

SEA Street

Seattle Public Utilities
Seattle, U.S.A. (2001)

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The Stormwater
Management
Challenge



Image courtesy of the Seattle P-I.

Seattle Public Utilities constructed a drainage project at 2nd Avenue NW known as a Street Edge Alternatives (SEA Streets) project. It involved the complete reconstruction of the street and its drainage system to reduce impervious area and install stormwater detention ponds. It was completed in the spring of 2001, and designed to provide drainage that more closely mimics the natural landscape prior to development than traditional piped systems. To accomplish this, Seattle reduced impervious surfaces to 11 percent less than a traditional street, provided surface detention in swales, and added over 100 evergreen trees and 1100 shrubs.

The SEA Street was developed by planners from Seattle's Public Utilities (SPU) in conjunction with local community groups, and the streets are partially maintained by homeowners on adjacent properties and by SPU.

Street flooding has significant impacts on the city's transportation infrastructure. Road flooding slows traffic and increases the risk of accidents. Standing water on streets erodes road surfaces and exacerbates pothole formation. In the winter, water from flooded streets can freeze and form hazardous driving conditions. Especially at intersections, street flooding makes crossing streets and walking difficult for pedestrians and bicyclists.

Location Map

The SEA Street was first implemented on a small two-block test site in north-west Seattle (NW 117th and NW 120th Street on 2nd Avenue), a low-density residential area that lacked sidewalks and drainage infrastructure.

Image courtesy of the Seattle P-I.



Hydraulic Engineering x Soil Science and Botany = SEA Street Drainage

SEA Street Design Features

- Natural Drainage System
- Bioswales
- Porous Paving
- Rain Gardens
- Curvilinear Street
- Community Improvement

Natural Drainage System

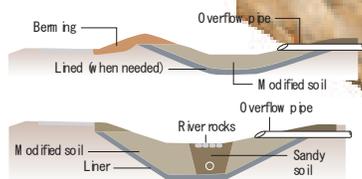
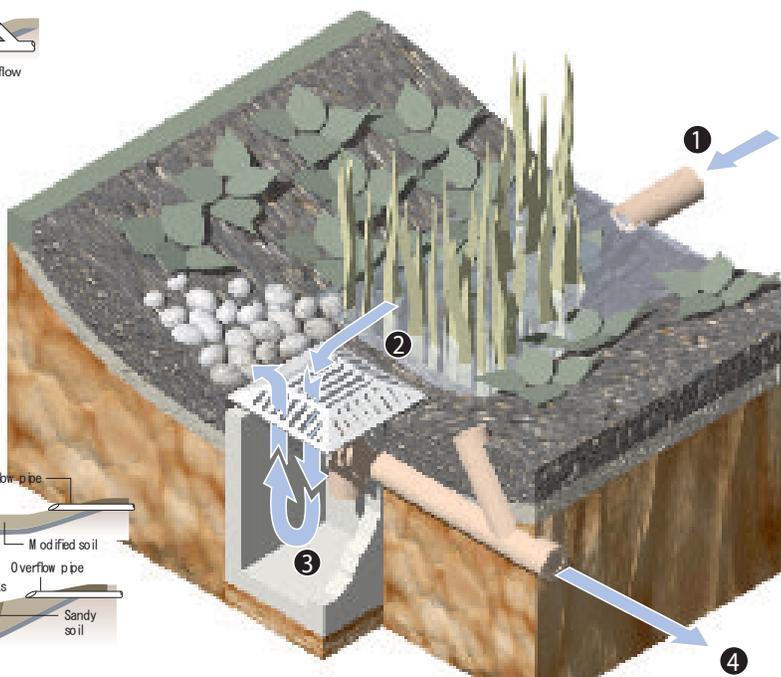
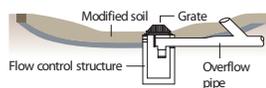
The natural drainage systems approach to these problems is simple in concept: restore and utilize the environment to do the work it was intended it to do. Generally, the NDS approach does so by: increasing, along the edges of city streets, the amount of soil and plants in an interlinked network of “vegetated swales and cascades”; reducing the area of impervious surfaces on the street itself by adopting new, multi-functional street designs; and using these landscape features to allow stormwater to be absorbed into the ground, rather than sending polluted water, at unnaturally high velocities, to rush into local streams, lakes, and bays.

Water Quality

In addition to flooding and damaging flows to the creek, stormwater pollution is also a serious concern. As rain washes over the developed landscape, it may be contaminated by oil and grease, heavy metals, pet waste, sediments, chemical fertilizers and pesticides.

