Transforming Gray Space to Green Space:

Integrating Stormwater Management With Urban Design

February 19, 2015

Kevin Robert Perry, ASLA

Urban Rain | Design

Why Retofit?

George Kessler
1900's

"Very little thought is given to [cities] qualitative characters. But there comes a time when development must be subject to control, when further growth must be planned such that urbanization will no longer proceed at the expense of devastating 'nature'."

1960's Urbanization

1960's Urbanization

Truth or Cartoon?

Urbanization Today

Photo: Google Earth

Natural Landscape

Photo: Google Earth

Urbanization

Houston, Texas

Photo: Google Earth

Natural Landscape

Photo: Google Earth

Urbanization

Calgary, Canada

Photo: Google Earth

Natural Landscape

Photo: Google Earth

Sub-Urbanization

Central Valley, California


Desert


Redwoods


Riparian


Oaks




Moving Towards An Unhealthy Watershed

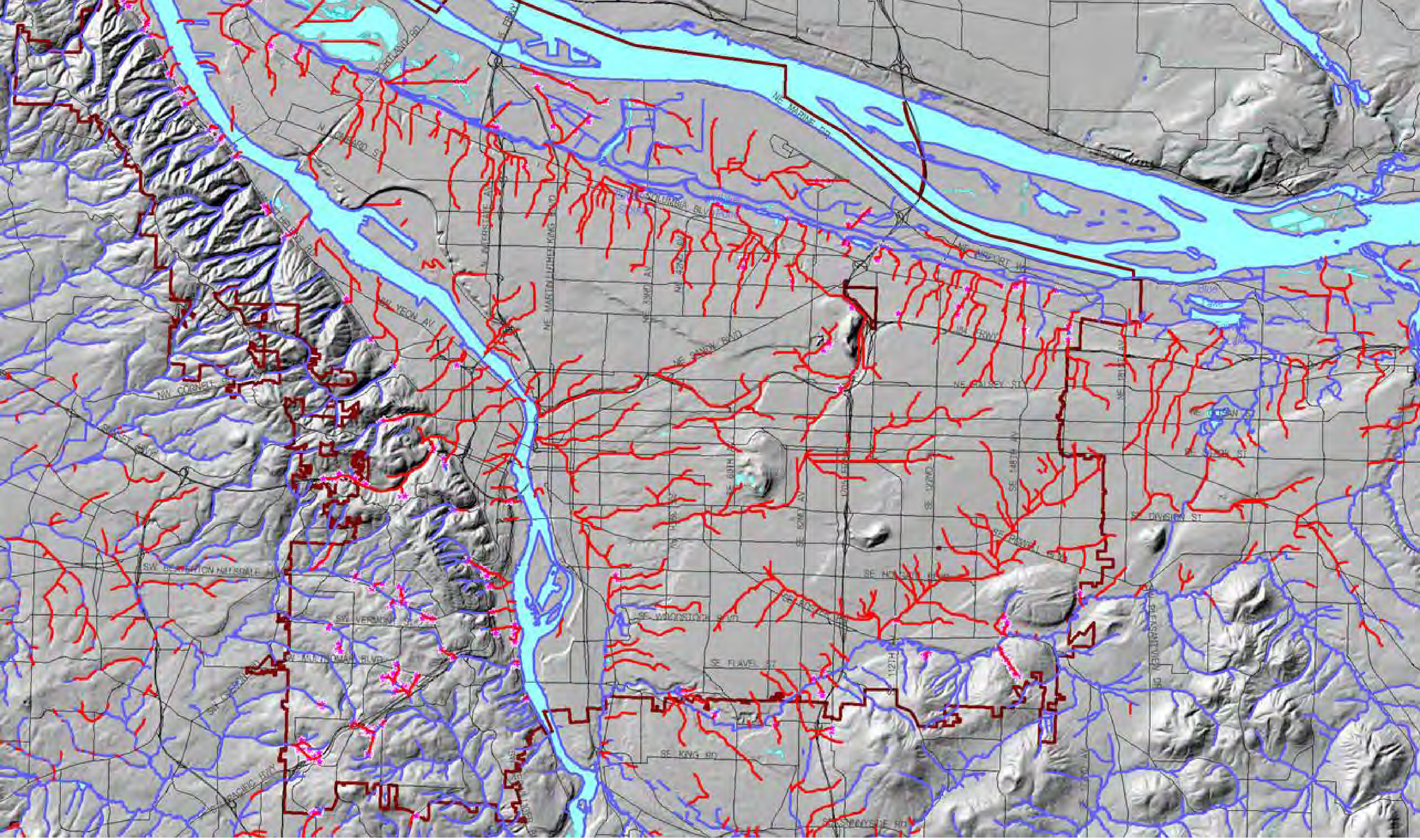
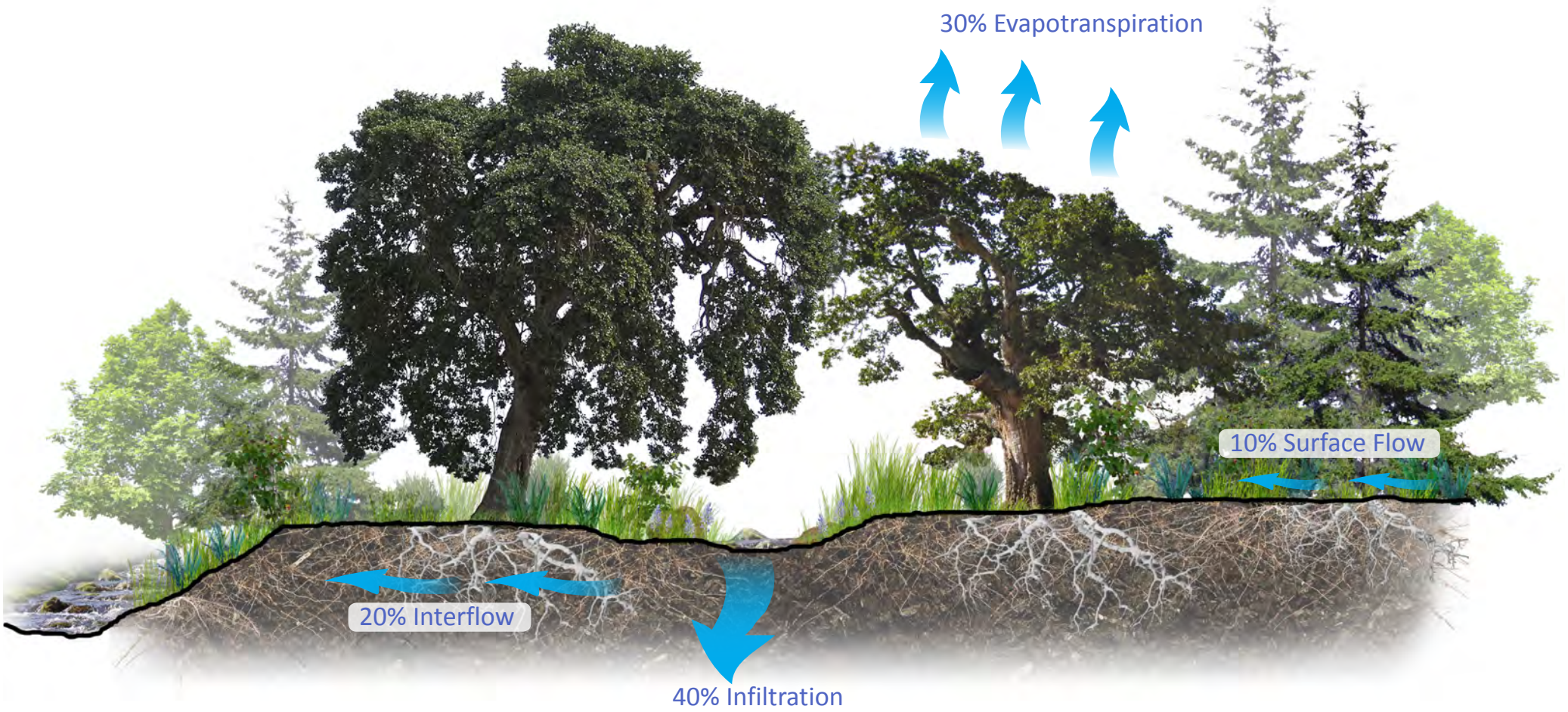


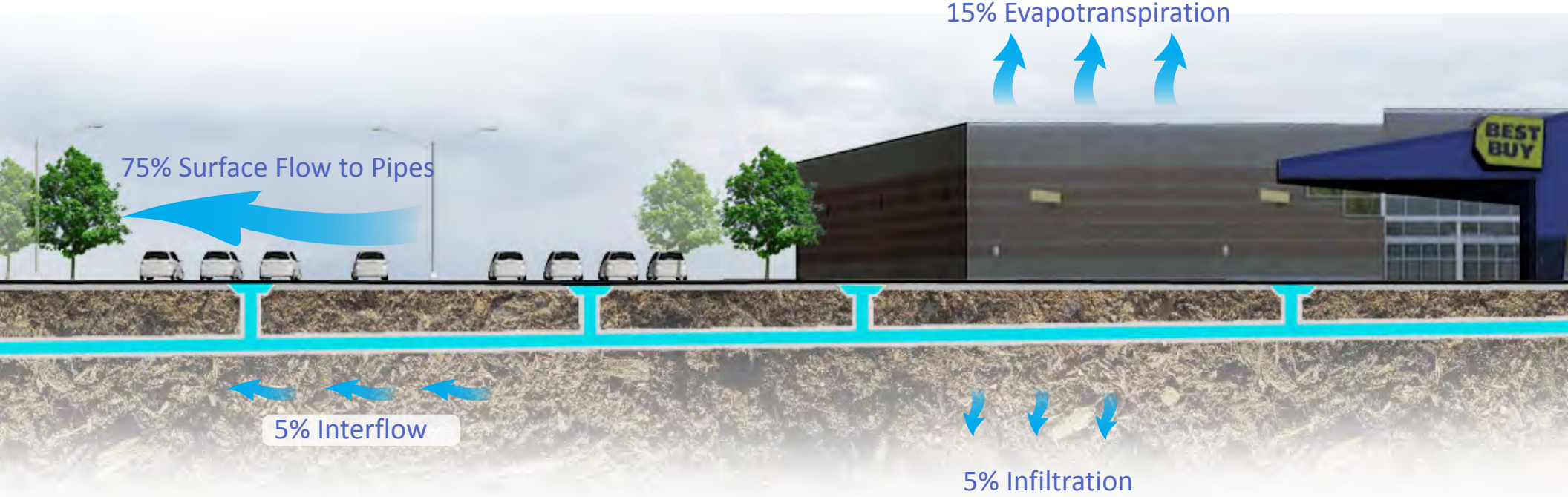
Photo: City of Portland Bureau of Environmental Services

