



# Implementation from Design to Monitoring of Blue-Green Systems: Creating connected and multi-beneficial solutions for the road right-of-way in Vancouver

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I gratefully acknowledge that we live, work and play on the traditional, unceded territories of the xʷməθkʷəy̓əm (Musqueam), Skwxwú7mesh Úxwumixw (Squamish Nation) and səlilwətał (Tsleil-Waututh) Peoples.





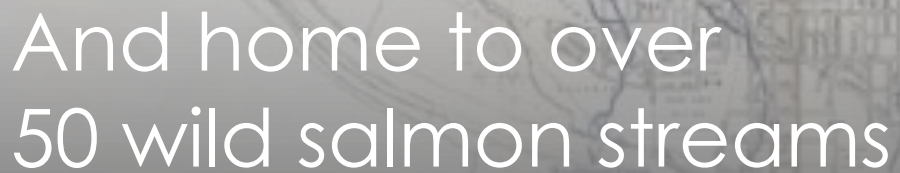
The city once was a  
temperate rainforest

Image: Capilano River Regional Park, North Vancouver  
Photo Credit: Robert Pennings

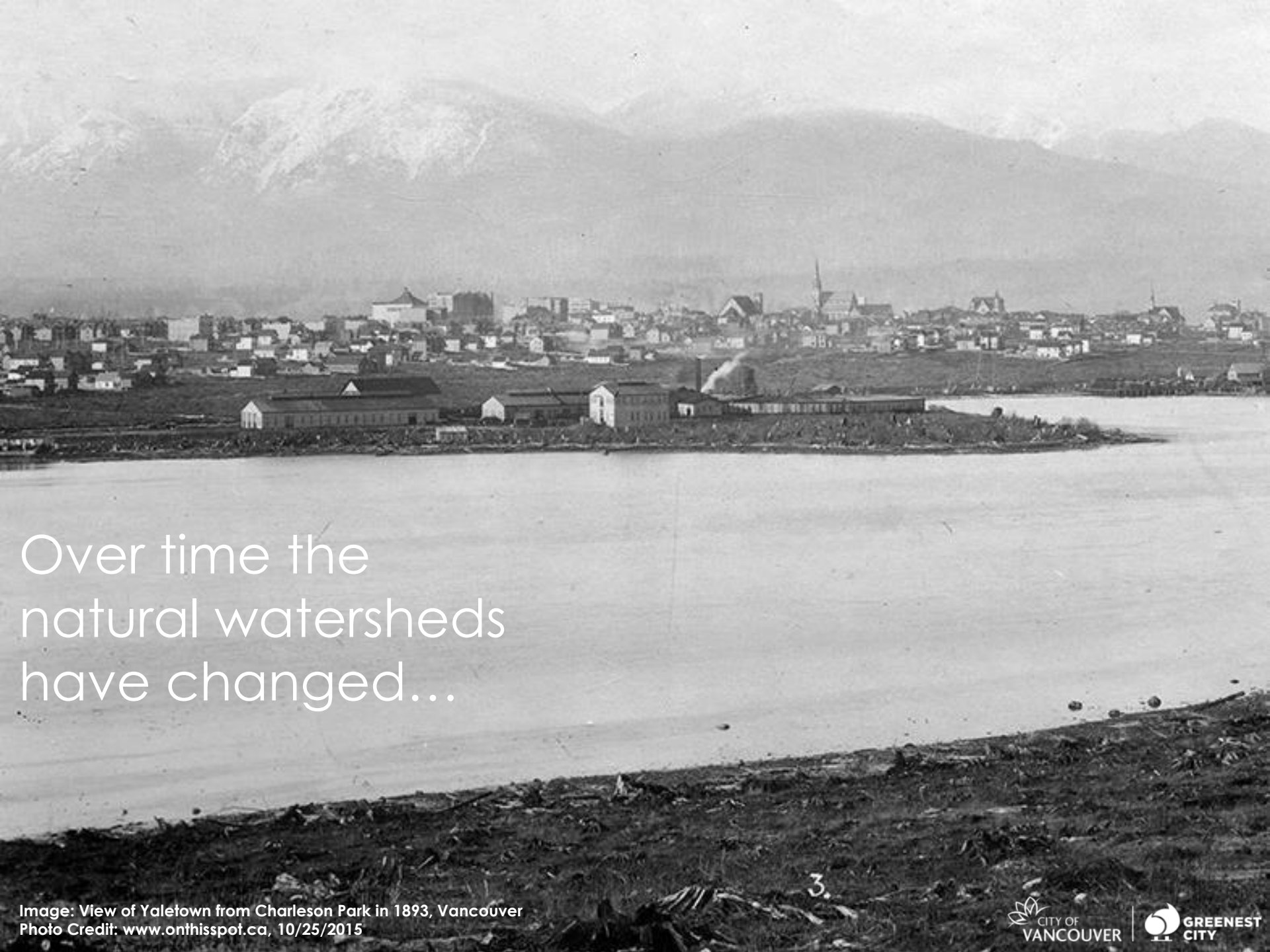


**Keywords:** *workplace spirituality, organizational commitment, organizational trust, organizational identification, organizational citizenship behaviors*

————— Original data line  
 ———— Revised and estimated  
 \*\*\*\*\* Estimated gaps of coverage







Over time the  
natural watersheds  
have changed...



to allow residents and  
businesses to grow



Image: View of Yaletown from Charleson Park in 2013, Vancouver  
Photo Credit: Wendy de Hoog



Think  
strategically  
about adapting  
for the future

**climate  
change**

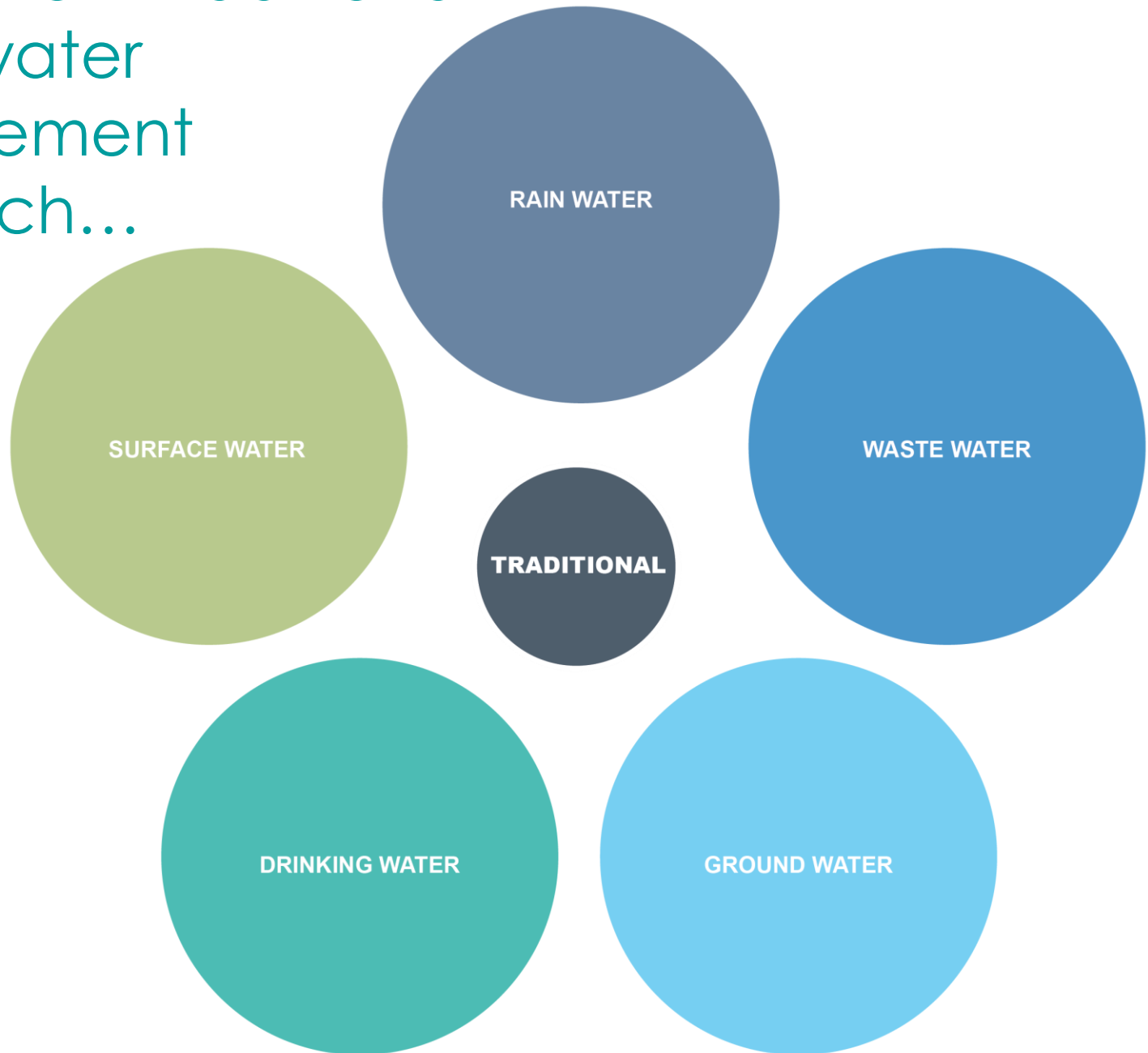
**water quality  
& ecosystem  
health**

**growth &  
utility servicing  
& economics**

**equity &  
reconciliation**

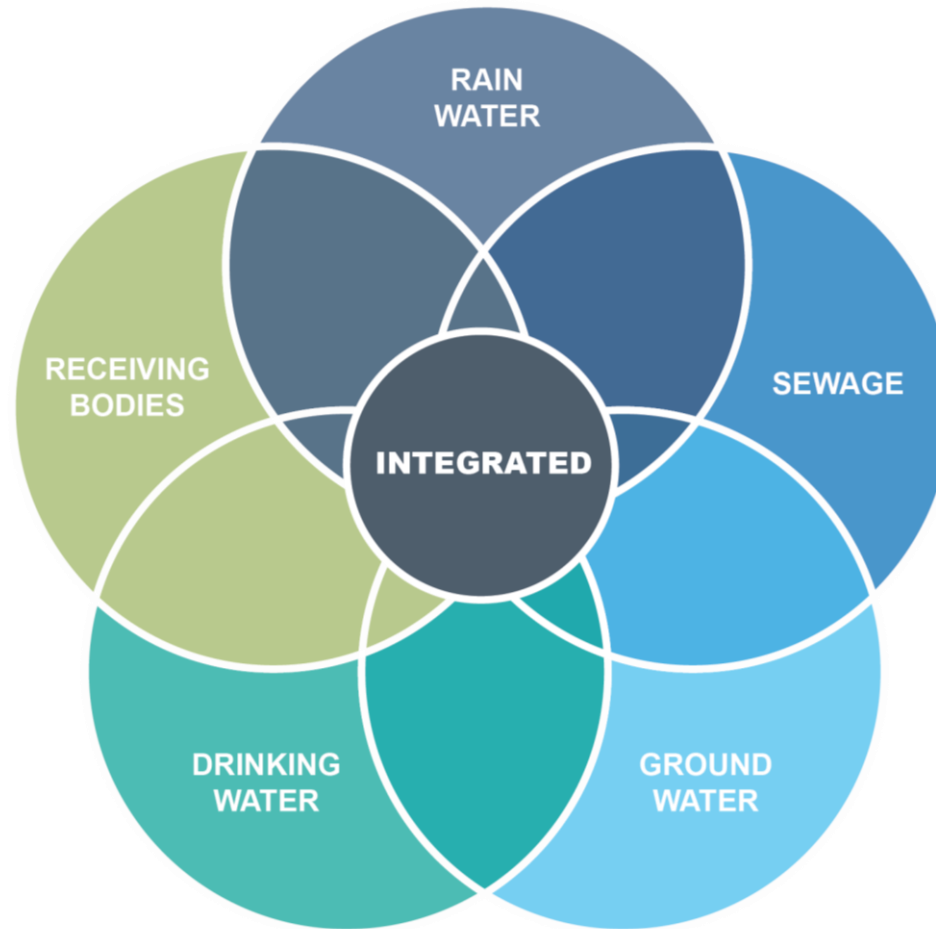


Shifting from traditional  
urban water  
management  
approach...



