LID ELEMENT #11: BIORETENTION STREET SECTION

OBJECTIVE

Improve the infiltration and water quality treatment of street generated runoff.

CONSIDERATIONS

For this memo, roadside bioretention swales are being considered. The term bioretention specifically refers to an integrated stormwater management practice that uses the chemical, biological and physical properties of plants, soil microbes, and the mineral aggregate and organic matter in soils to transform, retain or remove pollutants from stormwater runoff. In addition to water quality treatment, bioretention facilities provide a level of stormwater detention and flow control.

Biofiltration swales are another type of swale used in stormwater management. Biofiltration swales have been employed for decades with varying degrees of success. Biofiltration swales are separate and a distinct best management practice (BMPs) which provide a lesser level of stormwater management than bioretention. Biofiltration swales are not under consideration for this memo, but these best management practices are referenced here for comparison.

RELATED SECTIONS

Element 12 – Stormwater Use of Landscaping

Element 20 – Maintenance standards and inspections

TRADITIONAL STREET STORMWATER MANAGEMENT TECHNIQUES

Historically, runoff generated by streets has been managed in one of two ways depending on whether the street section had curbs or not:

<u>Streets without curbs</u>

For low density development roads without curbs, surface runoff is usually directed to street side ditches or swales that provide stormwater conveyance to a larger pond type facility or receiving water. Swales along streets are often lined with only grass. These swales provide basic water quality treatment and can be maintained with routine mowing – these are called biofiltration swales or sometimes "bioswales". These common swales and ditches are very different in design and function from bioretention facilities.

<u>Streets with curbs</u>

For urban street sections with curb and gutter, runoff is typically collected in catch basins and piped to a pond, or similar stormwater management system, for water quality treatment and flow control. These types of facilities are typically referred to as 'end of pipe' stormwater management practices. Concentration of stormwater flows in this manner is contrary to the goals of low impact development design.

> "The term bioretention was created to describe an integrated stormwater management practice that uses the chemical, biological, and physical properties of plants, soi microbes, and the mineral aggregate and organic matter in soils t transform, remove or retain pollutants from stormwater runoff.
>
> Low Impact Development Technical Guidance Manual fo Puget Sound December 2012

CODES AND STANDARDS REVIEWED

Olympia Municipal Code (OMC) Sections 18.36.060 (general landscaping standards)
Engineering Design and Development Standards (EDDS) Chapters 4 & 5
Drainage Design and Erosion Control Manual for Olympia (DDECM) Volumes III & V
Ecology's Stormwater Management Manual for Western Washington, December 2014, Volumes I & V

BENEFITS OF BIORETENTION STREET SECTIONS

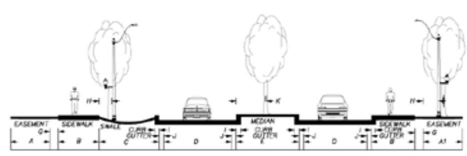
Bioretention systems are engineered facilities designed for specific water quality treatment and flow control objectives. To better replicate natural vegetated and soil infiltration conditions adjacent to urban streets, bioretention facilities can be used to collect and treat the runoff closer to where it is generated rather than concentrating and conveying these flows to another water quality or flow control facility. In some cases, a dedicated storm tract with ponds can be avoided or minimized when using bioretention. Bioretention systems are designed to more closely mimic natural site conditions where healthy soil structure and vegetation promote the infiltration, storage, filtration, and slow the release of stormwater flows. When properly planted, bioretention vegetation aids in the interception of rainfall and transpiration of water vapor to the environment. Bioretention swales and cells – cells being larger, more centrally located facilities than linear swales – include specially designed soil mixes that are the primary media for pollutant removal as water infiltrates downward to the native soil and groundwater.

Previously mentioned traditional approaches to stormwater runoff treatment – such as grass lined biofiltration swales or wetponds – only provide a basic level of runoff treatment suitable for low volume streets or sites with lower pollution potential. Per the DDECM and Ecology's current stormwater management manual, commercial sites or streets with an average daily traffic (ADT) count of more than 7500 vehicles require an enhanced level of treatment. Bioretention facilities fulfill this standard of pollutant removal.

