Metropolitan Water Reclamation District of Greater Chicago

GREEN INFRASTRUCTURE COMMUNITY GUIDE

Stormwater Strategies for Resilient Neighborhoods

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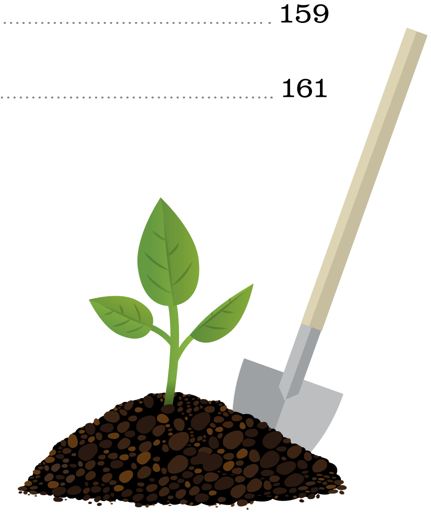
APPENDICES

Opposite: Cars line up at a green parking lot in Countryside that uses permeable pavers to manage stormwater runoff. The project was funded through the MWRD's Green Infrastructure Partnership Program.



Introduction

Heavy and unpredictable downpours in recent years force Cook County residents to navigate floodwaters through creative solutions.

GLOSSARY WORDS Highlighted words are defined in the ***Glossary*** at the end of this guide.

Communities across the Chicago region and beyond are grappling with the growing challenges of stormwater management and flooding. Green infrastructure offers a promising solution, not only to help protect communities from flooding but also to deliver significant public health, environmental and economic benefits.

Recognizing that communities throughout the Chicago region are increasingly turning to green infrastructure to manage excess stormwater, the Metropolitan Water Reclamation District of Greater Chicago (MWRD) developed this guide to make the process of selecting and implementing the right combination of green infrastructure practices less challenging.

This guide is a practical resource for planners, elected officials, public works staff and local champions of green infrastructure. It provides a menu of options and essential information for decision-making. Ultimately, this guide aims to empower your community with the knowledge and tools to build a more resilient and sustainable future.

The case for green infrastructure

Traditionally, communities have managed stormwater with “gray infrastructure” like concrete pipes and large detention basins. Green infrastructure, by contrast, uses neighborhood or site-scale practices that mimic natural systems to capture, store and infiltrate rainwater where it falls. This approach leverages nature to make our communities more resilient to climate change and deliver a wide range of social, economic and environmental benefits, transforming a costly problem into a community asset. It's important to note that while green infrastructure is a broad concept, practices used to meet the MWRD's regulatory requirements have specific design and performance standards, as detailed in this guide and the MWRD's Technical Guidance Manual (TGM) found at ***mwrd.org/wmo-tgm***.

Key benefits of going green

- **IMPROVES WATER QUALITY** Green infrastructure naturally filters pollutants from stormwater runoff before it reaches our rivers and lakes. In combined sewer areas, it also reduces the volume of water entering the sewer system, which helps prevent untreated overflows.
- **REDUCES FLOOD RISK** By increasing infiltration and providing distributed storage capacity, green infrastructure helps alleviate surface flooding and recharges groundwater, taking pressure off local sewer systems.
- **ENHANCES HABITATS AND NEIGHBORHOODS** Using native vegetation creates vital habitats for pollinators and improves air quality. Numerous studies have documented that green spaces can improve physical and mental health and increase property values.
- **OPTIMIZES CAPITAL COSTS** When planned comprehensively, a carefully balanced design of green and gray systems can lead to construction cost savings by reducing the need for traditional infrastructure like pipes and inlets. However, achieving these savings depends on site-specific conditions and a holistic design approach that considers long-term maintenance.

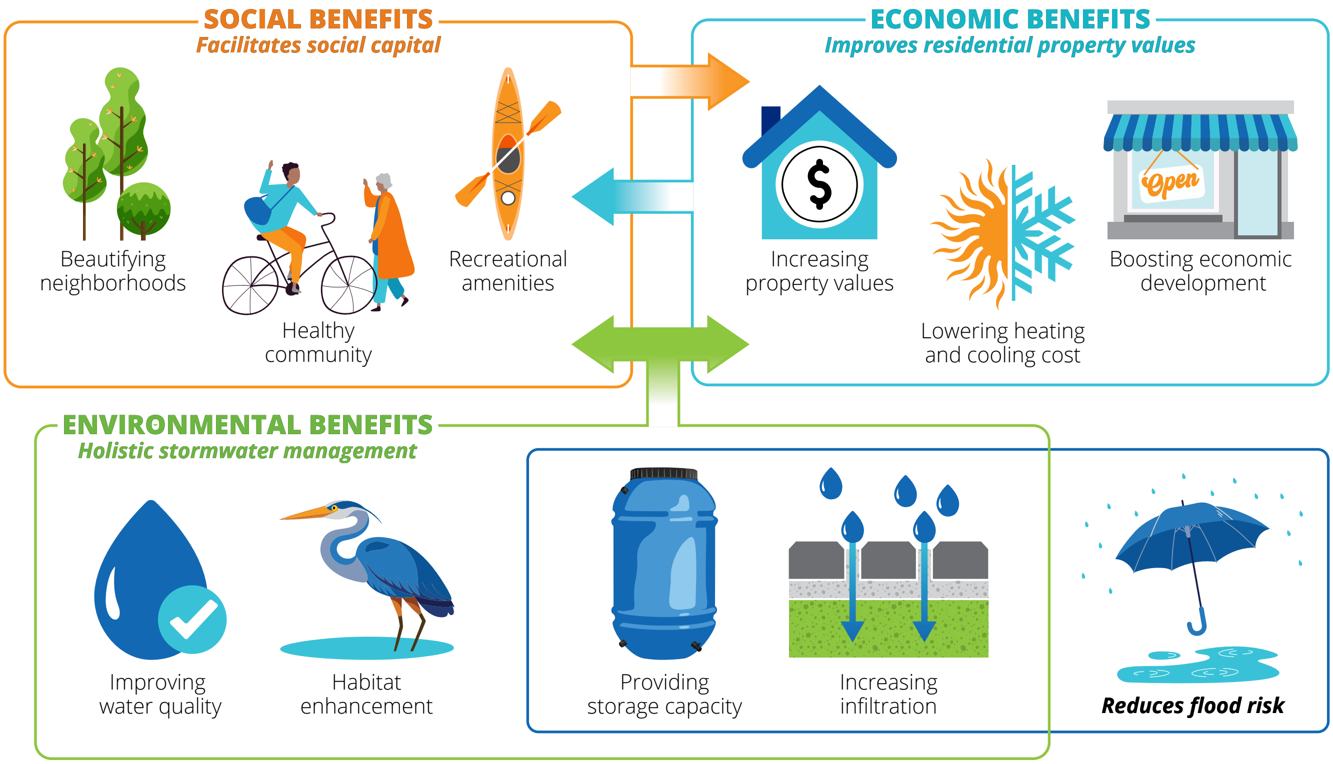
Partner with the MWRD on green infrastructure

The MWRD partners with municipalities and other local government entities to build green infrastructure throughout the Chicago region. Each year, local governments can apply for funding to implement projects through our Green Infrastructure Partnership Program (GIPP). In the decade since the program began in 2014, we have helped complete more than 130 projects with the capacity to capture over 22 million gallons of stormwater per rain event.

For local governments that need help planning and designing green infrastructure, we also offer our Conceptual Projects partnership to provide technical assistance.

For more information on the GIPP and other partnership opportunities, visit ***mwrd.org/gipp****.*

