

# Making the Invisible Visible: Seattle's Green Stormwater Infrastructure



*Presented by:*

**Tracy Tackett**

**Green Stormwater Infrastructure Program Manager**

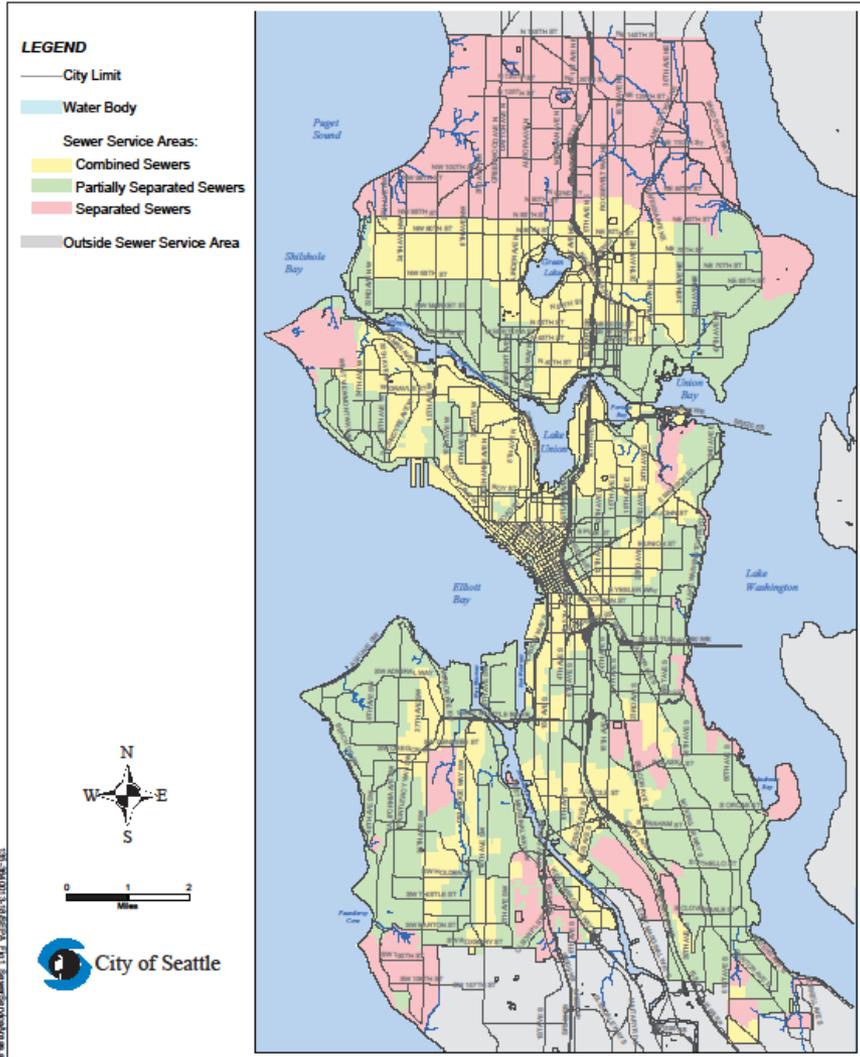


# Green Stormwater Infrastructure (GSI)

- 💧 GSI toolbox overview
- 💧 GSI projects in the separated system
- 💧 GSI standardization
- 💧 GSI for CSO reduction

# City Sewer System

- Combined and Partially Separated (2/3 of City)
- Separated (1/3 of City)

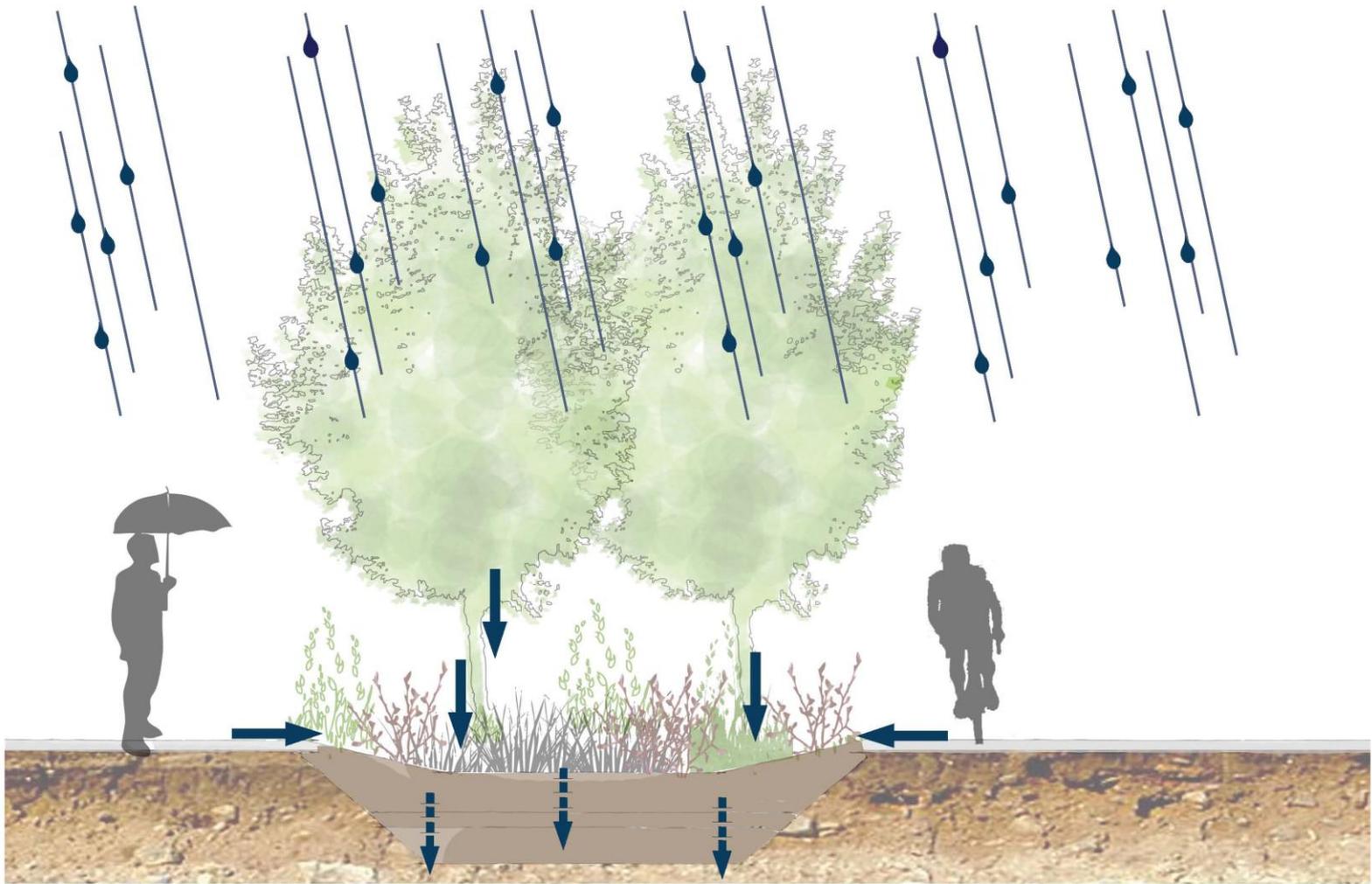


**TETRA TECH**  
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Seattle Public Utilities  
**2010 CSO REDUCTION  
PLAN AMENDMENT  
SEPA CHECKLIST**

Figure 1  
**CITY OF SEATTLE NPDES BASINS  
SEWER SERVICE AREAS**

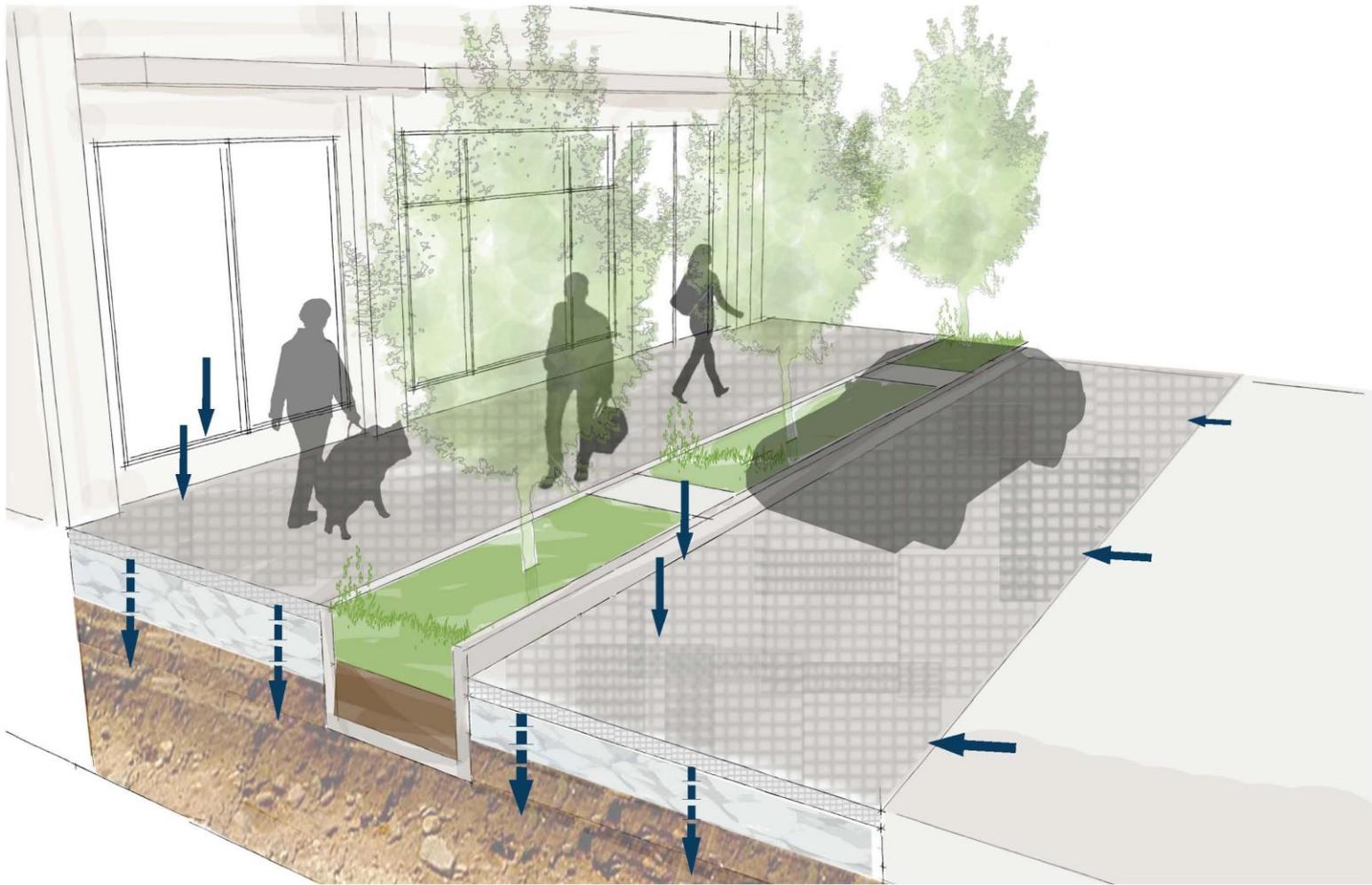




 infiltration | bioretention cells without underdrain

Seattle & Public Utilities **GREEN FUTURE<sup>SM</sup> RESEARCH & DESIGN LAB**  
University of Washington College of Built Environments 401 South East 20th Street, Seattle, WA 98101 www.greenfuture.washington.edu

