Sustainable in Seattle: From Street Edge Alternatives to City Standards

Presented by:

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Seattle Public Utilities

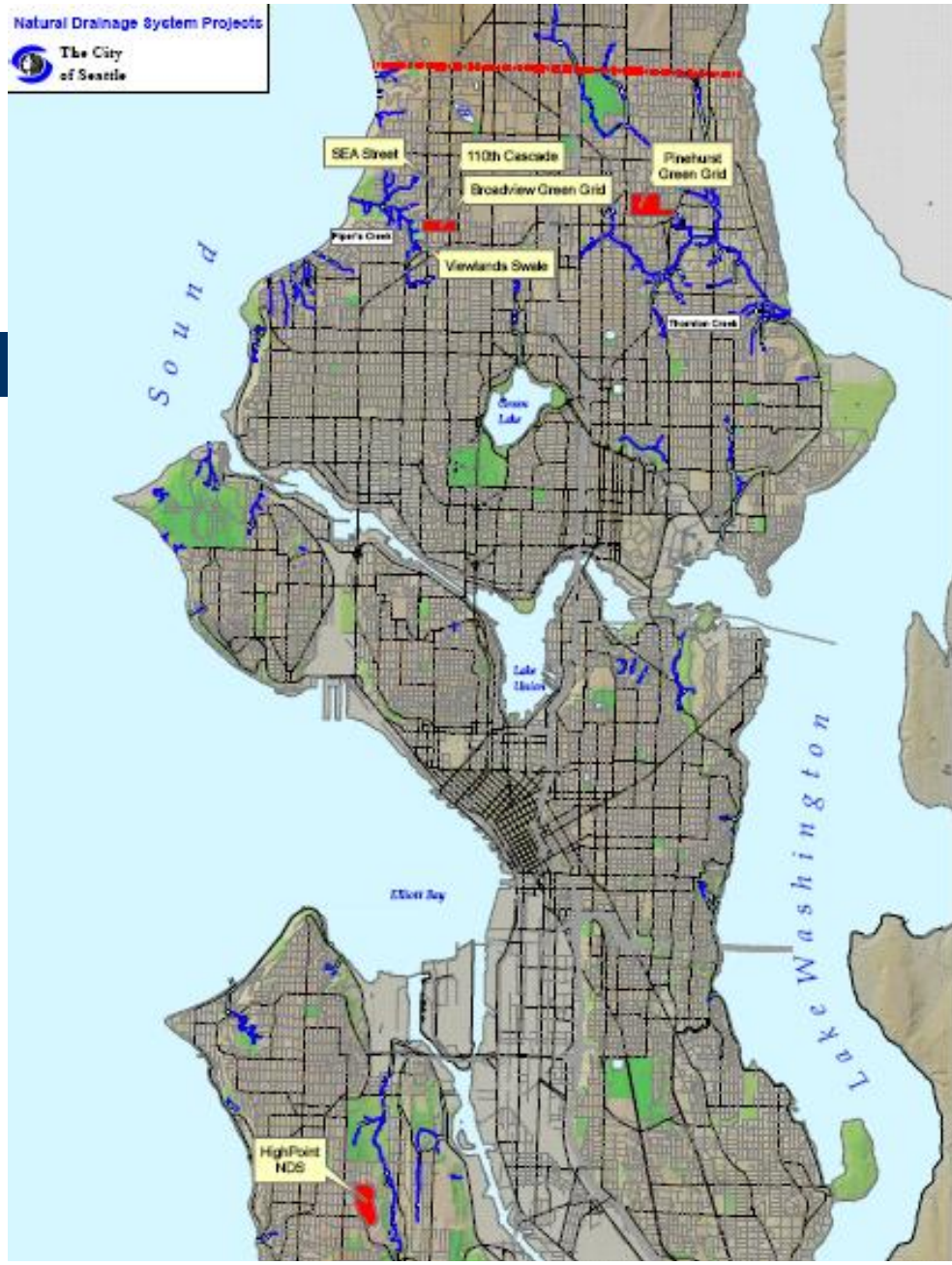
www.seattle.gov/util/naturalsystems

Today's presentation

- Natural Drainage Systems Projects
- Green Stormwater Infrastructure (GSI) as a requirement of new development
- Proposed CIP projects

Natural Drainage Systems

- Initiated in 1999
- Pilot blocks
- Pilot catchments
- Pilot partnering



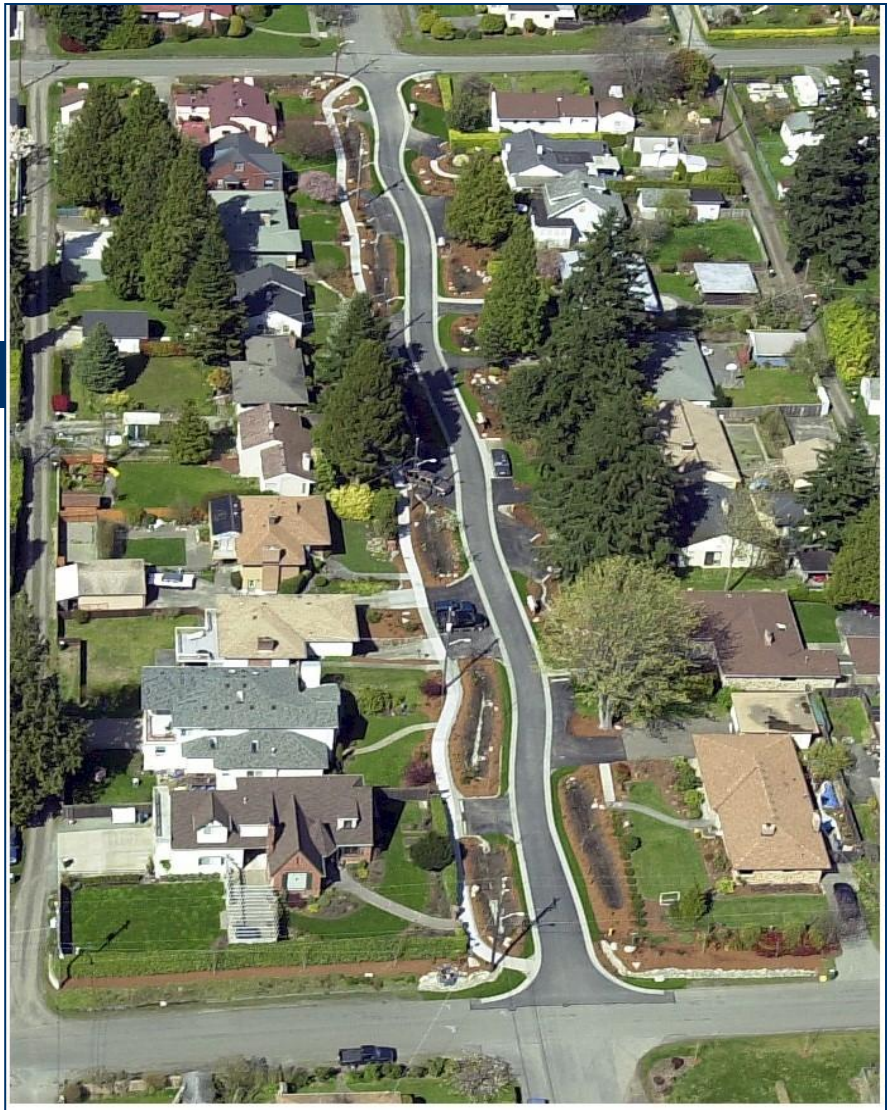
Green Stormwater Infrastructure

Tries to make this…

…function more like this.