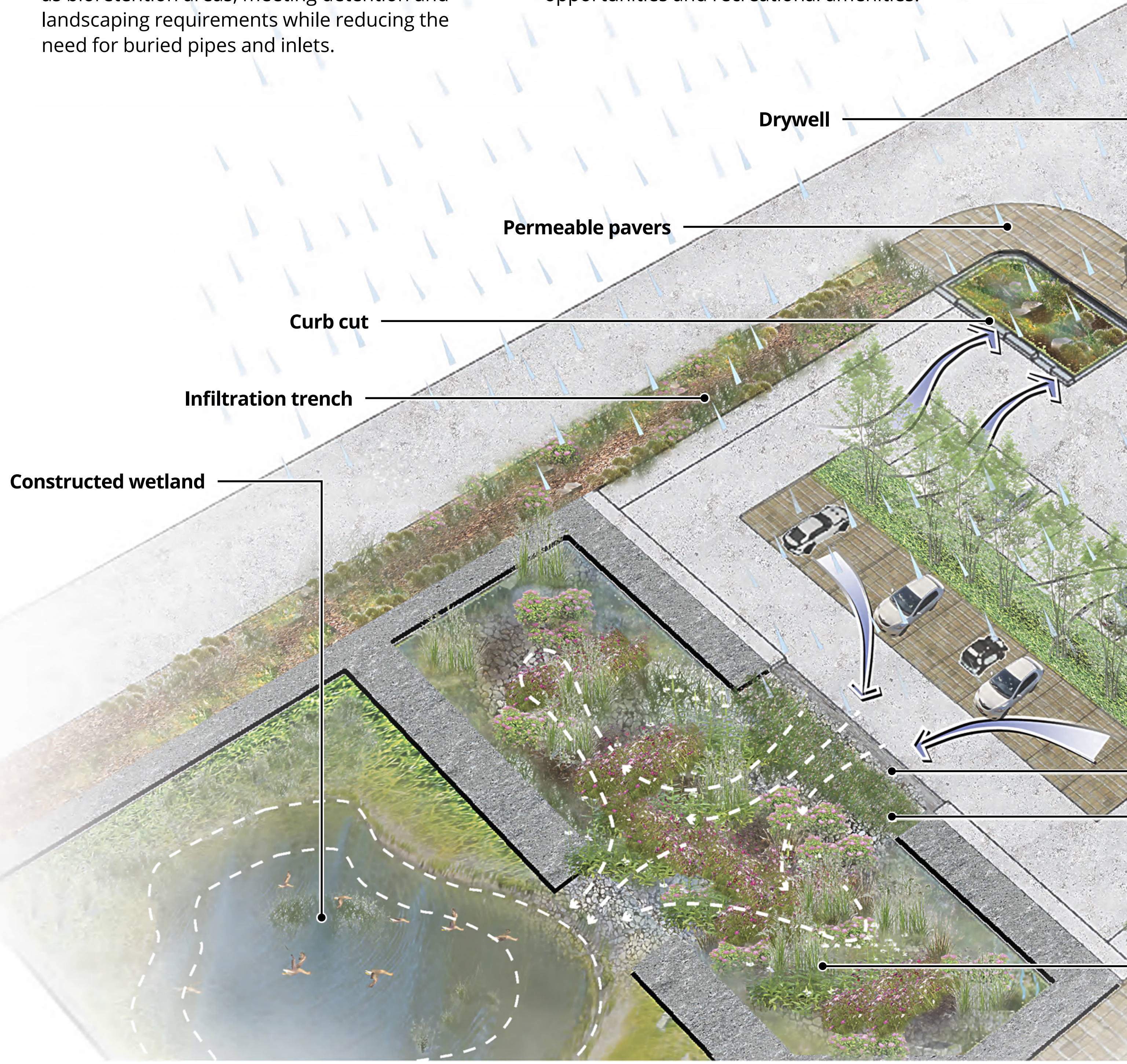
Interrelated benefits of green infrastructure practices

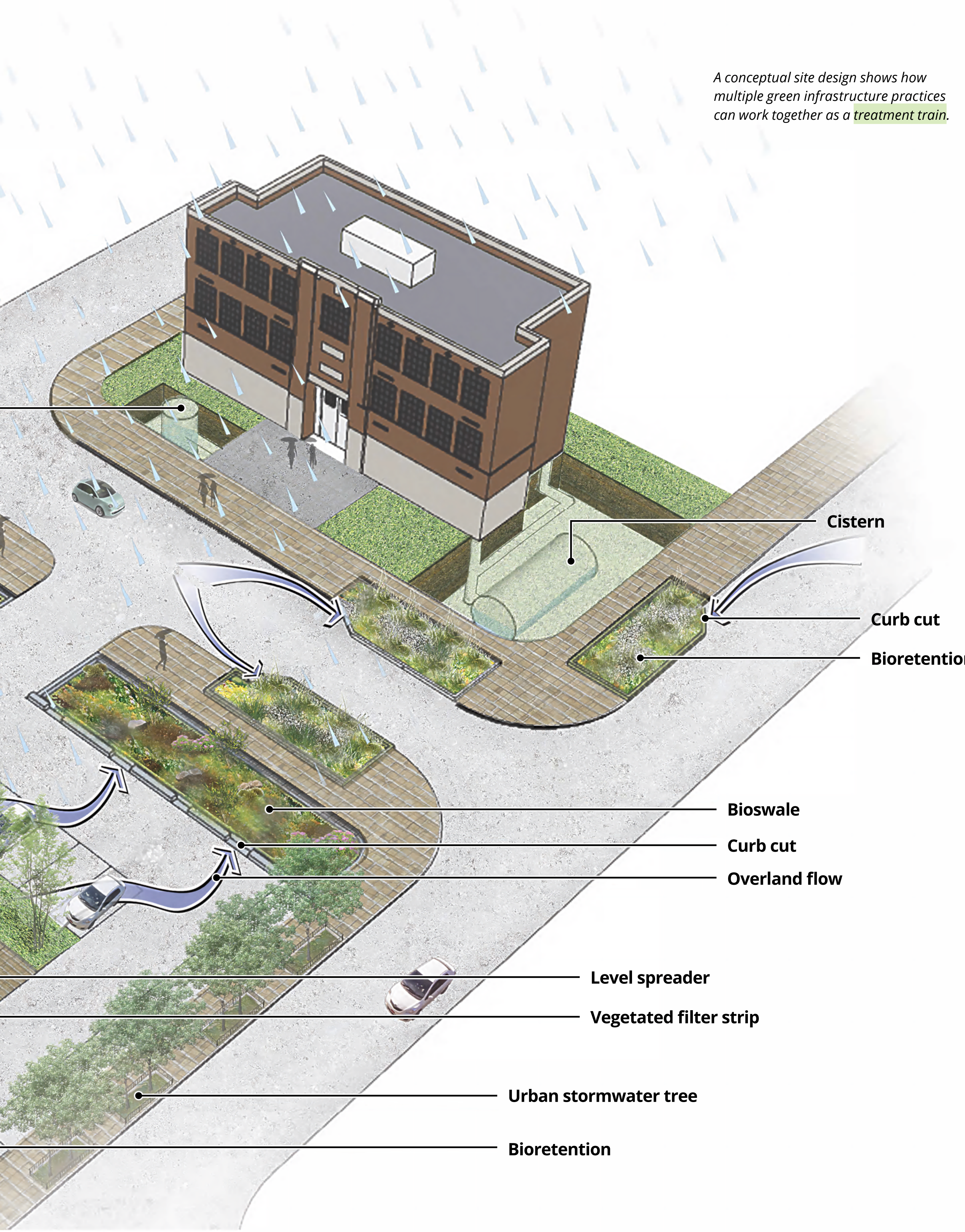


Integrating green infrastructure across your community

A key advantage of green infrastructure is its adaptability. It can be woven into the fabric of any community, transforming underutilized spaces into functional and attractive resources.

- **RESIDENTIAL AREAS** Networks of bioswales and small bioretention areas can reduce infrastructure costs while creating greenspace amenities that increase property values.
- **COMMERCIAL & INDUSTRIAL SITES** Parking lot islands and landscape buffers can be designed as bioretention areas, meeting detention and landscaping requirements while reducing the need for buried pipes and inlets.
- **PUBLIC RIGHT-OF-WAY** "Green streets" can enhance drainage, calm traffic and improve pedestrian safety.
- **SCHOOLS AND PARKS** Ample open space makes schools and parks ideal for demonstrating green infrastructure, creating hands-on educational opportunities and recreational amenities.





A conceptual site design shows how multiple green infrastructure practices can work together as a treatment train.

For your backyard: The Green Neighbor Guide

While this guide focuses on community-scale projects, the MWRD also offers the Green Neighbor Guide for homeowners. It provides ideas for managing stormwater on individual properties, such as installing rain barrels and creating rain gardens.

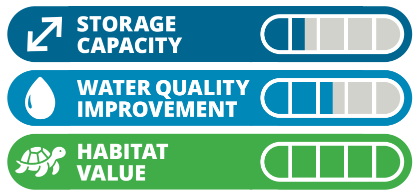
Download the guide from the MWRD website.

How to use this guide

This guide is designed to help you select the best green infrastructure practices for your community's needs. **Chapters 1 through 9** detail specific practices. To help you compare options, each chapter evaluates the practice based on key benefits and constraints using simple bar charts to provide a quick visual comparison.

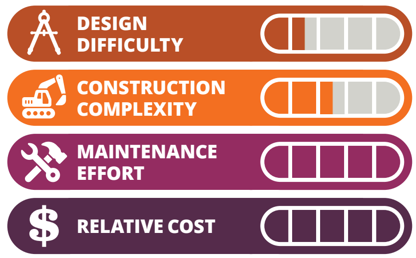
Benefits

Poor > Fair > Good > Very good > Excellent



Constraints

Low > Moderate-low > Moderate > Moderate-high > High



TECHNICAL SNAPSHOTS

Throughout the guide, you will find Technical Snapshots.

These snapshots provide a condensed summary of key information from the MWRD's TGM and other technical documents. They are designed to offer quick-reference guidance for engineers and designers but are not meant to be comprehensive. Instead, they highlight important requirements and key design considerations.

For any design intended to acquire a Watershed Management Ordinance (WMO) permit or meet WMO permitting requirements, designers must consult the latest official versions of the TGM and the WMO directly for complete and up-to-date information.

The **Appendices** provide valuable tools, including:

- **APPENDIX A** Recommended native plant lists
- **APPENDIX B** Inspection checklists
- **APPENDIX C** Maintenance checklists
- **APPENDIX D** Detailed cost information
- **APPENDIX E** Placement in street right-of-way
- **APPENDIX F** Selection tools
- **APPENDIX G** Additional resources

How to choose the right green infrastructure for your project

This guide details nine different green infrastructure practices, each with unique benefits and constraints. To help you select the best option for your project's specific goals, site conditions and budget, we have developed the following tools:

- **A SUMMARY COMPARISON MATRIX** (Table 1, page 8) Provides a quick reference to what each practice is best for and an at-a-glance overview of how the practices compare across key metrics.
- **SELECTION TOOLS IN APPENDIX F** Provides a detailed comparative matrix and a decision-making guide to walk you through a more in-depth selection process.

Key terminology: WMO, TGM and practice types

Watershed Management Ordinance (WMO)

The MWRD ordinance that sets the minimum requirements for stormwater management for developments in Cook County.

