# Pierce County
# Stormwater Management and Site Development Manual

## Volume VI
## Comprehensive Low Impact Development Site Designs

Prepared by:
Pierce County Surface Water Management

Ordinance No. 2015-48s
October 28, 2015
Effective Date: December 5, 2015

# Table of Contents

# Figures

# Chapter 1 - Introduction and Requirements

The primary focus of this volume is on the strategies and practices necessary to achieve the County's Comprehensive LID Site Design requirements, as required by PCC Title 18A – Development Regulations – Zoning, and Title 18J – Development Regulations – Design Standards and Guidelines (or other requirements).

## 1.1 Volume Intent

This volume presents general guidelines and strategies for site assessment and site layout, as well as detailed requirements for LID BMPs that are integral to Comprehensive LID Site Design. The guidelines and requirements outlined in this volume are to be used primarily to achieve the County's Comprehensive LID Site Design requirements, but also apply to other types of projects. **Regardless, all projects still must also review and adhere to the minimum requirements outlined in Volume I.**

## 1.2 Applicability and Administration

### 1.2.1 Applicability

This volume is applicable to development projects required to achieve the County's Comprehensive LID Site Design approach, per PCC 18J.

Chapter 2 of this volume contains BMPs that are also applicable to projects **not** subject to the County's Comprehensive LID Site Design approach. Some of the BMPs in Chapter 2 are standard LID BMPs that may be necessary to meet the minimum requirements of this manual.

### 1.2.2 Compliance with the Provisions of this Volume

The application of the Comprehensive LID Site Design approach is intended to reduce total impervious area, eliminate effective impervious area where possible, retain or restore native soils and vegetation, and reduce the overall development footprint and impact. A successful Comprehensive LID Site Design will use a combination of the LID BMPs included in Chapter 2 of this volume, and additional flow control LID BMPs included in Volume III. This comprehensive approach will achieve the performance goal and objectives outlined in Section 1.3, and will help meet several of the key minimum requirements for all development projects outlined in Volume I.

Where a Comprehensive LID Site Design is required by PCC Title 18A and Title 18J (or other requirements), it will be at the discretion of the county review staff to determine whether the Comprehensive LID Site Design performance goals and objectives have been adequately achieved through the proposed LID site design.

In addition, the applicant is required to meet any applicable requirements set forth in Volumes I through V of this manual. To determine the applicable minimum requirements and the thresholds that trigger those requirements, see Volume I, Chapter 2.

### 1.2.3 Submittal Requirements

Comprehensive LID Site Design proposals shall comply with the submittal requirements outlined in Volume I, Chapter 3 of this manual. In addition, the following is required with an application for a short plat, preliminary plat, large lot, or land use which has proposed a Comprehensive LID Site Design:

- An LID site design inventory (as outlined in Section 1.4).
- Preliminary road and stormwater design calculations to assure that the design of stormwater treatment for the site has been adequately considered during the lot and open space layout process.
- Documentation showing that any applicable maintenance, management, or ownership submittal requirements outlined in Section 3.2.
- Where required (per the performance goals and objectives outlined in Section 1.3), documentation showing that the BMPs outlined in Chapter 2 have been considered and applied where feasible, and that every attempt was made to achieve near zero effective impervious area for the project.

## 1.3 Performance Goal and Objectives

This section outlines the performance goals and objectives that govern the review of any proposed Comprehensive LID Site Design. Note that the project proponent must also review and meet any applicable requirements set forth in Volumes I through V of this manual. **With the exception of projects implementing 65/10 dispersion, the Comprehensive LID Site Design requirements outlined in this volume are insufficient by themselves to achieve Volume I, Minimum Requirements #5, #6, and #7.** See additional notes below, and Volume I for further guidance and requirements.

The LID site design goal shall be achieved through adherence to the following:

- **Target Comprehensive LID Site Design goal for <u>residential</u> projects:**
    - Retain or restore 65 percent of the site's native soils and vegetation and set aside these areas into permanent open space areas, such as within a natural resource protection area, or designated tract for the stormwater drainage system.
    - Limit the total impervious area of the site to no more than 10 percent, and disperse all impervious areas in accordance with Section 2.3, 65/10 Dispersion.
    - Residential projects meeting the 65/10 dispersion requirements (maximum of 10 percent impervious area dispersed to 65 percent native forest protection areas) **have fully met the requirements of Volume I, Minimum Requirements #5, #6, and #7**, and are not required to

demonstrate that additional BMPs outlined in Chapter 2 have been considered.

- **Minimum Comprehensive LID Site Design goal for <u>residential</u> projects:**

  - Where the above target goal of applying 65/10 dispersion is not achieved, the applicant must retain or restore a minimum of 50 percent of the site's native soils and vegetation and limit the total impervious area of the site to no more than 25 percent. (Note that sites unable to maintain or create a 65 percent forested or native condition may still use a portion of the retained area to achieve 65/10 dispersion for a lesser portion of the developed area, as long as the ratio of the native vegetation area to the dispersed impervious area is not less than 65 to 10. See Section 2.3, 65/10 Dispersion for further details.)

  - Where the above target goal of applying 65/10 dispersion is not achieved, the applicant must also demonstrate that the BMPs outlined in Chapter 2 have been considered and applied where feasible, and that every attempt was made to minimize effective impervious area for the project.

  - In addition, where the above target goal of applying 65/10 dispersion is not achieved, the applicant must demonstrate that Volume I, Minimum Requirements #5, #6, and #7 (if applicable) have been met.

- **Minimum Comprehensive LID Site Design goal for <u>commercial</u> projects:**

  - Retain or restore a minimum of 25 percent of the site's native soils and vegetation and set aside these areas into permanent open space areas such as within a natural resource protection area, or designated tract for the stormwater drainage system.

  - Limit the total impervious area of the site to no more than 25 percent, and disperse as much impervious area as feasible in accordance with Section 2.3, 65/10 Dispersion.

  - Demonstrate that the BMPs outlined in Chapter 2 and Volume III have been considered and applied where feasible, and that every attempt was made to minimize effective impervious area for the project.

  - Unlike for residential sites, commercial projects that meet the target Comprehensive LID Site Design goal still may not fully meet Volume I, Minimum Requirements #5, #6, or #7.

## 1.4 Conduct a Site Analysis Prior to Designing an LID Project

The site analysis is a method of evaluating the topography, soils, vegetation, and water features to determine how the site currently processes stormwater. This evaluation provides information essential for developing strategies to configure lots, determine

where best to locate natural resource protection areas, and align road networks in a way that retains and restores natural hydrologic function.

### 1.4.1 Site Inventory Process

In addition to the site design techniques and requirements outlined in Volume I, the following LID site inventory is a required component of a Comprehensive LID Site Design, and shall be submitted with the application for the project.

