



SOURCE OF STREAM

2024 Conference

Canada's Premier Stormwater and Erosion and Sediment Control Conference

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GRI Performance Monitoring in the City of Vancouver

Source to Stream Conference
March 2024



Cassandra Humes
Monitoring Technician
Green Infrastructure
Implementation



I gratefully
acknowledge that I
live, work and play on
the traditional,
unceded territories of
the x^wməθk^wəy^əm
(Musqueam),
Skwxwú7mesh
Úxwumixw (Squamish
Nation) and səliłwətał
(Tseil-Waututh)
Peoples.

Agenda

Where
Does
Rainwater
Go?

**GRI in
Vancouver**

Monitoring
Program

Monitoring
Results

Conclusion

Rain City Strategy

A high level, 30 year implementation plan that aims to manage rainwater sustainably through green infrastructure that

protects

restores

mimics

the natural water cycle



GRI in the City of Vancouver



Bioretention
187 Assets



Subsurface
Infiltration
95 Assets



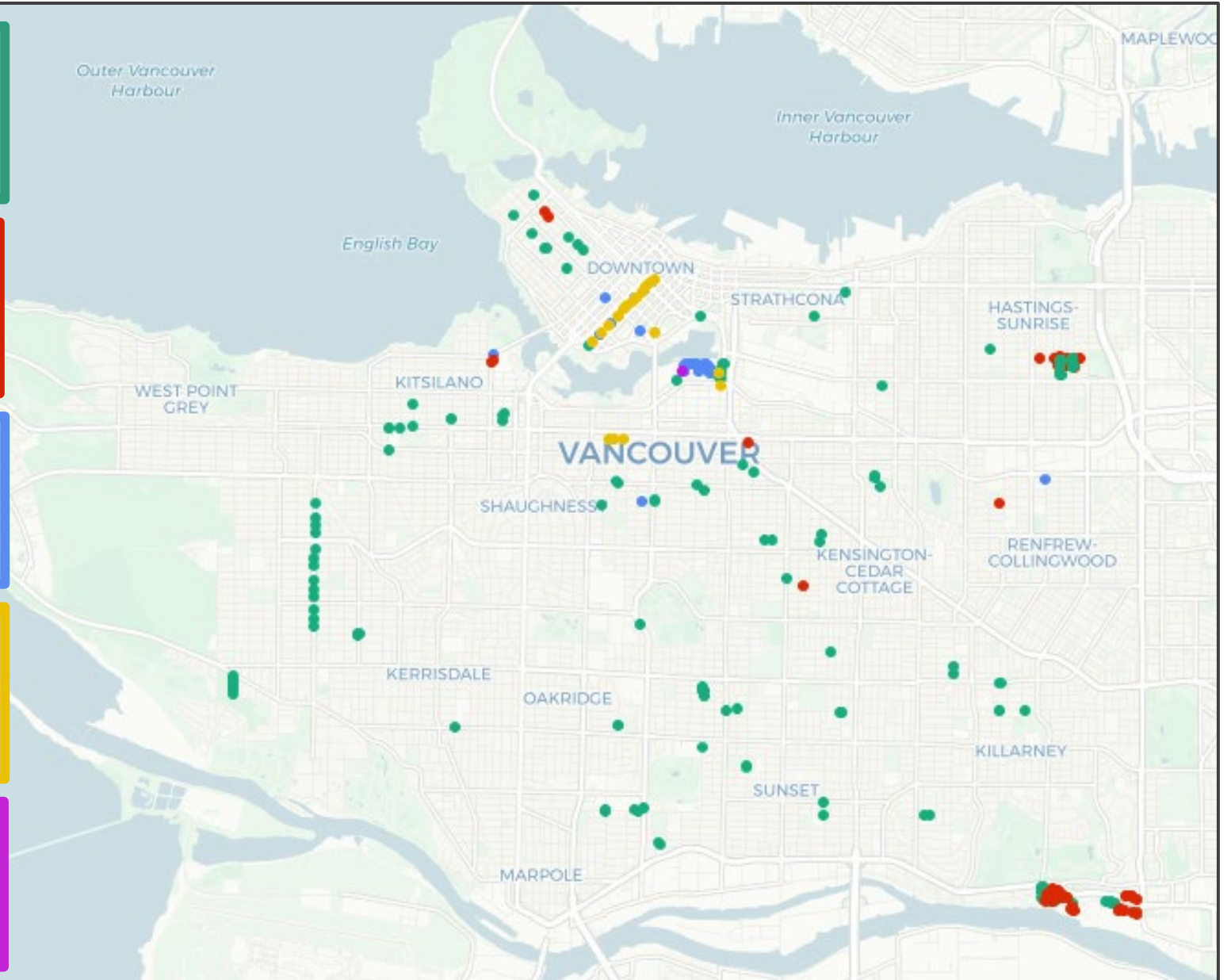
Permeable
Pavement
52 Assets



Rainwater
Tree Trench
28 Assets



Wetland
1 Asset



Monitoring Program

Where
Does
Rainwater
Go?

GRI in
Vancouver

**Monitoring
Program**

Monitoring
Results

Conclusion

Performance Monitoring Objectives

Surface
Ponding
<24 h

Design
infiltration
rates match
drawdown
rates

Retention/
filtration
target
being met

90% of
annual
rainfall

48mm in
24 h

Subsurface
Storage
empty in
<72 h

Soil
moisture for
plant
health

Evaluate
load
reduction
for target
pollutants

WATER IN THE
RAIN CITY

...an just a place to enjoy
... capture and clean
... more than 1,170 m² of
... keep this water out
... to control flooding
... and marine life.