The Red Lines Used To Be Streams



Pre-Urban Development

The Healthy Landscape

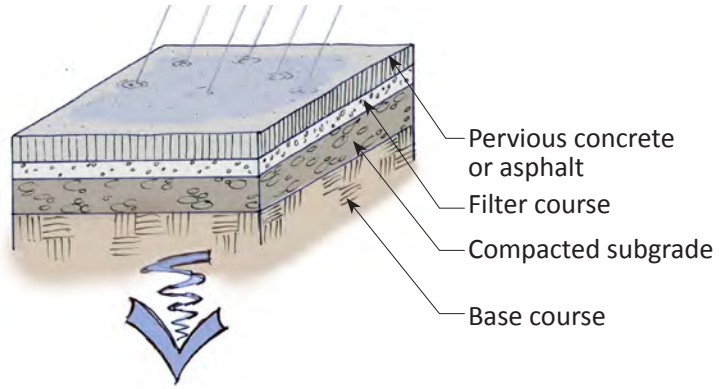


The Urbanized Landscape

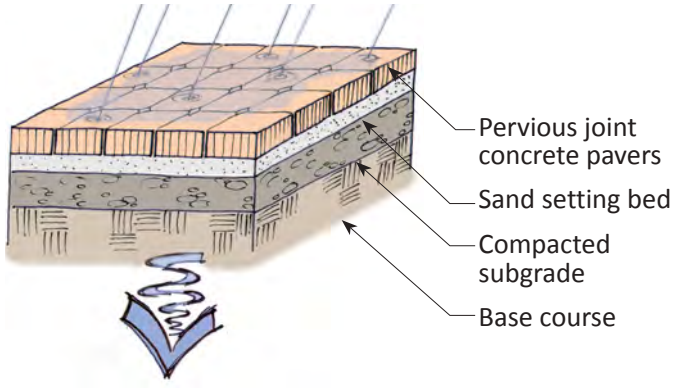
Moving Towards Watershed Destruction

The Tools For Green Streets

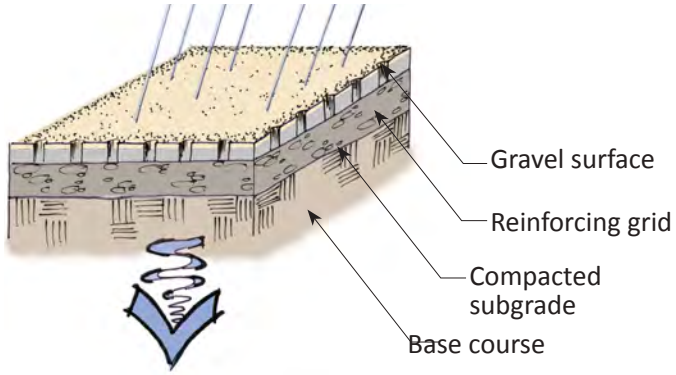
The Green Infrastructure “Toolbox”