Key physical and environmental features shall be inventoried on the proposed development site prior to the site planning process. In addition, important site characteristics on adjacent properties shall be assessed to identify how the project will impact or be influenced by the surrounding area. The functions of key environmental features shall be assessed for performance to determine potential impacts. Development areas shall be identified in the inventory, and ultimately shall be located outside of the natural resource protection areas and within designated buildable areas to minimize soil and vegetation disturbance. Development areas shall also take advantage of a site's natural ability to store and infiltrate stormwater.

The Comprehensive LID Site Design site inventory can be divided into two broad categories of activities: "desktop" assessments, and onsite reconnaissance. A desktop assessment focuses on gathering existing analyses, inventories, and historic information to support site planning and layout; while onsite reconnaissance is used to adequately characterize the hydrologic, geologic, and biologic conditions of the site to help design and locate specific site features.

A Comprehensive LID Site Design cannot be properly planned and implemented through desktop/map reconnaissance alone and will require onsite inventory and assessment. The following outlines the required elements of the "desktop" assessment only. (It will be up to the design engineer to identify additional onsite assessment requirements for Comprehensive LID Site Designs.)

- Soil surveys to provide broad characterization of regional soils (additional detailed analyses will be required for making detailed design decisions).
- Soil analyses from adjacent properties.
- Critical areas and associated buffers as set forth in PCC Title 18E.
- Tree conservation areas as set forth in PCC Title 18J. This should include the tree species, seral stage, diameter breast height, canopy cover, and condition of groundcover and shrub layer.
- Historic records documenting filling/altering of wetlands or stream channels.
- Aerial photos.

- Topographic features that may act as natural stormwater storage/conveyance (or alternatively, may hinder stormwater and LID approaches).

- Location of groundwater protection areas and/or 1-, 5-, and 10-year time-of-travel zones for municipal well protection areas.

- A description of local site geology, including soil or rock units likely to be encountered, the groundwater regime, and geologic history of the site.

- Identification of natural resource protection areas (e.g., riparian areas, wetlands, steep slopes, and other critical areas; significant wildlife habitat areas and their associated buffers; tree conservation areas; and permeable soils offering the best available infiltration potential).

- Areas suitable and/or proposed for development.

# Chapter 2 - Low Impact Development Strategies and BMPs

## 2.1 Introduction

In contrast to conventional BMPs that typically collect and convey runoff to one location on the site, LID BMPs manage stormwater in small-scale, dispersed facilities located as close to the source of the runoff as possible. Most of the strategies and BMPs outlined in this chapter are general approaches applicable to overall site design and construction. Additional design guidelines for several more common engineered LID BMPs are provided in Volume III, Chapter 3. In addition, Volume II, Chapter 3 provides information on requirements for protecting LID BMPs during construction (in accordance with Volume I, Minimum Requirement #2).

BMPs discussed in this chapter include:

- 65/10 Dispersion
- Better Site Design
- Preserving Native Vegetation
- Restoring Site Vegetation
- Minimize Impervious Areas
- Soil Preservation and Amendment.

## 2.2 Maintenance Criteria

Adequate operation and maintenance (O&M) must be provided for in the design, installation, and operation of all LID BMPs. See Minimum Requirement #9 in Volume I, as well Volume I, Appendix I-A for additional information on maintenance requirements. In addition, maintenance considerations and requirements specific to LID site designs are outlined in Chapter 3.

## 2.3 65/10 Dispersion (Ecology BMP T5.30)

This BMP allows projects to disperse runoff from impervious surfaces and cleared areas of development sites that protect at least 65 percent of the site (or a threshold discharge area on the site) in a forest or native condition. Comprehensive LID Site Design projects that meet the requirements outlined below have fully met the requirements of Volume I, Minimum Requirements #5, #6, and #7, and are not required to demonstrate that additional LID BMPs outlined in Chapter 2 have been considered.

### 2.3.1 Applicability

- Projects that retain 65 percent of the site (or a threshold discharge area on the site) in a forested or native condition may use dispersion to avoid triggering the flow control facility requirement (see Volume I, Minimum Requirements #5 and #7). Areas that are fully dispersed (in accordance with the requirements outlined herein) do not need to perform continuous runoff modeling to demonstrate compliance.

- Preservation of existing vegetation areas must meet the requirements outlined under Section 2.5, Preserving Native Vegetation.

- The preserved area may be a previously cleared area that has been replanted in accordance with Section 2.6, Restoring Site Vegetation.

- The preserved area shall be placed in a separate tract or protected through recorded easements for individual lots.

- All trees within the preserved area at the time of permit application shall be retained, aside from the removal of dangerous or diseased trees.

- The preserved area may be used for passive recreation and related facilities, including pedestrian and bicycle trails, nature viewing areas, fishing and camping areas, and other similar activities that do not require permanent structures, provided that cleared areas and areas of compacted soil associated with these areas and facilities do not exceed 8 percent of the preserved area.

- The preserved area may contain utilities and utility easements, but not septic systems. Utilities are defined as potable and wastewater underground piping, underground wiring, and power and telephone poles.

### 2.3.2 Design Criteria for Residential, Commercial, and Industrial Projects

Developments that preserve 65 percent of a site (or a threshold discharge area of a site) in a forested or native condition can disperse runoff from the developed portion of the site into the native vegetation area as long as the developed areas draining to the native vegetation do not have impervious areas that exceed 10 percent of the entire site.

Where a development has less than 65 percent of a site available to maintain or create into a forested or native condition, that area may still be used for 65/10 dispersion of a portion of the developed area. The ratio of the native vegetation area to the impervious area, which is dispersed into the native vegetation, must not be less than 65 to 10. The lawn and landscaping areas associated with the impervious areas may also be dispersed into the native vegetation area. (The lawn and landscaped area must comply with Volume III, Section 3.1 Soil Preservation and Amendment). All design requirements listed also must be met.

Additional impervious areas above the 10 percent are allowed, but should not drain to the native vegetation area, and are subject to the thresholds, treatment, and flow control requirements of this stormwater manual. The portion of the developed area that is not managed through 65/10 dispersion can be considered a separate project site. In this case, it must be evaluated against the thresholds in Figures 2.1 and 2.2 of Volume I, whichever is appropriate, to determine the applicable minimum requirements.

Within the context of this dispersion option, the impervious surfaces that are over and above the 10 percent maximum can be routed into an appropriately sized drywell or into an infiltration basin that meets the flow control standard and does not overflow into the forested or native vegetation area.

Dispersion devices are not allowed in critical area buffers or on slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.

The flowpath from contributing impervious areas to the dispersion area must meet all of the following criteria:

- A native vegetation flowpath of at least 100 feet in length (25 feet for sheet flow from a non-native pervious surface) must be available along the flowpath that runoff would follow (upon discharge from an appropriate dispersion device).

