



P4 INFRASTRUCTURE



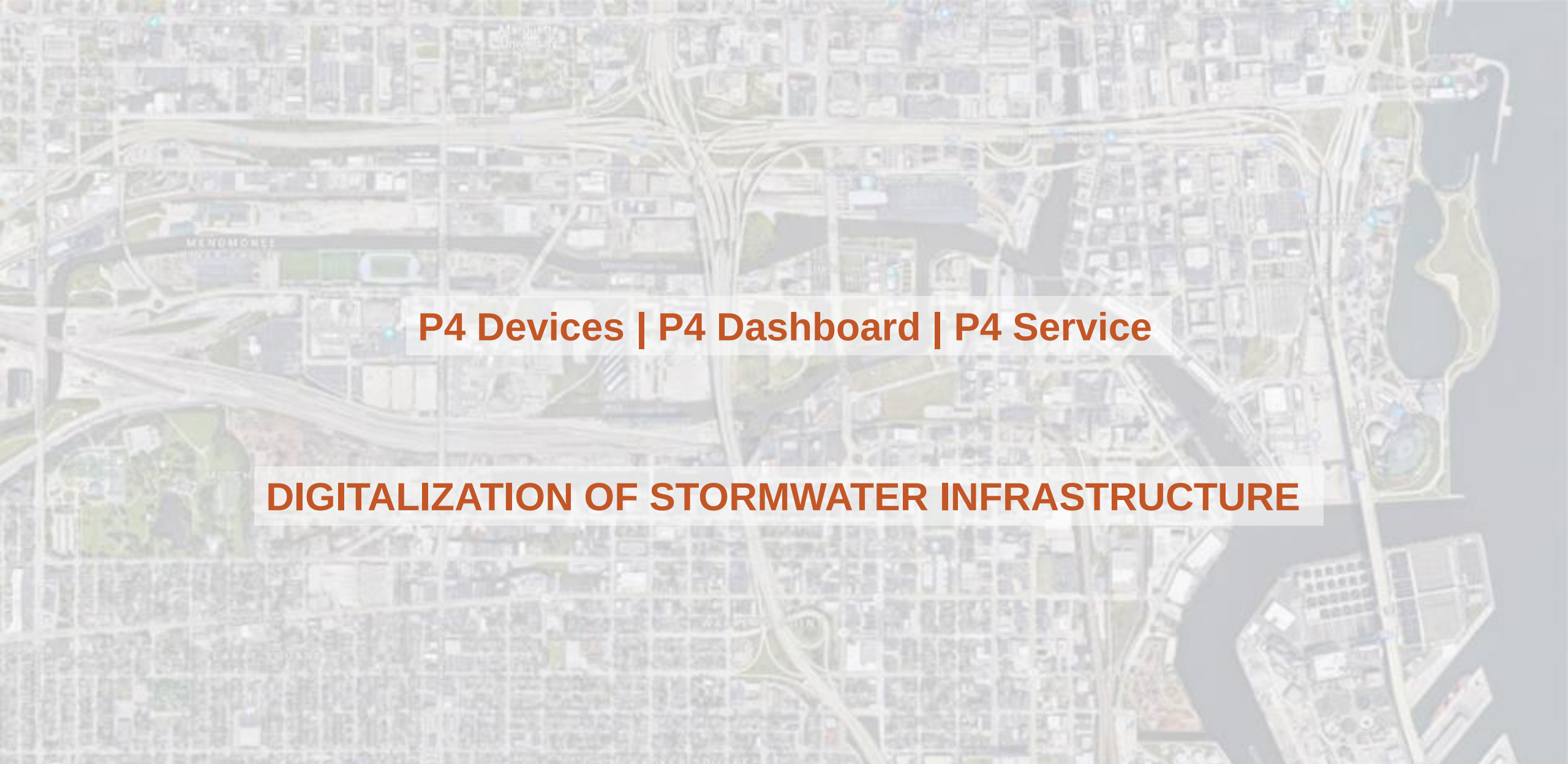
Digitalization of Stormwater Infrastructure

Fox-Wolf Watershed Conference
February 27, 2024

Joseph Diekfuss, PhD, PE
Vice President – Engineered Systems
Christopher M. Foley, PhD, PE, FASCE
President

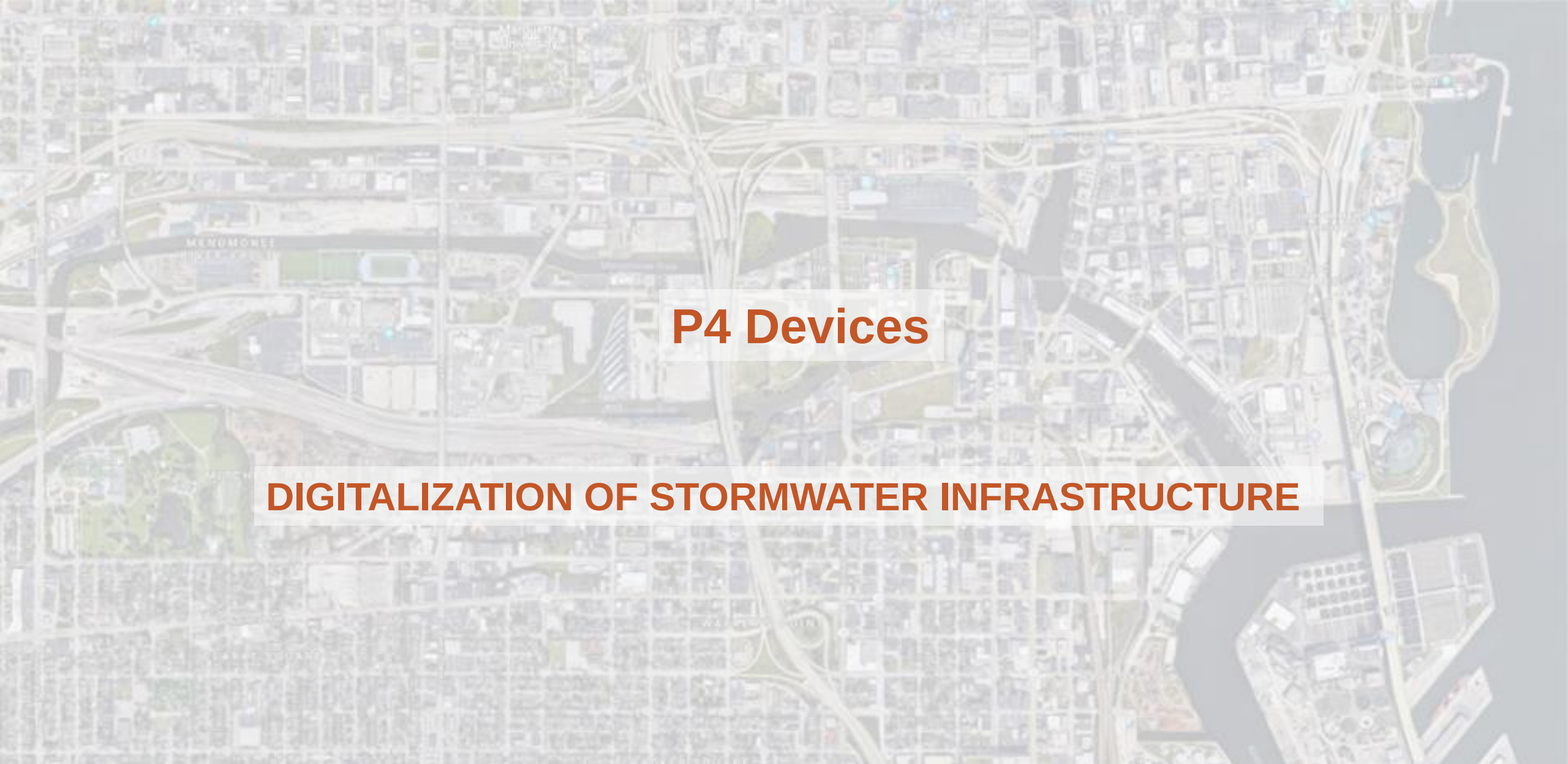
Nicholas J. Hornyak, PhD, PE
Vice President – Sensor Technology

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Brown Deer, WI 53233
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P4 Devices | P4 Dashboard | P4 Service

DIGITALIZATION OF STORMWATER INFRASTRUCTURE



P4 Devices

DIGITALIZATION OF STORMWATER INFRASTRUCTURE

Rain-mX



LIQUA-Level



INFIL-Tracker PaveDrain INFIL-Tracker Paver



Flow-RTC



DEPTH



Curated Data:

- Wireless Transmission (cellular or Wi-Fi)
- Common Storage
- Browser-Based Access
- Downloadable
- Dashboard Viewing

Power & Maintenance

- Battery Powered (solar re-charged) or Line Power
- Plug-and-Play Components
- Long-Term Battery Life
- Minimal Maintenance Interventions

CamVIEW



SoilSENSE



AVFM

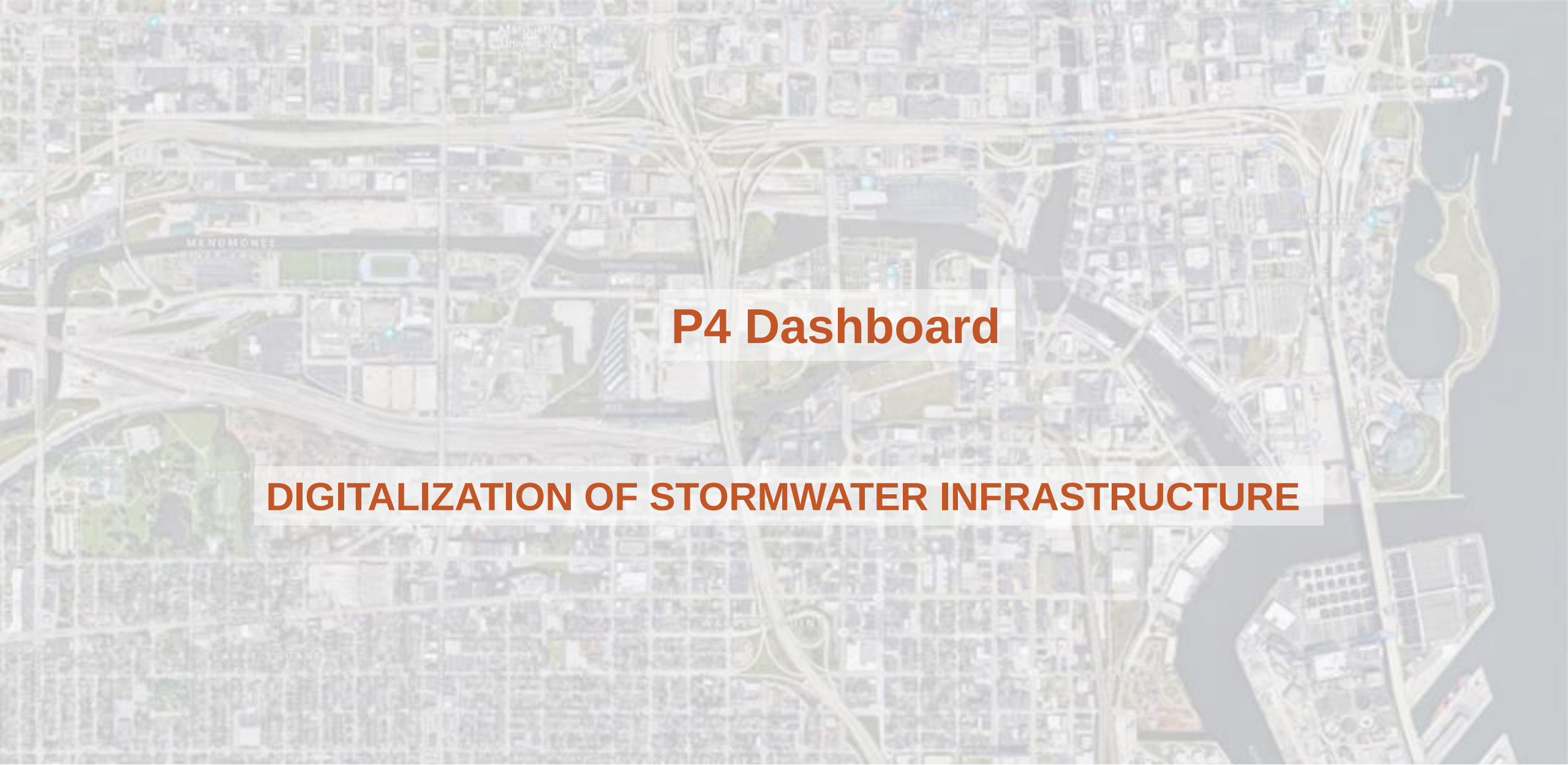


LIQUA-Level EPC



VELO





P4 Dashboard

DIGITALIZATION OF STORMWATER INFRASTRUCTURE

Basic viewing and downloading of data is available as soon as device is turned on.