SPU recognized that that the normalization of hydrologic conditions to pre-development levels is a key component of stream restoration efforts and concluded that infrastructure-based solutions alone would not restore aquatic habitat. This understanding, in conjunction with increasingly stringent water quality regulations (which require the monitoring of pollutants in stormwater) led to SPU’s decision to begin implementing “greener” stormwater management projects.

Addressing the quality of stormwater and its impact on local waterbodies was a major component of SPU’s push towards NDSs. In addition to improving the water quality of stormwater by removing contaminants, NDSs also enable greater groundwater recharge and significantly reduce the likelihood of flash flooding. SPU expects that the performance of NDSs will improve over time as plants mature and soil is stabilized, leading to an increase in overall filtration and retention.



Flow Control Swale

Regulates flow of stormwater for all swales

1. Flow Direction
2. Absorption
3. Ponding
4. Overflow Port

Image courtesy of the Seattle P-I.

Landscaping

The landscape elements serve an important role in both providing an aesthetic benefit as well as contributing to the management of rainfall. Trees will help to restore more of the evaporation and transpiration that was present before development.

The landscape architect was involved more during the design than a typical project. The most apparent example of this is a sidewalk design that not only serves but attracts pedestrians.

There also was an emphasis on retaining existing large-scale trees and relocating vegetation to meet homeowner needs and project goals. The swales and surrounding areas are artfully graded and planted with native wetland and upland plant species. Granite boulders and various sizes of washed river rock provide both function and beauty.

The landscape design complements the drainage system function and focuses on native and salmon-friendly plantings. The system is unique in its use of grading, soil engineering, plant selection and layout as components that function together -- much as they do in a natural ecosystem.

Porous Sidewalks/ Pervious Surfaces

Sidewalks are made of a more porous concrete mixture than traditional sidewalks that are highly impervious. Porous sidewalks have increased pore space in the concrete mixture, which allows for stormwater infiltration and reduced runoff volume.

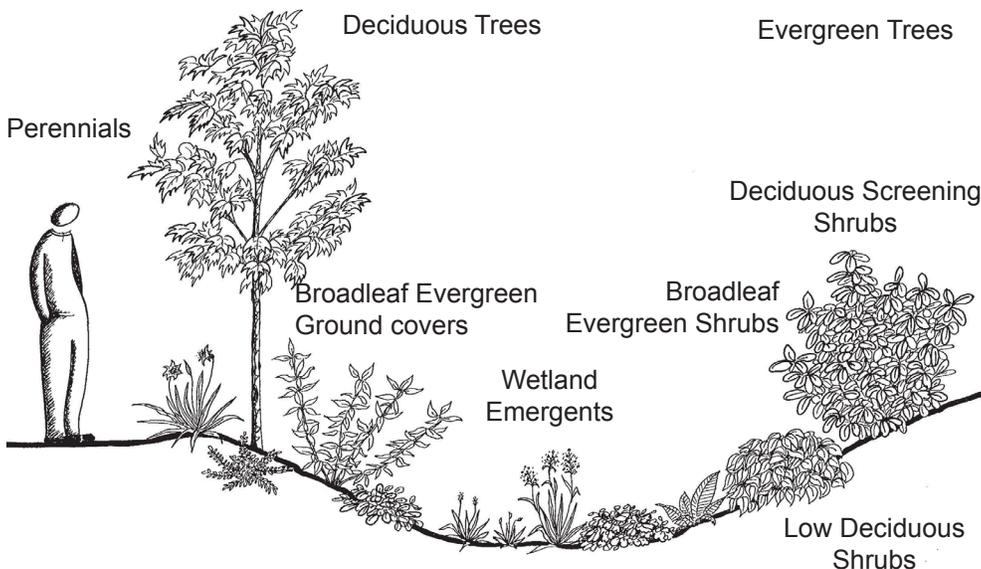


Top: Photo courtesy of SPU

Upper and lower middle: Photo by Hiroko Matsuno

Bottom: Photo courtesy of New York City Department of City Planning

Left: Image courtesy of SPU

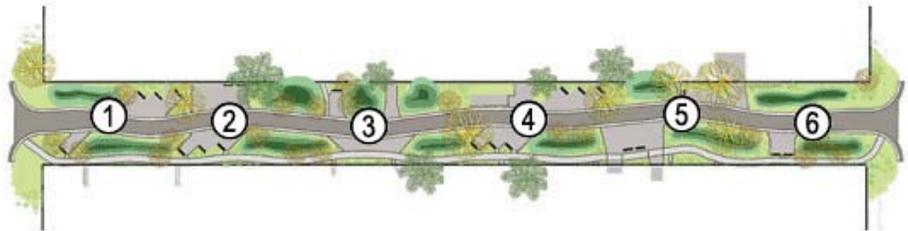


Traffic / Mobility

The design of SEA Street helps slow traffic. The narrower driving lane and meandering shape of the roadway create visual interest and cause traffic to move at a safe pace. Accordingly, this is an ideal location for pedestrians and bicyclists.