Pervious Asphalt/Concrete



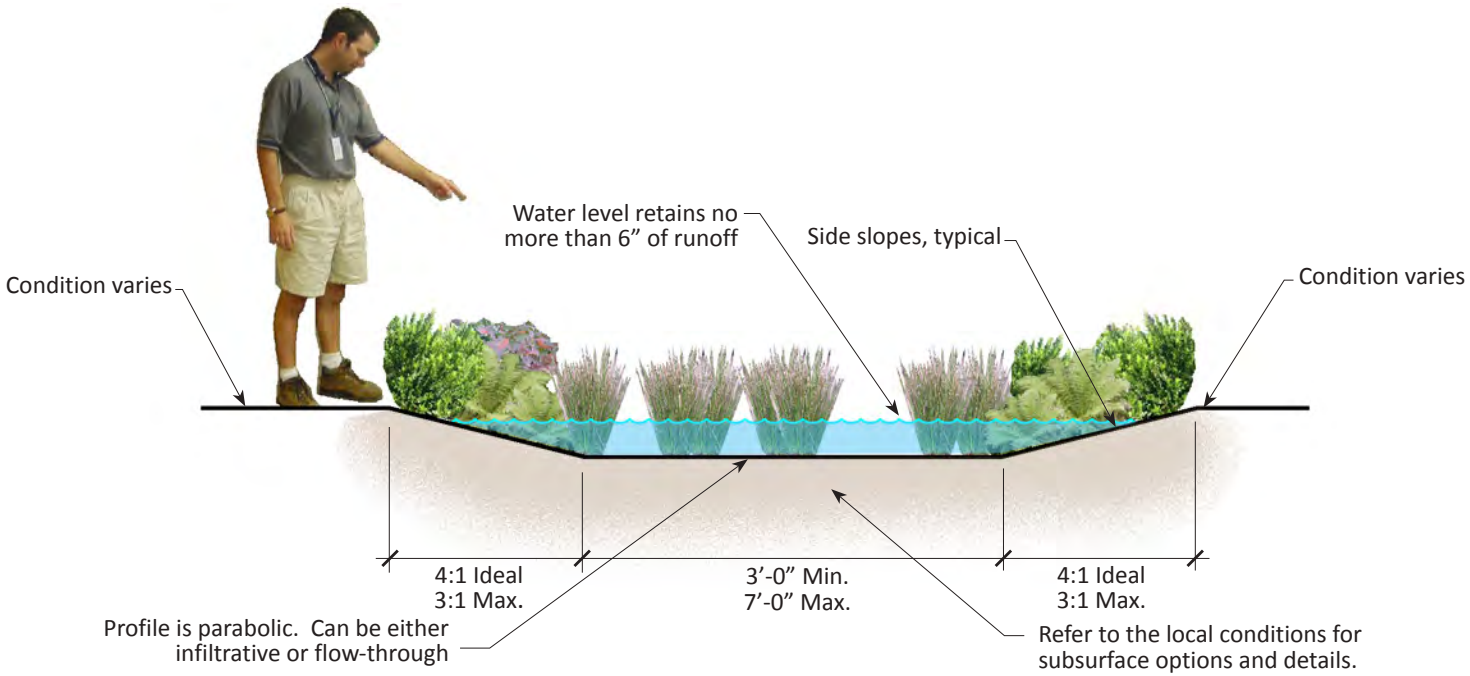
Interlocking Joint Pavers



Reinforced Gravel Paving

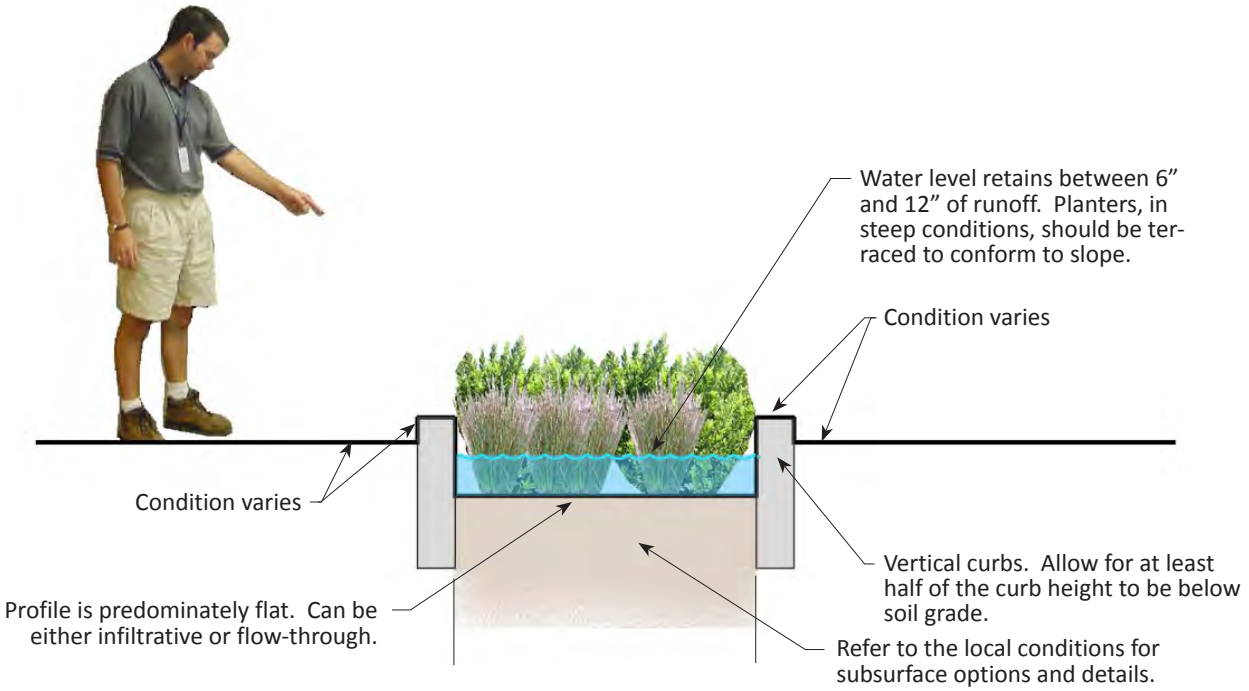
Pervious Paving

Rainfall Passes Through Paving or Pavement Joints



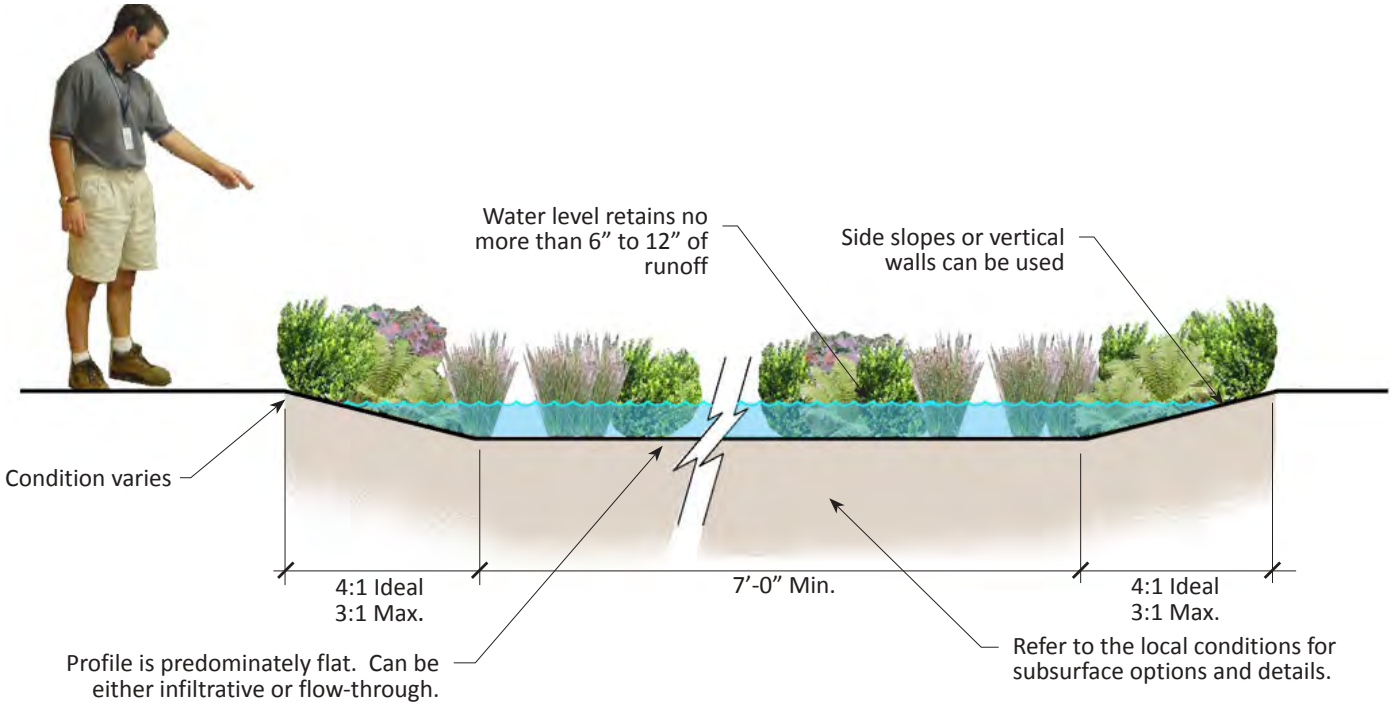
Stormwater Swales

Long, Linear, Shallow Landscapes With Side Slopes



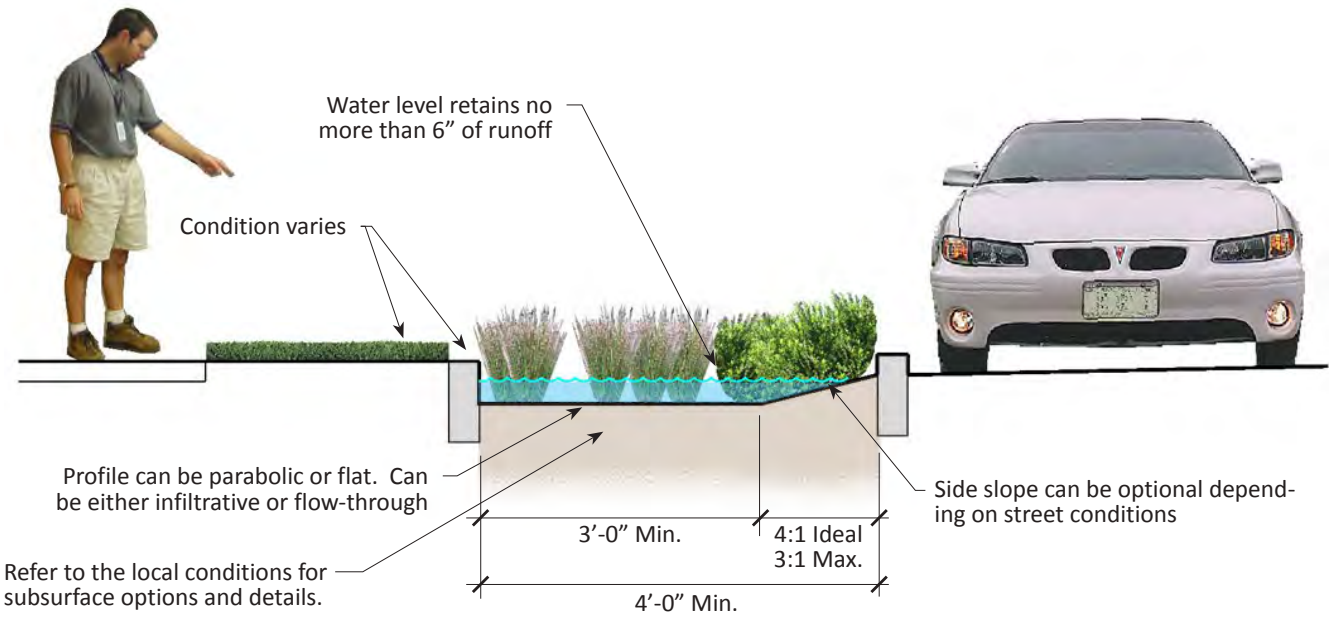
Stormwater Planters

Landscapes with Vertical Containment



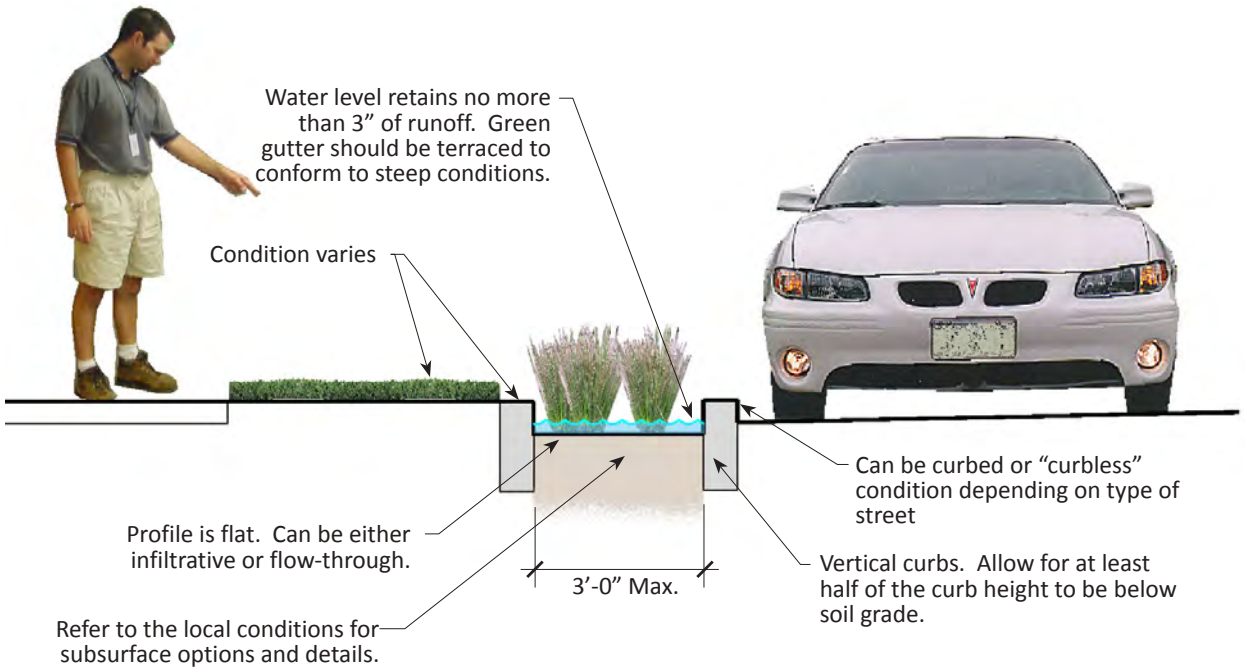
Rain Gardens

Larger Landscapes Used For Volume Reduction



Stormwater Curb Extensions

Landscapes Within the Parking Zone In The Street



Green Gutters

Very Narrow, Linear, and Shallow Landscape Systems

Retrofit Projects

Photo: Kevin Robert Perry, City of Portland

NE Siskiyou Green Street

Portland, Oregon

Photo: Kevin Robert Perry, City of Portland

NE Siskiyou Green Street

Portland, Oregon

Photo: Kevin Robert Perry, City of Portland

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Photo: Kevin Robert Perry, City of Portland

NE Siskiyou Green Street

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Photo: Kevin Robert Perry, City of Portland

NE Siskiyou Green Street

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

SE Clinton and 18th Green Street

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

SE Clinton and 18th Green Street

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

SE Clinton and 18th Green Street

Portland, Oregon

Photo: Kevin Robert Perry, City of Portland

SW 12th Avenue Green Street

Portland, Oregon

Photo: Kevin Robert Perry, City of Portland

SW 12th Avenue Green Street

Portland, Oregon

Photo: Kevin Robert Perry, City of Portland

SW 12th Avenue Green Street

Portland, Oregon

Photo: Kevin Robert Perry, City of Portland

SW 12th Avenue Green Street

Portland, Oregon

Nevue Ngan Associates recently assisted URS Engineers with the development of streetscape design plans for Sandy Boulevard between NE 14th and NE 48th Avenue. NNA was responsible for assessing existing street trees, developing and illustrating streetscape design alternatives related to landscape, and assisting with the development of construction documents.

NNA worked closely with the Portland Bureau of Environmental Services, Portland Office of Transportation, and Urban Forestry to create an innovative plan that incorporates several landscaped stormwater treatment areas into the right-of-way. Both infiltration basins and landscaped curb extensions are being utilized to achieve the dual purpose of reducing CSOs and to bring a stronger visual identity to specific intersections.