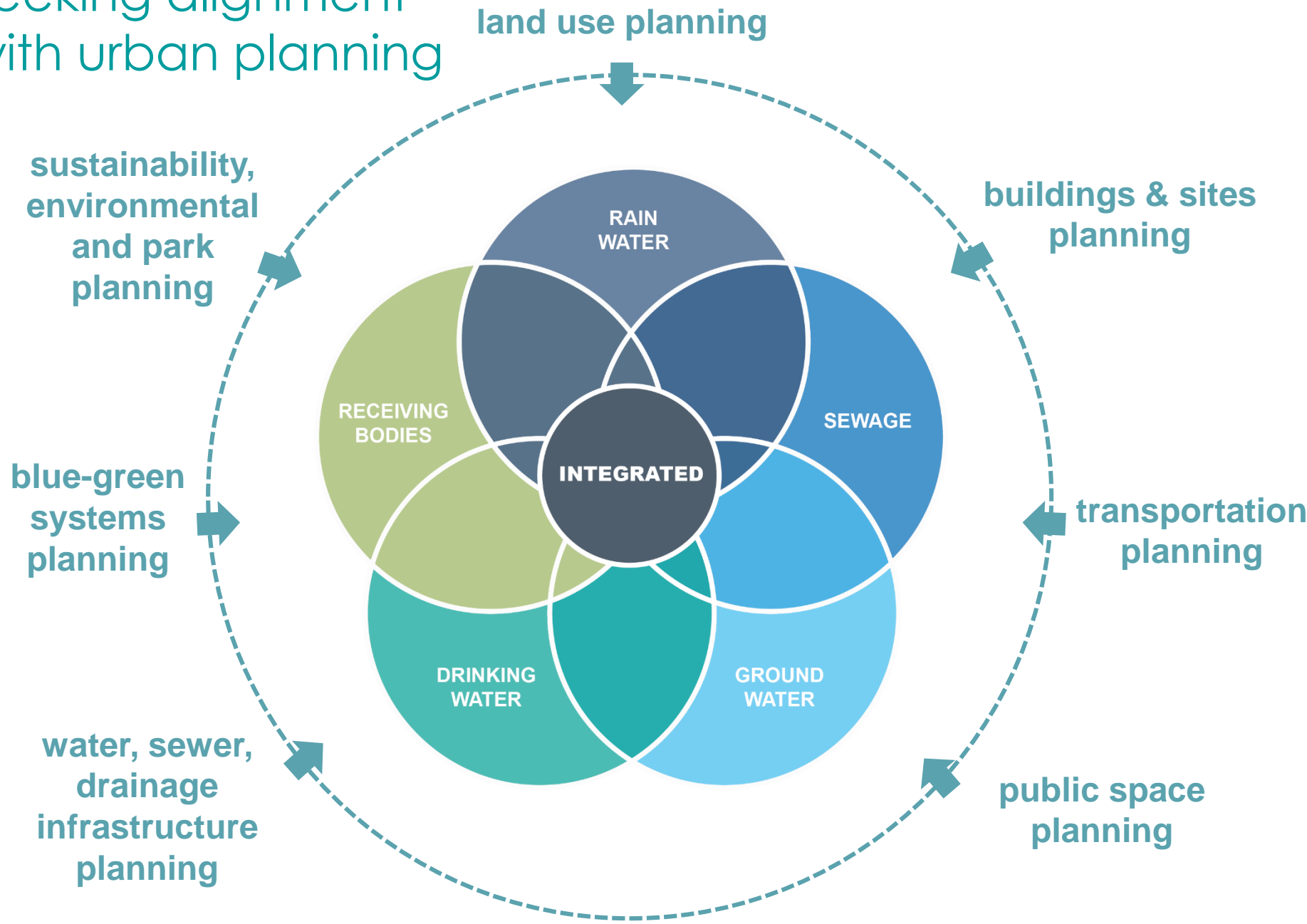


...to integrated urban  
water management  
approach





# Seeking alignment with urban planning





# Rain City Strategy

9

transformative  
directions

3

action plans

Streets & Public Spaces  
Buildings & Sites  
Parks & Beaches

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

protects

restores

mimics

the natural water cycle



# **TRANSFORMATIVE DIRECTION: BLUE GREEN SYSTEMS PLANNING**

Networks of park-like streets that manage water and land in a way that is inspired by nature and designed to replicate natural functions and provide ecosystem services