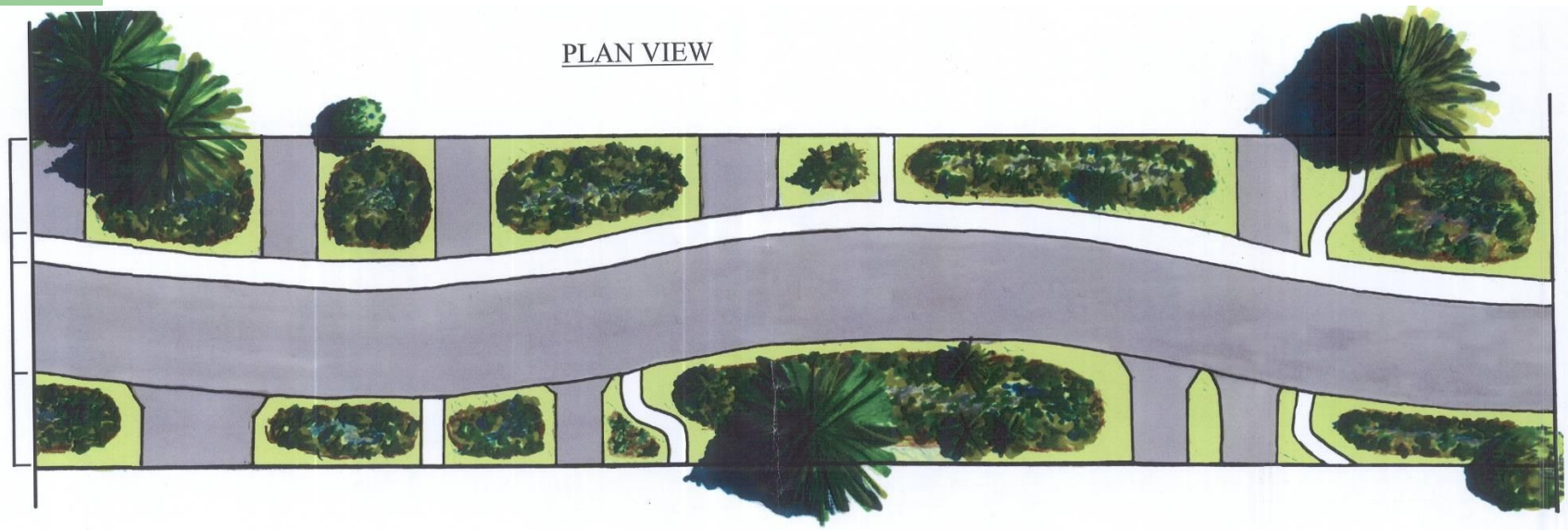
SEA Street #1

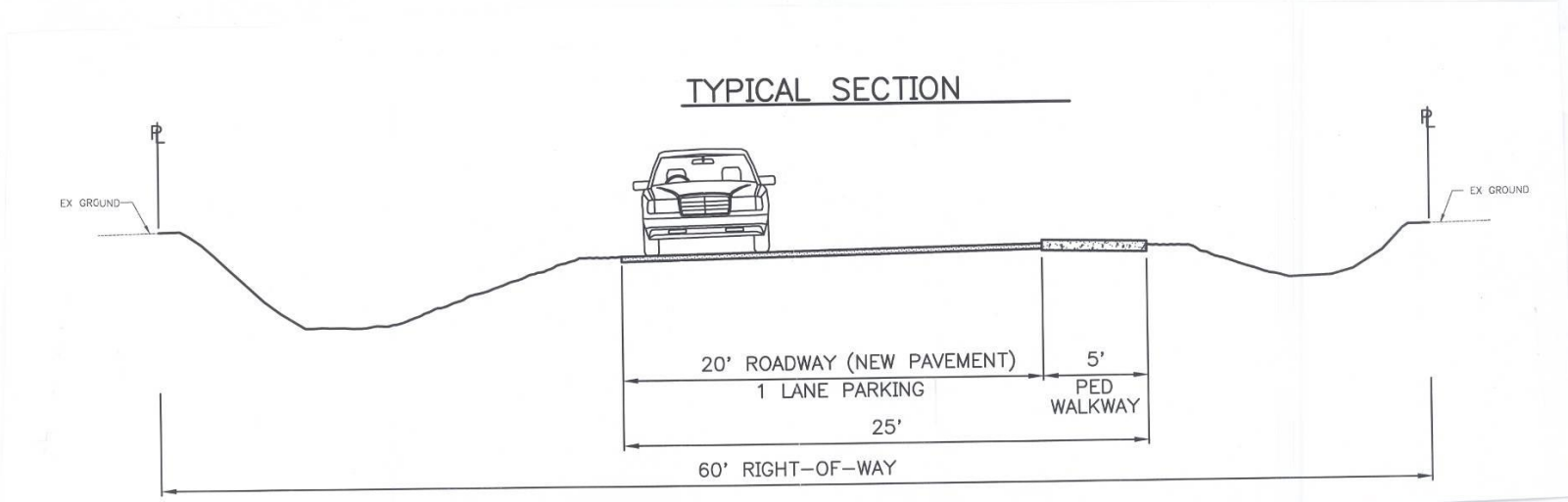
- 660 LF
- 2.3 acre drainage
- Goal: flow control via live storage (mini ponds orifice controlled in theory)
- Constructed 2000



SEA Streets - After Construction
2nd Ave NW - NW 117th St to NW 120th St

The SEA Street Prototype





SEA Street #1 Monitoring

- University of Washington
- three years of continuous monitoring
- **99%** reduction in total runoff volume

- Learned: standard geotech assumptions should be questioned

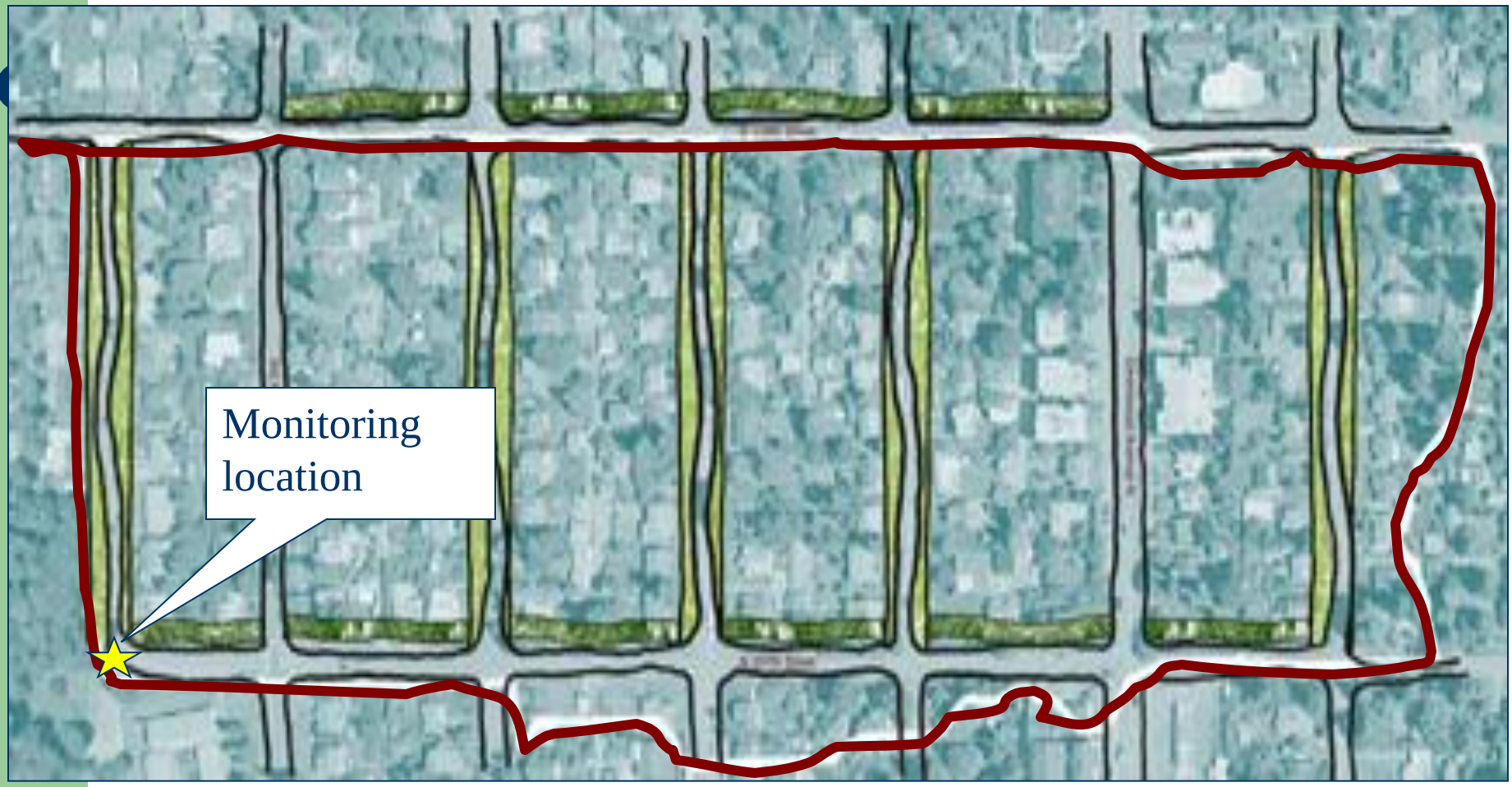
NW 110th Cascade

- 1400 LF
- 28 acre drainage
- Goal: water quality primary
- Constructed 2003

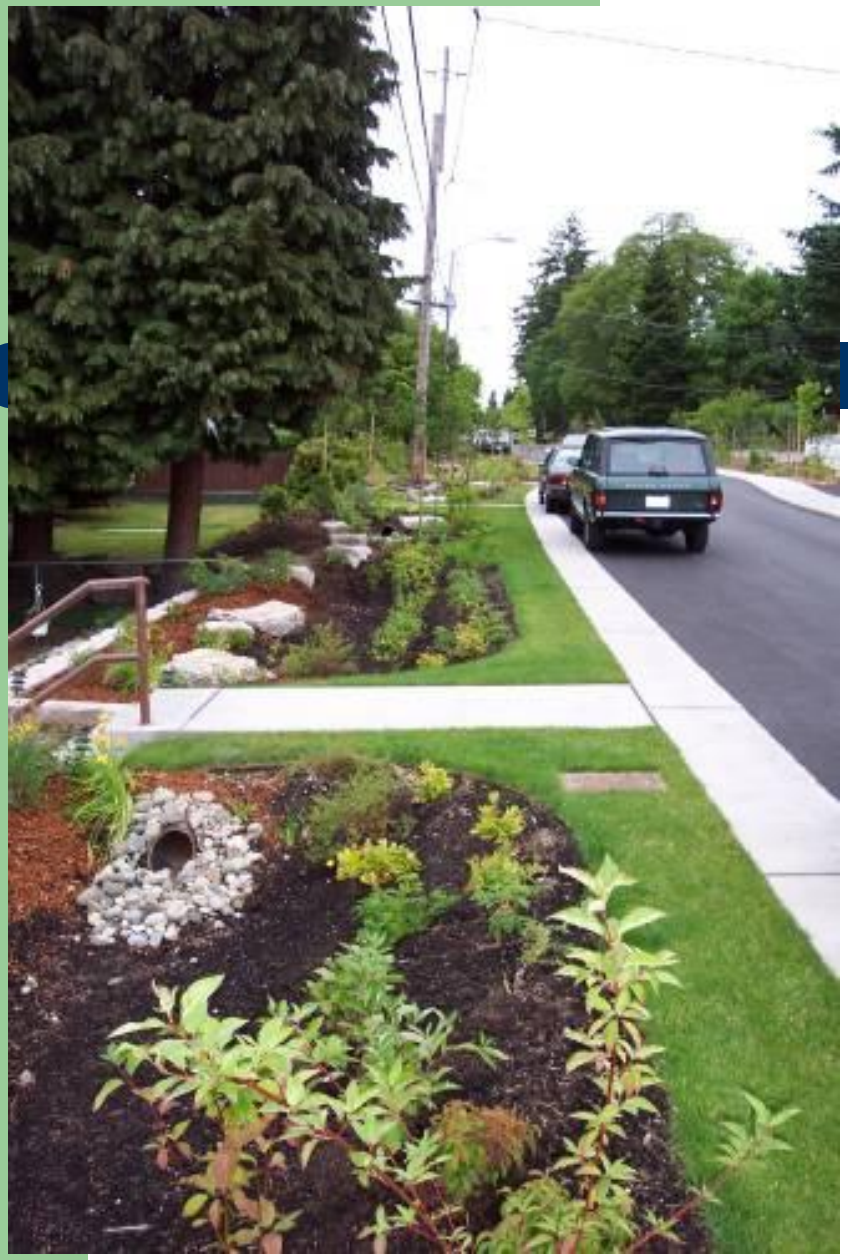
Broadview Green Grid

- 4,500 LF
- 32 acre drainage
- Cascade and SEA street designs
- Goal: flow and water quality
- Constructed 2004