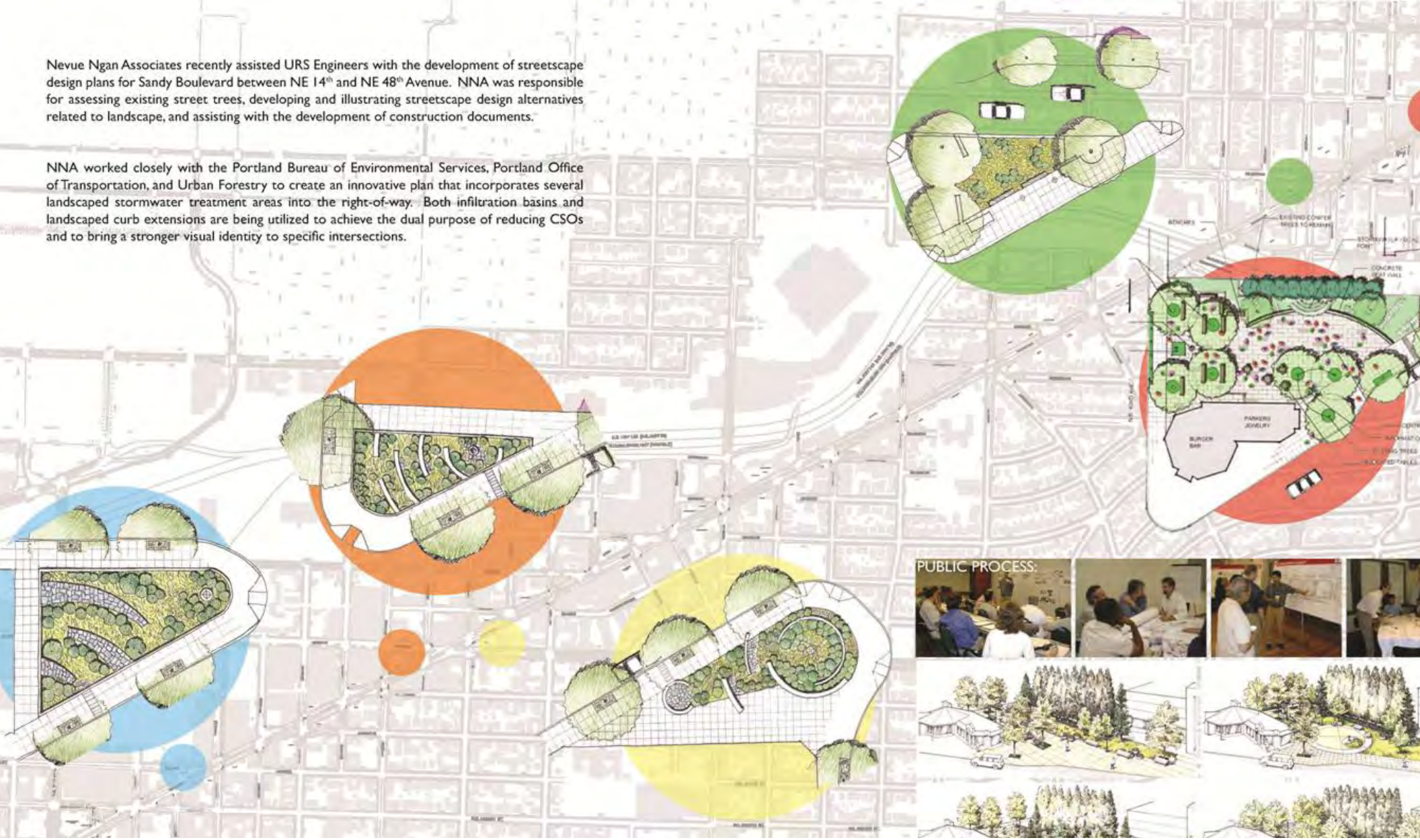

Illustration: Nevue Ngan Associates

NE Sandy Boulevard Rain Gardens

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

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NE Sandy Boulevard Rain Gardens

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

NE Sandy Boulevard Rain Gardens

Portland, Oregon

Photo: Google Earth

Brisbane City Hall Rain Garden

Brisbane, California

Photo: Kevin Robert Perry, Nevue Ngan Associates

Brisbane City Hall Rain Garden

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Brisbane City Hall Rain Garden

Brisbane, California

Photo: Kevin Robert Perry, Nevue Ngan Associates

Logus Road Green Street

Milwaukie, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

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Logus Road Green Street

Milwaukie, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

Logus Road Green Street

Milwaukie, Oregon

Site Plan

SW Montgomery Green Street

Connecting the West Hills to the Willamette River

The SW Montgomery Green Street is regarded as Portland's most innovative green street effort. The project demonstrates how, in even the most ultra-urban conditions, downtown streets can be planned and retrofitted not only to fully manage stormwater runoff but to also create, integrate, and preserve vibrant pedestrian spaces. This 9-block concept plan incorporates a variety of green infrastructure and alternative transportation strategies throughout this emerging neighborhood in downtown Portland.

The "Stormwater Spine"

SW Montgomery Green Street

Connecting the West Hills to the Willamette River

1 Stormwater Bridges

Multiple pedestrian bridges across the stormwater spine are needed to provide adequate pedestrian flow throughout the corridor. These bridges should be wide enough and spaced frequently to accommodate specific users such as bikes, people, and even autos.

2 "Curbless" Street Profile

Providing a flush drainage condition along the stormwater spine allows stormwater runoff to sheet flow into the landscape area. This provides both a barrier free condition for pedestrians and a shallower and more aesthetic stormwater facility.

3 High-Density Planting

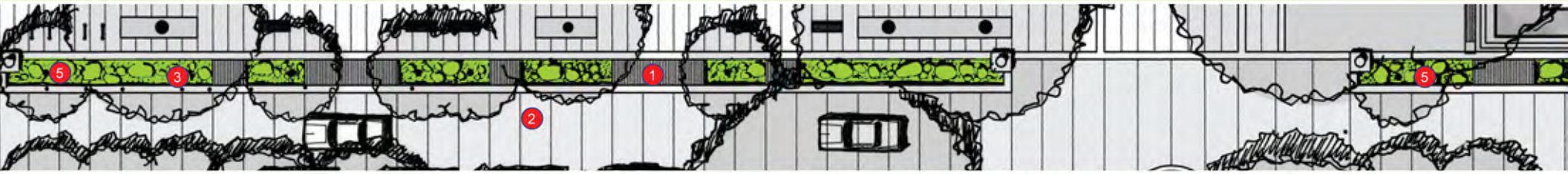
The stormwater spine is a functional landscape area used to clean and absorb stormwater runoff. Providing a high-density spacing of trees, shrubs, and groundcovers maximizes the ability for plant roots to clean pollutants and absorb runoff.

4 Simple and Shallow

There is a maximum grade change of 6-inches from the walking surface to the finish grade of the stormwater spine. This simple design approach eliminates the typical need for a perimeter curb around the landscape and still allows for adequate pedestrian safety.

5 A Continuous Theme

The stormwater spine functionally and visually links individual blocks within the street corridor. Planting types and the width of the spine does vary from block-to-block in response to unique conditions. However, the overall "green thread" remains consistent throughout.



The continuous Stormwater Spine along the SW Montgomery Green Street is planned as a highly functional landscape system used to capture and manage stormwater runoff from over 75,000 square feet of impervious area. The spine is the project site's "workhorse" for stormwater management. Each block along the corridor has the stormwater spine traversing through it, however, the form and size of the landscape system does vary in response to the unique conditions of each block. Sections of the stormwater spine have already been built along the SW Montgomery Green Street and are so well integrated into the urban fabric that many can not even distinguish them as being functional stormwater landscapes.