2

Optimization Monitoring Objectives

Permeable
Pavement
performance
over time

Condition
scores for all
GRI assets

Evaluate
impact
of GRI on
biodiversity

Performance Monitoring Programs

Water Level Monitoring



Measures drawdown performance of asset over time

- ❖ HOBO loggers installed in wells and data manually collected
- ❖ Novion® loggers installed in wells and data uploaded to Cloud Platform

Soil Monitoring



Measures

- **Volumetric Water Content**
- **Electrical Conductivity**
- **Temperature**

- ❖ Sensor installed during construction and logger installed post-construction

Performance Monitoring Programs

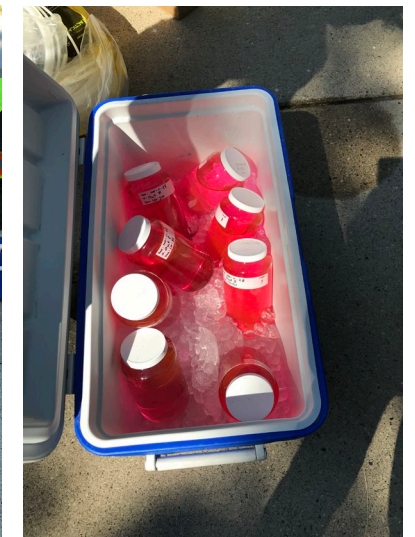
Synthetic Runoff Tests

Volume Reduction

- ❖ Water truck or hydrant as water source
- ❖ No bypass or overflows

GRI contaminant removal

- ❖ Pollutants of known mass injected
- ❖ Water samples collected at outlet
- ❖ Combine with flow measurements to get mass balance



Performance Monitoring Programs

Visual Monitoring



See systems in action!

Look at:

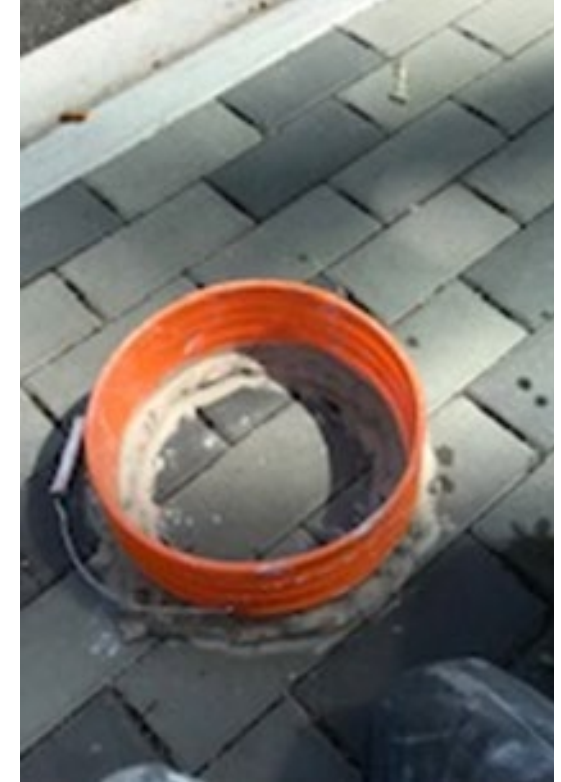
- Bypass
- Overflow
- Ponding
- Sediment Accumulation
- Overall Condition

❖ Rainspection: inspect during a large storm event

❖ Post-Rainspection: inspect 24 hours after a large storm event

Optimization Monitoring Programs

Permeable Pavement Testing



1. Test Infiltration



2. Clean



3. Refill Joint Material



4. Re-Test Infiltration

Appropriate maintenance tasks

Length of permeability

Optimization Monitoring Programs

Condition Assessments

Verify systems are performing as designed

- ❖ Condition scores based on evaluation of different components of the system



- 1 Very Good/ No Issues**
Everything is awesome. Works perfectly, don't change a thing!
- 2 Good/Minimal Issues**
In great shape. A few minor issues, but they aren't impacting overall function, and could be solved with routine maintenance. Functionality greater than 75%
- 3 Fair/ Some issues**
Still functions, but not to its design specifications, or site has noticeable issues that may impact function in the near future. Functionality between 25-75%. Requires routine maintenance and/or minor repairs.
- 4 Poor/ Moderate issues**
Functioning at 25% or less and requires rehabilitation.
- 5 Very poor/ Extensive Issues**
Pinterest level fail. Extensive damage and is non-functional. If the failure is a health and safety risk to the community, it should automatically be scored a 5.



Optimization Monitoring Programs

Biodiversity Monitoring

Understand impacts of the co-benefits of GRI

- ❖ Monitor biodiversity with citizen science bioblitzes
- ❖ Repeat bioblitzes post-construction



BIOBLITZ!

A **BioBlitz** is an event where members of the community **identify** and **record** as many species as they can in a specific location during a specific time frame. This information can be valuable for researchers monitoring **biodiversity**. The best part is that **anyone** can participate and contribute!

Some useful tools for a BioBlitz include **cameras, binoculars, microscopes, nets** for collecting insects, and clear **containers** for holding specimens during viewing. You'll also want a way to **record** what you find. If you have a smartphone, the **iNaturalist** app can make it simple to document your observations.



After identification, any captured species are released

You don't have to be an expert in identifying species to be part of a BioBlitz. Some BioBlitz organizers provide **guides** to help you recognize local flora and fauna. If you're using the iNaturalist app, you can take a photo of an unidentified species and the app will offer a suggestion of what it might be. Human observers can then confirm or correct that identification.

A BioBlitz can be a great, hands-on way to interact with nature. But it can also provide valuable data about **species distribution** for researchers. If captured through iNaturalist, the observations can achieve "research grade" status. This means they become part of the data available through the **Global Biodiversity Information Facility** and the **Encyclopedia of Life**.

Monitoring Results

Where
Does
Rainwater
Go?