Technical Guidance Manual (TGM)

The companion document to the WMO. It provides designers with the specific guidance and technical criteria needed to meet WMO regulations. This Green Infrastructure Community Guide supplements, but does not replace, the TGM.

Volume control practices

To meet the WMO's volume control requirements, the TGM outlines a clear hierarchy of practices:

- **RETENTION-BASED PRACTICES** These are the primary practices required by the WMO. They are designed to capture, store,and infiltrate a specific volume of water (e.g., bioretention, permeable pavements), reducing the total amount of runoff leaving a site.
- **FLOW-THROUGH PRACTICES** These practices, which primarily convey and treat water (e.g., vegetated filter strips, bioswales), play two key roles under the WMO. They are commonly used for pretreatment to filter runoff before it enters a retention-based practice. They may also be used as an alternative to meet volume control requirements but only when site constraints prevent the use of retention-based practices and the development drains to a waterway.

Designers and engineers whose projects are intended to meet the WMO requirements must consult the TGM for detailed requirements and design specifications.

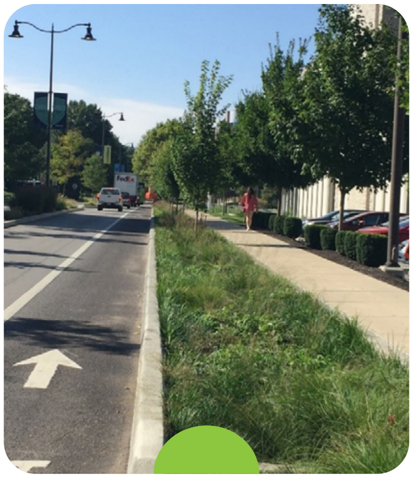
Visit ***mwrd.org/wmo*** for the latest version of the WMO and the TGM.

TABLE 1 Green infrastructure practice comparison matrix.

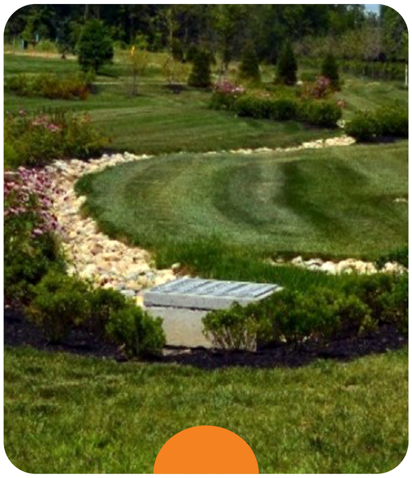
GI practice / Best for	BENEFITS: STORAGE CAPACITY	BENEFITS: WATER QUALITY IMPROVEMENT	BENEFITS: HABITAT VALUE	CONSTRAINTS: DESIGN DIFFICULTY	CONSTRAINTS: CONSTRUCTION COMPLEXITY	CONSTRAINTS: MAINTENANCE EFFORT	CONSTRAINTS: RELATIVE COST
Vegetated filter strip Simple, low-cost pretreatment for other GI practices.	Poor	Good	Poor to fair	Low	Low	Moderate-low	Low
Bioretention facility Versatile, high-performing storage and treatment in landscaped areas.	Very good	Very good	Good	High	High	Moderate-high	Moderate-low
Bioswale Conveying, treating, and storing runoff in linear spaces like roadsides.	Fair to good	Very good	Fair to good	Moderate to high	Moderate-high to high	Moderate to moderate-high	Moderate
Constructed wetland Large-scale treatment and stormwater storage on sites with available land.	Excellent	Excellent	Excellent	High	High	Moderate	Moderate-low
Urban stormwater tree Highly constrained urban sites like sidewalks and plazas.	Fair	Excellent	Poor to fair	Moderate	Moderate	Moderate	Moderate-high
Dry well Providing underground storage on space-limited sites with good soil infiltration.	Good	Poor	N/A[1]	Moderate	Moderate	Moderate-low	High
Infiltration trench Subsurface infiltration in narrow, linear areas with suitable soils.	Good	Fair	N/A[1]	Moderate	Moderate	Moderate-low	Moderate-low
Permeable pavement Integrating stormwater management directly into parking lots, alleys, and patios.	Good	Good	N/A[1]	Moderate-high	Moderate-high	High	High
Cistern Water conservation and volume reduction through rainwater harvesting and reuse.	Fair	N/A[2]	N/A[1]	Moderate-low	Moderate-low	Moderate-high	Moderate

1 This practice does not include vegetation and provides minimal to no habitat value.
2 Direct pollutant removal is not the primary function of rain cisterns.

CHAPTER 1
Vegetated Filter Strips



CHAPTER 2
Bioretention Facilities

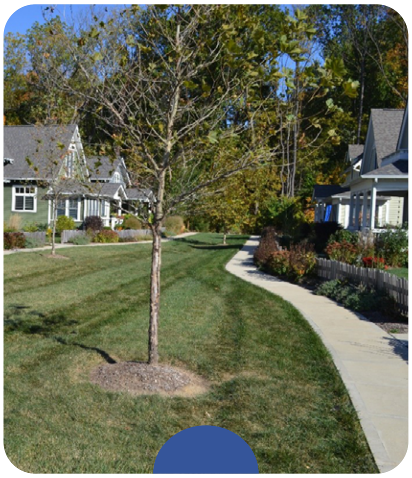


CHAPTER 3
Bioswales

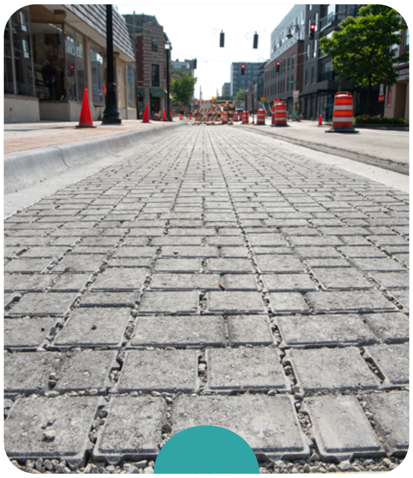
CHAPTER 4
Constructed Wetlands

CHAPTER 5
Urban Stormwater Trees

CHAPTER 6
Dry Wells



CHAPTER 7
Infiltration Trenches



CHAPTER 8
Permeable Pavements

CHAPTER 9
Cisterns

GI PRACTICES PROJECT SHOWCASE

- *Bioswales*
- *Bioretention Facilities*
- *Permeable Pavements*

Grissom Elementary Space to Grow

Traditional schoolyards usually have little option to absorb stormwater. That is not the case anymore at Grissom Elementary in the Hegewisch neighborhood on the Southeast Side of Chicago, where Space to Grow™ partners converted the schoolyard into a vibrant place to play, learn and retain more stormwater.

Through a unique partnership between the MWRD, Chicago Public Schools (CPS), the City of Chicago, Openlands and Healthy Schools Campaign, the Space to Grow program transforms CPS schoolyards to benefit students, their families and neighbors. Students also gain an important lesson on green infrastructure.

Grissom can retain up to 327,385 gallons, reducing the load on the combined sewer system. After removing asphalt, an old playground, fencing and utilities, crews constructed two playgrounds on rubber play surfacing, basketball and volleyball courts on permeable asphalt, a baseball backstop, artificial turf, an outdoor classroom, a running track, walkways, a community garden, rain gardens, permeable walks and infiltration planters.

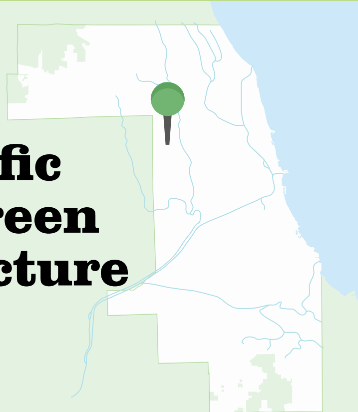

BEFORE


AFTER

GI PRACTICES PROJECT SHOWCASE

- *Bioswales*
- *Bioretention Facilities*

Franklin Park Pacific Avenue green infrastructure project



Native gardens in an industrial corridor can collect more water, tidy up high-trafficked streets and promote the power of green infrastructure for business owners and visitors.

In Franklin Park, the MWRD helped fund the construction of more than 1,000 square yards of rain gardens within the parkways of six village street intersections along Pacific Avenue. The $571,085 project was completed in 2022, thanks in part to funding from the MWRD through the Green Infrastructure Partnership Program.

The project improves the visibility for motorists turning on to Pacific Avenue, while capturing up to 78,000 gallons of stormwater to reduce flooding and improve area water quality. Franklin Park officials are again collaborating with the MWRD on adding more green space along the corridor by replacing existing areas of impervious surface with rain gardens. Under terms of an intergovernmental agreement, the MWRD will partially fund the project, and Franklin Park is responsible for design, construction, operation and maintenance.


BEFORE
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INDUSTRIES
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AFTER
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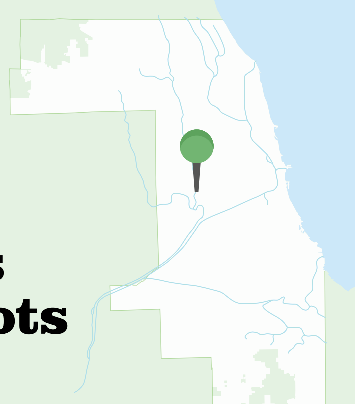
GI PRACTICES PROJECT SHOWCASE

Permeable Pavements



North Riverside Village Commons parking lots

Home to a village hall, police and fire stations and public works department, the Village of North Riverside Commons complex area has long been a central meeting place in the community, but one that also required significant parking.

