Landscape Solutions

Plants and trees add visual appeal and can increase property values. Careful landscaping can also help manage stormwater, save energy, reduce pollution and improve air quality. Even sites with space constraints or poor drainage can benefit from landscaping for stormwater management. It doesn’t have to be complex or expensive, and it can often reduce the development costs by eliminating the need for inlets, drains, and stormwater piping.

Stormwater treatments include:
- Trees
- Contained Planters
- Vegetated Swales
- Vegetated Infiltration Basins
- Flow-Through Planters
- Infiltration Planters

Paving Solutions

Even when an area requires paving, there are still options to infiltrate stormwater into the ground.

Stormwater treatments include:
- Pervious Pavers
- Pervious Pavement
- Turf Block
TREES

Adding trees to landscaping is easy, attractive, and has many stormwater benefits. A single mature tree with a 30 foot crown can intercept over 700 gallons of rainfall annually. Evergreen trees will capture more rainwater in winter months than deciduous trees.

Benefits

Trees capture and hold rainfall in leaves and branches. They slow runoff flow and can decrease stormwater volume by 35% or more for small storms. Trees improve water quality by filtering rainwater and holding soils in place, which is especially important along stream banks. Their shade reduces pavement heat, which in turn lowers runoff temperature. Tree wells can provide additional benefits by accepting runoff from sidewalks or other paved areas.

Maintenance

Selecting appropriate trees reduces maintenance needs. Trees usually require watering in the summer and wind protection in the first one to three years. Stake loosely for the first year. Routine maintenance includes raking and disposing of leaves and debris, removing weeds, pruning dead branches, and controlling pests.

Cost

Costs vary with the type and size of the tree, but the general range is $20 to $100 each, not including planting. Local non-profit groups often supply free or low-cost trees that are appropriate for our climate.

Safety and Siting Requirements

- Trees provide the greatest stormwater and environmental benefit when their canopy covers impervious areas and intercepts water before it falls to the ground.
- Choose trees suitable for the soil type, amount and intensity of sunlight and space requirements.
- Street trees are regulated by Portland Parks & Recreation. Call 503-823-PLAY for more information.
- Locate utilities before digging. Call 503-246-6699. (Portland)
- Refer to Portland’s Stormwater Management Manual for information on sizing, placement, and design.

Permits

- No permits are required for planting trees on private property.
- Planting or removing trees from the public right-of-way requires a tree permit from the City Forester.
- Natural area trees are regulated by E-Zone requirements.
To receive stormwater management credit per the *Stormwater Management Manual*, new deciduous trees must be at least 2” caliper and new conifers must be at least 6 feet tall. In the right-of-way, new trees must be at least 2” caliper for residential areas and 3.5” caliper in commercial and industrial zones.

For Clean River Rewards credit trees must be at least 15 feet tall and on private property. This does not include trees in the public right-of-way such as street trees.

**Examples**

SW Park Blocks

Friends of Trees, 3117 ML King Jr. Blvd.

NE Ainsworth Linear Arboretum, NE Ainsworth from ML King Jr. Blvd. to NE 42nd

SE Ladd’s Addition

Hoyt Arboretum
CONTAINED PLANTERS

(*contained planter boxes*)

A contained planter is filled with soil and plants that accept precipitation only, not stormwater runoff from another source. It is placed above ground on an impervious surface. Rainwater is temporarily stored above the soil, and then filters down through the planter. In some cases, weep holes provide drainage through the bottom of the planter onto the impervious surface. Contained planter boxes can be prefabricated pots or constructed in place. They come in all shapes and sizes, are made of stone, concrete, brick, plastic lumber or wood, and can hold a variety of plants.

**Benefits**
A contained planter reduces impervious area and stormwater runoff. Contained planters are simple, cost-effective, and visually appealing. They can be placed on many types of flat impervious surfaces, such as sidewalks, plazas, and rooftops.