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ASCE

ASCE - Liqua-Level Ch. 2

ASCE - LiquaLevel

ASCE Rain-mX

Cudahy

Cudahy - INFIL-Tracker - Squire

Cudahy - INFIL-Tracker - VanNorm

Cudahy - Rain mX

Demo Site

Appleton - LIQUA-Level

Appleton - Rain mX

Beaver Court - Rain-mX

Cudahy - INFIL-Tracker - Squire

Cudahy - INFIL-Tracker - VanNorm

Cudahy - Rain mX

Cudahy - Rain mX - Rain Only

EMCO - PGC - IT #3

EMCO

EMCO - PGC - IT #3

EMCO - PGC - Rain mX #2

EMCO - PGC - Rain mX #3

Gilbane - MKE City Hall

P4 Data_Cudahy - Rain mX_2023-01-20_2023-02-23

Joseph Diekfuss

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Texas

Arkansas

Oklahoma

Nebraska

Kansas

Colorado

Utah

Idaho

Montana

Wyoming

North Dakota

South Dakota

Minnesota

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2/26/2024

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P4 Devices | P4 Dashboard | P4 Service



P4 INFRASTRUCTURE

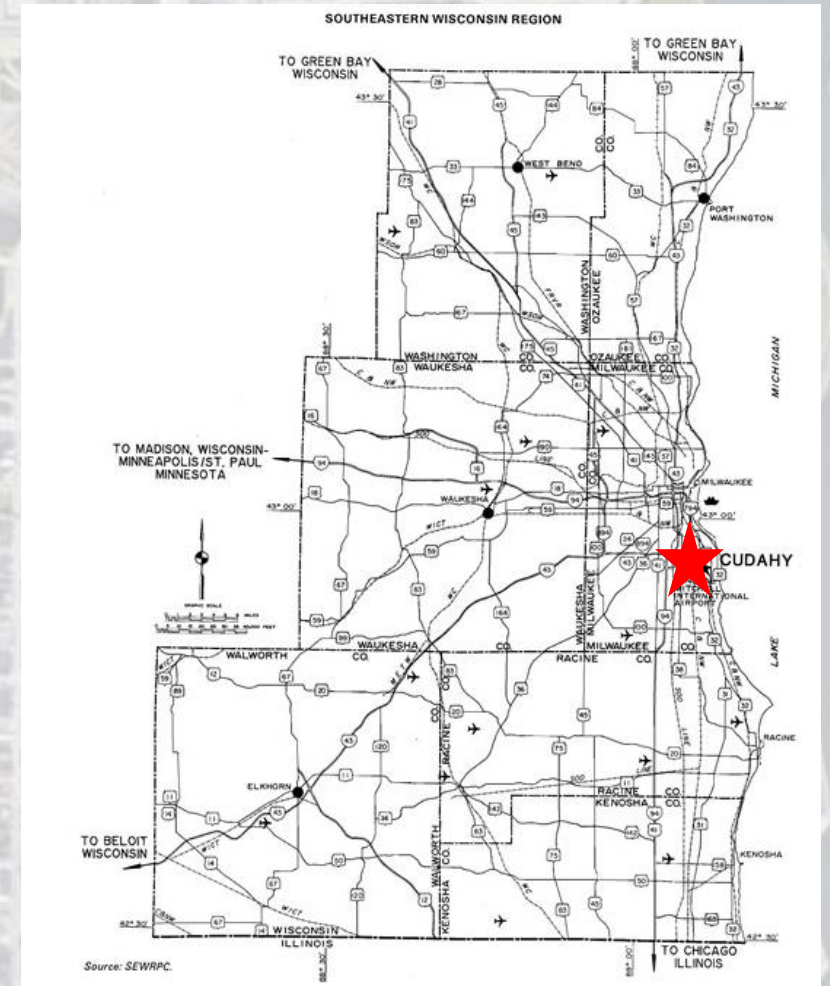


P4 Service

DIGITALIZATION OF STORMWATER INFRASTRUCTURE

Cudahy Case Study

- 150-year-old City in southeastern Wisconsin
- Highly urbanized
- MS4 and TMDL community



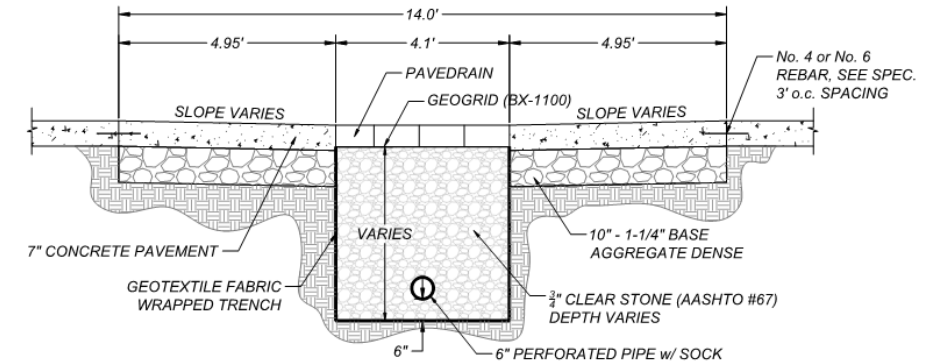
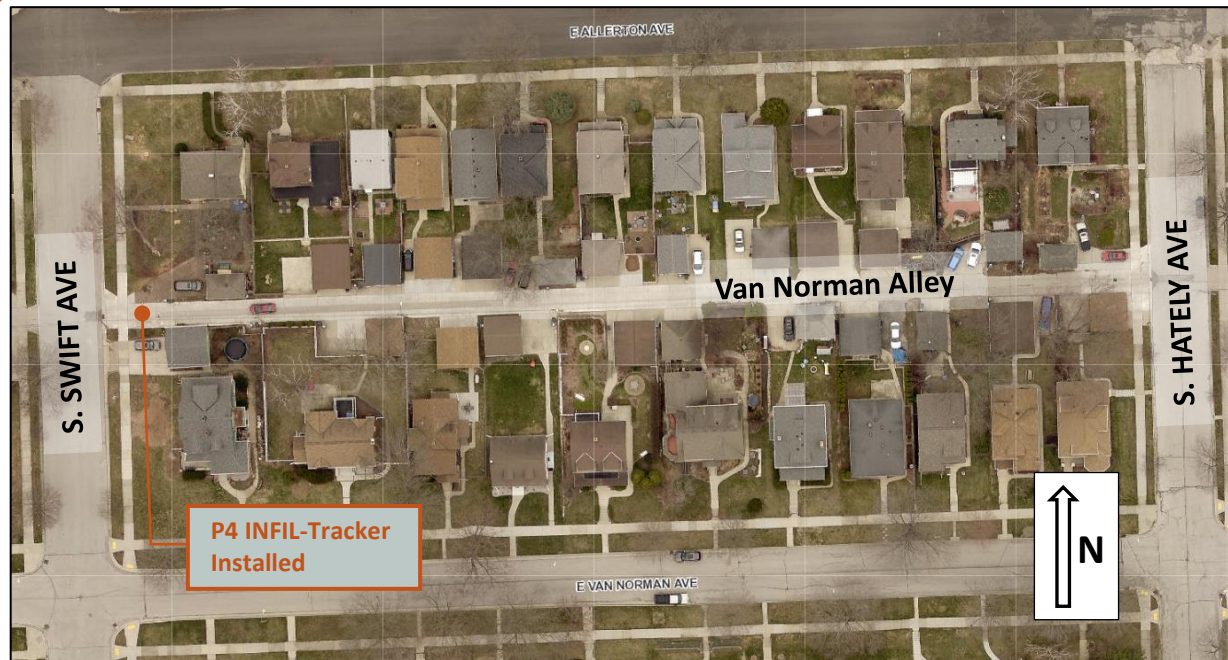
Cudahy Case Study: Van Norman Alley Permeable Pavement



