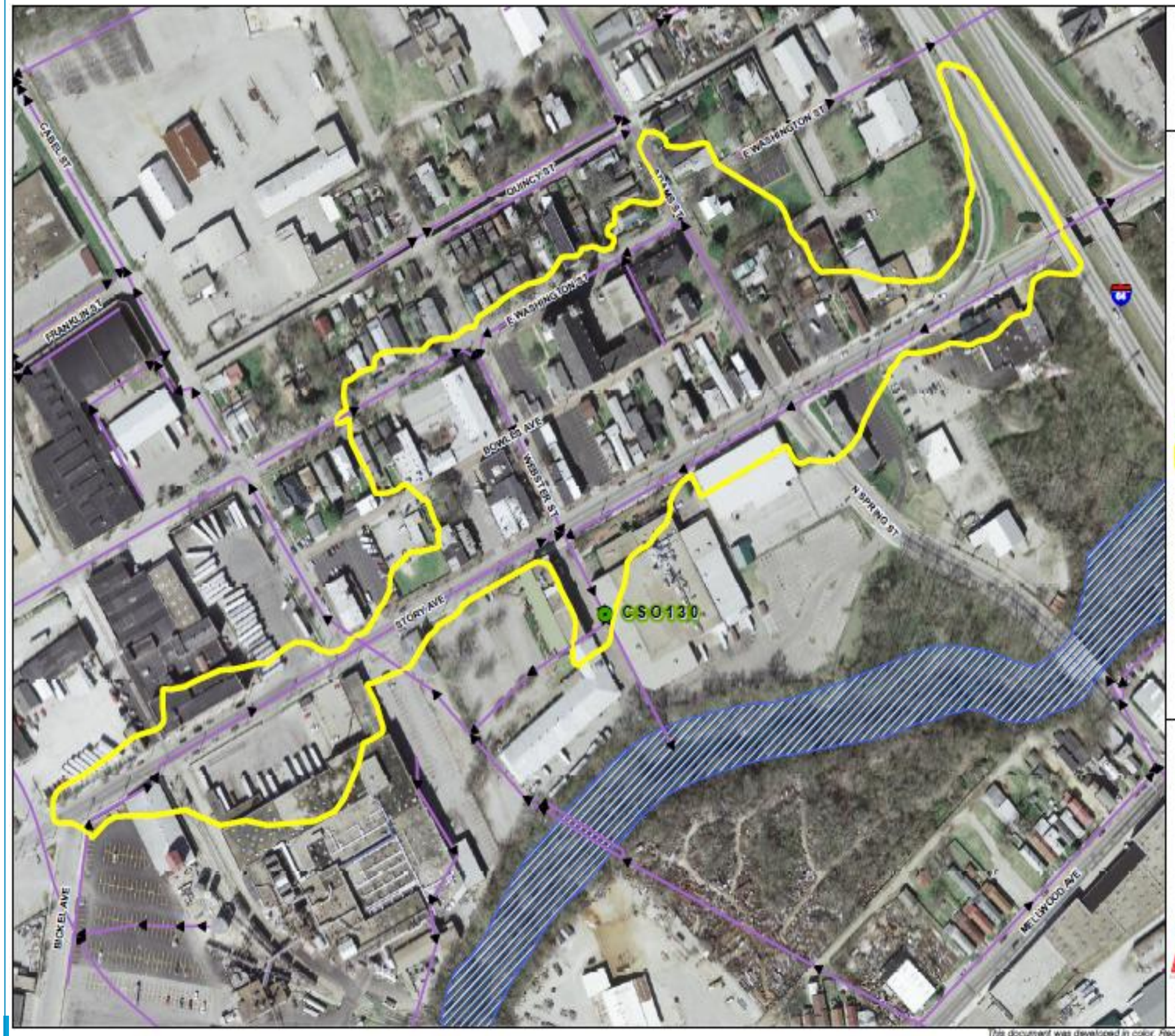
Incremental Cost Comparison

Green Project Suites

Cost (Million $)

Overflow Reduction (MG)

CSO 130
Project Area Map



Legend

- Active CSO
- Combined Sewer Pipe
- Floodway
- CSO 130 Drainage Boundary

1 inch = 175 feet
Scalable when printed on 11" X 17" paper

Some boundaries are uniquely symbolized within the map.

Map Revision
November 1, 2011

Aerial Date: 2007

N

LOJIC MSD PROJECT WIN

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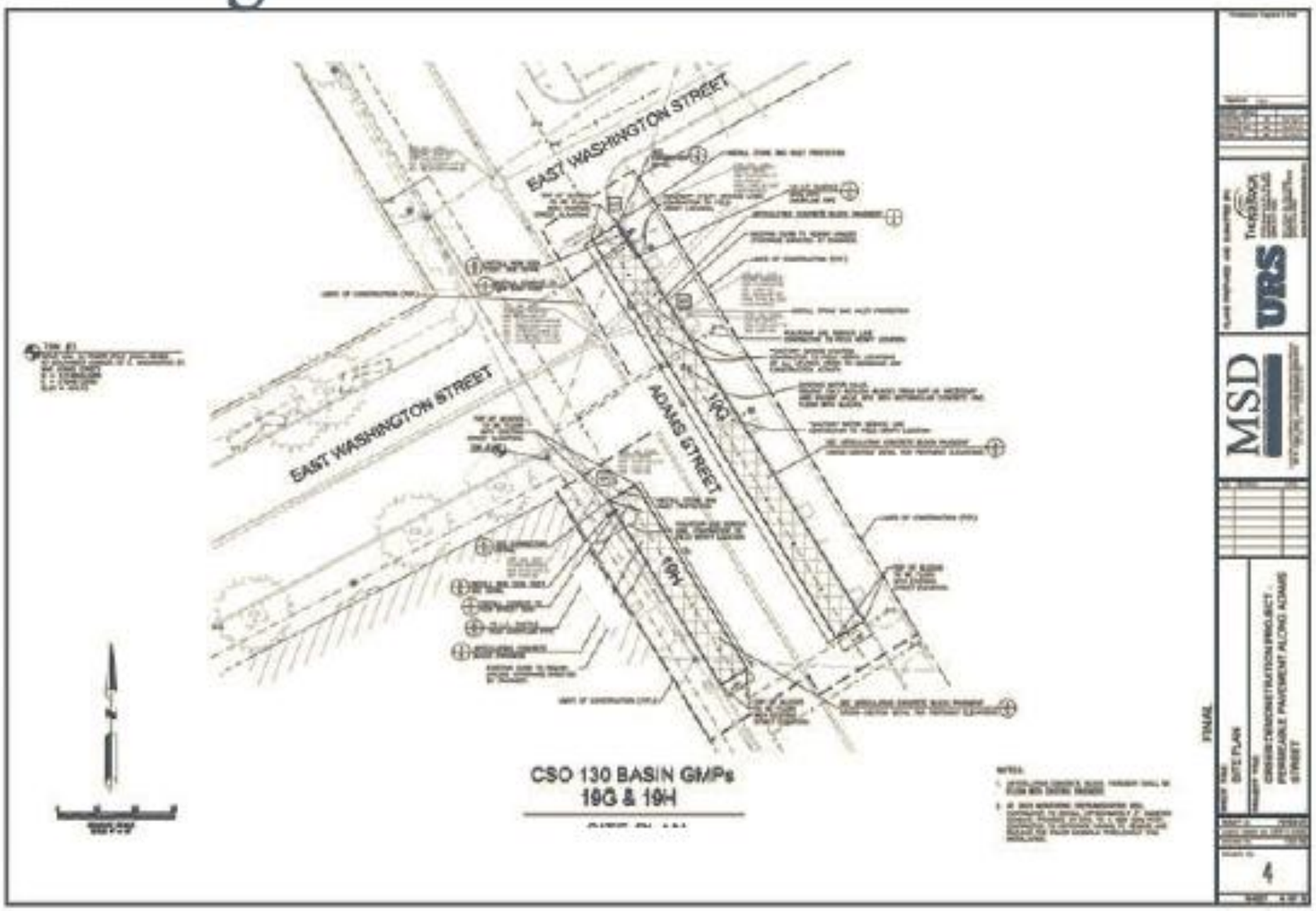
Butchertown Neighborhood Results

OPTION APPROACH	OVERFLOW VOLUME	NUMBER OF OVERFLOWS PER YEAR	20-YR LIFECYCLE COST
Gray Only	0.67 MG	8	$1,717,653
Green Only	0.28 MG	8	$938,000

20-yr life cycle costs include: planning, design, construction, treatment, and maintenance over a 20-yr period.