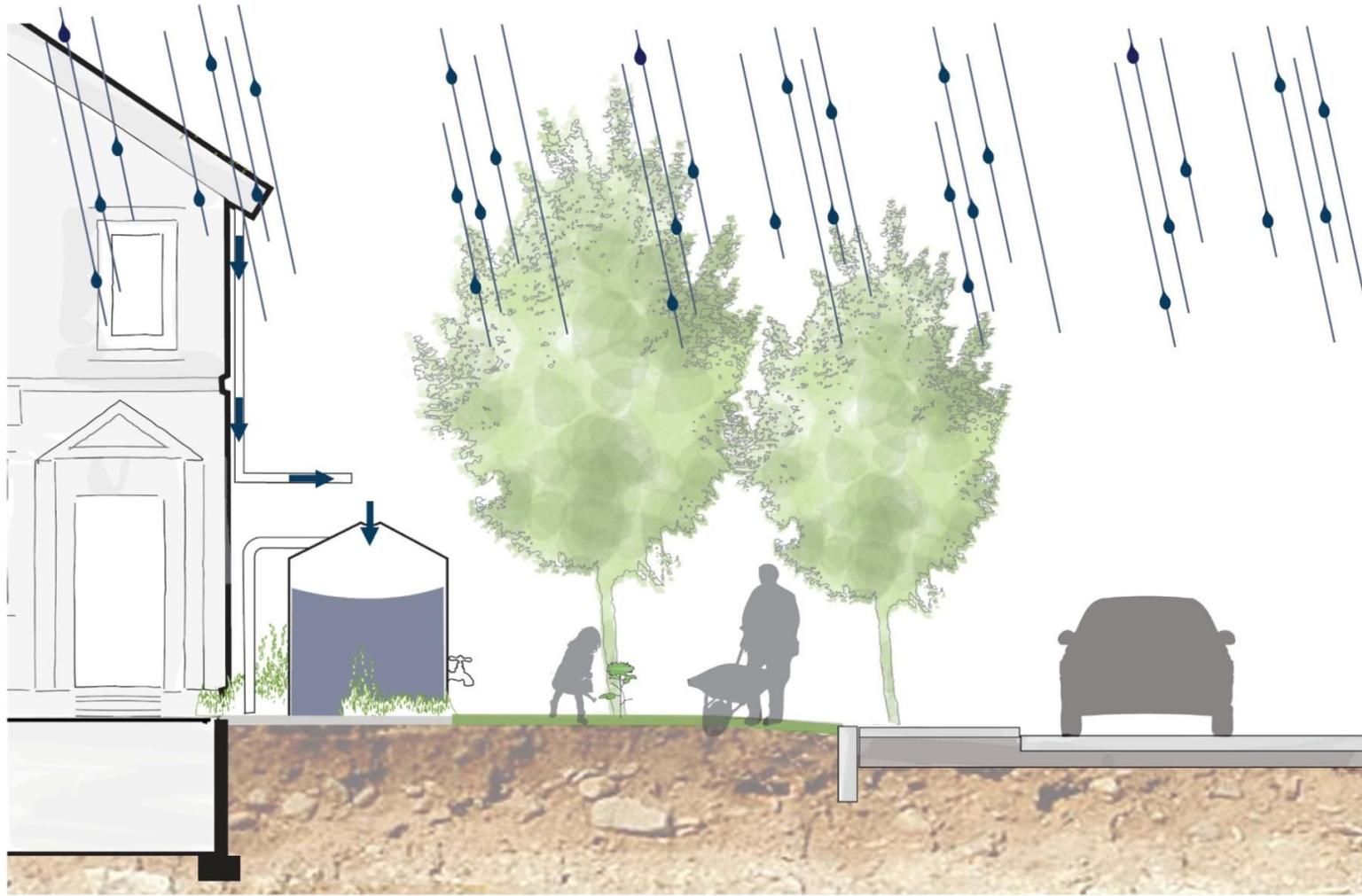
**RESTORE OUR WATERS**  
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**COMBINED SEWER OVERFLOW REDUCTION**



 infiltration | permeable pavement facilities

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1959 PAUL M. HARRIS CENTER, BOX 355095 SEATTLE, WA 98195 | [www.seattlepublicutilities.com](http://www.seattlepublicutilities.com)

 **RESTORE OUR WATERS**  
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 reuse | rainwater harvesting

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 401 South Hall Box 355090 Seattle, WA 98195 www.greenurology.com

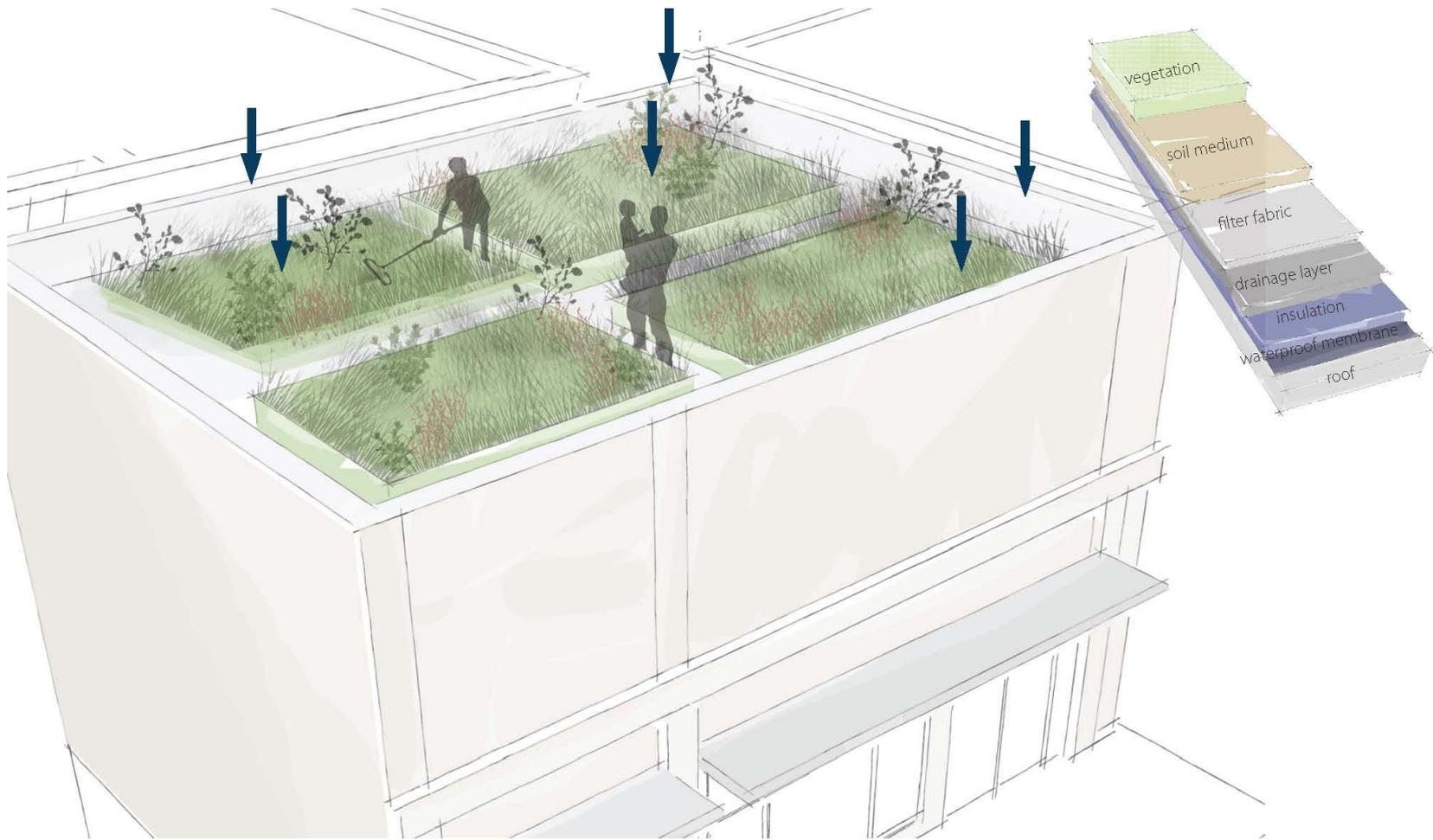
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 reduce | trees + compost-amended soils

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OVERFLOW REDUCTION**

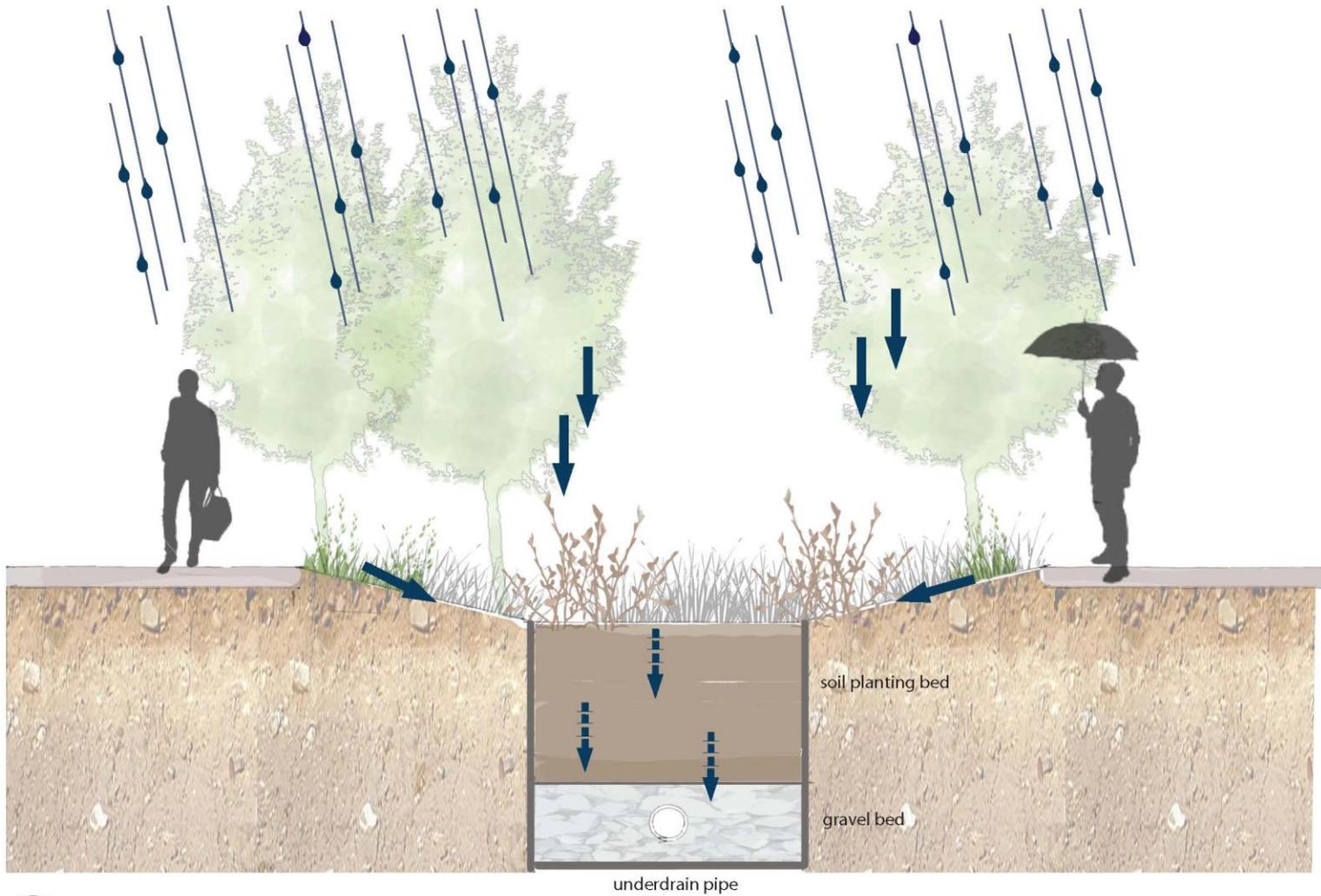


 reduce | green roofs

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 10700 1st Avenue NE, Seattle, WA 98115 | www.seattle.gov/greenfuture



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 slow+clean | bioretention cells with underdrain

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# GSI for CSO Reduction

	Stormwater Goals via Stormwater Code	CSO Reduction
Bioretention/ Rain Garden	✓	✓
Permeable Pavement	✓	✓
Rainwater Harvesting/ Detention Cistern	✓	✓
Trees	✓	
Greenroofs	✓	
Bioretention with Underdrain	✓	

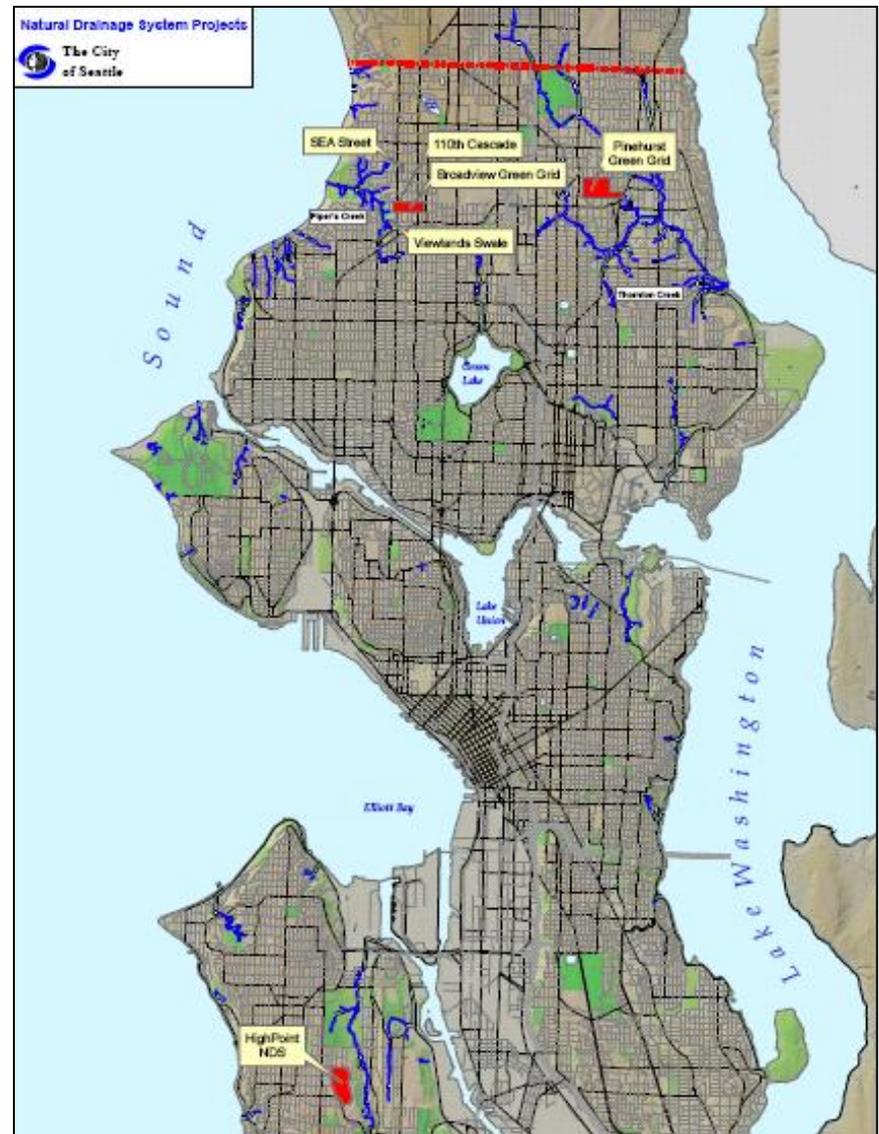


# GSI for Creeks



# Natural Drainage Systems

- 💧 Initiated 1999 for **creek restoration**
- 💧 Pilot blocks
- 💧 Pilot catchments
- 💧 Pilot partnering
- 💧 National leaders



