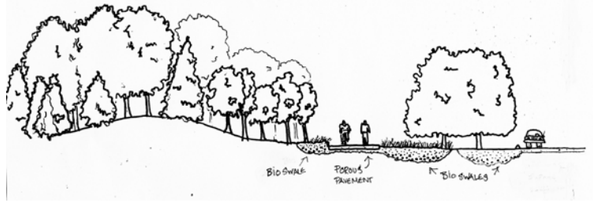
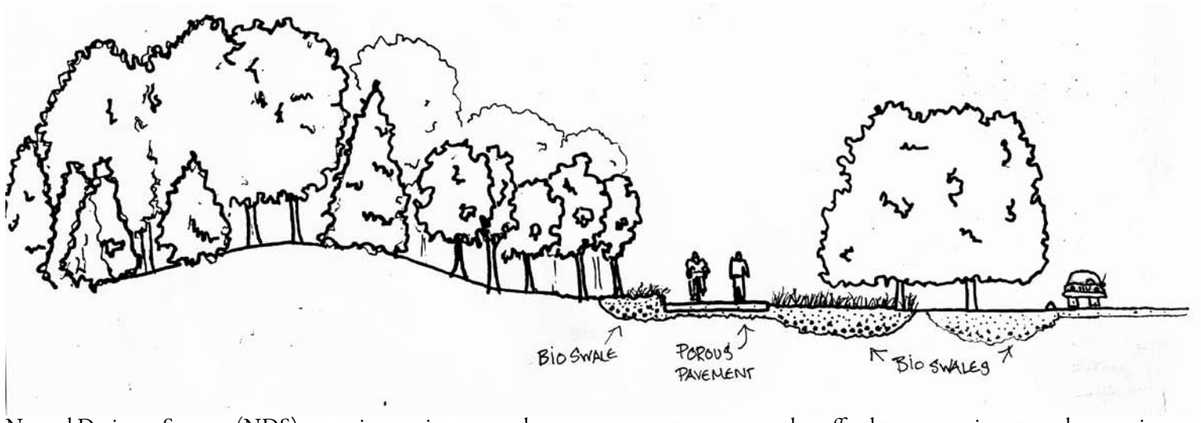
This chapter describes ways to enhance the ecological function of greenways. Two approaches are discussed. The first approach is natural drainage systems. Natural drainage systems use plants and soils to help manage stormwater runoff. The second approach is to create conservation corridors. Conservation corridors will help restore natural connections that have been broken by human activities.



Natural Drainage Systems

In a region so rich in shoreline, wetlands, and waterways, protecting water should be a priority greenway function. The key to protecting water is managing runoff from storms. With careful design, the South Shore Greenway can become part of the region's existing stormwater management system.

Rain and snowmelt become destructive, causing flooding, erosion, and water pollution, when they are not absorbed into the ground. Excess water carves through the land picking up soil and pollutants, eventually ending up in streams, rivers, and the ocean, clouding and polluting the water. Excessive runoff is a major problem in developed areas where buildings and roads prevent stormwater from being absorbed into the ground. Traditional storm sewer systems can aggravate the runoff problems. The speed and volume of water coming out of storm sewer pipes erodes stream channels, and like uncontrolled runoff decrease water quality, disrupt aquatic food chains, and destroy riparian wildlife habitat. The South Shore Greenway has reduce these problems by becoming a natural drainage system for stormwater.



Natural Drainage Systems (NDS) are an innovative approach to stormwater management that afford greater environmental protection at a lower cost than traditional gutter and pipe systems. The City of Seattle found that their first NDS project was 25% less expensive to build than a traditional storm sewer system and captured 99% of the stormwater runoff.

Natural drainage systems use plants and soil to manage stormwater. Unlike the gutters and pipes of traditional storm sewer systems which simply transport stormwater and all its pollutants to the most convenient stream or expensive, high maintenance water treatment facility, natural drainage systems are multifunctional with lower cost and lower maintenance. In addition to filtering, cleansing, and infiltrating stormwater, natural drainage systems provide wildlife habitat, reduce erosion, recharge groundwater and are more aesthetically pleasing than traditional stormwater sewer systems.

Natural drainage systems are very effective. They have been reported to reduce annual stormwater runoff volume by as much as 65 percent and to remove up to 80 percent of the suspended solids and heavy metals, and up to 70 percent of nutrients like phosphorous and nitrogen from stormwater runoff (Seattle Public Works).

