Guidelines for Green Streets

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To:	Jim Olson, City of Ashland
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Copies:	Project Management Team
Date:	February 2, 2011
Subject:	Green Streets Guidelines –White Paper
Project No.:	15702: City of Ashland Transportation System Plan Update

Direction to the Planning Commission and Transportation Commission

Five sets of white papers are being produced to present information on tools, opportunities, and potential strategies that could help Ashland become a nationwide leader as a green transportation community. Each white paper will present general information regarding a topic and then provide ideas on where and how that tool, strategy, and/or policy could be used within Ashland.

You will have the opportunity to review the content of each white paper and share your thoughts, concerns, questions, and ideas in a joint Planning Commission/Transportation Commission meeting. Based on discussions at the meeting, the material in the white paper will be: 1) Revised and incorporated into the alternatives analysis for the draft TSP; or 2) Eliminated from consideration and excluded from the alternatives analysis. The overall intent of the white paper series is to explore opportunities for Ashland and increase the opportunities to discuss the many possibilities for Ashland.

Definition a Green Street

Green Streets are an alternative to conventional street drainage systems designed to quickly collect stormwater and put it 'out of sight and out of mind' beneath our community streets. The historical message has been essentially that rain water is waste water. A more sustainable approach is to design for a better balance between urban development and natural hydrological processes that will result in a healthy watershed. As part of that approach, Green Streets are a significant new opportunity to promote a vision of sustainable urbanism for the City of Ashland. By more closely mimicking the natural hydrology of a particular site, Green Streets can help reduce the impact of urban development. Green street stormwater facilities have been shown to improve water quality of runoff through effective treatment, minimize erosion through the reduction of peak flow rates and discharge velocities, and decrease stormwater volumes discharged to local streams by infiltrating all or a portion of local rainfall events.

In elegant and attractive ways, Green Streets can integrate goals of livability, multimodal transportation choices, and innovative stormwater management. They can and should become a familiar part of the urban landscape. They can be regarded as an attractive and functional element of the street. What distinguishes Green Streets is primarily a series of landscape swales, planters, and permeable pavements designed with rainfall in mind. They provide public opportunities to appreciate the hydrological cycle and the importance of stormwater treatment. The fundamental concepts of a Green Street are:

Capture the raindrop where it falls. Managing stormwater at the source (i.e., where the rain drop falls) is an effort to imitate the hydrologic cycle of pre-developed conditions. This is done through small facilities that are well distributed throughout the street right-of-way.

Let nature do its work. These facilities treat stormwater and promote infiltration into the native soils. Keeping stormwater on the surface and out of a more conventional pipe system allows nature do its work. Plants and amended soils found in Green Street facilities will absorb, slow, and filter runoff.

Design stormwater facilities that are simple. Simple facilities are usually the most cost-effective and will enhance the aesthetics of the streetscape. They can be incorporated into sidewalks, tree wells, medians, or on-street parking lanes. The proper use of green street techniques can reduce the size and costs of conventional stormwater infrastructure needed for new or retrofit roadway drainage projects.

While Green Street facilities are intended to infiltrate as much runoff as the site conditions will allow, a conventional storm system will likely still be needed for larger, high intensity storm events. The facilities need to be designed to overflow during larger storms that may exceed the infiltration capacity of the facility and underlying soils. The overflow will need to discharge to a traditional storm conveyance system or an open channel properly protected from erosion. Depending on the native soil infiltration rates, runoff from lesser storms can be completely infiltrated, reducing the impacts on downstream systems. Infiltration rates of underlying soil will vary, even from site to site on the same project. Where infiltration rates are relatively poor, a sub-drain system may be required to remove stormwater from the Green Street facility after it has been treated. In general, a native soil infiltration rate of two inches per hour is viewed as the cutoff point for a facility to require an under drain. Because the native soil infiltration rate is so critical for the proper function of a Green Street facility, it is important to have a firm understanding of the site-specific geological conditions before beginning a project design.

Some street improvement projects or plans for new construction projects may present physical or budgetary constraints for the most robust design of Green Street facilities. In those situations, a 'multiple shades of green' approach can still maintain the essential link between transportation and sustainability. In that approach, outlined below, Level 3 represents what is commonly perceived to be a Green Street. At Level 4, the Green Street also strongly emphasizes facilities for walking, biking, and transit, further reducing the adverse environmental impacts of vehicle-centric transportation. Level 5 is the most comprehensive approach. It integrates the street with private development in a unified stormwater management strategy, blurring line between street and building. That is difficult to achieve except through carefully planned new development projects. Even then, it is an ambitious undertaking for most communities.