- The flowpath must be onsite or in an offsite tract or easement area reserved for such dispersion.

- The slope of the flowpath must be no steeper than 15 percent for any 20-foot reach of the flowpath. Slopes up to 33 percent are allowed where level spreaders are located upstream of the dispersion area and at sites where vegetation can be established.

- The flowpath is not permitted within an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80) unless the slope stability impacts of such systems have been analyzed and mitigated by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible.

- The flowpaths for adjacent dispersion devices must be sufficiently spaced to prevent overlap of flows in the flowpath areas.

- For sites with onsite sewage disposal systems, the discharge of runoff from dispersion devices must be at least 30 feet upgradient, or 10 feet downgradient of the primary and reserve drainfield areas (per WAC 246-272A-0210). This requirement may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the

drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.

- The dispersion of runoff must not create flooding or erosion impacts.
- Runoff from contributing impervious areas must be dispersed into the native vegetation area using the dispersion devices specified below.

### *Roof Downspouts*

Roof surfaces are considered to be "fully dispersed" (i.e., zero percent effective impervious) if they discharge to an area that consists of forested (or native vegetative cover) and is more than 65 percent of the development site area, AND if they comply with the requirements of Volume III, Section 3.9.4 Downspout Dispersion, but with vegetated flowpaths of 100 feet or more through the native vegetation preserved area. Roof surfaces that comply with Volume III, Section 3.9.3 Downspout Infiltration are considered to be "fully infiltrated" (i.e., zero percent effective impervious) and do not count against the maximum 10 percent impervious area allowed for 65/10 dispersion.

### *Driveway Dispersion*

Driveway surfaces are considered to be "fully dispersed" if they are within a threshold discharge area that is or will be more than 65 percent forested (or native vegetative cover) and less than 10 percent impervious (total), AND if they either: 1) comply with the concentrated flow dispersion BMP (see Volume III, Section 3.2.4) and have flowpaths of 100 feet or more through native vegetation; or, 2) disperse driveway runoff along with the road runoff in accordance with the roadway dispersion BMP section below.

### *Roadway Dispersion BMPs*

Roadway surfaces included as part of residential, commercial, or industrial projects are considered to be "fully dispersed" if they are within a threshold discharge area that is or will be more than 65 percent forested (or native vegetative cover) and less than 10 percent impervious (total), AND if they comply with the following dispersion requirements:

1. The road section shall be designed to minimize collection and concentration of roadway runoff. Sheet flow over roadway fill slopes should be used wherever possible to avoid concentration.

2. When it is necessary to collect and concentrate runoff from the roadway and adjacent upstream areas (e.g., in a ditch on a cut slope), concentrated flows shall be incrementally discharged from the ditch via cross culverts or at the ends of cut sections. These incremental discharges of newly concentrated flows shall not exceed 0.5 cfs from any single discharge location from a ditch for the 100-year runoff event. Where flows at a particular ditch discharge location were already concentrated under existing site conditions (e.g., in a

natural channel that crosses the roadway alignment), the 0.5 cfs limit would be in addition to the existing concentrated peak flows.

3. Ditch discharge locations with up to 0.2 cfs discharge for the peak 100-year flow shall use rock pads or dispersion trenches to disperse flows. Ditch discharges with between 0.2 and 0.5 cfs discharge for the 100-year peak flow shall use only dispersion trenches to disperse flows.

4. Dispersion trenches shall be designed to accept surface flows (free discharge) from a pipe, culvert, or ditch end, shall be aligned perpendicular to the flowpath, and shall be minimum 2 feet by 2 feet in section, 50 feet in length, filled with 0.75-inch to 1.5-inch washed rock, and provided with a level notched grade board. Manifolds may be used to split flows up to 2 cfs discharge for the 100-year peak flow between up to four trenches. Dispersion trenches shall have a minimum spacing of 50 feet between centerlines.

5. Flowpaths from adjacent discharge points must not intersect within the 100-foot flowpath lengths, and dispersed flow from a discharge point must not be intercepted by another discharge point. To enhance the flow control and water quality effects of dispersion, the flowpath shall not exceed 15 percent slope unless a level spreader is used (see criteria above), and shall be located within a designated open space.

6. Where the county determines there is a potential for significant adverse impacts downstream (e.g., erosive steep slopes or existing downstream drainage problems), dispersion of roadway runoff may not be allowed, or other measures may be required.

### *Cleared Area Dispersion BMPs*

The runoff from cleared areas that are comprised of bare soil, non-native landscaping, lawn, and/or pasture of up to 25 feet in flowpath length can be considered to be "fully dispersed" if it is dispersed through at least 25 feet of native vegetation in accordance with the following criteria:

1. The topography of the non-native pervious surface must be such that runoff will not concentrate prior to discharge to the dispersal area.

2. Slopes within the dispersal area should be no steeper than 15 percent.

If the flowpath length across the contributing non-native pervious surface is greater than 25 feet, the downstream native vegetation dispersion area flowpath must be extended 1 foot for every 3 feet of contributing flowpath beyond 25 feet (up to a maximum contributing flowpath of 250 feet).

### 2.3.3 Design Criteria for Roadway Projects

These dispersion criteria apply to the construction of public and private roads, typically on roads outside of the urban growth areas where roadside areas are not planned for urban density development.

1. Uncollected or natural dispersion into adjacent vegetated areas (i.e., sheet flow into the dispersion area):

   65/10 dispersion credit (i.e., no other treatment or flow control required) is given to projects that meet the following criteria:

   a. *Outwash soils* that have an initial saturated hydraulic conductivity rate of 4 inches per hour or greater. The saturated hydraulic conductivity must be based on a Pilot Infiltration Test or other methods outlined in Volume III, Appendix III-A (as applicable).

      - Up to 20 feet of contributing impervious width (i.e., perpendicular to the direction of roadway travel) requires 10 feet of dispersion area flowpath.

      - Each additional foot of contributing impervious width requires an additional 0.25 feet of dispersion area flowpath.

   b. *Other soils*: (Types C and D and some Type B not meeting the criterion in 1.a above)

      - 6.5 feet of flowpath for every 1 foot of contributing impervious width draining to it. A minimum distance of 100 feet is necessary.

   c. *Criteria applicable to all soil types*:

      - Depth to the average annual maximum groundwater elevation must be at least 3 feet.

      - The contributing impervious surface flowpath must be less than 75 feet. The contributing pervious flowpath must be less than 150 feet. Pervious flowpaths may include up-gradient road side slopes that run onto the road and down-gradient road side slopes that precede the dispersion area.

      - The lateral slope of contributing impervious drainage area must be less than 8 percent. Road side slopes must be less than 25 percent. Road side slopes do not count as part of the dispersion area unless native vegetation is re-established and slopes are less than 15 percent. Road shoulders that are paved or graveled count as impervious surface.