While the street's shape and layout are unconventional, the SEA Street design team has ensured that large trucks and emergency vehicles can still safely access the entire street. Although they are not typically used for driving, the white strips, or "flat curbs," provide an additional 2 ft. of driving room on either side of the 14 ft. roadway, for a total of 18 ft. across (enough for two fire trucks to pass each other). In addition, the roadside grass-planted strips are structural grass, reinforced with a lattice of material that can handle occasional traffic.

Parking needs for neighbors are also met on SEA Street based on parking surveys conducted by project planners. The angled parking distributed along the roadway in clusters is unique to SEA Street. Other NDS projects employ alternative parking plans.



Top: Photo courtesy of SPU

Bottom: Photo by Hiroko Matsuno

Community Benefit

Accompanying the drainage improvements, this project has created a sense of place and community in the neighborhood. The addition of a sidewalk separates pedestrians from traffic and increases the feeling of safety in the neighborhood. "Walkability" from the sidewalk and the "garden-street" appeal makes this street a common destination for nearby residents.

The maintenance agreement between residents and Seattle Public Utilities encourages neighbors to get to know each other while they care for the plants in their shared right-of-way garden. Clusters of mailboxes create additional gathering spaces. The visual continuity of the street design and the street's unique appearance also subtly link people together along the corridor.

Finally, anyone who lives on or near SEA Street project is now aware of their place in the larger context of the local watershed. Many community members have become involved in efforts to improve water quality and stream health in Pipers Creek. SEA Street evokes environmental awareness and action... stewardship by design.



Top: Photos courtesy of SPU

Bottom: Photo by Hiroko Matsuno



SEA Streets

Left picture:

A bird-eye view picture of 2nd Avenue NW and NW 117th Street

From this perspective, we can clearly see the linear street, the right-of-way plants and pedestrian path.

Photo courtesy by Harvard Report

Hydrologic Monitoring of Stormwater Management Project

Seattle Public Utilities constructed two drainage projects in the north western part of the city to decrease stormwater quantities discharged to Pipers Creek, with the goal of reducing channel erosion there and water pollutant loadings to the stream. One project, the Viewlands Cascade Drainage System, replaced a narrow, partially concreted ditch with a wide series of stepped pools. The second installation, at 2nd Avenue NW and know as a Street Edge Alternatives (SEA Streets) project, involved the complete reconstruction of the street and its drainage system to reduce impervious area and install stormwater detention ponds. These projects have been monitored for flow in relation to precipitation to determine their actual benefits. Flow was sensed with shaft encoder floats and pressure transducers that recorded water depths behind V-notch weirs. Precipitation was recorded using tipping bucket gauges.

Monitoring has demonstrated that the Viewlands Cascade is capable of reducing the influent runoff volume by slightly more than one-third during the wetter months and overall for the year. Based on estimates for the ditch that preceded the Viewlands Cascade project, the new channel reduces runoff discharged to Pipers Creek in the wet months by a factor of three to the old ditch.

Based on estimates for a street drainage system design according to City of Seattle conventions, the SEA Street alternative reduces runoff discharged to Pipers Creek in the wet months by a factor of 4.7 relative to the conventional street. Despite serving a catchment less than 10% as large as the Viewlands Cascade, the 2nd Avenue NW project retains more than 1/3 as much runoff volume in the wet season as Viewlands, and thus has higher efficiency on a unit area basis. However, when normalized in terms of the cost per unit catchment area served, the SEA Streets project is considerably less cost-effective than the Cascade channel.

according to Harvard Report on Conservation Innovation, the NDS program is positively characterized by:

- Novelty
- Significance
- Effectiveness
- Transferability



photo on the TOP:
2nd Avenue before SEA
Street project reconstruction

photo on the RIGHT:
2nd Avenue after SEA
Street project

Both Photos by Selina Chiu



Transfer Neighborhood Streets into Traffic Calm Region

City traffic engineers were at first opposed to the redesigned street plans that reduced the total paved surface area. According to SPU the redesigned streets are gradually gaining favor with this impair the delivery of public safety services. Once the pilot project was completed, the alternative street designs gradually gained acceptance among public safety officials, as they found that their ambulances and fire trucks could navigate the curvilinear street without exceptional difficulty.

photo on the LEFT:
drainage system in SEA
Street

photo on the RIGHT:
drainage system outside of
SEA Street

Both Photos by Selina Chiu



Stormwater management Evaluation

studies of the SEA program suggest that over the two-block area that was monitored during the first two years of operation, the transmission of pollutants through stormwater runoff was reduced by 98% and stormater flow velocities were reduced by approximately 20%, compared to a conventional street and gutter system.