**Water  
management**

**Nature  
in the city**

**Active  
Transportation**

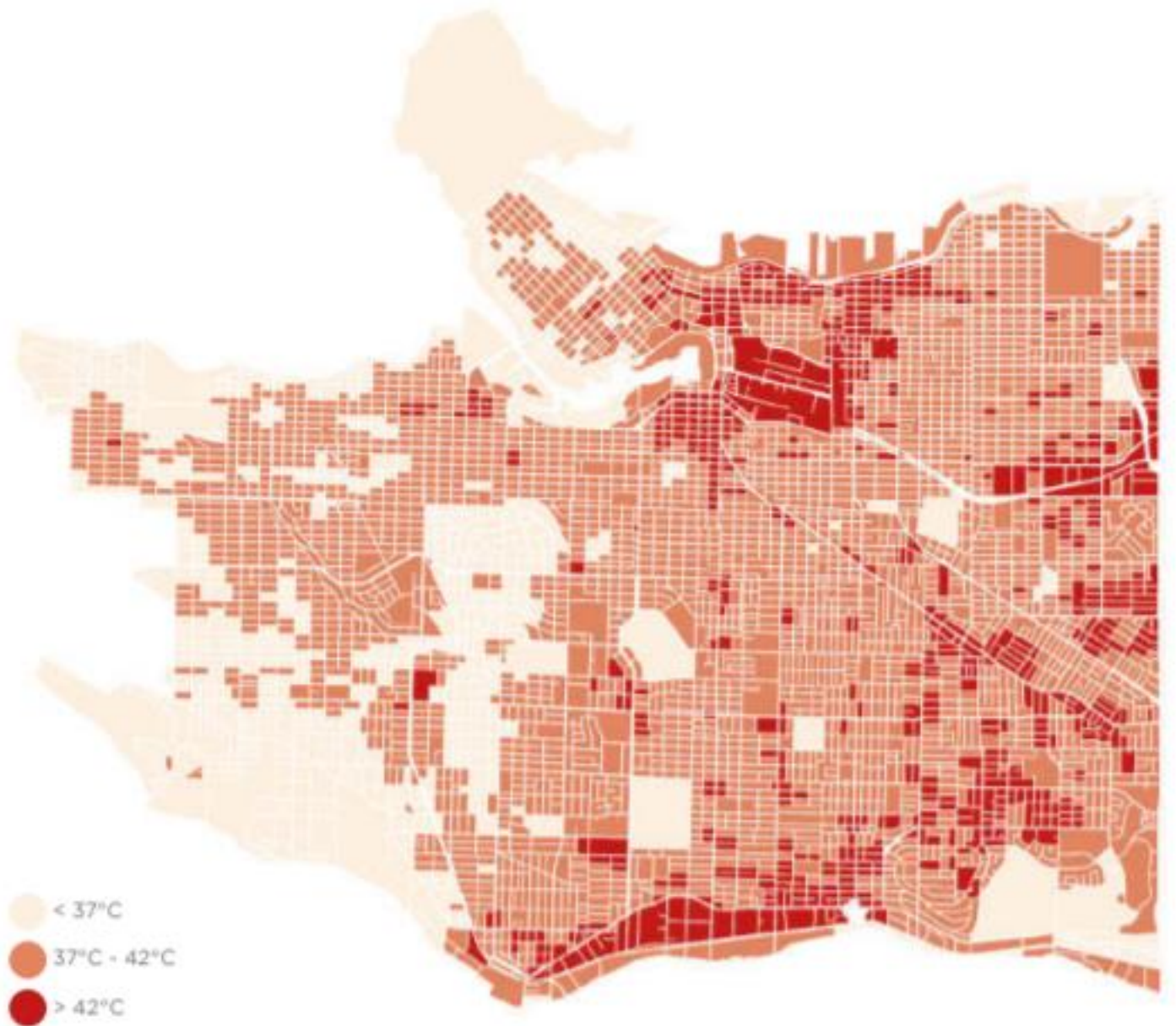






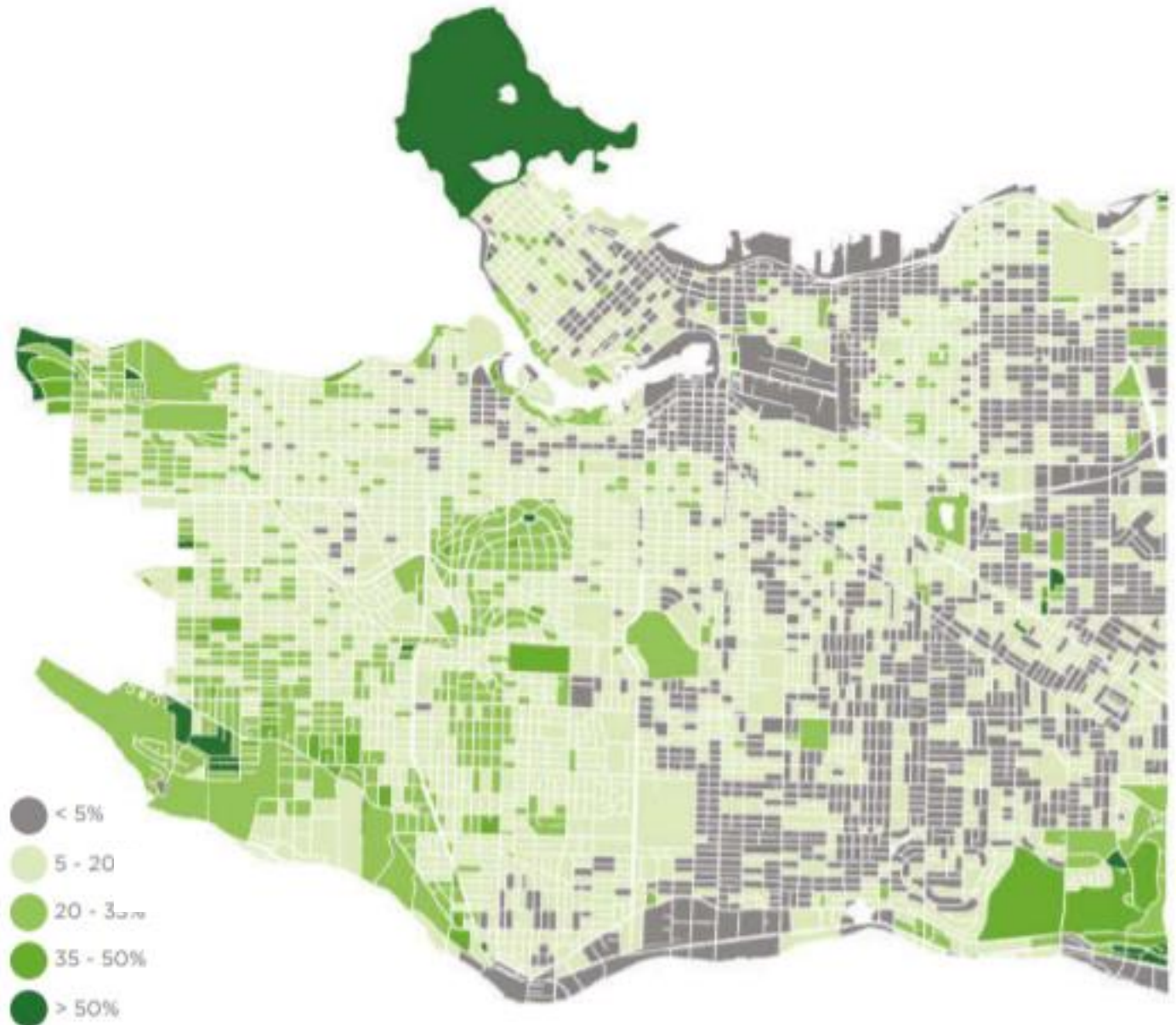
# BLUE GREEN SYSTEMS PLANNING

Urban heat island



# BLUE GREEN SYSTEMS PLANNING

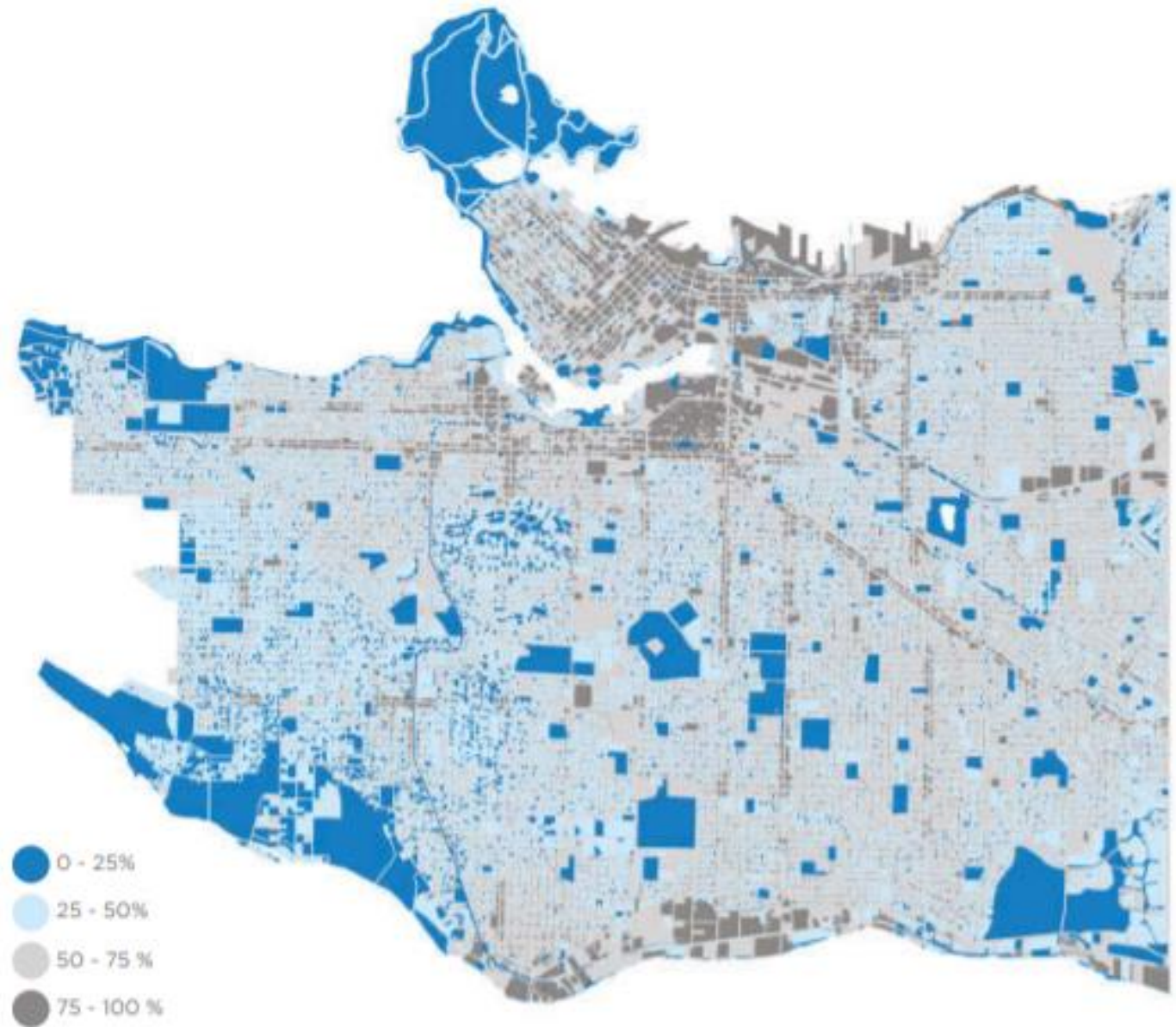
## Tree Canopy Cover





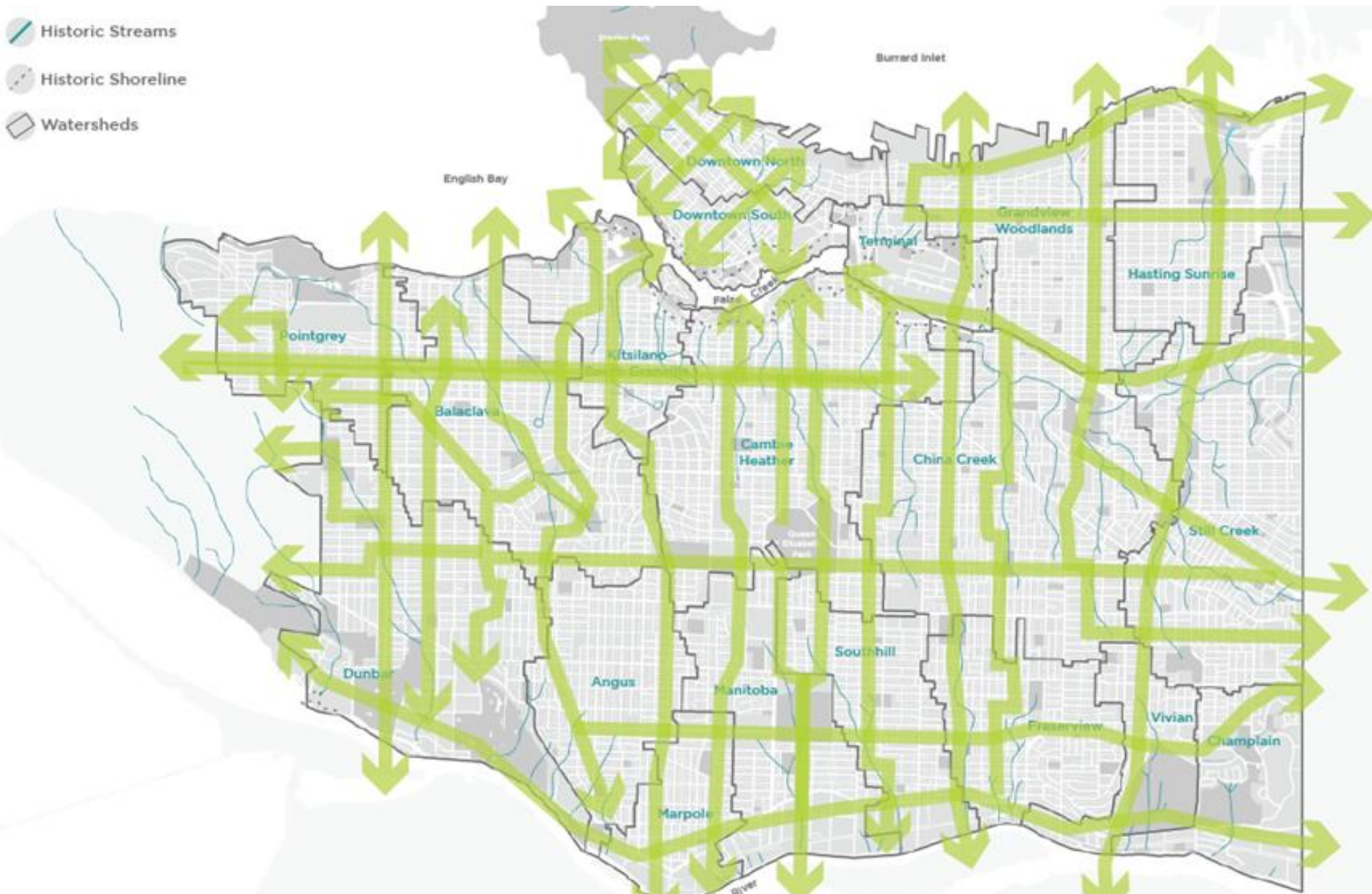
# BLUE GREEN SYSTEMS PLANNING

Perviousness



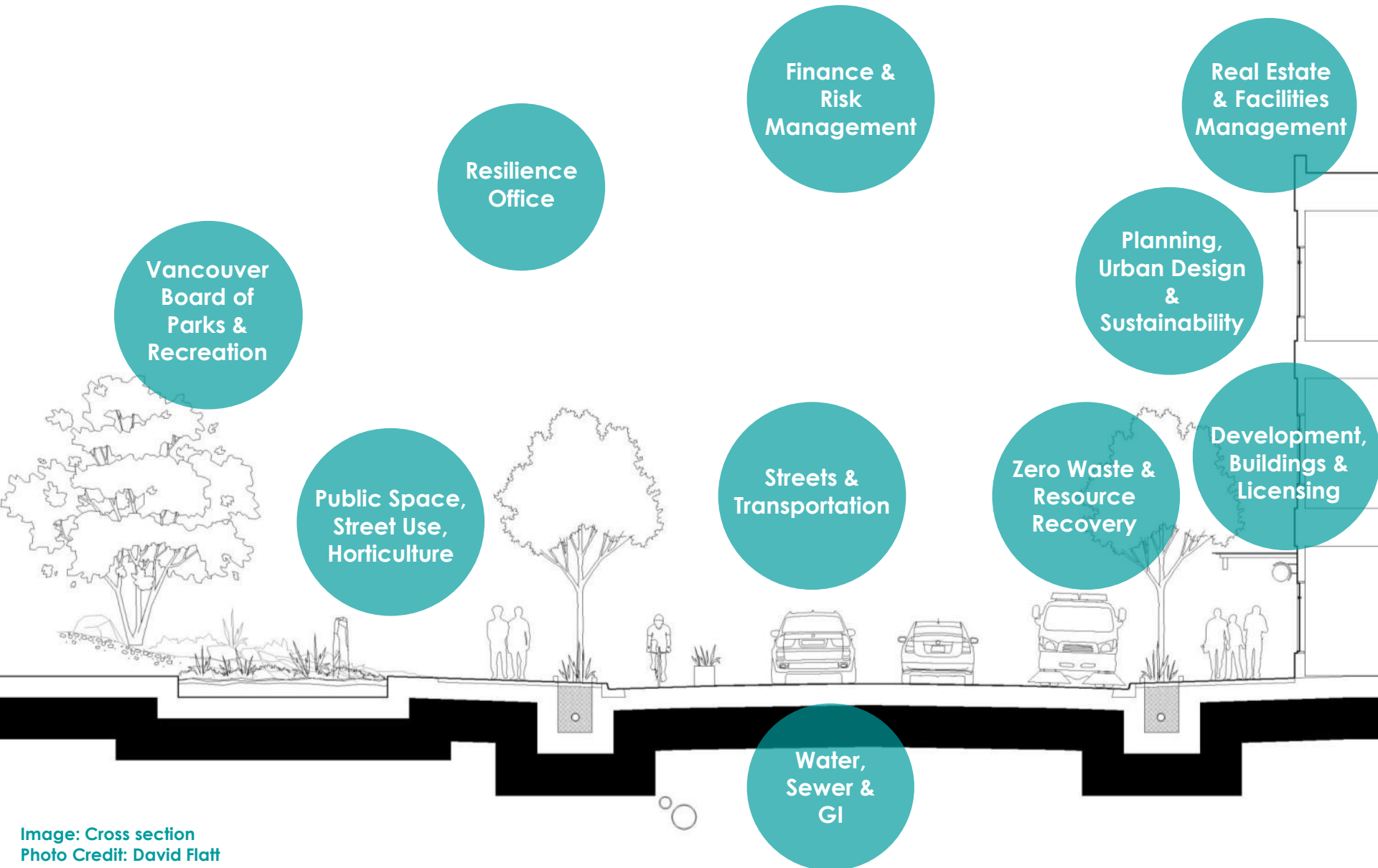
# BLUE GREEN SYSTEMS PLANNING

- Historic Streams
- Historic Shoreline
- Watersheds





# A collaborative effort across departments






Image: Bioretention Bulge, River District  
Photo Credit: Kristen Hudson

# Today

## 300+

Existing green  
infrastructure practices

## 400+

Public realm practices  
being pursued

## 55%

Impervious area (citywide scale)

## 45%

Pervious area (citywide scale)