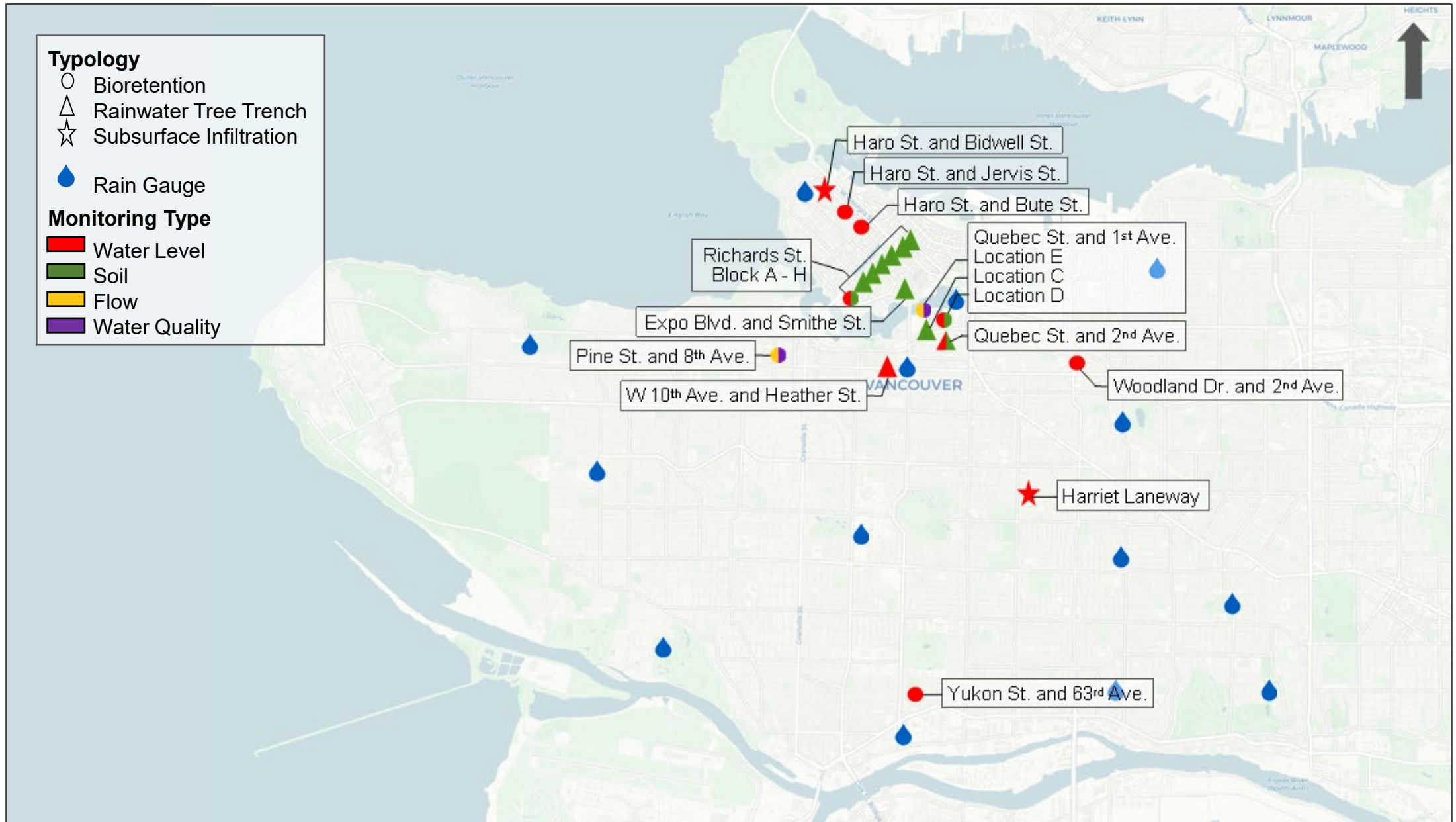
GRI in
Vancouver

Monitoring
Program

**Monitoring
Results**

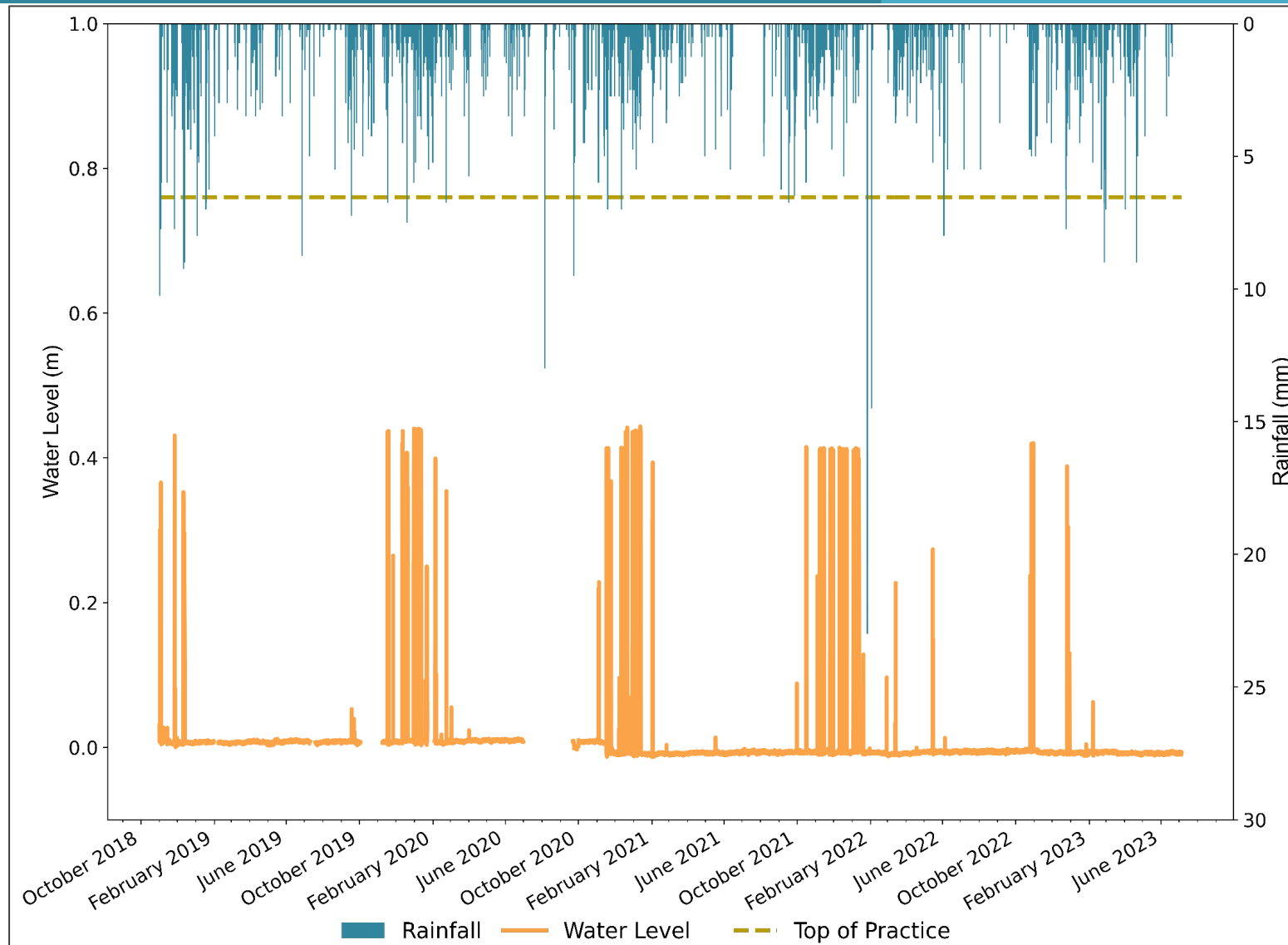
Conclusion

Monitoring Sites



Water Level

63rd Ave. and Yukon St.



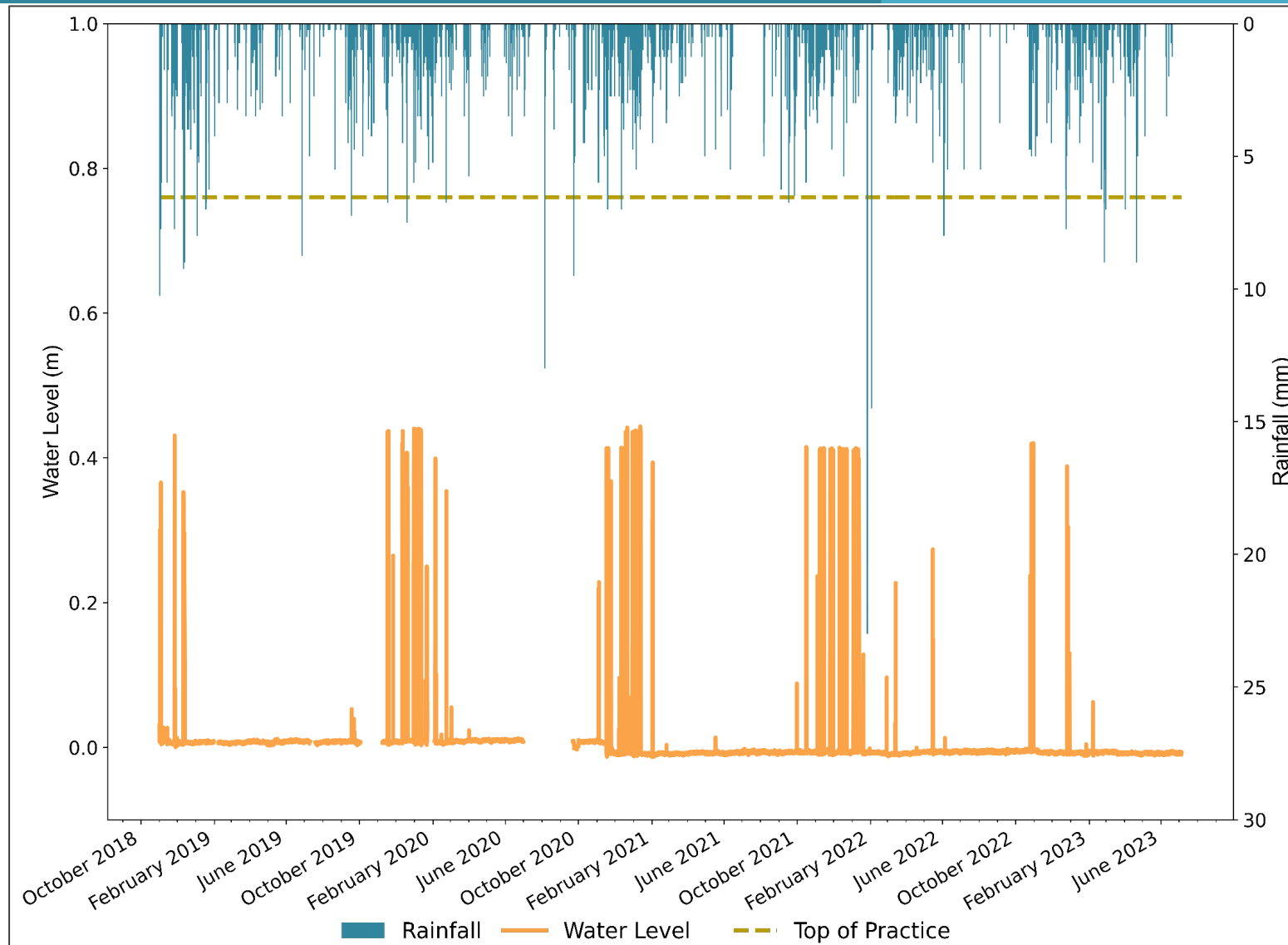
Subsurface Storage empty in <72 h

Design infiltration rates match drawdown rates

Storm Category	Normal (under 24 mm)	Large (between 24 and 48 mm)	Extreme (larger than 48 mm)	Average (weighted)
Drawdown Duration (h)	1	1	3.1	1.3
Drawdown Rate (mm/h)	466	583	465	497
Design Infiltration Rate (mm/h)	39			

Water Level

63rd Ave. and Yukon St.