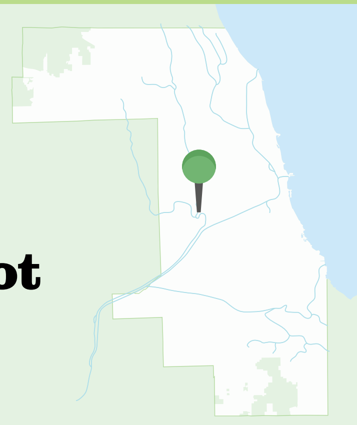
When time came to improve the Commons' six parking lots, North Riverside officials turned to the MWRD's Green Infrastructure Partnership Program (GIPP) to rebuild using permeable pavers. This 71,000-square-foot lot is designed to capture more than 539,000 gallons, reducing the load on local sewers and nearby waterways.

Following demolition and removal of the existing asphalt, construction crews then dug down about 21 inches and backfilled with filter fabric, 17 inches of three distinct stone layers and an under-drain system set higher up in the stone base. They then topped it with brick pavers to create a natural solution, establishing the $1.53 million project as one of the MWRD's largest GIPP projects to date.

GI PRACTICES PROJECT SHOWCASE

- *Bioswales*
- *Bioretention Facilities*
- *Permeable Pavements*

Riverside Metra parking lot



In 2019, the Village of Riverside completed Metra Commuter Lot #1. This green parking lot surface provides more than 252,000 gallons of stormwater storage per rain event. Serving Metra commuters near downtown Riverside, the permeable parking lot and bioretention areas reduce the current load to the combined sewer system and help alleviate flooding within the project area.

The MWRD funded approximately half of the $1.1 million construction project. The parking lot is comprised of interlocking concrete permeable pavers to absorb more water and prevent it from running off into the nearby Des Plaines River. The rain garden uses bioswales filled with native plants that filter the stormwater runoff from the parking lot, reducing the concentration of pollutants. The installation was so successful that the MWRD and Riverside again partnered in 2024 on a similar green commuter lot a block away that captures over 97,000 gallons.

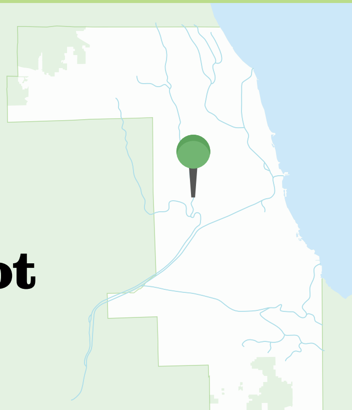

BEFORE


AFTER

GI PRACTICES PROJECT SHOWCASE

- *Bioretention Facilities*
- *Permeable Pavements*

Schuth's Grove parking lot



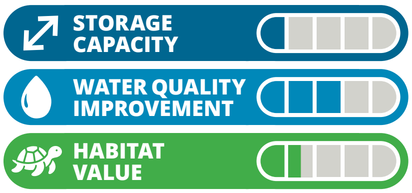
A green parking lot yields multiple benefits, but when also attached to a boat launch those advantages of clean water are instantly realized. The Forest Preserves of Cook County upgraded the Schuth's Grove canoe and kayak launch in 2022 with a new permeable parking lot made possible via the MWRD's Green Infrastructure Partnership Program.

Through the installation of permeable pavement, the Schuth's Grove parking lot green infrastructure retrofit now provides 110,700 gallons of stormwater storage each time it rains. Construction on the porous parking lot included approximately 2,000 square feet of permeable pavers with bioretention areas at four parking lot islands. The MWRD reviewed the project's design, performed inspections and agreed to partially fund the $615,870 project with the Forest Preserves assuming responsibility for design, construction, and perpetual maintenance and operations.

1 Vegetated Filter Strips

Vegetated filter strips, also known as buffer strips, are landscaped areas that use a gentle slope and dense vegetation to treat stormwater runoff from adjacent surfaces like roads and parking lots. Their primary function is to slow runoff and allow the dense vegetation to filter out sediment and other coarse pollutants.

Key benefits



Why use a vegetated filter strip?

Vegetative filter strips are one of the simplest and most cost-effective green infrastructure practices and are often used as filters to complement and protect more complex downstream practices (like bioretention or bioswales) from being clogged by sediment.

Filter strips are a versatile and low-impact tool to improve water quality. They can be seamlessly integrated into almost any landscape, from residential lots to the edges of commercial parking lots.

- **COST-EFFECTIVE PRETREATMENT** Filter strips are an inexpensive option to meet pretreatment requirements. Since most construction sites require grading and seeding anyway, installing a filter strip often adds little to no extra cost.
- **IMPROVED WATER QUALITY** The dense vegetation is effective at trapping coarse sediment, trash and pollutants bound to sediment particles, protecting downstream infrastructure and waterways.

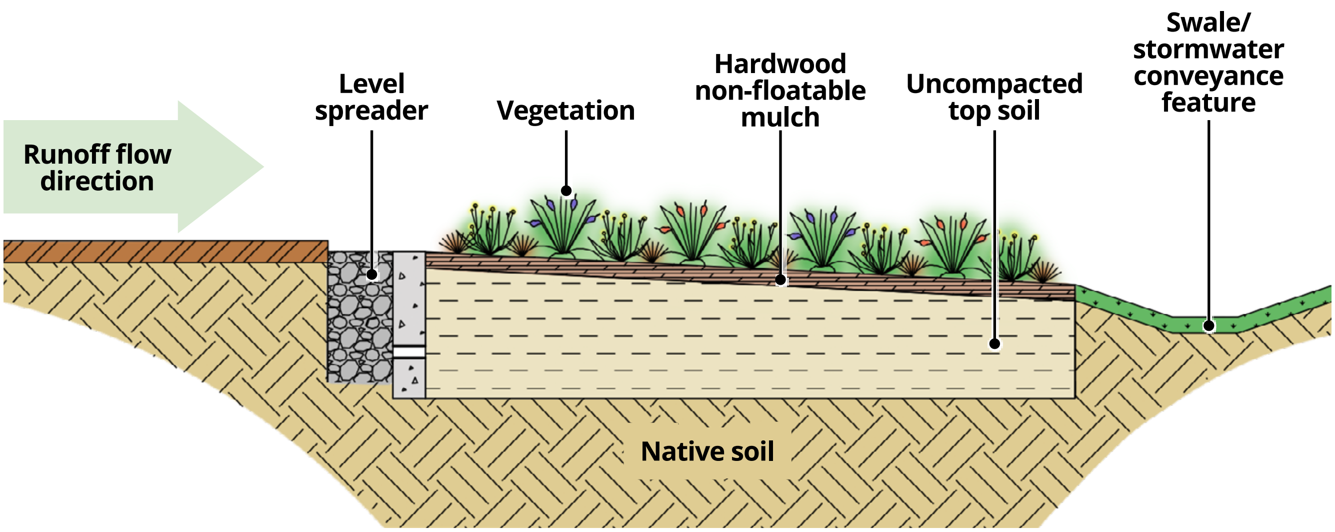


FIGURE 1.1 A typical filter strip cross section demonstrates how street flow can be captured from an adjacent impervious surface area. See *TGM Appendix C* (Vegetated Filter Strip Detail) for detailed specifications and dimensions.

- **EASE OF INSTALLATION** Construction is straightforward, closely resembling standard landscaping practices.
- **MINIMAL MAINTENANCE** Long-term care is similar to typical lawn or landscape maintenance, consisting primarily of mowing and occasional inspections.
- **ENHANCED HABITAT (OPTIONAL)** While a simple turf filter strip has low habitat value, designing them with a diverse mix of native grasses and wildflowers can attract birds, butterflies, and other pollinators.

Example applications of vegetated filter strips for different land uses are shown in **Figures 1.2 to 1.5.**

FIGURE 1.2 A vegetated filter strip (left of cobbles) provides simple, low-cost pretreatment for an infiltration trench in a new residential development.

FIGURE 1.3 A filter strip provides pretreatment for a bioswale in a commercial parking lot.

FIGURE 1.4 Filter strips (turf areas) surrounding an infiltration trench provide pretreatment in a public right-of-way.

FIGURE 1.5 The surrounding filter strips provide pretreatment for a bioswale in an open space.

Suitability and placement

Filter strips are highly adaptable, but their effectiveness depends on proper placement. The strips have limited treatment capabilities and, as flow-through practices, do not provide the quantifiable storage needed to meet WMO volume control requirements. They must be located directly adjacent to the impervious area they are treating and are not suitable for handling concentrated flow from pipes or ditches. The design must ensure that runoff enters as slow, shallow sheet flow.

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles: 5.3.4, 5.3.6, 5.3.10.6

Designers should follow specific criteria outlined in the TGM.

Practice type: Filter strips are considered a flow-through practice and do not provide quantifiable storage volume.

Tributary area: Suitable for draining areas of 5 acres or less. The flow path length across the contributing impervious area should not exceed 75 feet.

Length (in direction of flow): Minimum of 30 ft and maximum of 150 ft. Ideal length depends on site conditions like slope and tributary area.

Slope: Should be uniform and less than 15%. Slopes of 1-5% are ideal.

Key separation distances:

» 10 feet from a building foundation (unless waterproofed).

» 100 feet from potable water wells or septic tanks.