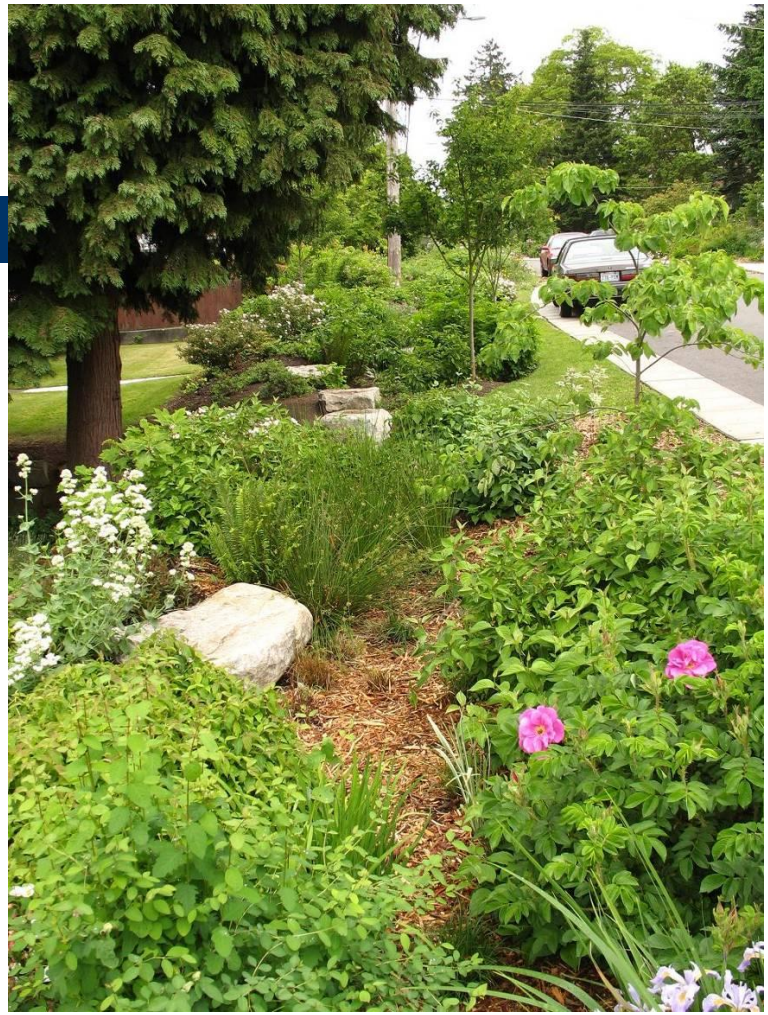
Broadview Green Grid



SEA Streets and Cascades

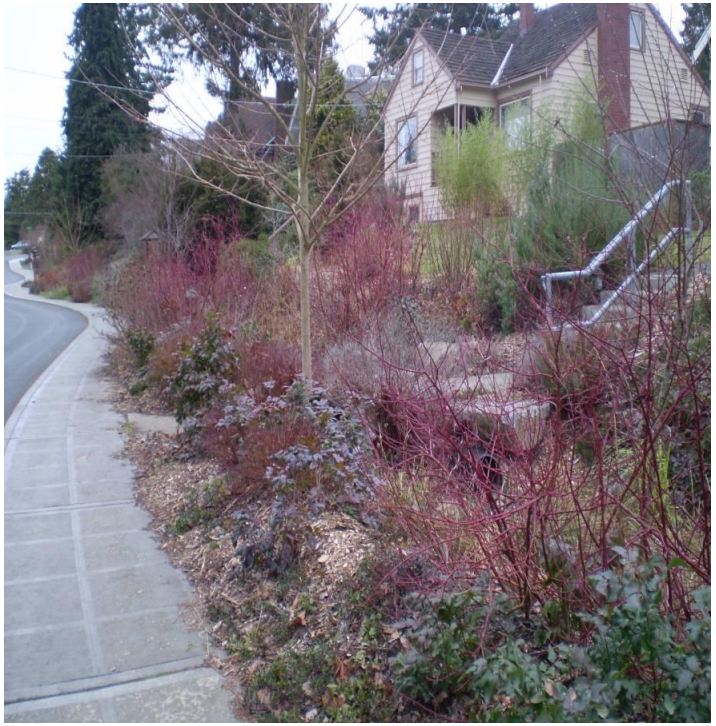


2004



2006

Broadview Green Grid

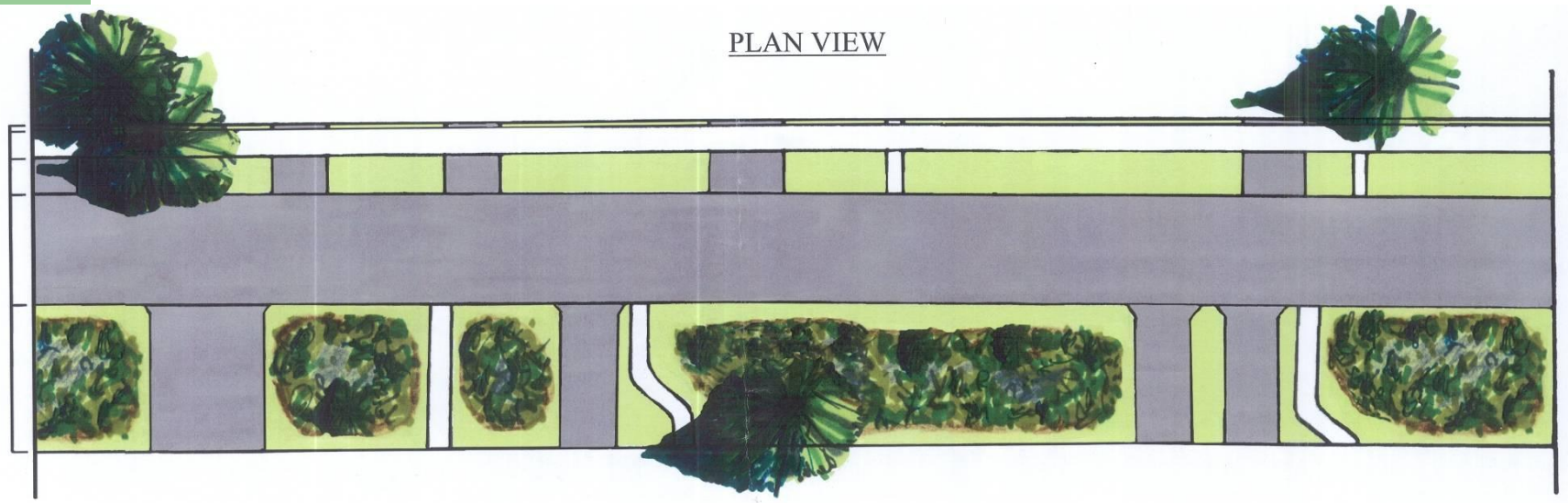


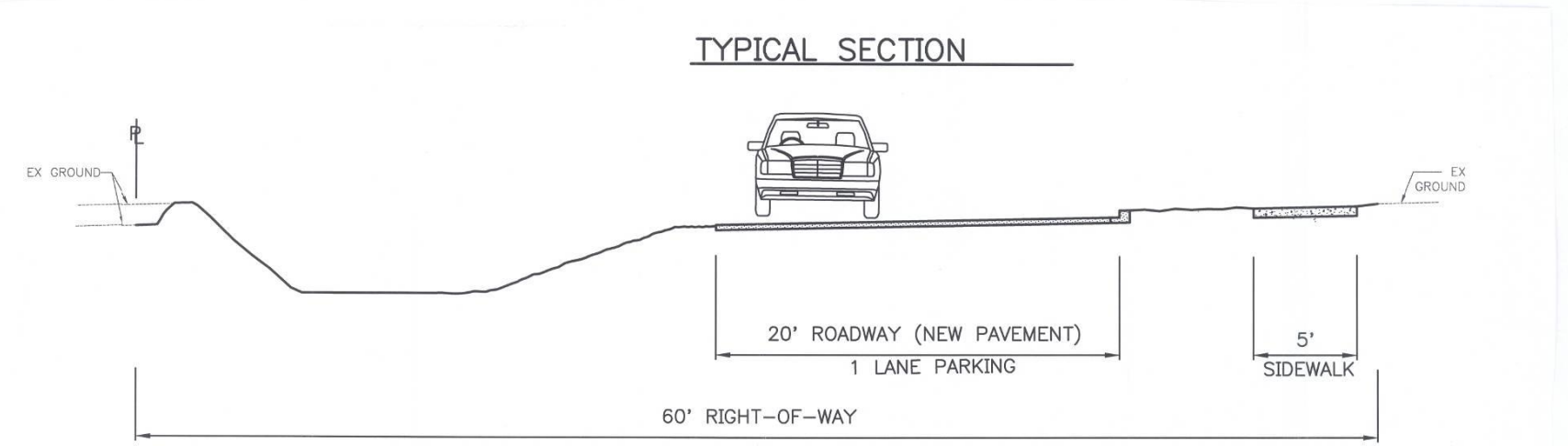
Why Full Street Improvements?

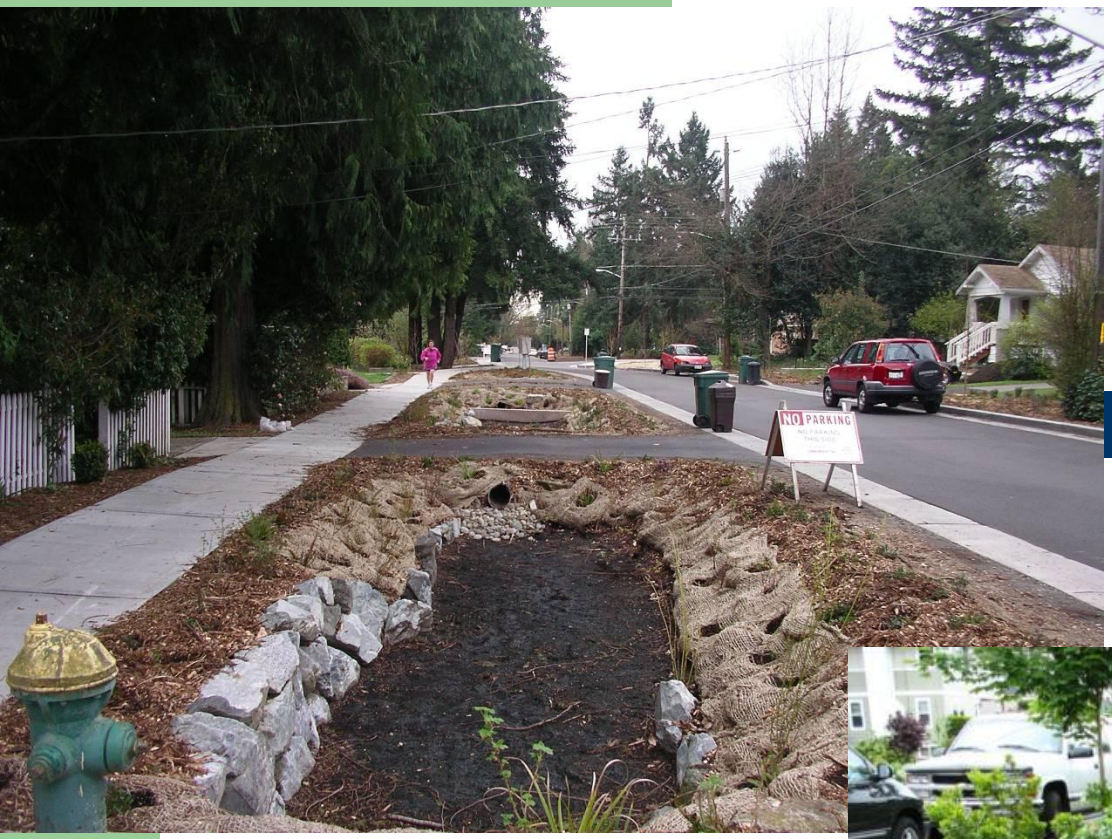
Pinehurst Green Grid

- 3,800 LF
- 49 acre drainage
- Merged Cascade approach into SEAstreet design
- Constructed 2005