Two articulated paver strips were installed at the corner of East Washington and Adams Streets in Louisville, KY, during Dec. 2011.

EPA
United States
Environmental Protection
Agency



MSD URS UofL

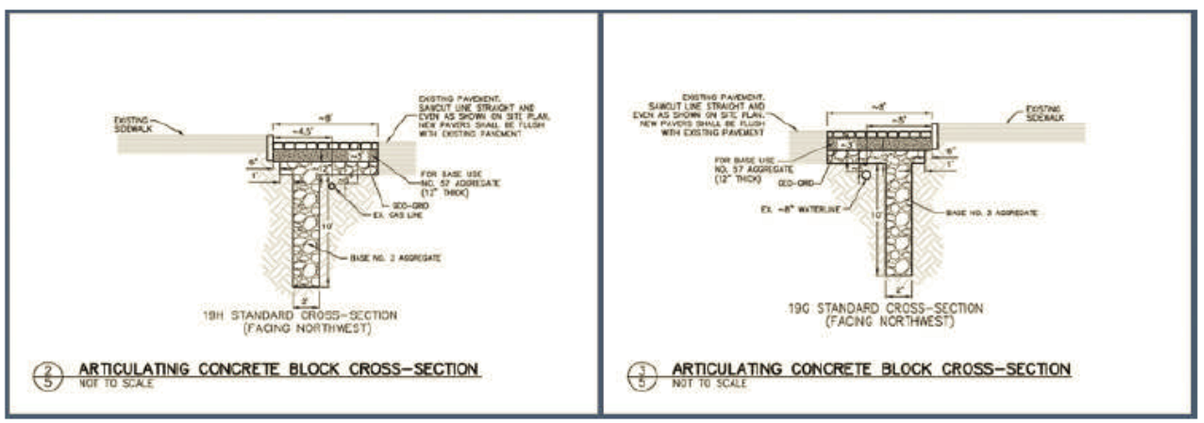

CAUTION
CAUTION
CAUTION
3212

Within CSO 130, permeable pavement is the preferred technique .

EPA United States Environmental Protection Agency

The limited publically-owned property and generally narrow sidewalks forced the controls into the streets.

Off-center trenches were installed to access soil with higher hydraulic conductivity and avoid existing utilities.

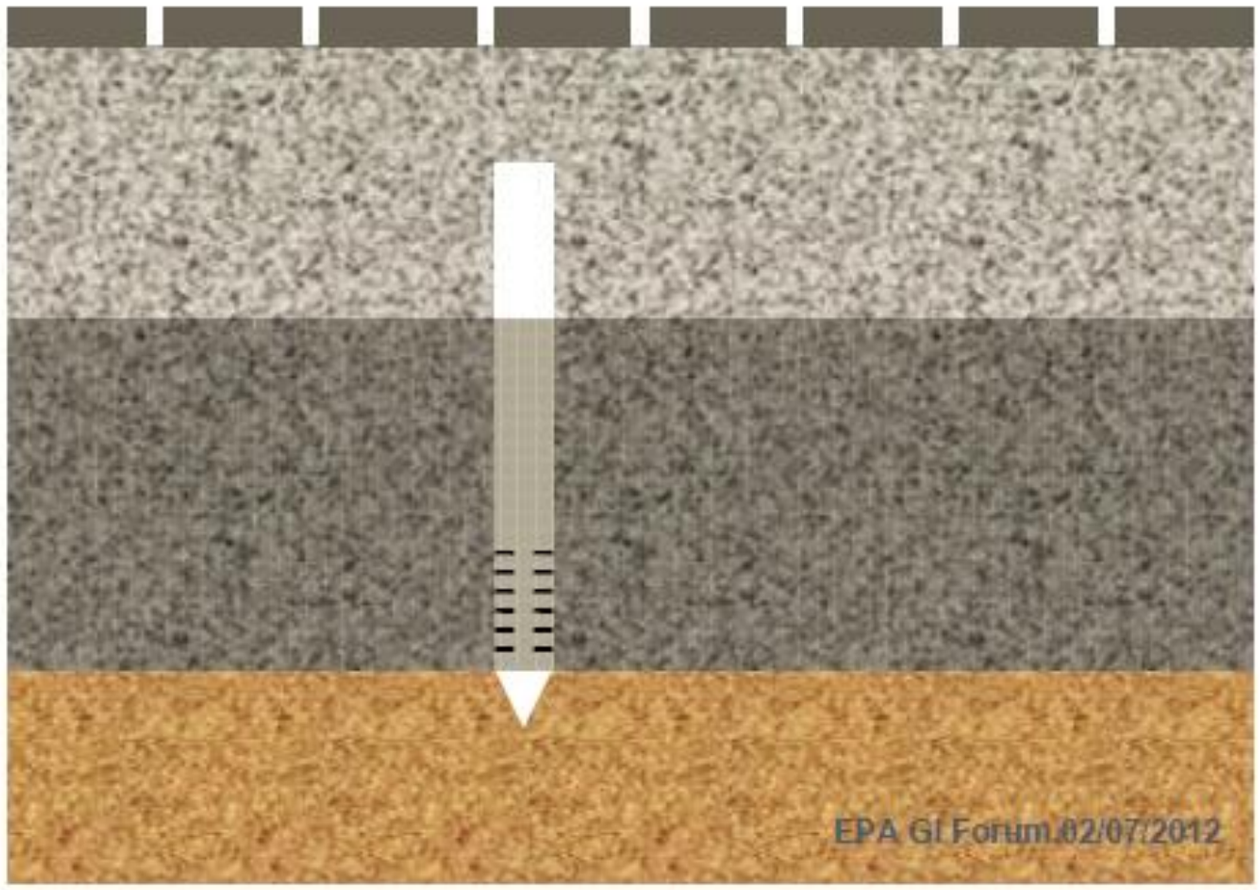


MSD URS UL

We installed the pressure transducers in the piezometers to measure the accumulation and infiltration (rise and fall) of captured water

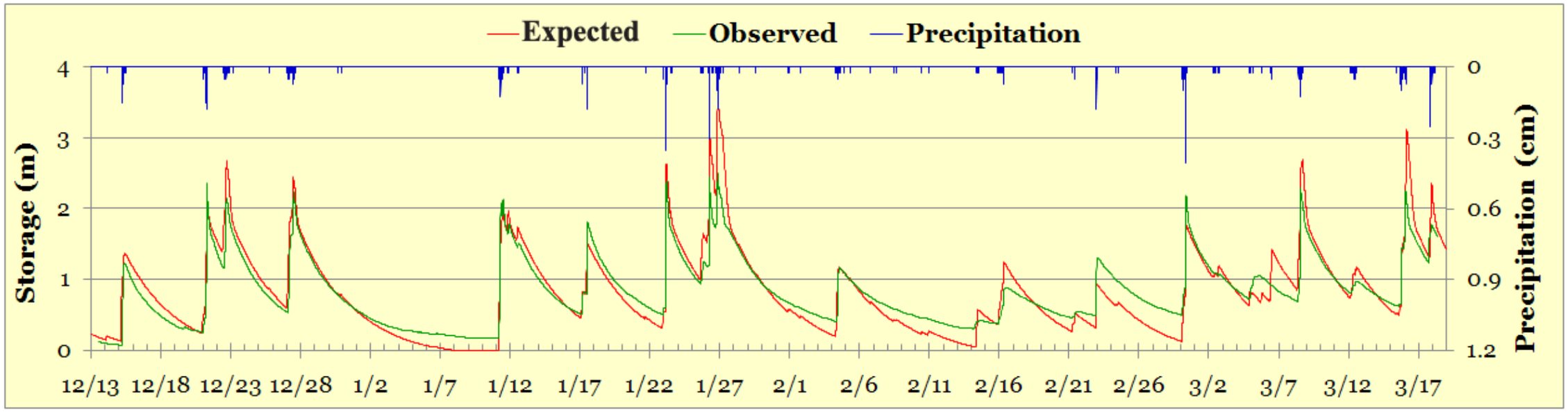
The fill rate is controlled by rainfall intensity while drain is controlled by saturated infiltration rate.