Natural drainage systems in urban and suburban settings use a combination of approaches to minimize run-off. Two of the most applicable to a greenway are permeable surfaces and bioswales.

Three guidelines characterize the natural drainage system approach:

- Create a network of bioswales and gardens planted with native plants to collect and absorb stormwater from streets, roads, and buildings.
- Replace impervious surfacing materials on sidewalks, roads, and streets with permeable materials.
- Narrow streets and roads to reduce the amount of impervious surface, to slow traffic, and to provide space for sidewalks and bikeways.

Permeable Paving

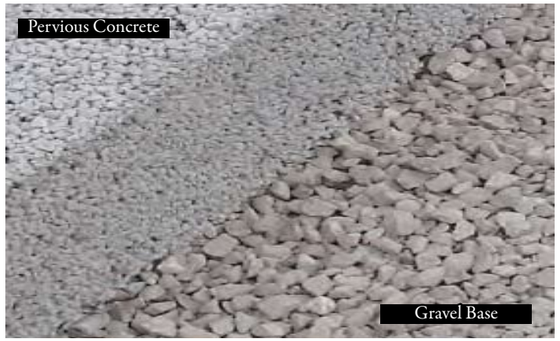
The material used to surface a trail within a greenway has a profound impact on the greenway's ecological function and sustainability. The surface must drain well and be strong enough to handle a trail's intended use. A strong, well-drained surface will ensure that a trail is long-lasting and easier to maintain, two elements of sustainability. For high ecological function, the surface should minimize trail runoff. By letting water seep through into the soil below, permeable surfaces reduce stormwater runoff, help recharge groundwater, and filter pollutants. They may reduce or eliminate the need for an underground storm drain system or a curb and gutter system.

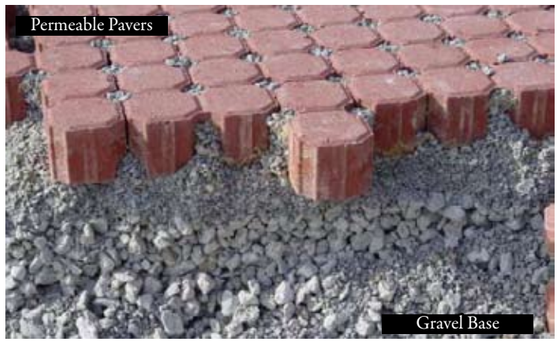
The best way to minimize run-off is to use a surface material which lets water seep through into the soil below. Materials which allow water to move through them are called permeable or porous. Until fairly recently, the only options for creating permeable trail surfaces were soft natural materials such as soil, bark, wood chips, gravel, and crushed stone. The problem with these soft materials is that they do not hold up very well under heavy trail use, especially in places like the South Shore where winters are harsh. Nor are soft materials practical in urban and suburban environments where tidiness tends to be highly valued. New permeable surfacing materials overcome these problems; they are strong, have an orderly appearance, and most important for ecological function, they allow water to drain through them.

Two new types of poured permeable pavement are available, concrete and porous. They resemble conventional concrete and asphalt, but have more air spaces to let water percolate through them. Because they drain so well, these newer materials are less prone to cracking or buckling from freezing and thawing. Studies indicate they require less frequent repair and patching than conventional paving which reduces their maintenance costs.

Pervious pavers are interlocking blocks of brick, stone, cobbles, or pre-cast concrete placed in a rigid frame on top of a bed of gravel. Sand-filled gaps between the pavers allow water to seep into the gravel bed below and then beyond into the soil. Pavers form a durable and strong surface. They are easy to repair or replace because they can be lifted easily. In addition, pavers come in many colors, shapes, and textures to make interesting designs possible.

To maintain surface drainage, some manufacturers recommend vacuuming permeable paving once or twice a year to prevent them from clogging. In addition, the gaps between pavers may require occasional sand or gravel replenishment.





Seattle SEA Project
A major storm causing three hundred landslides and millions dollars of damage to city and private property galvanized Seattle, Washington to attend to a traditional storm sewer system that just wasn't working. As a result, the Street Edge Alternative (SEA) program began. This innovative program has three goals: stormwater management, water quality protection, and preservation of healthy riparian habitat for fish and wildlife.