      - The longitudinal slope of road must be less than 5 percent.

- The length of the dispersion area must be equivalent to length of road.
- The average longitudinal (parallel to road) slope of the dispersion area must be less than 15 percent.
- The average lateral slope of the dispersion area must be less than 15 percent.

2. Channelized (collected and re-dispersed) stormwater into areas with (a) native vegetation or (b) cleared land in areas outside of urban growth areas that do not have a natural or manmade drainage system:

   65/10 dispersion credit (i.e., no other treatment or flow control required) is given to projects that meet the following criteria:

   a. *Outwash soils* that have an initial saturated hydraulic conductivity rate of 4 inches per hour or greater. The saturated hydraulic conductivity must be based on a Pilot Infiltration Test or other methods outlined in Volume III, Appendix III-A.
      - The dispersion area flowpath must be at least half the width of the contributing impervious drainage area.

   b. *Other soils*: (Types C and D and some Type B not meeting the criterion in 2.a above)
      - The dispersion area must have 6.5 feet of width for every 1 foot width of impervious area draining to it. A minimum distance of 100 feet is necessary.

   c. *Other criteria applicable to all soil types*:
      - Depth to the average annual maximum groundwater elevation must be at least 3 feet.
      - Channelized flow must be re-dispersed to produce the longest possible flowpath.
      - Flows must be evenly dispersed across the dispersion area.
      - Flows must be dispersed using rock pads and dispersion techniques as specified under Section 2.3.2, Roadway Dispersion BMPs.
      - Approved energy dissipation techniques may be used.
      - This option is limited to onsite (associated with the road) flows.
      - The length of dispersion area must be equivalent to length of the road.

- The average longitudinal and lateral slopes of the dispersion area must be less than 8 percent.

- The slope of any flowpath segment must be no steeper than 15 percent for any 20-foot reach of the flowpath segment.

3. Engineered dispersion of stormwater runoff into an area with engineered soils:

65/10 dispersion credit (i.e., no other treatment or flow control required) is given to projects that meet the following criteria:

a. *Outwash soils* that have an initial saturated hydraulic conductivity rate of 4 inches per hour or greater must be compost amended in accordance with guidelines in Volume III, Section 3.1 Soil Preservation and Amendment.

   - Up to 20 feet of impervious width needs 10 feet of dispersion area flowpath.

   - Each additional foot of impervious width needs 0.25 feet of dispersion area flowpath.

b. *Other soils*: (Types C and D and some Type B not meeting the criterion in 3.a above) must be compost-amended following the guidelines for the soil preservation and amendment BMP in Volume III, Section 3.1.

   - The dispersion area must meet the 65 to 10 ratio.

c. *Other criteria applicable to all soil types*:

   - Stormwater can be dispersed via sheet flow or via collection and re-dispersion in accordance with the techniques specified under Section 2.3.2, Roadway Dispersion BMPs.

   - Depth to the average annual maximum groundwater elevation shall be at least 3 feet.

   - Average longitudinal (parallel to road) slope of dispersion area must be less than 15 percent.

   - Average lateral slope of dispersion area must be less than 15 percent.

   - The dispersion area should be planted with native trees and shrubs.

### 2.3.4 Calculation of the Total Native Vegetation Retention Achieved

Calculation of native vegetation retention achieved shall exclude water bodies (such as large ponds or lakes 10 acres or greater) and include areas part of a common conservation easement (such as parks, stormwater, open space, wetland buffers, or critical area tracts) or areas incorporated into the individual lot design where conservation

easements are placed on that portion of the lot. However, proposed residential subdivisions and PDDs shall locate a minimum of 75 percent of the required native vegetation within areas of land separate from residential lots, such as those listed above. When lots or building sites are located contiguous to protective tracts the preferred location of the native vegetation areas is the area adjacent to these tracts.

## 2.4 Better Site Design (Ecology BMP T5.41)

Fundamental hydrological and stormwater management concepts must be applied at the site design phase to help projects better integrate with natural topography.

### 2.4.1 Design Criteria

Knowing how the site processed stormwater historically is important in determining appropriate Better Site Design strategies. The site analysis (see Section 1.4) will provide information on how the site and the surrounding areas process stormwater both currently and historically (before any land use changes had altered those processes). This information will aid the designer in determining preferred site layout options, and in deciding what appropriate site design BMPs will help either maintain or restore natural pre-developed stormwater processes.

Initial delineation, site management, and site design strategies to be considered and implemented as feasible include:

- Based on the site inventory, delineate the best areas to direct development. Building sites, road layout, and other site infrastructure shall be configured within these development areas to minimize soil and vegetation disturbance and take advantage of a site's natural stormwater processing capabilities.

- Minimize clearing and grading by incorporating natural topographic depressions into the development, and in particular limiting the amount of cut and fill on those portions of the site with permeable soils.

- Establish limits of disturbance to the minimum area required for roads, utilities, building pads, landscape areas, and the smallest additional area needed to maneuver construction equipment.

- Delineate natural resource protection areas with appropriate fencing and signage to provide protection from construction activities.

- Eliminate stream crossings with roads and conveyance systems whenever possible.

- Maintain predevelopment flowpath lengths in natural drainage patterns whenever possible.

- Preserve the existing upper soil horizon to the maximum extent feasible. Where excavation is necessary, excavated topsoil shall be utilized elsewhere on the site to amend areas with sparse or nutrient deficient topsoil.

- Any portion of the site with permeable soils shall be closely considered for preservation to promote infiltration of stormwater runoff.

- Maximize permeability by minimizing impervious areas, paving with permeable pavements (e.g., porous asphalt pavement, pervious concrete pavement, and pavers for roads, driveways, alleys, parking lots, or other types of drivable or walkable coverage), clustering buildings, and reducing the land coverage of buildings by smaller footprints. Applicable strategies shall be reflected at all levels of a project, from site planning to materials selection.

- Manage stormwater as close to the origin as possible.

- Maximize the use of small, dispersed stormwater management facilities to capture, store, and infiltrate stormwater onsite.

- Minimize directly connected impervious areas – i.e., any impervious surface that drains directly into a catch basin or other conveyance structure.

- Where concentrated flow conveyance systems must be used (in lieu of the preferred sheet flow and infiltration approaches), vegetated open channels must be used where feasible instead of piped conveyance systems. Vegetated open channels are most applicable adjacent to roadways where the linear nature of the road can make it difficult to provide enough area within the right-of-way for infiltration or dispersion options.

- Layout roads, lots, and other proposed site features to follow topographic contours to minimize soil and vegetation disturbance and loss of topsoil or organic duff layer.