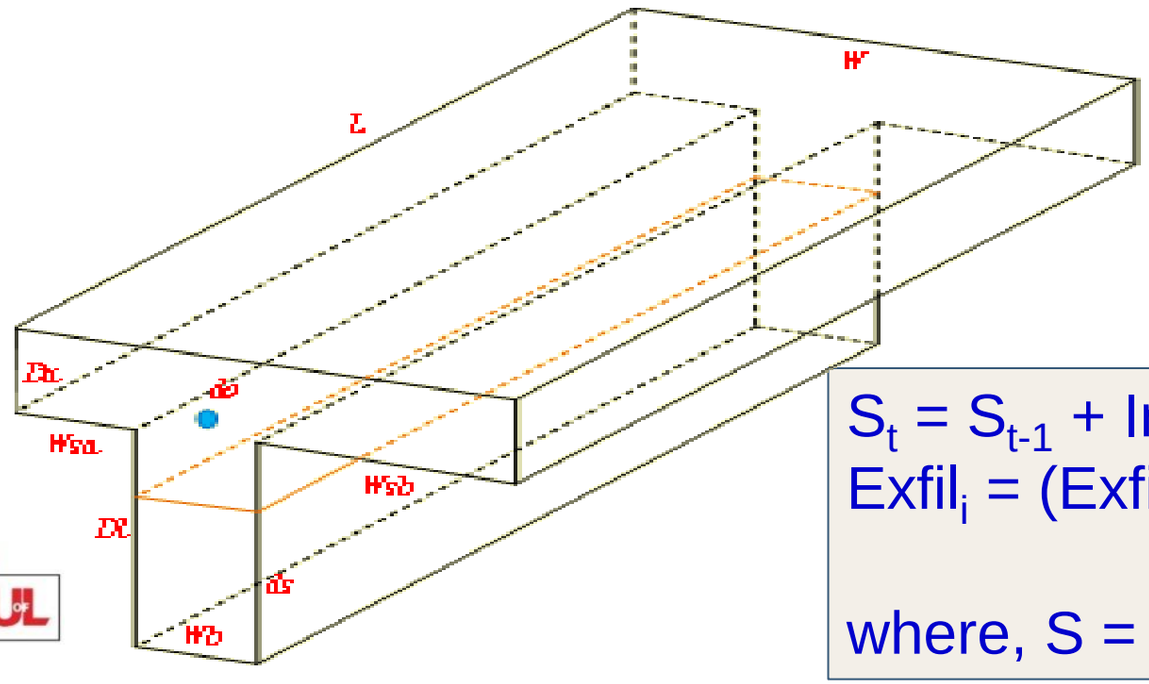
Depth (volume) is controlled by depth of rainfall and porosity (and infiltration during event and dimensions).



Monitoring

Green Management Practices are working as expected and are in good agreement with modeled performance

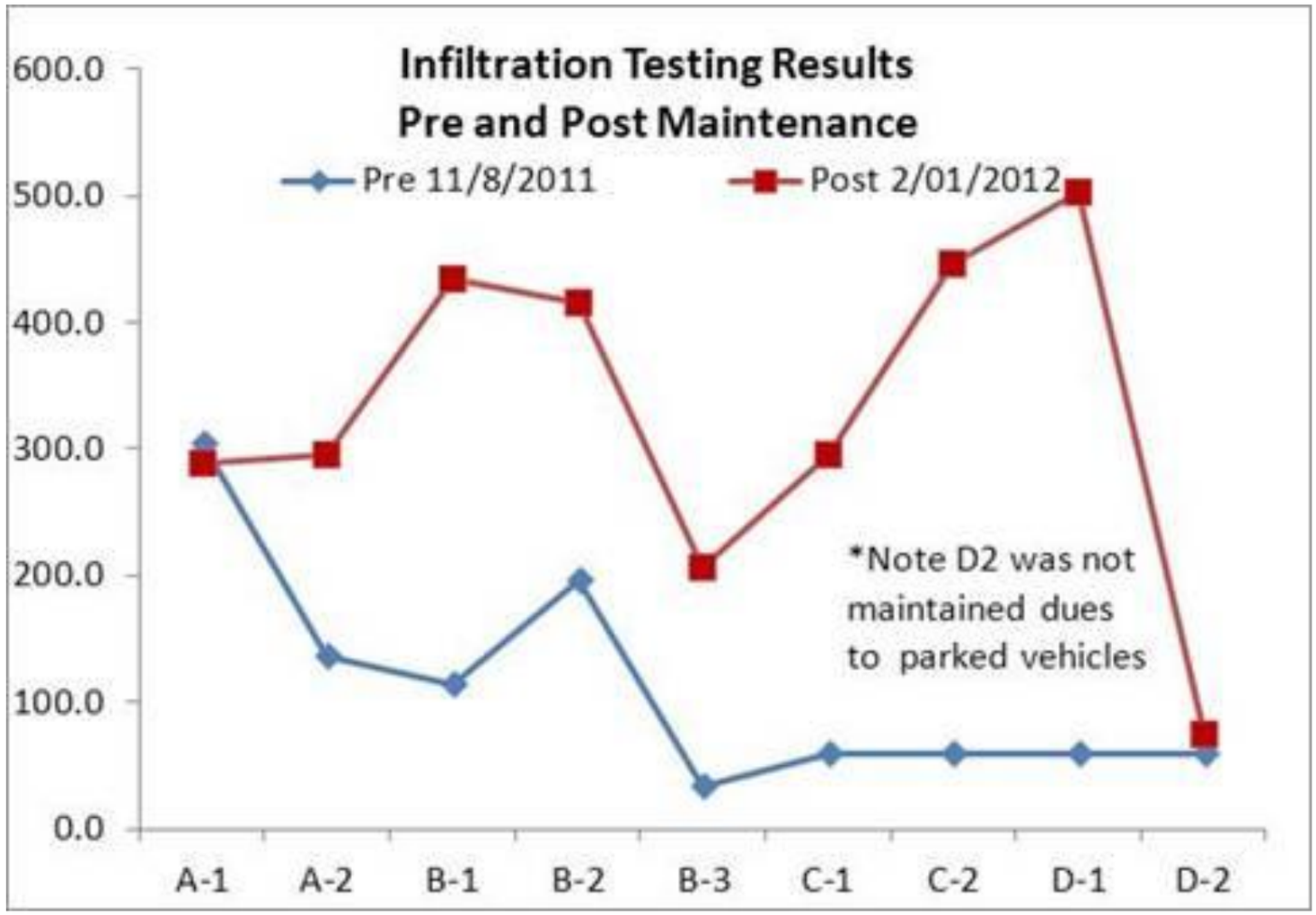




$S_t = S_{t-1} + \text{Inflow} - \sum(\text{Exfil})_i - \text{Overflow} - \text{Bypass}$