Key design elements

DESIGN DIFFICULTY

The design of a filter strip focuses on a uniform grade, gentle slope and dense, erosion-resistant vegetation to maintain sheet flow and maximize contact time between runoff and the plants.

Pretreatment

While a filter strip is a pretreatment practice, it often needs its own pretreatment in the form of a level spreader. This is a crucial component that takes runoff from a curb cut or the edge of a parking lot and spreads it evenly across the top width of the filter strip. This is critical, as concentrated flow would carve channels and bypass the filtering vegetation entirely. Failure to maintain sheet flow is the most common reason filter strips underperform. Examples of pretreatment include gravel trenches, concrete sills, flush curbs, or turf-reinforced earthen berms.

Growing media

Healthy, uncompacted soil is essential for establishing the dense vegetation required for a filter strip to function effectively.

TECHNICAL SNAPSHOT

GROWING MEDIA

Requirement: Uncompacted topsoil.

Preparation: At a minimum, compacted soils should be tilled to a depth of 12 inches to reduce compaction.

Amendments: Given the prevalence of heavy clay soils in the region, amending the soil is often necessary. Incorporating several inches of compost fertilizer can improve soil structure and support the hearty healthy vegetative growth required for effective filtering.

Vegetation

Dense, erosion-resistant vegetation is the most critical component of a filter strip. The plants slow runoff, filter sediment and help stabilize the soil. Plant selection should be based on site conditions, maintenance capacity and aesthetic goals.

TECHNICAL SNAPSHOT

PLANT SELECTION AND INSTALLATION

Installation: Seeding should be done via drilling or hydromulching to ensure dense coverage. Broadcasting is not a suitable method.

Stabilization: An erosion control blanket is required on slopes exceeding 5% or where concentrated flow is anticipated.

Plant type: Dense, deep-rooted grasses and perennials that form a thick mat of vegetation.

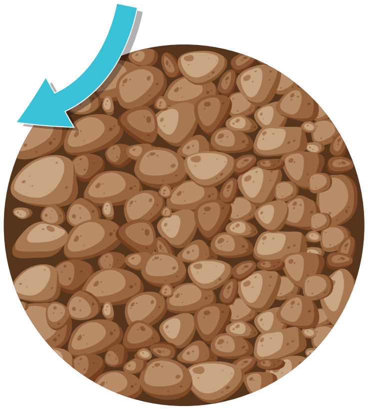
Key characteristics: Look for plants with stiff stems and a bunch-forming or sod-forming growth habit. Drought tolerance is essential.

Plant selection: For simple applications, a dense stand of turf-type tall fescue is effective. Densely seeded native grasses like Little Bluestem or Prairie Dropseed are excellent. Mixing in hardy, upland wildflowers such as Black-Eyed Susans or Purple Coneflower can increase habitat value. If deep-rooted native grasses are used, setbacks of at least 3 feet from paved surfaces should be provided.

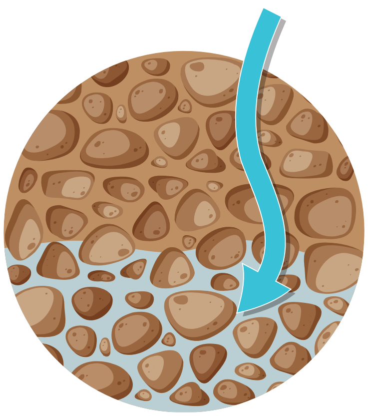
Establishment: Establishing dense native vegetation from seed can take up to three years. A cover crop should be included in the seed mix to ensure site stability during this period.

Refer to *Appendix A* on page 92 for a detailed list of recommended plants. Species from the Facultative Upland section are well-suited for filter strips.

Uncompacted soil, as shown in the bottom image, allows water to percolate between the pore spaces of the soil particles, providing temporary storage and filtration for runoff.



compacted soil



uncompacted soil

Opposite: Native species like Liatris, seen here at Schuth's Grove, are ideal for vegetated filter strips because their deep root systems help slow runoff velocity and capture sediment.

Construction

CONSTRUCTION COMPLEXITY

Construction is low in complexity but requires careful attention to grading and soil protection. The primary goal is to achieve a uniform grade while avoiding compaction of the underlying soil. A preconstruction meeting is essential to clarify the schedule, protection methods, and coordination with other site work.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING

1. **Protect area:** Fence off the filter strip footprint to prevent soil compaction by heavy equipment.
2. **Rough grading:** Establish uniform grade during major site grading. Avoid over-compacting the native soils.
3. **Stabilize site:** Stabilize all tributary drainage areas.
4. **Final grade:** Perform final grading to establish a uniform slope.
5. **Planting:** Install erosion control blankets (if required), seeding, and any live plants.

During construction, use a consistent checklist (see ***Appendix B*** on page 101) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Maintenance is generally low, consisting of typical landscape care. The goal is to maintain a dense stand of vegetation, prevent the formation of rills or channels, and remove accumulated sediment as needed.

Maintenance activities

Typical maintenance tasks are similar to those for any lawn area.

- » **MOWING** Mow turf grass to a height of 3 to 6 inches. Native grasses should be mowed once annually in the late fall or early spring.
- » **WEED CONTROL** Manage invasive weeds as needed. A licensed applicator is required if using herbicides.
- » **SEDIMENT REMOVAL** Periodically remove accumulated sediment, especially at the upstream edge of the strip, to maintain sheet flow.
- » **REPAIRS** Regrade and reseed any eroded areas immediately. If erosion persists, the cause should be investigated (e.g., concentrated flow from an upstream source).

Performance indicators

Monitoring helps diagnose problems early. Look for:

- **EROSION** Rills, gullies, or any other observable soil loss is a sign of concentrated flow and requires immediate repair.
- **VEGETATION LOSS** Bare ground covering more than 10% of the surface (after initial establishment) indicates a problem with soil health or vegetation choice.
- **CHANNELIZATION** Evidence that water is flowing in concentrated paths rather than as sheet flow across the strip.

Use the maintenance checklist on page 121 in ***Appendix C*** to guide monitoring and maintenance activities. Use ***Appendix A.6*** on page 98 to help identify invasive and aggressive plants.

Cost

$ RELATIVE COST

Filter strips are one of the most cost-effective green infrastructure practices. Because grading and seeding are part of nearly every construction project, they can often be implemented with little to no additional cost.

Assuming the use of native seed mixes, the estimated cost for filter strips ranges from \$11 to \$21 per square foot. See page 131 in ***Appendix D*** for detailed cost information.

Cost offsets

The primary cost offset is the avoidance of more expensive structural pretreatment options. While installing native seed mixes may be more expensive upfront than turf grass, they typically require less long-term maintenance (mowing, fertilizing, irrigation) once established, leading to savings over the life of the project.

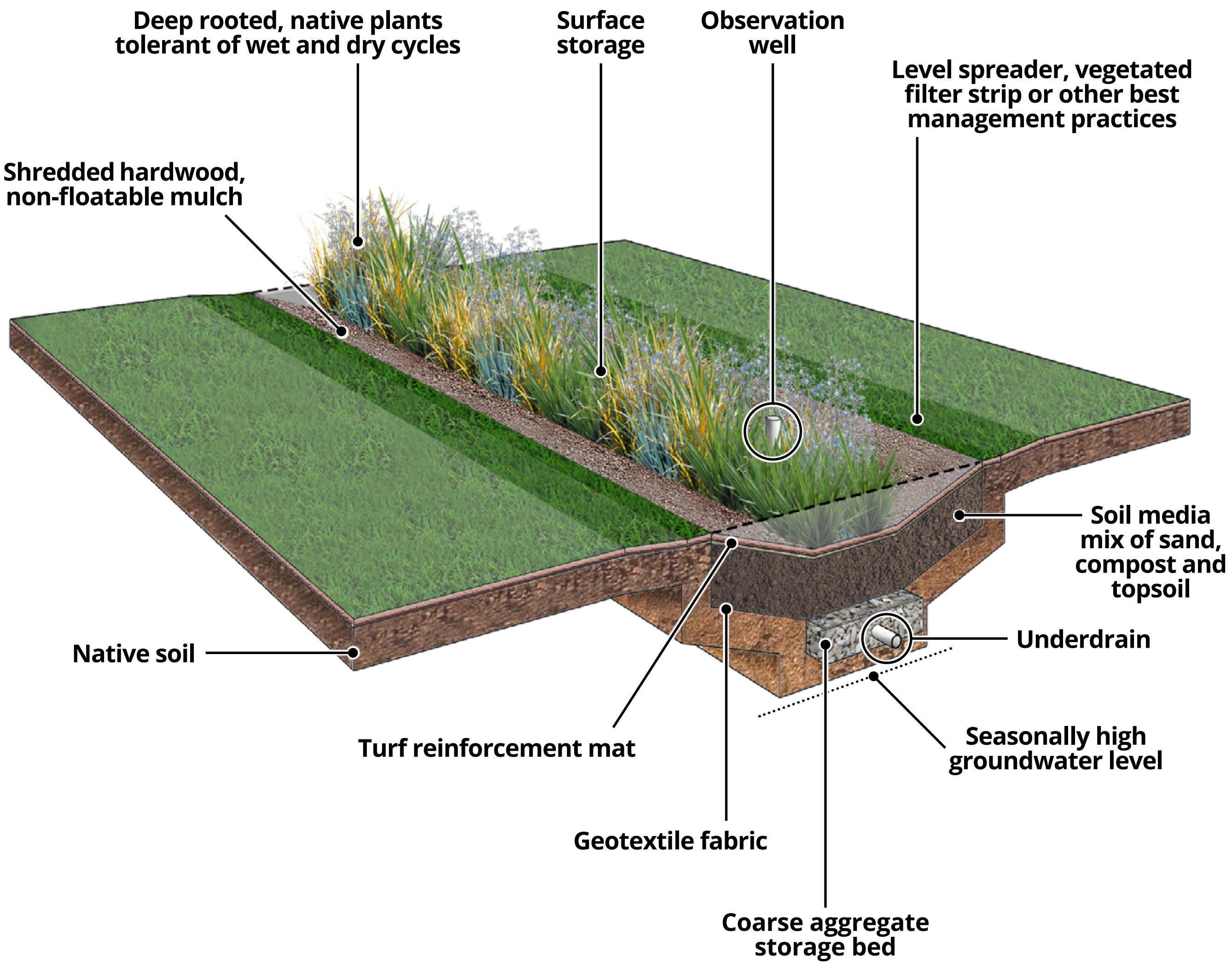
2 Bioretention Facilities

Bioretention facilities, often called rain gardens, are shallow, landscaped depressions that act like natural sponges for stormwater. As one of the most versatile and effective green infrastructure tools, bioretention facilities provide significant storage and water quality benefits while also beautifying the landscape.