Multi-Modal Street Planning

SW Montgomery Green Street

Connecting the West Hills to the Willamette River

Light Rail/Streetcar

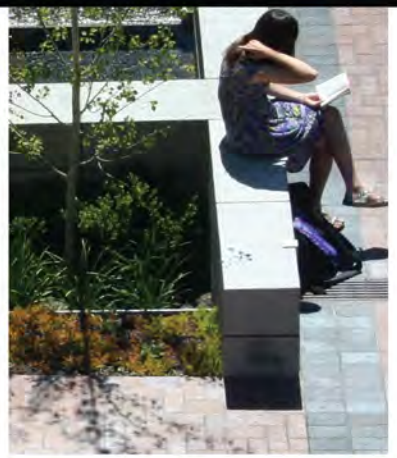
Lines of Rail Transportation **4**

Active Pedestrians

Average Sidewalk Width in Feet **17**

Bike Transit

Additional Bike Spaces Provided **82**

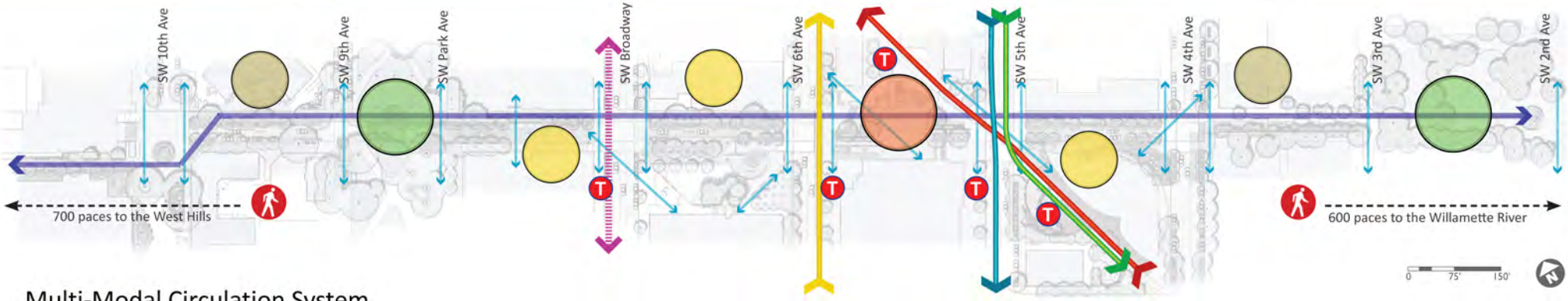


Passive Pedestrians

Additional Benches for Seating **63**

Electric/Hybrid Autos

Parking Spaces for plug-in parking **12**



Multi-Modal Circulation System

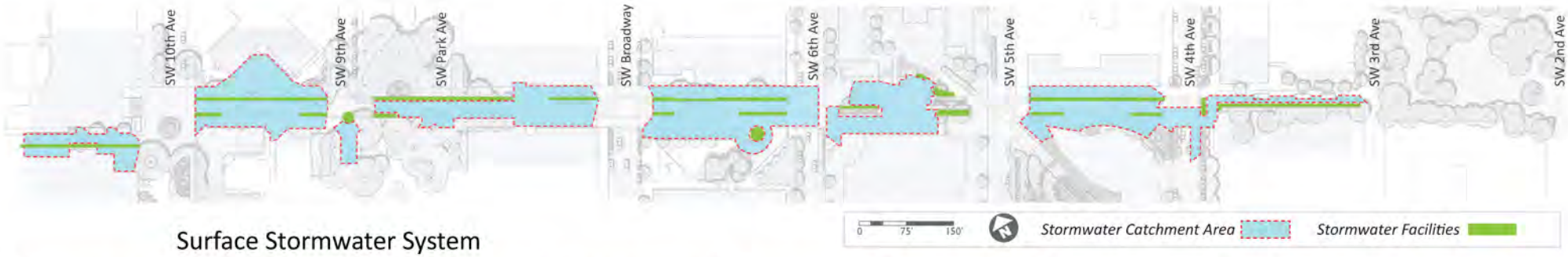
North Bound Street Car
South Bound Street Car
SW Broadway Cycle Track
South Bound Light Rail
North Bound Light Rail
Primary Pedestrian Corridor
Secondary Pedestrian
Transit Stop
Significant Green Space
Significant Urban Space
Academic Hub
Student Housing

The highest caliber green street looks beyond only managing stormwater runoff. It also promotes a transportation mode switch from primarily auto-centric design to a street that emphasizes alternative transportation. The SW Montgomery Green Street exemplifies complete street planning by providing a balanced set of transportation choices, but also provides a clear emphasis on enhanced pedestrian and bicycle infrastructure. The street's "curbless" cross section and wide sidewalks allows for maximum flexibility in overall street programming. Autos are allowed within the corridor, however, the concept plan allows the street to be phased into a pedestrian-only promenade in the future.

Stormwater Performance

SW Montgomery Green Street

Connecting the West Hills to the Willamette River



Surface Stormwater System

11th to 10th	10th to 9th	Park Blocks	Park to Broadway	Broadway to 6th	Urban Center Plaza	5th to 4th	4th to 3rd	Pettygrove Park
4,000 SF Catchment Area 830 SF Landscape Area 21% Landscape to Impervious	17,200 SF Catchment Area 830 SF Landscape Area 8% Landscape to Impervious	4,880 SF Catchment Area 780 SF Landscape Area 16% Landscape to Impervious	10,630 SF Catchment Area 780 SF Landscape Area 9% Landscape to Impervious	13,500 SF Catchment Area 1,650 SF Landscape Area 12% Landscape to Impervious	12,320 SF Catchment Area 1,010 SF Landscape Area 8% Landscape to Impervious	9,315 SF Catchment Area 1,450 SF Landscape Area 16% Landscape to Impervious	5,350 SF Catchment Area 950 SF Landscape Area 18% Landscape to Impervious	No on-site stormwater management due to the historical character of Pettygrove Park
92 THOUSAND GALLONS	397 THOUSAND GALLONS	113 THOUSAND GALLONS	245 THOUSAND GALLONS	311 THOUSAND GALLONS	284 THOUSAND GALLONS	215 THOUSAND GALLONS	123 THOUSAND GALLONS	

Estimated Annual Stormwater Performance

11th to 10th	10th to 9th	Park Blocks	Park to Broadway	Broadway to 6th	Urban Center Plaza	5th to 4th	4th to 3rd	Pettygrove Park
Significant Landscape Area High Street Tree Cover Manages Stormwater Emphasizes Alt. Transportation Building, Site, and Street	Significant Landscape Area High Street Tree Cover Manages Stormwater Emphasizes Alt. Transportation	Significant Landscape Area High Street Tree Cover Manages Stormwater	Significant Landscape Area High Street Tree Cover Manages Stormwater Emphasizes Alt. Transportation Building, Site, and Street	Significant Landscape Area High Street Tree Cover Manages Stormwater Emphasizes Alt. Transportation Building, Site, and Street	Significant Landscape Area High Street Tree Cover Manages Stormwater Emphasizes Alt. Transportation	Significant Landscape Area High Street Tree Cover Manages Stormwater Emphasizes Alt. Transportation Building, Site, and Street	Significant Landscape Area High Street Tree Cover Manages Stormwater	Significant Landscape Area High Street Tree Cover
LEVEL 5	LEVEL 4	LEVEL 3	LEVEL 5	LEVEL 5	LEVEL 4	LEVEL 5	LEVEL 3	LEVEL 2

Green Street Rating Block-by-Block

Gallons of Runoff Managed/Year: **1.8** Million

Combined Green Street Rating: Level **4**

Once fully implemented, the SW Montgomery Green Street has the potential to manage millions of gallons of runoff each year. However, there is a lot of variability in how "green" a street really is and all green streets are not created equal. Within some streets, and as in the case of SW Montgomery, individual blocks can vary on how aggressive the green street approach is. The graphic to the right shows "Multiple Shades of Green" when defining a green street. Level 1 is considered a beginning approach, while Level 5 represents the boldest design effort.

Level 1	Maximize landscaped areas along the street and minimize overall impervious area. Some runoff from adjacent sidewalks may be managed in landscaped areas.
Level 2	Significant tree canopy is added to the urban streetscape.
Level 3	Stormwater runoff is fully managed from the street, sidewalk, and driveway areas within a landscaped system. Design solutions are cost effective, provide direct environmental benefits, and are aesthetically pleasing.
Level 4	Green street provides a direct focus on alternative modes of transportation including mass transit, biking, and walking.
Level 5	The building, site, and street "envelope" becomes one integrated space for private and public stormwater management.

University Services Block

SW Montgomery Green Street

Connecting the West Hills to the Willamette River

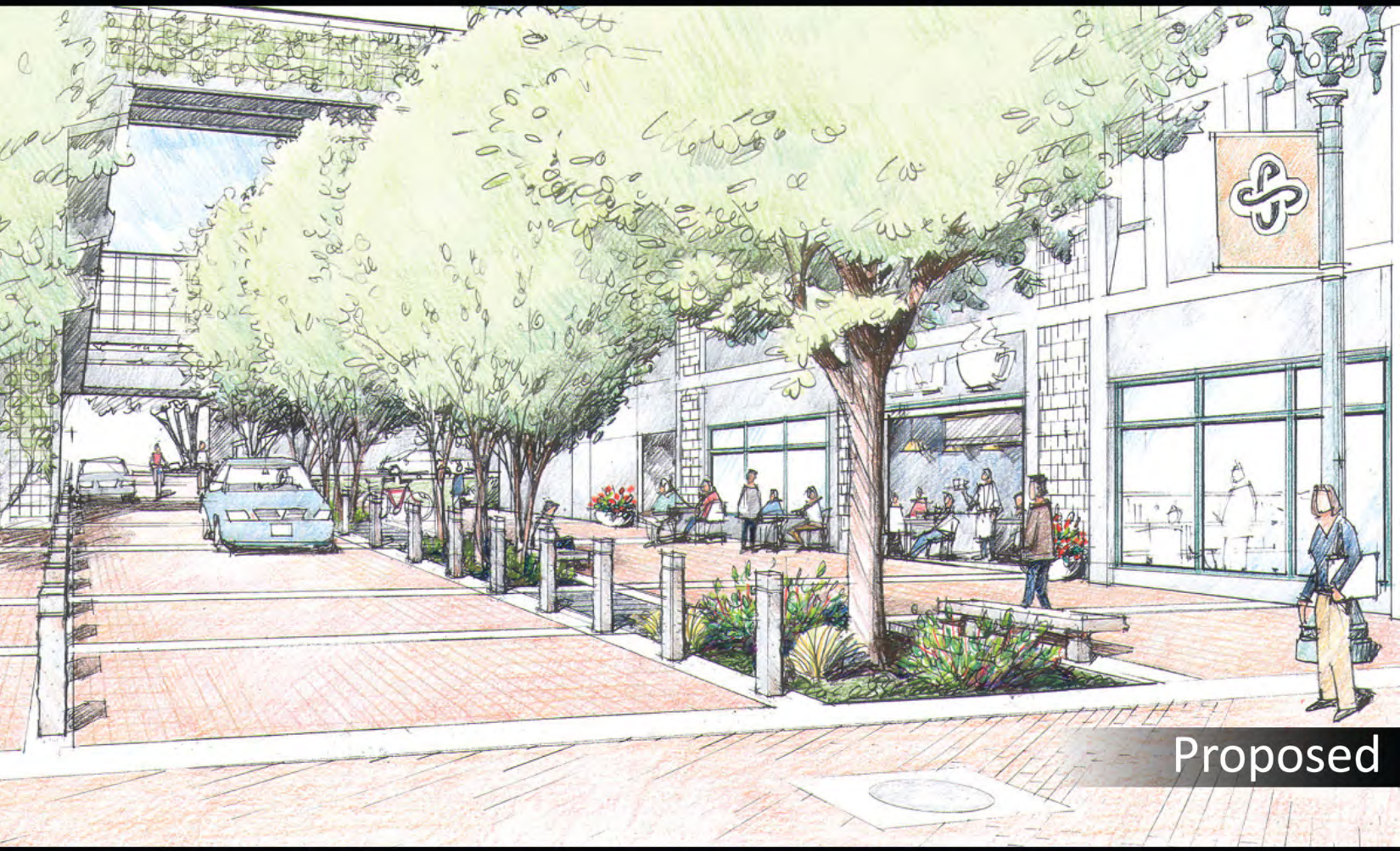
Existing Condition

Opportunities abound on all of the blocks within the SW Montgomery Green Street to manage stormwater runoff in a more sustainable way. However, the three blocks that currently carry auto traffic hold a special opportunity to transform the auto-based vernacular into an enhanced pedestrian condition that connects to urban and green spaces surrounding the project area. In addition, many of the existing buildings along the corridor are poised for redevelopment or reuse. When redevelopment does occur, there will be the potential to capture stormwater runoff from these areas and redirect it into the SW Montgomery Green Street's landscaped system.

