

4.5 City of Indianapolis Stormwater Green Infrastructure Guidance: Bioretention (rain gardens)

Bioretention Fact Sheet

Bioretention Technical Design Specification

Bioretention O & M Manual





4.5 Bioretention

Bioretention areas typically are landscaping features adapted to treat stormwater runoff. Bioretention systems are also known as Mesic Prairie Depressions, Rain Gardens, Infiltration Basins, Infiltration swales, bioretention basins, bioretention channels, tree box filters, planter boxes, or streetscapes, to name a few. Bioretention areas typically consist of a flow regulating structure, a pretreatment element, an engineered soil mix planting bed, vegetation, and an outflow regulating structure. Bioretention systems provide both water quality and quantity stormwater management opportunities.

Bioretention systems are flexible, adaptable and versatile stormwater management facilities that are effective for new development as well as highly urban re-development situations. Bioretention can readily adapt to a site by modifying the conventional “mounded landscape” philosophy to that of a shallow landscape “cup” depression. Such landscape depression storage and treatment areas fit readily into: parking lot islands; small pockets of open areas; residential, commercial and industrial campus landscaping; and, urban and suburban green spaces and corridors.

Bioretention works by routing stormwater runoff into shallow, landscaped depressions. These landscaped depressions are designed to hold and remove many of the pollutants in a manner similar to natural ecosystems. During storms, runoff ponds above the mulch and Engineered Soil Mix in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The runoff remaining in the bioretention facility filters through the Engineered Soil Mix. The filtered runoff can either be designed to enhance groundwater infiltration or can be collected in an underdrain and discharged per local stormwater management requirements.

Key elements:

- Stormwater management design intended to replicate a site’s pre-developed natural hydrologic processes through runoff storage and filtration.
- Flexible in size and configuration; can be used for a wide variety of applications. Can be used for Water Quality Volume (WQv) requirements for most local ordinances.
- Water Quality and Quantity volume that drains down in no more than 72 hours.
- Engineered Soil Mix that provides stormwater treatment through filtration while enhancing plant growth.
- Native and/or ornamental vegetation that provide evapotranspiration of stormwater, pollutant filtration, and an aesthetically designed landscape area.
- Flood control bypass system for runoff in excess of designed filtration capacity.
- Maintenance of Engineered Soil Mix and vegetation is required.



Highlights:

- Contributes to enhanced air quality, water quality and can assist in directly reducing urban heat island impacts.
- Can improve property value through attractive landscaping.

Effectiveness

- Structural stormwater management practices such as bioretention can be used to achieve four broad resource protection goals. These include flood control, channel protection, ground water recharge, and pollutant removal. Bioretention systems tend to behave similarly to swales; their pollutant removal rates are relatively high.



SEATTLE STREET EDGE ALTERNATIVES (SEA)

Potential applications		Stormwater regulations		
			Infiltration	No Infiltration
Residential Subdivision:	Yes	Water Quality Benefit	Yes	Yes
Commercial:	Yes	Water Quantity Benefit	Yes	Yes
Ultra Urban:	Yes	Volume Reduction	Yes	Yes
Industrial:	Yes	Attenuation Benefit	Yes	Yes
Retrofit:	Yes	Level of Benefit dependent on design criteria		
Highway Road:	Yes			



PRE-TREATMENT IN INDIANAPOLIS CULTURAL TRAIL BIORETENTION (ALABAMA STREET)

Acceptable forms of pre-treatment

- Energy dissipation to prevent erosion and scour of Stormwater Quality Practice (SQP).
- Pretreatment pollutant removal areas for concentrated collection of trash, debris, sediment, and other suspended and dissolved pollutants.

Bioretention in the Urban Landscape

Bioretention systems are shallow, vegetated depressions used to promote absorption and infiltration of stormwater runoff. This management practice is very effective at removing pollutants and reducing runoff volume. Stormwater flows into the bioretention area, ponds on the surface, infiltrates into the soil bed, and is used by plants and trees in the system.