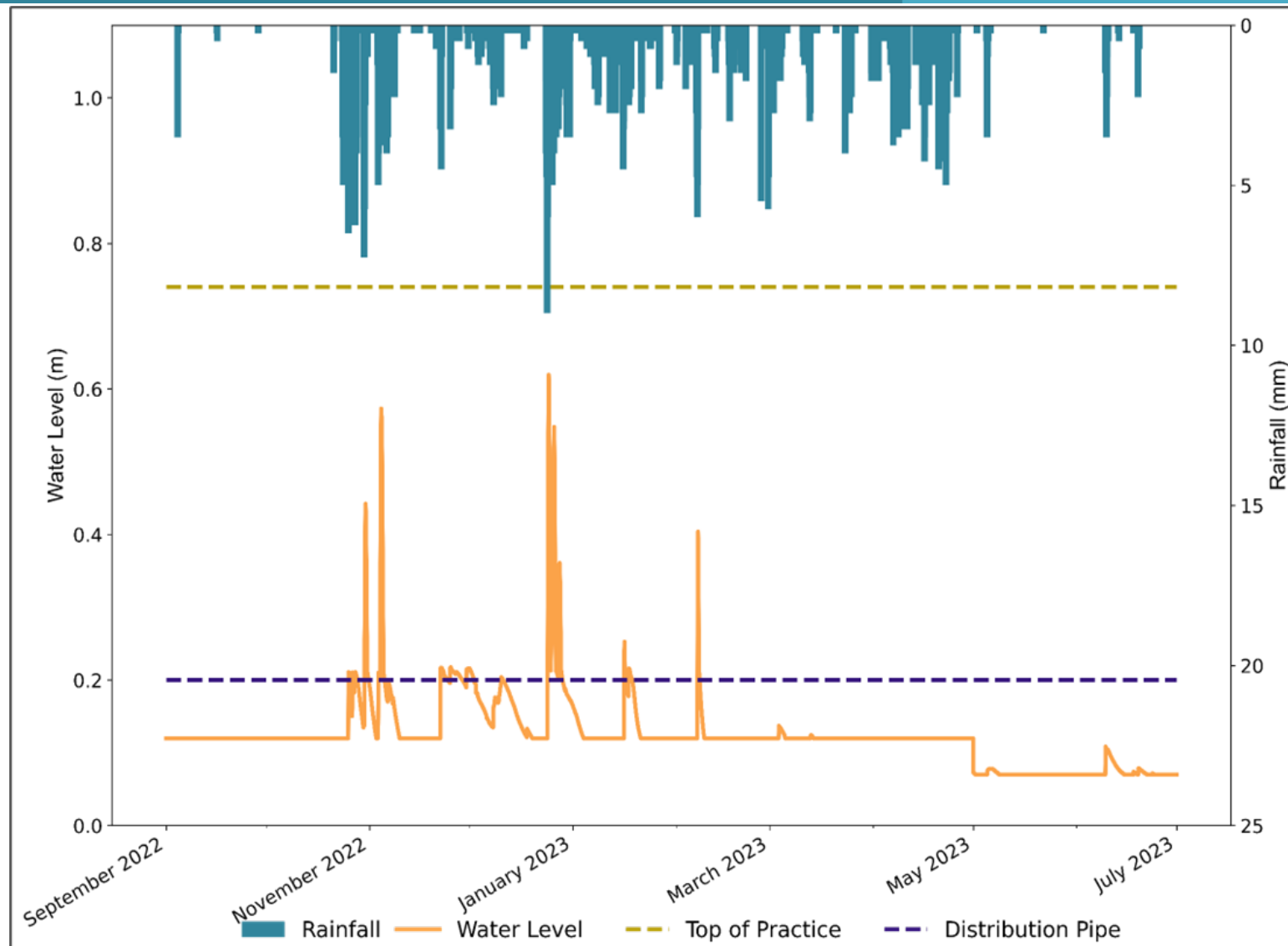
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Water Level