# Natural Drainage Systems

## *Building GSI Experience and Knowledge*

Project	Project Drainage Area
SEA Street #1	2.3 acres
NW 110 <sup>th</sup> Cascade	28 acres
Broadview Green Grid	32 acres
Pinehurst Green Grid	49 acres
High Point	129 acres

# SEA Street

- 💧 Constructed in 2000
- 💧 660 linear feet
- 💧 2.3-acre drainage
- 💧 99-percent reduction in runoff volume



# NW 110th Cascade



- Constructed 2003
- 1400 linear feet
- 28-acre drainage
- 48-74 percent reduction in runoff volume
- Released water in only 49 of 235 storms

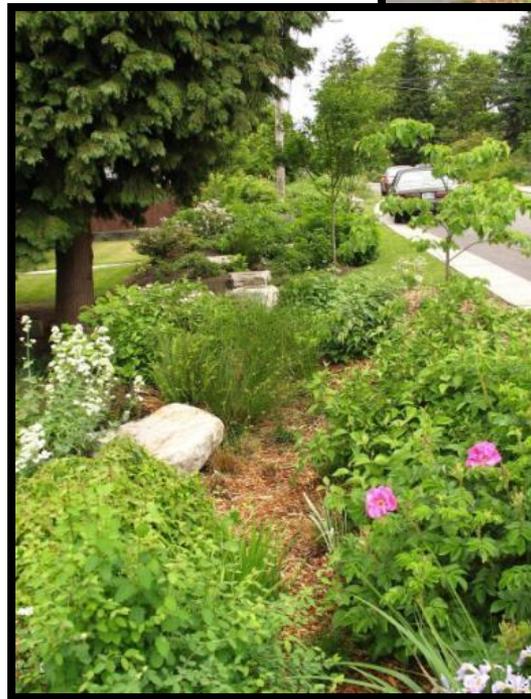
# NW 110<sup>th</sup> Monitoring

- Water quality monitoring, removal rates based on mass loading (and no ‘biofiltration plants’):
  - total suspended solids (TSS), 84%;
  - total nitrogen, 63%;
  - total phosphorus, 63%;
  - total copper, 83%; dissolved copper, 67%;
  - total zinc, 76%; dissolved zinc, 55%;
  - total lead, 90%; and
  - motor oil, 92%.



# Broadview Natural Drainage System

- 💧 Constructed 2004
- 💧 4,500 linear feet
- 💧 32-acre drainage



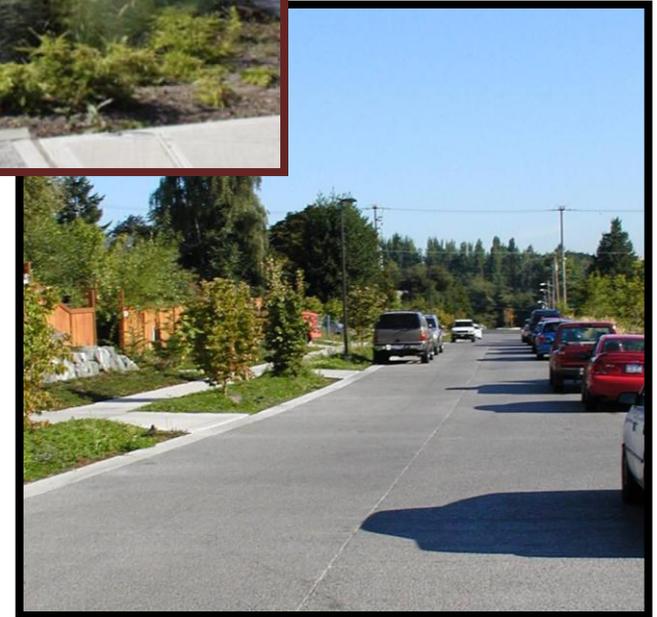
# Pinehurst Natural Drainage System



- 💧 Constructed 2005
- 💧 3,800 linear feet
- 💧 49-acre drainage
- 💧 Infiltrate 82 percent average annual volume (9.7 million gallons)

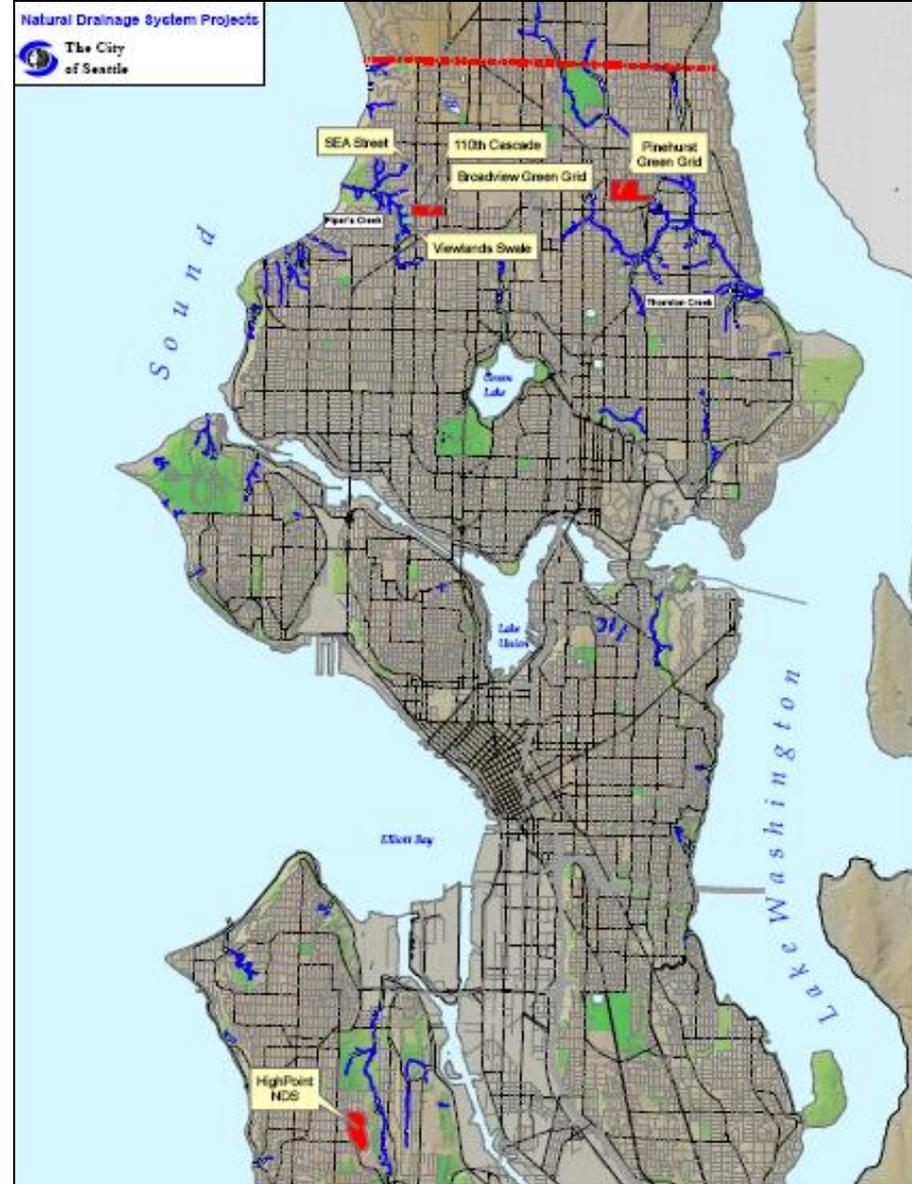
# High Point

- 💧 Constructed 2005-2009
- 💧 Seattle Housing Authority project
- 💧 120 acres of compact mixed-income development

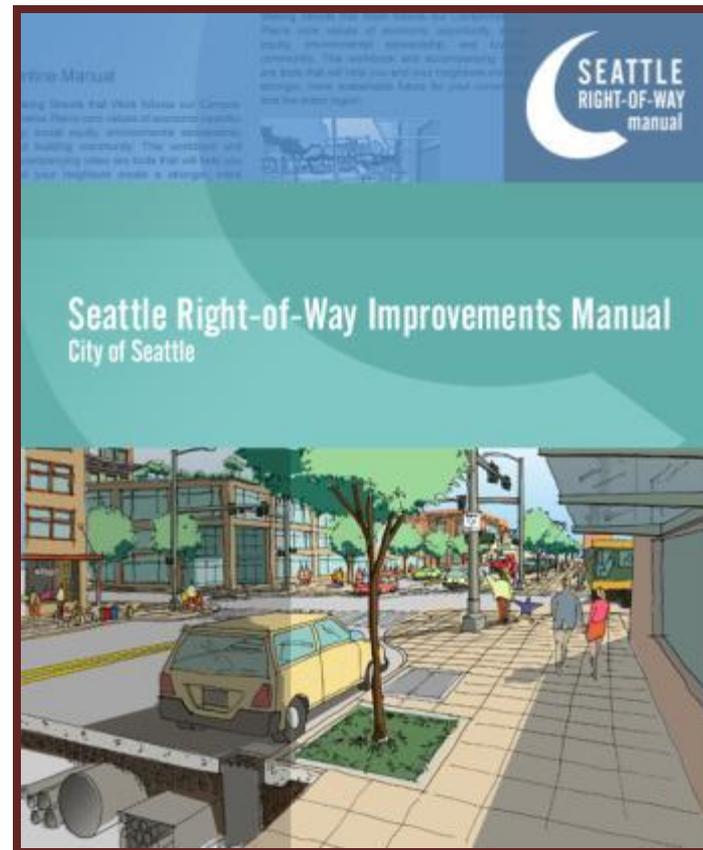
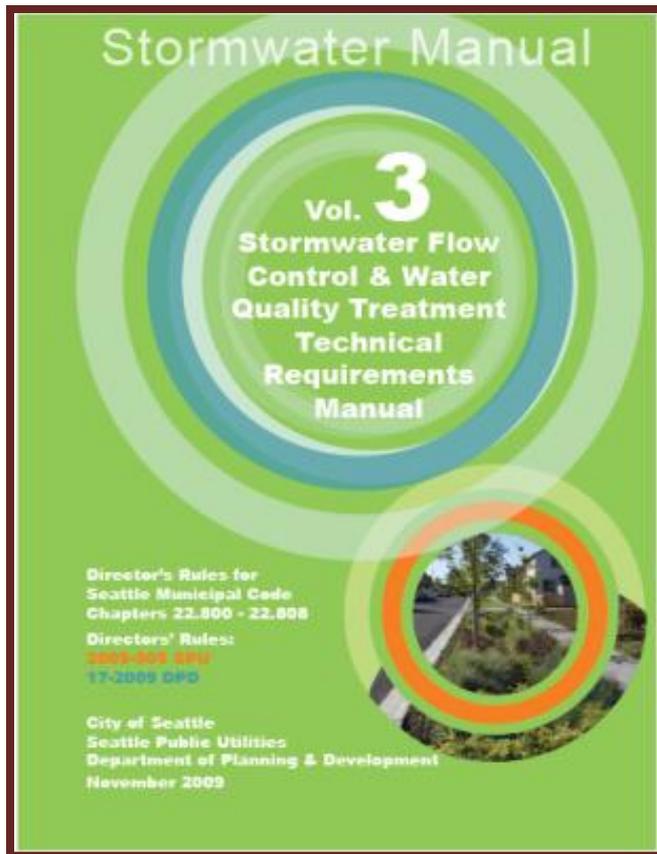


# Citywide Natural Drainage Systems

💧 232 acres



# GSI Standardization



[seattle.gov/util/greeninfrastructure](http://seattle.gov/util/greeninfrastructure)