$\text{Exfil}_i = (\text{Exfil rate})_i \times (\text{Exfil area})$

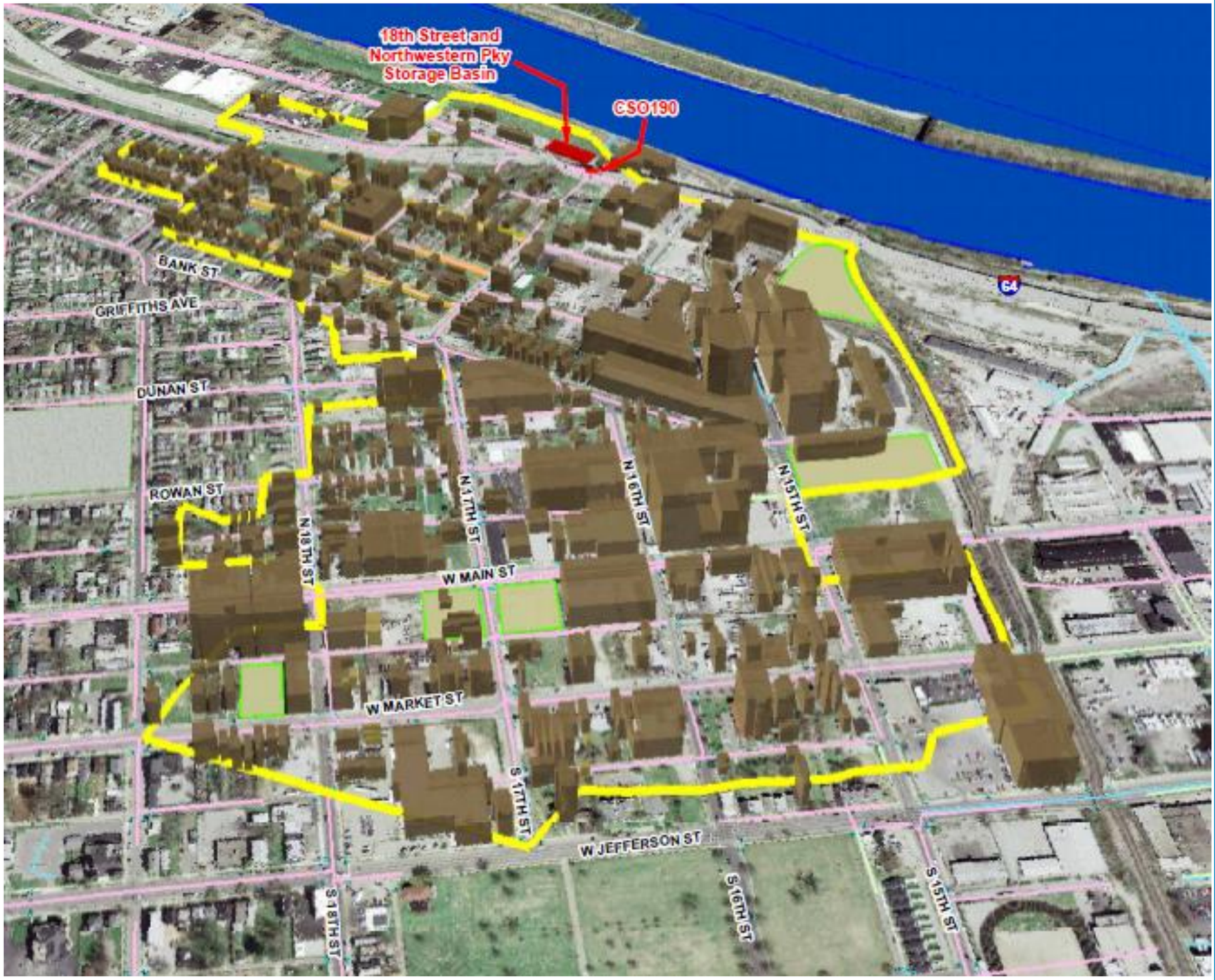
where, S = storage and Exfil = Exfiltration.


Infiltration Testing Results
Pre and Post Maintenance
Pre 11/8/2011
Post 2/01/2012
*Note D2 was not maintained dues to parked vehicles
600.0
500.0
400.0
300.0
200.0
100.0
0.0
A-1
A-2
B-1
B-2
B-3
C-1
C-2
D-1
D-2


A1
A2
B1
B2
B3
C1
C2
D1
D2
CEDAR ST
S 7th
S 6TH ST
W MUHAMMAD ALI BLVD
OFFICE OF EMPLOYMENT AND TRAINING
ASPHALT PAVEMENT MILLING (1.5 INCH DEPTH)
ASPHALT PAVEMENT REMOVAL
ASPHALT ISLAND REMOVAL
EXISTING CONTOUR ELEVATIONS

Portland Neighborhood Traditional Solution

- 145 acre drainage area
- Average annual discharge: 36 million gallons of combined sewage and 52 overflows
- 1.5 million gallon storage basin proposed
- Consent decree requires discharge volume reduced to 3.65 million gallons annually, and overflows of 8 (typical yr.)



Portland Green Evaluation

OPTION APPROACH	OVERFLOW VOLUME	NUMBER OF OVERFLOWS PER YEAR	20-YR LIFECYCLE COST
Gray Only	3.65 MG	8	$5.7 M
Green Only	0.70 MG	8	$4.7 M
Green with Community Enhancements	0.70 MG	8	$5.0 M

20-yr life cycle costs include: planning, design, construction, treatment, and maintenance over a 20-yr period.

Green Impact Collaboration –

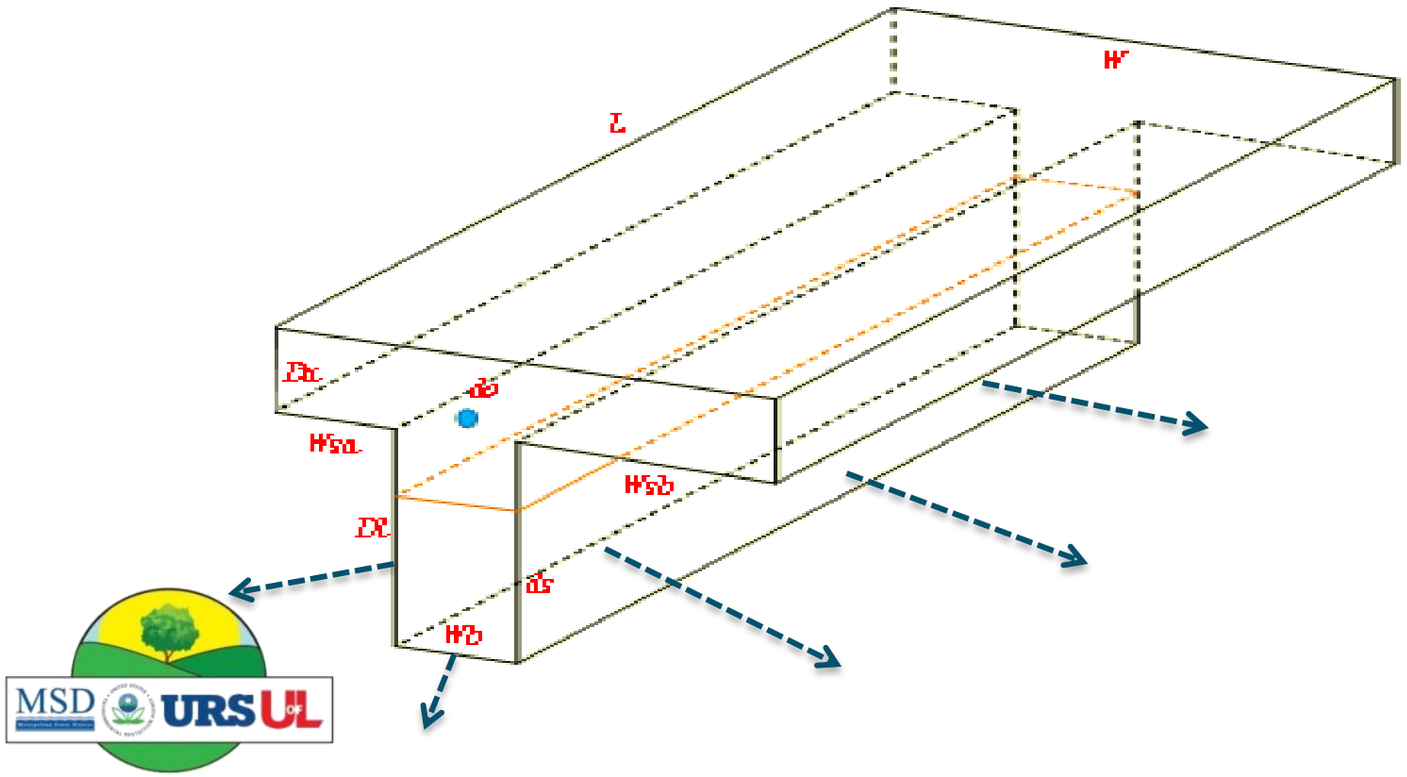
Answering the Green Infrastructure Questions