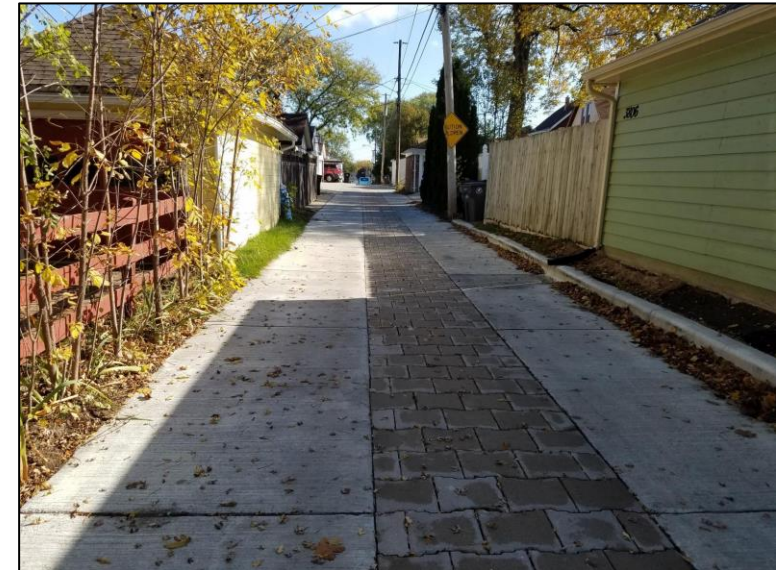
Drainage Area: ~0.5 acre

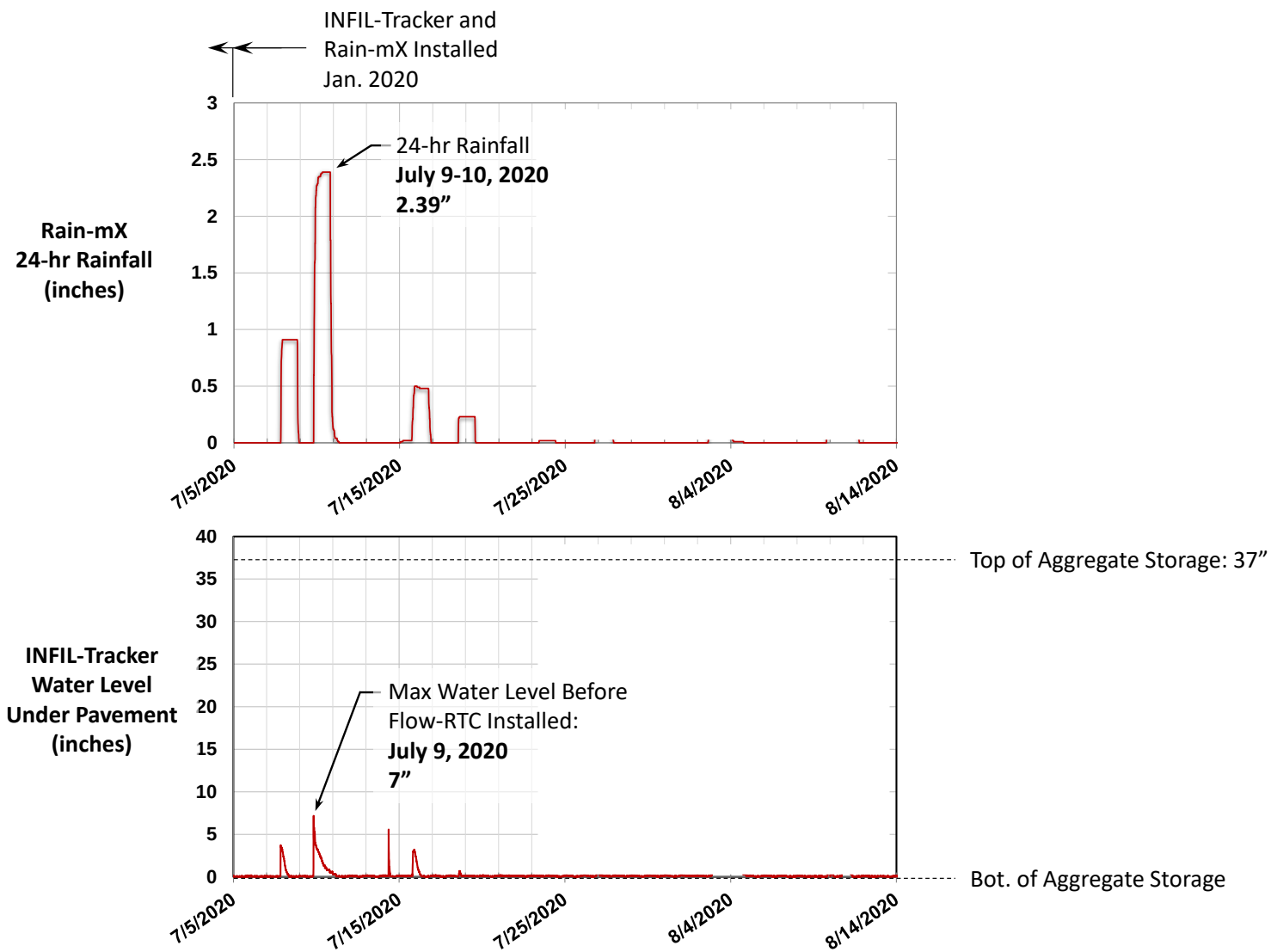
BMP Area: 826 SF

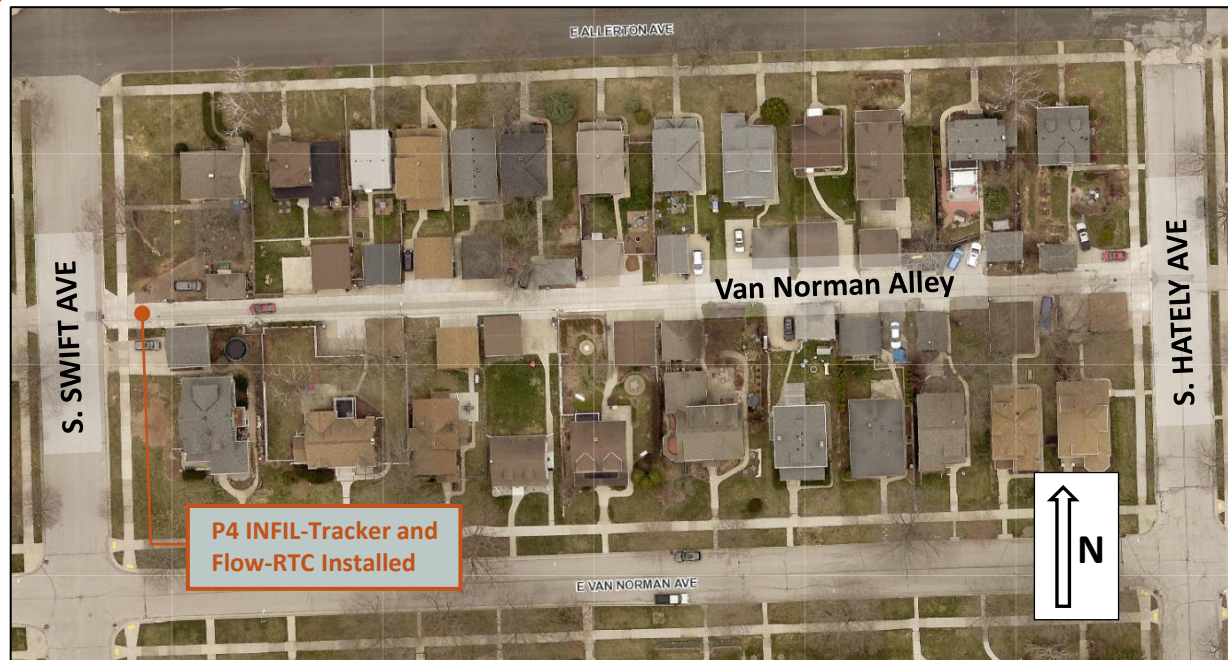
Run-on Ratio: ~25:1



Installed January 2020







Installed January 2020



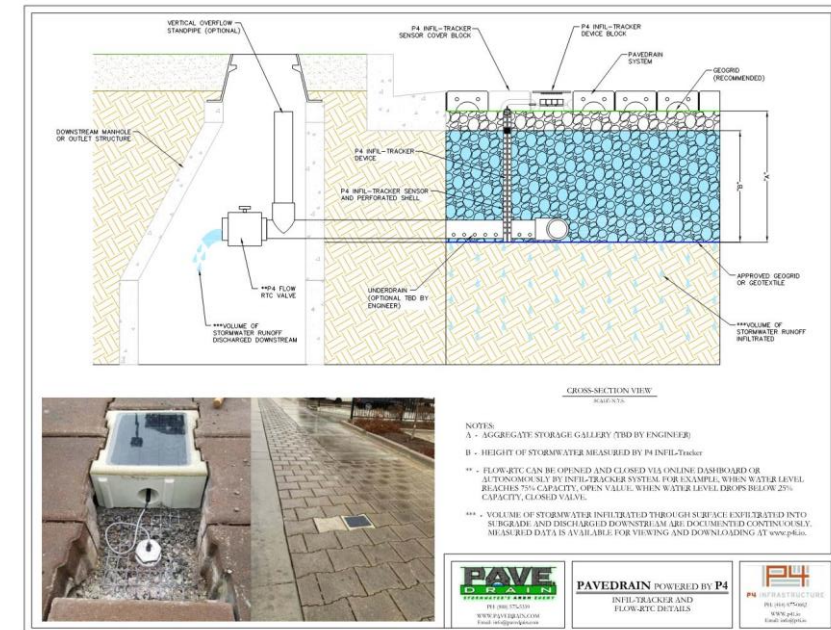
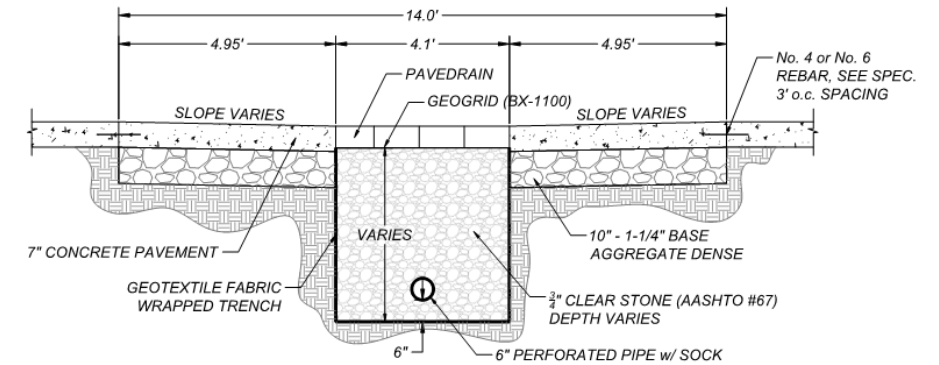
Rain-mX