# GSI for CSO Reduction



# Combined vs. Partially Separated

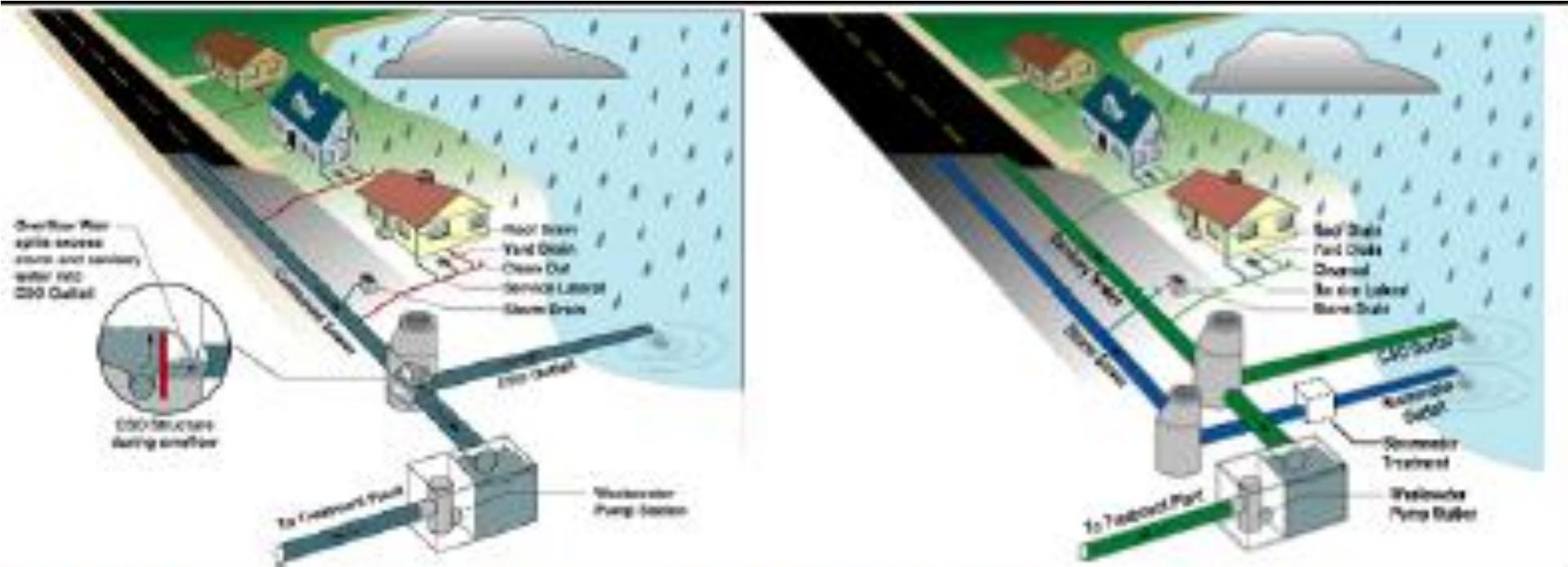


Figure 5-7. Typical Combined (left) and Separated (right) Sewer Systems

# Green Stormwater Infrastructure

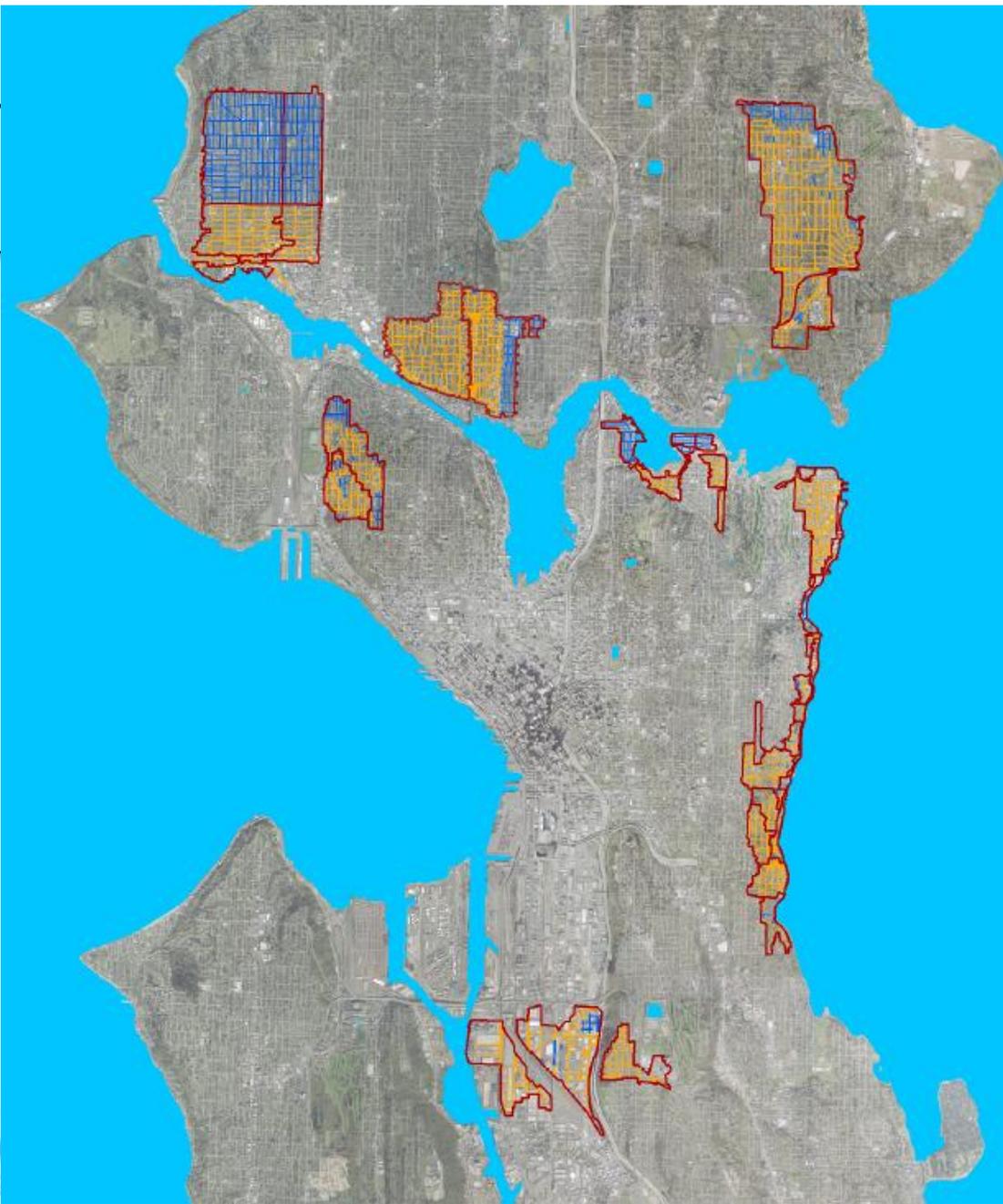
## Fully Combined Area

- Private Property
  - RainWise to manage flows
- Public Property
  - Permeable Pavement Alleys
  - Roadside Raingardens
  - Natural Drainage Systems (only if no existing curb and gutter)

## Partially Separated Area

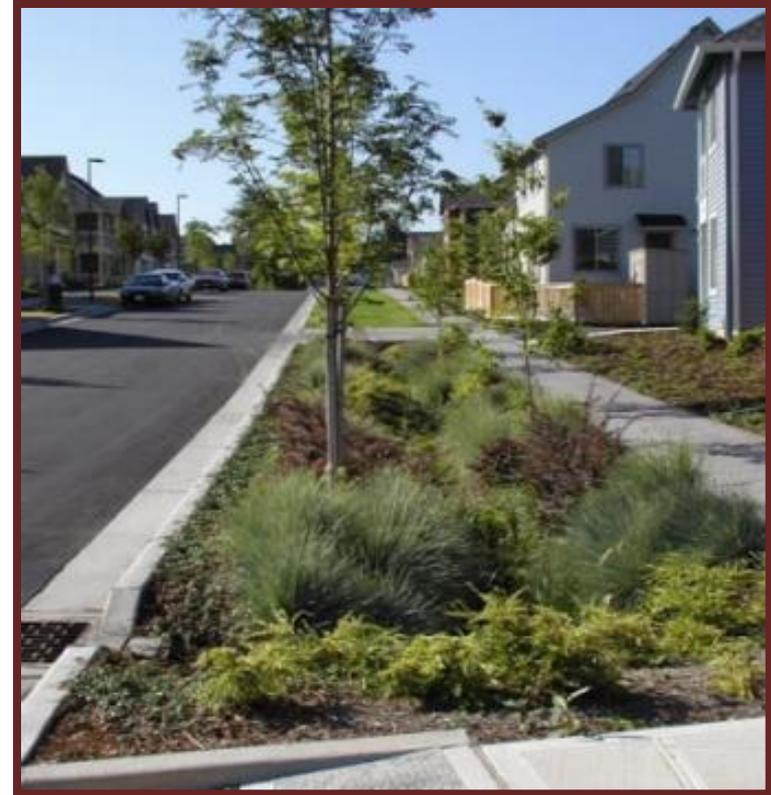
- Private Property Only
- RainWise – primarily to disconnect flows and direct to street

- NPDES Basin Boundary
- ROW to Storm
- ROW to Combined



# Public Rights-of-Ways

- 💧 Roadside Raingardens
- 💧 Permeable Pavement Alleys



# Roadside Raingarden Planting Strip Concept Street



Before



After

Images courtesy King County

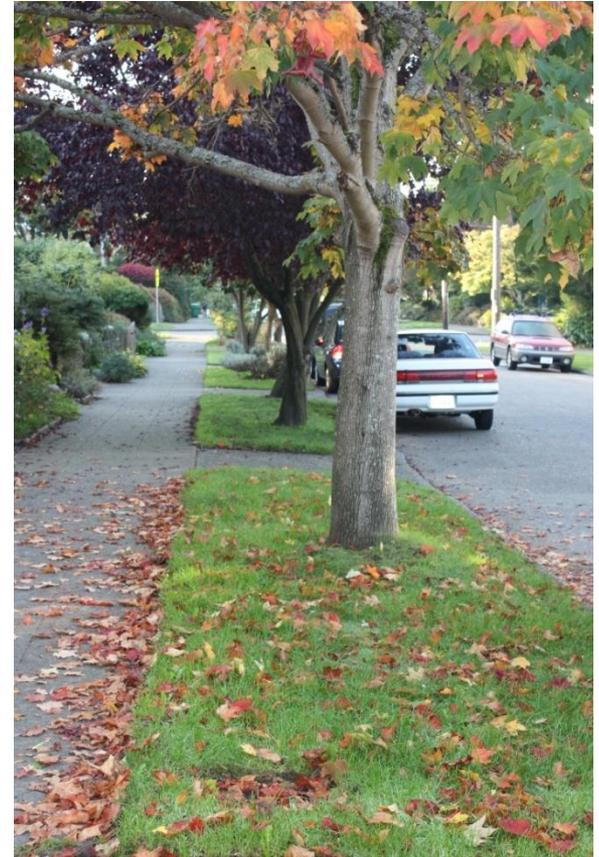
# Roadside Raingarden Curb Bulbs



# Roadside Raingardens

## *planting strip vs. curb bulbs*

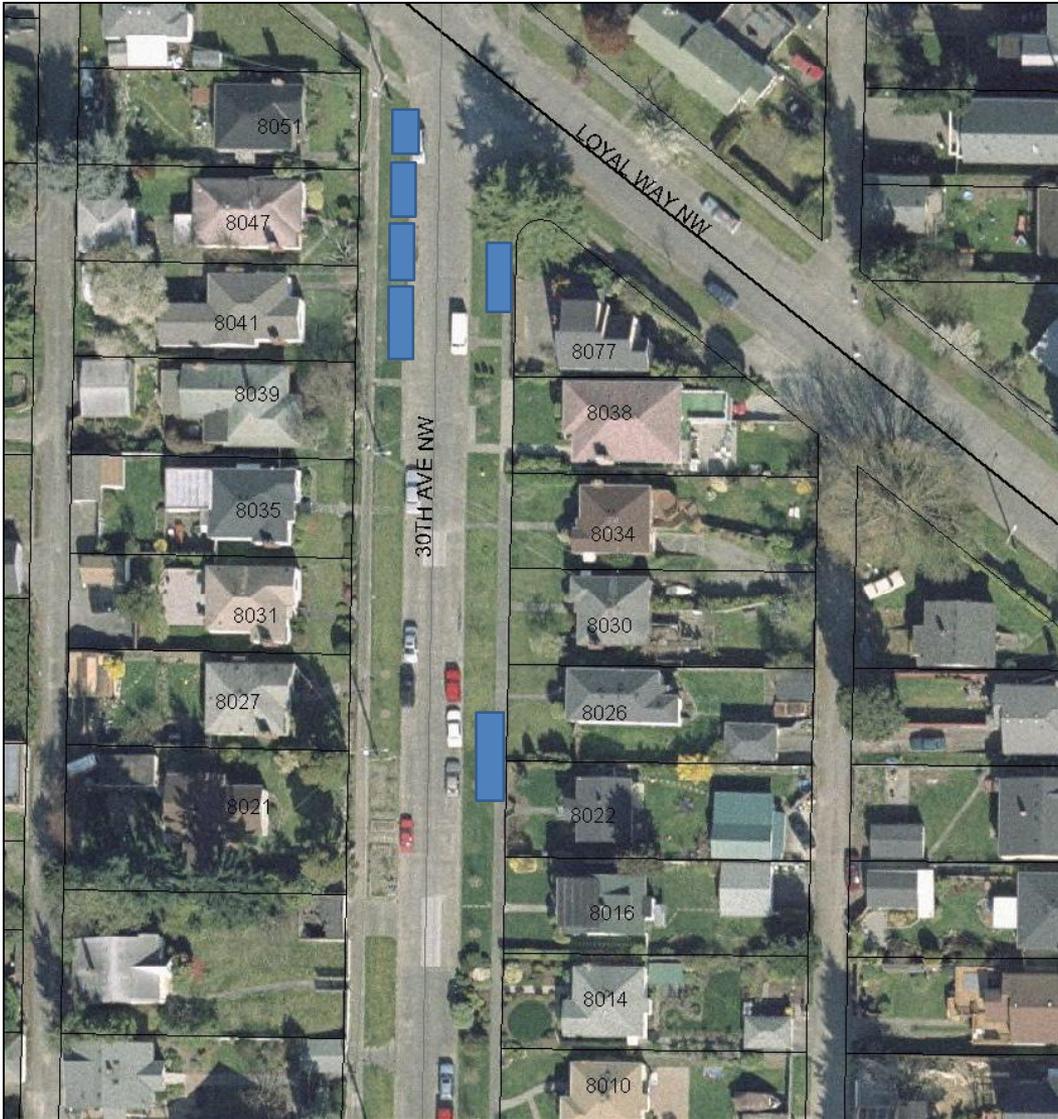
- Existing Planting Strip
  - No parking Impact
  - Applicable with 9.5-foot minimum width
- Curb Bulb
  - Use when need larger raingarden footprint