SEA Street Design






NO PARKING

100 yr + flood

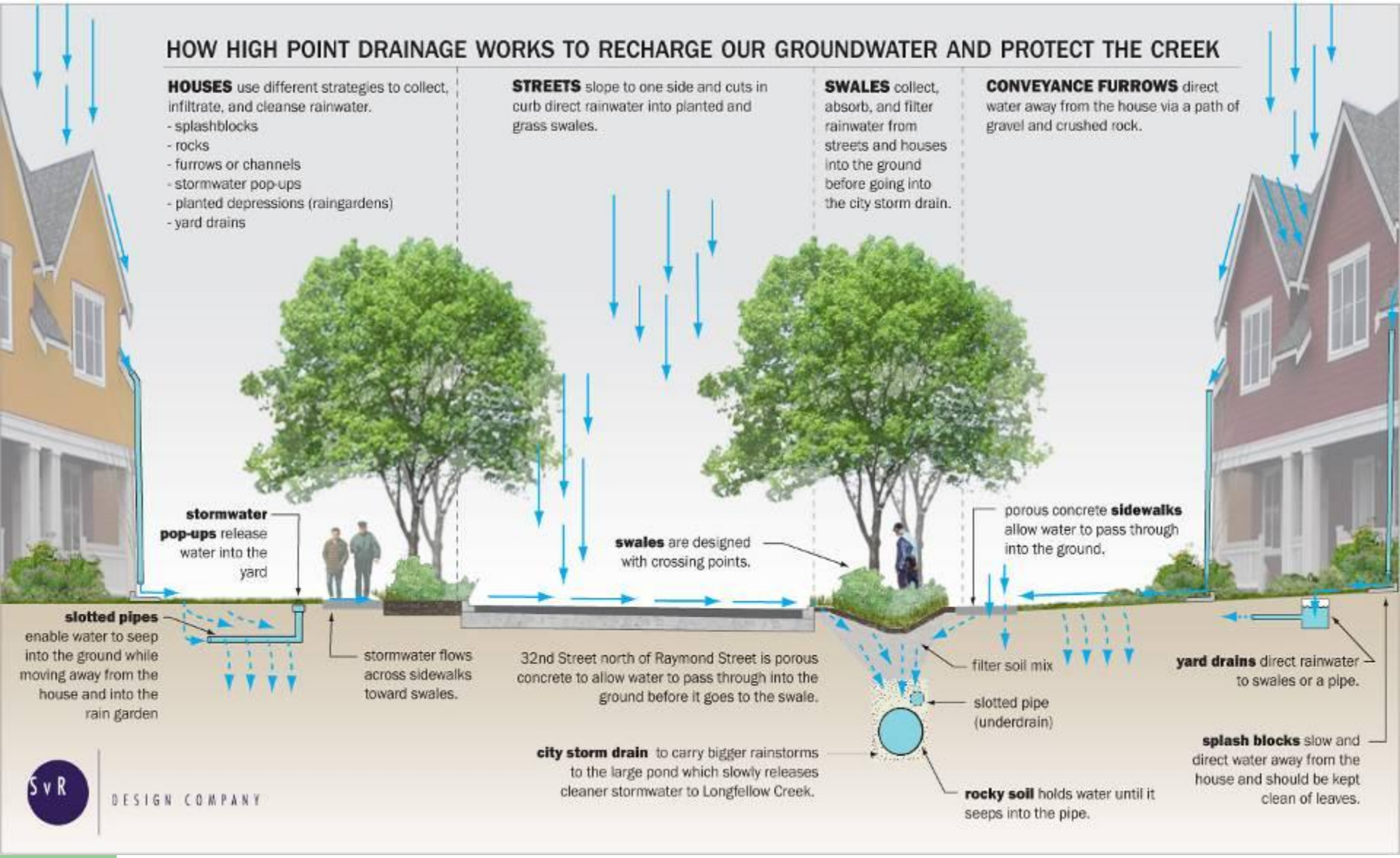
I-5 at Chehalis, WA, December 3, 2007

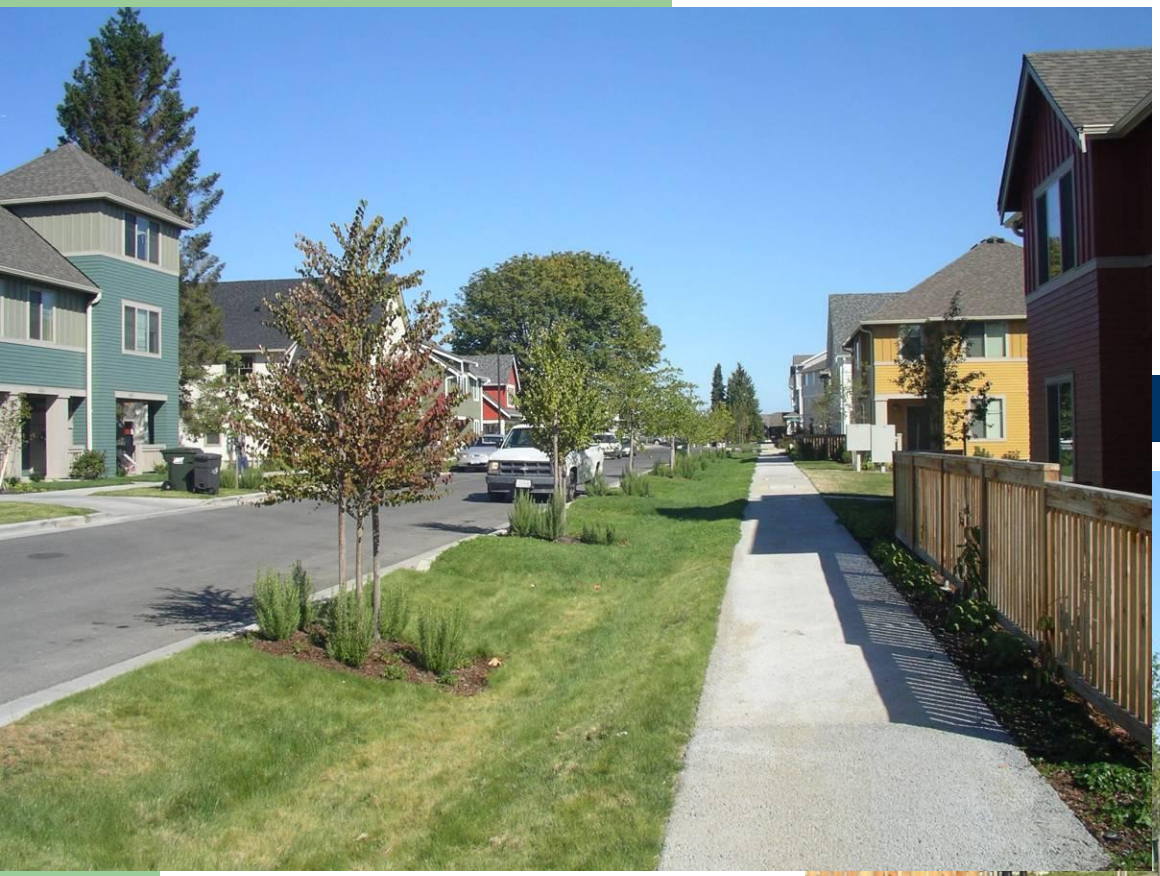
High Point – partnering with Housing Authority

- 120 acre drainage
- Swales within planting strip
- Goal: water quality treatment and flow delay
- Constructed 2005-2009