**Vegetation**
Planters can contain small trees, shrubs, flowers, bulbs, and groundcovers. Trees are especially recommended because they provide canopy cover for impervious surfaces not covered by the planter. Self-sustaining plants that do not require additional fertilizers or pesticides are recommended.

**Maintenance**
Contained planters require minimal maintenance. Check them periodically to maintain adequate drainage. They are likely to need summer watering and weeding. Potted plants require more water than the same plants growing in the ground.

**Cost**
The cost of contained planter boxes varies, depending on the size and materials.

**Safety and Siting Requirements**
- Locate planters on virtually any impervious surface. They can be any shape or size, as site requirements, budget and maintenance dictates.
- Refer to Portland’s Stormwater Management Manual for detailed information on sizing, placement, and design.

**Permits**
- Planters located on ground level within the public right-of-way may require approval from the City Forester and Portland Department of Transportation.
Examples
1100 block of the downtown
Portland transit mall

Federal Building, 1200 SW 3rd Ave.
VEGETATED SWALES
(bioswales, grassy swales)

Swales are gently sloping depressions planted with dense vegetation or grass that treat stormwater runoff from rooftops, streets, and parking lots. As the runoff flows along the length of the swale, the vegetation slows and filters it and allows it to infiltrate into the ground. Where soils do not drain well, swales are typically lined and convey runoff to a drywell or soakage trench. Swales can include check dams to help slow and detain the flow. A swale can look like a typical landscaped area.

Benefits
The plants in a swale filter and slow stormwater runoff while sediments and other pollutants settle out. Swales are cost-effective, attractive and can provide wildlife habitat and visual enhancements. Single or multiple swale systems can treat and dispose of stormwater runoff from an entire site. Swales can reduce the number and cost of storm drains and piping required when developing a site.

Vegetation
Swales can be planted with a variety of trees, shrubs, grasses, and ground covers. Plants that can tolerate both wet and dry soil conditions are best. Plant grassy swales with native broadleaf, dense-rooted grass varieties. Avoid trees in areas that require enhanced structural stability, such as bermed side slopes. Summer irrigation and weed pulling may be required in the first one to three years.

Maintenance
Inspect swales periodically, especially after major storm events. Remove sediment and trash, clean and repair inlets, curb cuts, check dams, and outlets as needed. Maintain side slopes to prevent erosion and ensure proper drainage. With proper construction and maintenance, swales can last indefinitely.

Cost
Costs vary but swales typically cost less than a standard piped, drainage system.

Safety and Siting Requirements
- Swales located closer than 10 feet from building foundations need a variance from Bureau of Development Services (BDS)
- Locate swales at least 5 feet from any property line
- Grade the site so that water drains to the swale, or provide some form of conveyance such as a trench or berm to direct the runoff into the swale if site grading is impractical.
- Many parking lot planting islands can be excavated and retrofitted into swale systems with curb cuts.
- Refer to Portland’s Stormwater Management Manual for detailed information on sizing, placement, and design.
Permits

- Swales that accept roof runoff may require altering downspouts or other piping and a plumbing permit from the Bureau of Development Services (BDS).

- Depending on the area of ground disturbance, a clearing and grading permit may be required from BDS.

- The stormwater management portion of the facility may need review from the Bureau of Environmental Services (BES).

- Stormwater systems on non-residential sites need a commercial building permit.

Examples

OMSI and PCC annex parking lots, 1945 S.E. Water Ave.

Water Pollution Control Lab, 6543 North Burlington Ave.

Parkrose Middle School, 11800 NE Shaver

Glencoe Elementary School, 825 SE 51st Ave.

Siskiyou Green Street, NE Siskiyou between 35th Place and 36th Ave.
VEGETATED INFILTRATION BASINS

(*rain gardens*)

Vegetated infiltration basins are landscaped depressions that are either excavated or created with bermed side slopes. An inlet pipe from or sheet flow over impervious surfaces conveys stormwater runoff into the basin, where it is temporarily stored until it infiltrates into the ground. Basins often provide complete onsite infiltration for small storm events. Check dams or weirs can be used to detain the flow. They can be sized to infiltrate large storms in areas where soils drain well, or they may require a safety overflow or disposal method.