# Public Sensitivities to Roadside Raingardens

- Resistance to any changes
- Standing water
- Loss of parking
- Change in aesthetics
- Signs are intrusive

# Loyal Way NW & 30<sup>th</sup> Ave NW (Ballard)



## Raingarden Types



Raingarden with the existing curb line and planting strip



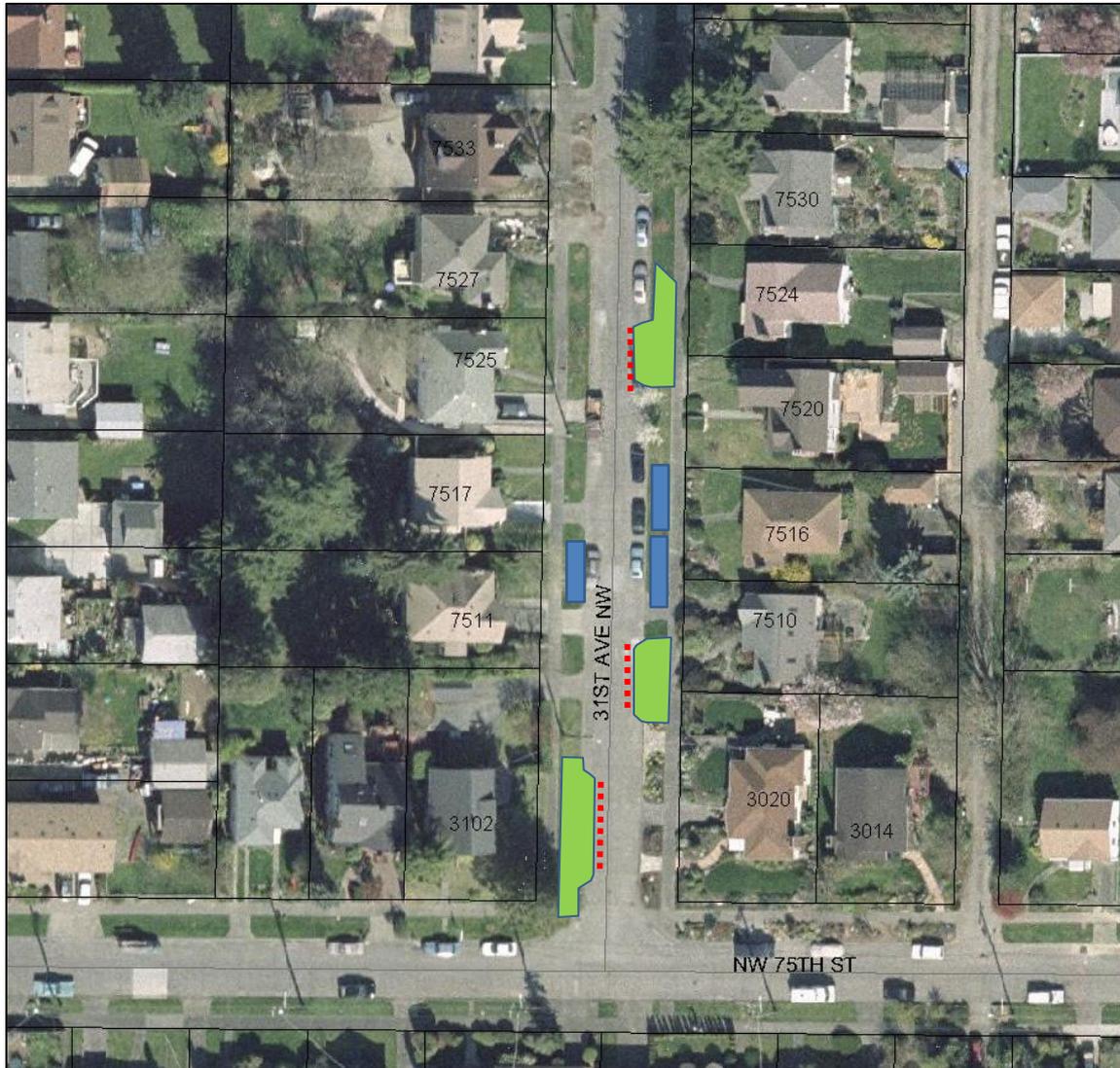
Raingarden with modified curb and planting strip



No parking area

Prepared November 2009

# NW 75<sup>th</sup> St & 31st Ave NW in Ballard



## Raingarden Types

-  Raingarden with the existing curb line and planting strip
-  Raingarden with modified curb and planting strip
-  No parking area

Prepared November 2009

# Roadside Raingardens Effectiveness Estimates

- 💧 Step 1: Roadway connected to combined sewer
- 💧 Step 2: Technically feasible
  - Infiltration restrictions
  - Site restrictions (slope less than 7 percent, existing large trees)
- 💧 Step 3: Participation estimates

# Roadside Raingardens

## Participation: Voluntary vs. Mandatory



# Permeable Pavement Alleys

## Effectiveness Estimates

- 💧 Step 1: Alley connected to combined sewer
- 💧 Step 2: Technically feasible
- 💧 Step 3: Participation estimates: not applicable



# Permeable Pavement: Step #2 Technical Feasibility

- 💧 Slope
- 💧 Debris loading
- 💧 Structural conflicts, retaining walls
- 💧 Dense utilities
- 💧 Alley width



# GSI on Private Property

## 💧 RainWise – Rebates for Property Owners



# RainWise: Rainwise.seattle.gov

The screenshot shows the RainWise website interface. At the top, it features the Seattle.gov logo and the Seattle Public Utilities logo. The main navigation bar includes links for 'My Community', 'My Footprint', and 'Marketplace'. Below this, there are tabs for 'Overview', 'RainWise Solutions', 'Related Programs', and 'Map'. A search bar is present for finding a property's footprint. The main content area is titled 'Be RainWise' and contains text explaining the benefits of rain gardens. A large image of a rain garden is shown with the text 'Rain gardens: Retain, filter and clean stormwater with native plants'. There are three main sections: 'Explore' (with an icon of a house and garden), 'Find' (with an icon of a map), and 'Get Started' (with an icon of a person). A search bar for 'Enter Your Address' is followed by a 'Get Started' button and the text 'Find your home on a map and calculate your stormwater impact.' Below this, there is a section for 'Do you live in Ballard?' with a map of Ballard and a 'Learn More' button. To the right, there are two sections: 'Contractor Workshops' and 'Contractors and Vendors'. The footer contains contact information for Seattle Public Utilities and a copyright notice for 1999-2009 City of Seattle.

SEATTLE.GOV  
Seattle Public Utilities  
Powered by project:10  
Log in or Register

My Community | My Footprint | Marketplace  
Find your property's footprint

Overview | RainWise Solutions | Related Programs | Map

## Be RainWise

Rain that falls on our roofs, driveways and other hard surfaces can carry pollutants to our creeks, Lake Washington, and Puget Sound. During big storms, the sheer volume of this "storm water" can flood homes, cause sewer overflows, and erode hillsides and streambanks.

We can all help to slow and clean the rain runoff from our homes with simple projects that are useful and attractive additions to our yards.

### Rain gardens

Retain, filter and clean stormwater with native plants

**Explore**  
Explore useful solutions for controlling stormwater around your home.

**Find**  
Locate RainWise projects and share your own.

**Get Started**  
Select a contractor to install your project.

Enter Your Address **Get Started** Find your home on a map and calculate your stormwater impact.

### Do you live in Ballard?

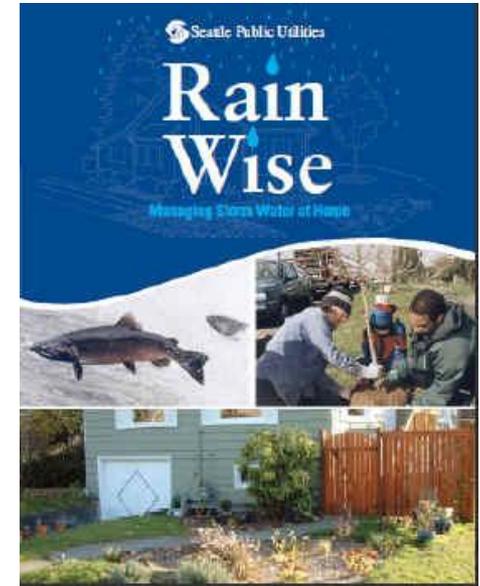
Find out about financial incentives for stormwater actions.

**Learn More**

**Contractor Workshops**  
Business opportunities for Seattle licensed contractors and design professionals.  
[Learn more.](#)

**Contractors and Vendors**  
Want to register as a Rainwise Contractor? Find out more [here.](#)

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# RainWise Effectiveness Estimates

- Step 1: Roof connected to combined sewer
- Step 2: Technically feasible
- Step 3: Participation estimates



# RainWise: Step #2 Technical Feasibility

- 💧 Roof area that can be directed to a GSI 'tool'
- 💧 Infiltration restrictions
- 💧 Site restrictions /Space



# RainWise Feasibility: Site Restrictions



# RainWise Participation Estimates

- 💧 Low = 1 percent
- 💧 High = 30 percent
- 💧 Why not 100%?
  - Volunteer program
  - Landscape choices, aesthetics
  - Concern that will cause wet basements
  - Rebate level and turnaround time
  - Awareness