# 312 GRI Assets in Vancouver



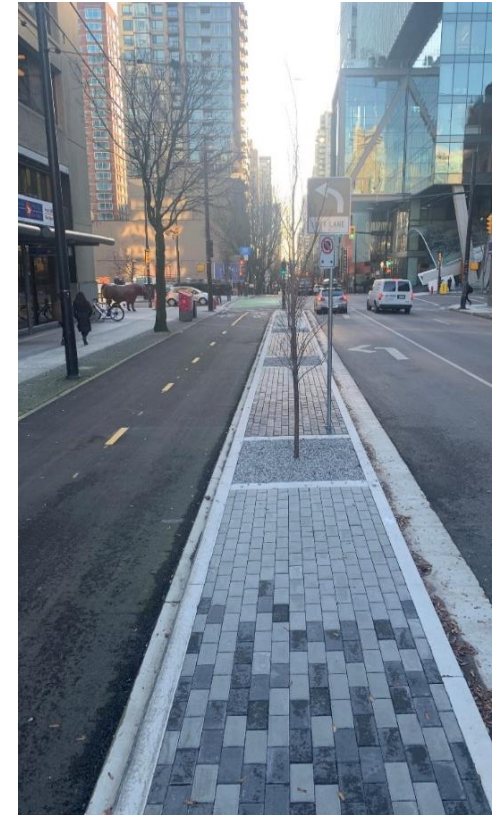
**Bioretention (62%)**



**Permeable  
pavement (15%)**



**Sub-surface infiltration (19%)**

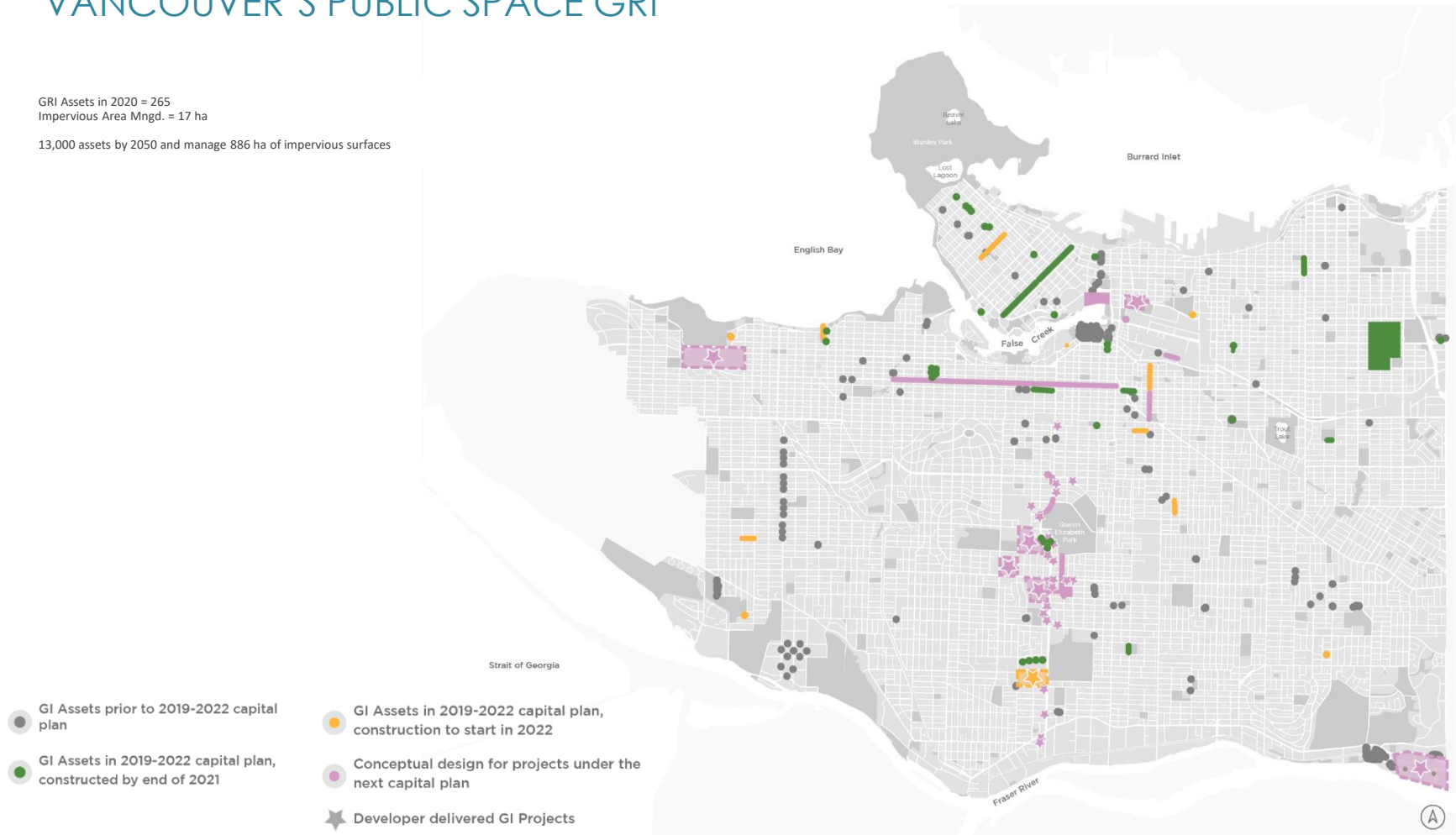


**Rainwater tree trenches (4%)**

# VANCOUVER'S PUBLIC SPACE GRI

GRI Assets in 2020 = 265  
Impervious Area Mngd. = 17 ha

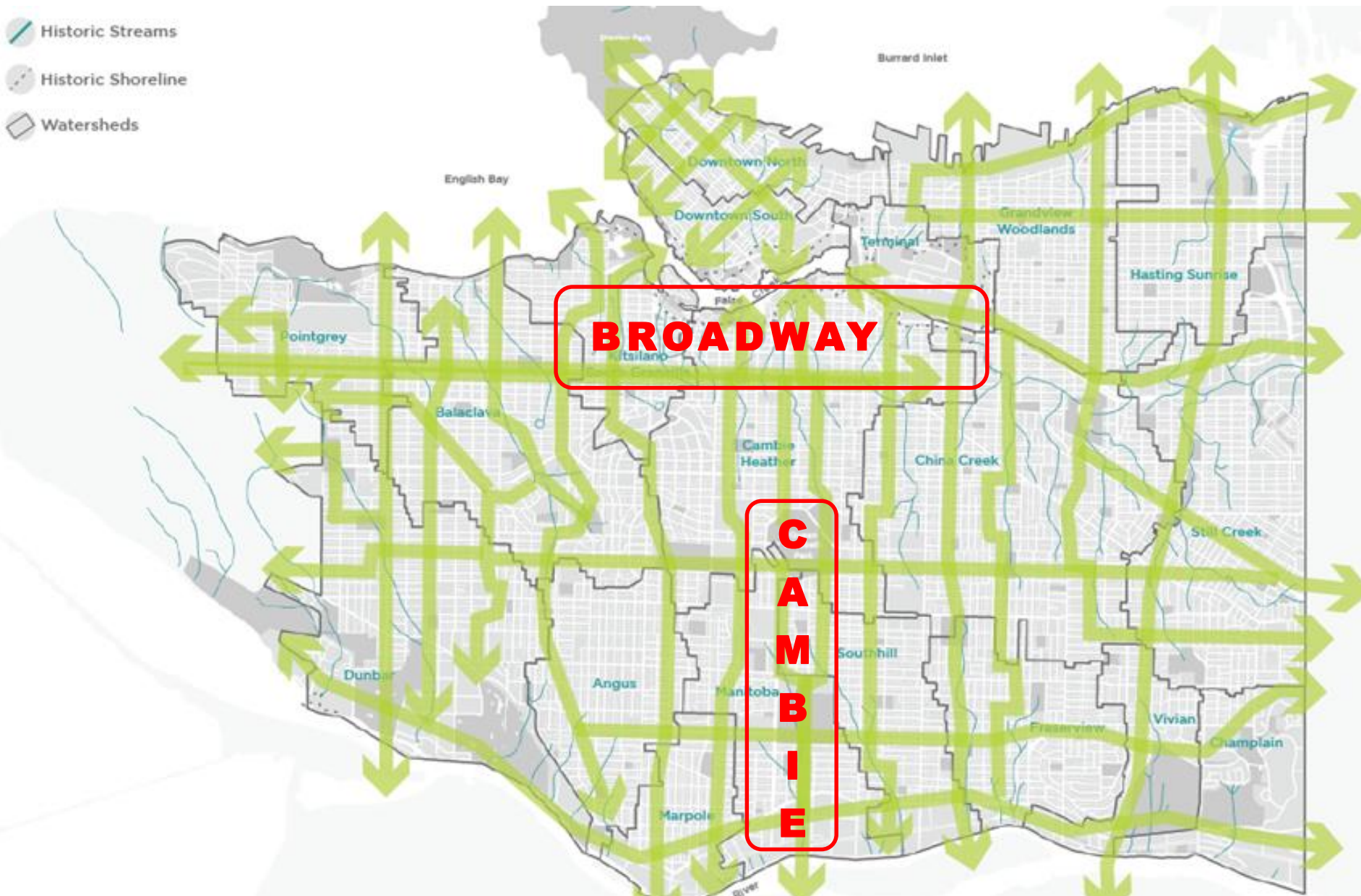
13,000 assets by 2050 and manage 886 ha of impervious surfaces





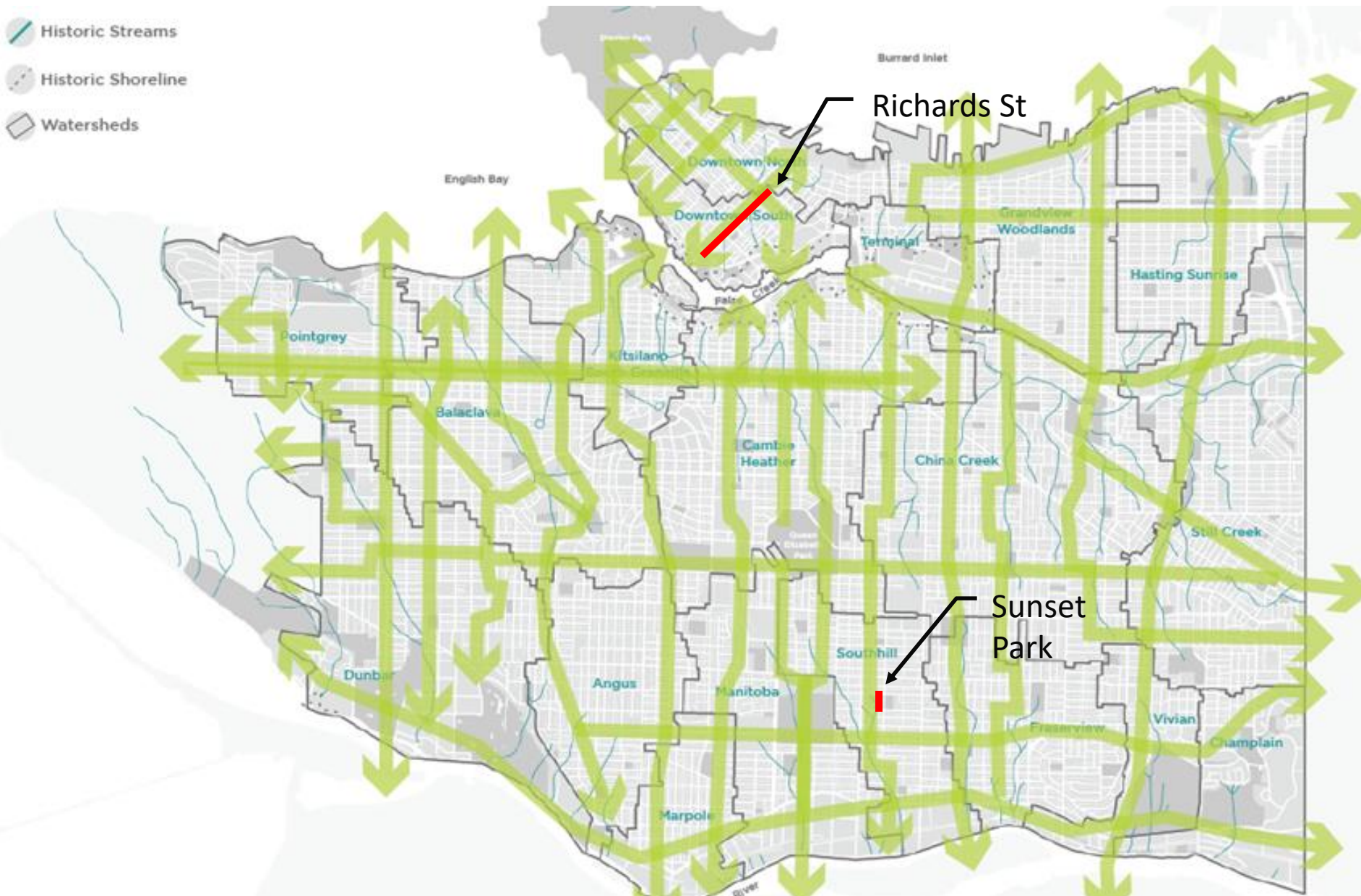
# BLUE GREEN SYSTEMS PLANNING

- Historic Streams
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# BLUE GREEN SYSTEMS PLANNING

- Historic Streams
- Historic Shoreline
- Watersheds





# Richards Street Blue-Green System



 **16 sensors installed**  
Monitoring soil moisture levels

 **8 Blocks, two-way**  
All ages separated bike Lane

 **4.2 Thousand lbs**  
Carbon sequestration annually

 **1.1 hectares**  
Street runoff managed annually

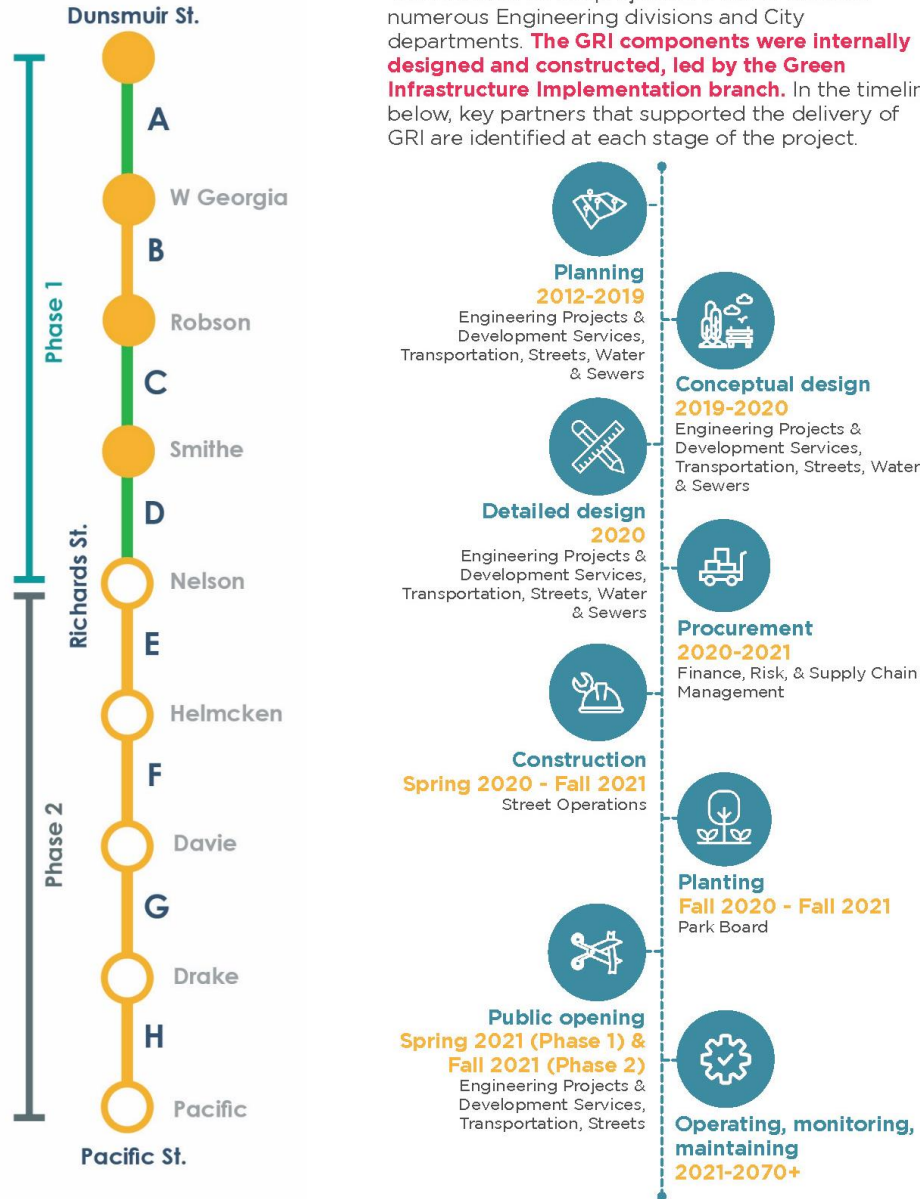
 **11 million litres**  
Runoff diverted from sewers annually

 **15 million litres**  
Runoff treated on-site annually

 **100+**  
New trees

## Timeline & partners for GRI

The Richards Street project as a whole involved numerous Engineering divisions and City departments. **The GRI components were internally designed and constructed, led by the Green Infrastructure Implementation branch.** In the timeline below, key partners that supported the delivery of GRI are identified at each stage of the project.