GREEN STREETS AND PARKING LOTS CAN BE "MULTIPLE SHADES OF GREEN"

Level 1	Maximizes landscape areas along the street and minimizes overall impervious areas of the land. Some runoff from sidewalks may be managed in landscape areas.
Level 2	Significant tree canopy is added to the urban streetscape.
Level 3	Fully manages street, sidewalk, and driveway runoff by using a landscape system. Design solutions are cost effective, provide direct environmental benefits, and are aesthetically pleasing.
Level 4	Green street provides direct focus on alternative modes of transportation including mass transit, biking, and walking.
Level 5	Green street frontage manages both public and private stormwater runoff. Building, site, and street frontage become one integrated space designed for stormwater management.

Source: San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook, First Edition – January 2009

Types of Facilities

Certain low impact development (LID) stormwater management facilities have emerged as types commonly used for Green Streets. They use a combination of processes, including hydrologic operations, physical operations, and biological processes to achieve treatment goals. Bioretention is a cornerstone strategy for developing an effective Green Street. Bioretention facilities can take many forms, including planters or tree wells within the furnishing zone of a sidewalk, a swale or depression in a landscaped roadway median, or a larger stormwater facility set back from the roadway and sidewalk.

Stormwater treatment is a primary goal of bioretention facilities. Each layer of the facility provides a mechanism for improving water quality as the runoff passes through. The vegetation planted in the basin, the amended soil/growing media, and drain rock all remove pollutants of concern through various methods. Vegetation can remove dissolved metal and organics through direct uptake and storage. Excretion from plant roots assists in metal removal. The vegetation reduces flow velocities allowing particulates to be removed by sedimentation. Vegetation increases microbial populations, which transforms and/or removes a variety of organic and inorganic constituents. Plant detritus provides absorption sites for various organics and metals. Metal stabilizing plants limit the mobility and bio-availability of metals in soils. Metal stabilizing plants have extensive root systems that grow rapidly and can tolerate high concentrations of metals in the roots. In addition to providing a base for plant growth, the amended soil acts as a filter as the runoff infiltrates through the facility. Pollutants are also broken down by interactions with bacteria, fungi, and other organisms found in the soil.

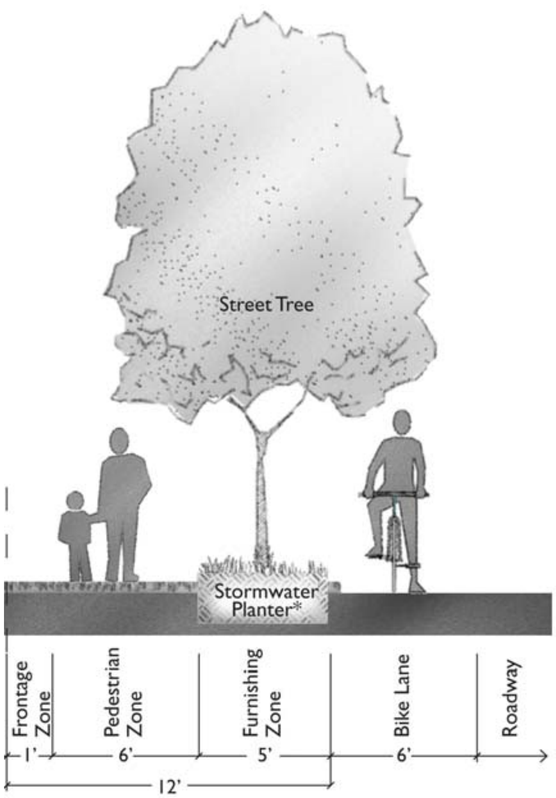
Each of the facilities discussed below have been in use long enough, and by multiple jurisdictions, for modifications to initial design concepts to have occurred and for lessons to be learned about effectiveness and performance. Design standards and guidelines developed by some of those communities have been included in the bibliography. Before Ashland adopts any specific design standards or preference for facility types, it might serve the community well to review those standards carefully and contact representatives of those jurisdictions to discuss lessons learned and their current expectations regarding performance, construction techniques, short- and long-term maintenance, and life-cycle cost. It will also be important to factor in the unique characteristics of Ashland's climate (temperature and rainfall patterns) and potential impacts to water quality limited downstream systems such as Bear Creek and the Rogue River.