OLYMPIA CODE ANALYSIS

Chapter 4 of the EDDS provides the guidelines for street design within the City of Olympia. City streets are classified by the physical size of the street cross section, their principal uses, and the amount of vehicle traffic using the street. Arterial streets (e.g. Capitol Way, Black Lake Boulevard, Plum Street) and Major Collector streets (e.g. Boulevard Road, Kaiser Road, North Street) have the highest traffic volumes. Smaller streets such as Neighborhood Collectors and Local Access streets serve primarily residential areas and have less vehicle traffic.

The EDDS currently provides optional street sections with swales.



The EDDS currently provide street sections that can incorporate optional swales for the Neighborhood Collector Boulevard, Neighborhood Collector, and Local Access streets. Integration of swales is not provided for other City street sections such as the larger Arterials or Major Collectors.

The current DDECM, Volume V – Runoff Treatment, provides design guidelines for simple biofiltration swales, but lacks current design standards for LID best management practices such as bioretention. City review staff routinely direct designers to the current Ecology manual design guidelines for bioretention specifications. Bioretention systems have been approved by the City on a case by case basis.

Landscaping standards are generally addressed in the OMC Section 18.36. Within this code section, street landscaping is focused on street trees. Section 18.36.060.J addresses landscaping within stormwater ponds and swales but provides no specific guidance. Volumes III & V of the DDECM provides the guidance for planting ponds and biofiltration swales. Bioretention plantings are not addressed in the current DDECM. Maintenance of streetside features including vegetation is assigned in the EDDS, Section 4C.030G – Sidewalks: "Repair, maintenance, and upkeep of the sidewalk and all streetside features, including landscaped areas and trees, is the responsibility of the abutting property owner."

HURDLES TO IMPLEMENTING BIORETENTION STREET SECTIONS

Requiring bioretention for runoff management on city streets could present the following challenges:

Inappropriate In Some Areas – Infiltrating stormwater to underlying native soils with bioretention is not always feasible or appropriate in some areas of the City. Areas with poorly draining soils, high groundwater table or steep slopes, may not be appropriate for infiltration of stormwater. Infeasibility criteria will need to be considered for bioretention facilities in a similar way to other more conventional stormwater infiltration facilities.

Unknown Long Term Durability and Life Cycle Costs – Engineered bioretention systems are a fairly new concept lacking data on long term performance, maintenance and durability. Life cycle costs (costs throughout life of facility including maintenance, repair and replacement costs) are not well understood.

Construction Challenges – Areas proposed for infiltration need to be protected from compaction and sediment-laden runoff during construction. Engineering, construction, and related inspections could be made especially complex given bioretention areas will typically span the length of the roadway project and are integrated into the project landscape rather than being an isolated facility.

Increased/Modified Maintenance Needs – Streetside swales have traditionally been landscaped with grass, where grass was the primary mechanism for pollutant removal. Mowing is the main maintenance requirement for such swales with occasional sediment removal if necessary. Bioretention systems are different in design and function than these simple grassed swales, and they are planted with a variety of vegetation necessary to meet the function of bioretention. Plant maintenance is more complex. In addition, the specialized soil mix will require reconditioning over time.

Bioretention maintenance generally includes:

- Increased inspection of facilities to monitor plant life and soil component function.
- Removal of decomposing vegetation which can release pollutants and clog storm filters or drains.
- Removal of sediments to preserve infiltration capabilities and remove potential contaminants that may be present.
- Removal of blockages from inlet pipes or overflow structures.
- Periodic (2-5 years) infiltration testing to ensure continued functionality of facility.
- Periodic reconditioning or replacement of engineered soil mix (usually at a depth of 2 or more feet).
- Replanting or replacement of vegetation within the bioretention cell.
- Removal of weeds or other undesirable vegetation.
- Irrigation of plantings during the first one to three years of establishment.

In addition, fertilizer and pesticide use is restricted or eliminated in bioretention systems. When a bioretention facility is used for water quality treatment, it is counterproductive to introduce these substances to the facility.

Given the increased complexity of maintenance in bioretention areas, careful consideration should be given to how these areas are managed. While City staff is, or could be, trained to manage bioretention areas and vegetation, it is anticipated that maintenance costs will be higher than for traditional facilities. City staff is developing site-specific maintenance costs for several existing bioretention facilities in Olympia.