University Services Block

SW Montgomery Green Street

Connecting the West Hills to the Willamette River

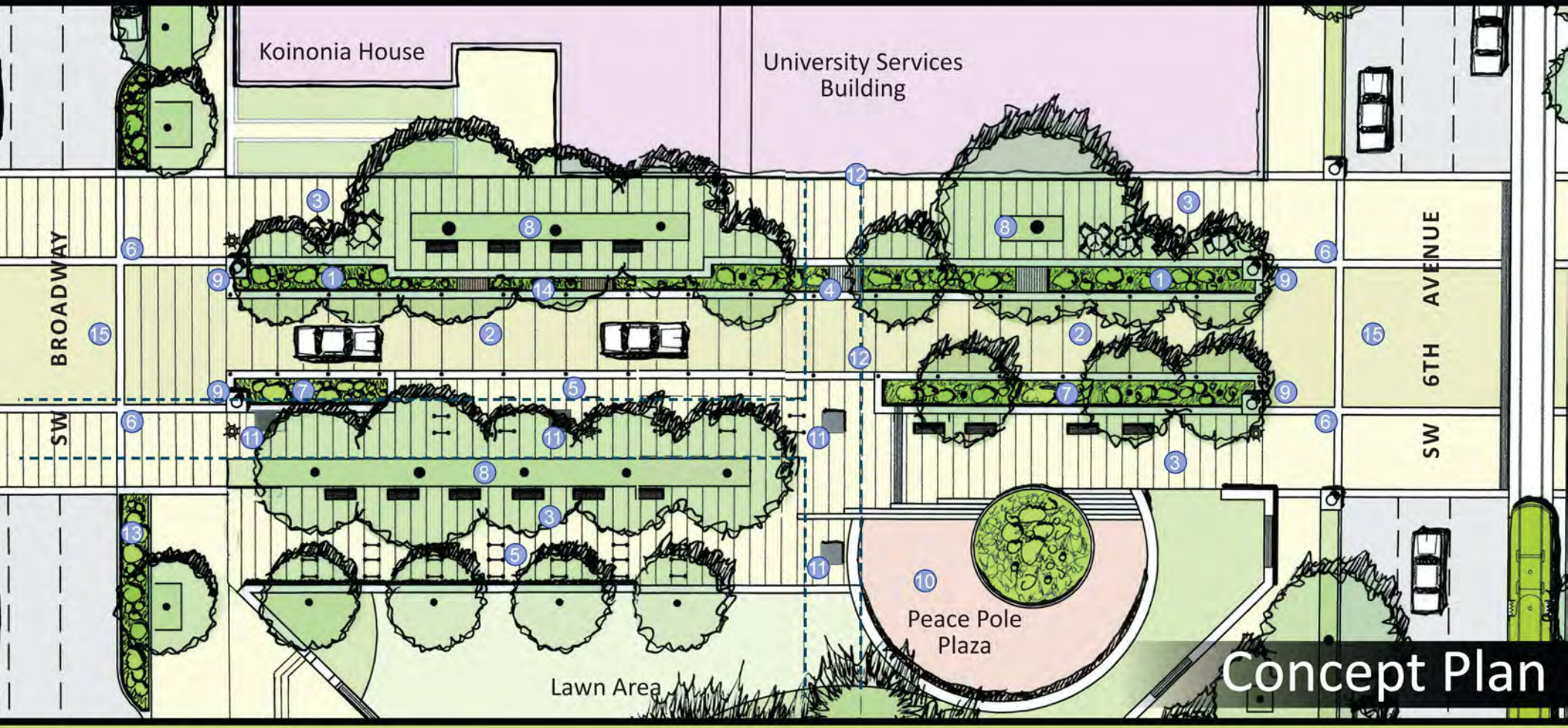


A revitalized pedestrian and stormwater streetscape at the University Services Block illustrates the enormous potential for the SW Montgomery Green Street. The wider sidewalks and "curbless" street condition allows for various site furnishings and will help activate newly refurbished ground-floor retail. Removable bollards provide the flexibility to occasionally or permanently close the street to automobile use. Stormwater runoff from the street and redeveloped buildings is conveyed to the stormwater spine's landscape system. In addition, various green wall technologies are also applied to the existing skybridge system to mimic the multiple vegetated layers of Portland's West Hill's forests.

University Services Block

SW Montgomery Green Street

Connecting the West Hills to the Willamette River



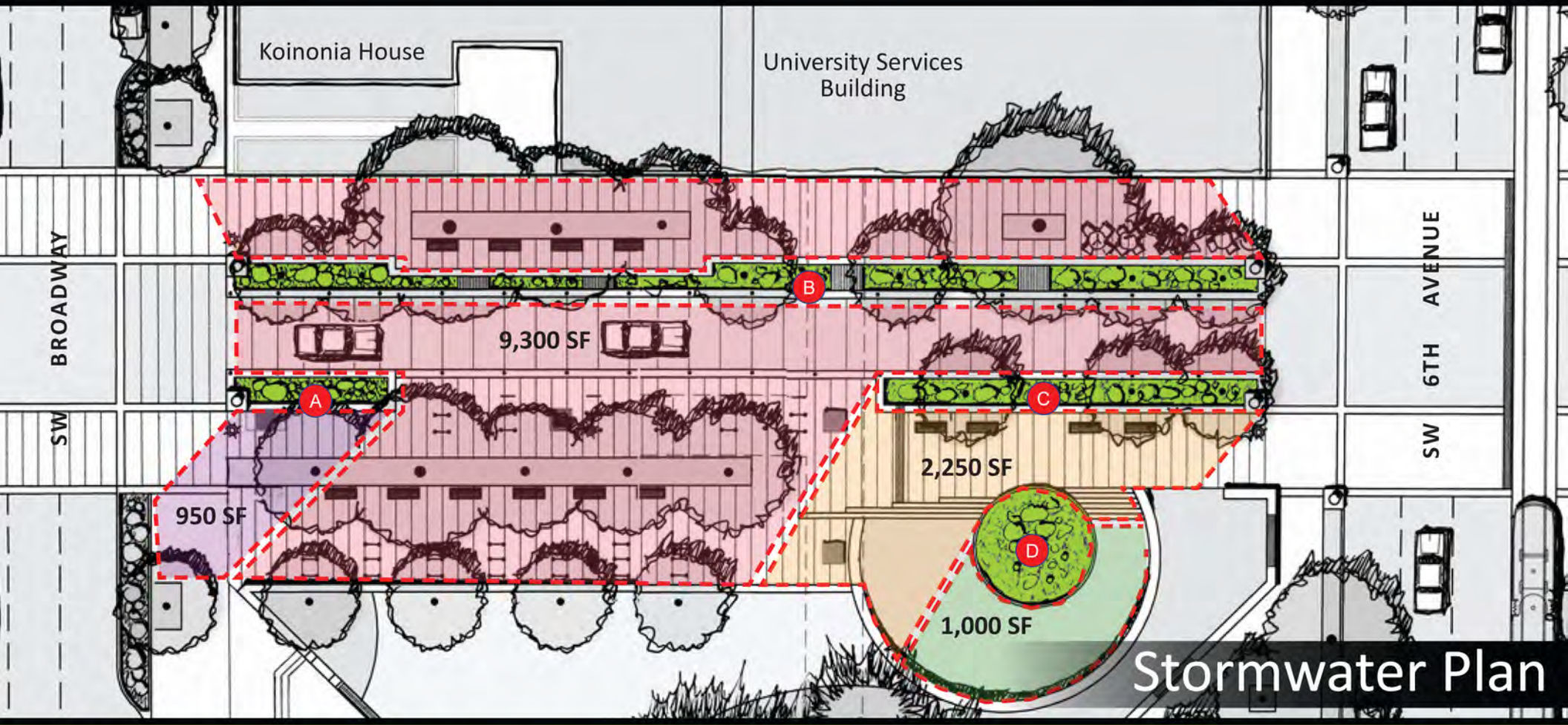
Key Streetscape Improvements

1. SW Montgomery stormwater spine. This 5-foot wide stormwater planter, with significant landscaping and street trees, retains stormwater to a design depth of 6 inches.
2. SW Montgomery allows for one-way eastbound vehicular traffic. The street is "curbless" to allow all modes of traffic to be integrated on one horizontal plane.
3. Sidewalk zones are widened to allow for a generous pedestrian through zone, cafe and park seating, moveable planters, street lighting, and bike parking.
4. Stormwater bridges/boardwalks allow pedestrians to cross the stormwater spine.
5. Flexible space that can be used for large capacity bike parking and/or food carts.
6. Tactile warning strips alert pedestrians to oncoming traffic from vehicles and mass transit.
7. Secondary stormwater planters accept stormwater from additional sidewalk space and skybridge system.
8. Existing trees to be preserved.
9. Ornamental art/landscape features at intersection demarcate the block's entry points.
10. Elevated brick plaza space allows stormwater to flow into a circular stormwater planter. The existing Peace Pole installation is relocated to this space to form the "Peace Pole Plaza."
11. Existing skybridge structural columns.
12. Potential location for vegetated green wall.
13. Stormwater curb extensions capture runoff from SW Broadway.
14. The stormwater spine is narrowed to 3-feet wide to preserve existing large-canopy trees.
15. Street intersection extends the sidewalk paving treatment into the street reinforcing the strong east-west pedestrian connectivity of SW Montgomery Street.