**Benefits**

Basins or rain gardens eliminate or dramatically reduce stormwater flow rates and volumes. They improve water quality by settling and filtering out pollutants, they recharge groundwater, and they can provide stormwater storage capacity in a large drainage area. Trees planted in infiltration basins can shade buildings and parking lots or other paved areas, reducing runoff temperatures. The vegetation also helps prevent soil erosion, provides wildlife habitat, and is visually attractive. Vegetated infiltration basins can have an informal or formal design and are easily integrated into the overall landscape or site design.

**Vegetation**

Vegetated infiltration basins can be planted with a variety of trees, shrubs, grasses, and ground covers. Trees are highly recommended for their shading and temperature reduction benefits. Avoid permanent irrigation where possible. Basins are likely to need watering and weed pulling during the first one to three years.

**Maintenance**

Inspect the vegetation and structure periodically and after major storm events. Vegetation maintenance is similar to that used for other types of managed landscapes. Maintenance needs include removing sediment and debris; cleaning and repairing inlets, embankments, berms, dams, and outlets as needed; controlling erosion; and ensuring proper drainage. Some plant replacement may be necessary. With proper construction and maintenance, a vegetated infiltration basin can last indefinitely.

**Cost**

The cost of vegetated infiltration basins varies depending on size, site conditions, and the type and size of the vegetation used. Costs compare favorably with conventional stormwater management facilities.

**Safety and Siting Requirements**

- Vegetated infiltration basins work best in areas that drain relatively shallow slopes of usually less than 5%. Runoff from steeper slopes can be piped into the basin with proper erosion control measures in place.
• Infiltration basins located closer than ten feet from building foundations need a variance from Bureau of Development Services (BDS).

• Locate basins at least five feet away from property lines.

• Underlying soils should have a minimum infiltration rate of two inches per hour and should not be compacted.

• Where needed include an emergency overflow disposal system to a drywell or to the City’s storm system.

• Infiltration basins may not be appropriate in areas with high water tables. They should not be designed as a pond, and should drain a storm event within 30 hours.

• Refer to Portland’s Stormwater Management Manual for details on sizing, placement, and design.

**Permits**

• Depending on the size of ground disturbance, a clearing and grading permit may be required from the Bureau of Development Services.

• The stormwater management portion of the facility will need review from the Bureau of Environmental Services (BES).

• Stormwater systems on non-residential sites need a commercial building permits.

**Examples**

Buckman Heights Apartments, 430 NE 16th Ave.

Glencoe Elementary School, 825 SE 51st Ave.

Oregon Convention Center, NE 1st Ave. and Lloyd Blvd.

Wattles Boys and Girls Club 9330 SE Harold Street
FLOW-THROUGH PLANTERS

Flow-through planters are structures or containers with impervious bottoms or placed on impervious surfaces. They do not infiltrate into the ground. They can be placed in or above the ground level. Flow-through planters are filled with gravel, soil, and vegetation and are typically waterproofed. They temporarily store stormwater runoff on top of the soil and filter sediment and pollutants as water slowly infiltrates down through the planter. Excess water collects in a perforated pipe at the bottom of the planter and drains to a destination point or conveyance system. Flow-through planters come in many sizes and shapes, and are made of stone, concrete, brick, plastic lumber or wood.

Benefits
Because flow-through planters can be built immediately next to buildings, they are ideal for constrained sites with setback limitations, poorly draining soils, steep slopes, or contaminated areas. Flow-through planters reduce stormwater flow rates, volume, and temperature, and improve water quality. They can also provide shading and energy benefits when sited against building walls. They can be an attractive landscape feature and provide wildlife habitat.