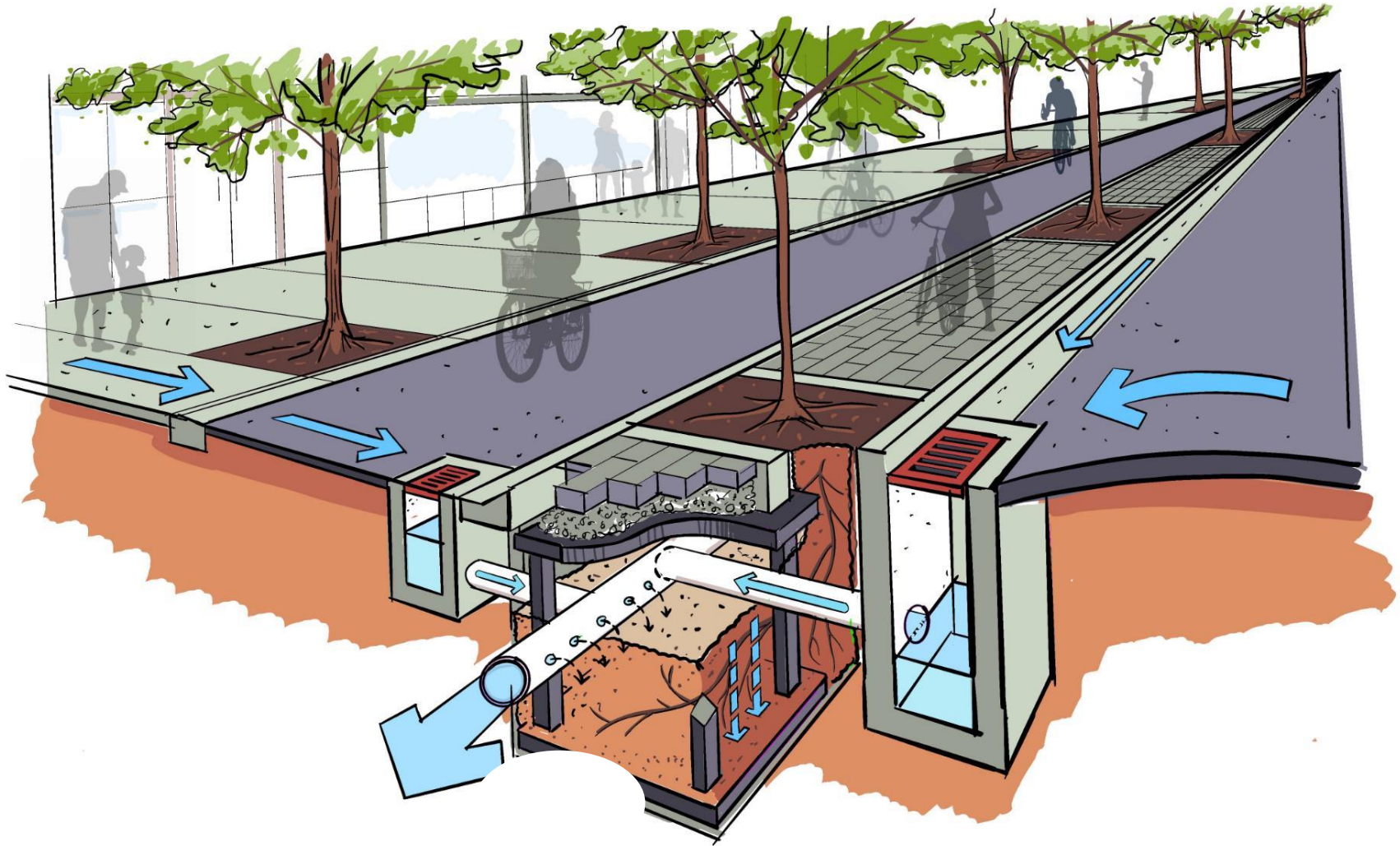


## Stakeholders (13 internal & external stakeholders)

- Transportation Design Branch
- Street Design Branch
- Electrical Design Branch
- Water Design Branch
- Sewer Design Branch
- Project Delivery Branch
- Traffic and Data Management
- Street Operation
- Supply Chain Management
- Central Store
- BC Hydro
- Utility Branch
- Communications



# Rainwater Tree Trenches





# Rainwater Tree Trenches at Richards St

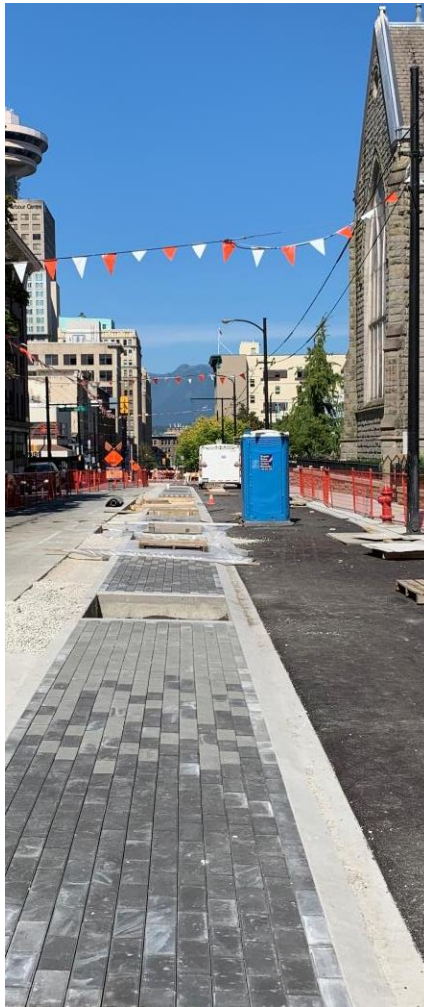
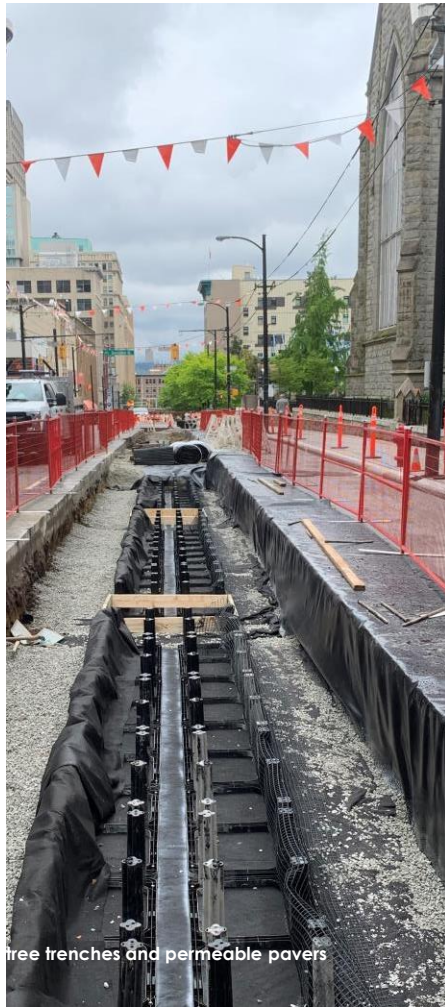


Image: Construction of Richard Street bike lane with tree trenches and permeable pavers  
Photo Credit: Connor Redman



# Rainwater Tree Trenches at Richards St

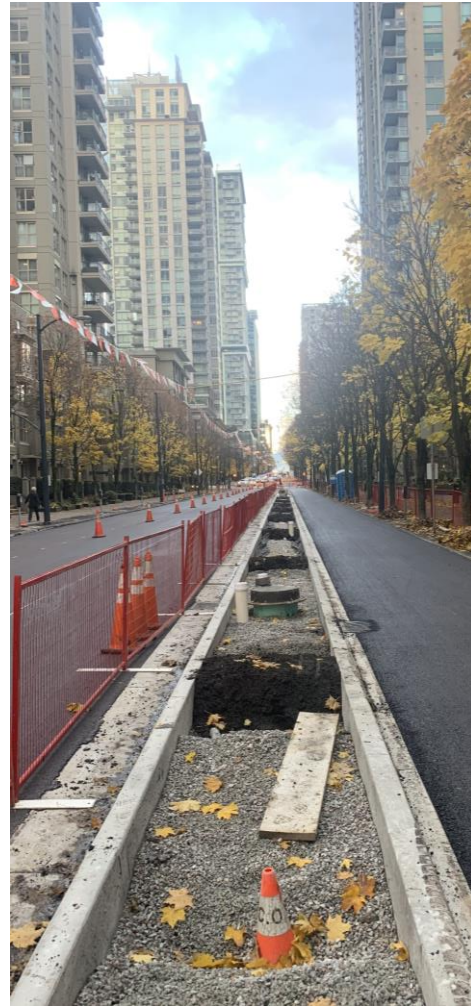
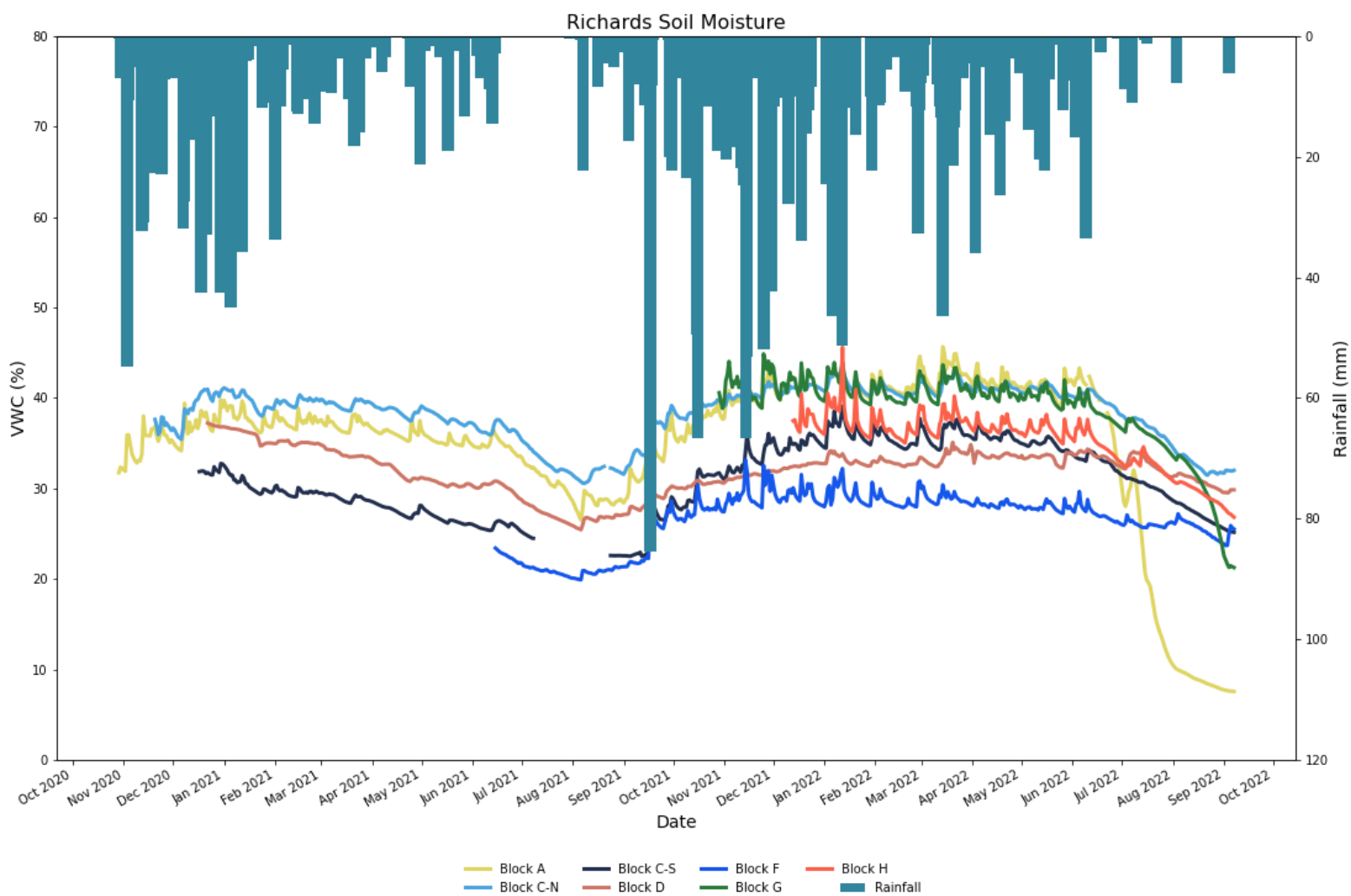
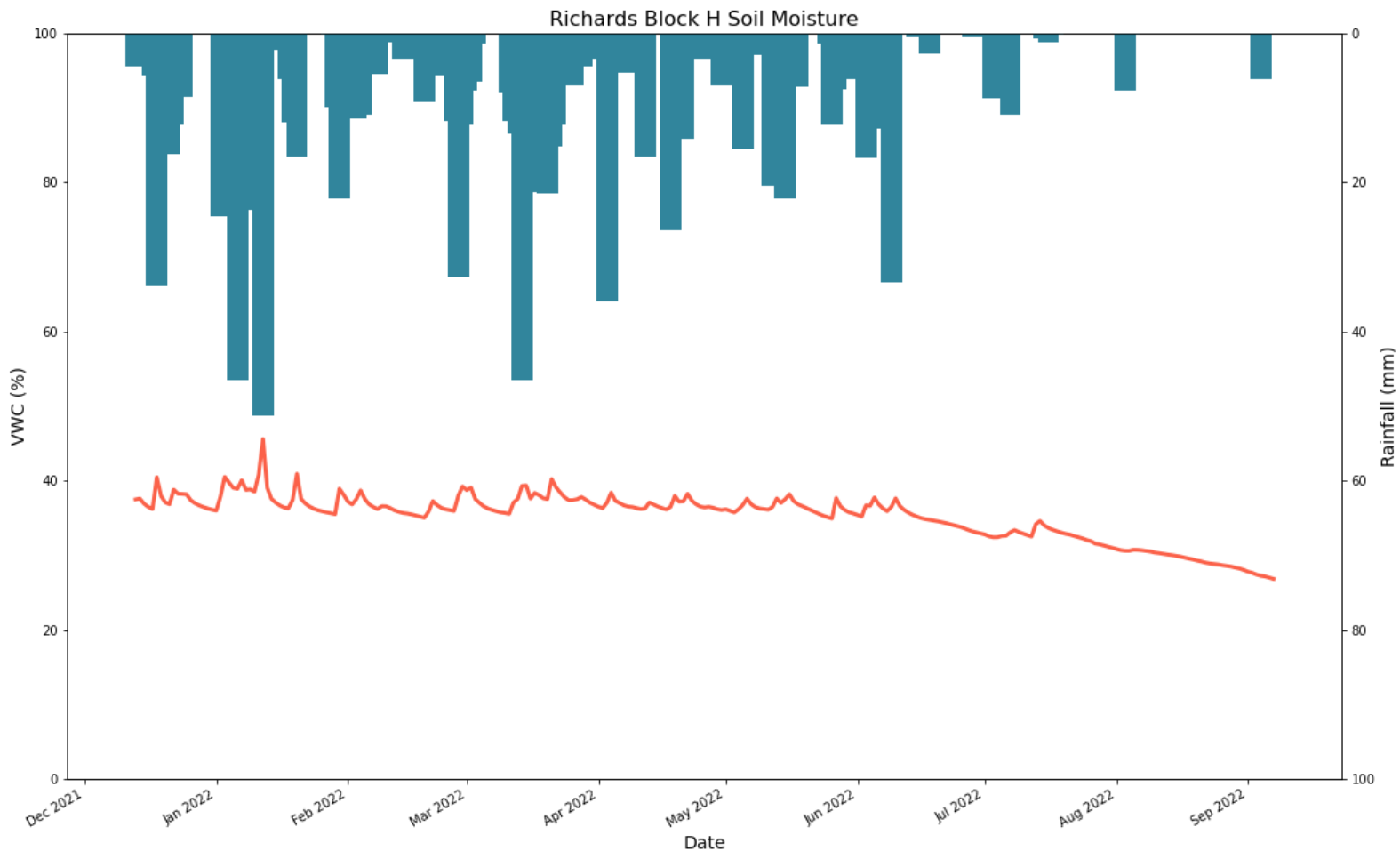