They are designed to:

- » Capture runoff from nearby surfaces like roofs and pavement.
- » Treat the captured runoff by filtering it through a special soil mix and plant roots.
- » Manage the water by storing it temporarily and allowing it to soak into the ground or be released slowly into the sewer system.

FIGURE 2.1 A perspective illustration of a bioretention facility, showing the layers of mulch, engineered soil, and aggregate storage that work together to manage stormwater. For specifications, designers and engineers should refer to the TGM.



Why use bioretention?

Bioretention's ability to provide quantifiable storage, improve water quality and enhance habitat makes it a popular and versatile choice for meeting WMO volume control requirements. These facilities can be integrated into nearly any landscape, from small residential rain gardens to large systems in commercial parking lots or along public roadways.

- **SIGNIFICANT STORMWATER STORAGE** Bioretention is a retention-based practice, meaning it is designed to hold a specific volume of water, which helps reduce local flooding and relieves pressure on the sewer system.
- **EXCELLENT WATER QUALITY IMPROVEMENT** The engineered soil media and plant roots are highly effective at filtering sediment and breaking down pollutants commonly found in urban runoff.
- **ENHANCED HABITAT AND AESTHETICS** These facilities create valuable green space that can attract pollinators, birds and butterflies, turning functional infrastructure into a community amenity.
- **FLEXIBLE AND SCALABLE** Bioretention can be designed to fit a wide variety of spaces and can be distributed across a site to manage runoff close to its source.
- **INCREASED SAFETY AND TRAFFIC CALMING** When installed along streets, bioretention can create a buffer between pedestrians and vehicles and can help slow traffic.

Example applications of bioretention for different land uses are shown in **Figures 2.2 to 2.5.**

Key benefits

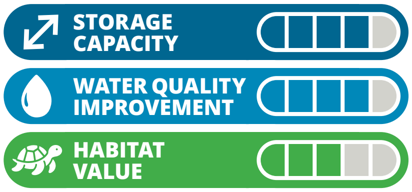


FIGURE 2.2 In a residential setting, a bioretention facility, seen here in Blue Island, can be an attractive landscape feature that also manages runoff from homes and streets.

FIGURE 2.3 In commercial parking lots, bioretention islands can break up large expanses of pavement, treat runoff and help meet landscaping requirements.

FIGURE 2.4 Along roadways, bioretention facilities can treat runoff, calm traffic and increase the capacity of existing sewer systems.

FIGURE 2.5 In parks and on campuses, bioretention can serve as an educational tool, often paired with informational signs and walking paths.

Suitability and placement

A feasibility study is critical to determine if bioretention is the right fit for a project. This involves assessing subsurface conditions (soil, groundwater), environmental factors (contaminated soils, floodplains) and site constraints (buildings, utilities).

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles: 5.3.4, 5.3.5.2; Appendix E of this guide

Designers should follow specific location and separation criteria outlined in the TGM to ensure safety and functionality.

Practice type: Bioretention is a **retention-based** practice with quantifiable storage.

Key separation distances:

» 10 feet from a building foundation (unless waterproofed).

» 20 feet from a gravel road shoulder.

» 100 feet from potable water wells or septic tanks.

» 2 feet minimum separation between the bottom of the facility and the estimated seasonal high groundwater table when discharging to a waterway (3.5 feet when discharging to MWRD facilities).

Key siting constraints:

» Should not be installed on slopes greater than 5:1 (20%) to prevent erosion and ensure stability.

» Prohibited within a floodway.

» Should not be located directly above utilities if avoidable.

» Should not be installed on top of fill material.

Additional considerations:

» **Road intersections:** Maintain a distance of at least 20 feet from intersections to prevent wide-turning vehicles from accidentally entering the facility.

» **Barriers:** Barriers (like curbs or low fencing) are required when facilities are placed closer than 2 feet from a sidewalk or road.

» **Parking spaces:** Maintain at least a 2-foot offset from the back of the curb for safe passenger egress from parked vehicles.

» **Maintenance access:** Ensure a clear access route for maintenance vehicles.

For requirements for co-locating with sewers, designers should consult the TGM directly. Refer to page 150 in ***Appendix E.1*** for further guidance for placing bioretention within a street right-of-way.

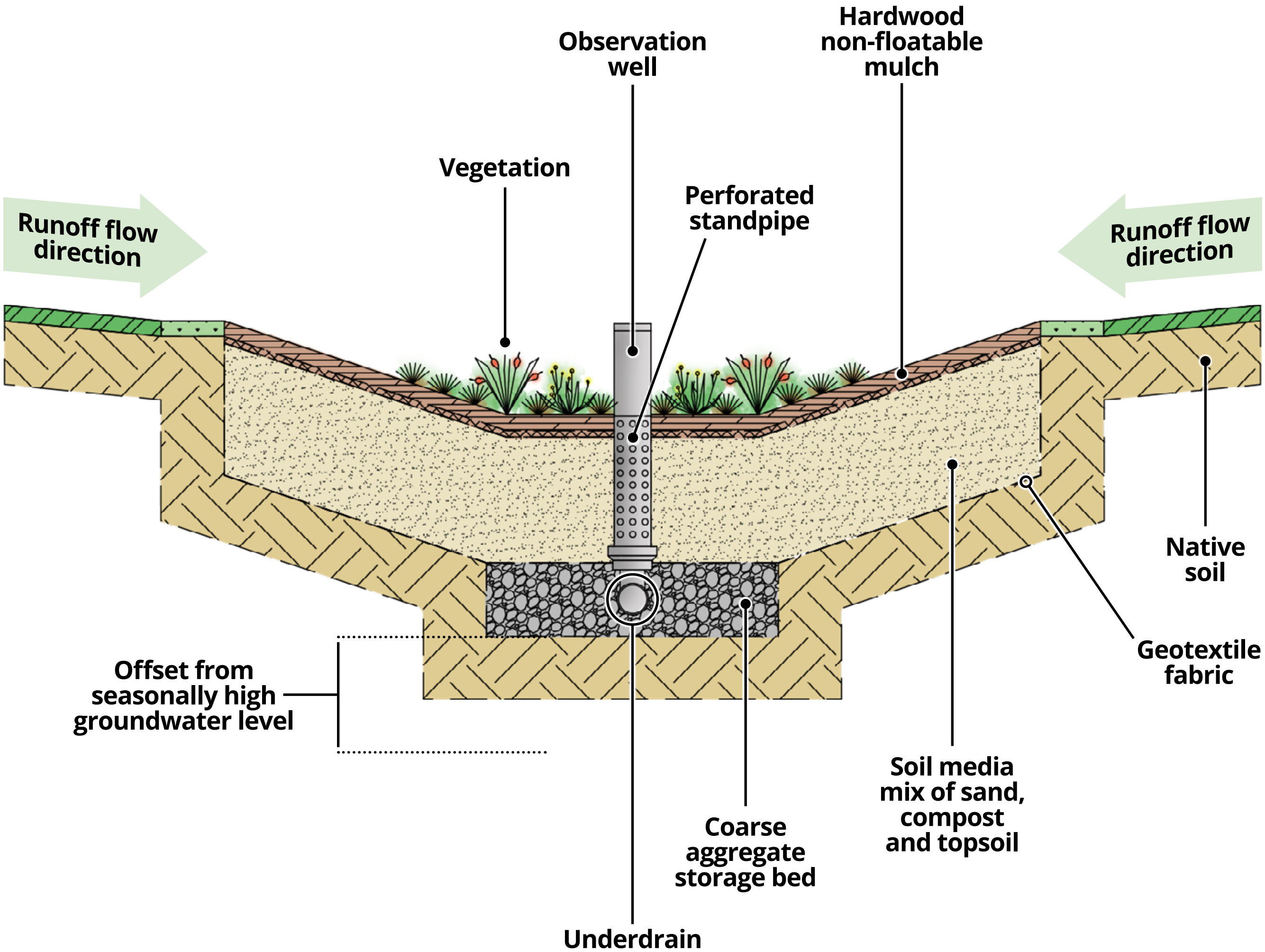
Key design elements

A bioretention facility is a layered system that mimics natural hydrologic processes. Runoff flows into the depressed area, ponds temporarily, and then slowly filters through layers that typically include mulch, growing media and a coarse aggregate base for storage (see **Figure 2.6**).