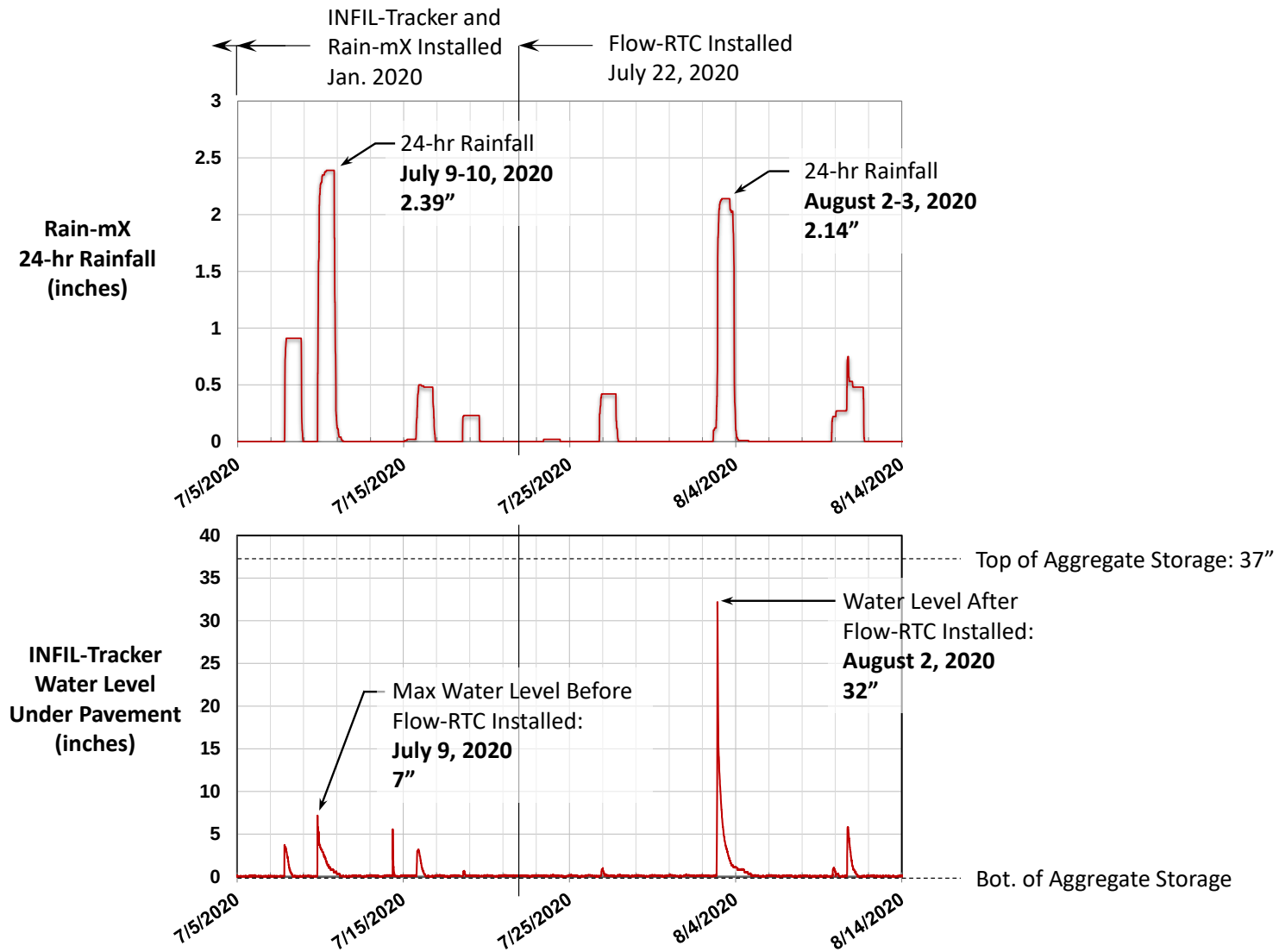


INFIL-Tracker



Flow-RTC

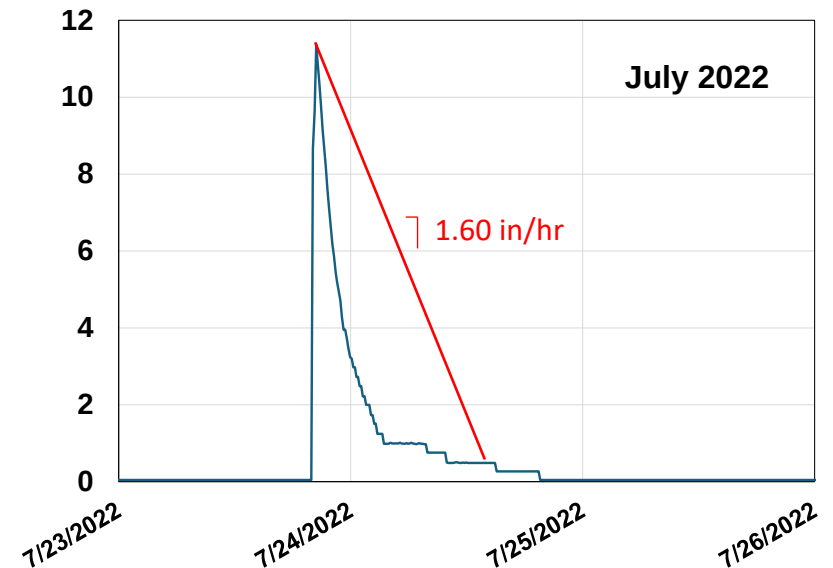
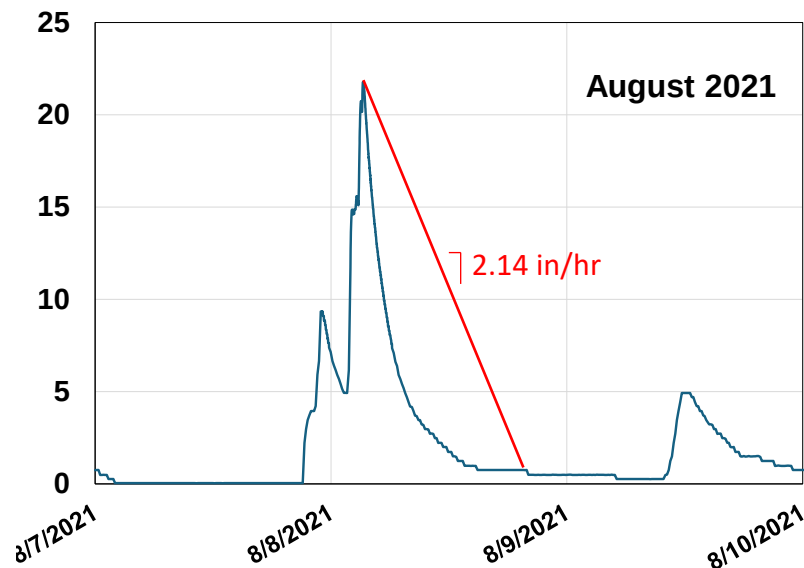
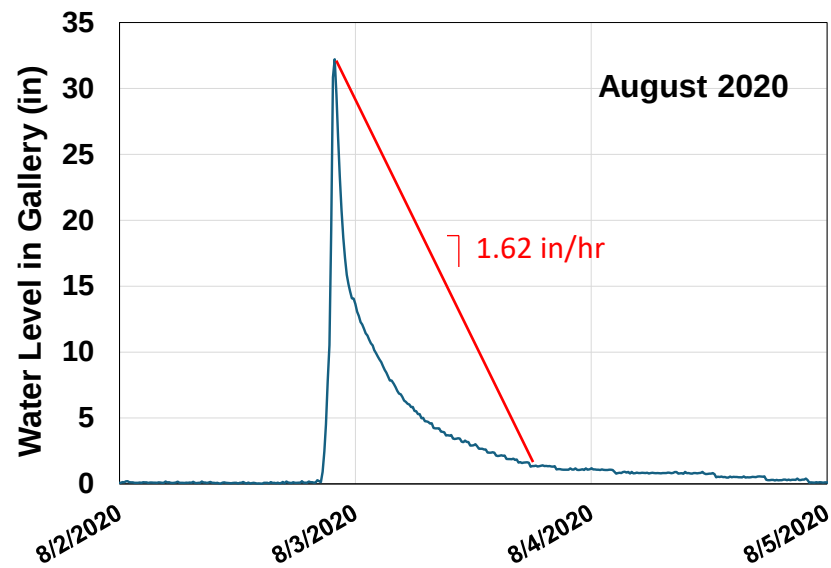