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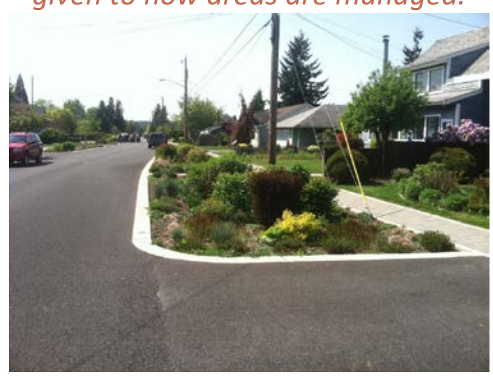

Where bioretention areas front private property, leaving maintenance of bioretention to adjacent property owners would be more cost-effective for the City, but the facilities would still require continuous monitoring and inspection by City staff to assure proper function. Extensive outreach, education, and community participation in bioretention maintenance would be essential for privately-maintained bioretention facilities to be successful.

Traditional stormwater management facilities are located within protected tracts or easements that clearly delineate the limits of the facility. If bioretention facilities are broken up along a street to many small pieces or placed behind the sidewalk where the city of right of way typically ends, the lack of clear facility limits could lead to mismanagement. If placed behind the sidewalk, property owners may treat the bioretention area as part of their property which could result in improper management, or otherwise render the facility nonfunctioning.

Visibility/Clear Zone – The bioretention areas include plants, trees and grasses that mature to various forms and heights. Careful consideration is needed when selecting vegetation to maintain pedestrian and vehicle visibility, in particular: clear zones at intersections, crosswalks, fire hydrants, street signage and driveways. Consideration is needed both during the original design and planning as well as over the life of the project as plants grow or are replaced.

Utility Conflicts – Current City road sections with optional swales locate the swale in an area between the curb and sidewalk typically referred to as the planter strip. In addition to street trees, planter strips also include street lights, utility services such as water meters, fire hydrants and other underground utilities. Standard details for utility placement in the public right-of-way will need to be modified to address location of these improvements in conjunction with streetside bioretention swales. The City will need to work with private utilities to potentially modify and monitor franchise and master use permits.

Pedestrian Challenges – On roadways with on-street parking, pedestrians leaving their vehicles need access to the sidewalk. Crossing swales, especially when filled with water, is not practical. If on-street parking adjacent to a bioretention facility is allowed, other accommodations should be considered, such as foot bridges or directing pedestrians to breaks in the swale. In addition, pedestrians with disabilities will require a safe and reasonable way to access the sidewalk from their parked vehicle or from an ADA accessible transit vehicle.

Increased Need for Driveway Planning – The road side swale area would be reduced by each driveway that crosses a swale. In dense residential developments, if driveway placement is not planned and managed, the bioretention swale could be rendered so small as to be ineffective. Many small bioretention cells along a street also become an inspection and maintenance issue. In some cases, parking along a city block may also be impacted. On a Local Access street with a 350 foot block length and 14 residential lots and associated driveways, as few as 7 parking spaces might be available along the block.

Increased Right-of-Way Needs – Recent evaluation of current City street standard details by Parametrix (May 2015) determined that roadside bioretention swales could be incorporated within standard street cross sections with little to no additional right-of-way acquisition necessary. However, for street classifications where on-street parking is required, additional right-of-way may be necessary to provide width for safe passage of passengers exiting parked vehicles adjacent to bioretention. Further, maintenance of bioretention swales in the City has historically shown that widths of ten to twelve feet with gentle side slopes are favorable to narrower sections with steeper slopes. These wider sections may require additional right-of-way be dedicated where linear bioretention swales are proposed.

Redundant Stormwater Systems – If bioretention facilities are constructed in an area with poor infiltrative soils or if systems are not intended to meet the flow control standard of the DDECM, an underdrain and overflow system will need to be installed along with a secondary stormwater facility. This would likely be a more conventional facility such as a pond, vault, or infiltration gallery.

Compliance with Ecology Flow Standards – The Ecology stormwater manual and the requirements of the City's Phase II NPDES permit specify that projects meeting certain development thresholds must mitigate stormwater by implementing LID best management practices, water quality treatment, and water quantity control measures. All three standards are not required for every project, and simple application of bioretention to street projects will not meet all these needs in every situation. Analysis of bioretention street swales performed by Parametrix (May 2015) found that street side bioretention would meet the LID performance standard and in some cases the runoff treatment needs, but fail to meet the flow control standard on some streets. This analysis shows that an additional stormwater detention system beyond bioretention would be necessary to meet the flow control requirements, or another LID BMP must be selected during design.