High Point

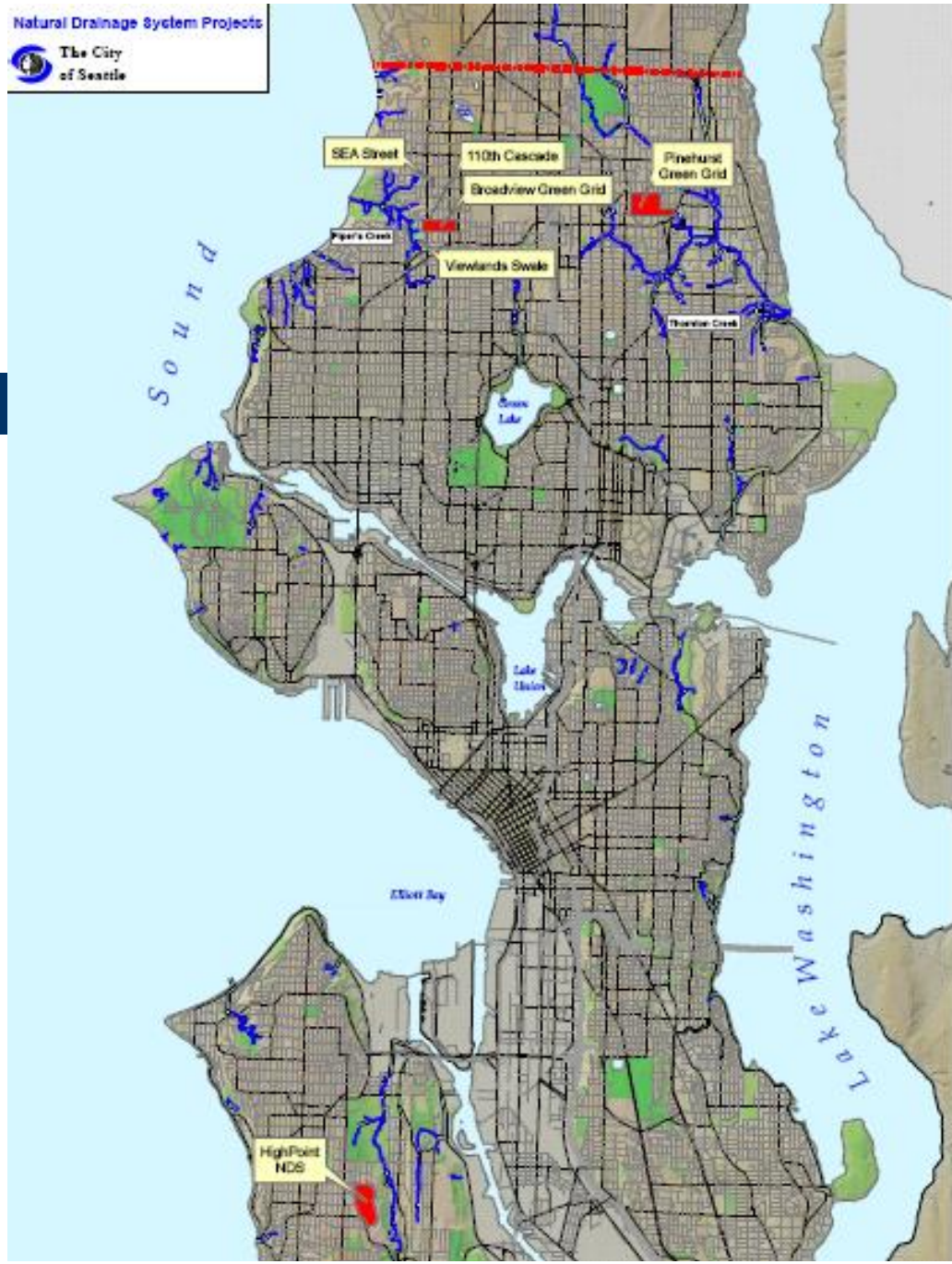
High Point


HOW HIGH POINT DRAINAGE WORKS TO RECHARGE OUR GROUNDWATER AND PROTECT THE CREEK
HOUSES use different strategies to collect, infiltrate, and cleanse rainwater.
- splashblocks
- rocks
- furrows or channels
- stormwater pop-ups
- planted depressions (raingardens)
- yard drains
STREETS slope to one side and cuts in curb direct rainwater into planted and grass swales.
SWALES collect, absorb, and filter rainwater from streets and houses into the ground before going into the city storm drain.
CONVEYANCE FURROWS direct water away from the house via a path of gravel and crushed rock.
stormwater pop-ups release water into the yard
swales are designed with crossing points.
porous concrete sidewalks allow water to pass through into the ground.
slotted pipes enable water to seep into the ground while moving away from the house and into the rain garden
stormwater flows across sidewalks toward swales.
32nd Street north of Raymond Street is porous concrete to allow water to pass through into the ground before it goes to the swale.
filter soil mix
slotted pipe (underdrain)
city storm drain to carry bigger rainstorms to the large pond which slowly releases cleaner stormwater to Longfellow Creek.
rocky soil holds water until it seeps into the pipe.
yard drains direct rainwater to swales or a pipe.
splash blocks slow and direct water away from the house and should be kept clean of leaves.
SvR
DESIGN COMPANY



Natural Drainage Systems

- 65 blocks
- 232 acres
- $17M

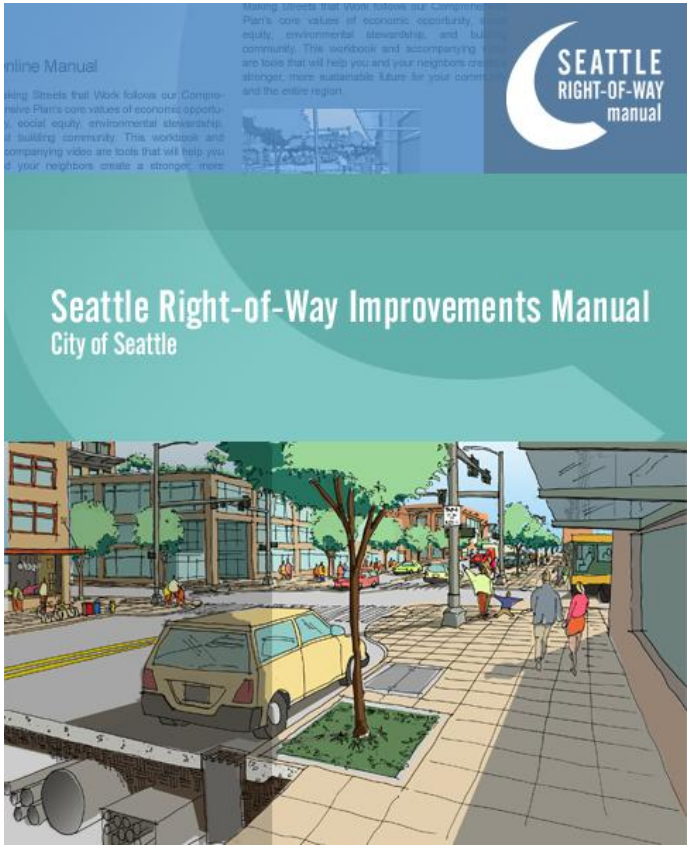


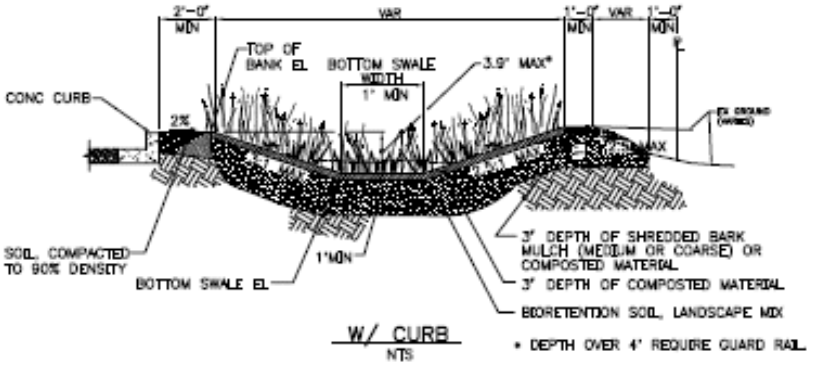
Green Stormwater Infrastructure (GSI) standards

- Right-of-way Improvement Manual
- Stormwater requirements: Stormwater Infrastructure (GSI) as a requirement of new development
- Proposed CIP projects

Right-of-Way Improvement Manual

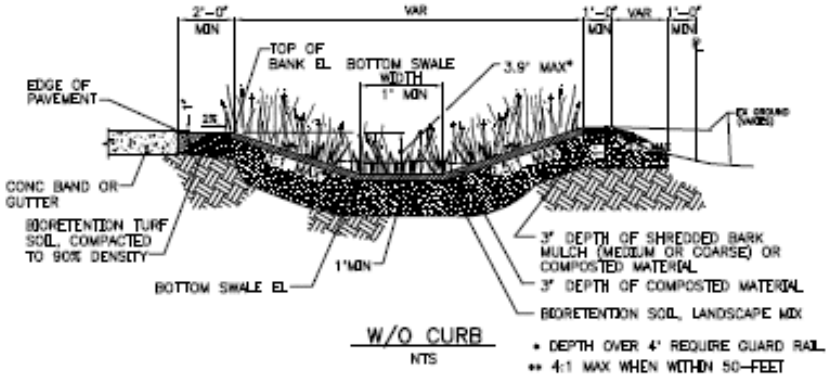
- Guidance where SEA Streets can be considered
- Bioretention Information
  - Details
  - Bioretention soil specification
- Permeable Pavement
  - Details
  - Approved Permeable Pavement List





W/ CURB
NTS

* DEPTH OVER 4' REQUIRE GUARD RAIL



W/O CURB
NTS

* DEPTH OVER 4' REQUIRE GUARD RAIL.

** 4:1 MAX WHEN WITHIN 50-FEET FROM INTERSECTIONS

APPLICATION OF THESE DETAILS REQUIRE APPROVAL FROM SDOT AND SPU.

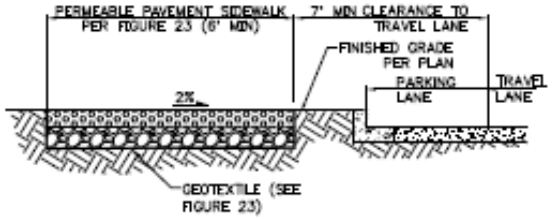
SEATTLE RIGHT-OF-WAY manual

NATURAL DRAINAGE SYSTEM DETAIL

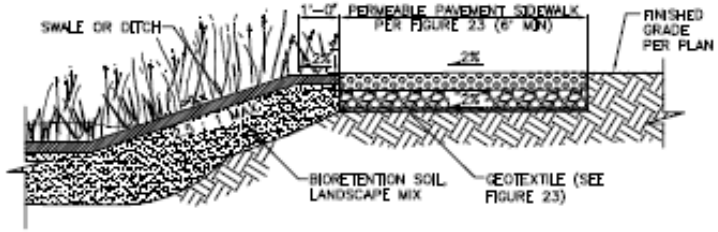
BIORETENTION SWALE

JULY 2009

FIGURE 6-15



PERMEABLE PAVEMENT SIDEWALK ADJACENT TO CURB



PERMEABLE PAVEMENT SIDEWALK ADJACENT TO SWALE OR DITCH

NOTE: PERMEABLE PAVEMENT FACILITIES ARE FOR LONGITUDINAL SLOPE OF 0 ~ 5% ONLY. TO MAXIMIZE THE PONDING CAPACITY USE OF CHECK DAM OR OTHER METHOD ARE RECOMMENDED. (SEE FIGURE 25 FOR DETAIL).

APPLICATION OF THESE DETAILS REQUIRE APPROVAL FROM SDOT AND SPU.