- Meet and walk the property with the owner, engineers, landscape architects, and others directing project design to identify problems and concerns that should be evaluated when implementing the site plan.

- Meet and walk the property with equipment operators prior to clearing and grading to clarify construction boundaries and limits of disturbance. Pay particular attention to subgrade preparation for permeable pavement and bioretention installations and techniques to avoid subgrade compaction.

- Encourage erosion and sediment control training for operators.

- See Volume II, Section 3.3 for additional requirements specific to protection of LID BMPs during construction (in accordance with Volume I, Minimum Requirement #2, Element #13).

Finally, designers should also refer to the Low Impact Development Technical Guidance Manual for Puget Sound (WSU 2012), specifically Chapter 3, for additional guidelines and graphics for better site designs and layouts.

### 2.4.2 Lot Layout

In addition to the general delineation, site management, and site design strategies outlined above, lot layout can play a particularly important role in Comprehensive LID Site Designs. Comprehensive LID projects shall employ planning strategies to minimize site disturbance, maximize protection of native soil and vegetation, and permanently set aside the open tracts for multiple objectives including stormwater management. The following general objectives should guide the placement and orientation of lots for LID projects:

- Cluster homes to reduce overall development envelope and road length.
- Orient lots to use shared driveways to access houses along common lot lines.
- Reduce front yard setbacks to reduce driveway length.
- Strategically locate lots for dispersing stormwater to open space areas.
- Orient lots and buildings to maximize opportunities for on-lot infiltration or open conveyance through vegetated systems.

## 2.5 Preserving Native Vegetation (Ecology BMP T5.40)

Preserving native vegetation onsite to the maximum extent feasible will minimize the impacts of development on stormwater runoff. Per Section 1.3, it is preferable that 65 percent or more of the project site be protected for the purposes of retaining or enhancing existing forest cover and preserving wetlands and stream corridors. Where that cannot be achieved, the minimum vegetation retention requirements outlined in Section 1.3 must be met. The following sections present the strategies and practices for meeting the native vegetation preservation requirements. Additional details on flow dispersion to native vegetation areas are presented under Section 2.3, 65/10 Dispersion.

### 2.5.1 Applicability

New development often takes place on tracts of forested land. Unless sufficient care is taken and planning done, in the interval between buying the property and completing construction much of this resource is likely to be destroyed.

With vegetation retention, the primary goal is to retain large, connected tracts of native vegetation areas, either through a cluster design or on individual lots, to maintain the natural hydrologic function and provide infiltration areas for overland flows generated in developed portions of the site. Forest and native growth areas allow rainwater to naturally percolate into the soil, recharging groundwater for summer stream flows and reducing surface water runoff that creates erosion and flooding. Conifers can retain up to about 50 percent of all rain that falls during a typical storm. Of this rainfall, 20 to 30 percent may never reach the ground but evaporates or is taken up by the tree.

On lots that are one acre or greater, preservation of 65 percent or more of the site in native vegetation will allow the use of flow dispersion techniques presented in Section 2.3, 65/10 Dispersion. Sites that can fully meet the requirements of 65/10 dispersion are not required to provide runoff treatment or flow control facilities (as required by Volume I, Minimum Requirements #5, #6, and #7).

### 2.5.2 Design Criteria

- The preserved area shall be situated to minimize the clearing of existing forest cover, to maximize the preservation of wetlands, and to buffer stream corridors.

- Where feasible, trees and other native vegetation shall be retained in groups of sufficient size to maintain adequate growing conditions to support natural successional patterns and develop diverse multilayer canopy structure, snags, large woody debris, understory vegetation, and forest duff. Growing conditions include slope, aspect, soil structure and moisture, sun exposure, humidity, wind, co-dependence on or competition among adjacent plants as well as other microclimatic factors.

- The preserved area shall be shown on all property maps and shall be clearly marked during clearing and construction on the site.

- Maximize the amount of preserved area that can be located downslope from the building sites, to optimize the use of 65/10 dispersion.

- For trees that are adjacent to existing or proposed structures or other impervious surfaces, it is important to also review Volume III, Section 3.3 Tree Retention and Tree Planting to identify possible flow control credits that may be achieved through targeted tree retention.

### 2.5.3 Vegetation Protection Post-construction

The following steps must be taken to protect vegetation after construction:

- Mechanisms shall be put in place to assure long-term protection of vegetation retention areas. Mechanisms to protect conservation areas include setting aside conservation areas into separate tracts, permanent easements, homeowner covenants, maintenance agreements, and education (see Chapter 3 for additional detail).

- Maintenance plans and agreements must be in compliance with Volume I, Chapter 3, and must address issues including but not limited to:

    - Pest and disease management practices

    - Pruning requirements

  - Irrigation requirements
  - Fertilization requirements
  - Fire fuel management practices.

- Permanent signs shall be installed indicating that removal of trees or vegetation is prohibited within the native vegetation retention areas (with the exception of the removal of dangerous and diseased trees).
- Permanent fencing is required around the limits of the vegetation retention areas. The type, size, and location of the fencing shall be approved by county review staff and should be made of materials that blend in with the natural surroundings (e.g., wood split-rail, pinned if necessary) and located in such a manner as to not impede the movement of wildlife within the vegetation retention areas.

### 2.5.4 Additional Requirements

In addition to the general requirements outlined above, criteria specified in Volume III, Section 3.3 Tree Retention and Tree Planting are pertinent to vegetation retention. In particular, developers should be aware of the specific measures to protect trees during construction.

## 2.6 Restoring Site Vegetation

### 2.6.1 Application

Restoration of site vegetation shall be applied in the following situations:

1. Where project areas have been disturbed and are scheduled to be replanted with native trees and vegetation, in order to maximize the hydrologic benefits of a native site (in accordance with the Comprehensive LID Site Design performance goals outlined in Section 1.3).
2. Where a project wishes to convert a previously developed surface to a native vegetation landscape, either for purposes of meeting the requirements of 65/10 dispersion or code requirements for vegetation restoration.

*See also Section 2.3 65/10 Dispersion for requirements related to using vegetated areas for dispersion credits, as well as Volume III, Section 3.3, Tree Retention and Tree Planting for requirements specific to trees (as well as tree flow control credits).*

Vegetation restoration/planting methods shall conform to published standards as appropriate to the type of natural resource protection area.

### 2.6.2 Design Criteria

In situations where it is not feasible to retain existing trees and vegetation of sufficient size and quantity to achieve the target amount of tree cover, additional tree cover shall be provided where feasible through supplemental tree and vegetation plantings. In addition, on those sites where vegetation cover does not exist due to previous removal, vegetation cover shall be reestablished to the maximum extent feasible. The following standards shall be utilized:

### 2.6.3 Planning and Design

- The applicant shall comply with the provisions for tree replacement as set forth in PCC Title 18J.