University of Louisville

- Provide monitoring and installation assistance
- Evaluate data and quantify performance
- Enhance U of L campus with green management practices
- Drainage and flood reduction
- Improved water quality
- Comprehensive green planning for college campus

Measuring Performance

- Surface Infiltration
  - Clogging patterns
- Subsurface infiltration
  - Soil infiltration capacity

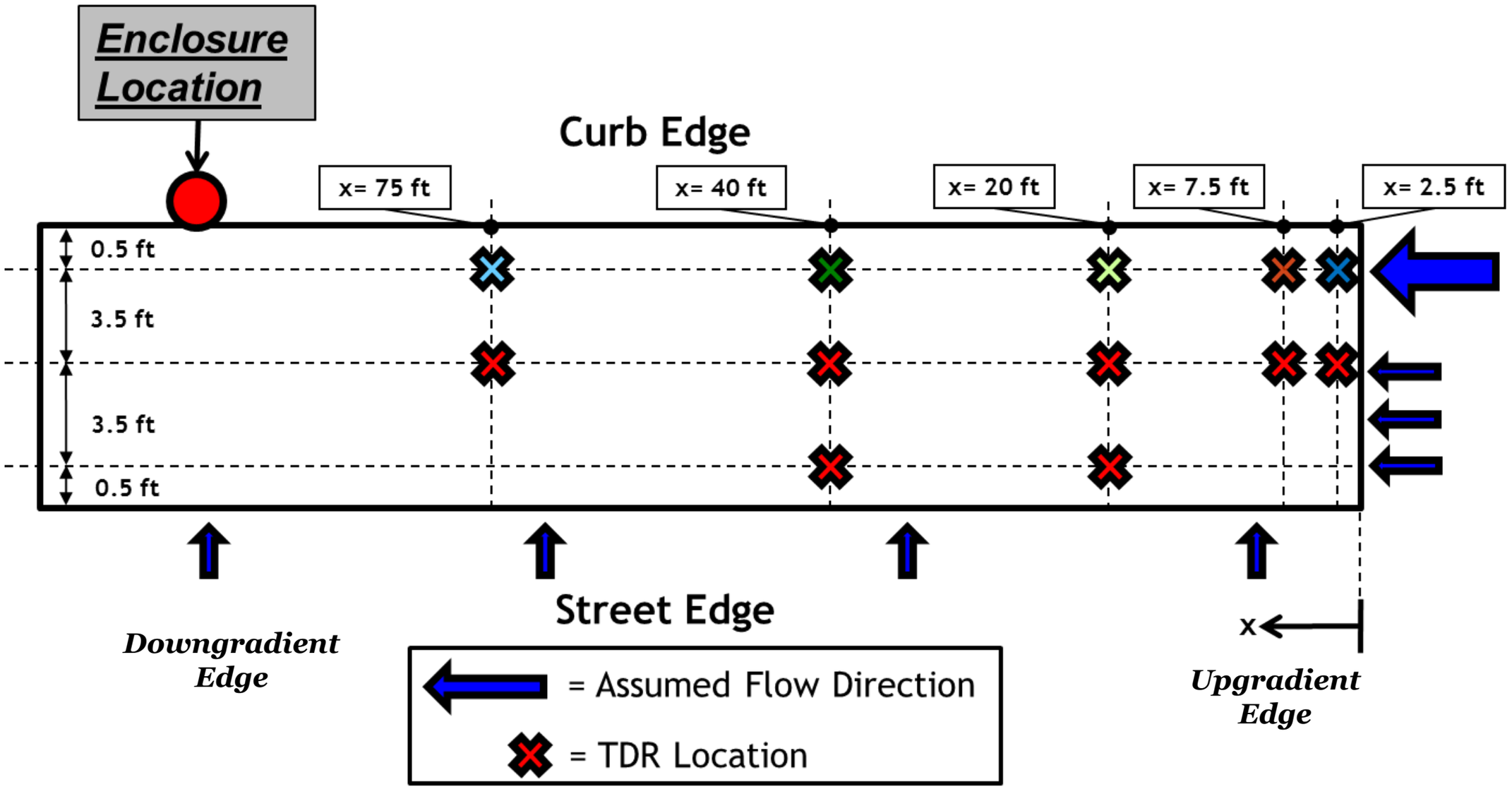


Surface Infiltration

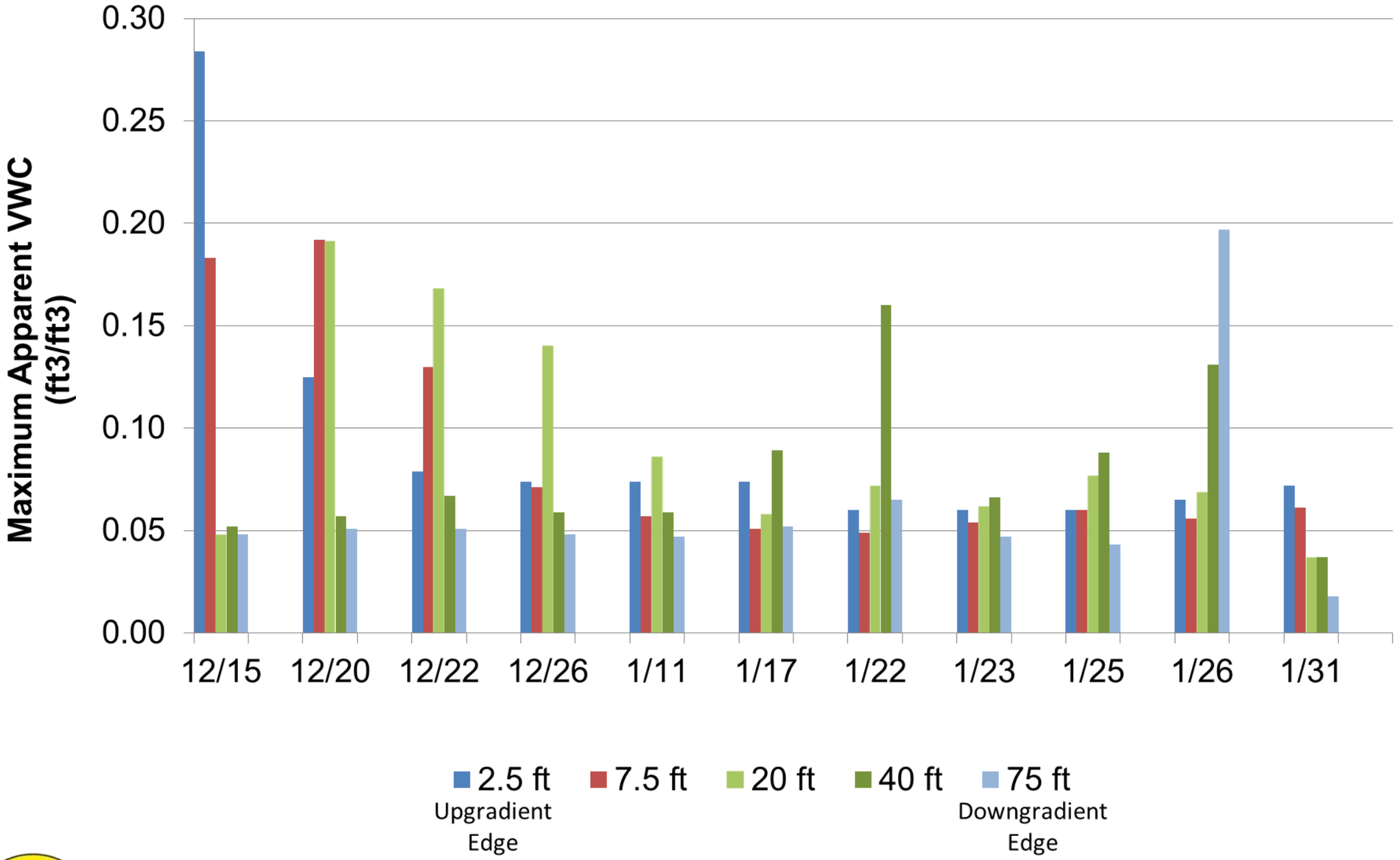
- Embedded equipment : Time Domain Reflectometers (TDRs)