Harriet Laneway



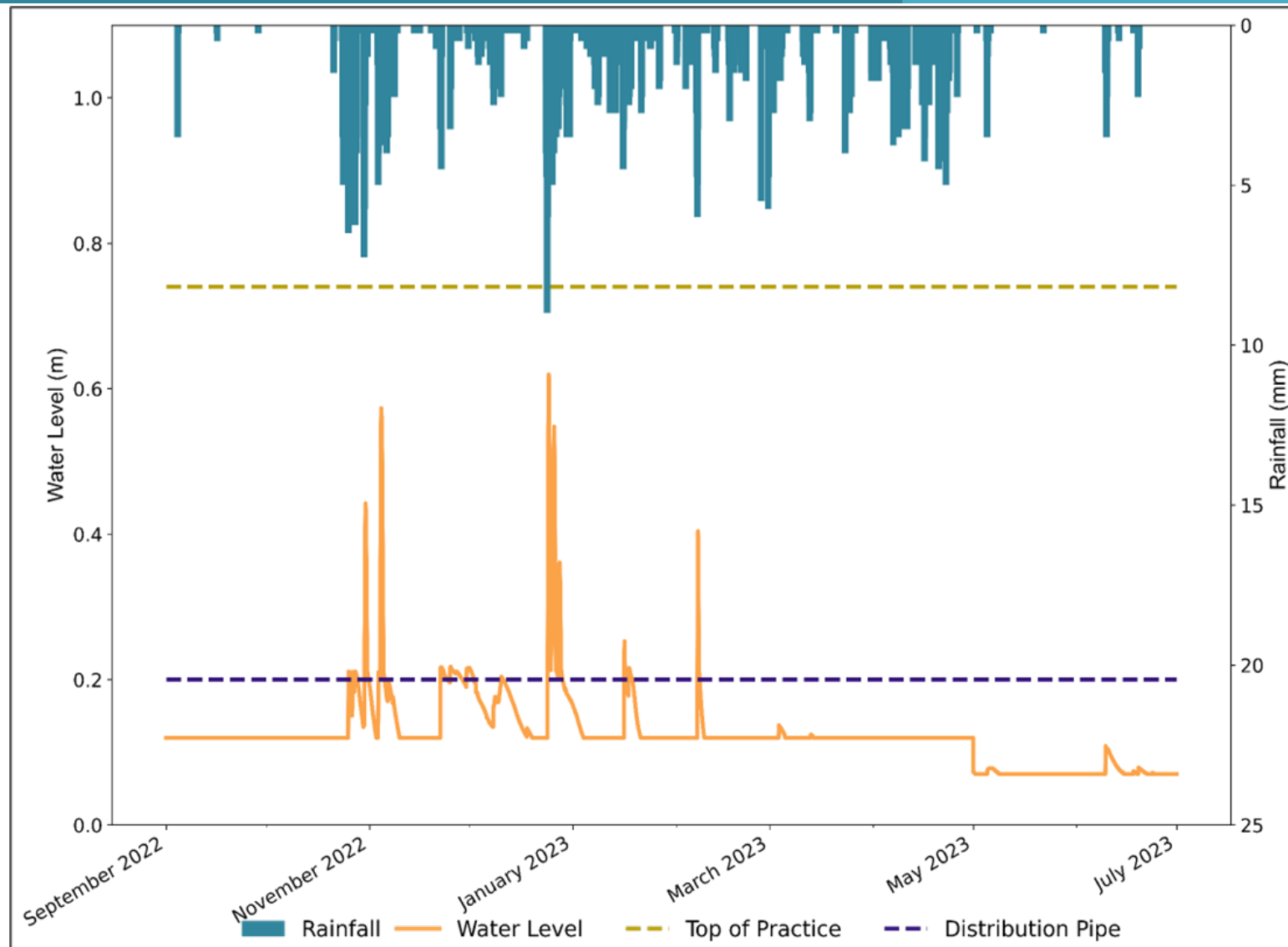
Subsurface Storage empty in <72 h

Design infiltration rates match drawdown rates

Storm Category	Normal (under 24 mm)	Large (between 24 and 48 mm)	Extreme (larger than 48 mm)	Average (weighted)
Drawdown Duration (h)	-	30.1	49.2	37.7
Drawdown Rate (mm/h)	-	4.1	11.2	6.9
Design Infiltration Rate (mm/h)	1			

Water Level

Harriet Laneway



Subsurface Storage empty in <72 h

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Design Infiltration Rate (mm/h)	1			

Water Level

Site Summary

Subsurface Storage empty in <72 h

Design infiltration rates match drawdown rates

Site	Typology	Average Drawdown Time (h)	Average Drawdown Rate (mm/h)	Design Infiltration Rate (mm/h)
Yukon St. and 63 rd Ave.	Bioswale	1.3	497	39
Quebec St. and 2 nd Ave. South	Soil Cell RTT	27.9	9.4	10
Quebec St. and 2 nd Ave. North	Soil Cell RTT	35.9	8.7	10
Richards St. Block H	Bioretention	13.8	40.3	5
Haro St. and Bidwell St.	Dry Well	12.3	92	47
Haro St. and Jervis St.	Bioretention	18.5	20.6	5
Haro St. and Bute St.	Bioretention	N/A	N/A	N/A
W 10 th Ave. and Heather St. East	RTT	22.7	29.7	50
W 10 th Ave. and Heather St. West	RTT	5.15	35.8	50
Harriet Laneway	Infiltration Trench	37.7	6.9	1
Woodland Dr. and 2nd Ave. North	Bioretention	18.5	13.1	1
Woodland Dr. and 2nd Ave. South	Bioretention	9	44	1
Average		16.5	72.5	