Bioretention Planters and Basins

Basins and planters both fit under the category of bioretention facilities. They allow runoff to infiltrate into the native soil. They can also be adapted for areas with less permeable native soils by installing a rock layer and an underdrain pipe. Planters have vertical sidewalls and an overall width of 4 to 6 feet. Basins are typically larger, with sloped earthen sides instead of the vertical walls. Basins have lower construction costs, but planters are more appropriate when space is at a premium, such as the furnishing zone of a sidewalk in a commercial or mixed use district with high levels of pedestrian activity.

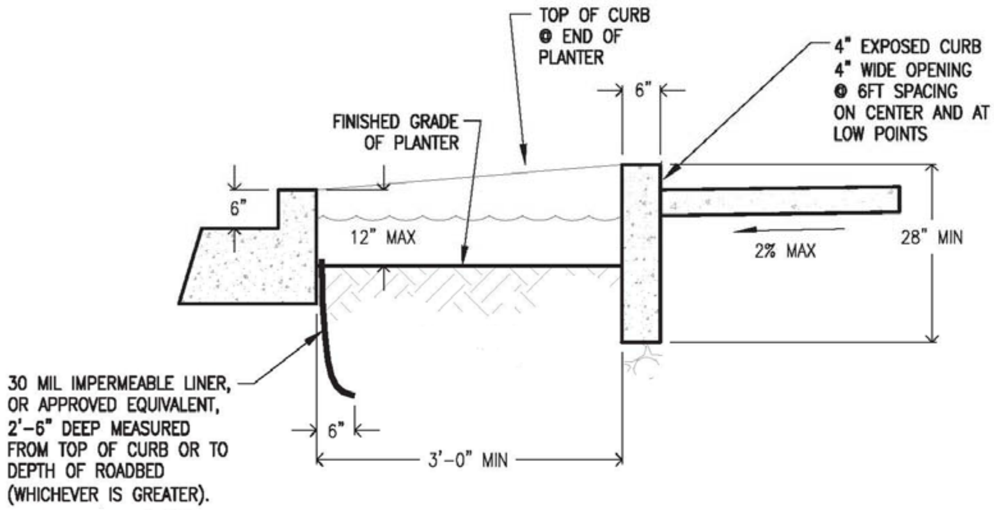
Planters

Flow-through stormwater planters are a common bioretention facility in our more developed urban areas. They provide a distinctive architectural feature for the sidewalks of an urban Green Street where sidewalk widths are 12 feet or greater, with a minimum 5-foot furnishing zone available. The design and location of planters should consider other sidewalk uses, such as outdoor seating storefront displays, as well as maintenance of adequate passenger loading/unloading space for on-street parking.



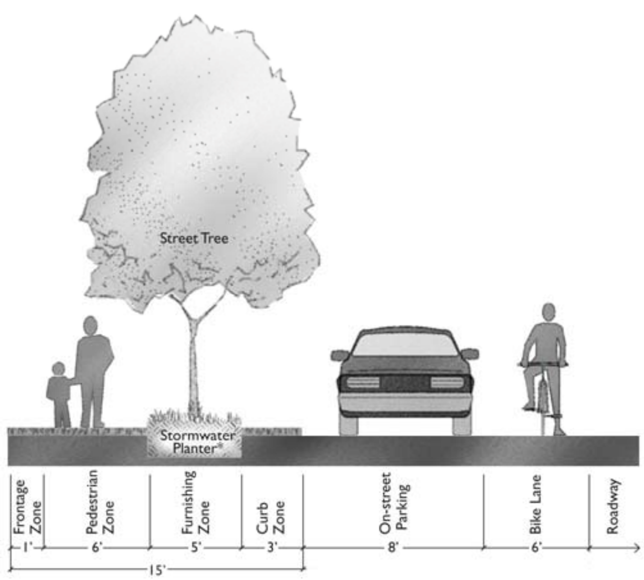
Cross-Section Planter Without Parking

Constructed Example



Planter Cross-Section (modified from Portland Bureau of Environmental Services)

The need to provide on-street parking often precipitates conflicts between pedestrian circulation and the use of stormwater planters. When on-street parking is provided next to stormwater planters, it is critical to design a space where people can step out of their cars and walk. This egress zone should have a width of 3 feet. People leaving the parking zone will also need access to the sidewalk area behind the planters. Green Streets accommodate this with frequent spaces between planters or small footbridges across long planters. For any given drainage basin, the total square footage of a planter will be considered the treatment area. The treatment area needed will be in proportion to the amount of impervious surface that drains to the planters.