Vegetation
Flow-through planters can contain a variety of shrubs, small trees, and other plants appropriate for seasonally moist and dry soil conditions. Summer irrigation and weed pulling may be required. Minimize the need for permanent irrigation as much as possible by using native and well-adapted plants.

Maintenance
Inspect plants and structural components periodically. Maintenance is similar for all container plantings. Other maintenance needs may include removing sediment, cleaning and repairing pipes, and maintaining proper drainage. Downspouts, curb cuts, and other features where debris may obstruct flow must be inspected and cleaned periodically.
Cost
The cost of flow-through planter boxes varies depending on size and materials. For new development and redevelopment, they are often less expensive than conventional stormwater management facilities.

Safety and Siting Requirements
• Flow-through planters are recommended for compact sites because their size can vary.
• An approved overflow to a proper destination disposal point is required.
• Flow-through planters can be located next to building foundations or in other situations where infiltration is a concern.
• They are ideal for sites with soil that does not drain well, and are suitable to all soil types.
• Refer to Portland’s Stormwater Management Manual for details on sizing, placement, and design.

Permits
• Flow-through planters that alter existing plumbing such as downspouts, or add new pipes for disposal require a plumbing permit from the Bureau of Development Services (BDS).
• Depending on the area of ground disturbance, in-ground systems may need a clearing and grading permit from BDS.
• The stormwater management portion of the facility will need review from the Bureau of Environmental Services (BES).
• Stormwater systems on non-residential sites need a commercial building permit.

Examples
Pearl Court Apartments, 920 NW Kearney St.

Rebuilding Center of Our United Villages, 3625 N. Mississippi Ave.

George Middle School, 10000 N. Burr

Portland State University-Helen Gordon Child Development Center, SW 12th and Mill and SW 13th and Market

PSU Stephen Epler Hall
INFILTRATION PLANTERS

Inffiltration planters are structures or containers with open bottoms to allow stormwater to slowly infiltrate into the ground. They contain a layer of gravel, soil, and vegetation. Stormwater runoff temporarily pools on top of the soil, and then slowly infiltrates through the planter into the ground. Infiltration planters come in many sizes and shapes, and are made of stone, concrete, brick, plastic lumber, or wood. Infiltration planters are not recommended for soils that don’t drain well. Use flow-through planters instead.

Benefits
Inffiltration planters are ideal for space-limited sites with good drainage. They reduce stormwater runoff flow rate, volume, temperature and pollutants, and recharge groundwater. Inffiltration planters can be attractive, and are easily integrated into the overall landscape design. They can also provide energy benefits when sited near building walls.

Vegetation
Inffiltration planters can contain a variety of shrubs, small trees, and other plants appropriate for seasonally moist and dry soil conditions. Avoid permanent irrigation if possible. Planters are likely to need watering and weeding in the first one to three years.

Maintenance
Inspect plants and structural components periodically. Remove sediment and clear debris from inlet pipes and curb cuts to maintain proper drainage.

Cost
Costs vary depending on size and materials. For new development and redevelopment, inffiltration planters are often less expensive than more conventional stormwater management facilities.

Safety and Siting Requirements
- Inffiltration planters located closer than ten feet from foundations need a variance from Bureau of Development Services (BDS).
- Locate planters at least five feet from any property line.
- Inffiltration planters are only suitable for soil types that drain well.
- Place them flush to the ground or above it.
- An approved overflow to a proper destination point is required.
- Refer to Portland’s Stormwater Management Manual for details on sizing, placement, and design.
Permits

- Infiltration planters that require alteration of downspouts or other piping require a plumbing permit from BDS.
- Depending on the size of ground disturbance, in-ground systems may need a clearing and grading permit from BDS.
- The stormwater management portion of the facility must be reviewed by the Bureau of Environmental Services (BES).
- Stormwater systems on non-residential sites need commercial building permits.

Examples

Liberty Centre Parking Garage, 600 NE Holladay

Buckman Terrace Apartments, 303 NE 16th Ave.