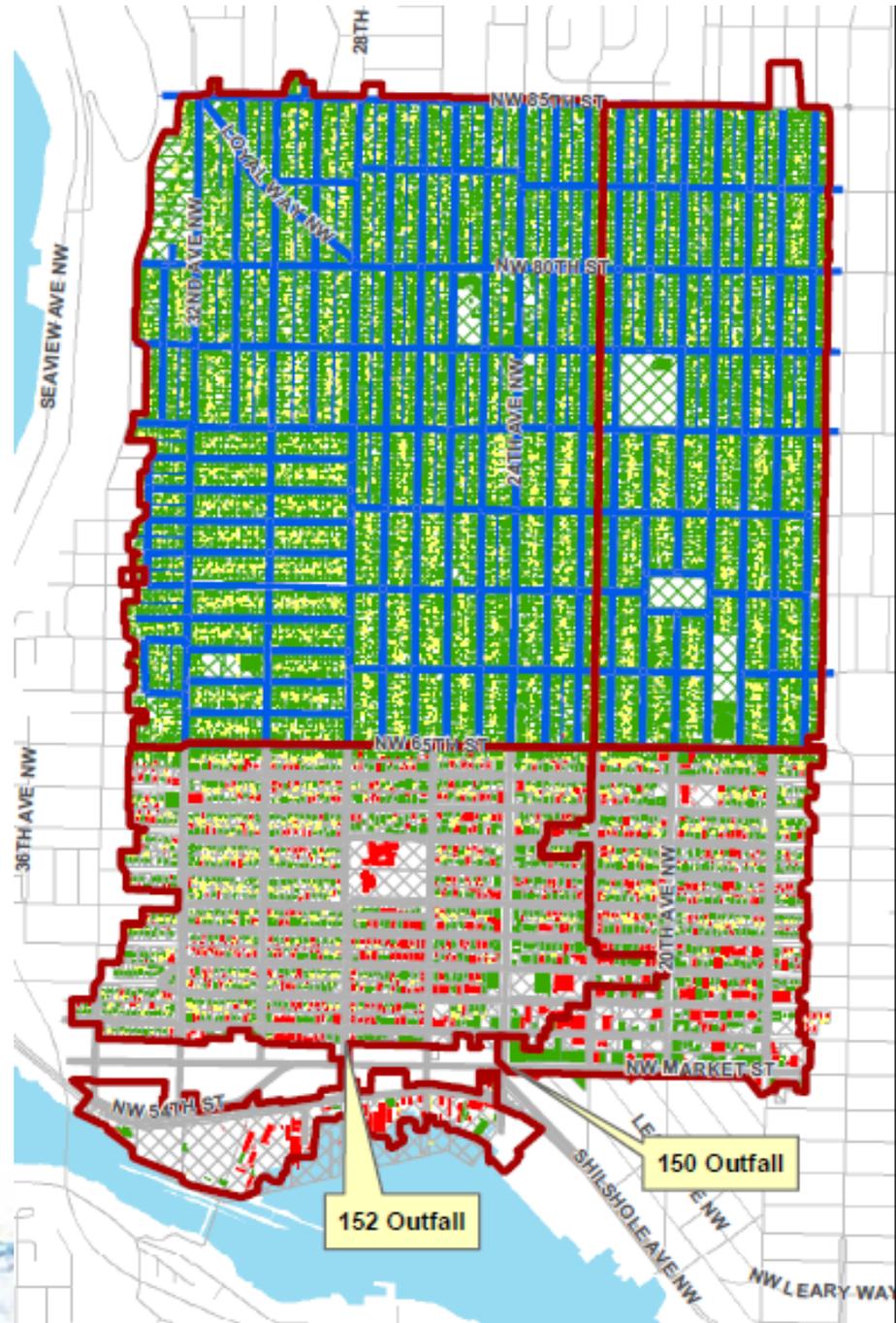


# RainWise Promotion

- 💧 Variety of tools to maximize participation
  - Direct mail to all eligible households (4x/year)
  - Listserv messages via e-mail
  - Demonstration projects (Sunset Hill Community Club, Loyal Heights Elementary)
  - Local media (Ballard News-Tribune, local blogs)
  - Point-of-sale promotions at local businesses
  - Presence at Ballard Sunday Market
  - Trusted advocates (Groundswell, Sustainable Ballard)
  - November 6 – Ballard RainWise Roadshow