Image: Construction of Richard Street bike lane with tree trenches and permeable pavers  
Photo Credit: Connor Redman







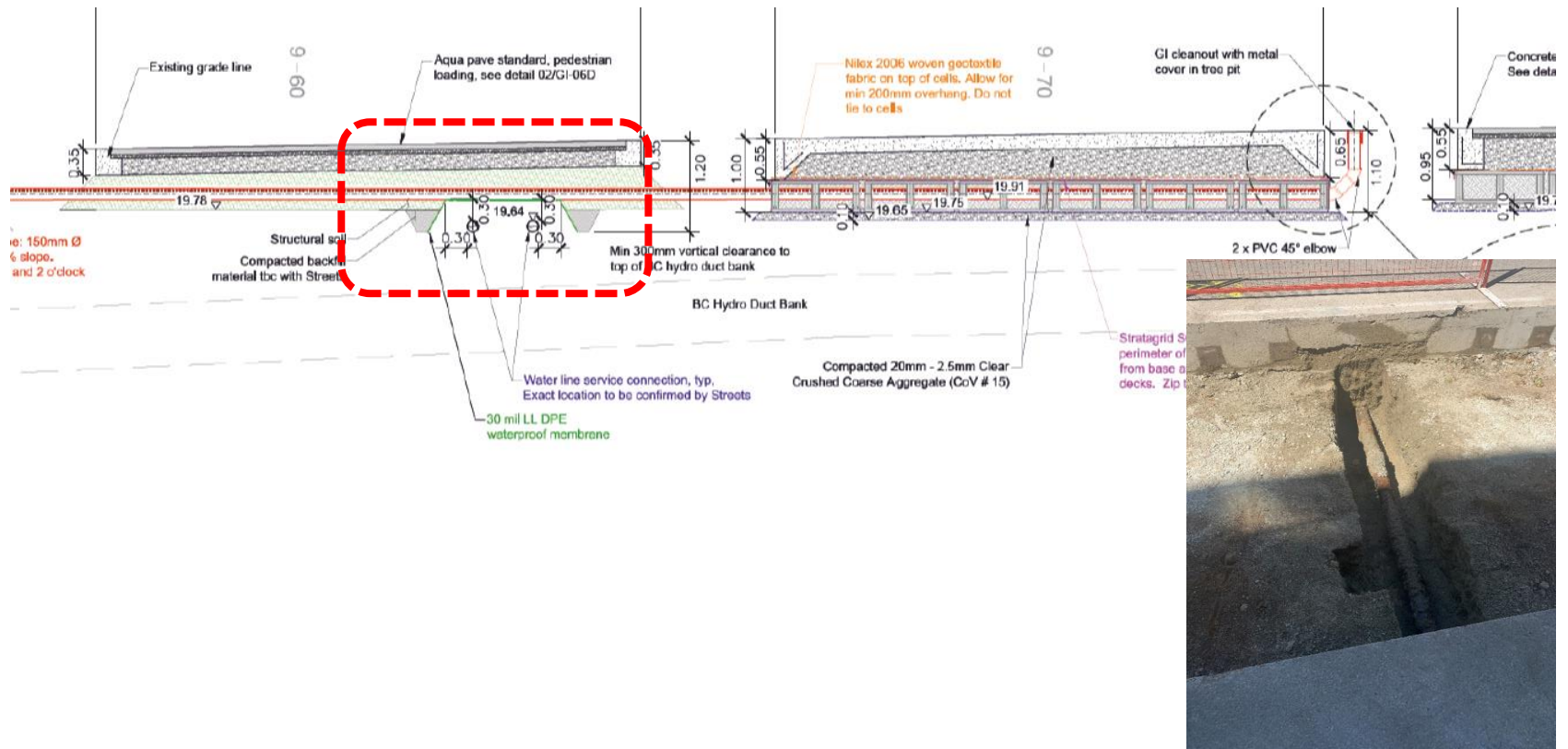
# Richards St Lessons Learned-GI install

1. **Structural soil vs Soil Cell** - Structural soil is about **15%** faster for installation time. Crews have shown no preference for soil cells vs structural soil. Cost-saving by using Structural soil is **15-20%** compared originally estimated **30%**.



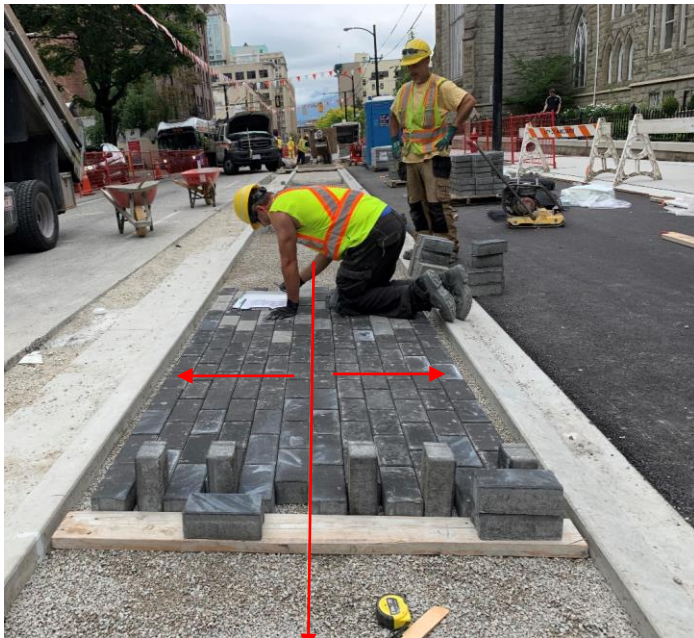


# Richards St Lessons Learned-Utility Crossing



# Lessons Learned-Permeable Pavers

- 1) Connect with crew during design phase for input on details, layout etc.
- 2) Work with TDE during Geometric Design to determine the width of the median so as to eliminate the need for cutting. Paver install is labor intensive, labor cost is up to 85%, Eliminating cutting will significantly reduce Interlocking Permeable Paver rates.



With no consideration given to median width, pavers along both sides of the median need to be cut one by one.



Block A- Permeable pavers with non-modified median width



Block B - Permeable pavers with modified median width – no paver cutting



## Lessons Learned-Asphalt bikelane paving

- 1) North half of Block A and Block D - Bikelane was paved with crown instead of 1-2% cross fall resulting in surface runoff bypassing GI CB. 1.0% crossfall is difficult to pave to and it doesn't provide much construction tolerance.
  - Block A (Dunsmuir to Georgia) – north of the midblock driveway – 1.5%
  - Block A (Dunsmuir to Georgia) – south of the midblock driveway – 2.5%
  - Block D (Smithe to Nelson) – 1.0%
  - Cost increase from 1%-2% crossfall \$90,000/block
- 2) Asphalt has been left quite high against the tree trench gutter at Type E curb and low spots in bikelane.

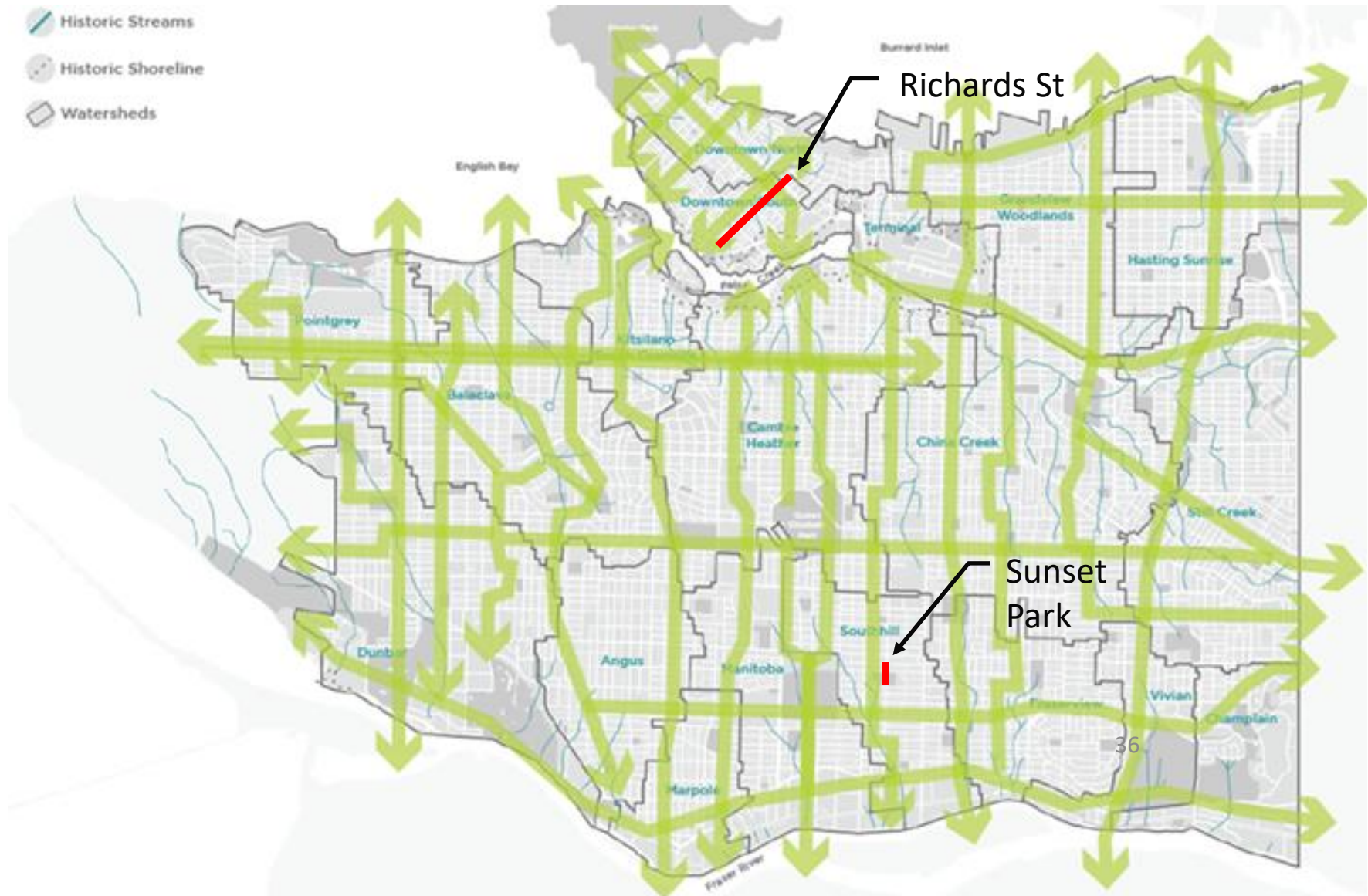








# Blue-Green Networks



# Prince Edward Street Closure— Sunset Park Bioswale



**Current:** Construction Complete

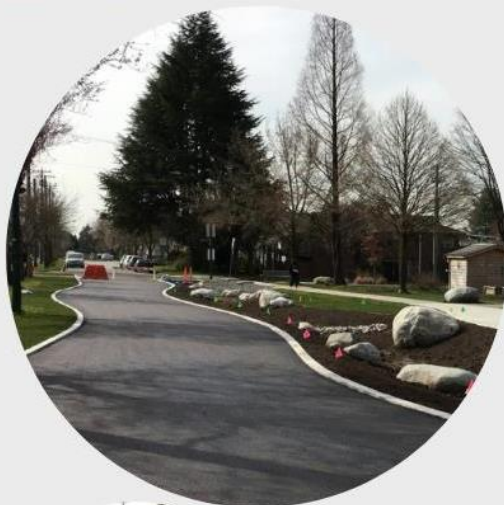
**Timeline:** Q3 2020 - Q1 2021

**Cost:** \$500 K

## Highlights:

- Road closure with bioswale and AAA bike lane
- 3 new trees planted
- Carbon sequestration: 33 lbs/yr
- Manages: 0.45 ha impervious
- Captures & cleans: 4.2 M L/yr



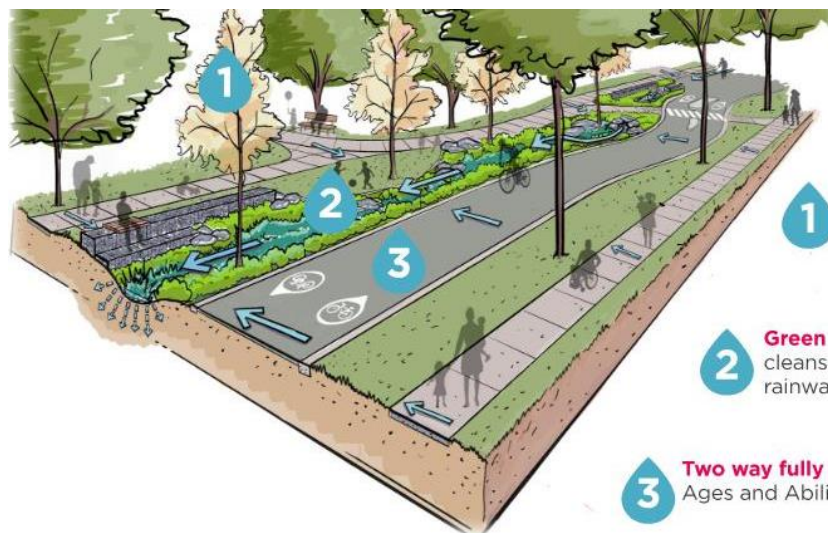


 **3**  
new trees

 **2097 kg**  
carbon sequestration over 50 years

 **4.5 thousand m<sup>2</sup>**  
impervious area managed

 **4 million litres**  
urban rainwater runoff treated  
onsite annually



## Project design

### Project elements

**1** **Trees** create a shady canopy while also cleaning the air, improving habitat for birds, and improving our health and wellbeing.