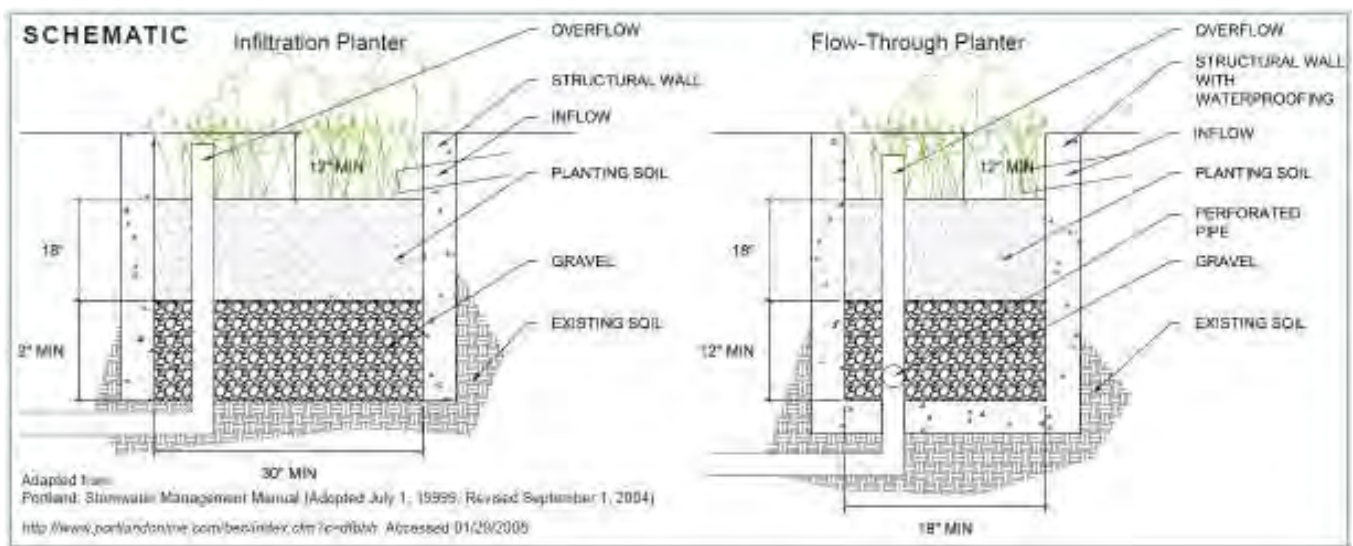
OVERFLOW PIPE

Bioretention areas are suitable for many types and sizes of development, including single-family residential, high-density commercial, and ultra urban re-development projects. Bioretention areas are generally relatively small landscaped areas that can be integrated throughout a site to manage all or part of the site's stormwater runoff. Flexible and easy to incorporate in landscaped areas, bioretention facilities are ideal for placement in roadway median strips and parking lot islands. They can also provide water quality treatment from pervious areas, such as golf courses, filter strips and other large lawn areas.

In highly urbanized watersheds, bioretention is often one of the few retrofit options that can be cost effectively employed by modifying existing landscaped areas, converting islands or under-used parking areas, or integrating into the resurfacing of a parking lot. Applications of bioretention systems in urban environments include planter boxes, residential, commercial and/or industrial on site landscaping, parking lots, and roadways, which can capture both site and roof runoff. The applications of bioretention systems are not limited to this list; however, examples for each of these alternatives are provided below.

Planter Boxes

A flow-through the planter box is designed with an impervious bottom or is placed on an impervious surface. Pollutant reduction is achieved as the water filters through the soil. Flow control is obtained by storing the water in a reservoir above the soil and detaining it as it flows through the soil. This planter can be used adjacent to a building if the box is properly lined.



Residential On-lot

Landscaped garden areas (rain gardens) can be designed with bioretention systems to create decorative features, habitat, and stormwater treatment at a residential site. The design can be as simple as incorporating a planting bed into the lowest point on a site. It is recommended that downspouts be directed into these systems after appropriate pre-treatment.