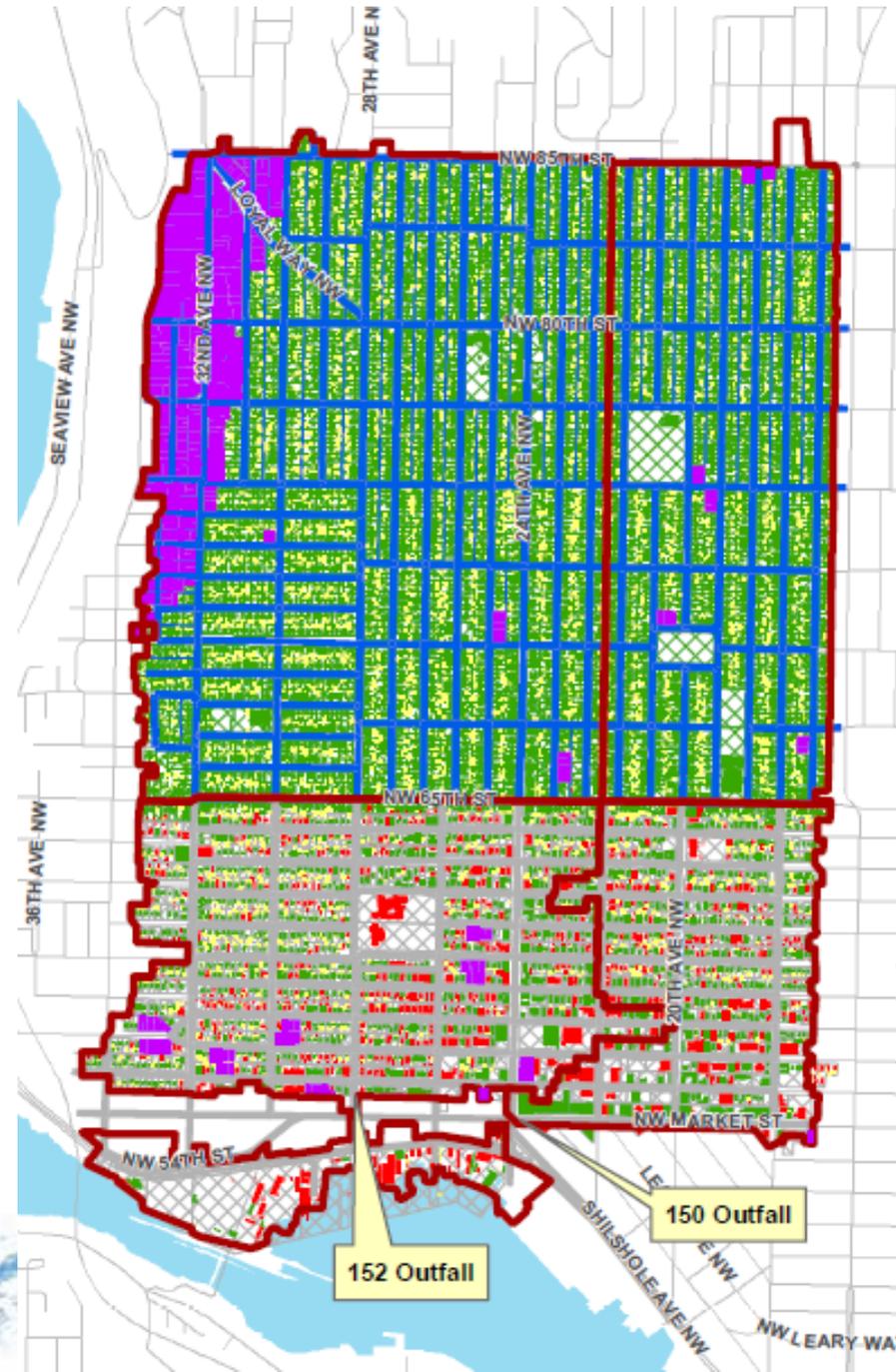
# Ballard

💧 Step 1: Connectivity to combined sewer

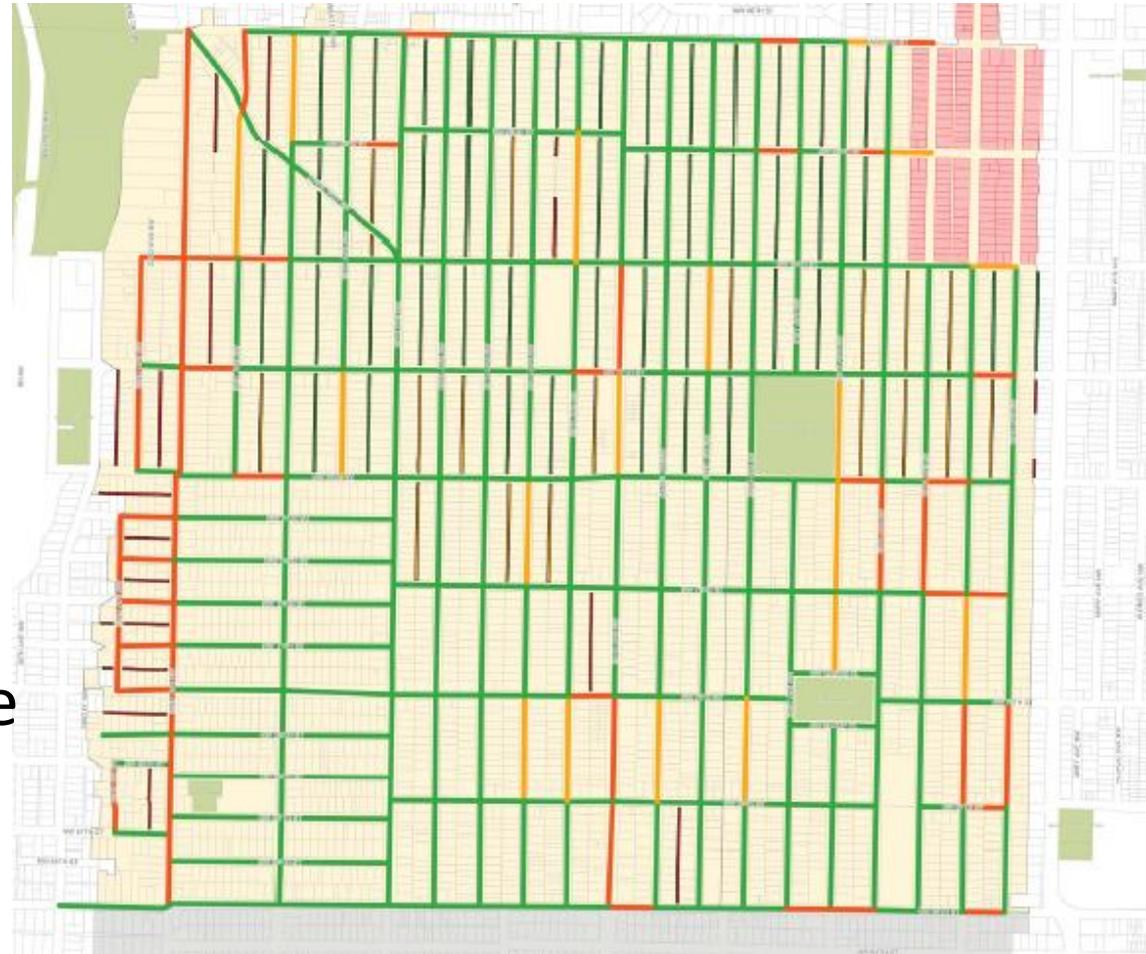


# Ballard

- Step 2: Technical Feasibility
  - Step 2a: Infiltration Restrictions

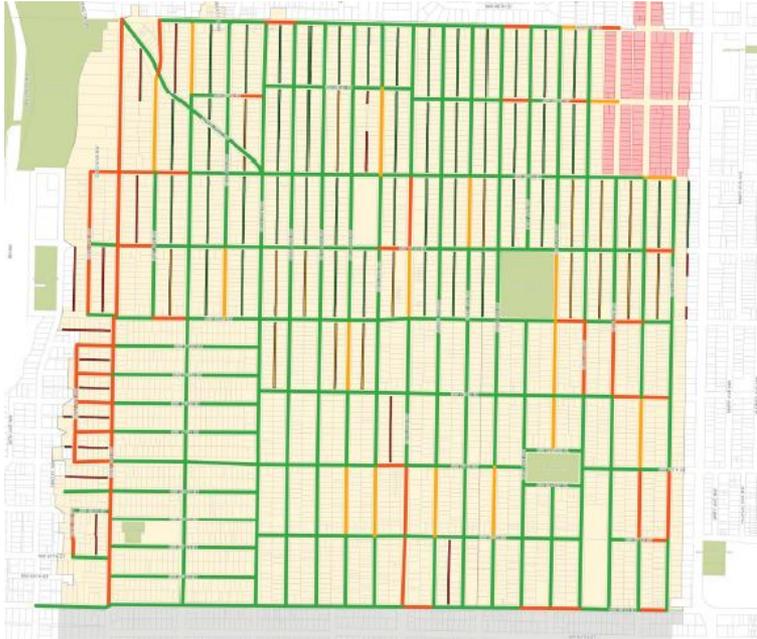


# Ballard



- Step 2: Technical Feasibility
  - Step 2b: GSI practice specific feasibility

# Ballard



## Step 3: Participation Estimates

### Step 3a: Roadside Raingardens

High: 60%

Low: 30%

### Step 3b: RainWise

High: 35%

Low: 15%

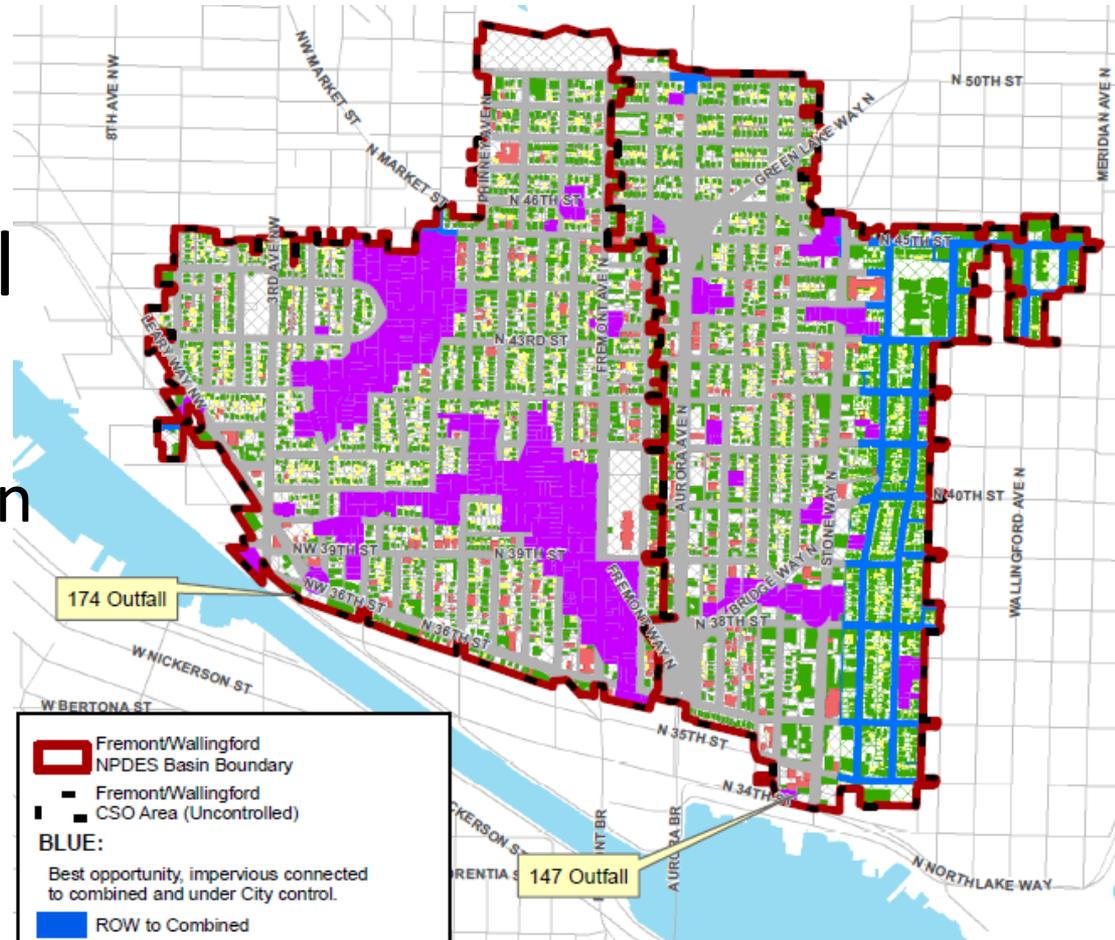
# Fremont/Wallingford

💧 Step 1:  
Connectivity to  
combined  
sewer

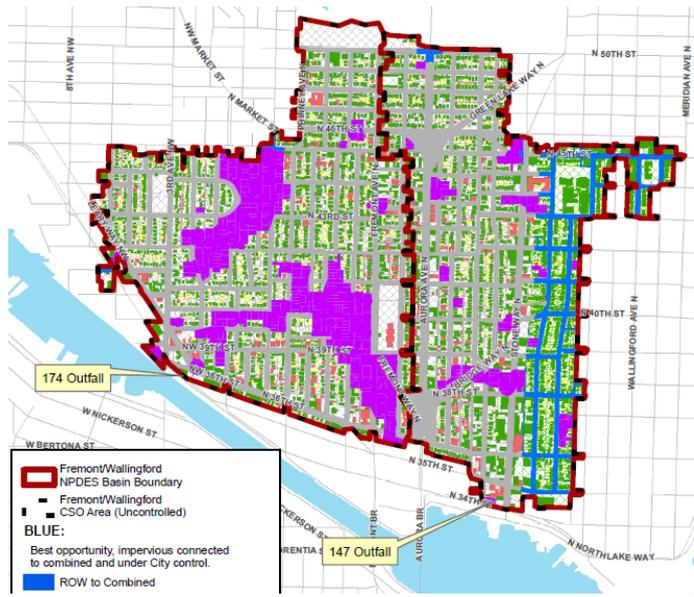


# Fremont/Wallingford

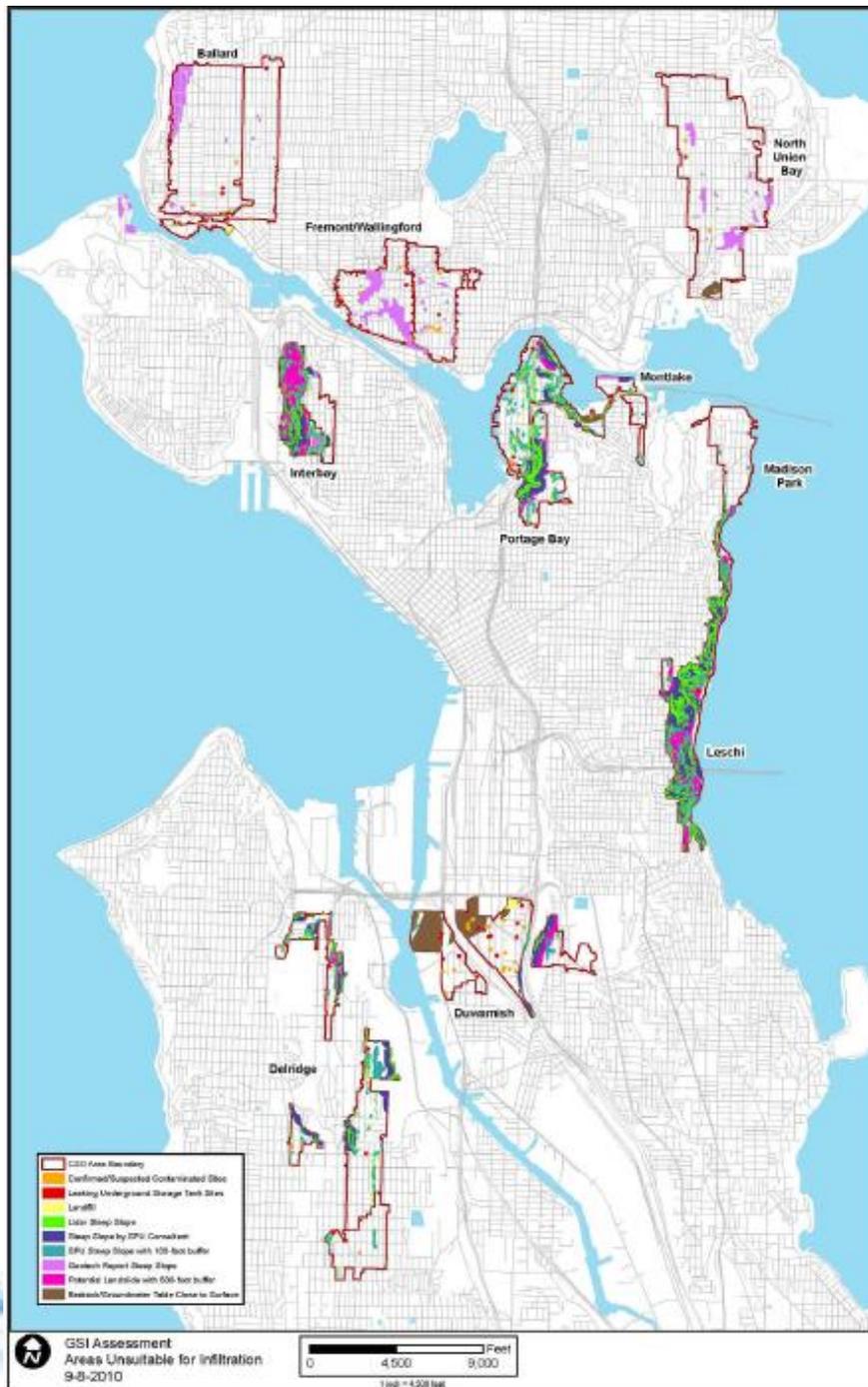
- Step 2: Technical Feasibility
  - Step 2a: Infiltration Restrictions



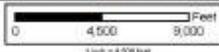
# Fremont/Wallingford Participation Estimates



- Roadside raingardens participation estimate 5%
- Planting strips too narrow
- Parking evaluation not yet conducted but anticipate majority of streets would NOT meet the criteria for parking policy memo




**GSI Assessment**  
 Areas Unsuitable for Infiltration  
 9-8-2010



  
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**COMBINED SEWER OVERFLOW REDUCTION**

# GSI Potential for CSO Control Planning Areas

- Area 1

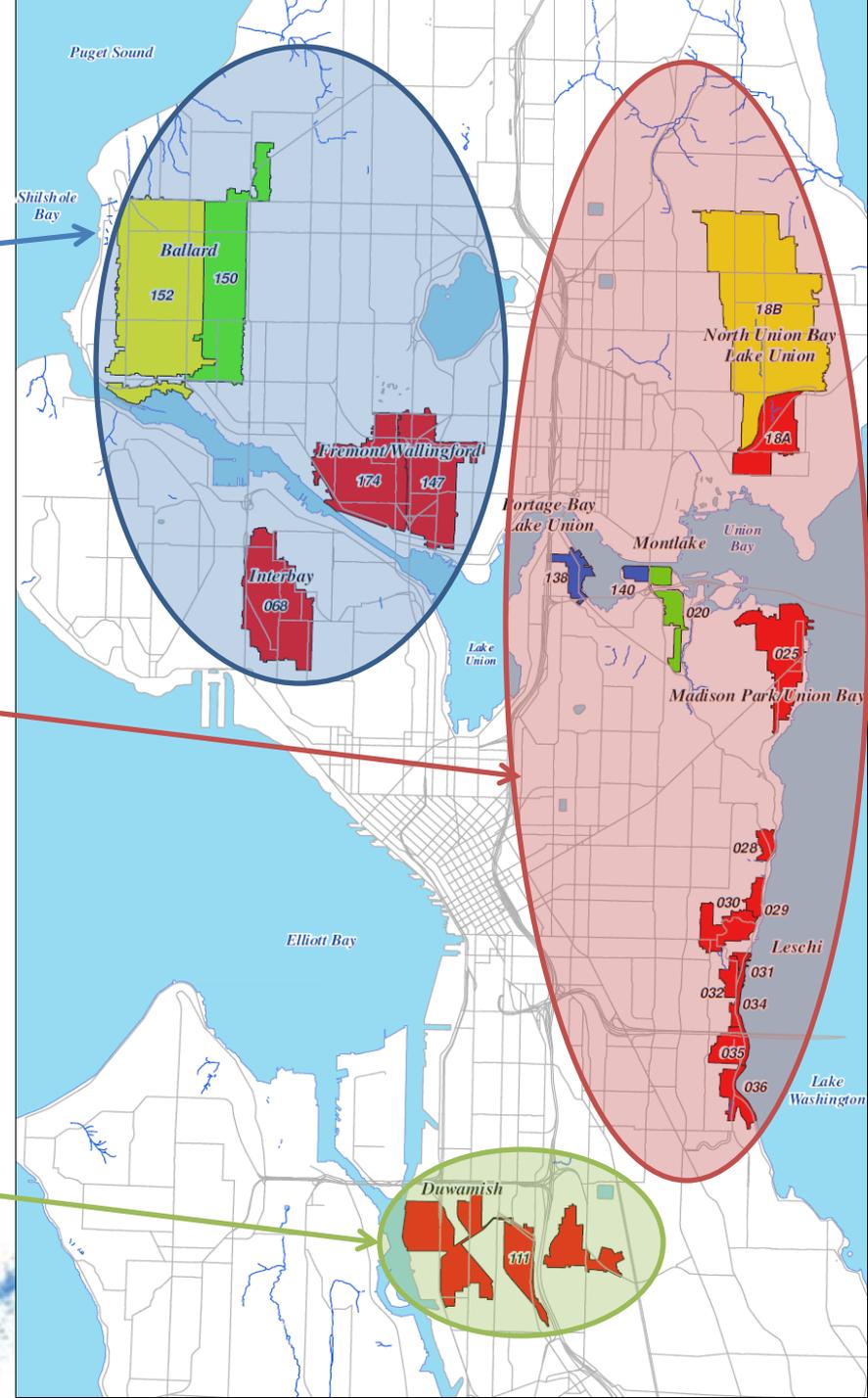
- Ballard
- Fremont/Wallingford
- Interbay