**2** **Green rainwater infrastructure** collects, cleans, and absorbs polluted urban rainwater runoff from streets and sidewalks.

**3** **Two way fully protected bike lanes** provide an All Ages and Abilities active transportation route.

## Design components



**Inlet** directs water into the bioswale and removes sediment.



**Bioretention soil** has a high capacity for rainwater infiltration, removes pollutants, and supports plant growth.



**Juncus** is the main functional plant for infiltration through its root systems and for pollutant removal.



**The subdrain** removes excess rainwater when soil is saturated.

## Design considerations



**Native soil** consists of areas of high infiltration sand and areas of slower infiltration silt. The design allows for infiltration in some areas and filtration and detention in slower infiltration areas within the bioswale.

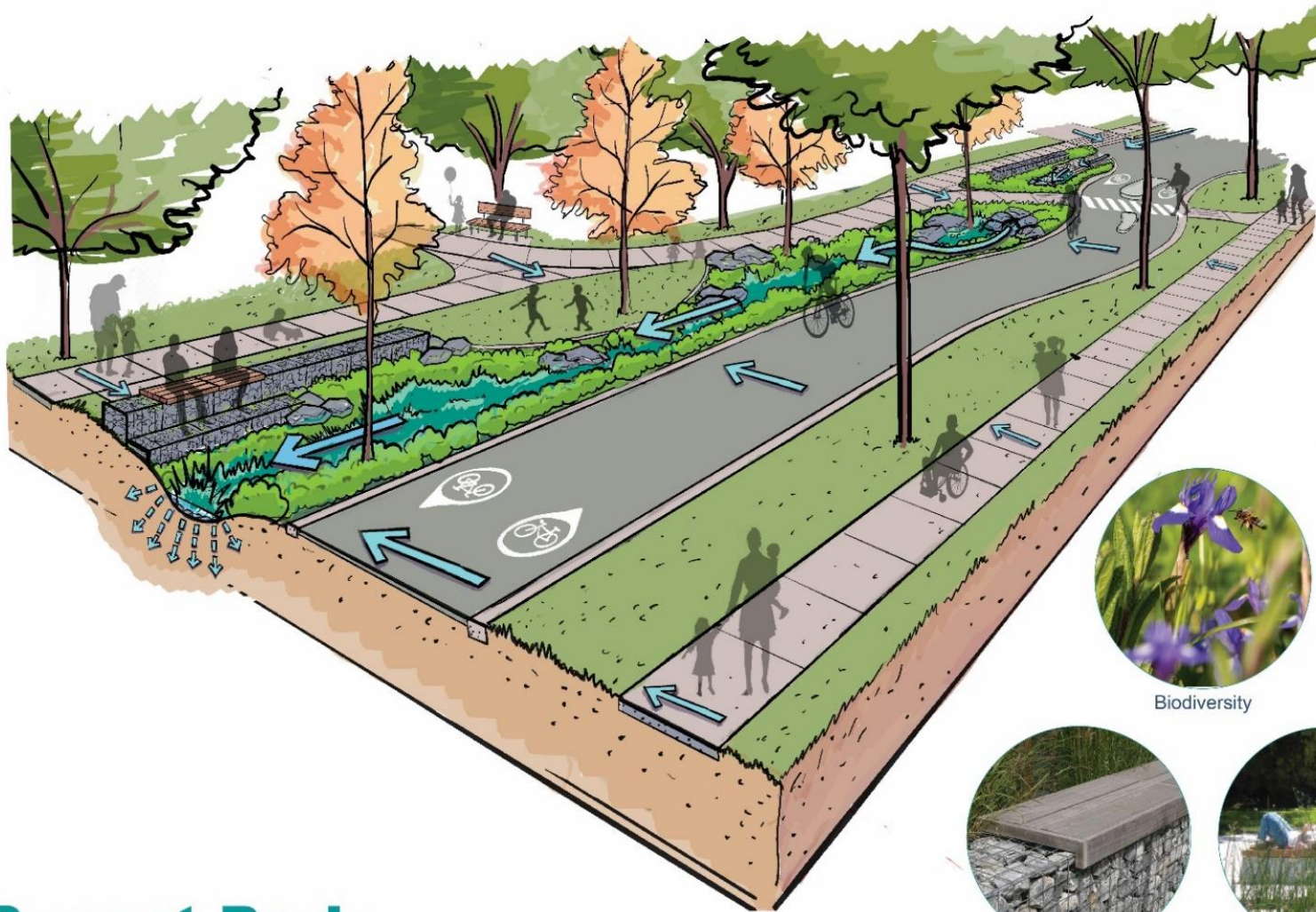


**Clearances from underground utilities**, including street lighting and a telecom duct which run under the street.



**Planting palette** developed in coordination with the Park Board.





Rainwater Management



Biodiversity



Informal Play



Gabion Basket Benches

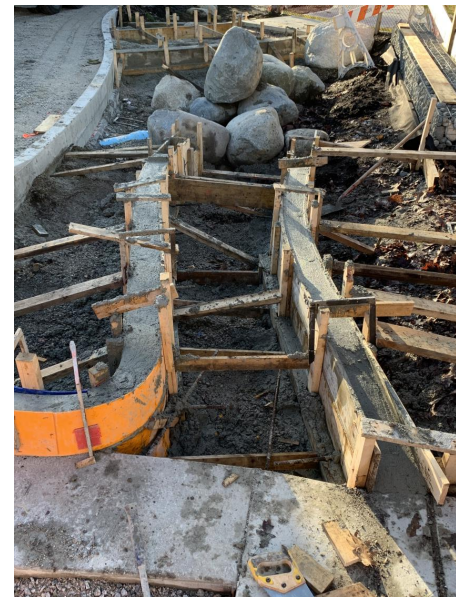


Livability

# Sunset Park Prince Edward Street Bioswale



# Construction Process



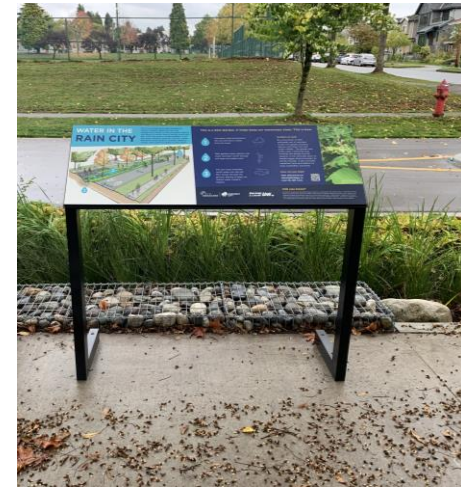


## Sediment Pad





# Public Interaction





# Lessons Learned-Gabion baskets

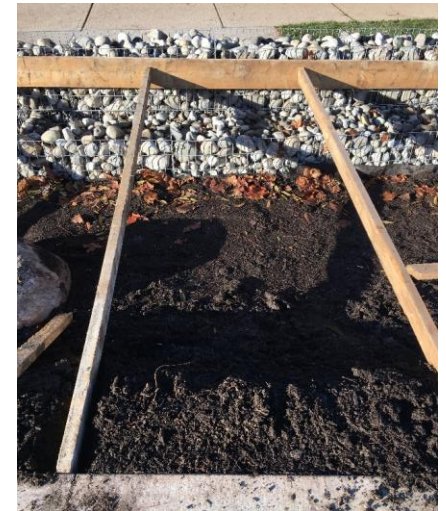
## 1. Gabion Baskets

	Gabion Wall	Concrete Wall
Benefits	<ul style="list-style-type: none"><li>• Inexpensive materials</li><li>• Easy to install</li><li>• Visually interesting</li><li>• Potential for recycled fill material</li></ul>	<ul style="list-style-type: none"><li>• Crew familiar with installation</li><li>• Long lifespan</li><li>• Can be in contact with ponded water</li></ul>
Drawbacks	<ul style="list-style-type: none"><li>• Arrangement of fill material takes time</li><li>• Shorter lifespan</li></ul>	<ul style="list-style-type: none"><li>• Expensive</li></ul>

- Approx. \$625/l.m.
- Some installation steps can be labour intensive – i.e. arranging fill material, securing lids once gabions are filled
- Baskets can be difficult to keep aligned straight
  - Need lots of interior bracing – diagonal across corners & front-to-back
  - Wood formwork used while filling and attaching lids



Bracing wires



Formwork



# Lessons Learned-Gabion Baskets

## 1. Gabion Baskets

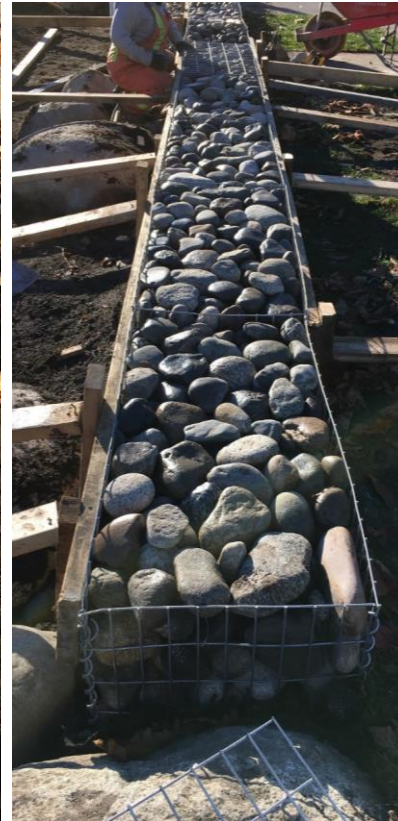
- There are many gabion product options – ensure the best one is chosen for the design application
- Coordinate gabion mesh size with planned fill material. If possible get samples to test function & aesthetics.

### Design Considerations

- Woven vs welded
- Wire gauge & coating
- Mesh aperture size
- Fill material
- Base



Gabion basket with 75mm clear crush



Gabion basket with 2" – 6" river rock



# Lessons Learned-Soil Shortage and Substitution

## 2. Soil Shortage and Substitution

- Ensure material availability before each major component of construction.  
1 contract with Veratec was being used for multiple projects.
- Include outline spec for materials on IFC drawings for internally delivered projects.
- Communicate reasons for specs if there need to be substitutions.

Spec'd	Installed
Veratec Thrive Planter Blend (Bioretention Soil)	Lawnboy Garden Mix
70 – 85% Sand 10 – 20% Organic Matter 5 – 15% Silt 0 – 15% Clay	25% Sand 75% Organic Matter



New growing medium being mixed with subsoil



## Wet Weather Inspections





## Wet Weather Inspections





# VANCOUVER'S OLD STREAMS

June 1981

This map shows the natural drainage of Vancouver, as it was before the City was built. Based on old maps, archival records and interviews with pioneers, it continuously changes as additional sources of information emerge or as people dig new holes in the ground.

Original stream line  
Acres and tributaries  
Disputed parts of coverage

Lost creek on  
St. George

# ST. GEORGE RAINWAY



**Public Engagement 1: Values and Vision**

**Fall 2020**



**Public Advisory Committee Establishment**

**March/April 2021**



**Public Engagement 2: Co-design for co-benefits**

**June 2021**



**Public Engagement 3: Initial Concept Design**

**Fall 2021/Winter 2022**



**Public Engagement 4: Preferred Concept Design**

**Spring 2022**

Community reviews and gives feedback on the preferred concept design.



**City Staff Develop Detailed Design**

**Spring-Fall 2022**

The City completes a detailed design of the St. George Rainway.