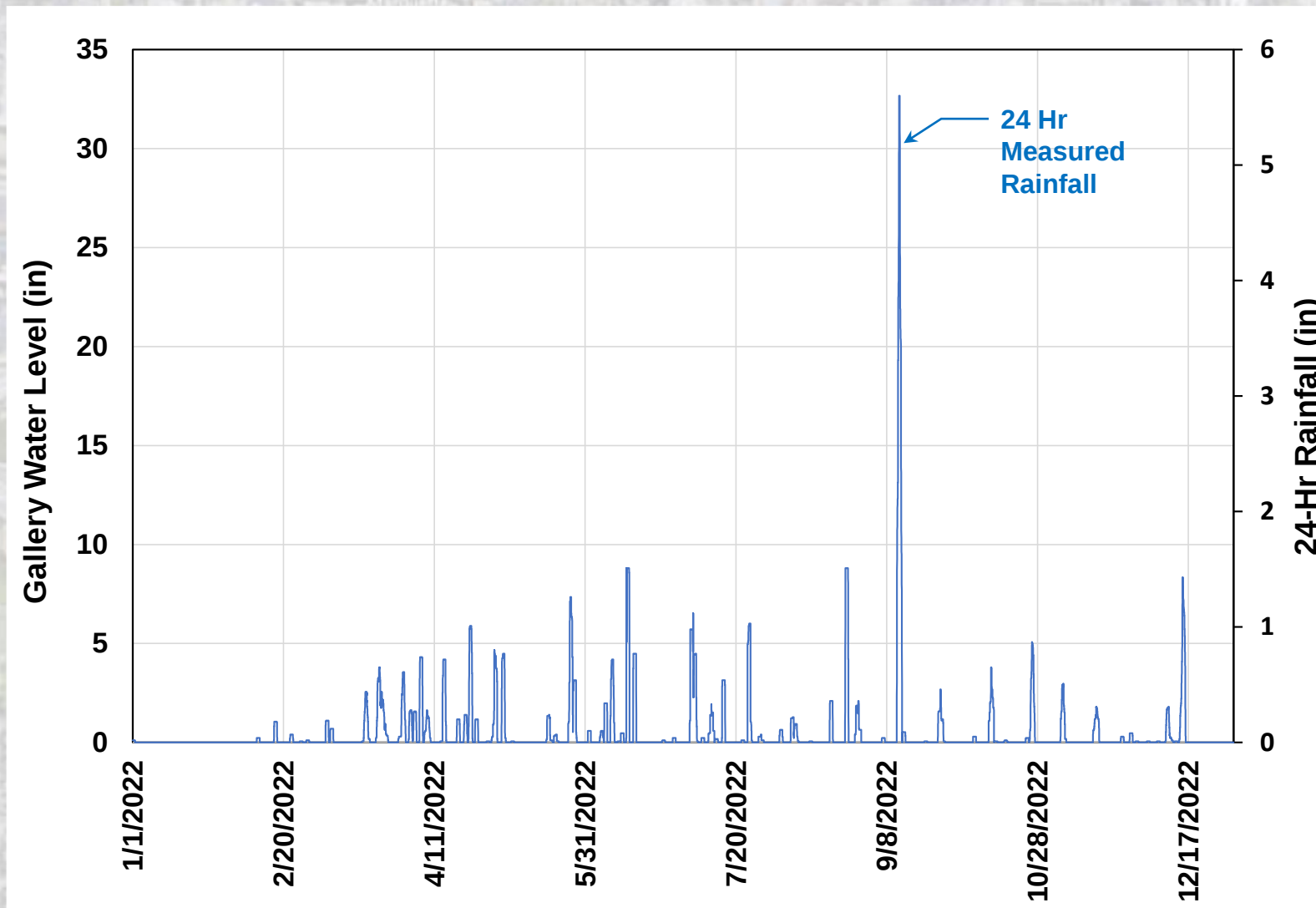


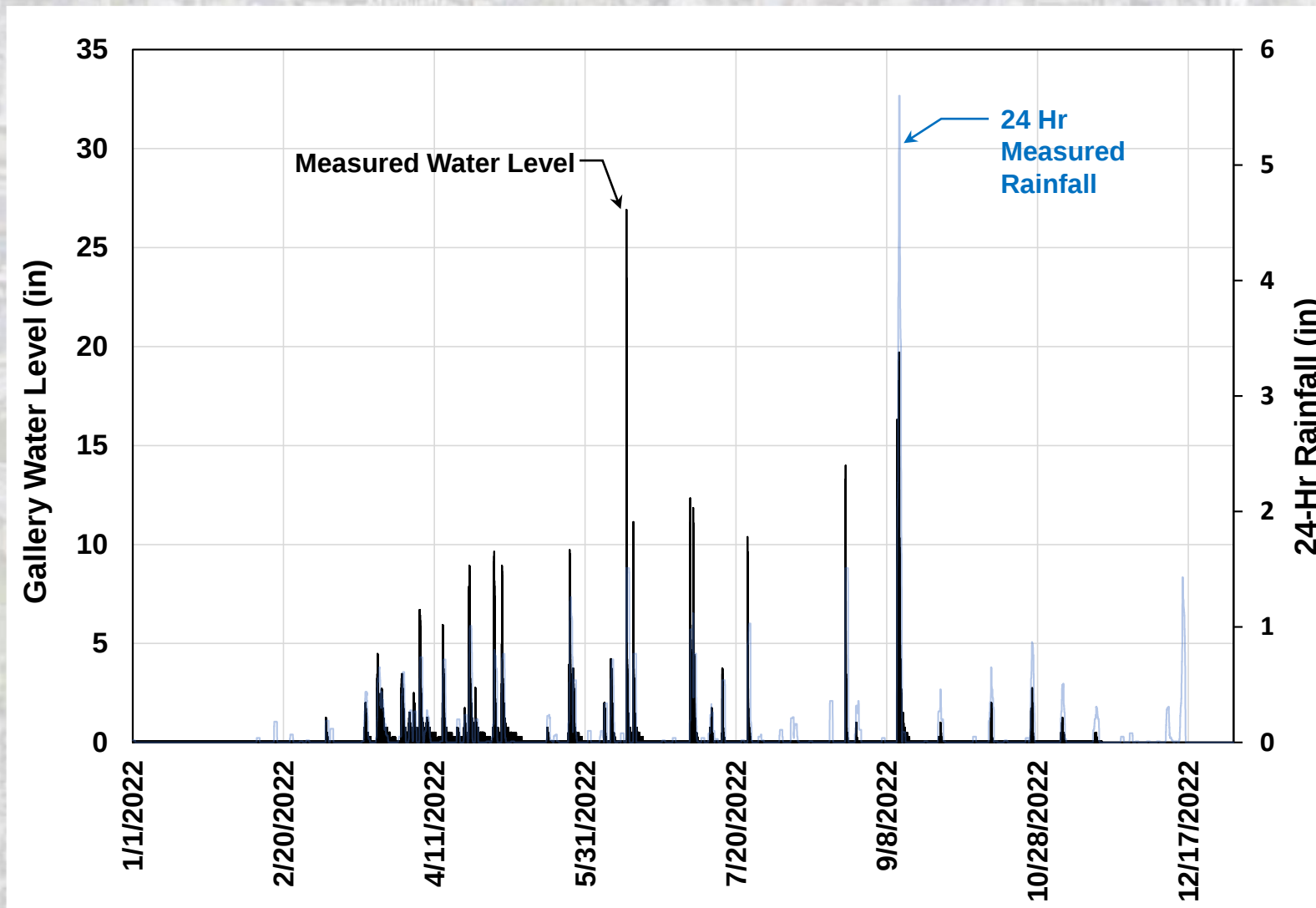
Van Norman Alley Water Level and Subgrade Infiltration Records

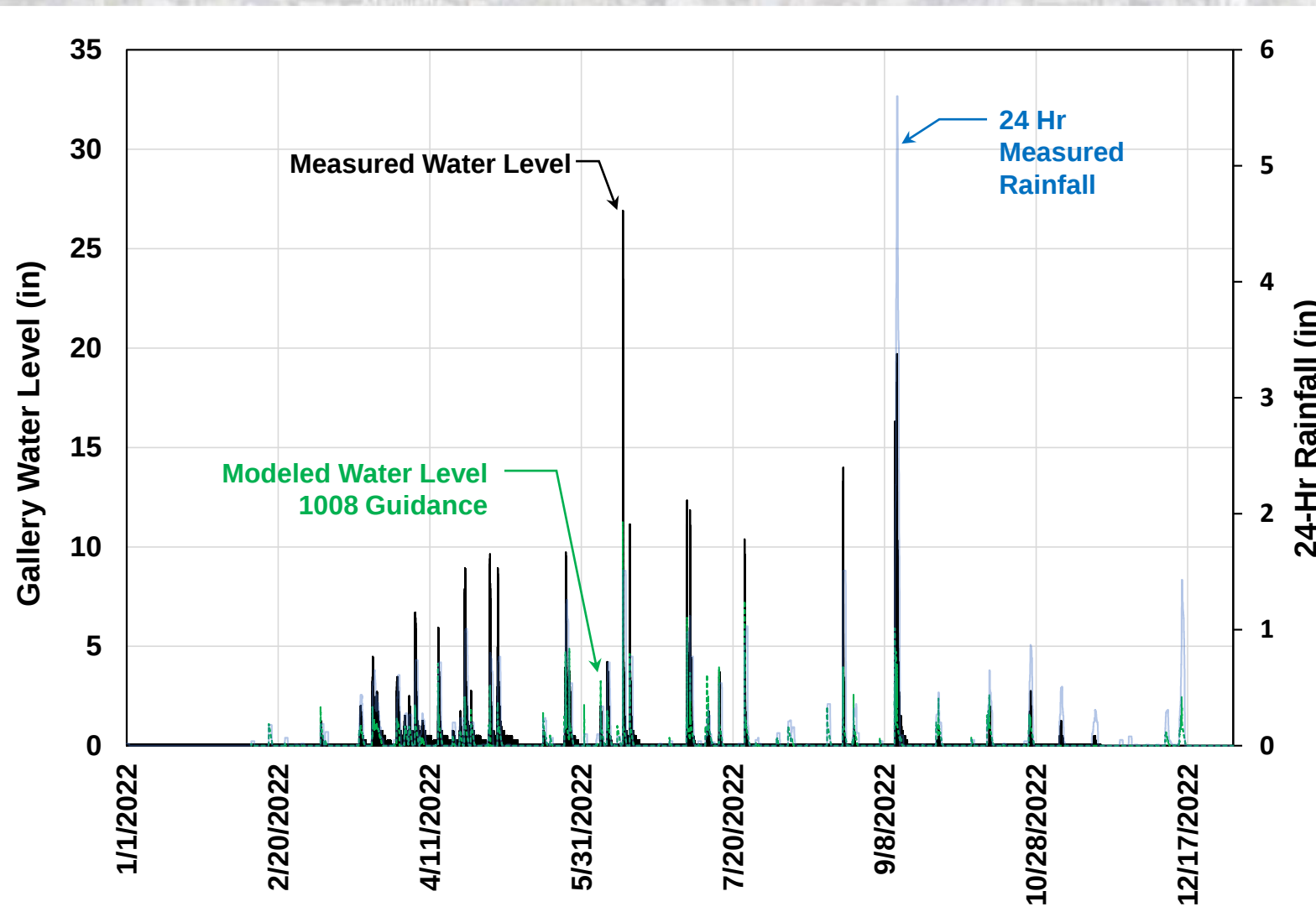
Subgrade infiltration degradation rate MAY NOT follow WinSLAMM Modeling assumptions.

Infiltration rates measured from several events in year 2020 suggested site drained at 1.34 in/hr, NOT 0.04 in/hr used during design phase.



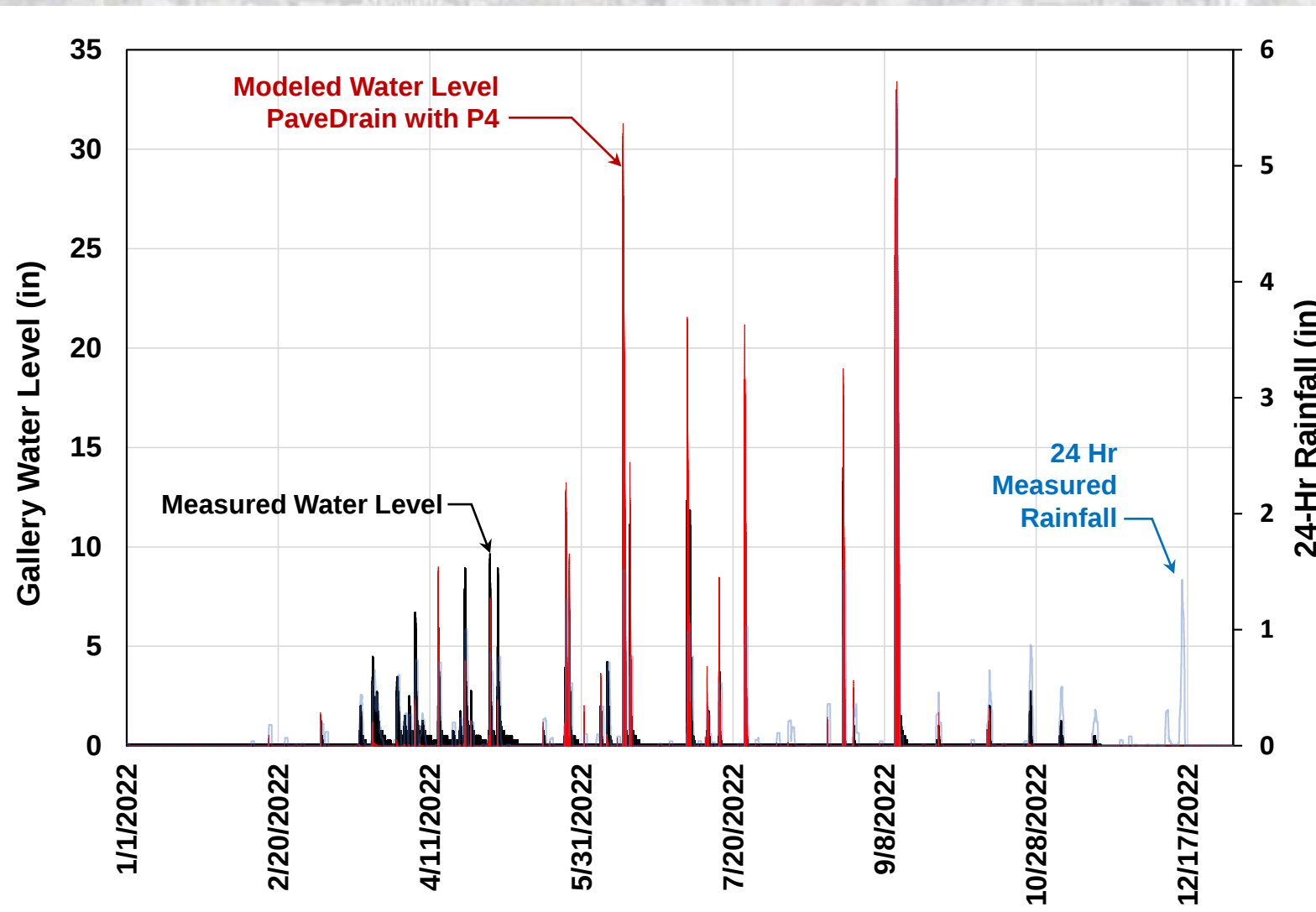






Modeled Water Level 1008 Guidance

- 5:1 max run-on (violated | 25:1 used)
- 100 in/hr initial surface infil. rate
- 0.06 lbs/sf surface clogging capacity
- 0.04 in/hr initial subgrade infil. rate