- Quarterly surface infiltration testing

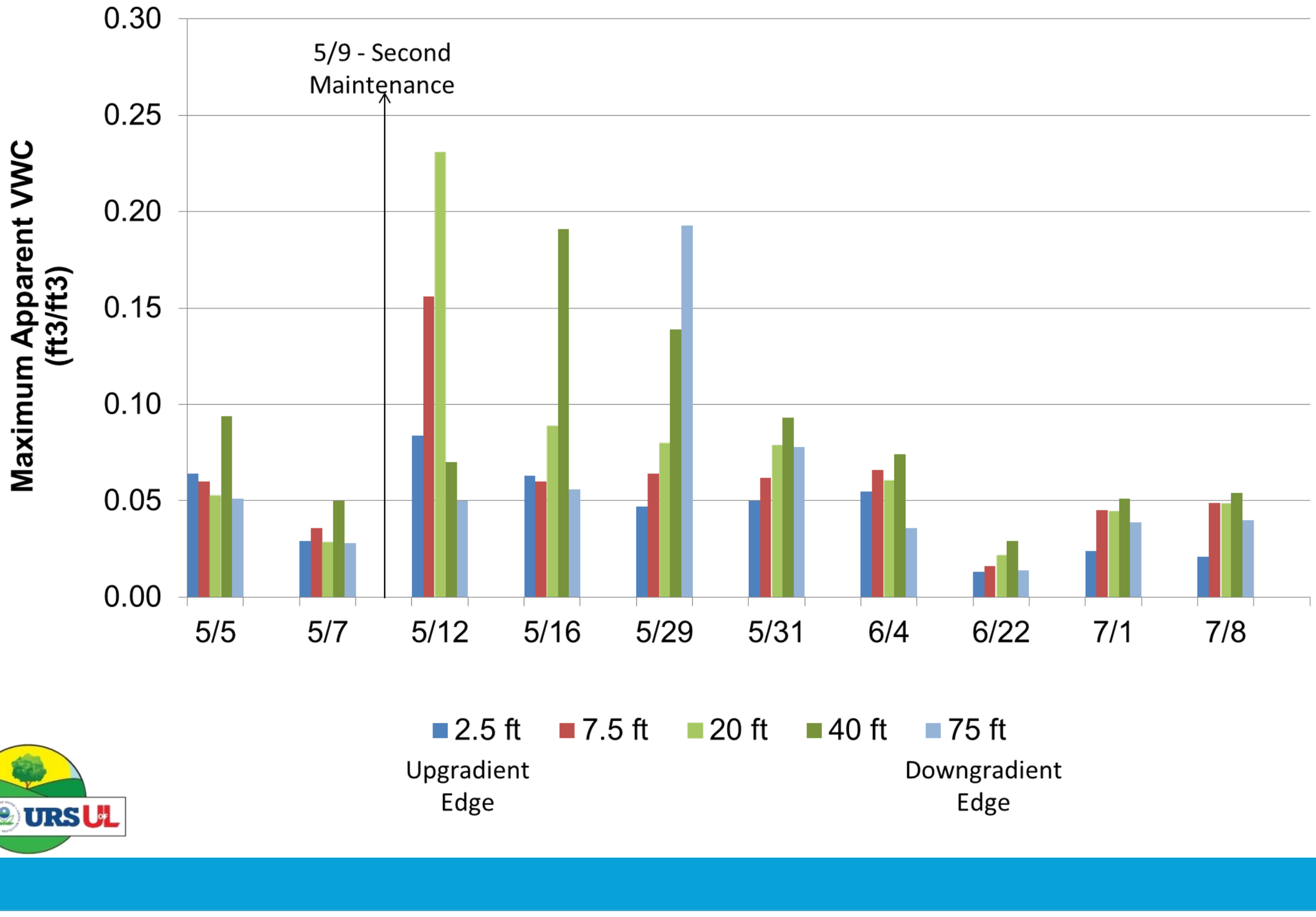
- Overview of TDR Location 19G



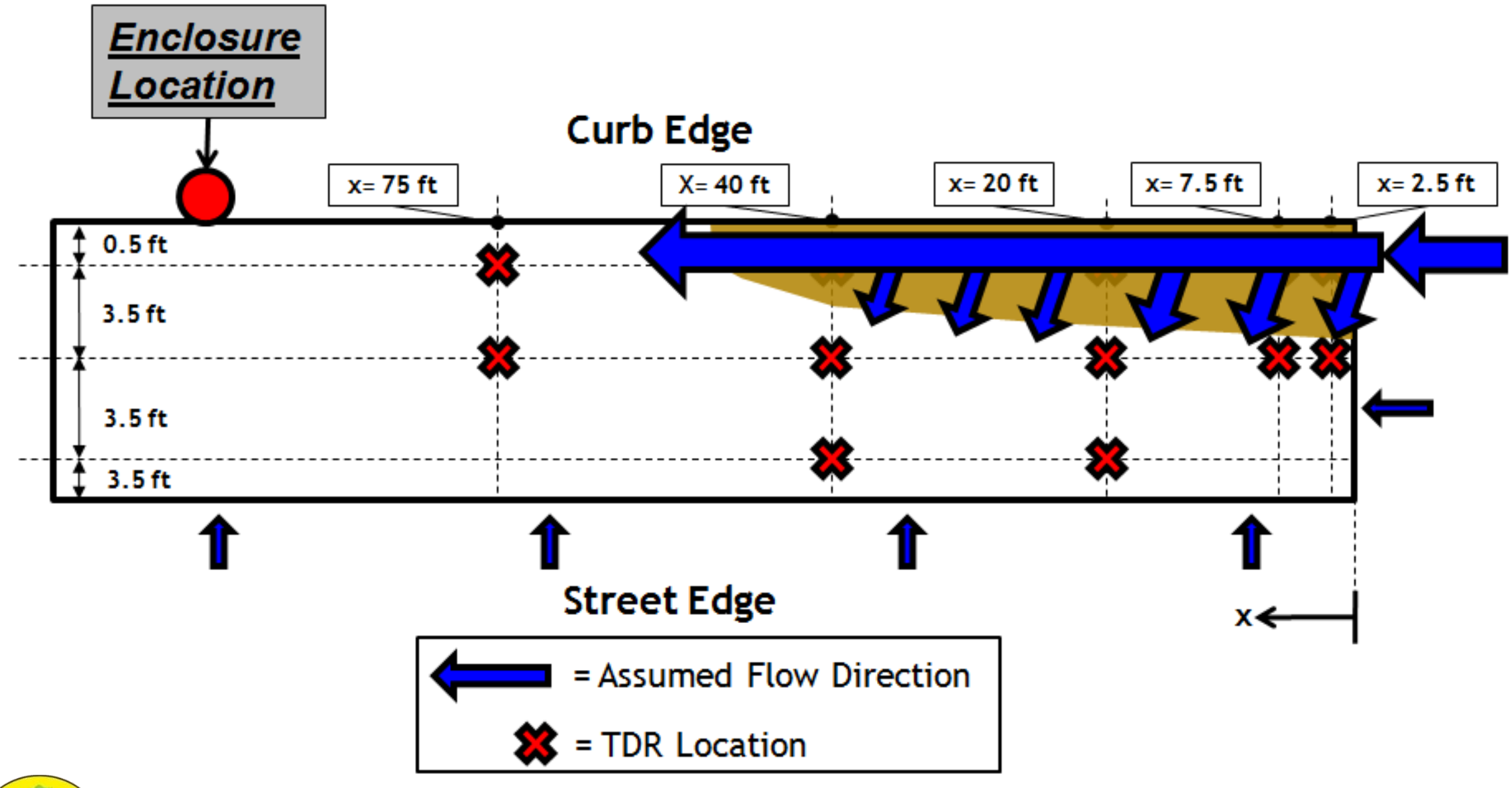
Initial Clogging Progression
Curb-Edge TDRs in 19G