SEATTLE RIGHT-OF-WAY manual

NATURAL DRAINAGE SYSTEM DETAIL

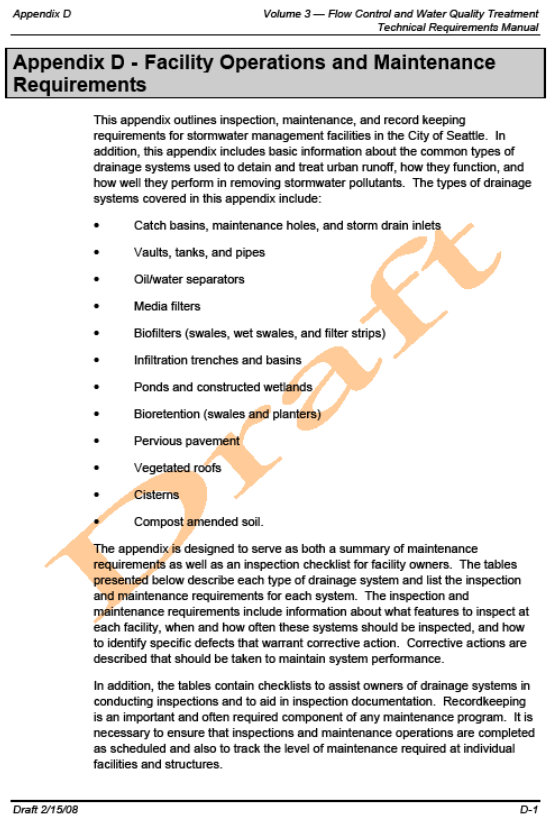
PERMEABLE PAVEMENT FACILITY ,SIDEWALK

JULY 2009

FIGURE 6-24

City of Seattle Stormwater Code (SMC 22.800 – 22.808)

- Green Stormwater Infrastructure (GSI) minimum design requirements
- GSI modeling inputs
- Presized facilities
- **GSI required to MEF**
- In ROW, 2-year GSI maintenance agreement required



Appendix D - Facility Operations and Maintenance Requirements

This appendix outlines inspection, maintenance, and record keeping requirements for stormwater management facilities in the City of Seattle. In addition, this appendix includes basic information about the common types of drainage systems used to detain and treat urban runoff, how they function, and how well they perform in removing stormwater pollutants. The types of drainage systems covered in this appendix include:

- Catch basins, maintenance holes, and storm drain inlets
- Vaults, tanks, and pipes
- Oil/water separators
- Media filters
- Biofilters (swales, wet swales, and filter strips)
- Infiltration trenches and basins
- Ponds and constructed wetlands
- Bioretention (swales and planters)
- Pervious pavement
- Vegetated roofs
- Cisterns
- Compost amended soil.

The appendix is designed to serve as both a summary of maintenance requirements as well as an inspection checklist for facility owners. The tables presented below describe each type of drainage system and list the inspection and maintenance requirements for each system. The inspection and maintenance requirements include information about what features to inspect at each facility, when and how often these systems should be inspected, and how to identify specific defects that warrant corrective action. Corrective actions are described that should be taken to maintain system performance.

In addition, the tables contain checklists to assist owners of drainage systems in conducting inspections and to aid in inspection documentation. Recordkeeping is an important and often required component of any maintenance program. It is necessary to ensure that inspections and maintenance operations are completed as scheduled and also to track the level of maintenance required at individual facilities and structures.

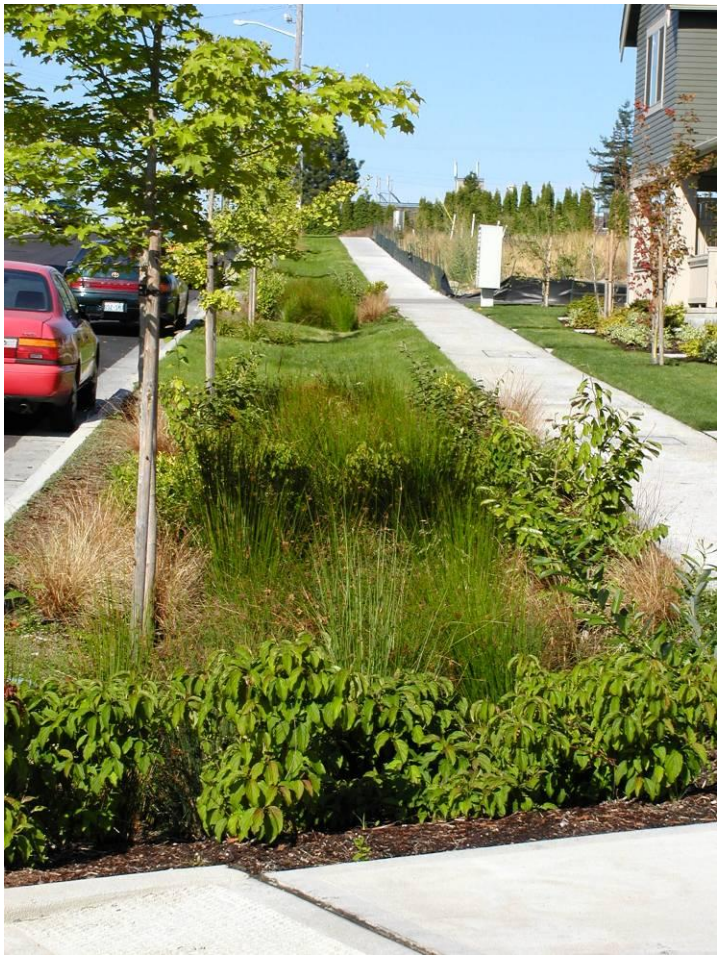
City of Seattle Stormwater Code -Implementation

- Review/inspector checklist
- Directors Rules for clarification of GSI to MEF
- O&M inspector checklists
- City staff training

Bioretention – on parcels

Bioretention – on parcels

Bioretention – in the Right of Way



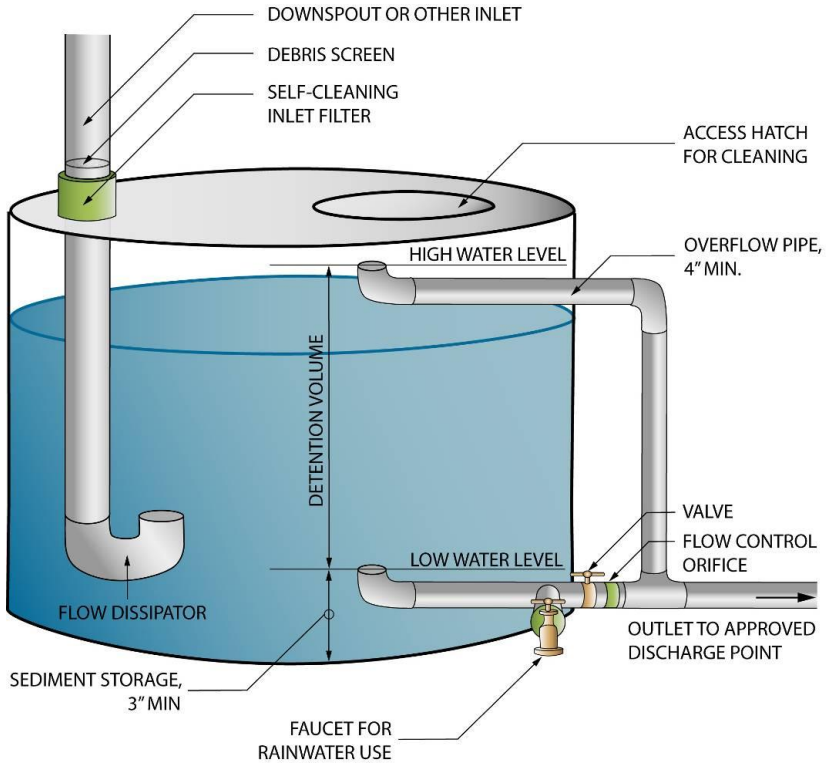
Green Roofs

Ballard Library

Seattle City Hall

Justice Center

Rainwater Harvesting



DETENTION CISTERN
(SINGLE FAMILY RESIDENTIAL ONLY)

Permeable Pavement

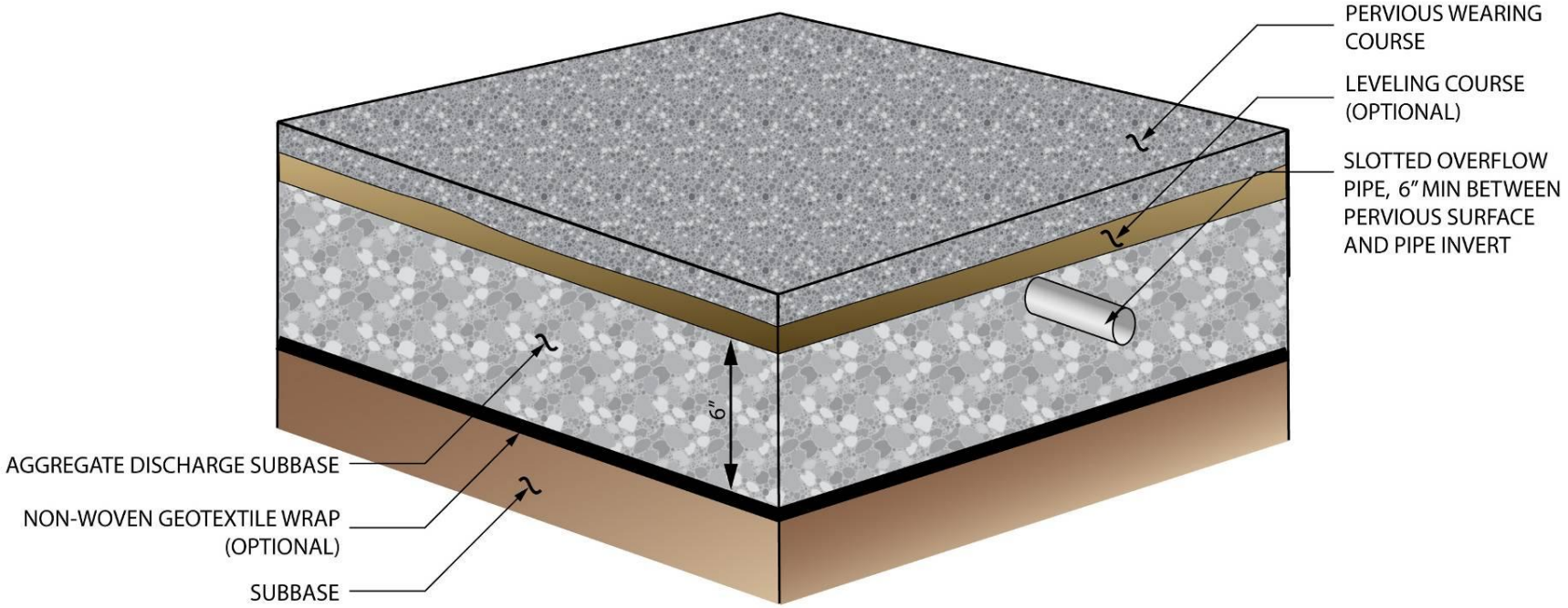
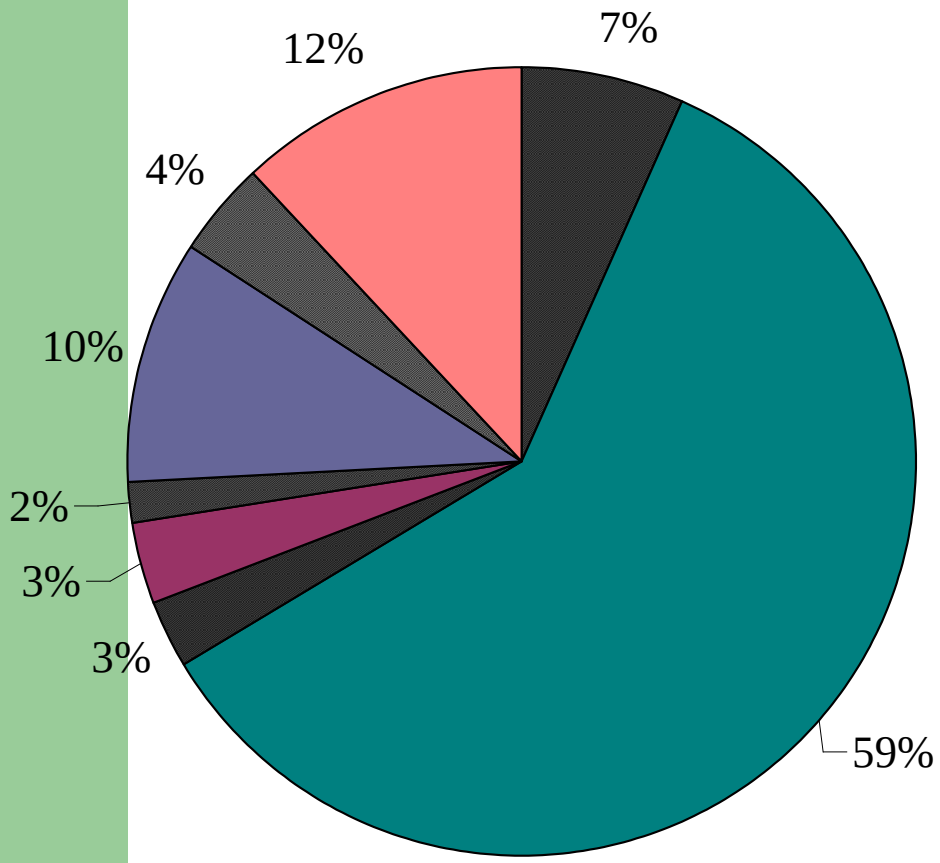