Tree Wells

Bioretention principles can be incorporated into a tree well design to create mini- treatment areas throughout a site. Care should be taken to ensure that the Engineered Soil Mix, in-situ soils and ponding area depth is appropriate to the tree size and species.



BIORETENTION INTEGRATED INTO URBAN LANDSCAPE (ALABAMA STREET, INDIANAPOLIS)



ALTERNATIVE “STREAM BED” URBAN BIORETENTION

Parking Lots

Parking lots are an ideal location for bioretention systems. Bioretention can be incorporated as an island, median, or along the perimeter of the parking area. Bioretention areas can enhance the aesthetics of a parking lot while managing stormwater from the site. Bioretention is an excellent discharge location for parking lot pervious pavement sub-drain seep or direct discharges. Whether by curb cuts, sheet flow or sub-drains, runoff flowing into bioretention must not result in erosive velocities.

Roads and Highways

Linear bioretention basins can be constructed alongside roads or highways, in roadway medians, or in bump-outs that double as traffic calming devices. The system will manage runoff from the street and help to control automotive pollutants. The systems can also help to control roadway flooding.

Commercial/Industrial/Institutional

At commercial, industrial, and institutional sites, areas for stormwater management and green space are often limited. At these sites, bioretention systems serve the multiple purposes of stormwater management and landscaping. Bioretention areas can be used to manage runoff from impervious site areas such as parking lots, sidewalks, and rooftops.



NATIVE/ORNAMENTAL MIX PARKING ISLAND LANDSCAPING

Typical Components of a Bioretention System

Bioretention systems can be designed to infiltrate all or some of the flow that they treat. The primary components of a bioretention system are:

- Pretreatment
- Flow entrance/inlet
- Surface storage (ponding area)
- Organic layer or mulch
- Engineered Planting Soil Mix filter media
- Vegetation (Native and Ornamental plantings)
- Sand bed or stone filter and underdrain, if required
- Stone storage for additional storage, if needed
- Positive overflow