The ReBuilding Center of Our United Villages, 3625 N. Mississippi Ave. (on Missouri Street)

PSU Green Street, SW 12th between Montgomery and Mill

Mississippi Commons 3701 N Mississippi Avenue
PERVIOUS PAVERS

(UNIT PAVERS)

PerVIOUS pavers are typically made of pre-cast concrete, brick, stone, or cobbles. Pavers usually form interlocking patterns, and are placed within a rigid frame on top of a sand bed or an under drain system. Sand or gravel fills the gaps between pavers, allowing water to pass to the underlying subgrade then infiltrate into the ground. Some pavers also have small voids in the pavement surface to increase permeability. Pervious pavers are available in many colors, shapes, sizes, and textures, and can support heavy traffic loads and weights. They can replace conventional asphalt or concrete paving in parking lots, roads, and sidewalks.

Benefits
By infiltrating precipitation, pervious pavers reduce stormwater runoff flow rate, volume, and temperature, and filter pollutants. They help recharge groundwater and maintain stream base flows. Pervious pavers may reduce or eliminate the need for an underground storm drain system or a curb and gutter system. They are durable and attractive, and allow great flexibility of design. Pervious paver areas can serve as an overflow for other stormwater management techniques.

Cost
Pervious paver systems range in cost depending on the size of the installation and the installation technique. Data gathered from Bureau of Environmental Services Westmoreland Pilot Project (2004) indicate an estimated cost of $5 per square foot installed, including base rock.

Safety and Siting Requirements
- Follow the manufacturer's installation specifications.
- Use over soils that drain well such as gravelly or loamy sand.
- Do not use pervious pavers in areas with high sediment loads that can clog pores in the pavement.
- Pervious pavers are not allowed in areas where hazardous material is stored or transported.
- Refer to Portland’s Stormwater Management Manual for details on sizing, placement, and design.
Permits

- Pavers used in public areas and City rights-of-way require City review for drainage and Americans with Disabilities Act (ADA) compliance. Contact the Portland Office of Transportation (PDOT) or the City’s Bureau of Development Services (BDS) with questions about use in these areas.

- Stormwater systems on non-residential sites need commercial building permits.

Examples

Oregon Natural Resources Council building parking lot, 5825 N. Greeley Ave.

Multnomah Arts Center, SW 31st and Capital Hwy

SE Westmoreland, SE 21st and Rex and SE Knapp

East Holladay Park
NE 128th and Holladay
PERVIOUS PAVEMENT

(*porous pavement, porous concrete/asphalt*)

Pervious pavement is made of either pervious asphalt or pervious concrete. Both materials resemble conventional asphalt and concrete, but have more air spaces that allow water to pass through the pavement into a reservoir base of crushed aggregate, then infiltrate into the ground. Pervious pavement is designed to accept precipitation only and is typically thicker than traditional concrete to support the same loads.

**Pervious asphalt** consists of coarse stone aggregate and asphalt binder, with very little fine aggregate. Water percolates through the small voids left in the finished asphalt. A thick layer of gravel underneath allows water to drain through quickly. Pervious asphalt looks similar to conventional asphalt, although with a rougher surface, which accounts for its common name “popcorn mix.”

**Pervious concrete** consists of specially formulated mixtures of Portland cement, open-graded coarse aggregate, and water. It has enough void space to allow rapid percolation of water and resembles exposed aggregate concrete.

**Benefits**
Pervious pavement reduces stormwater runoff flow rate and volume, recharges groundwater and maintains stream base flows. The subgrade also filters pollutants. Pervious pavement is less prone to cracking or buckling from freezing and thawing. Studies indicate it requires less frequent repair and patching than conventional paving. In some cases, pervious pavement may reduce or eliminate the need for an underground storm drain system or a curb and gutter system. Pervious pavement is an effective method of managing stormwater runoff without limiting use of the space.