University Services Block

SW Montgomery Green Street

Connecting the West Hills to the Willamette River



Catchment Area	Contributing Impervious Area (IA)	Stormwater Planter Area	Percentage Landscape to IA*	Additional Capacity**
Catchment Area A	950 SF	140 SF	16%	650 SF
Catchment Area B	9,300 SF	760 SF	8%	0 SF
Catchment Area C	2,250 SF	350 SF	16%	1,800 SF
Catchment Area D	**1,000 SF**	400 SF	40%	3,650 SF

* This percentage uses the Bureau of Environmental Services (BES) Simplified Approach of a ratio between impervious area catchment and stormwater facility size.

** Additional capacity looks at how much additional impervious area can be potentially managed in a 10-year storm event based on using the BES Presumptive Approach Calculator.

2009

Photo: Kevin Robert Perry, Nevue Ngan Associates

Smith Memorial Student Union Plaza

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

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Urban Center Plaza Stormwater Retrofit

Portland, Oregon

Photo: Kevin Robert Perry, Nevue Ngan Associates

Urban Center Plaza Stormwater Retrofit

Portland, Oregon

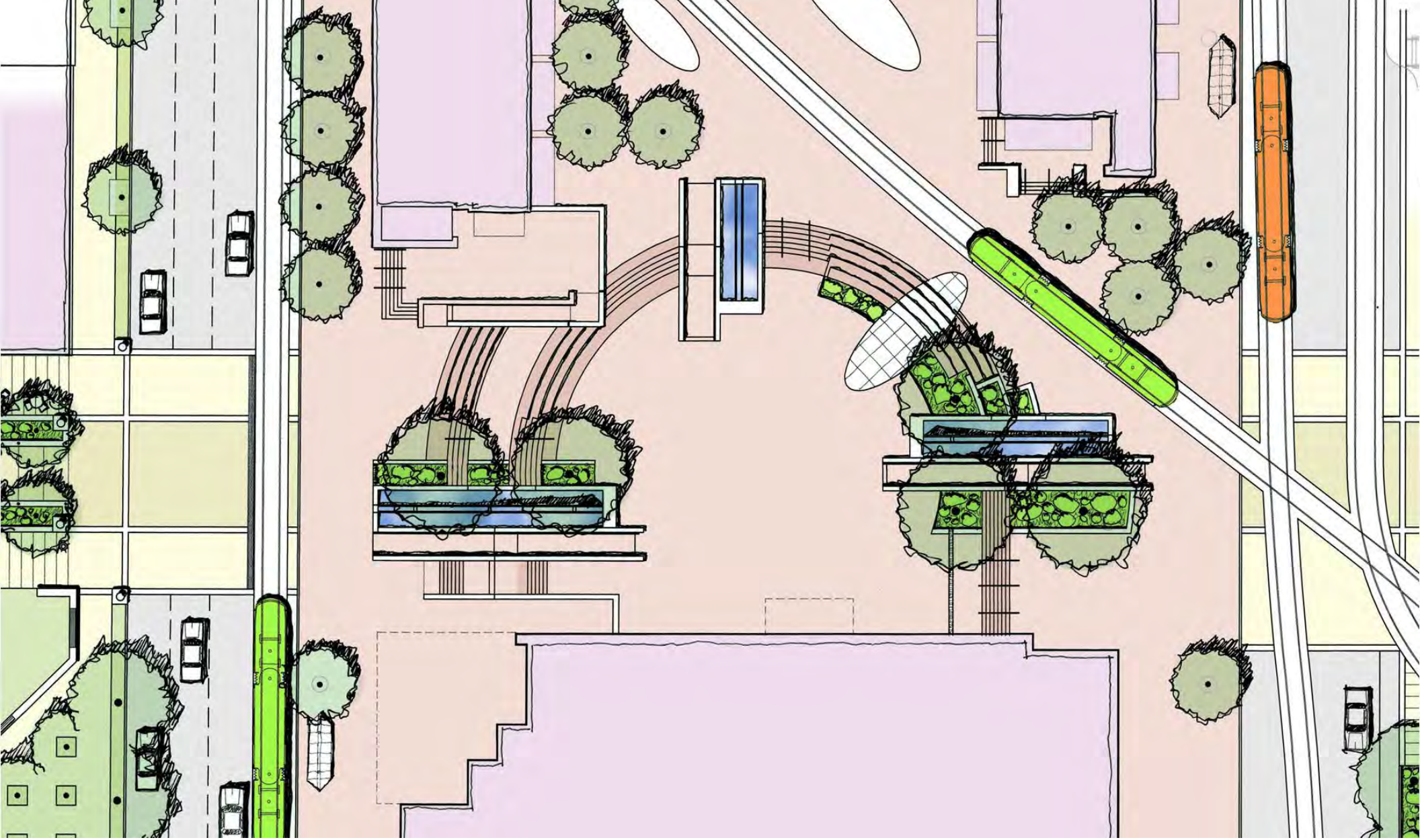

Photo: Kevin Robert Perry, Nevue Ngan Associates

Urban Center Plaza Stormwater Retrofit

Portland, Oregon

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Photo: Kevin Robert Perry, Nevue Ngan Associates

Urban Center Plaza Stormwater Retrofit

Portland, Oregon

Visualizing Retrofits

Photo: Kevin Robert Perry, ASLA

Capturing Sidewalk and Street Zones

San Francisco, California

Photo: Kevin Robert Perry, ASLA

Capturing Overly Wide Streets

Hartford, Connecticut

Photo: Kevin Robert Perry, ASLA

Capturing Sidewalk and Street Zones

Hartford, Connecticut

Photo: Kevin Robert Perry, ASLA

Capturing Landscape Zone

Hartford, Connecticut

Photo: Kevin Robert Perry, ASLA

Capturing Sidewalk and Street Zones

Nashville, Tennessee

Photo: Kevin Robert Perry, ASLA

Capturing Sidewalk Zone

Nashville, Tennessee

Photo: Kevin Robert Perry, ASLA

Capturing Parking Zone

Philadelphia, Pennsylvania

Photo: Kevin Robert Perry, ASLA

Capturing Sidewalk and Street Zones

Sacramento, California

Photo: Kevin Robert Perry, ASLA

Capturing Overly Wide Streets

Sacramento, California

Photo: Kevin Robert Perry, Nevue Ngan Associates

Typical Residential Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Typical Residential Street

San Mateo County, California

Conceptual Green Street

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Typical Residential Street

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Conceptual Green Street

San Mateo County, California

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

Covington, Kentucky

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

Covington, Kentucky

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

Covington, Kentucky

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

Covington, Kentucky

Photo: Kevin Robert Perry, ASLA

Typical Commercial Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

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Typical Commercial Street

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Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

San Mateo County, California

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

Nashville, Tennessee

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

San Mateo County, California

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

San Mateo County, California

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

Indianapolis, Indiana

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

Indianapolis, Indiana

Photo: Kevin Robert Perry, ASLA

Typical Arterial Street

San Mateo County, California

Illustration: Kevin Robert Perry/Jason Hirst, Nevue Ngan Associates

Conceptual Green Street

San Mateo County, California

San Pablo

Richmond

El Cerrito

Albany

Berkeley

Emeryville

Oakland

San Pablo Avenue Green Stormwater Spine

Retrofitting 7 Sites in 7 Cities in the East San Francisco Bay Area

San Pablo Avenue Green Stormwater Spine

Retrofitting 7 Sites in 7 Cities in the East San Francisco Bay Area

San Pablo Avenue Green Stormwater Spine

Retrofitting 7 Sites in 7 Cities in the East San Francisco Bay Area

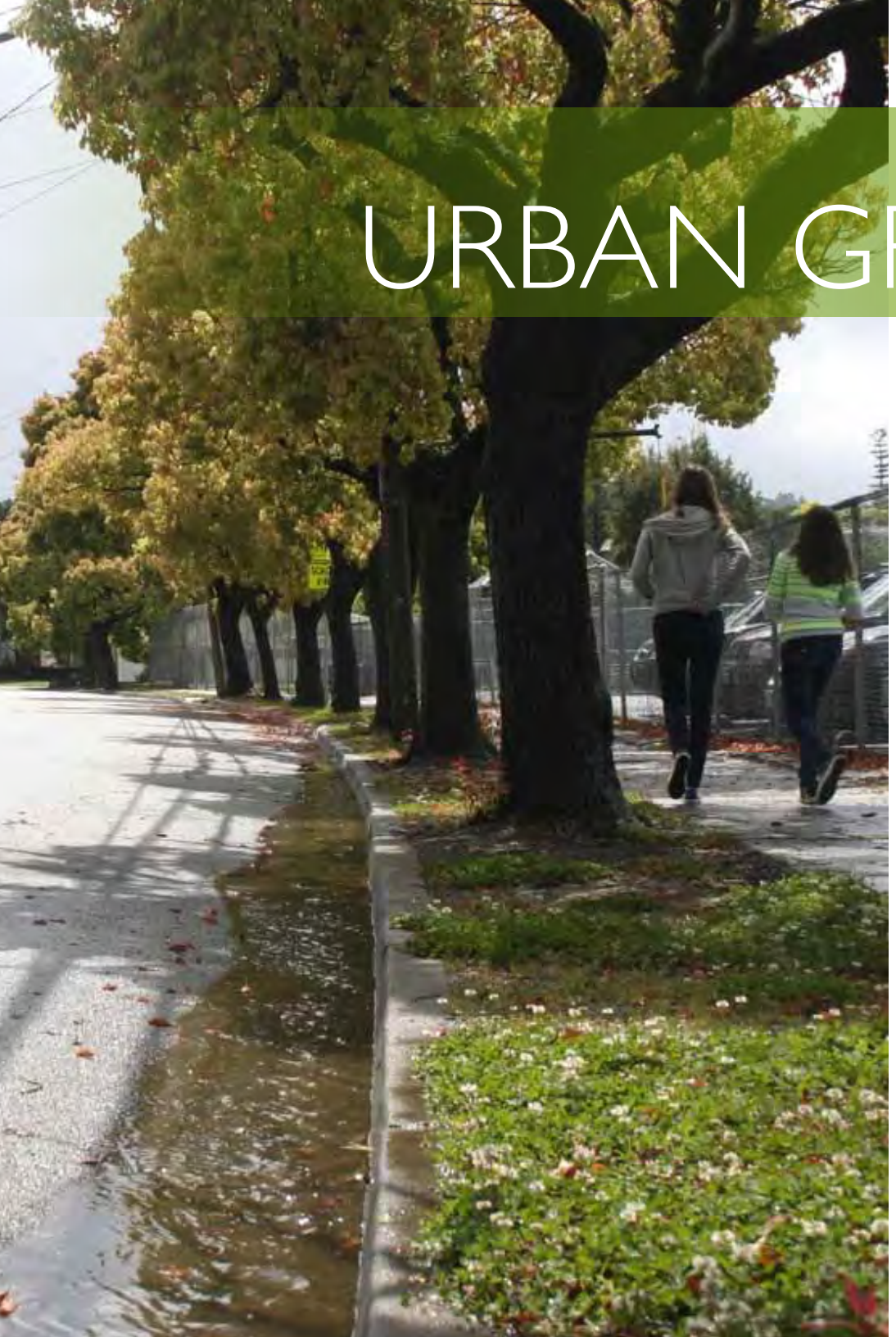
San Pablo Avenue Green Stormwater Spine

Retrofitting 7 Sites in 7 Cities in the East San Francisco Bay Area

Greening Our Schools

Photo: www.parknpool.com

Green Routes To School



City of San Carlos and Redwood City

URBAN GREENING PLAN

PROPOSED WORK PLAN

CITY OF SAN CARLOS
The City of Good Living
CALIFORNIA

Redwood City
California
Founded 1867

SAN MATEO COUNTYWIDE
Water Pollution
Prevention Program
Clean Water, Healthy Community