Table 4.5. Sizing Factors for Pre-Sized Approach (for sites with less than 10,000 sf impervious surface).

Facility Type	Facility Overflow Depth	Native Soil Design Infiltration Rate (inch/hour)	Sizing Factor [1] (% of contributing impervious area)		Section Providing Design Requirements
			Creek Protection Standard	Capacity Control Standard	
Bioretention Cell (without Underdrain)	2 inch ponding depth	0.25	25.6%	--	4.4.1
		0.5	16.7%	--	
		1.0	13.6%	--	
	6 inch ponding depth	0.25	14.4%	31.6%	4.4.1
		0.5	9.3%	19.1%	
		1.0	6.0%	9.7%	
	12 inch ponding depth	0.25	8.8%	17.9%	4.4.1
		0.5	6.2%	12.6%	
		1.0	3.8%	6.7%	
Bioretention Planter with Underdrain	6 inch ponding depth	NA	NA	8.3%	4.4.1
	12 inch ponding depth	NA	NA	5.8%	
Permeable Pavement Facility (with Storage Reservoir & Overflow)	6 inch aggregate discharge subbase depth	0.25	48.8%	128.3%	4.4.2
		0.5	33.3%	54.1%	
		1.0	33.3%	33.3%	
Infiltration Trench	1.5 foot depth	0.25	27.3%	56.6%	4.5.2
		0.5	16.8%	30.8%	
		1.0	10.7%	18.1%	
	3.0 foot depth	0.25	17.0%	33.1%	4.5.2
		0.5	12.0%	22.5%	
		1.0	7.8%	13.4%	
Drywell	4.0 foot depth	0.25	13.6%	24.5%	4.5.3
		0.5	10.1%	17.6%	
		1.0	6.7%	11.1%	
		0.25	9.7%	18.1%	

Stormwater Regulations will NOT address the problems alone.

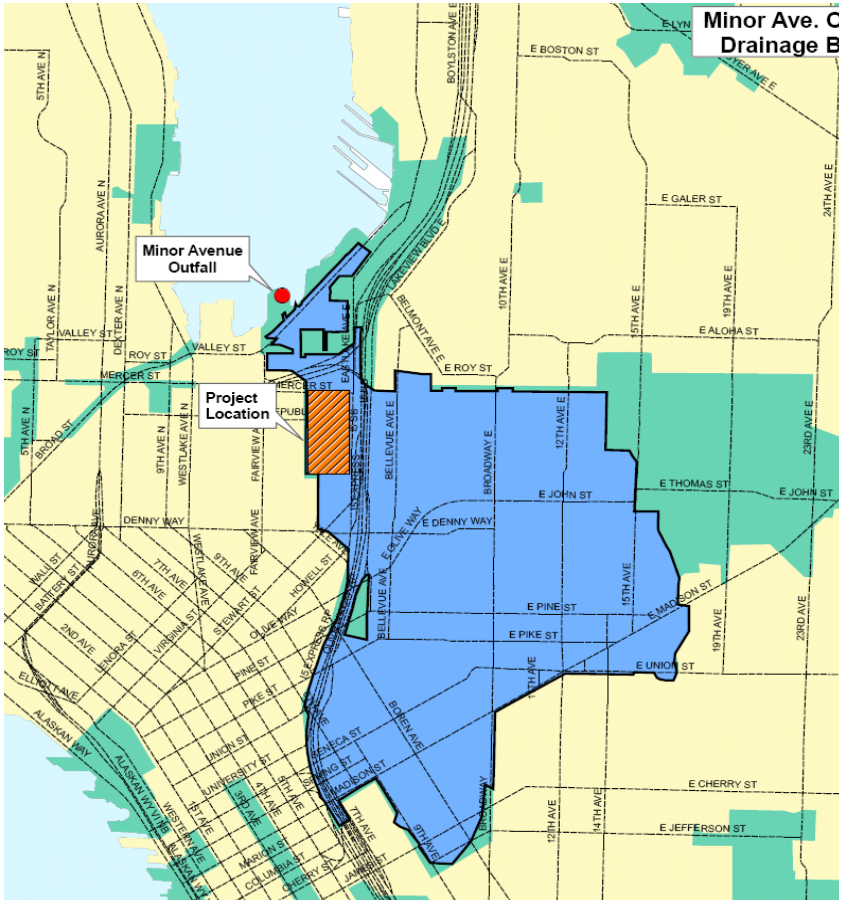


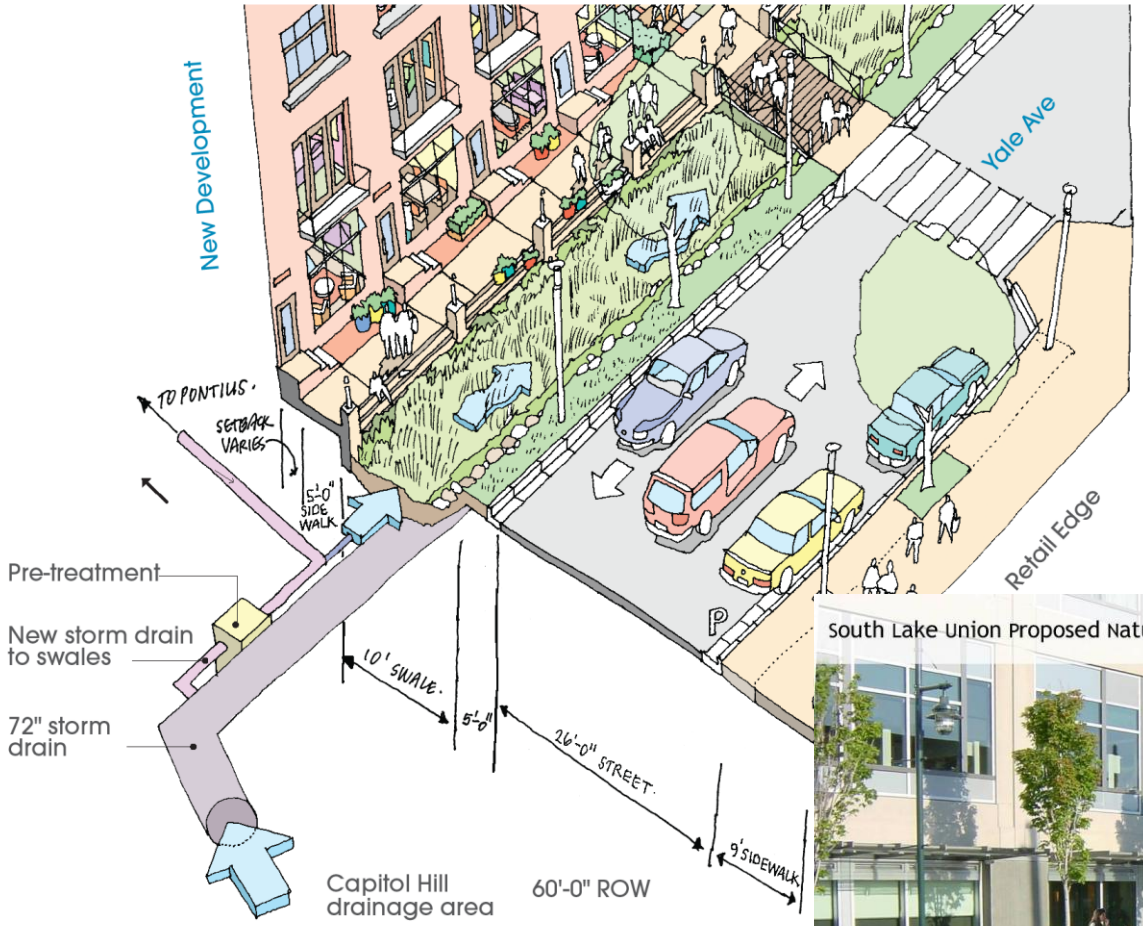
16% developable area anticipated to be retrofitted via Stormwater Code requirements over 50-year time period