The first SEA project transformed a suburban street in the Piper's Creek watershed into a 660-foot long natural drainage system by eliminating eleven percent of the neighborhood's impervious surfaces and planting a roadside bioswales with over 1,100 native shrubs and trees. Mature trees were preserved where ever possible. The street is also narrower than before to reduce impervious surface, and has gentle curves slow traffic. A two-foot wide concrete border separates the street from the bioswales and helps define the roadway edge. All bioswales are within the street right-of-way, demonstrating Seattle's growing commitment to streets that are part of community space, not just thoroughfares for cars. The design does accommodate cars with angle and parallel parking stalls grouped between bioswales and driveways. Most properties also have alley access with parking. The cost of this project was $850,000.

Benefits
The natural drainage system provides many benefits to the neighborhood. It creates much needed open space in a dense suburban neighborhood. It provides a place for neighbors to meet, walk, talk, and share gardening activities. The curving sidewalk, separated from the street by lovely bioswales jammed with grasses, perennials and shrubs, has the feel of a graden walk; it beckons walkers. The meandering narrow street not only reduces the total amount of impervious surface, it slows traffic reinforcing the invitation to walk. Most importantly, stormwater runoff has been reduced to almost nothing. Residents report that their property values have increased.

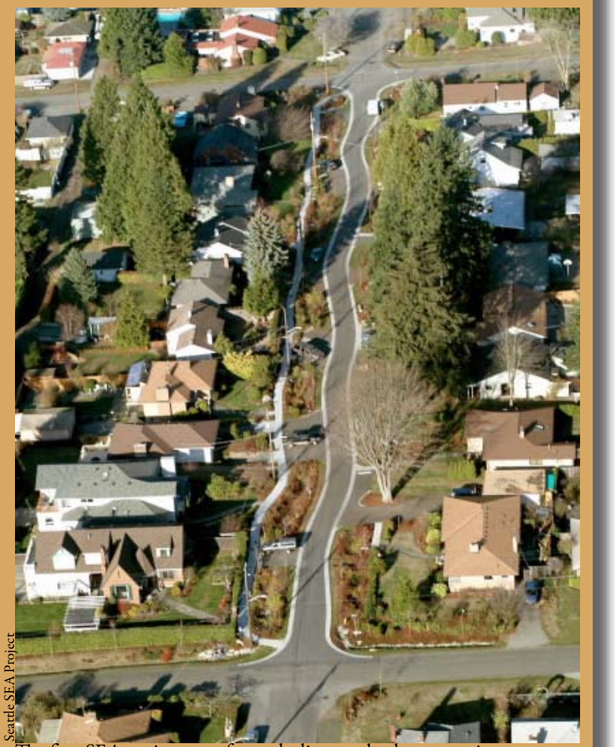
The first project has been so successful that two additional natural drainage systems projects are underway and one is in the planning stages. All three are in higher density neighborhoods. The Broadview Green Grid increases the scope of Seattle's SEA projects to a fifteen city block neighborhood. Like the first project, the 32-acre Green Grid uses bioswales and porous surfaces to manage stormwater runoff.

The most ambitious project yet is the 34-block, 1,600-unit, mixed-income High Point housing redevelopment project which is creating bioswales, porous concrete sidewalks, and frontyard rain gardens a 129-acre former public housing project site. When completed, the High Point project will integrate more than four miles of bioswale into the planting strip in the street right-of-way.


Seattle SEA Project
The first SEA project was a typical suburban street before its transformation.


Seattle SEA Project
The first SEA project after it was transformed into a natural drainage system.

The project is expected to reduce stormwater runoff by sixty-five percent.
Finally, the South Lake Union neighborhood is being rapidly redeveloped with a natural drainage system. The new mixed-use neighborhood will be an uban center with ten to twelve story high buildings built to the property line. The plan is for a shallow (two-foot deep), but wide (twenty foot) wide bioswale to run for 12 blocks. The space for the bioswale will be created by eliminating a parking lane and narrowing the street. The streets will have sidewalks on both sides.


Seattle SEA Project
The first SEA project transformed a linear suburban street into a garden walk which reduced stormwater runoff by ninety-eight percent at seventy-five percent of the cost of a traditional storm sewer system.