Pretreatment

Pretreatment measures protect the long-term function of a bioretention facility by capturing sediment and debris before they can clog the system. This can be achieved with vegetated filter strips, grass-lined channels, or a sump in an upstream catch basin. Where runoff enters as concentrated flow (e.g., from a pipe), a level spreader or energy dissipater (like riprap on geotextile fabric) must be used to prevent erosion.

FIGURE 2.6 A typical cross section documents the surface ponding area and the subsurface layers for filtering and storage. See *TGM Appendix C* (Bioretention Facility Detail) for detailed specifications and dimensions.



Storage and drainage

Bioretention facilities are designed to temporarily store stormwater on the surface and within the growing media and aggregate base. In areas with tight, clay soils (like much of Cook County), an underdrain—a perforated pipe at the bottom of the aggregate layer—is almost always necessary. The underdrain collects the filtered water and discharges it to the storm sewer or another downstream practice, ensuring the facility drains within 72 hours to be ready for the next storm. An observation well is also required to monitor how quickly the facility drains.

TECHNICAL SNAPSHOTS

UNDERDRAIN & OBSERVATION WELL

TGM Articles 5.3.7.2.2 & 5.3.7.2.4; TGM Appendix C (Bioretention Facility Detail)

Underdrain specs:

Required if soil test filtration rate <= 0.5 in/hour.

» **Pipe Diameter:** Maximum 4-inches.

» **Placement:** Zero slope, perforations down.

» **"Sock":** Do not use a filter sock in clay soils.

Observation well:

» **Purpose:** Required to visually monitor the drawdown rate.

» **Quantity:** One well required for every 6,000 square feet of surface area. Effective storage design is key to cost-effectiveness. While the design should aim for the maximum allowable ponding depth (typically 6 to 12 inches), the underdrain placement is critical for function, not just storage credits. The TGM requires the underdrain bedding to be between 2 and 12 inches deep. The final design should prioritize reliable drainage to ensure the facility is ready for the next storm.

QUANTIFYING STORAGE VOLUME

TGM Article 5.3.7.2.1; Tables 5.5 & 5.6; TGM Appendix C (Bioretention Facility Detail)

Designers should follow TGM guidance for calculating storage volume and designing drainage components.

» **Storage components:** Volume is calculated from surface ponding, growing media voids and coarse aggregate voids.

» **Volume credit:** TGM Table 5.6 specifies how storage volume is credited depending on the presence and location of an underdrain.

» **Surface storage:** 100% credit (up to 12 inches).

» **Storage in aggregate/growing media:** 100% credit for storage below the underdrain invert; 50% credit for storage above it. 100% credit for storage with no underdrain.

» **Porosity values:** Use TGM Table 5.5 for material porosity (e.g., coarse aggregate = 0.36, growing media = 0.25) unless test data is available. (See page 5-33 of ***TGM Article 5***.)

Growing media

The soil in a bioretention facility is a carefully specified mix—not just topsoil. It is typically a blend of sand, compost and topsoil. The growing media serves to support plant growth, filter pollutants, and provide some stormwater storage. The mix must be permeable enough to drain properly but have enough organic content and topsoil to retain moisture for plants.

TECHNICAL SNAPSHOT

GROWING MEDIA MIX

TGM Reference Table 5.4

The TGM recommends specific growing media mixes based on the underlying native soil. A standard mix is 50% sand, 30% organic compost and 20% high-quality topsoil. Designers should consult TGM Table 5.4 for other mixes based on underlying soil.

Depth: Minimum 18 inches and should extend 4 inches deeper than the largest planted root ball.

Vegetation

Plants are a critical, living component of a bioretention facility. Their roots help maintain soil porosity, they absorb nutrients and pollutants, and they release water back into the atmosphere through evapotranspiration. Plant selection should prioritize deep-rooted native species that can tolerate both wet and dry conditions.

TECHNICAL SNAPSHOT

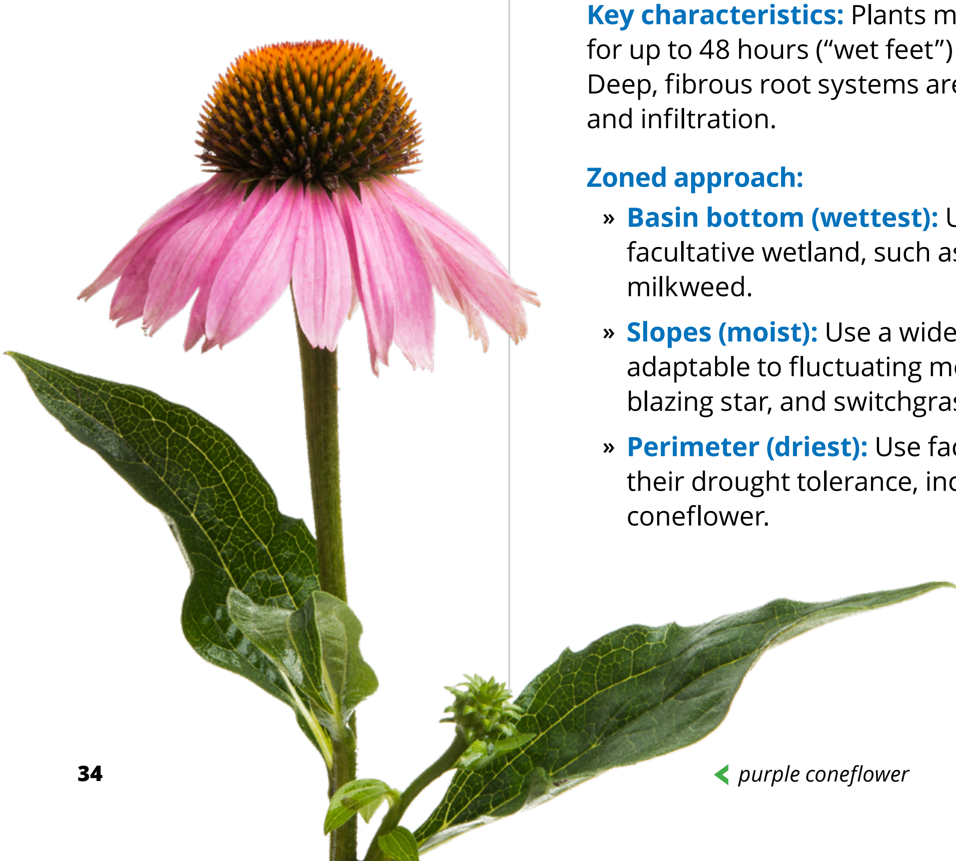
PLANT SELECTION

Plant type: A diverse mix of wildflowers, sedges, rushes and grasses. Small shrubs can also be included for structure.

Key characteristics: Plants must be able to tolerate inundation for up to 48 hours ("wet feet") as well as extended dry periods. Deep, fibrous root systems are critical for maintaining soil porosity and infiltration.

Zoned approach:

- **Basin bottom (wettest):** Use plants rated as obligate or facultative wetland, such as blue flag iris, fox sedge and swamp milkweed.
- **Slopes (moist):** Use a wide range of facultative plants that are adaptable to fluctuating moisture, like Joe Pye weed, prairie blazing star, and switchgrass.
- **Perimeter (driest):** Use facultative upland species known for their drought tolerance, including little bluestem and purple coneflower.



purple coneflower

Urban settings: Use low-growing, clump-forming plants or monocultures for a neat, maintained appearance.

Large-scale areas: A diverse mix of native grasses and perennials is ideal, especially if maintained by knowledgeable professionals.

Simplicity: Limiting the number of species can make it easier for maintenance crews to identify and remove weeds.

Refer to ***Appendix A*** for recommended native plants suitable for bioretention facilities.

Construction

CONSTRUCTION COMPLEXITY

Proper construction sequencing is vital to the long-term success of a bioretention facility. The most critical goal is to prevent compaction of the underlying native soils, which would inhibit infiltration. A preconstruction meeting is essential to review the schedule, protection methods and material specifications.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING AND PROTECTION

Construction sequencing:

1. **Protect area:** Fence off the bioretention facility footprint to prevent soil compaction by heavy equipment.
2. **Subgrade grading:** Excavate to the required depth and grade the subgrade to slope gently (approximately 1%) toward the underdrain to ensure positive drainage.
3. **Stabilize site:** Stabilize all tributary drainage areas.
4. **Surface grading:** Place growing media and mulch layers to achieve a uniform, level surface that allows for even ponding of stormwater.
5. **Planting:** Install erosion control blankets, seeding and live plants.

During construction, pay close attention to:

- **Erosion control:** Ensure soil erosion sediment control measures are in place before excavation begins.
- **Compaction:** Avoid over-compacting the underlying native soils. Scarify any smeared surfaces on the sides of the excavation.
- **Materials:** Ensure washed stone and the specified soil media mix are used.

Do not use as sediment trap: Bioretention facilities should not be used as temporary sediment traps during construction. If unavoidable, a detailed plan should be prepared and implemented to restore functionality.

During construction, use a consistent checklist (see page 102 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Bioretention facilities require regular maintenance to maintain their aesthetic and, most importantly, to function properly. The primary goals are to prevent clogging, manage vegetation, and repair any erosion. A dedicated Operations and Maintenance Plan is essential.

Maintenance activities

Typical maintenance tasks are very similar to those for any landscaped area.