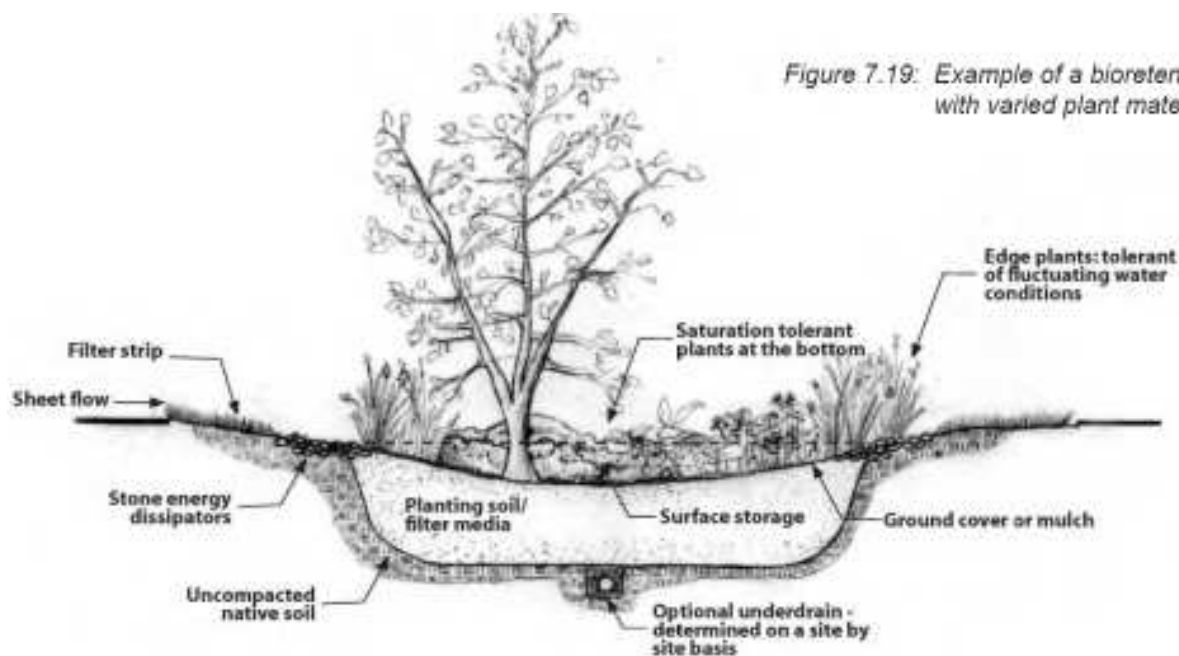


Figure 7.19: Example of a bioretention system with varied plant materials

Pretreatment

Pretreatment is required for all bioretention systems in order to protect the soil-plant system that provides treatment. Pretreatment protects and prolongs the life of the system by reducing sediment and other pollutant loads.



**CURB CUT INLET – INDIANAPOLIS
CULTURAL TRAIL BIORETENTION
(ALABAMA STREET)**

Flow Entrance / Inlet

It is recommended that runoff is conveyed to bioretention areas via sheet flow over a vegetated or gravel filter level spreader strip. This is not always possible due to site constraints or space limitations. On sites where curb removal is not an option or where flow is concentrated by the time it reaches the bioretention area, energy dissipation and equal flow distribution is required. Roof leaders that flow into bioretention areas also require flow energy dissipaters and equal distribution to prevent erosion in the bed.

Surface Storage (Ponding Area)

Surface storage provides temporary storage of stormwater runoff before infiltration, filtration, evaporation, and uptake (evapotranspiration) can occur within the bioretention system. Ponding time provides water quality benefits by allowing larger debris and sediment to settle out of the water. Ponding design depths are directly related to the Engineered Soil Mix design criteria and are generally limited to a range of 6-inches to 18-inches in order to reduce hydraulic loading of underlying soils, minimize facility drainage time, and prevent standing water.

Engineered Planting Soil Mix and Filter Media

The Engineered Soil Mix provides a medium suitable for plant growth. This designed media acts as a physical filter between the surface storage and the native soil or sub-drainage system. It provides additional storage and a place for biological and chemical pollutant treatment before the water infiltrates into the native soil or sub-drainage system. Storage area is a function of both soil depth and bioretention surface area.

Native and Ornamental Vegetation

The plant material in a bioretention system provides a physical barrier for pollutant filtration and energy dissipation; removes nutrients and stormwater pollutants through vegetative uptake; removes water through evapotranspiration; and, creates pathways for infiltration through root development and plant growth. A varied plant community is recommended to avoid susceptibility to insect and disease infestation and to ensure viability. A mixture of groundcover, grasses, shrubs, and trees is recommended to create a microclimate that can improve urban stresses as well as discourage weed growth and reduce maintenance. (Refer to Chapter 5: Stormwater Landscape Guidance) Do not use invasive species as listed by local, state and federal; agencies.

Organic layer or mulch

The organic layer or mulch provides a medium for biological growth, decomposition of organic material, adsorption, and binding of heavy metals. The mulch layer can also serve as a sponge that absorbs water

during storms and retains water for plant growth during dry periods. It is recommended that shredded hardwood mulch be utilized to minimize washout from stormwater flows.

Stone bed or filter and Underdrain (if necessary)

An underdrain is generally a perforated pipe or protected bed of gravel that collects water at the bottom of the system and conveys it to the system outlet. Underdrains eliminate most infiltration because they provide a preferential pathway for flow. A large diameter rock or gravel filter should surround the underdrain to facilitate flow to the underdrain. The underdrain stone bed should be surrounded by a non-woven, geotextile filter fabric to prevent clogging.



INSTALLATION OF BIORETENTION UNDERDRAIN

Stone Storage (if necessary)

A stone storage layer can be included to provide higher void space storage if needed in addition to the surface and soil storage.

Positive Overflows

A positive overflow must be provided at the maximum ponding depth. When runoff exceeds system storage capacity, the excess flow leaves the system through the positive overflow. If additional stormwater controls are required on the site, the overflow can connect to a system that will provide further quantity control. If no additional stormwater controls are required, the overflow can be connected to storm sewer or receiving water in compliance with local stormwater management requirements.