- Area 2

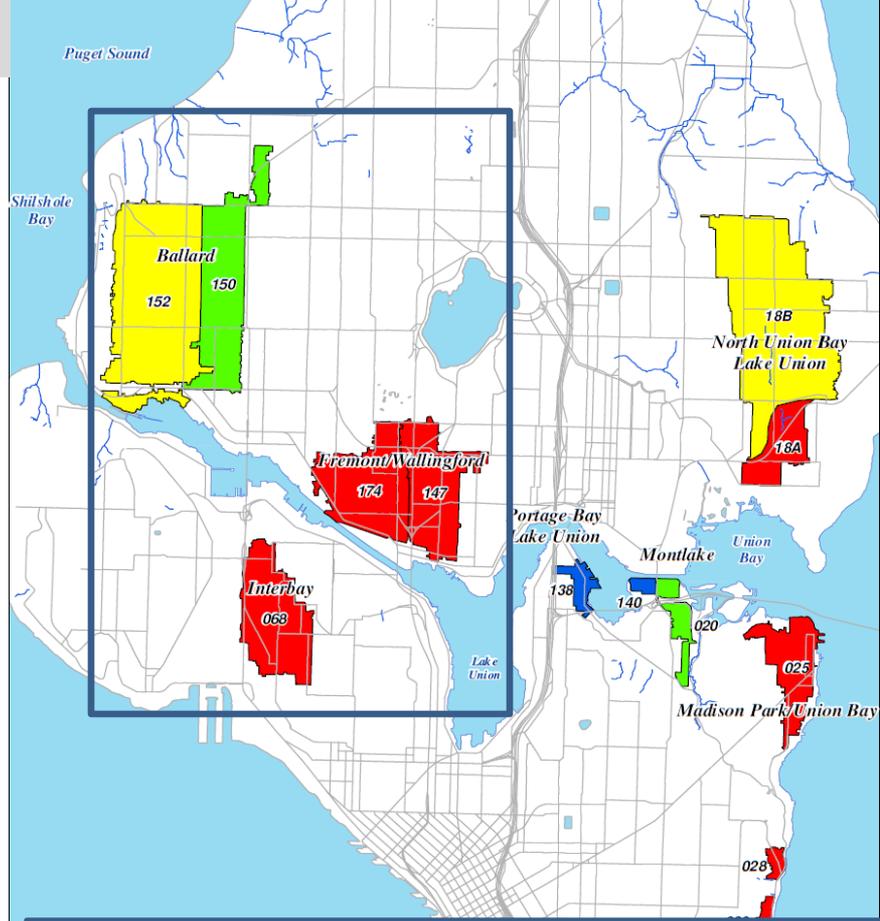
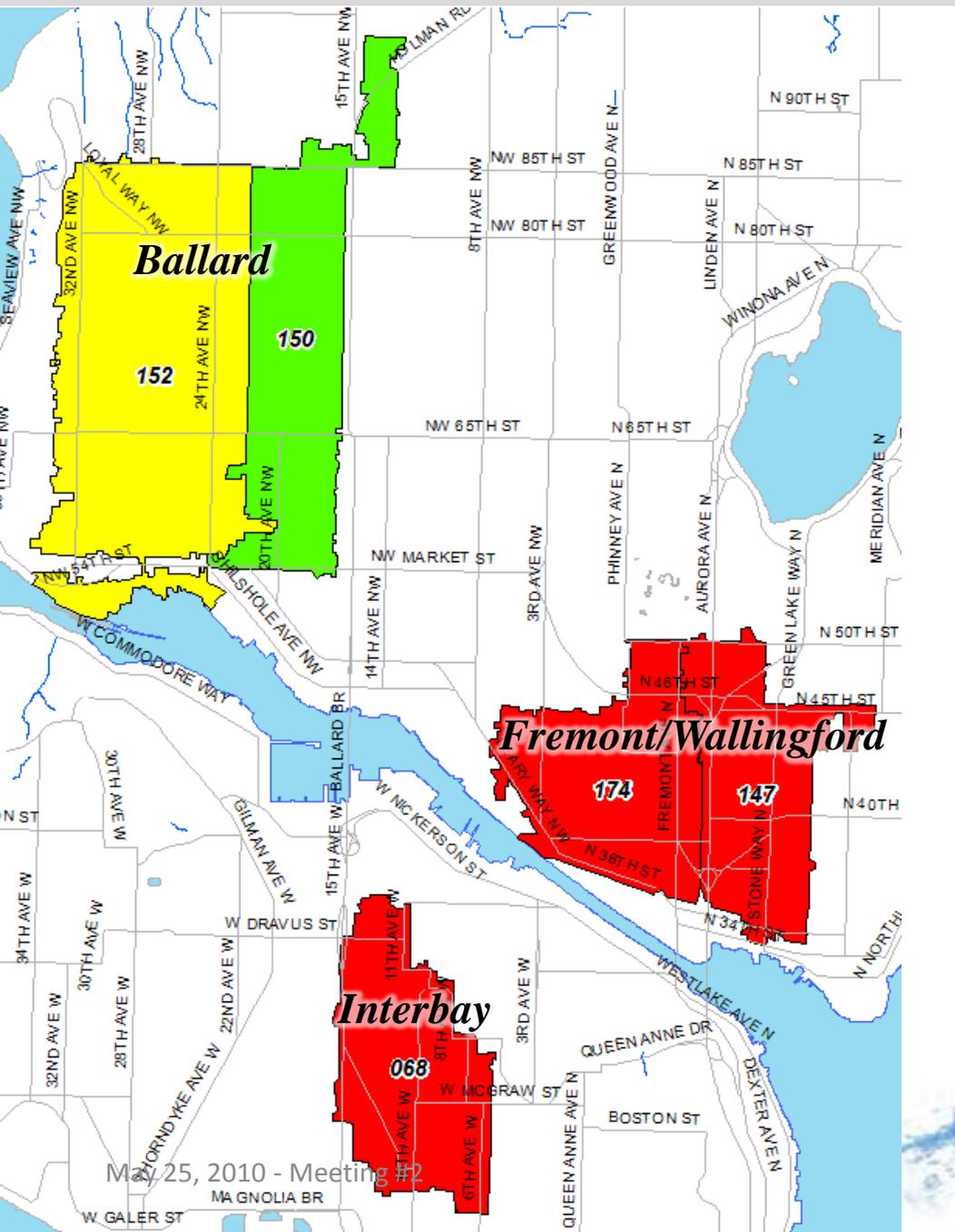
- North Union Bay
- Portage Bay
- Madison Park/Union Bay
- Montlake
- Leschi

- Area 3

- Duwamish



# Planning Area 1: GSI Potential for CSO Control

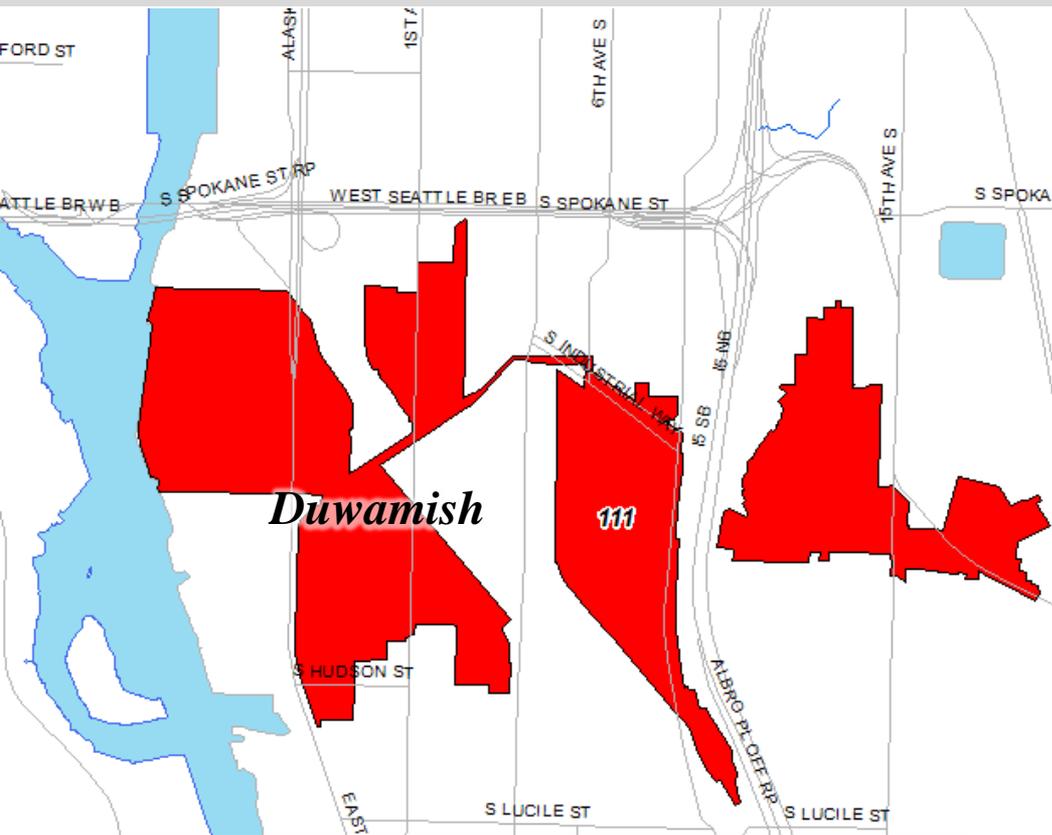


**Legend**

- Basins with Potential to Fully Control CSOs – **Maximum Potential**
- Basins with Potential to Fully Control CSOs – **Most Practical**
- Basins with **Moderate Potential** to Reduce Control Volumes
- Basins with **Low Potential** to Reduce Control Volumes

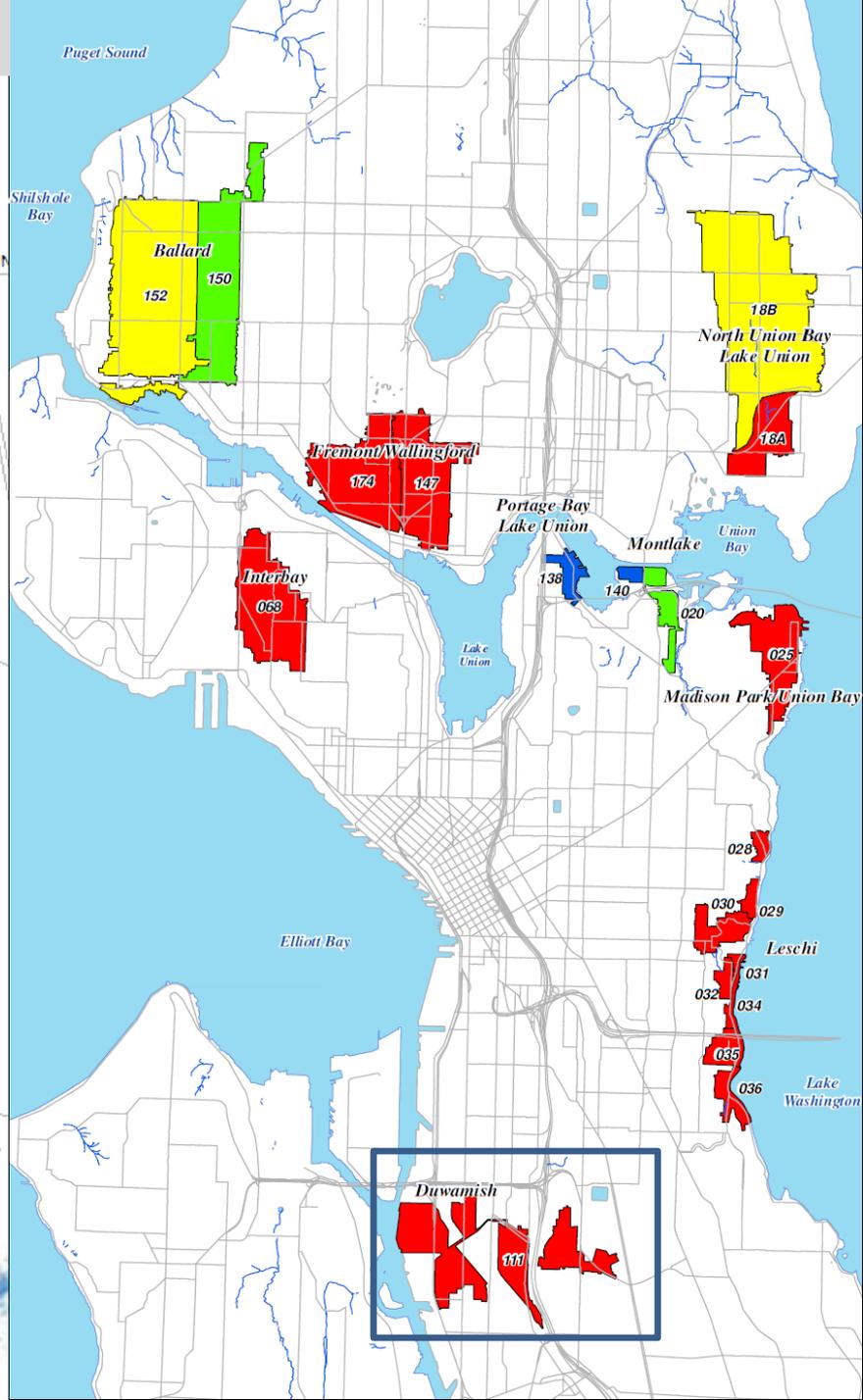


# Planning Area 3: GSI Potential for CSO Control



**Legend**

- Basins with Potential to Fully Control CSOs – **Maximum Potential**
- Basins with Potential to Fully Control CSOs – **Most Practical**
- Basins with **Moderate Potential** to Reduce Control Volumes
- Basins with **Low Potential** to Reduce Control Volumes



# Other benefits of GSI

- Significant reduction in total volume of combined stormwater flows
  - Water quality benefit
  - Energy savings from decreased pumping and Wastewater Treatment costs
- Increased awareness about stormwater and impacts
- Increased green space (increased walkability, increased habitat)

# GSI Roll Out: Leading with Green

## 2010

- Ballard Roadside Raingardens, Phase 1
- Ballard RainWise

## 2011

- Ballard Permeable Pavement Alleys, Phase 1
- Windermere RainWise
- Montlake RainWise, Roadside Raingardens and Perm Pvmt Alley
- North Union Bay RainWise

## 2012

- Ballard Roadside Raingardens, Phases 2-5
- Interbay RainWise
- Genesee RainWise
- Henderson RainWise
- Fremont/Wallingford RainWise

## 2014

- Ballard Permeable Pavement Alleys, Phase 2

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