Seattle SEA Project

Seattle SEA Project

Bioswales

Bioswales are linear rain gardens, gently sloping depressions planted with dense vegetation. In contrast to traditional rural drainage ditches and urban gutter systems, bioswales are designed to slow, cleanse, and absorb stormwater runoff. In a well designed bioswale, runoff moves slowly along the gentle incline, depositing sediment and percolating into the ground where plant roots and soil microbes remove salt, oil, gas, antifreeze, and other pollutants in runoff from roads as well as pesticides and fertilizers in runoff from lawns and fields. Bioswales are especially effective at removing sediment, fertilizer, and heavy metals (City of Portland, 2006). With careful design, bioswales absorb almost all the runoff from normal rainstorms (Virginia Center for Watershed Protection, 2007). Careful design includes planting bioswales with appropriate trees, shrubs, and perennials. Studies show that forested areas capture, absorb and store fifteen times more rainfall than grass or turf.

Ideally for water management, bioswales should form a continuous line along the greenway path. On roads with existing grass-covered drainage ditches, replacing the the grass with trees, shrubs, and perennials is a relatively low cost first step toward a bioswale-lined greenway. Bioswales should sandwich a greenway path wherever possible to catch runoff from both the path and road. Bioswales should replace traditional gutter-and-curb systems along roads with low traffic volumes. Where the greenway path follows heavily trafficked roads requiring curbs, curb-cuts can be made so that runoff from the street can enter the bioswale.

New Style in Stream Crossings

Massachusetts recently set new standards for bridges over rivers and streams. The intent of these new guidelines is to create an efficient human transportation system without undermining the natural transportation system. The new standards call for bridges, rather than culverts to create a passageway for both aquatic and terrestrial organisms. The bridge should be high and wide enough to span the stream and its bank to preserve the riparian corridor for terrestrial species. The stream bed should have a natural substrate which mimics the substrate up and downstream from the bridge to facilitate passage of fish and other aquatic organisms. Finally, the bridge should be engineered so that the depth and velocity of water flowing beneath the bridge matches up and downstream flow.

Integrating Human and Natural Connections

Not every part of the South Shore greenway must serve all possible functions. In some cases, what suits humans harms other species. Compatibility issues can be addressed by physically separating the most intensive human activities from the most important conservation areas. Some greenway segments can be designated as conservation corridors and left in an undeveloped state. Other greenway segments can be designed to accommodate humans and other species.

Decisions about the level of human use should be based on a site's ecological characteristics and its capacity to sustain human use without harming other species. For example, many wetland plants are extremely sensitive to compaction. Simply walking across a wetland meadow leaves a scar on the landscape that will be visible for years. Human use should be minimized where it will cause long-term damage, especially if the area contains endangered species. In areas where humans have already shaped the landscape to suit their needs, the greenway can be designed to accommodate species adapted to living in concert with humans. For example, planting trees along a greenway path in a surburban neighborhood provides habitat for songbirds without compromising the alternative transportation function of the greenway.

Restoring Natural Connections

With careful planning the South Shore Greenway can restore connections which have been broken by human development. Several strategies can be used to restore natural connections.

- Encourage compact development to preserve existing open space and minimize demand for new roads.
- New and replacement bridges should be meet design standards which facilitate passage for wildlife, fish, and other aquatic species by matching the environment beneath the bridge to the up and downstream environments.
- Acquire land to expand riparian corridors. The Massachusett's River Resource Protection Act mandates a 200-foot buffer zone around all perennial streams and rivers (except in some very densely populated urban areas). This buffer zone provides the minimum level of protection. A wider buffer will provide greater protection of this extremely sensitive and valuable ecosystem.
- Work with property owners and municipal governments to encourage creating a naturalized landscape in all riparian corridors.