- Trees selected for replacement purposes must be free from injury, pests, diseases, and nutritional disorders. Trees must be fully branched and have a healthy root system.

- Coniferous and broad leaf evergreen trees shall be no less than 4 feet in height at time of planting. Deciduous trees shall be a minimum of 8 feet in height or have a minimum caliper size of 1.5 inch at time of planting.

- PCC Title 18J contains recommended tree species to be used. The area of native vegetated landscape must be planted with native species trees, shrubs, and ground cover. Species must be selected based on the underlying soils, shade, and moisture conditions; as well as the historic, native indigenous plant community type for the site. Vegetation shall be selected in accordance with the following requirements:

    - **Trees:** a minimum of two species of trees must be planted, one of which is a conifer. Conifer and other tree species must cover the entire landscape area at a spacing recommended by a professional landscaper or in accordance with county requirements. No individual species of replacement tree should exceed 50 percent of the total nor should any individual species be less than 10 percent of the total.

    - **Shrubs:** a minimum of two species of shrubs should be planted. Space plants to cover the entire landscape area, excluding points where trees are planted.

    - **Groundcover:** a minimum of two species of ground cover should be planted. Space plants so as to cover the entire landscape area, excluding points where trees or shrubs are planted.

*Note: for landscape areas larger than 10,000 square feet, planting a greater variety of species than the minimum suggested above is strongly encouraged. For example, an acre could easily accommodate three tree species, three species of shrubs, and two or three species of groundcover.*

### 2.6.4 Construction and Operation

Conversion of a developed surface to native vegetation landscape requires the removal of impervious surface; de-compaction of soils; and/or the planting of native trees, shrubs, and ground cover in compost-amended soil according to all of the following specifications:

1. Existing impervious surface and any underlying base course (e.g., crushed rock, gravel, etc.) must be completely removed from the conversion area(s).

2. Underlying soils must be broken up to a depth of 18 inches. This can be accomplished by excavation or ripping with either a backhoe equipped with a bucket with teeth, or a ripper towed behind a tractor.

3. At least 4 inches of well-decomposed compost must be tilled into the broken up soil as deeply as possible. The finished surface should be gently undulating and must be only lightly compacted.

4. At least 4 inches of hog fuel or other suitable mulch must be placed between plants as mulch for weed control. It is also possible to mulch the entire area before planting; however, an 18-inch-diameter circle must be cleared for each plant when it is planted in the underlying amended soil. *Note: plants and their root systems that come in contact with hog fuel or raw bark have a poor chance of survival.*

Conversion of an area that was under cultivation to native vegetation landscape requires a different treatment. Elimination of cultivated plants, grasses, and weeds is required before planting and will be required on an on-going basis until native plants are well-established. In addition:

1. The soil shall be tilled to a depth of 18 inches. A minimum of 8 inches of soil having an organic content of 6 to 12 percent is required, or a four inch layer of compost may be placed on the surface before planting, or 4 inches of clean wood chips may be tilled into the soil, as recommended by a landscape architect or forester.

2. After soil preparation is complete, continue with steps 3 through 4 above. Placing 4 inches of compost on the surface may be substituted for the hog fuel or mulch. For large areas where frequent watering is not practical, bare-root stock may be substituted at a variable spacing from 10 to 12 feet on center (with an average of 360 trees per acre) to allow for natural groupings and 4 to 6 feet on center for shrubs. Allowable bare-root stock types are 1-1, 2-1, P-1, and P-2. Live stakes at 4 feet on center may be substituted for willow and red-osier dogwood in wet areas.

Maintenance shall include intensive site preparation, including weed control and soil amendment. Ongoing maintenance shall include weeding and watering for a minimum of 3 years from installation so as to achieve a minimum 90 percent survival of all planted

vegetation. If during the 3-year period survival of planted vegetation falls below 90 percent, additional vegetation shall be installed as necessary to achieve the required survival percentage. Additionally, the likely cause of the high rate of plant mortality shall be determined and corrective actions shall be taken as needed to ensure plant survival. If it is determined that the original plant choices are not well suited to site conditions, these plants shall be replaced with plant species that are better suited to the site.

Clearly written management plans and protection mechanisms are necessary for maintaining the benefits of vegetation restoration areas for the long term. Some of the mechanisms for protection include dedicated tracts, transfer to local land trusts (large areas), and homeowner association covenants. Property owner education should be incorporated in all of these strategies.

## 2.7 Minimize Impervious Areas

The following sections contain strategies for reducing the impacts of impervious surfaces associated with transportation and mobility related networks.

### 2.7.1 Road Design

The objective for a Comprehensive LID roadway system design is to reduce the amount of impervious area associated with the road network. This may be achieved by utilizing permeable pavement, examining alternative street layouts, and determining the best option for increasing the number of homes per unit length of road, as well as aligning roads to maximize opportunities for discharging to adjacent dispersion or bioretention areas. Strategies to be applied (where feasible) for reducing the amount and impact of impervious area associated with the road network include:

- Design the road layout to follow the existing topographic contours to minimize cuts and fills.
- Design the road layout to avoid crossing natural resource protection areas, thereby minimizing the disruption of sheet flow within these areas.
- Natural resource protection areas or bioretention areas shall be located down-gradient of roads, alleys, and other impervious surfaces when feasible.
- Minimize effective impervious area and concentrated surface flows on impervious surfaces by eliminating hardened conveyance structures (e.g., pipes, curbs and gutters).
- Infiltrate or slowly convey storm flows in roadside bioretention cells and swales, and through permeable paving and aggregate storage systems under the pavement. (Note that if using infiltration and/or conveyance under roads and parking areas in a retrofit setting the design must consider the integrity and protection of adjacent infrastructure.)
- Roads should be designed to service clusters of development located within the buildable portions of the site (i.e., cluster housing), thereby reducing the overall length of the roadway network.

- In higher density residential neighborhoods with narrow roads and where no on-street parking is allowed, pullout parking can be used. Pullouts (often designed in clusters of 2 to 4 stalls) should be strategically distributed throughout the area to minimize walking distances to residences. Depending on the street design, the parking areas may be more easily isolated and the impervious surface rendered ineffective by sloping the pavement to adjacent bioretention swales or bioretention cells.

### *Road Layout*

One type of road layout cannot be used in all situations, so it is usually necessary for a designer to explore different strategies and decide which ones will work best for the existing site. At a minimum, the following types of layouts must be considered:

- **Grid layouts:** Grid patterns provide multiple access routes to each parcel and may include alleyways between blocks with garages located at the back of the house. However, it should be noted that the use of alleys may increase the total road network and associated impervious surface, unless permeable pavements are utilized.

- **Cul-de-sacs:** In those instances where cul-de-sacs are used, techniques must be used to reduce or disconnect the impervious area. This can be accomplished by increasing the diameter of the cul-de-sac, but including a bioretention area in the center where stormwater can be directed.