Capital Improvement Projects

Swale on Yale

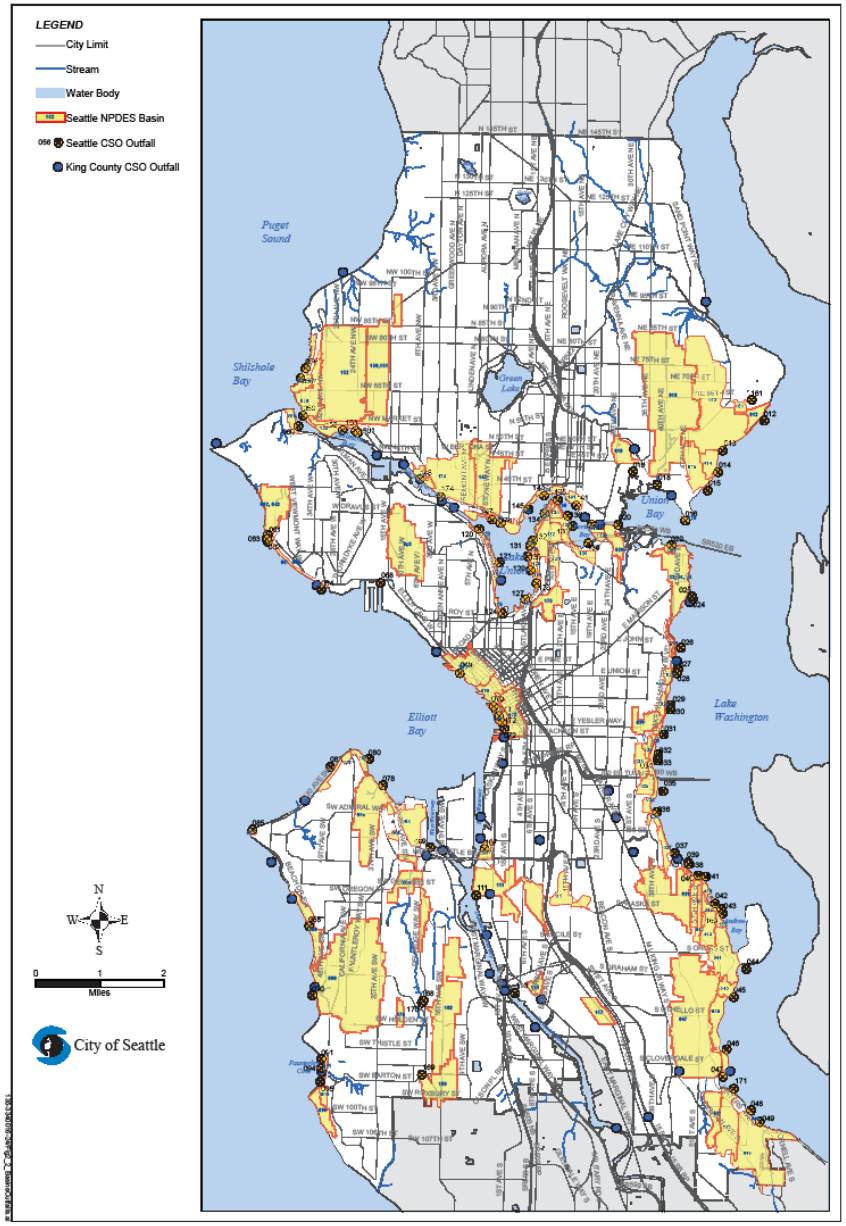
Designed to treat stormwater runoff from a 160-ac watershed, but at times, can treat the whole watershed (335-acres)



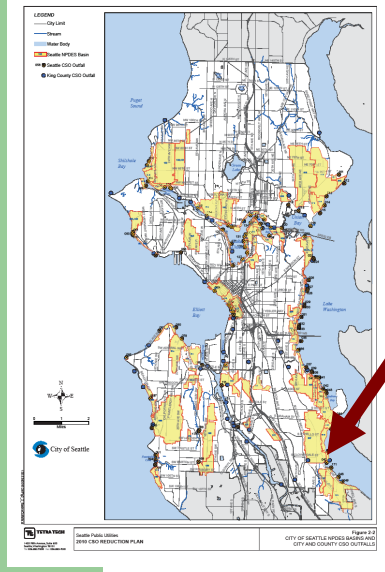

New Development
Yale Ave
TO PONTIUS
SETBACK VARIES
5'-0" SIDE WALK
Pre-treatment
New storm drain to swales
72" storm drain
10' SWALE
5'-0"
26'-0" STREET
9' SIDEWALK
Capitol Hill drainage area
60'-0" ROW
Retail Edge
P


South Lake Union Proposed Natural Drainage System
Seattle Public Utilities
Draft
SvR Design Company
August 15, 2005
figure 3

Integrating GSI into CSO control



Lakewood Raincatcher

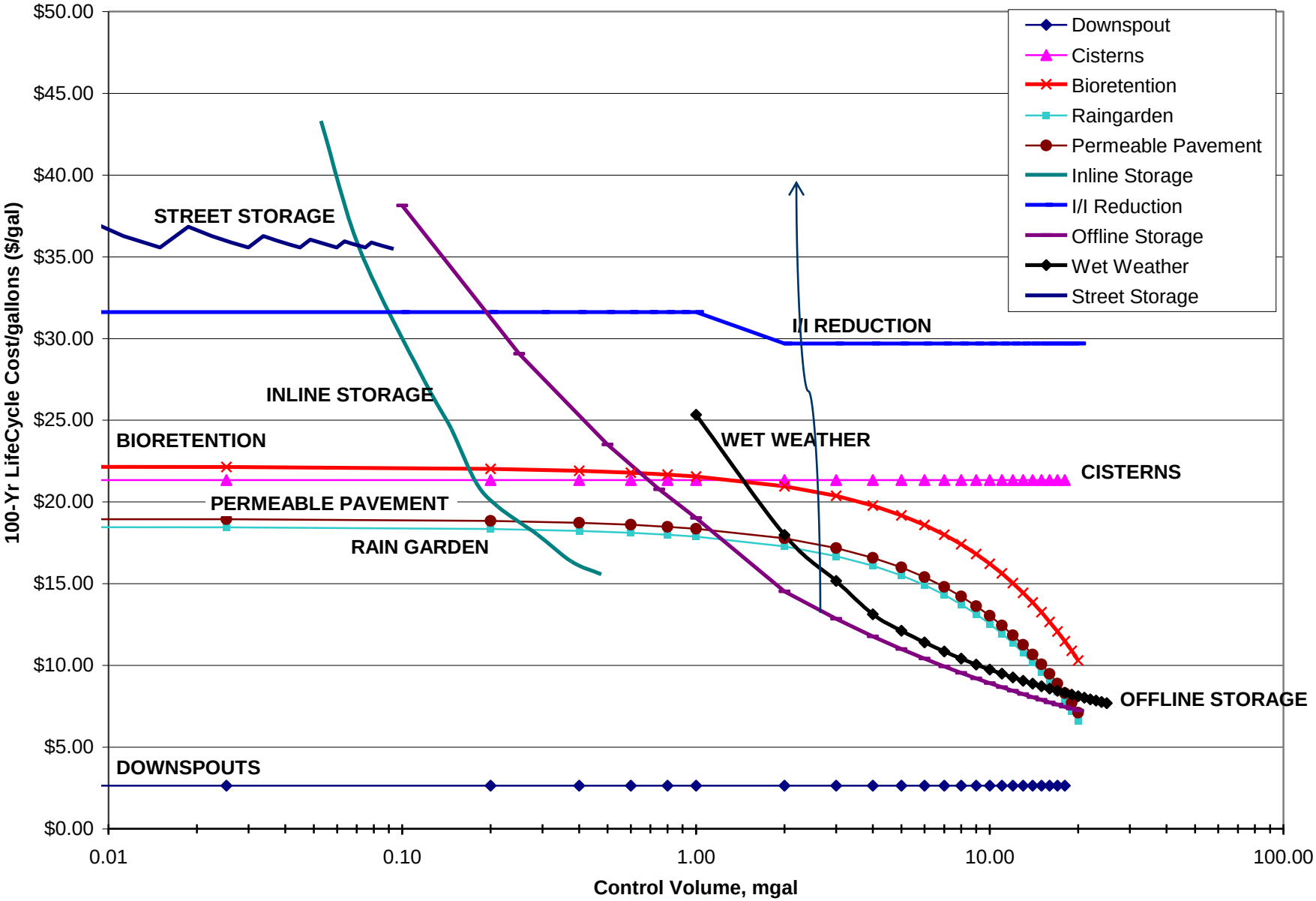


Installation of rain gardens and cisterns on private property to reduce downstream impacts and gather information

Triple Bottom Line Analysis

Real Discount Rate:	5%	Lifecycle 1, yrs:	50					
Full Series LCA?	1	Lifecycle 2, yrs:	100					
	Parcel	Parcel	ROW	ROW	ROW	Parcel	Parcel	ROW
Cost Calculation Assumption or Parameter	Residential Downspout Disconnect	Residential Rain Harvest Cistern	ROW Bioretention NDS	ROW Bioretention Rain Garden	Alley/Sidewalk Perm Paving Retrofit	Remove Impervious Areas	Commercial Green Roof, New Roof	Alley/Sidewalk Perm Paving New Project
Construction Cost	$0.85	$55.60	$85.88	$32.39	$8.00	$2.04	$10.25	$1.85
Allied Costs	35%	35%	140%	110%	140%	35%	35%	140%
Measure Life	100	20	50	50	28	100	40	28
Replacement	1%	6.7%	525%	525%	5%	5%	5%	5%
O&M, Early	$0.25	$3.54	$1.45	$1.45	$0.05	$0.00	$2.15	$0.05
O&M, Mature	$0.00	$3.54	$0.70	$0.70	$0.05	$0.00	$1.62	$0.05
Area Ratio	100%	2.0%	3.8%	3.8%	33.3%	100%	100%	33%
Ancillary Benefit %	2%	5%	15%	10%	10%	5%	10%	10%
Capital Cost per SF Managed	$1.15	$1.50	$7.83	$2.58	$6.39	$2.75	$13.84	$1.48
50-yr Lifecycle Cost per SF Managed	$1.74	$4.06	$10.98	$4.10	$8.85	$4.39	$51.74	$2.27
50-yr Lifecycle Cost per SF, Triple BL	$1.71	$3.85	$9.33	$3.69	$7.96	$4.17	$46.57	$2.04

CSO Plan Updates- cost curves



Initiating Green Streets Program

Initiating Residential Rainwise

- Contractor reimbursement for construction of GSI on private parcels

Questions?

www.seattle.gov/util/naturalsystems