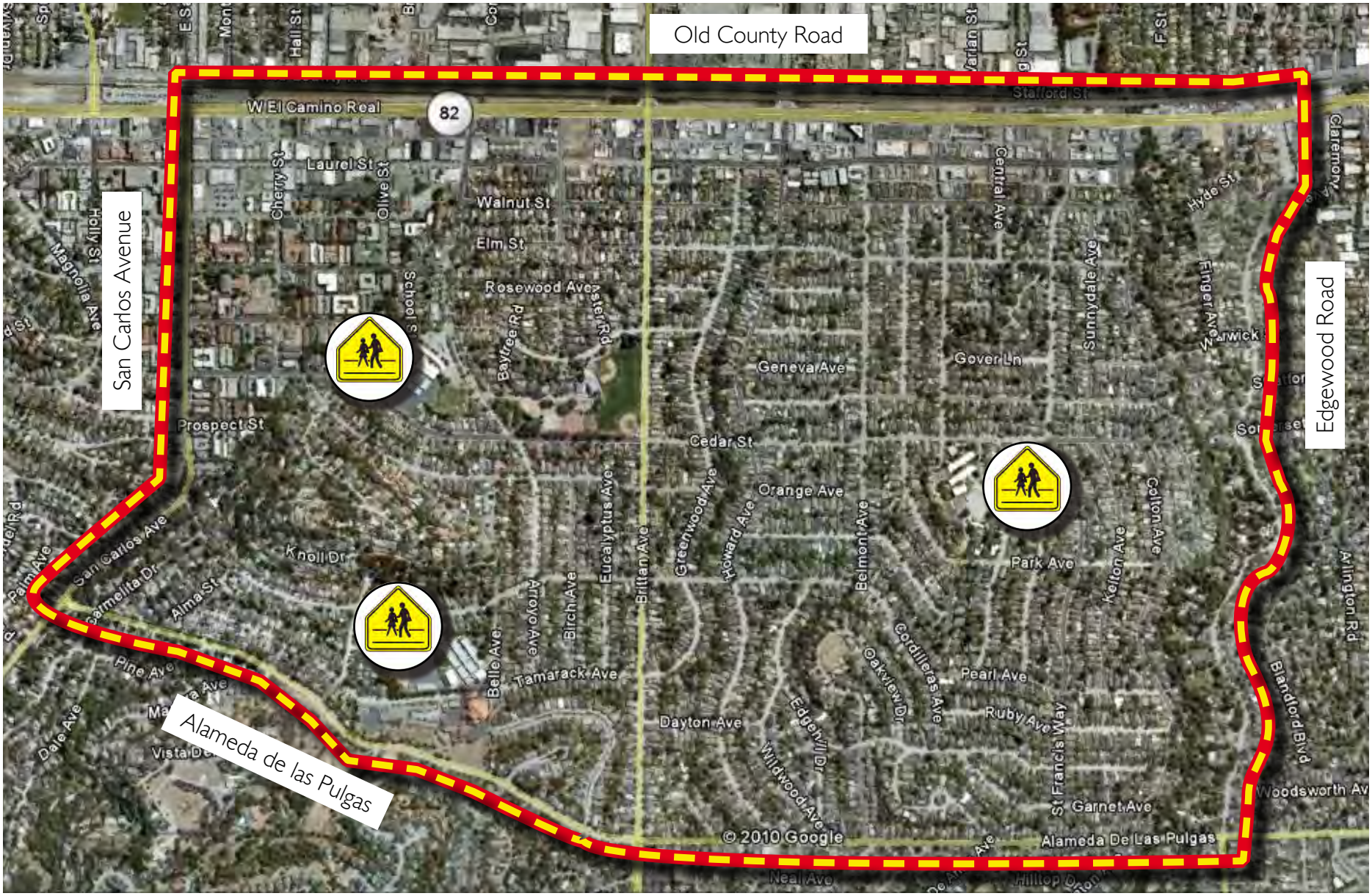


Illustration: Nevue Ngan Associates

The Retrofit of A Neighborhood

San Carlos Urban Greening Plan

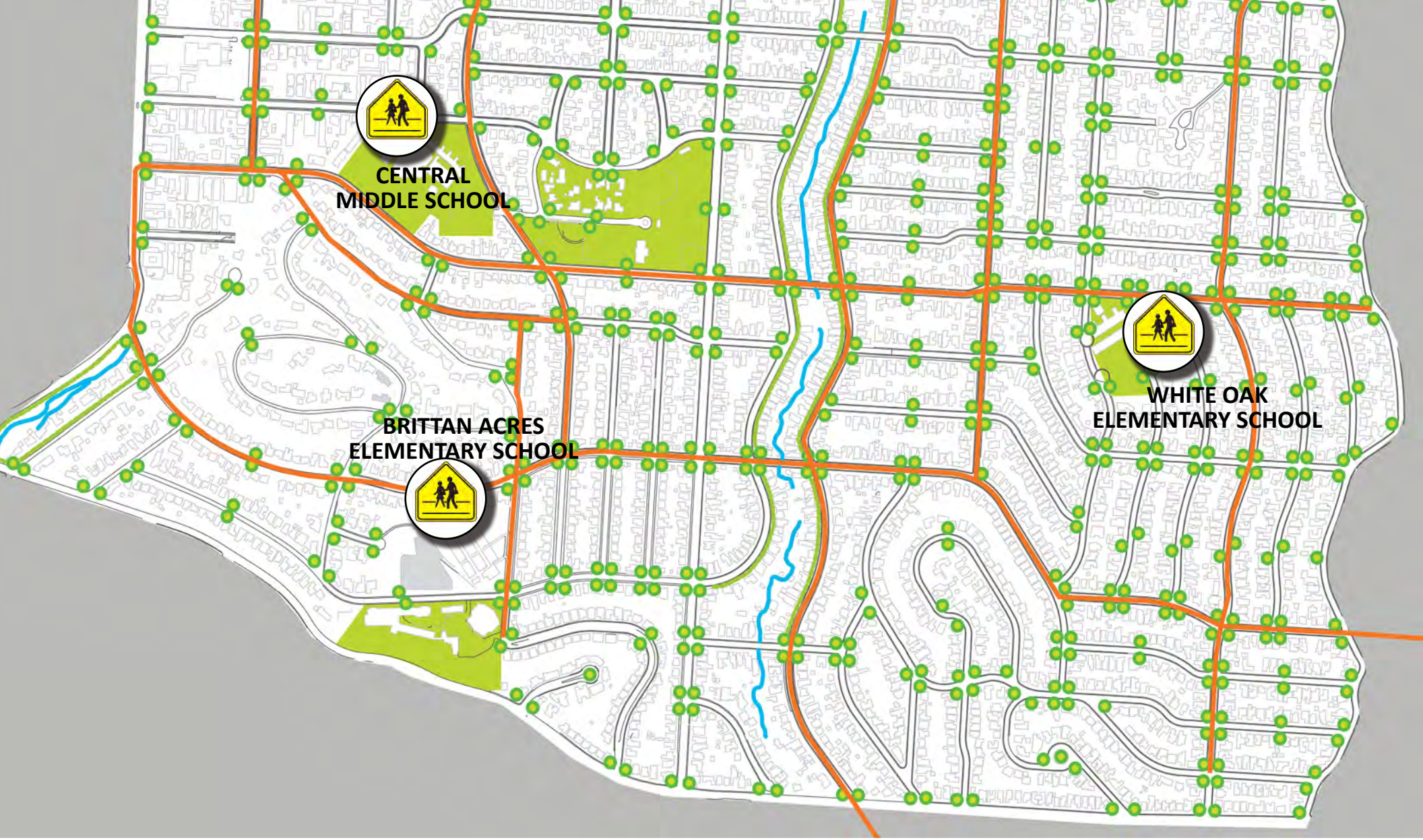


Illustration: Nevue Ngan Associates

Conceptual Master Plan

San Carlos Urban Greening Plan

Photo: Kevin Robert Perry, Nevue Ngan Associates

Typical Residential Street

San Carlos Urban Greening Plan

Illustration: Nevue Ngan Associates/Mark Sanborn

Conceptual Green Street

San Carlos Urban Greening Plan

Photo: Kevin Robert Perry, Nevue Ngan Associates

Typical Residential Street

San Carlos Urban Greening Plan

Illustration: Nevue Ngan Associates/Mark Sanborn

Conceptual Green Street

San Carlos Urban Greening Plan

Photo: Kevin Robert Perry, ASLA

Emerald Oak Drive

Elk Grove, California

Illustration: Kevin Robert Perry/Ray Papa

Emerald Oak Drive

Elk Grove, California

Urban Rain | Design

Kevin Robert Perry, ASLA

kevin@urbanraindesign.com
www.urbanraindesign.com
(503) 928-5522