Design Considerations

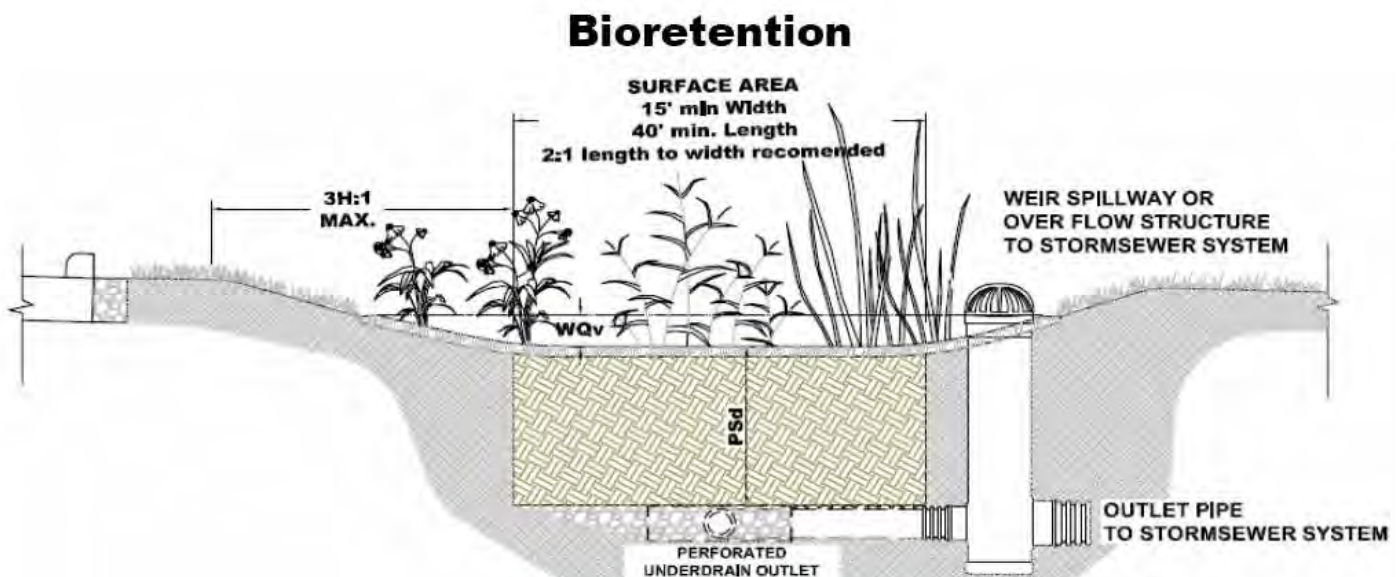
Design of bioretention systems is somewhat flexible. The area, depth, and shape of the system can be varied to accommodate site conditions and constraints. The following design procedures are general guidelines that designers can follow.

- Determine the Water Quality and Quantity requirements on the site. See City of Indianapolis Stormwater Specifications Manual.
- Investigate the feasibility of infiltration in the area proposed for bioretention. If infiltration is not feasible, consider an underdrained bioretention system or an alternate location for the bioretention area. If infiltration is feasible, determine the saturated vertical infiltration rate.

Table 4.5.1: Suggested Starting Design Values for Areas and Depths	
Area (surface area and infiltration area)	Largest feasible on site (*sized for expected runoff volume)
Typical Ponding Depth	6-18 inches
Soil Depth	2-4 feet

*Note pond depth may not exceed 3 feet

- Estimate the total storage volume and adjust area and/or depths as needed to provide required storage.
- Estimate how long the surface ponding and soil storage will take to drain based on the infiltration area and the saturated vertical infiltration rate of the native soil. The maximum drain down time for the surface storage volume is 72 hours. If storage does not drain in the time allowed, adjust surface depth, soil depth, and/or surface area. Adjust the design until the volume, drainage time, and site constraints are met.
- Underdrain if necessary.
- Choose plants, trees, and either mulch or seeding appropriate to the site.