**Maintenance**
It is important to control site erosion and sedimentation of the pavement surface to prevent clogging and maintain permeability. Cleaning or vacuuming the surface once or twice a year maintains porosity. Properly installed pervious paving systems last more than 20 years.

**Cost**
Pervious concrete pavements range in cost depending on the size of the installation. In the Bureau of Environmental Services North Gay Avenue Project (Summer 2005), a pervious concrete street cost about $100 per square yard installed, including base rock.

**Safety and Siting Requirements**
- Follow manufacturer's installation instructions.
- Weather conditions during installation can affect the performance and longevity of pervious pavement. Check with manufacturers for guidelines.
• Slope must be less than 10% over the paved area.
• Use pervious pavement over soils that drain well, like gravelly or loamy sand.
• Do not use pervious pavements in areas with high sediment loads.
• Pervious pavement is not allowed in areas where hazardous material is stored or transported.
• Most systems include an under layer of at least 12 inches of clean gravel over a layer of geotextile fabric. The under layer serves as an underground detention basin and should include an overflow outlet to prevent water from rising through the pavement.
• Refer to Portland’s Stormwater Management Manual for details on sizing, placement, and design.

Permits
• Pervious pavement systems used to replace public parking or walkway areas require a building permit from the City’s Bureau of Development Services.
• Stormwater systems on non-residential sites need commercial building permits.

Examples
The Rebuilding Center of our United Villages, parking lot, 3625 N. Mississippi Ave.

N. Gay Avenue
between N. Wygant and N. Sumner
(pervious concrete and asphalt)

Pervious Concrete at Broadway Pump Station, NE 91st and Broadway

Ecotrust Building Parking Lot (Drive aisles), 721 NW 9th Ave.
TURF BLOCK
(grass grid, open-cell unit paver, geoblock)

Turf block consists of interlocking concrete or plastic cells filled with soil and planted with turf grass or a low-maintenance groundcover. Water passes through the turf block into a reservoir base of crushed aggregate, then infiltrates into the subgrade. Turf block accepts precipitation only, not stormwater runoff. It is available in a variety of colors, shapes, sizes, and textures. Turf block is best suited for areas of low traffic and infrequent parking, such as patios, walkways, and terraces, residential driveways, overflow parking areas, emergency access roads, and street shoulders.

Benefits
Turf block reduces stormwater runoff flow rate, volume, and temperature, filters pollutants, helps recharge groundwater and maintain stream base flows, and controls erosion. In some cases, turf block may reduce or eliminate the need for an underground storm drain system or a curb and gutter system. It has a green appearance and structural strength.

Vegetation
Turf block systems can be planted with a variety of grasses and low-growing groundcovers that can withstand foot and vehicular traffic and occasional heavy loads. Self-sustaining native species are recommended.

Maintenance
Maintenance is similar to a regular lawn, requiring mowing, irrigation, raking, and occasional reseeding. Native grass species suitable for the specific area can minimize maintenance needs. It is important to control site erosion, sedimentation, and soil compaction to prevent clogging and maintain permeability.

Cost
Installation costs $4 to $6 per square foot, higher than for conventional concrete or asphalt paving. This cost may be offset if it is not necessary to install an underground drainage system or curb and gutter drainage system.

Safety and Siting Requirements
- Follow manufacturer’s installation and sitting instructions.
- Use only in gravelly sand, loamy sand or other pervious native soils.
- Like other pervious pavement, turf blocks are not allowed for areas where hazardous material is stored or transported.
- Use in low to moderate traffic areas without high weight-bearing loads.
- Refer to Portland’s Stormwater Management Manual for details on sizing, placement, and design.
Permits

- Using turf blocks in public parking areas, walkways or rights-of-way requires a building permit from the City’s Bureau of Development Services, with review from the Portland Office of Transportation.

- Stormwater systems on non-residential sites need commercial building permits.

Examples

Dosha Building, 2281 NW Glisan

SE Water Avenue - across from OMSI

Washington School for the Blind
2310 E 13th street
Vancouver, Washington