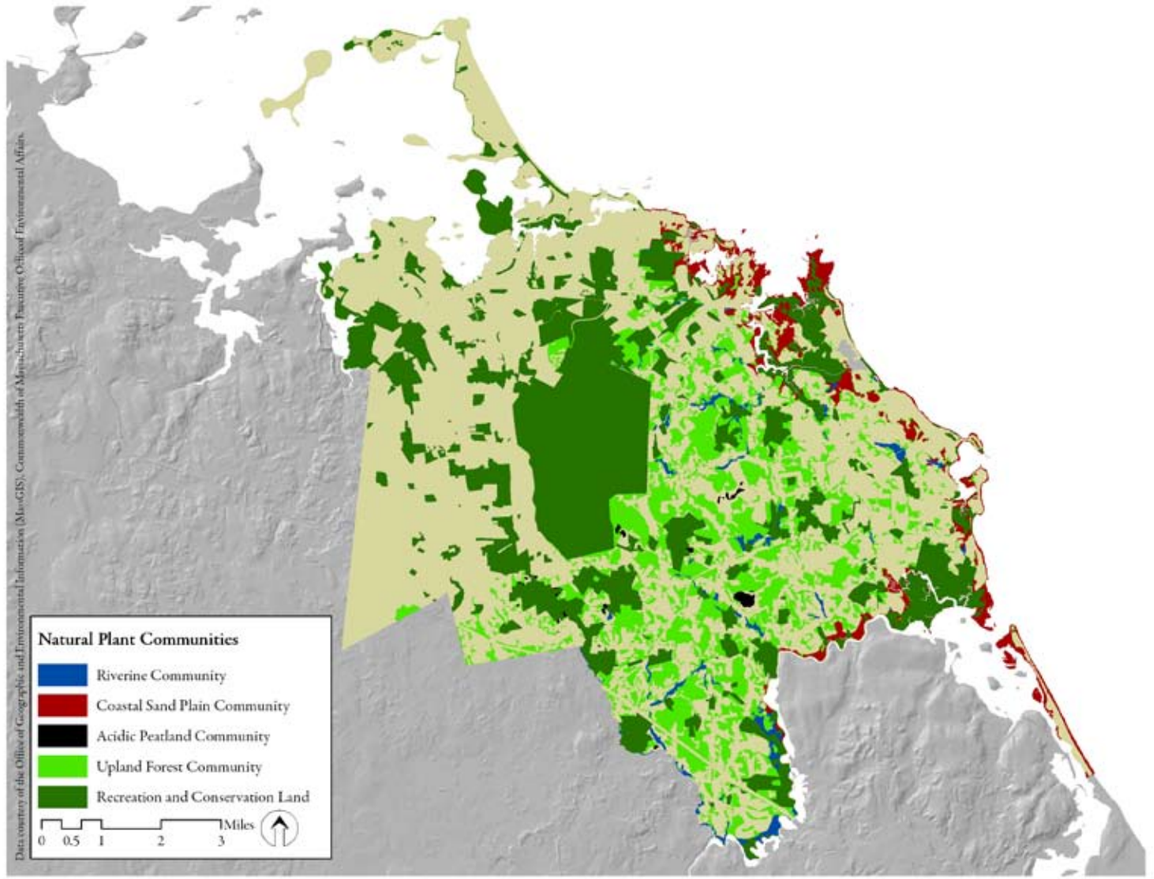
Expanding Natural Connections

The South Shore Greenway can improve the ecological health of the entire region by expanding the existing system of natural connections. One straightforward strategy for doing this is to create a naturalized buffer zone around all properties that border on existing open space. This will require working with private property owners as well as government agencies. As a first step, naturalized landscape borders around all public parks and school grounds could be created to serve as models for the rest of the community.

Natural connections can also be expanded by increasing the amount of permanently protected land through acquisition or legal means. Identifying land for protection will require very careful consideration. The greatest gains in ecological can be obtained by prioritizing certain types of land for protection.

- Land which recharges groundwater and aquifers is essential for protecting water quality and quantity. Land around the headwaters of surface water supplies should also receive priority because whatever happens at the headwaters will affect all downstream water quality.
- Protecting land areas which are large enough to maintain viable populations of plants and animals will ensure that each species has the flexibility to adjust to changes which might threaten survival.

- Protecting land which supports native plant and animals species will help to maintain the unique character of the South Shore. The Commonwealth's Natural Heritage Atlas can provide guidance about the location of important habitats.
- Protecting land which is rich in species number will help ensure that biodiversity is maintained. The Commonwealth is currently mapping the location of plant communities considered most critical to maintaining biodiversity. Scituate, Cohasset, and Norwell have been mapped. The South Shore contains three of the less common plant communities in the Commonwealth. Protecting these areas is important for biodiversity at a state level.



The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has defined eight ecological communities that are the most critical for preserving the Commonwealth's natural history and diversity.