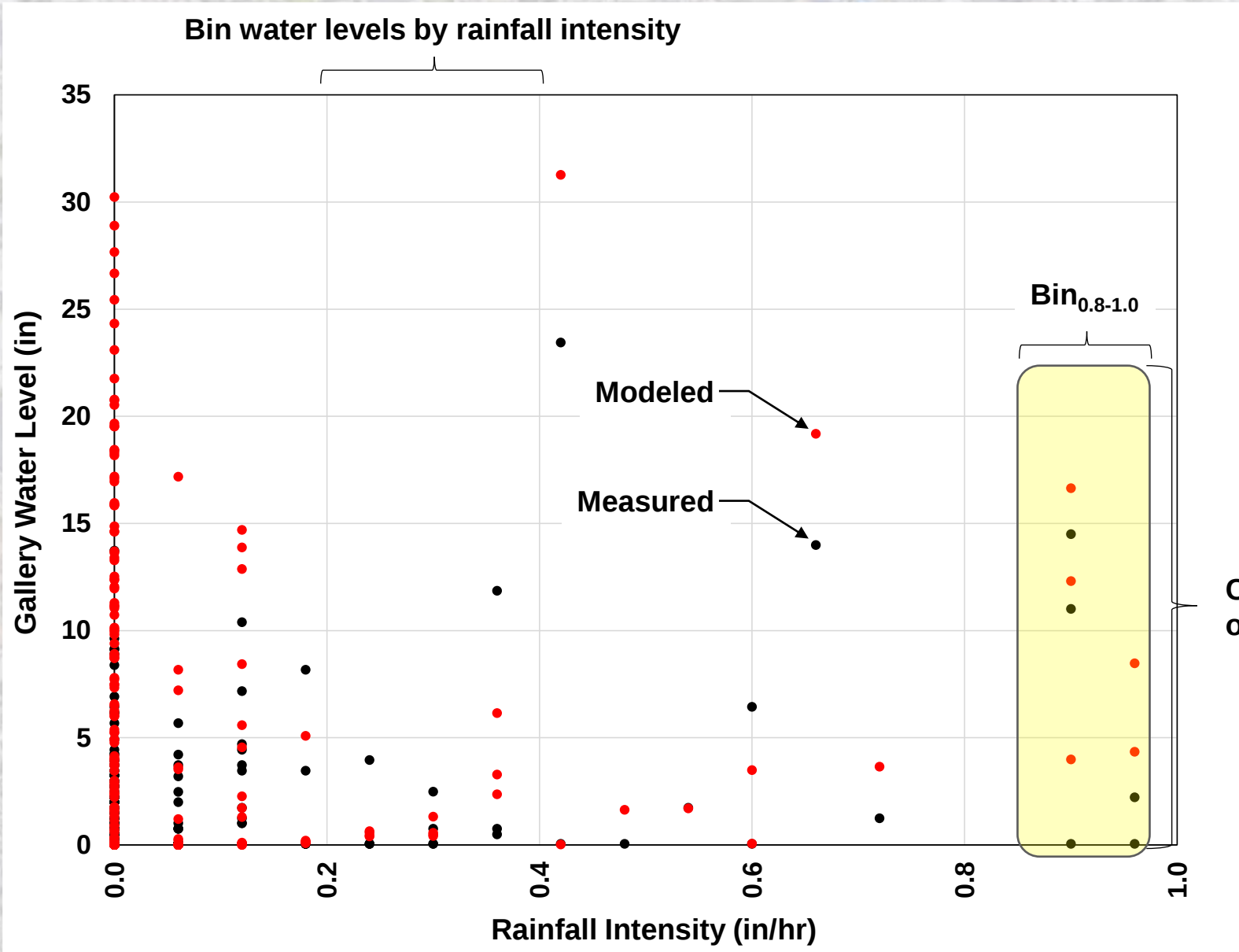


Modeled Water Level 1008 Guidance

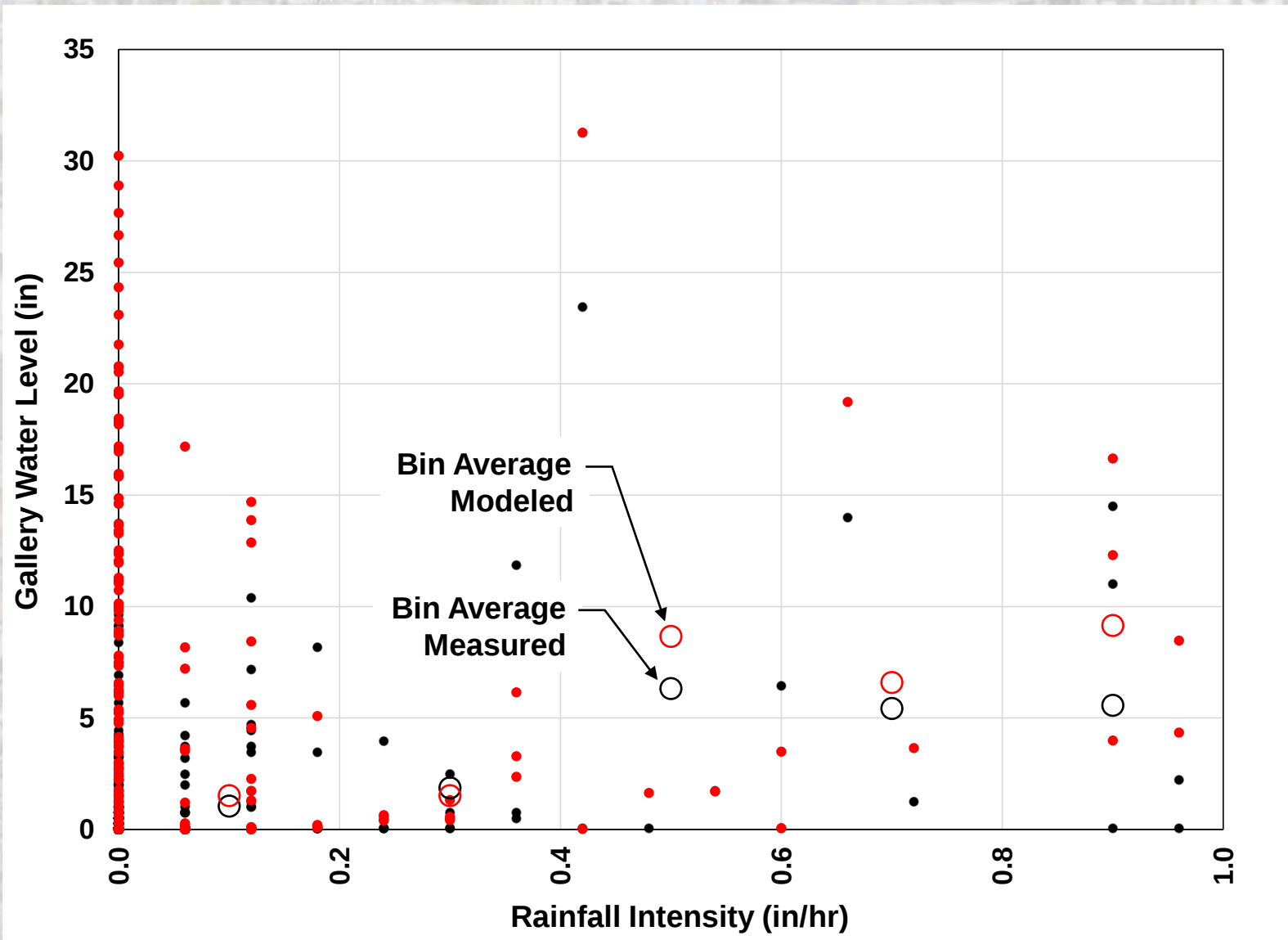
- 5:1 max run-on (violated | 25:1 used)
- 100 in/hr initial surface infil. rate
- 0.06 lbs/sf surface clogging capacity
- 0.04 in/hr initial subgrade infil. rate