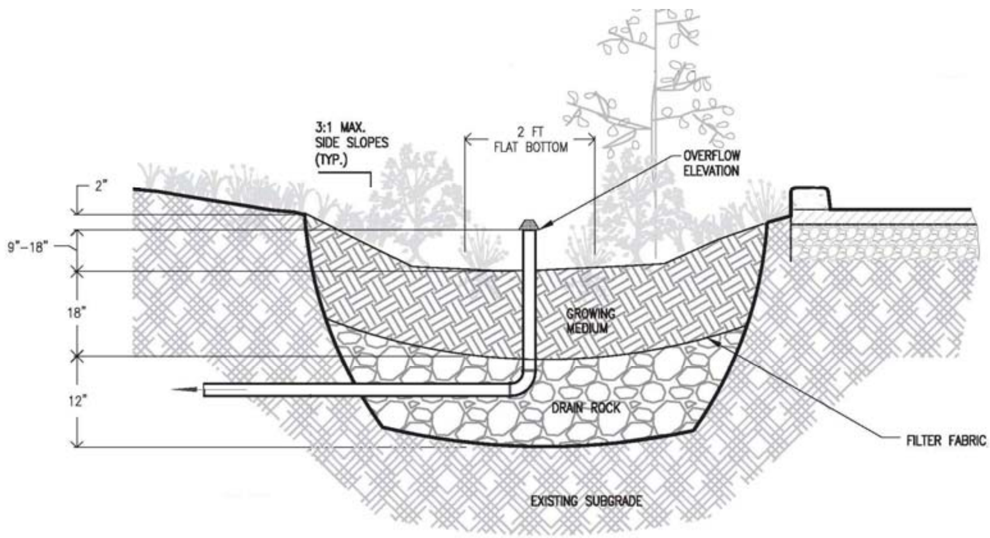


Cross-Section Planter With Parking

Constructed Example

Basins

Because of their larger size, basins are usually located behind the sidewalk. They are an alternative to planters in the furnishing zone if the sidewalk width is too constrained to accommodate both the planter and a comfortable walking space for pedestrians. In those instances, the overall street right-of-way need may be greater, or a stormwater management easement required since the width of a basin is greater than a planter due to side slopes. An alternative may be to locate the facility at a curb extension to avoid the conflicts.



Basin Cross-Section (modified from Portland Bureau of Environmental Services)

Constructed Example

Sizing. Planters and basins are similarly sized and use the same methodology. Determining the overall size (e.g. treatment area) of a bioretention facility depends on the size of the roadway, and thus, the amount of stormwater runoff to be treated. The facility must be large enough to treat the chosen rain event by filtering it through the vegetation and growing media without passing water through the overflow devise. The rain event used for sizing is usually referred to as the water quality design storm, which in other jurisdictions in Oregon ranges between 0.83 inches per 24-hour to 50 percent of the 2-year event. As a typical rule of thumb, the total amount of planter area required for maximum treatment will be equal to approximately 6 percent of the contributing impervious area. If the street accommodates on-street parking, the use of curb extensions is a cost-effective way to increase the size of the treatment area or to consolidate the treatment area to fewer locations.

Curb Extension with Stormwater Treatment

Design Parameters. A variety of parameters should be considered when designing a bioretention facility. The chosen site needs to be large enough to account for the facility, required freeboard, and maintenance access to the facility. Local setback requirements should also be considered. In the absence of an impermeable liner, bioretention facilities should be at least 10 feet from building foundations.

Soil amendment and vegetation choices will be affected by target pollutants, plant types, irrigation requirements, and expected hydrologic conditions. Native soil suitability will dictate infiltration capacities and whether a gravel rock and sub-drain system is required. Typically, depending on the plants chosen, the bioretention facility should be designed to drain completely within 12 hours of a storm event. The facility should receive some direct sunlight to maintain vegetation. Erosion control measures are recommended at the facility entrance to discourage concentration of flow and erosive channeling in the facility bottom. Check dams may be beneficial for keeping the flow dispersed.

Steep Slopes. For street slopes greater than 5 percent, check dams or weirs will be required to slow the velocity of run-off. This allows water to be retained for treatment or infiltration and prevents corrosive damage of water moving at higher velocities. As a rule of thumb, check dams are spaced at approximately 25 feet apart, with closer spacing as the gradient of the street increases. Erosion countermeasure will be especially important for bioretention facilities placed on steep slopes.