- **Hybrid road layouts:** Hybrid layouts integrate the grid layout and cul-de-sac approach to minimize impervious coverage per dwelling unit and improve fire and safety access. The loop road design in Figure 2.1 provides an example of the hybrid layout and includes bioretention installed in the interior of the loop for stormwater management that also offers a visual buffer for homes.

### *Road Cross Sections*

The objective of modifying road cross sections is to reduce the roadway width to the minimum amount of impervious surface necessary, while still accommodating emergency vehicle access, and utilizing permeable pavements where feasible. Note: Existing applicable road standards still apply except as modified below:

- For projects that trigger Minimum Requirements #1 through #5 or #1 through #10 (see Volume I, Chapter 2), permeable pavement is one option that must be evaluated for onsite stormwater management for roads with very low traffic volumes and very low truck traffic (see Volume III, Section 3.3.5 for additional details). If permeable pavement surfaces are used adjacent to conventional impervious road sections for sidewalks or pullout parking, use design techniques described in Volume III, Section 3.5 to prevent saturation of the impervious road section and migration of aggregate base material from the impervious to the permeable section.

- An example LID road section is provided in Attachments Section A, Detail 27.0.

**Figure 2.1. Hybrid Road Layout.**

- Cement/concrete pavement strips (1-foot-wide strips of concrete that act as a transition between the traveled lane and non-rigid permeable pavement surfaces adjacent to the traveled way) may be utilized to delineate the traveled lane areas. These delineator strips shall be at least 6 inches thick with expansion joints every 10 feet.

- Curbs and gutters are highly discouraged for use as stormwater collection systems in conjunction with catch basins and pipes. Where there is a legitimate need for constructing a curb and gutter system, Section 2.7.4 provides guidance for designing curb and gutter alternatives. The following general requirements apply to curb and gutter applications for Comprehensive LID Site Designs:

    - Curbs are allowed when the sidewalk is adjacent and connected to the traveled way provided they are used only on one side of the road and the road cross slope is away from the curb or if curb cuts are utilized,

as shown in Figure 2.2, and drain to a vegetated open channel or bioretention area behind the curb.

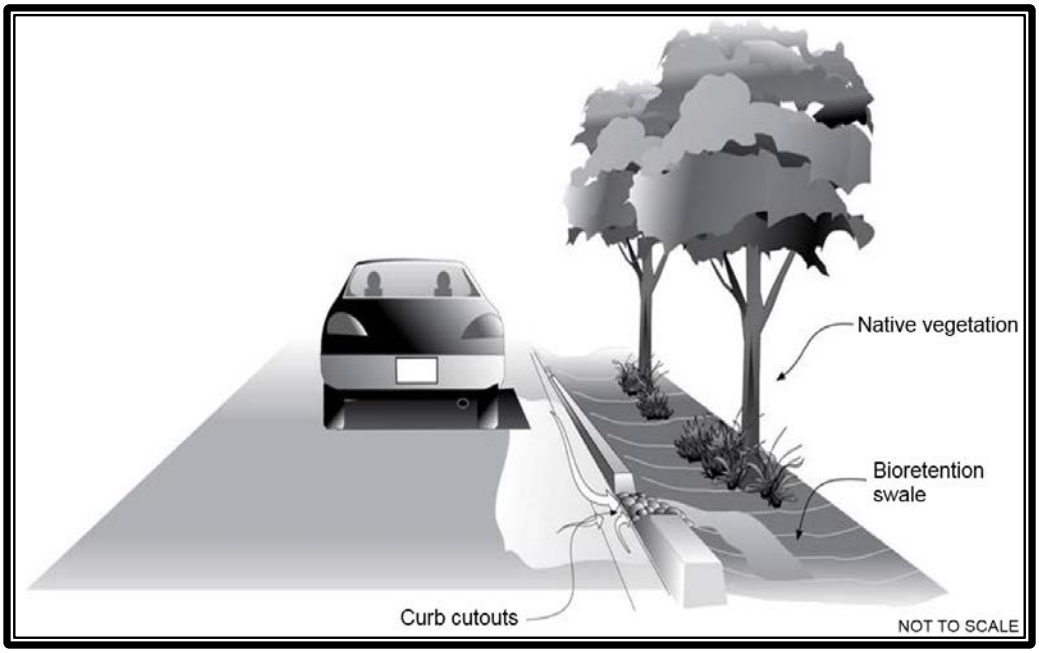


**Figure 2.2. Curb and Gutter Cutouts.**

- Sidewalks and trails must be disconnected from the traveled way portion of the road, to the maximum extent feasible. Although sidewalks are not required on both sides of the roadway, every lot shall have pedestrian access to an abutting trail or to a sidewalk located on at least one side of the road. Sidewalks may be separated from the roadway by placement of a vegetated open channel or bioretention area between the sidewalk and the roadway.

- Sidewalks and trails shall be constructed of permeable pavement, provided that the runoff through the material will not be directed towards the subgrade of the traveled lane portion of a roadway (unless the subgrade is designed to handle these flows). Permeable pavement with subsurface engineered soil systems can be particularly beneficial in areas surrounding newly planted trees, as they provide soil volume and sustained root development in a manner compatible with pavement and other subsurface infrastructure. Permeable pavement for sidewalks and trails which abut lots, in lieu of a roadside sidewalk, shall be Americans with Disabilities Act (ADA) compliant. An example sidewalk design is provided in Attachments Section A, Detail 27.0.

- Alleys shall be constructed with permeable pavement, provided that the runoff through the material will not be directed towards the subgrade of the traveled lane portion of a roadway (unless the subgrade is designed to handle these flows).

- The use of additional pullout parking spaces is required to compensate for narrower road widths which restrict roadside parking. An example design is provided in Figure 2.3.

- Bioretention should be incorporated into traffic calming designs associated with retrofit or new streetscapes.