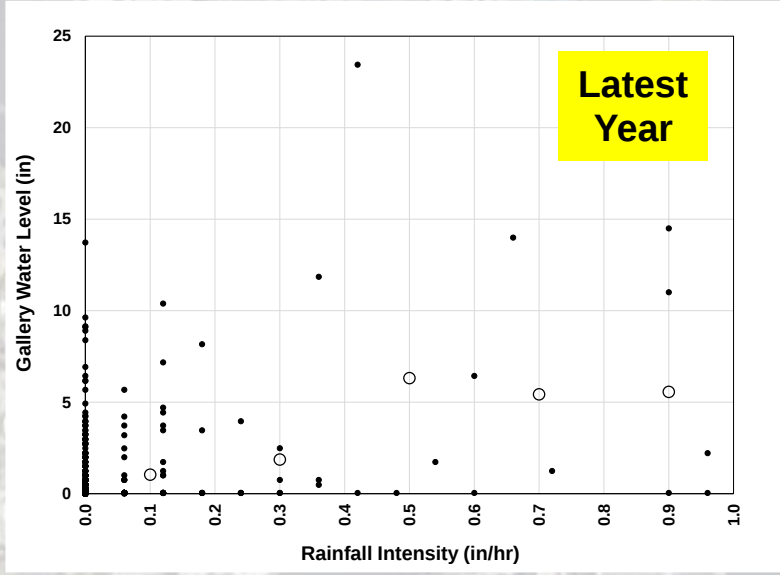
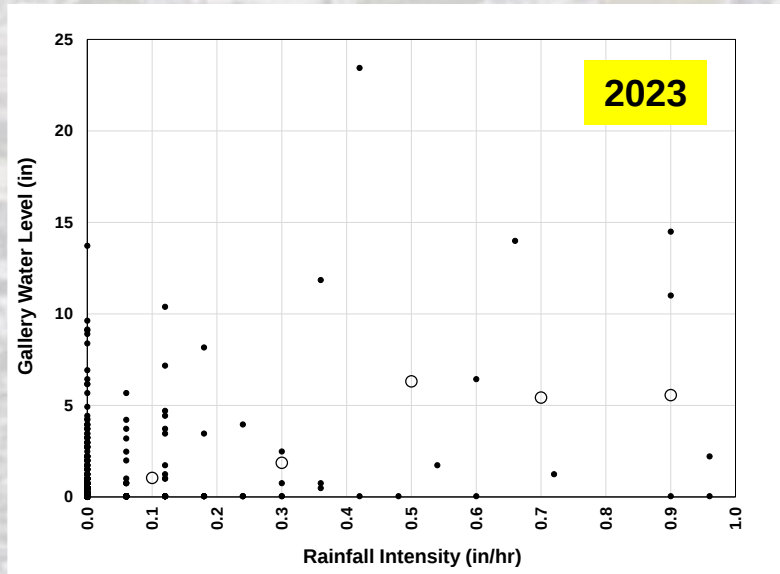
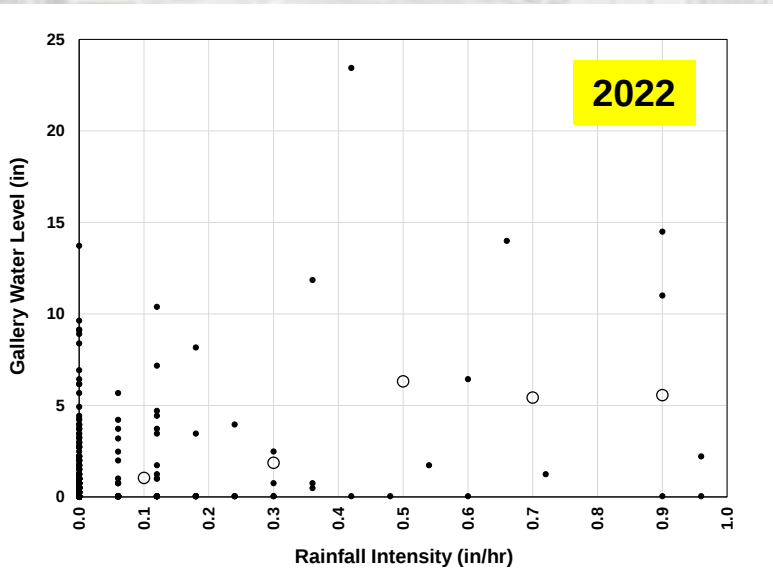
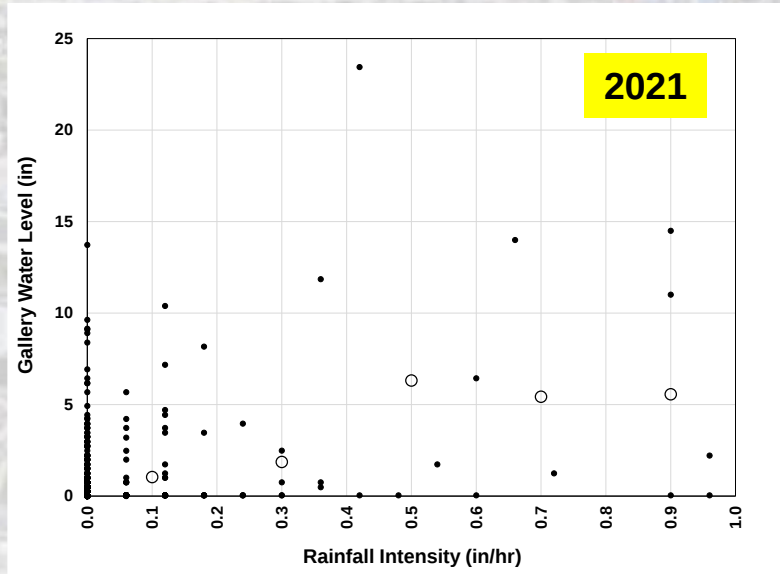
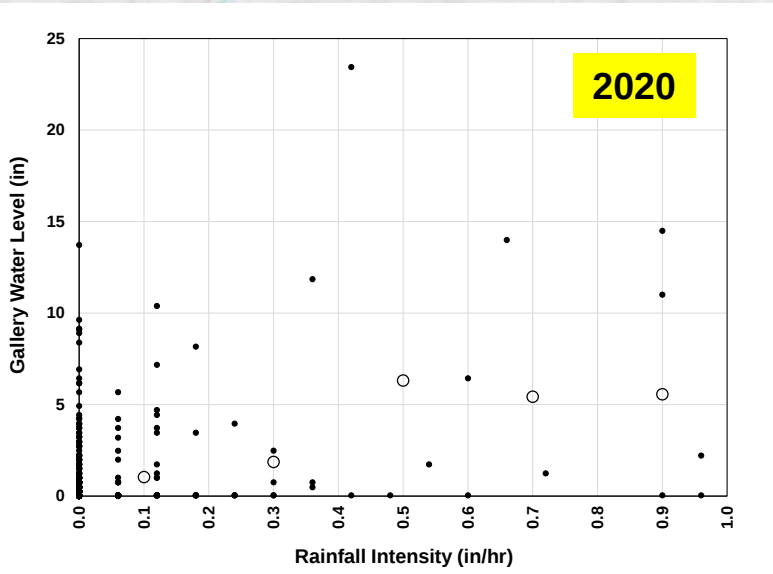
Modeled Water Level PaveDrain with P4

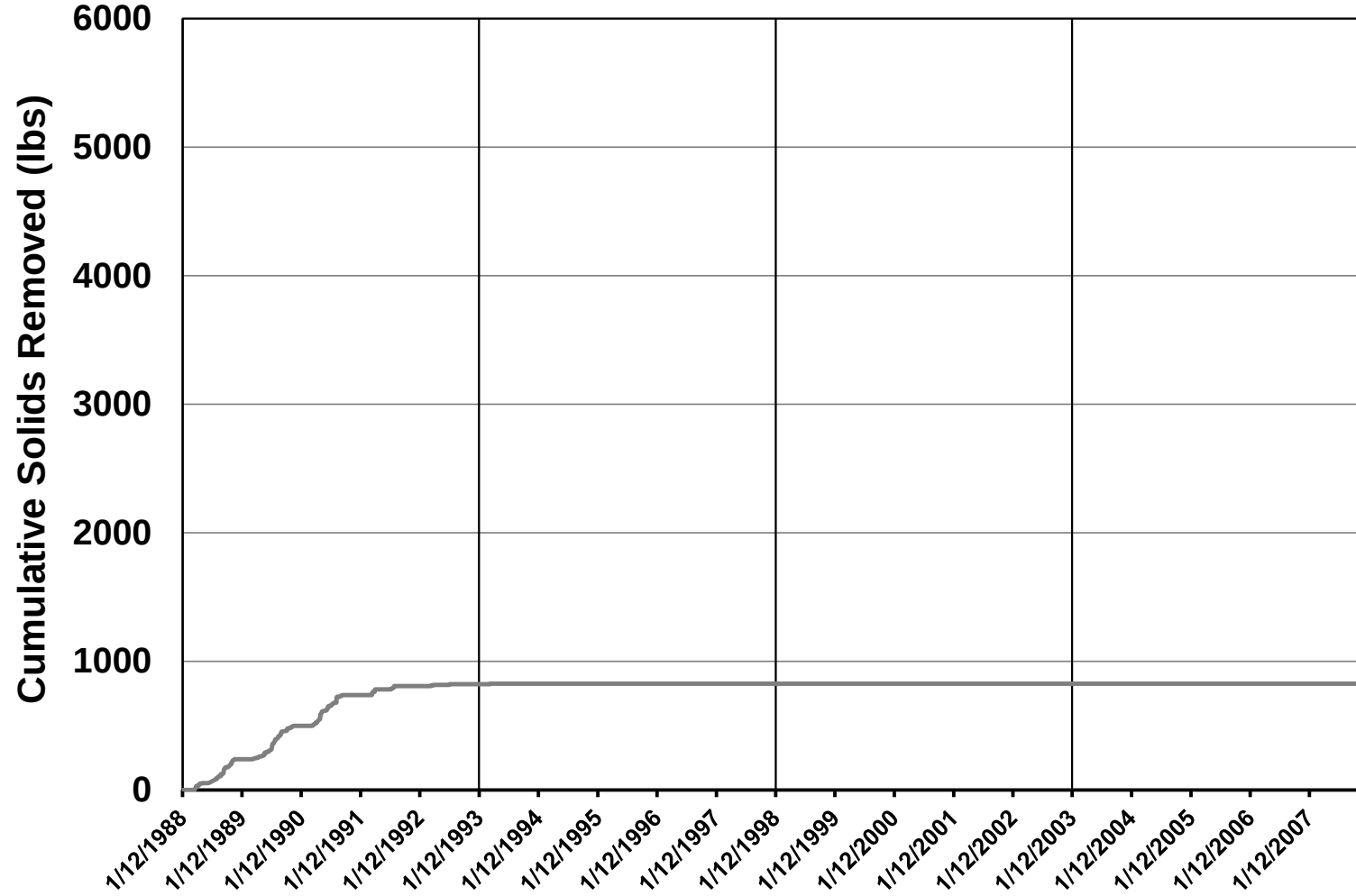
- No max run-on (25:1 used)
- 1,500 in/hr initial surface infil. rate
- 1.2 lbs/sf surface clogging capacity
- 1.34 in/hr *measured* subgrade infil. rate



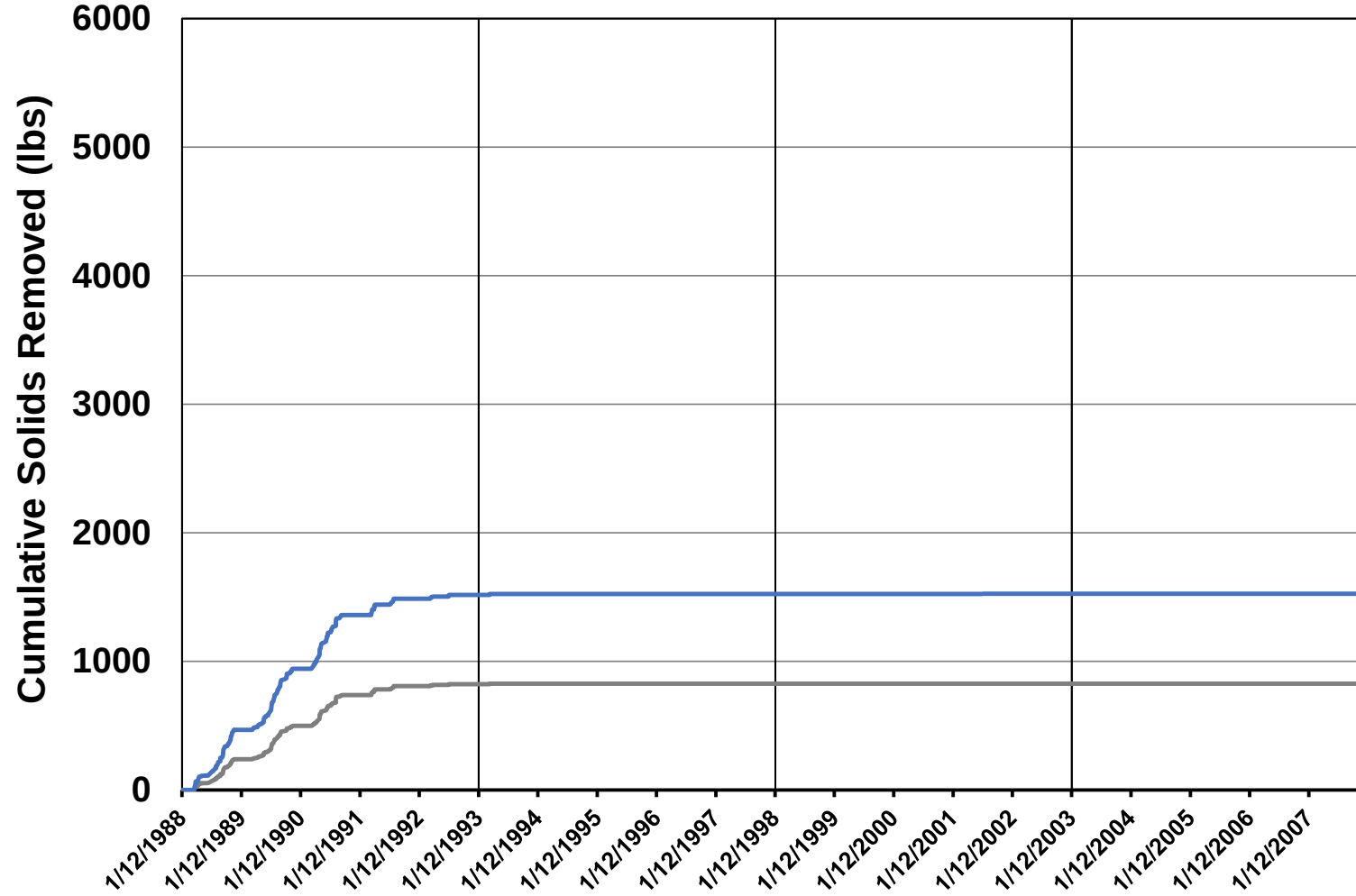
Compute statistics on each bin.



