LOW IMPACT DEVELOPMENT

The term *low impact development* (LID) refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat. EPA currently uses the term green infrastructure to refer to the management of wet weather flows that use these processes, and to refer to the patchwork of natural areas that provide habitat, flood protection, cleaner air and cleaner water. At both the site and regional scale, LID/GI practices aim to preserve, restore and create green space using soils, vegetation, and rainwater harvest techniques. LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels and permeable pavements. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions.

The categories below provide general descriptions for some LID/Green BMP strategies. For each method selected, detailed construction specifications shall be created which comply with all requirements for stormwater management and watershed health.

- **CONSERVATION EASEMENTS**
- **LAND COMPATIBLE DESIGN**
    - **GRASSED/VEGETATED SWALE**
- **NATIVE LANDSCAPING**
- **RIPARIAN BUFFERS**
- **ON-LOT TREATMENT FOR RESIDENCES**
    - **LOW WATER USE LANDSCAPE**
    - **RAINWATER HARVEST & CATCHMENT**
    - **ROCK SWALE & DRY CREEK**
    - **SLOTTED/FRENCH DRAIN**
- **URBAN FEATURES & TREATMENTS**
    - **IMPERVIOUS SURFACE REMOVAL**
    - **RAIN GARDEN**
    - **TREE WELL/BOX FILTER**

CONSERVATION EASEMENTS

DEFINITION

Conservation easements are voluntary agreements that allow individuals or groups to limit the type or amount of development on all, or just a portion of their property. By agreeing to give up or restrict the development rights for a parcel of land, landowners can guarantee that their property will remain in a prescribed state for perpetuity while receiving tax benefits.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

Easements should include (1) a description of the resource they are designed to protect (e.g., agricultural, forest, historic, water quality or open space easements), (2) restrictions on the uses and development (3) who is responsible (land trust, government agency, etc.) for maintenance, (4) language that is clear and enforceable, (5) maps, descriptions and baseline documentation of the property's characteristics, and (6) explanation of how the use of the land will be monitored on a regular basis.

MAINTENANCE

The responsibility for maintenance of property in a conservation easement depends on the individual agreement with a land trust or agency. While many organizations assume the responsibility for managing and monitoring a property, some land trusts leave maintenance responsibilities to the landowner and act only to monitor that the terms of the easement are met.

LAND COMPATIBLE DESIGN

DEFINITION

Natural drainage patterns, native vegetation, and stabilization of soil during construction are important factors in the prevention of flooding and degradation of water quality. Priority shall be placed on site design that maintains natural drainage patterns and watercourses. Alterations to natural drainage patterns shall not create flooding or degradation in water quality for adjacent downstream property. Site design shall minimize the disturbance and loss of vegetation.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

Site development should be fitted to the topography and soil to create the least potential for vegetation loss and site disturbance; Vegetation removal should be limited to that amount necessary for the development of the site; Vegetation native to the site or plant community should be restored in areas affected by construction activities.

MAINTENANCE

New planting shall be given sufficient water, fertilizer if necessary, and protein to ensure re-establishment.

EXAMPLES

- **GRASSED/VEGETATED SWALE**
    - Vegetated swales can be installed and established prior to the commencement of major construction activities and use of existing topographic features, natural vegetated buffers and existing structures that prevent, reduce or filter storm water run-on or runoff.
    - Grass lined swales are difficult to establish in the Truckee Meadows unless they have a permanent irrigation system or are supported hydrology (shallow depth to groundwater or active channel).

NATIVE LANDSCAPING

DEFINITION

Natural landscaping refers to the use of native vegetation (particularly prairie, wetland and wooded species) on a development or redevelopment site. The preservation and restoration of natural plant communities is important for the protection of natural resources and habitat, prevention of flooding and erosion, and the enhancement of the quality and quantity of water resources, and therefore encourages their protection and enhancement.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

New development should incorporate plant species native to Nevada and tolerant to local environments. Native vegetation should factor in topography, soils, drainage patterns and sun exposure, and should be considered for use for: detention basins and drainage features, edges of streams, lakes and wetlands, residential areas and gardens, agricultural, commercial, industrial and institutional developments, common areas and parking lots.

MAINTENANCE

Native vegetation typically requires less routine maintenance than conventional landscaping.

RIPARIAN BUFFERS

DEFINITION

A riparian or forested buffer is an area along a shoreline, wetland, or stream where development is restricted or prohibited to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment. If properly designed, a buffer can provide stormwater management, and can act as a right-of-way during floods, sustaining the integrity of stream ecosystems and habitats.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

The following criteria should be considered when establishing a stream buffer: minimum total buffer width; mature forest or shrubland as a vegetative target; conditions for buffer expansion or contraction; conditions where buffer can be crossed; integrating stormwater and stormwater management within the buffer; buffer education, inspection, and enforcement; buffer flexibility.

MAINTENANCE

An effective buffer management plan includes establishment, management, and distinctions of allowable and prohibited uses in the buffer zones. Buffer boundaries should be well defined and visible before, during, and after construction. Buffers designed to capture urban stormwater runoff will require more maintenance if designated as a bioretention or other engineered depression area.

ON-LOT TREATMENT FOR RESIDENCES

DEFINITION

The primary purpose of most on-lot practices is to manage runoff from rooftops, driveways and sidewalks. Rooftop runoff generally has low pollutant concentrations compared to other urban sources. The practice most often used to infiltrate rooftop runoff is the drywell. In this design, the storm drain is directed to an underground rock-filled trench that is similar in design to an infiltration trench. French drains or Dutch drains can also be used for this purpose. Runoff can also be diverted to a pervious area or a treatment area using site grading, or channels and berms.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of residential runoff.