Surface Ponding



24 hours later

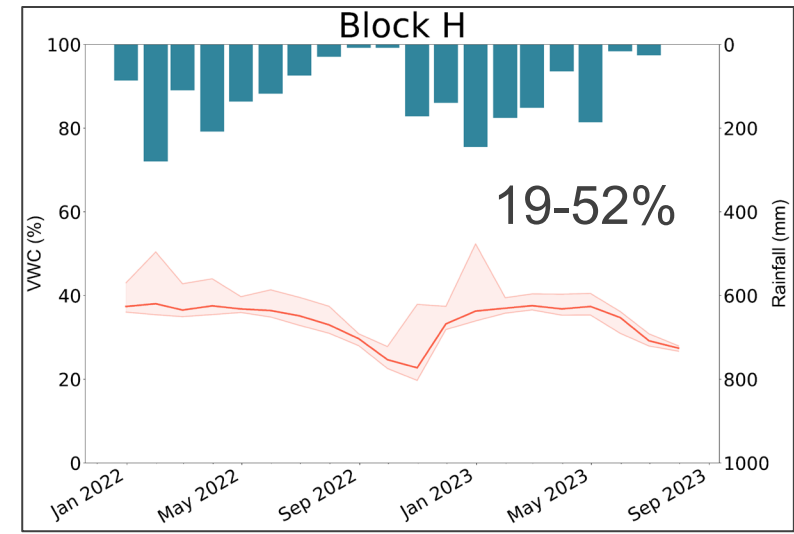
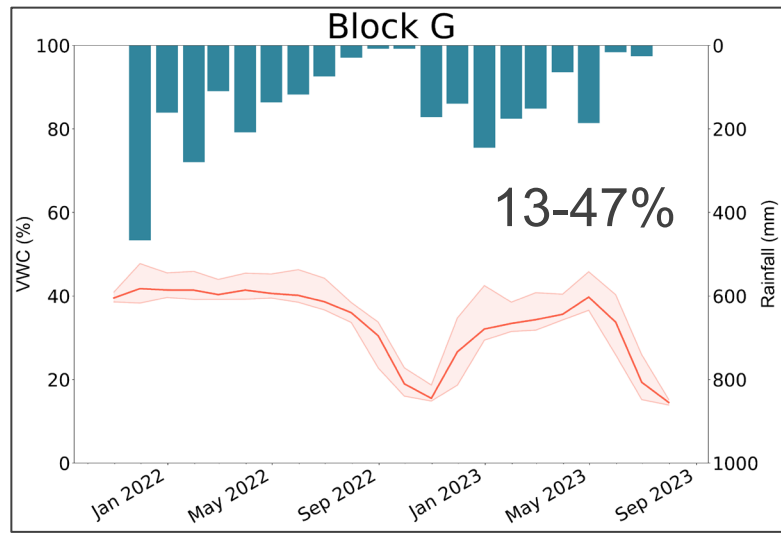
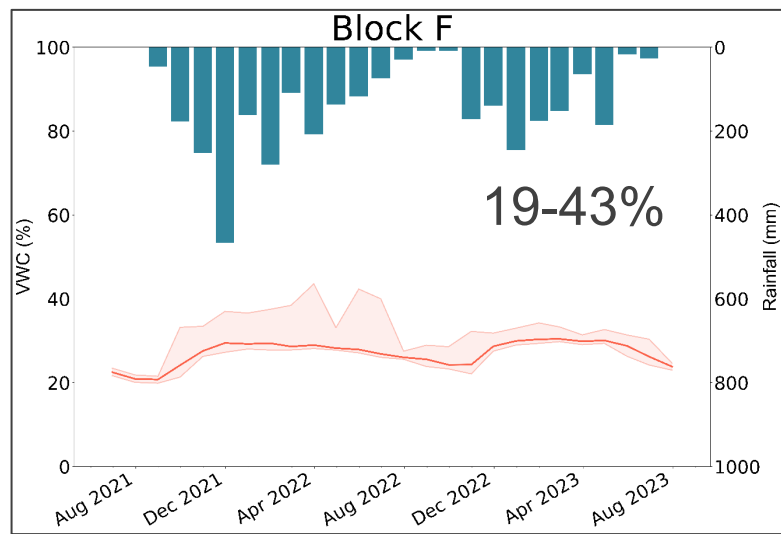
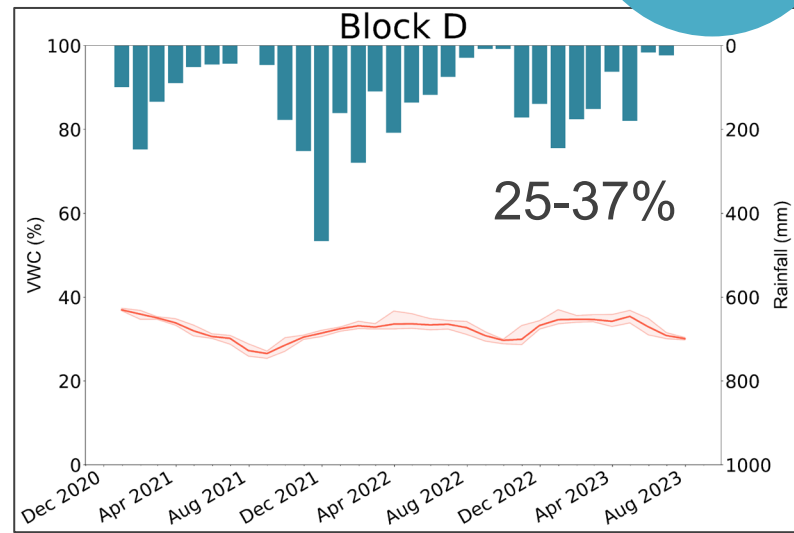
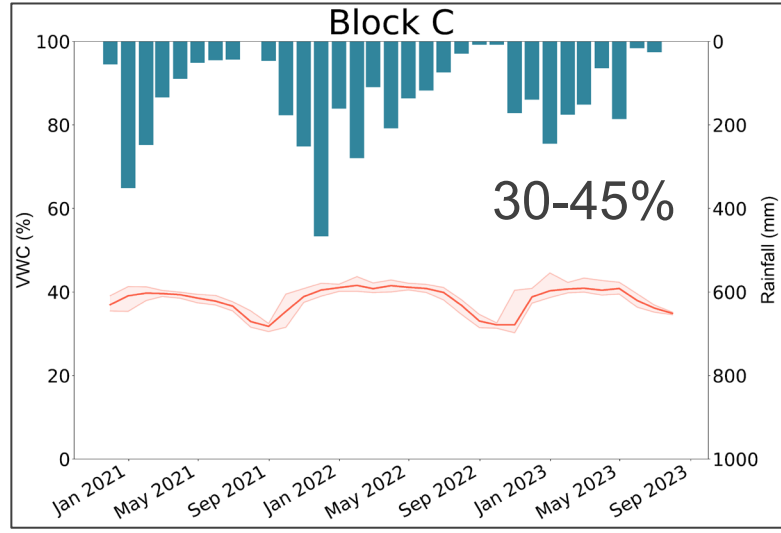
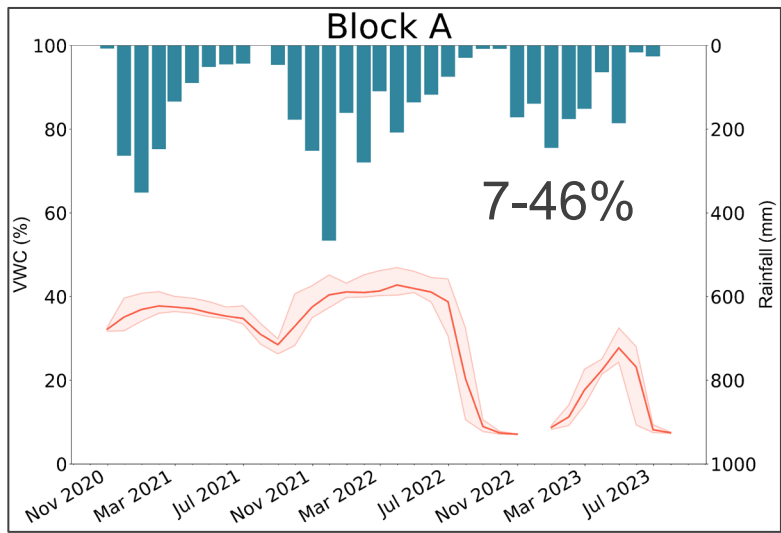