**Ready for Construction**

**2023**

The St. George Rainway is ready for the construction



*Note: detailed alignment of future bike routes is subject to change*



# ST. GEORGE RAINWAY: 4 BLOCKS OF GREEN INFRASTRUCTURE

The Rainway will sequester  
**335 kg**  
of carbon  
each year

The Rainway will filter  
**10,500 m<sup>3</sup>**  
of polluted  
rainwater  
each year

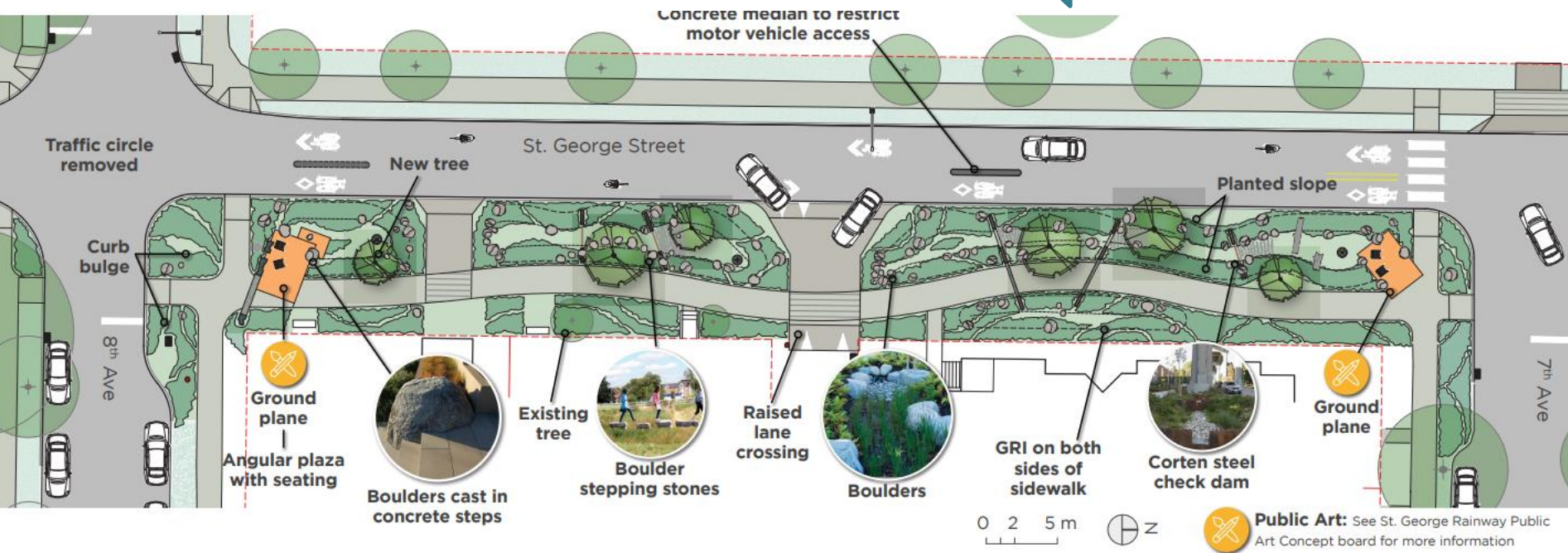
**19** new  
trees on the  
Rainway will  
help keep the  
street cool

The Rainway  
will add  
**1,100 m<sup>2</sup>**  
of natural  
habitat



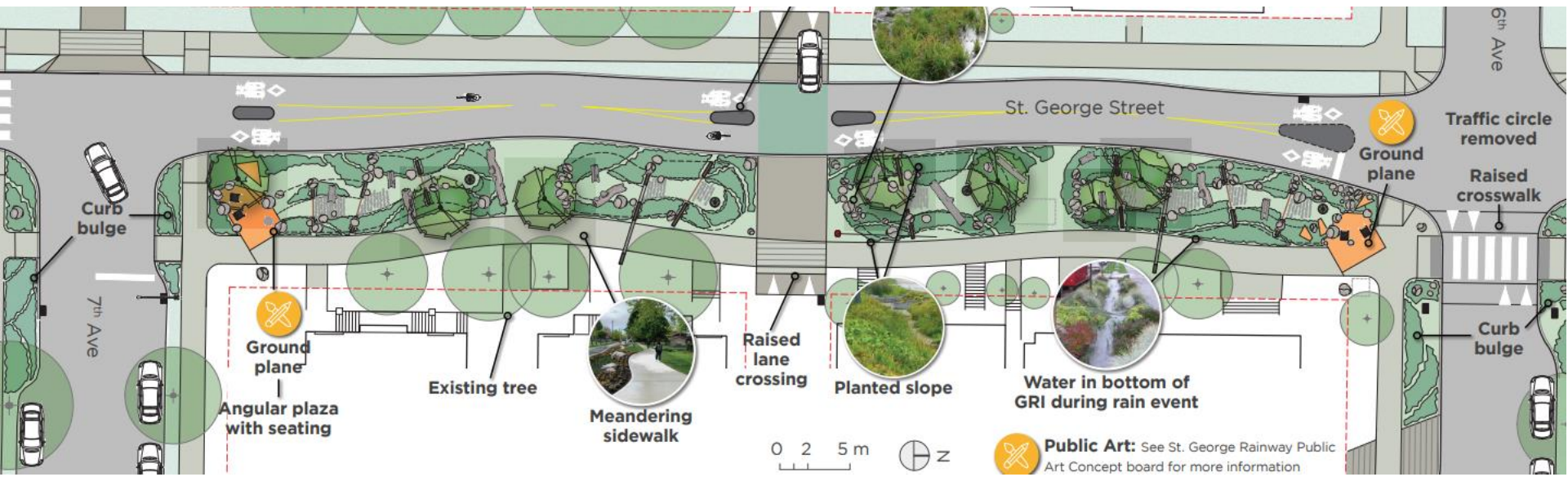


## BROADWAY TO 8TH



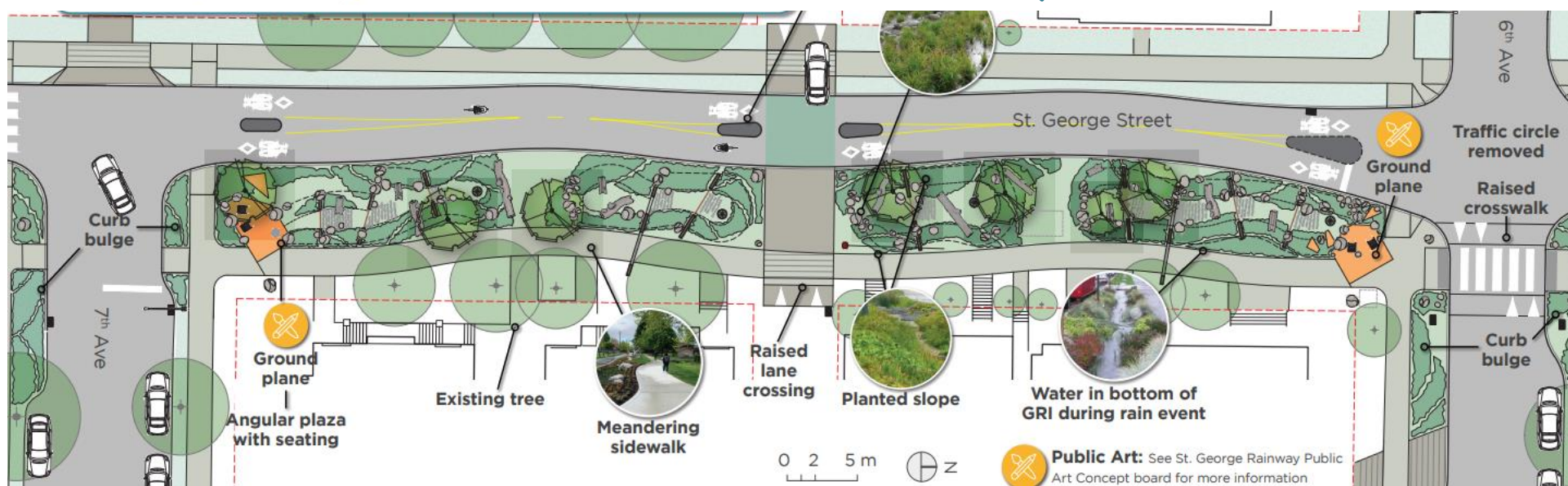


8<sup>TH</sup> to 7<sup>TH</sup>



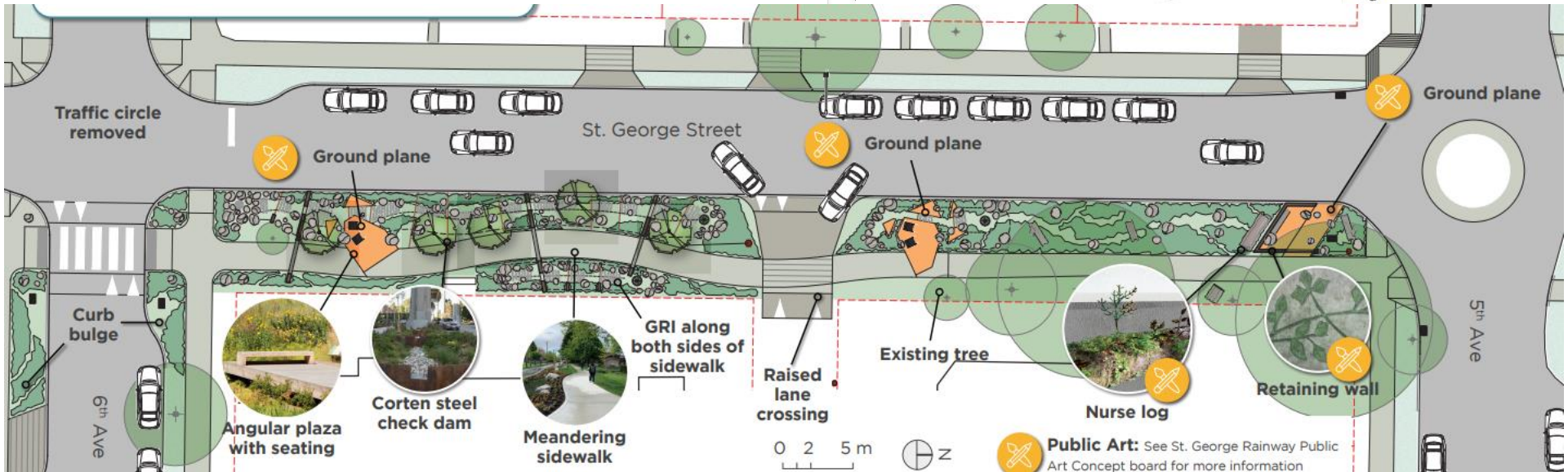


7<sup>TH</sup> to 6<sup>TH</sup>

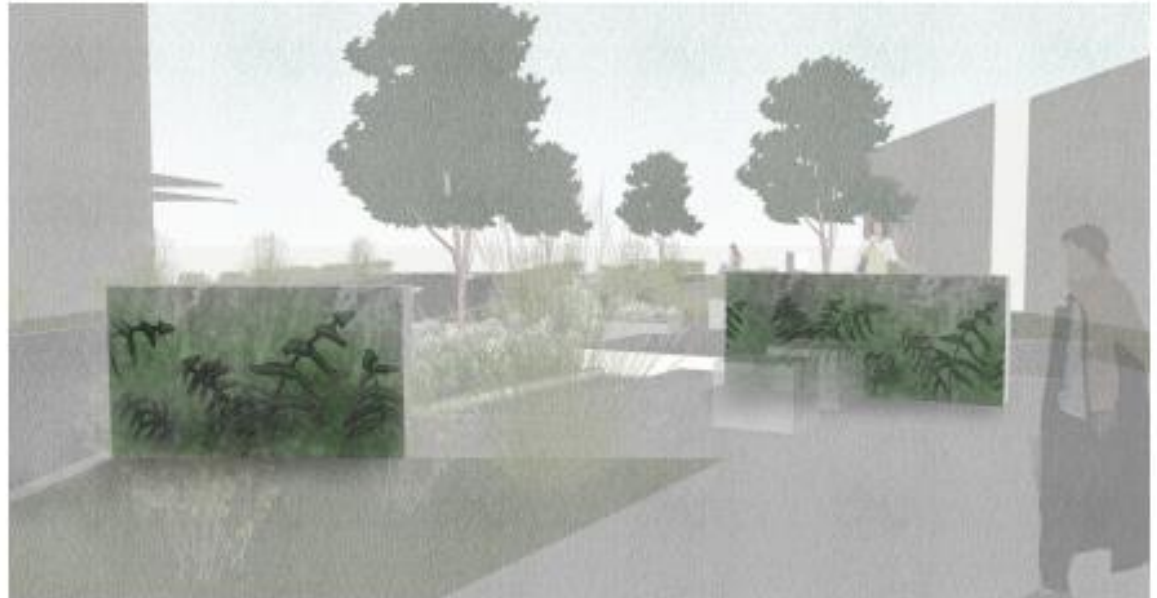




# 6<sup>TH</sup> to 5<sup>TH</sup>



# CREATING ROOM FOR PEOPLE AND NATURE





# CITIZEN SCIENCE BIODIVERSITY MONITORING

**ST. GEORGE RAINWAY**  
CITIZEN SCIENCE BIODIVERSITY PROJECT

**Calling All Citizen Scientists:**  
Help us Collect Important  
Biodiversity Data Along St.  
George Rainway!

**JANUARY 29, 2022**  
**8- 10 AM**

**Meet at St. George  
Street and 7th Avenue**

For more information and to  
register visit [https://www.  
eventbrite.ca/e/224353807277](https://www.eventbrite.ca/e/224353807277)





# ETHNOBOTANY





## Summary

BGS manage water and provide nature in the city and active transportation routes

Many considerations go into planning alignments, including equity, overland flows, future planning projects, utility capacity issues and constrains

Implementation challenges are numerous, but when coincided with upcoming area plans or infrastructure upgrades, there are more opportunities

There are various typologies for different contexts, i.e. city, by park, etc.

They require internal buy-in and collaboration throughout the planning to implementation processes





**THANK  
YOU!**