PLANNING CRITERIA & IMPLEMENTATION

Treatment options can include grassed swales, bioretention, or filter strips. The bioretention design can be simplified for an on-lot application by limiting the pre- treatment filter and, in some cases, eliminating the underdrain. Alternatively, rooftop runoff can simply be diverted to pervious lawns, as opposed to flowing directly onto the street and then to the storm drain system.

MAINTENANCE

Infiltration practices require regular removal of sediment and debris settled in the pretreatment area, and the media might need to be replaced if it becomes clogged. Bioretention areas, filter strips, and grassed swales require regular maintenance to ensure that the vegetation remains in good condition.

EXAMPLES

- **LOW WATER USE LANDSCAPE**
    - Vegetated swales can be installed and established prior to the commencement of major construction activities and use of existing topographic features, natural vegetated buffers and existing structures that prevent, reduce or filter storm water run-on or runoff.
    - Grass lined swales are difficult to establish in the Truckee Meadows unless they have a permanent irrigation system or are supported hydrology (shallow depth to groundwater or active channel).
- **RAINWATER HARVEST & CATCHMENT**
    - Practices that store rooftop runoff, such as cisterns and rain barrels, are the simplest of the on-lot treatment systems. Cisterns and rain barrels can be particularly valuable

where rainfall is infrequent, and reuse for irrigation can save homeowners money. Down spouts can be disconnected from the storm drain system and rainfall can instead be collected and stored on site.
    - Rain barrels and cisterns require minimal maintenance, but the homeowner needs to ensure that the hose remains elevated during the winter to prevent freezing and cracking. In addition, the tank needs to be cleaned out about once per year. Rain barrels and cisterns should be checked periodically to ensure that they are properly sealed to prevent mosquito breeding.

- **ROCK SWALE AND DRY CREEK**

    - Drainage swales are shallow ditches that blend in with surrounding landscape design, facilitate water management, and encourage natural irrigation. Swales take advantage of natural slopes in the land to direct water downward into all the soil as opposed to letting it pool above ground or waterlog a specific region. Property owners can make use of these self-sufficient, permaculture storm drains, particularly if they live in wetland areas.

- **SLOTTED DRAINS**

    - A slotted channel drain is a drainpipe placed below grade and constructed with a slot inlet along its entire length used to intercept sheet flow from paved driveways, roads, and parking lots and convey it downstream to a treatment and/or infiltration system. Contemporary slotted drains have removable grates and should be installed in conjunction with some type of sediment trap to accommodate easy maintenance.
    - A slotted channel drain has no water quality benefit alone; however, in a developed watershed it is often a required component of a drainage system that as a whole improves water quality.

- **FRENCH DRAINS**

    - A subsurface drain is a trench or system of trenches containing a perforated pipe surrounded by gravel. It is designed to collect stormwater runoff or groundwater and convey it from undesirable locations to a stable discharge point or hydrologic source control such as an infiltration basin or rain garden. While a perforated pipe may permit some infiltration, credit is typically not given because it is negligible, and the primary purpose of a subsurface drain is conveying stormwater to a separate treatment and/or infiltration BMP in a more appropriate location.

URBAN FEATURES & TREATMENTS

DEFINITION

Natural drainage patterns, native vegetation, and stabilization of soil during construction are important factors in the prevention of flooding and degradation of water quality. Priority shall be placed on site design that maintains natural drainage patterns and watercourses. Alterations to natural drainage patterns shall not create flooding or degradation in water quality for adjacent downstream property. Site design shall minimize the disturbance and loss of vegetation.

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies as a result of property development and natural or human-induced erosion.

PLANNING CRITERIA & IMPLEMENTATION

Site development should be fitted to the topography and soil to create the least potential for vegetation loss and site disturbance; Vegetation removal should be limited to that amount necessary for the development of the site; Vegetation native to the site or plant community should be restored in areas affected by construction activities.

MAINTENANCE

New planting shall be given sufficient water, fertilizer if necessary, and protein to ensure re-establishment.

EXAMPLES

- **IMPERVIOUS SURFACE REMOVAL**
    - The adverse impact of impervious surfaces can be mitigated by designing them so that they are not directly connected to a site's drainage system. When impervious surfaces are "disconnected," runoff is allowed to sheet flow from the impervious area across a downstream pervious surface, where it can re-infiltrate into the soil, reducing the total runoff volume. These areas should be designed so that the shape, slope, and vegetated cover in the downstream area is sufficient to maintain the flow as sheet flow and that the discharge does not erode the downstream area.
    - Particularly good opportunities for disconnection of impervious surfaces include roof runoff, patios and driveways, and sidewalks. For example, roof runoff can be converted to sheet flow using downspouts equipped with splash pads, level spreaders, or dispersion trenches to reduce flow velocity and disperse the flow. Sheet flow from driveways, patio areas, and sidewalks can be directed toward vegetated buffers.

- **RAIN GARDEN**

    - Rain gardens are small, vegetated depressions used to promote infiltration of stormwater runoff. Runoff may enter the gardens via sheet flow or point discharge. Rainwater gardens can be planned and integrated into both new and existing developments and usually combine amended soils, shrubs, grasses, and flowering perennials. Planting roots, foliage, and soil help to retain and infiltrate water.
    - Rain gardens can achieve an appealing, aesthetic look and are well suited for small sites, such as individual homes, and larger sites, such as common areas and schools.

- **TREE WELL/BOX FILTER**

    - Tree box filters are a proprietary biotreatment device that is designed to mimic natural systems such as bioretention areas by incorporating plants, soil, and microbes. Tree box filters are installed at curb level and consist of an open bottom concrete barrel filled with a porous soil media, an underdrain in crushed gravel, and a tree. Tree box filters are highly adaptable solutions that can be used in all types of development and in all types of soils but are especially applicable to ultra-urban areas.