Surface
Ponding
<24 hours

Soil Moisture

Soil moisture for plant health

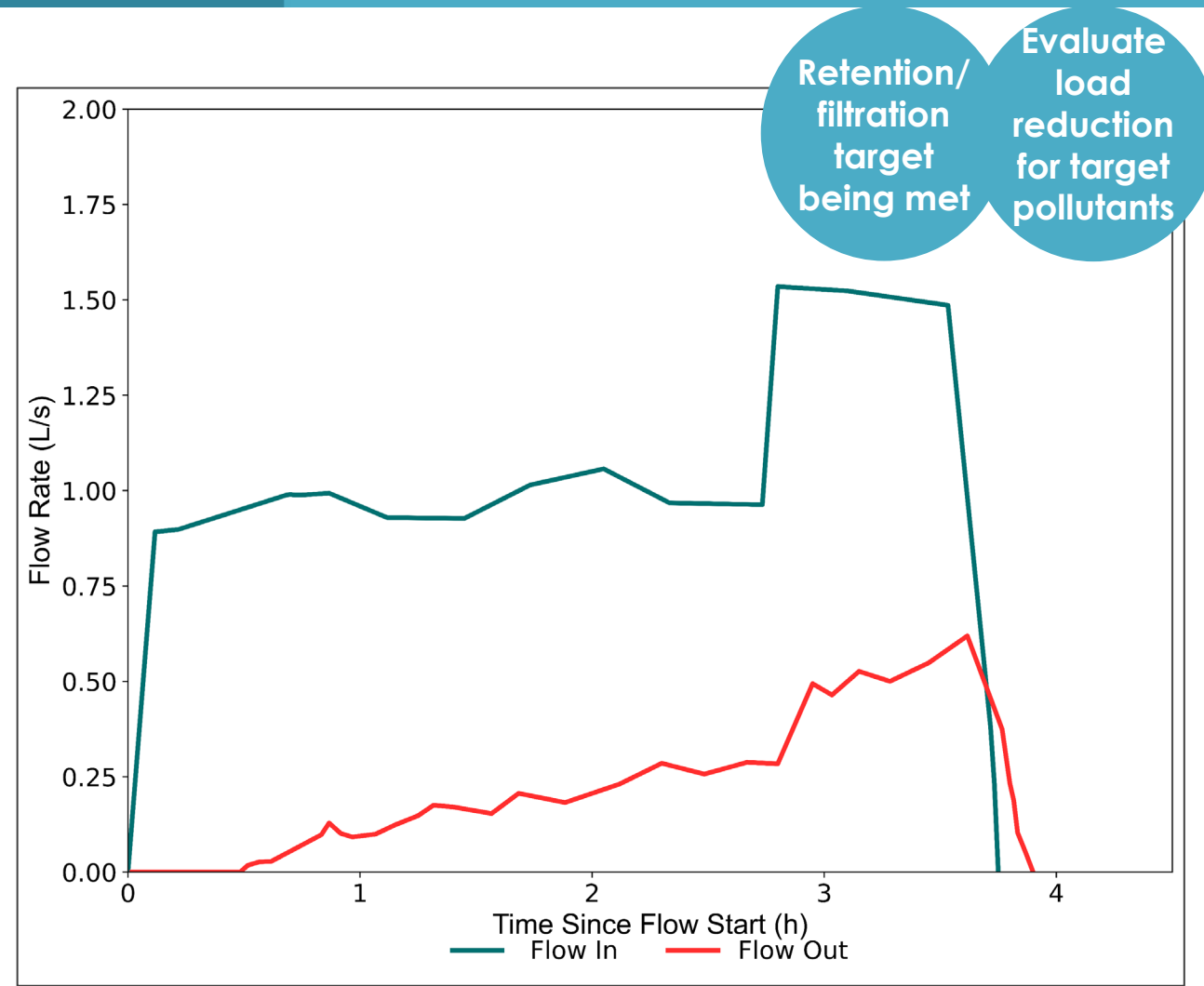
Richards St




Synthetic Runoff Tests



Test # 1 – Bioretention 2021
77% Volume Reduction
>99% TSS Mass Removal



Test # 2 – Bioretention 2022 
76% Volume Reduction
98% 6PPD-quinone Mass Removal

Conclusion

Where
Does
Rainwater
Go?

GRI in
Vancouver

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Performance Monitoring Objectives

**Surface
Ponding
<24 h**

No ponding
after 24
hours

**Design
infiltration
rates match
drawdown
rates**

7 sites equal
or greater
than design
infiltration
rate

**Retention/
filtration
target
being met**

Add caps to
underdrains

**Subsurface
Storage
empty in
<72 h**

More
capacity for
subsurface
storage

**Soil
moisture for
plant
health**

Moisture
range
amenable to
plant health

**Evaluate
load
reduction
for target
pollutants**

High
pollutant
mass
removal

Next Steps

- Continue to monitor water level and drawdown
- Spot check soil moisture
- Water quality and flow testing as opportunities arise
- New assets typologies to monitor
- Sediment monitoring in dry wells
- Adapt GRI practices after installation
- Network connected monitoring devices
- Citizen science biodiversity monitoring



For more information about City of Vancouver's GRI Performance Monitoring



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