Health and productivity

Residents and community activists have enthusiastically supported the NDS approach in their neighborhoods because it improves quality of life by adding trees and plantings that have visual and aesthetic appeal, by adding sidewalks where there were none before, and slowing the speed of local traffic.

Cost efficiency

The City of Seattle has found it is more cost-effective. Seattle Public Utilities estimates that the construction of infrastructure based on the NDS approach costs 25% less than traditional roadside stormwater systems, because reducing runoff at source reduces the need to build additional pipes and holding tanks.

Education

Local level—residents have been involved in many stages of planning and implementation of individual NDS components.

Promotion—the strong link between the City and researchers from the University of Washington ensures that the effectiveness of the program is studied quantitatively and can be rigorously applied elsewhere.



photo on the TOP:
community mail boxes

photo on the DOWN:
another SEA Streets Project
on 2nd Avenue NW to NW
120th Street



photo on the TOP:
community mail boxes

photo on the DOWN:
another SEA Streets Project
on 2nd Avenue NW to NW
120th Street

All photos by Selina Chiu

The Lesson We Learn

We read a lot of articles about the design, construction and management about the SEA Streets project. And we also visited several streets. The 2nd Avenue NW and NW 117th Street is a successful project with high quality in our opinion. The beautiful curvy shape of street, off-road parking lot for every house and well maintained natural drainage system that looks like part of the garden, make us impressive by this project. To compare the 2nd Avenue NW and NW 117th Street with 2nd Avenue NW to NW 120th Street, it is obvious that 2nd Avenue NW to NW 120th Street is not as attractive as the previous one. In our analysis, we believe that it is because that 2nd Avenue NW to NW 120th is not as wide as 117th. And the terrain is different—117th is more flat than 120th.

We think SEA Streets is a very good pilot project in Seattle. To form a community with traffic calm, stormwater management and attractive visual appeal, SEA Streets project can provide many useful data and information. The best of all, it is also a cost-efficiency program that can tight-up the connection between neighborhoods.

Innovative Stormwater Solutions

- Re-creating wetland
- Rain garden and swales
- Stormwater parks, bio-retention ponds
- Green roofs
- Cisterns and rain barrels
- Cascades, mini-waterfalls
- Urban “greening” and natural plantings

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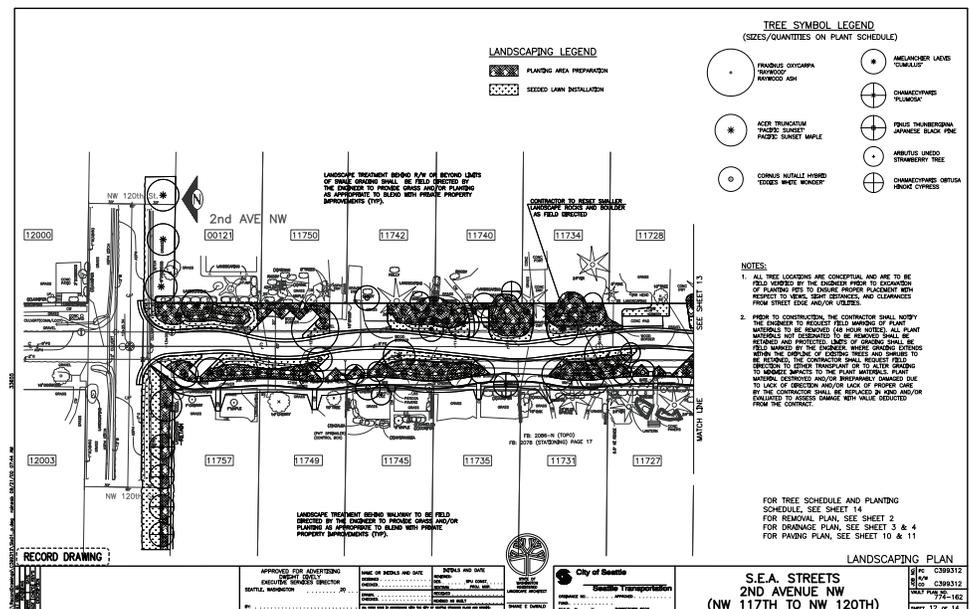


Image courtesy by Seattle Public Utilities