Stormwater Treatment Facility with Check Dams

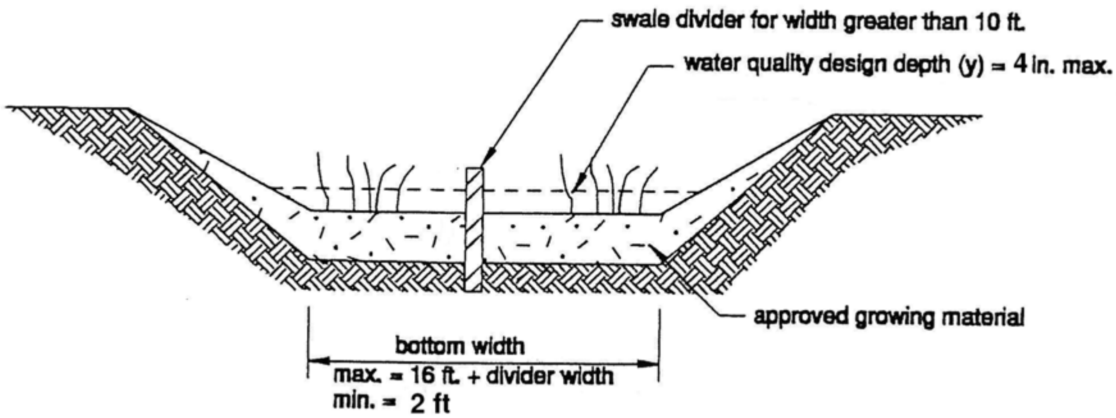
Swales

Swales are narrow channels with angled sides and are planted with a variety of shrubs and grasses. They provide stormwater treatment by moving water from end to end along a sloped bottom. Primary treatment comes from the vegetation the water moves through. This is in contrast to planters, where water moves directly downward through a special soil matrix in order to achieve treatment.

A swale can be attractively landscaped to fit a variety of locations. Advantages include low maintenance requirements and low construction costs. The construction of swales does not require as deep of an excavation as planters and basins, allowing them to be used in certain applications where excavation is constricted. They are also a common facility found in roadway construction and most contractors are familiar with how to construct them properly. The primary disadvantage of swales is that they are long, narrow facilities, with a typical minimum swale length of 100 feet. This can be a limiting factor, especially in urban environments.

Often used interchangeably, a "bioswale" is similar to a traditional vegetated swale, with the key addition of bioretention media and specialized vegetation. These changes enhance water quality treatment, increase detention of runoff, and decrease peak runoff rate.

Swales can be difficult to locate in an urban area. Natural, non-architectural side slopes, and wide bottoms make their functional width greater than planters. They generally do not fit well into sidewalk furnishing zones. Their use typically requires additional street right-of-way or acquiring drainage easements to construct them behind sidewalks. Land availability and limited rights-of-way can make it difficult to locate them behind sidewalks and keep them away from buildings. Landscaped medians in the roadway or parking lots present better opportunities for these facilities.



Typical Swale Cross-Section

Constructed Example

Design Parameters. There are many potential swale designs. Shape, slope, plantings, soil composition, inlet, and outlet treatments can all be varied significantly. They are usually designed to allow stormwater to enter at one point at the top of the swale. Soil amendment choices will be affected by target pollutants, plant types, irrigation requirements, and expected hydrologic conditions. Typically, depending on the plants chosen for the facility, the swale should dry out between storms to prevent vegetation die off.

Sizing. The chosen site needs to be large enough to hold the facility and to account for maintenance access to the facility. Local setback requirements should also be considered. In the absence of an impermeable liner, swales should be at least 10 feet from building foundations. The size of the facility itself will vary depending on run-off area being treated, but they are typically large facilities compared to planters and basins. Length, longitudinal slope, and width are usually set to achieve a minimum residence time of nine minutes in the facility, which studies have shown provides effective treatment. Maximum longitudinal slope for a swale is usually 1.5 percent, with check dams and step downs needed for application in steeper areas.

Permeable Paving

Nearly all impermeable surfaces within the right-of-way could be constructed using permeable paving material such as permeable asphalt, permeable concrete, or porous paving blocks. In several metropolitan areas, permeable paving is commonly being applied to sidewalks and parking lanes. This can also be an effective strategy on low volume streets and 'shared space streets' and alleys. Reducing the amount of fines in the paving mixture leaves small pores in the finished surface, allowing water to pass though the driving surface to the subgrade, and then infiltrate into the native soils. This requires well-draining native soil. The disadvantages of permeable paving include difficulties with maintenance and repair, higher cost, and limited infiltration effectiveness of streets with a gradient over five percent. Permeable pavement can be used in conjunction with other Green Street features and will help reduce the required size of these facilities by lessening the amount of runoff coming off the paved surface.