Materials

Planting Soil

Refer to Chapter 5: Stormwater Landscape Guidance.

Mulch

Organic mulch shall be aged, double-shredded hardwood bark mulch or composted leaf mulch.

Plants

It is critical that plant materials are appropriate for soil, hydrologic, light, and other site conditions. Select bioretention plants that will survive within the selected zone of ponding, drain down time, sunlight, salt tolerance, and other site specific conditions. Refer to Chapter 5: Stormwater Landscape guidance for plant selection. Although plants will be subject to ponding, they may also be subject to lack of water (drought) especially in areas that get a lot of sunlight or are in otherwise highly impervious areas.

Construction Guidelines and Considerations

- Areas for bioretention shall be clearly marked before any site work begins to avoid soil disturbance and compaction during construction.
- Provide erosion and sedimentation control protection on the site such that construction runoff is directed away from the proposed bioretention location. Proposed bioretention areas may only be used as sediment traps during construction if at least two feet of soil are removed and replaced.
- Complete site elevation grading and stabilize the soil disturbed within the limits of disturbance. Do not finalize bioretention excavation and construction until the drainage area is fully stabilized.
- Excavate bioretention area to proposed invert depth and manually scarify the existing soil surfaces. Do not compact in-situ soils. Heavy equipment shall not be used within the bioretention basin. All equipment shall be kept out of the excavated area to the maximum extent possible.
- If using an underdrain and/or a gravel storage bed, place filter fabric or gravel filter, then place the rock, and set the underdrain according to the plans.
- Backfill the excavated area as soon as the subgrade preparation is complete to avoid accumulation of debris. Place bioretention soil in 12-18 inch lifts without compaction. Overfilling will be necessary to account for settlement. Presoak soil at least one day prior to final grading and landscaping to allow for settlement.
- After allowing soil to settle, complete final grading within 2 inches of the proposed design elevations, leaving space for top dressing of mulch or mulch/compost blend.
- Seed and plant vegetation as indicated on the plans and specifications.
- Place mulch and hand grade to final elevations.
- Water vegetation regularly during first year to ensure successful establishment.

Maintenance Guidelines

Properly designed and installed bioretention systems require little maintenance. Bioretention requires landscaping maintenance to ensure that the area is functioning properly. Bioretention areas initially require intense maintenance, but less maintenance is needed over time. In many cases, maintenance tasks can be completed by a landscaping contractor, who may already be hired at the site. Landscaping maintenance requirements can be less resource intensive than with traditional landscaping practices such as elevated landscaped islands in parking areas. During periods of extended drought, bioretention systems may require watering as needed.



Curb Inlet, Pre-treatment and Raised Outlet for Indianapolis Cultural Trail Bioretention (Alabama Street)

Table 4.5.2: Bioinfiltration/Bioretention Maintenance Guidelines		
	Activity	Schedule
	<ul style="list-style-type: none"> • Water vegetation at the end of each day for two weeks after planting is completed. • Water vegetation regularly to ensure successful establishment. 	First year after installation or as needed during drought conditions
	<ul style="list-style-type: none"> • Remulch void areas. • Treat diseased trees and shrubs. • Keep overflow free and clear of leaves. 	As needed
	<ul style="list-style-type: none"> • Inspect soil and repair eroded areas. • Remove litter and debris. • Clear leaves and debris from overflow. 	Monthly
	<ul style="list-style-type: none"> • Inspect trees and shrubs to evaluate health, replace if necessary. • Inspect underdrain cleanout. • Verify drained out time of system. 	Twice Per Year
	<ul style="list-style-type: none"> • Add additional mulch. • Inspect for sediment buildup, erosion, vegetative conditions, etc. 	Annually
	<ul style="list-style-type: none"> • Maintain records of all inspections and maintenance activity. 	Ongoing

Note: Design of bioretention systems are not limited to the examples shown within this text. Successful stormwater management plans will combine appropriate materials and designs specific to each site.