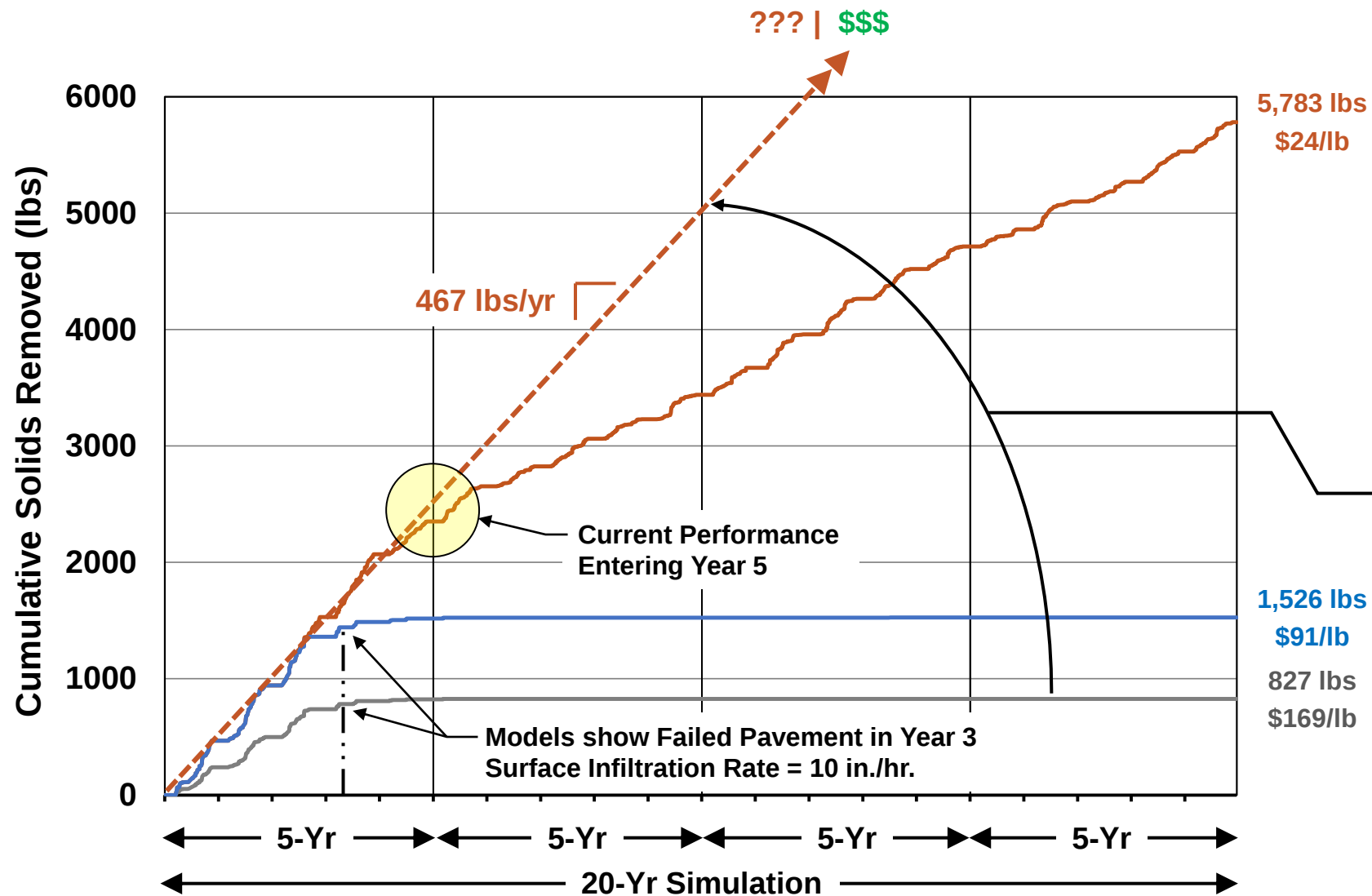




- P4 and PaveDrain | 25:1 run-on
- 1008 Guidance | 1.34 in/hr | 25:1 run-on
- 1008 Guidance | 0.04 in/hr | 25:1 run-on



- P4 and PaveDrain | 25:1 run-on
- 1008 Guidance | 1.34 in/hr | 25:1 run-on
- 1008 Guidance | 0.04 in/hr | 25:1 run-on



- P4 and PaveDrain | 25:1 run-on
- 1008 Guidance | 1.34 in/hr | 25:1 run-on
- 1008 Guidance | 0.04 in/hr | 25:1 run-on

As price per pound of pollutant removed decreases, value of BMP increases.

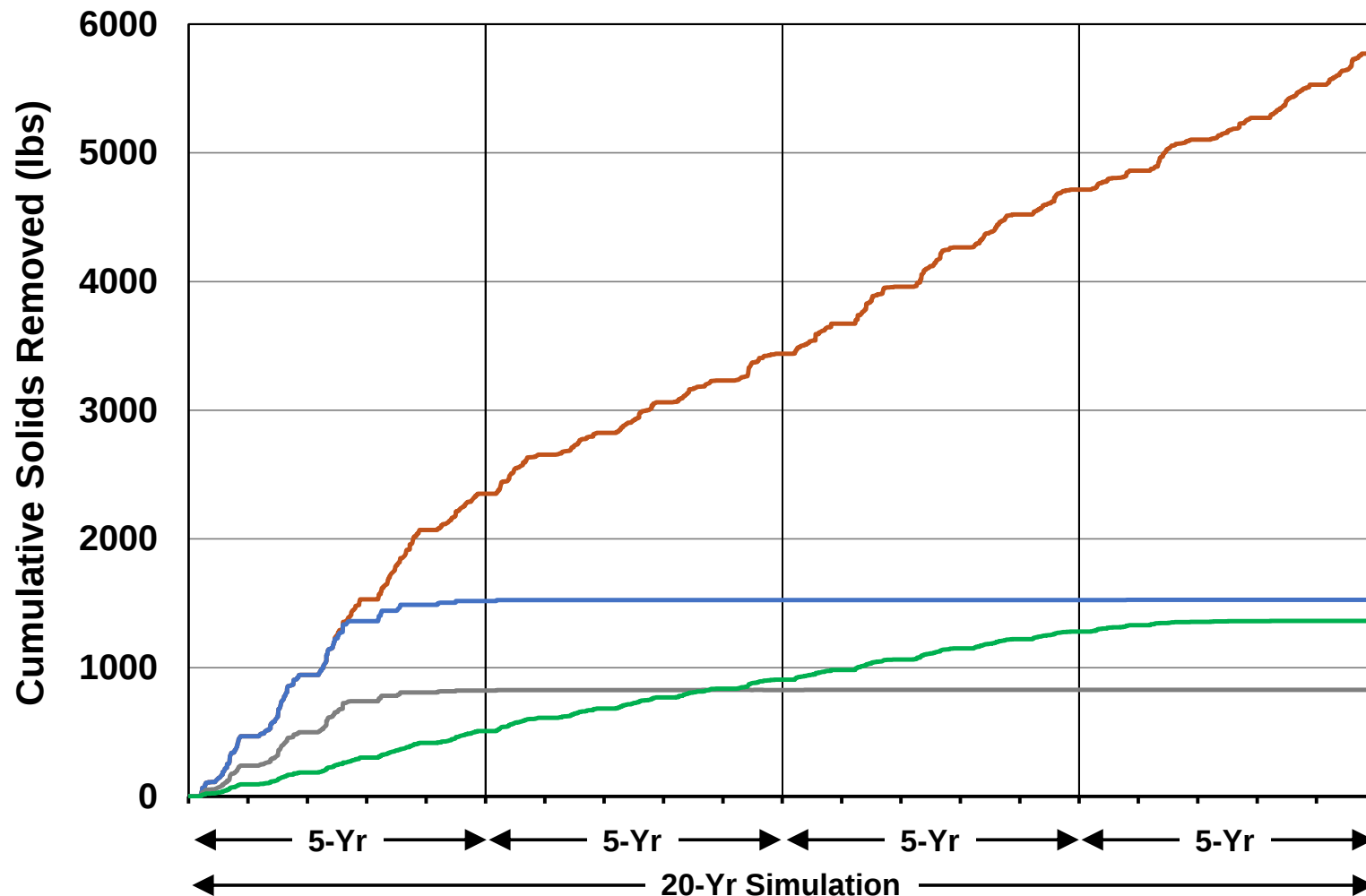
Only possible through **DIGITALIZATION**.



Drainage Area: ~0.09 acre

BMP Area: 826 SF

Run-on Ratio: 5:1



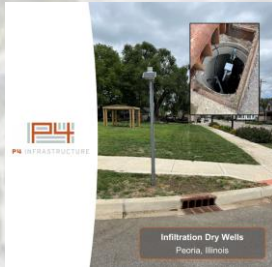
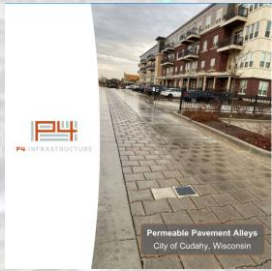
5,783 lbs
\$24/lb

- P4 and PaveDrain | 25:1 run-on
- 1008 Guidance | 1.34 in/hr | 25:1 run-on
- 1008 Guidance | 0.04 in/hr | 25:1 run-on
- 1008 Guidance | 0.04 in/hr | 5:1 run-on

1,526 lbs
\$91/lb

1,362 lbs
\$103/lb

827 lbs
\$169/lb



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Christopher

Search

ASCE

- ASCE - Liqua-Level Ch. 2
- ASCE - LiquaLevel
- ASCE Rain-mX

Cudahy

- Cudahy - INFIL-Tracker - Squire
- Cudahy - INFIL-Tracker - VanNorman
- Cudahy - Rain mX

Demo Site

- Appleton - LIQUA-Level
- Appleton - Rain mX
- Beaver Court - Rain-mX
- Cudahy - INFIL-Tracker - Squire
- Cudahy - INFIL-Tracker - VanNorman
- Cudahy - Rain mX
- Cudahy - Rain mX - Rain Only
- EMCO - PGC - IT #3

EMCO

- EMCO - PGC - IT #3
- EMCO - PGC - Rain mX #2
- EMCO - PGC - Rain mX #3

Gilbane - MKE City Hall

- MKE_CH - Backflow Device
- MKE_CH - Floor Drain
- Rain-mX - 622 N. Water - Roof Top

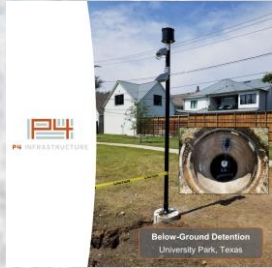
Green Tech Station

- GTS - LiquaLevel
- GTS - Rain mX

MSOE

- MSOE - LiquaLevel Ch 2

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