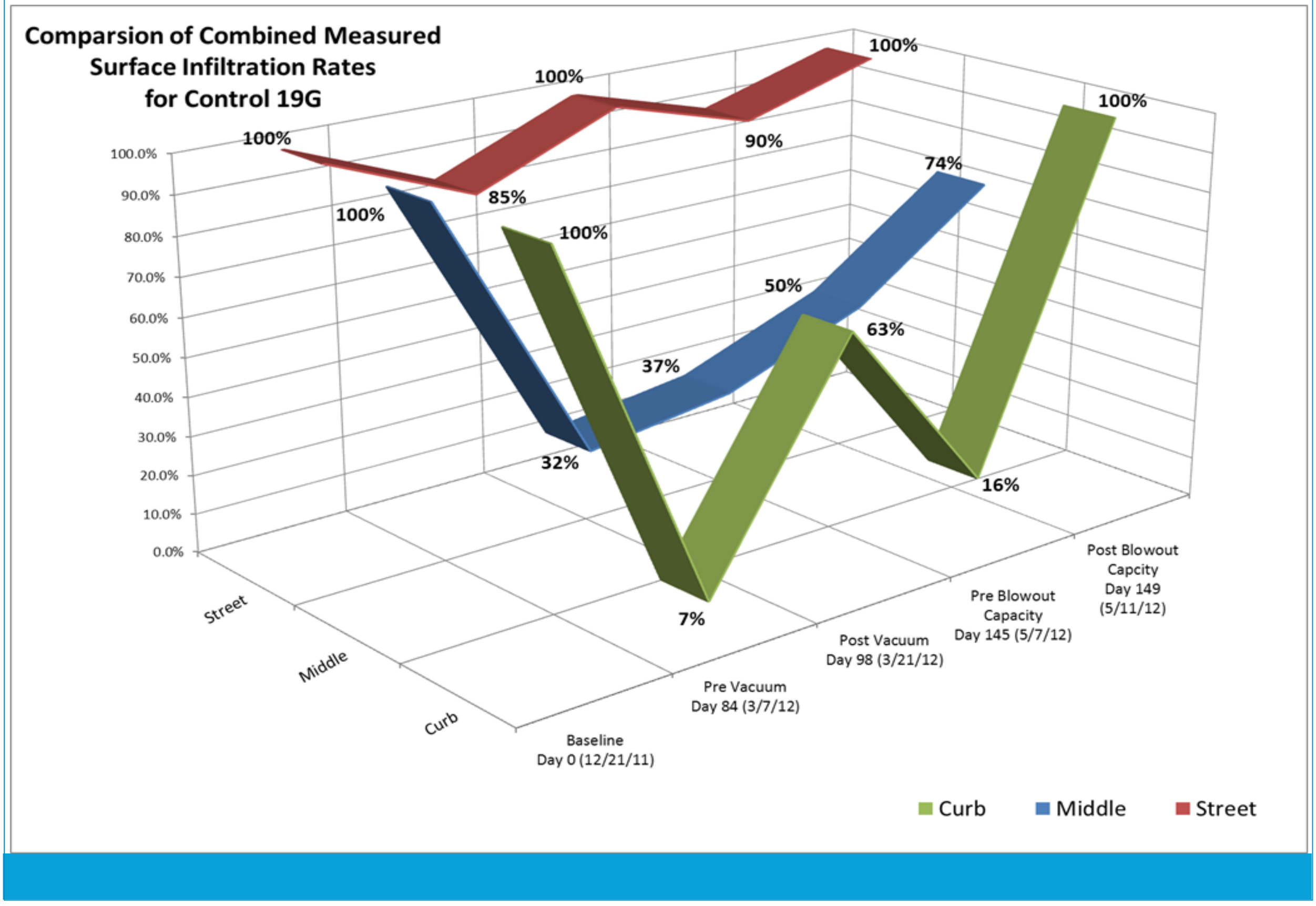
Following Maintenance Clogging Progression
Curb-Edge TDRs in 19G