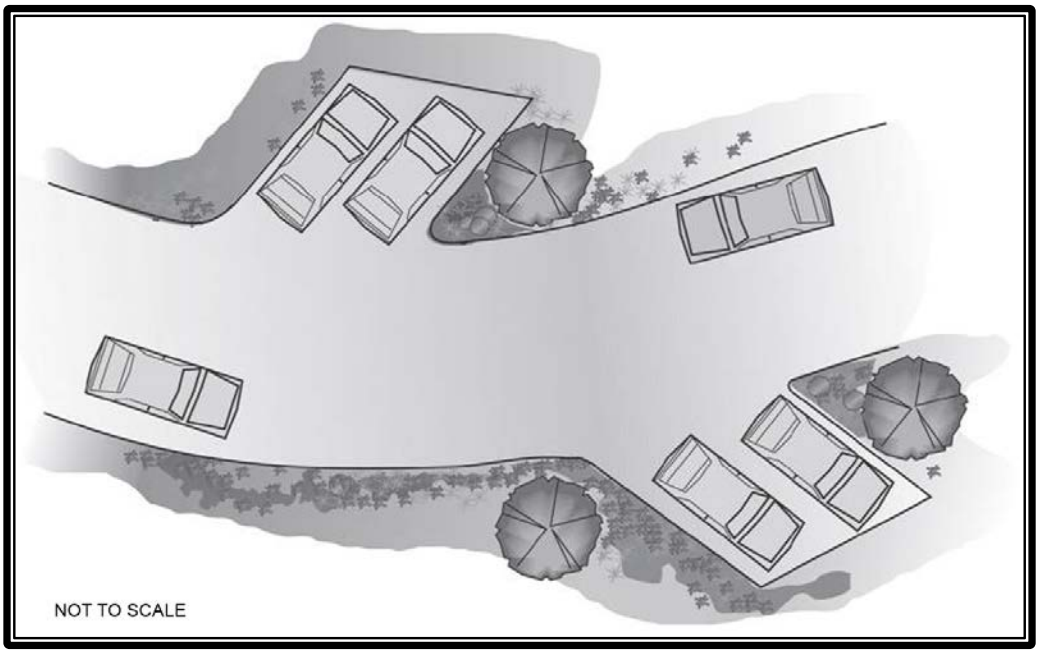


**Figure 2.3. Alternative Parking.**

### 2.7.2 Parking Lots

The objective of alternative parking lot designs is to eliminate excessive impervious areas dedicated to parking and to minimize the effective impervious area of parking areas, while still providing adequate parking for various land use classifications.

#### *Parking Lot Requirements*

- Utilize the minimum off-street parking requirements outlined in PCC Title 18A for non-residential uses. The total amount of parking spaces may exceed the minimums outlined in Title 18A. However, any parking lot space above the required minimum amount shall be constructed of permeable pavement or accommodated in a multi-storied or underground parking structure.

- The designer must incorporate permeable pavement to the maximum extent feasible into the parking lot to promote infiltration of runoff (see also Volume III, Section 3.5, as well as Volume I, Minimum Requirement #5).

- Bioretention areas shall be used to maximize infiltration and attenuation of surface runoff (see also Volume III, Section 3.4).

### 2.7.3 Driveways

Driveways are typically constructed with impervious surfaces and as such represent an opportunity to further minimize impervious surfaces and their hydrologic impacts. The

following methods shall be used to reduce the amount and hydrologic impact of impervious surfaces associated with driveways:

- Driveways shall be constructed using permeable pavement and graded in such a manner to prevent stormwater runoff from saturating the subgrade of the traveled lane portion of the roadway (if not using permeable pavement for the adjacent road). Surface and subsurface (e.g., discharge from the permeable pavement) stormwater runoff should drain to the adjacent permeable road, vegetated infiltration areas such as soil amended lawns, vegetated open channels, or bioretention areas.

- Runoff from driveways constructed of impervious surfaces shall be directed to vegetated infiltration areas such as soil amended lawns, dispersion areas, or bioretention areas.

### 2.7.4 Curb and Gutter Alternatives

Because of the effect they have on concentrating runoff flows, the use of curb and gutter systems is highly discouraged in Comprehensive LID Site Designs. The discussion below is intended to give guidance for appropriate LID methods for designing curb and gutter alternatives in situations where there is a need for constructing a curb and gutter system.

#### *Applicability*

- Needs where use of curb and gutter may be considered include incorporation of or tie into a road with a functional classification of Collector or Secondary Arterial, or in an ultra-urban setting. Local feeder roads in Comprehensive LID sites should not be designed with curb and gutter systems.

- Where specific community design standards require the use of curb and gutters in all or part of the road network, alternative curb and gutter designs (discussed below) must be considered that will still meet the functional requirements.

#### *Design Criteria*

- Where curb and gutters are required in a community to provide a means of separation between the pedestrians and the motorized traffic, an alternative design using placement of a vegetated channel between the sidewalk and the roadway should be considered. In addition, a visual barrier consisting of a 1-foot-wide concrete strip along the edge of the pavement at the same surface elevation of the pavement shall be constructed. This concrete strip gives drivers a visual cue of the edge of the driving surface and can help protect the vegetated channel from tire ruts.

- Another alternative is to provide cuts in the curb at 10 to 15 foot spacing to allow runoff to enter adjacent stormwater management areas. See Volume III, Section 4.9 for additional flow spreading options.

- Design options for curb and gutter alternatives are provided in Attachments Section A, Detail 27.0.

## 2.8 Soil Preservation and Amendment (Ecology BMP T5.13)

Preservation and enhancement of the existing upper soil horizon is of primary importance to the success of Comprehensive LID Site Designs. Maintaining and amending the upper soil structure plays a significant role in maintaining natural stormwater processes on the site, and can be a low-cost way to minimize impacts to site hydrology. The details of this BMP are provided in Volume III, Section 3.1, and must be incorporated into Comprehensive LID Site Designs to the maximum extent feasible.

# Chapter 3 - Easements, Maintenance, and Enforcement

In order to assure that the Comprehensive LID Site Design techniques continue to function over time, long-term management and maintenance strategies need to be addressed. The goal is to ensure successful management and maintenance of the vegetation retention areas, open space tracts, and LID BMPs through proper transition to subsequent owners and/or organizations that have long-term responsibility and vested interest. In addition to the O&M requirements for individual BMPs required under Volume I, Minimum Requirement #9, and outlined in Appendix I-A; the following apply specifically to Comprehensive LID Site Design projects.

## 3.1 Dedicated Tracts and Conservation Easements

- Any vegetation retention, open space areas, bioretention areas, bioswales, or any other feature utilized for stormwater purposes shall be adequately protected through the application of dedicated tracts and, where applicable, conservation easements, so that these elements will remain in such capacity in perpetuity.

- Large open space areas adjacent to riparian areas, wetlands, or critical fish and wildlife habitat areas may be transferred to local land trusts for long-term management and stewardship or managed by homeowners/building associations with specific maintenance covenants.

- Stewardship and management plans that address long-term protection and maintenance shall be developed for these sites and submitted to the county for approval.

## 3.2 Maintenance Requirements

Management plans and maintenance agreements for vegetation retention areas, open space tracts, and LID BMPs shall be in conformance with the requirements set forth in Section 2.5, Preserving Native Vegetation, and Volume I, Chapter 3 of this manual.

## 3.3 Enforcement

Enforcement of this volume shall be in conformance with provisions established in PCC Title 18.

# Volume VI References

WSU. Low Impact Development Technical Guidance Manual for Puget Sound. 2012.