Permeable Paving Example

Maintenance

Regularly scheduled maintenance is necessary in order to ensure Green Street facilities continue to function as intended. In general, they are more maintenance intensive than a traditional catch basin and pipe stormwater system. Depending on the types of vegetation chosen, irrigation might be required for the first two years after construction of the facility, particularly in the dry summer months.

Typical Annual Maintenance Requirements:

- Remove nuisance or invasive plants such as weeds, blackberry, and ivy.
- Remove trash and debris.
- Remove oil and gasoline build-up.
- Remove and replace damaged or dead plants.
- Repair erosion damage over 2 inches deep or 12 inches wide.

- Remove material from clogged inlets and outlets.
- Remove sediment accumulation greater than 3 inches.
- Check that each basin is level and flow is distributed evenly.
- Perform a conductivity test to determine if ecology mix's infiltration capacity has decreased.

It is worth noting that maintenance efforts required by LID stormwater facilities have not been tested for an extended period.

Suggested Next Steps for Ashland

Strictly speaking, Green Streets are not transportation facilities. They are stormwater management facilities, used in place of more familiar street elements for collecting stormwater. Unlike those familiar facilities, the Green Street function is to collect, infiltrate, and cleanse as much storm run-off as possible and only then convey run-off to a discharge point. Implementation of Green Streets in Ashland will require shifting attention away from a transportation system update and toward updating the stormwater management plan. Green Streets are likely to become a chapter in the plan, providing engineering design standards, treatment requirements, and clear direction to development and construction communities for whom Green Street facilities will likely be a relatively unfamiliar element of the street right-of-way. Key considerations in making that shift include:

- Research the Green Street design standards and practices of other communities, including those in the bibliography provided below.
- Understand the local hydrology in order set achievable targets for infiltration and for the amounts of stormwater to be treated by Green Streets. Performance targets set too high may result in an unreasonable size for the facilities within all other elements of the streetscape. This will be especially true when using biorention planters in the furnishings zone of the sidewalk.
- Identify a design storm event for Green Street facilities based on the design storm events already used in the stormwater management plan. Changes in the design storm treatment thresholds can be part of a stormwater management plan update that will include Green Streets stormwater facilities.
- Update the stormwater management plan to reflect Green Street design standards that are consistent with the 'design storms' and any NPDS discharge requirements applicable to other types of facilities. Design standards should be coordinated with the Handbook for Planning and Designing streets in order to fit within designated parkrow areas and should not create obstructions for pedestrian movement along sidewalks.
- Identify the agency and staff responsible for maintenance and implement a training program.
- Identify any maintenance requirements expected of private property owners fronting a Green Street.

It may also be useful to initiate a public outreach and education program regarding the application and benefits of widely using Green Streets throughout the transportation system. That program could include pilot projects to create Green Streets in order to monitor and demonstrate their effectiveness and compatibility with other street improvement objectives. Potential opportunities for pilot projects include:

- Include Green Streets as part of the Pedestrian Place overlay zoning being considered as part of the TSP update
- Select streets to be retrofitted with Green Street facilities as part of a larger street improvement projects.
- Partner with medium- to large-scale development projects, such as larger mixed use projects or development of new Southern Oregon University facilities, to test as combination of stormwater facilities and other elements working together as a 'multiple shades of green' strategy. As a learning process, these projects can become a 'living laboratory' for evaluating performance and on-going maintenance requirements.
- Establish a Green Streets program that will provide City assistance and funding to private properties for Green Streets retrofit projects with a matching or 'in-kind' contribution from the property owner(s).

Bibliography

These documents represent well-developed design standards and guidelines for further research and consideration as the City moves toward modifying their stormwater management plan and policies and their street design handbook to include adopted design standards for Green Streets.

Low Impact Development Approaches Handbook
http://www.cleanwaterservices.org/PermitCenter/NewsAndResources/LIDAHandbook.aspx

City of Portland 2008 Stormwater Management Manual
http://www.portlandonline.com/bes/index.cfm?c=47952&

San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook
http://www.flowstobay.org/ms_sustainable_guidebook.php