Visual Representation of Clogging Progression
Curb-Edge TDRs in 19G

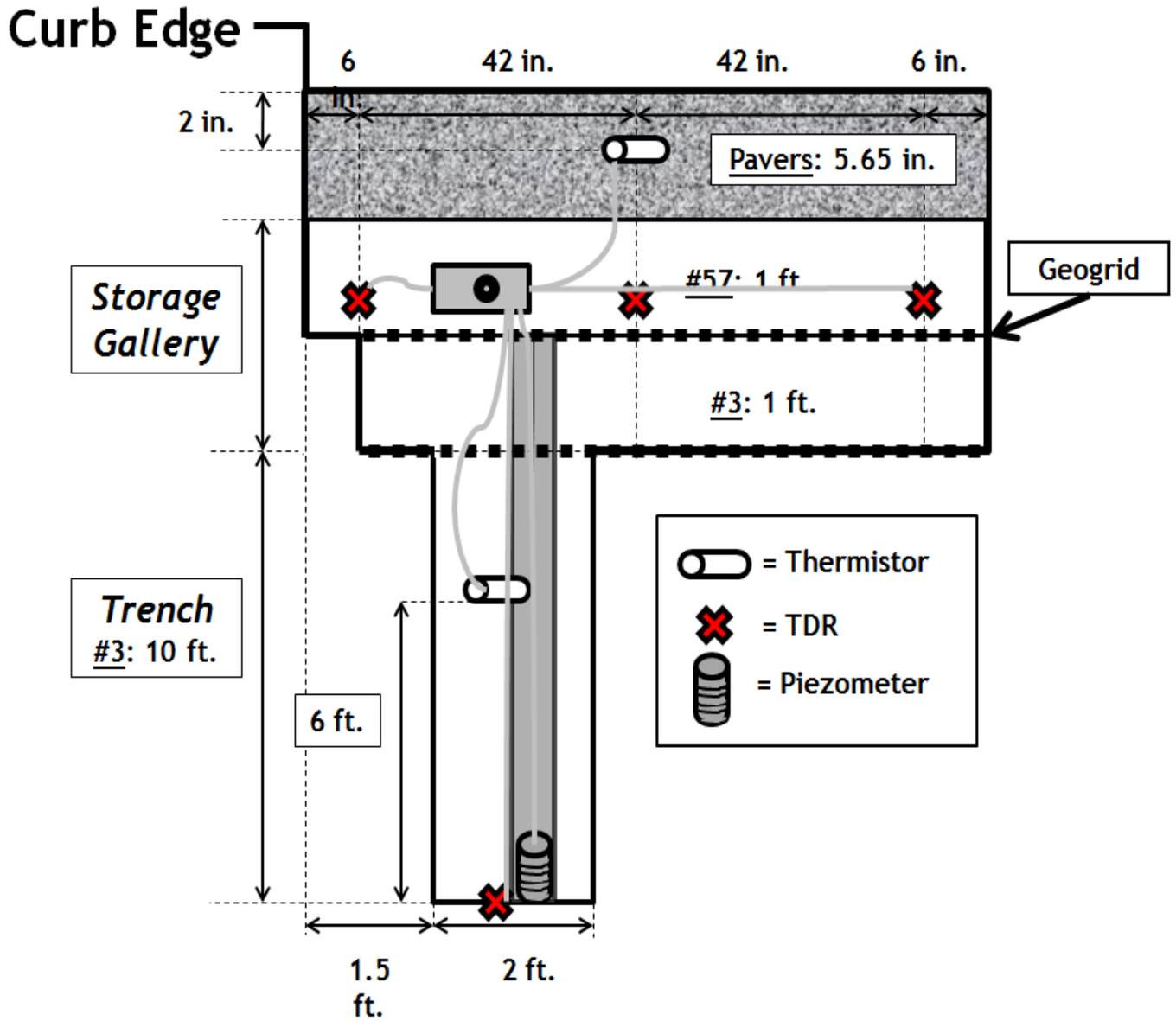


Field Validation



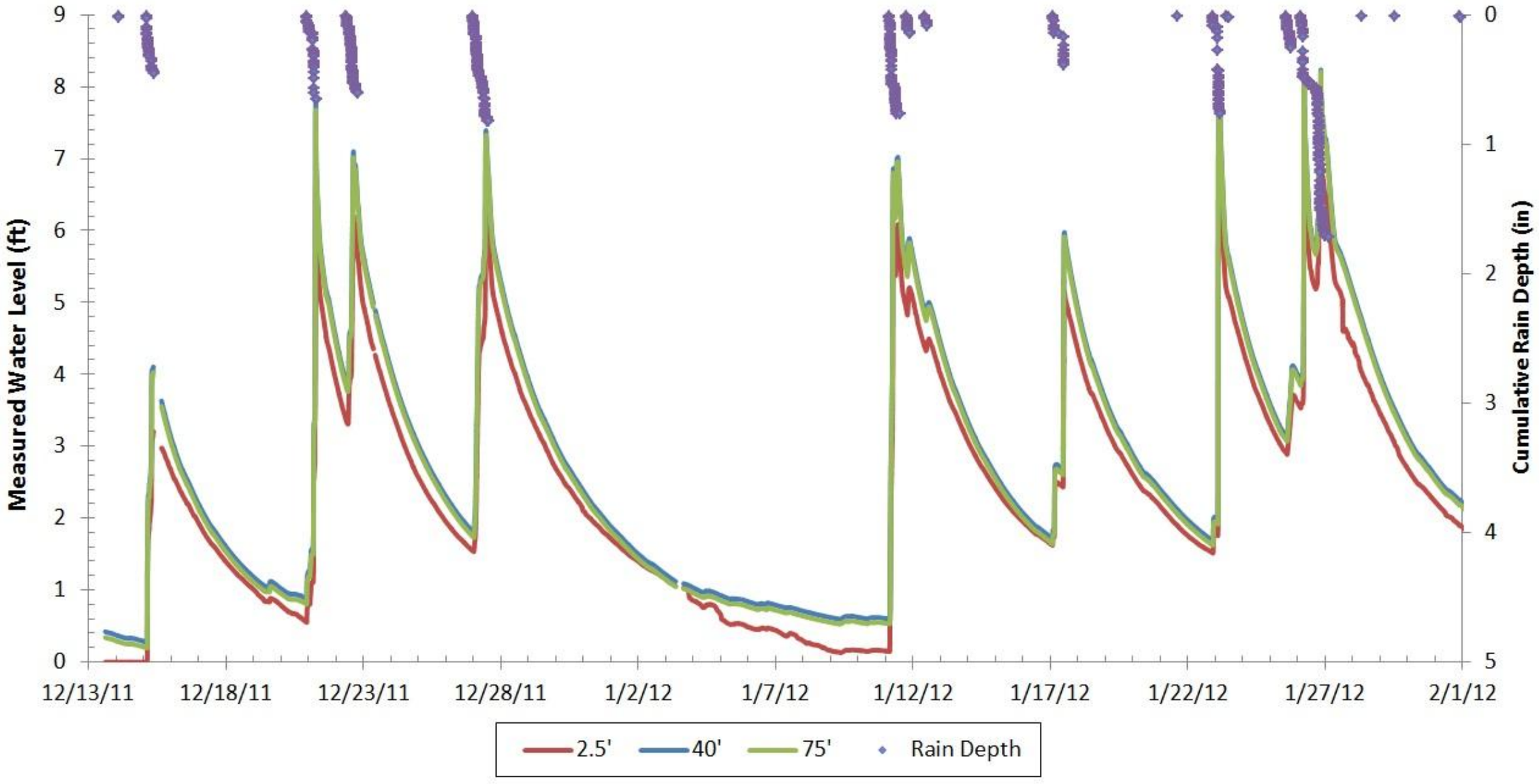
Subsurface Infiltration

- Limited to Embedded equipment :
  - Piezometer
  - Pressure transducers

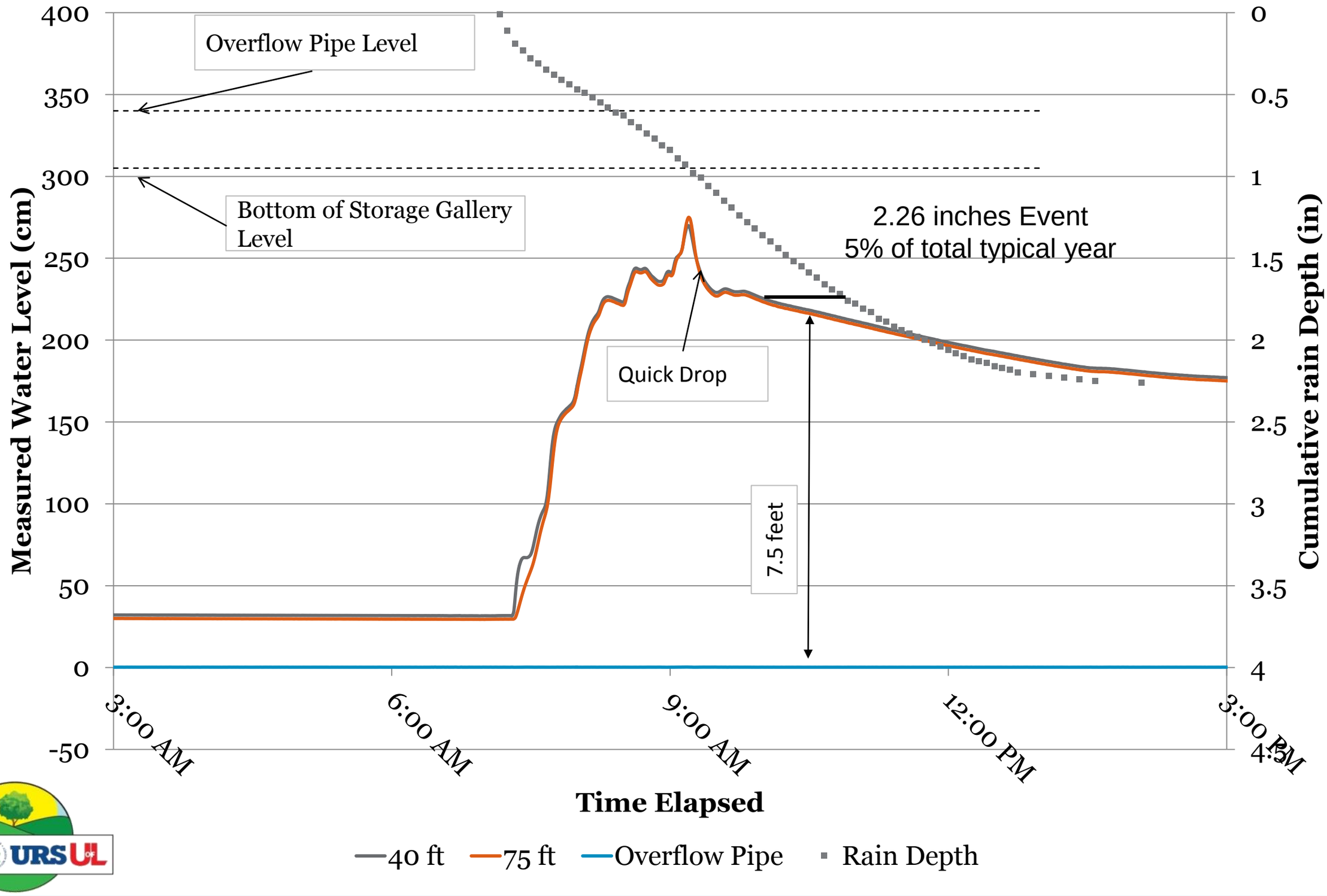


Measuring Storage Gallery Water Level

Control 19G



Single Rain Event Infiltration Performance



Path Forward

- Seasonal effects of the BMP
- One year data
- Maintenance
- Completion of the CSO130 constructions
- Start of CSO190 project

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