OPTIONS

The bioretention options considered are as follows:

- Option 1: No change to current codes or standard details.
- Option 2: Update codes to not allow bioretention within the public right-of-way. Bioretention may still be used to meet LID requirements, but it must be located in a private easement or separately owned tract.
- Option 3: Update codes and create standard details that incorporate various forms of bioretention into public streets. Allow the use of bioretention within the City right-of-way to meet LID requirements. A project may choose to use bioretention to meet water quality treatment objectives, but water quantity flow control must be achieved with a separate facility.

ANALYSIS

Bioretention is a valuable tool for successful implementation of LID. If designed and constructed properly, use of these systems meets many of the goals of LID including mimicking the pre-disturbance hydrologic processes of infiltration, filtration, and storage. Per the Ecology standards, use of low impact development BMPs on streets must be evaluated in the following order of preference:

1. Full dispersion of street runoff to native vegetation
2. Permeable pavements
3. Bioretention
4. Concentrated flow dispersion to vegetated areas

Bioretention is a valuable tool for successful implementation of LID.

While full dispersion of runoff is highest on this list, it also comes with requirements to maintain 65% of the site in native vegetation and limits effective impervious area to 10% of total site area. These requirements are challenging with Olympia's urban development densities. Permeable pavements are not recommended for use on higher volume public streets. Therefore bioretention is likely the preferred method for meeting Ecology's LID requirements. If bioretention is deemed infeasible using Ecology's site design criteria, dispersion of concentrated flows from driveways or other pavements through a vegetated area will also meet LID standards. Concentrated flow dispersion requires a minimum fifty foot flow path – making this option difficult for mitigating stormwater from streets within the right-of-way. If all BMPs above are deemed infeasible – a difficult case to make – a project may manage stormwater with traditional methods of treatment and detention.

Option 1

This option would maintain the status quo. Current codes (EDDS and DDECM) do not include sufficient guidance for proper design, implementation and maintenance of bioretention systems adjacent to roadways. The EDDS have an optional swale cross section for some road classifications but lack guidance on swale construction. The DDECM has design requirements for biofiltration swales which are used to incorporate those features into street sections. This option would not meet the LID requirements from Ecology. Use of City street sections that provide no allowance for swales would require a deviation granted by the City Engineer to use bioretention within the right-of-way.

Option 2

Not allowing bioretention within the right-of-way would require that a project either utilize a different low impact development BMP (such as full dispersion) or bioretention facilities be located outside of the right-of-way. This option would require that these facilities be placed in an easement or separate storm tract outside the right of way similar to how ponds and stormwater facilities are sited currently. Identification and delineation of bioretention facilities would be easier and maintenance would be more focused to a specific facility boundary. Maintenance would be the responsibility of the private property owner or development. Bioretention under private ownership would allow the developer to use bioretention to meet the LID requirement, as well as potentially meeting flow control and water quality requirements from Ecology.

Option 3

This option would create standard details for streets to include either bioretention swales or centralized cells – such as intersection and mid-block bulb outs. Bioretention within the right of way could be used for LID compliance and runoff treatment, but flow control and detention of runoff from larger storm events would need to be located in a separate facility such as a pond or subsurface vault. Restricting bioretention use in mitigating large storm events would help assure street and property flooding impacts are reduced or eliminated. This option would also shrink the necessary bioretention facility footprint required within the right of way, and maintenance needs associated with these facilities can also be assumed to be reduced. Because the design of bioretention to meet flow control standards is highly dependent on the infiltration rate of the underlying native soils, bioretention design and construction is a careful practice. This option reduces potential issues with variable site infiltration rates and extensive infiltration testing along a street. While Option 3 would require the design of a separate stormwater detention facility outside the right of way, this secondary facility could potentially be smaller than conventional pond designs since flows into that facility will be attenuated by the upstream bioretention systems.

Allowing bioretention within the right-of-way does present a dilemma in assignment of maintenance for the facility. Stormwater facilities, including drains and pipes, within public right-of-way are typically maintained by the City. Bioretention could be treated the way street landscaping or grass planter strips are maintained, with the responsibility to maintain becoming that of the abutting property owner. Though because of its critical stormwater function, leaving maintenance to private parties may be problematic.

RECOMMENDATION

City Staff recommends Option 3. Bioretention will be encouraged by allowing its use within the public right-of-way.