- » **DEBRIS REMOVAL** Regularly remove trash, leaves and accumulated sediment from the inlet and surface of the facility.
- » **WEED CONTROL** Remove invasive species. A licensed applicator is required if using herbicides.
- » **PLANT CARE** Prune, mulch and replace plants as needed to maintain a healthy, dense plant community.
- » **REPAIR** Promptly fix any damage from erosion, animal burrowing or vehicles.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- » **CLOGGED INLETS** Sediment buildup in the curb gutter or on the splash pad.
- » **EROSION** Any observable soil loss, especially on slopes or near inlets/outlets.
- » **VEGETATION LOSS** Bare ground covering more than 10% of the surface.
- » **FLOODING** Standing water for more than 72 hours after a storm or water stains indicating past flooding.

Use the maintenance checklist on page 122 of this guide's ***Appendix C*** to guide monitoring and maintenance activities. Use ***Appendix A.6*** on page 98 to help identify invasive and aggressive plants.

Cost

RELATIVE COST

Bioretention can be a very cost-effective practice, but costs can vary significantly based on size, location and site constraints. Larger facilities in open areas are generally more cost-effective per gallon of storage than smaller facilities in tight, urban spaces with many utility conflicts.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	Volume per unit area (gal/sq ft)	Cost per unit volume ($/gal)
$11 to $30	10.2 to 12.5	$1.09 to $2.46

NOTE These ranges are for planning purposes only. See page 135 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

Bioretention's value extends beyond its direct stormwater benefits. These additional advantages can help offset project costs:

- **MEETING LANDSCAPE REQUIREMENTS** The facility can often be counted toward a development's open space or landscaping requirements.
- **GRANT FUNDING** As a highly effective green infrastructure practice, bioretention is often eligible for grant funding.
- **REDUCED PIPED INFRASTRUCTURE** By managing stormwater at the surface, bioretention can reduce the need for and the size of traditional pipes, inlets and manholes.

Native plantings, such as these Black-eyed Susans, allow bioretention areas to manage roadway runoff while enhancing neighborhood aesthetics.

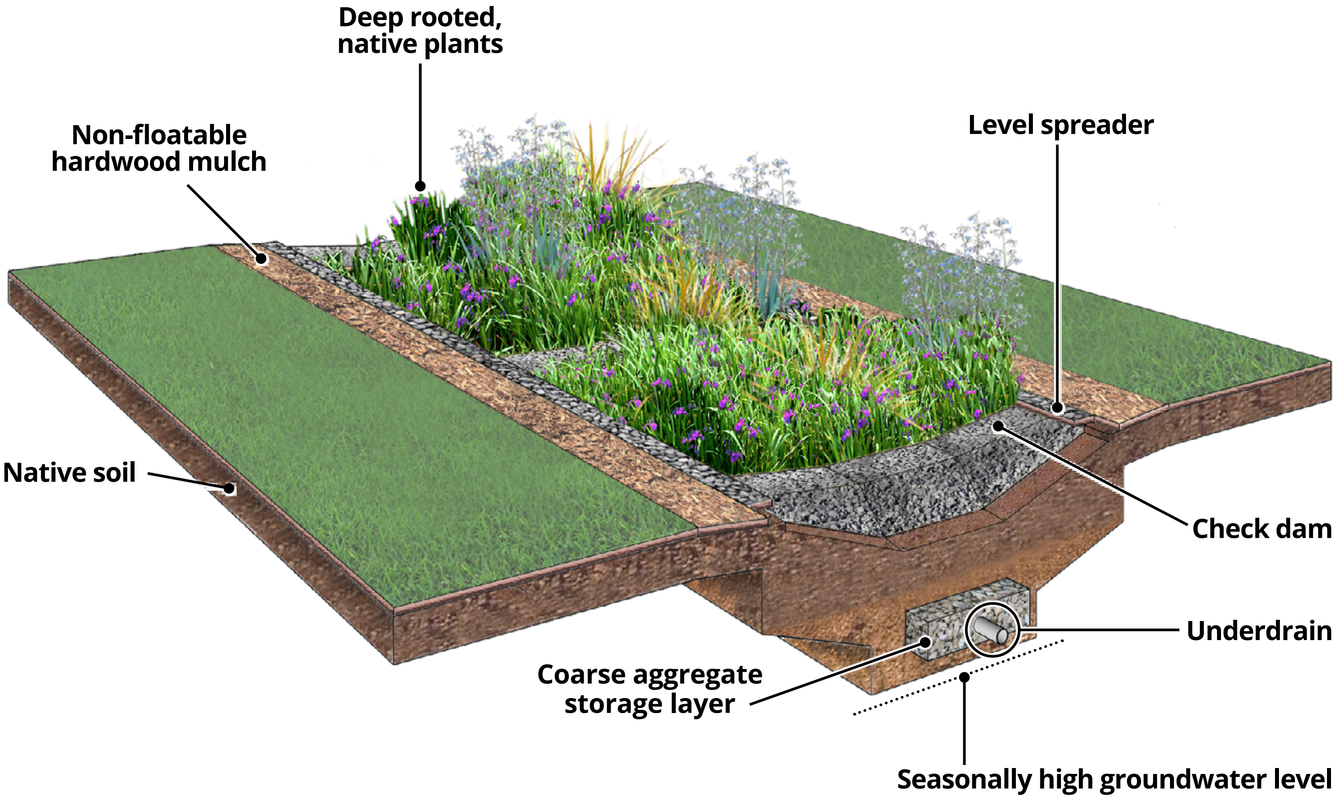
3 Bioswales

Bioswales are vegetated, constructed channels designed to convey, treat, and sometimes store stormwater runoff. Think of a bioswale as a living, vegetated replacement for a traditional storm sewer pipe or concrete-lined ditch. Instead of simply moving water away, a bioswale is designed to slow water down, clean it and allow it to soak into the ground as it flows.

Under the TGM, there are two types of bioswales depending on the design. A simple vegetated channel used for conveyance is classified as a "vegetated swale," a flow-through practice. When adding an underlying aggregate storage layer or check dam structures that hold back and slow the speed of concentrated runoff, it becomes a retention-based practice that can provide quantifiable storage to meet volume control requirements. A bioswale is essentially a long and narrowly shaped bioretention that conveys runoff. This guide uses "bioswale" as a general term to cover both designs.

Bioswales are a versatile practice that can be adapted to meet a range of stormwater management goals, from simple conveyance to full volume control. Their linear form makes them ideal for placement along roadways, at the perimeter of parking lots, and within open spaces.

FIGURE 3.1 A perspective illustration of a bioswale, featuring check dams to slow flow and increase infiltration and storage.



Key benefits

- **COST-EFFECTIVE CONVEYANCE AND STORAGE** Bioswales can replace or reduce the need for costly storm sewer pipes. When designed as a retention-based practice with check dams and storage layers, they can also provide significant, quantifiable storage to meet WMO requirements.
- **IMPROVED WATER QUALITY** The dense vegetation and optional growing media are effective at filtering sediments and breaking down pollutants found in urban runoff.
- **ENHANCED HABITAT** The use of native plants attracts pollinators, songbirds and other wildlife. Their linear shape can also function as a wildlife corridor, connecting fragmented habitats.
- **AMENITY CREATION** Bioswales can be integrated with trail networks and serve as attractive landscape features, turning functional infrastructure into a community amenity.

Example applications of bioswales for different land uses are shown in **Figures 3.2 to 3.5**.

Key benefits

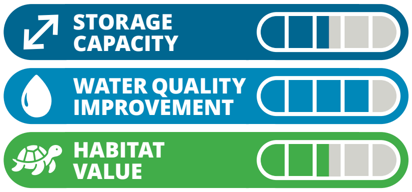


FIGURE 3.2 In a residential subdivision, a bioswale can be integrated into common areas or along roadsides.

FIGURE 3.3 In a commercial parking lot, a bioswale serves as both a landscape island and a stormwater treatment feature.

FIGURE 3.4 A simple bioswale in a public right-of-way (on the left side of the trail) provides drainage and treatment for road and trail runoff.

FIGURE 3.5 In an open park or school campus, a bioswale can serve as an outdoor educational feature.

Suitability and placement

Bioswales are adaptable but require linear space. A feasibility study is critical to determine if a bioswale is the right fit. Key considerations include the slope of the site, soil conditions, and available space. Because a retention-based bioswale is essentially an elongated bioretention facility, the placement requirements are very similar.

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles 5.3.4, 5.3.6, 5.3.7, 5.3.10.7

Designers should follow specific criteria outlined in the TGM, especially for retention-based designs.

» **Practice type:** Bioswales can be designed as flow-through practices (primarily for conveyance and basic treatment) or retention-based practices (providing quantifiable storage volume with check dams and an aggregate base).

» **Slope:** The longitudinal slope should range from 0% to 4%. The TGM allows for slopes greater than 4% if check dams are used to reduce flow velocity.

As a retention-based practice, a bioswale should follow the same placement, separation, and siting criteria as a bioretention facility. Refer to the ***Technical Snapshot: Placement Requirements*** (Chapter 2, page 31) for detailed requirements.

Key design elements

DESIGN DIFFICULTY

The design of a bioswale depends on its primary goal: simple conveyance or conveyance plus storage and infiltration. If designed as a flow-through conveyance system, a bioswale is simply an enhanced vegetated channel with deep-rooted vegetation and engineered growing media. In a retention-based design, a coarse aggregate layer can be added to provide additional storage.

Pretreatment

To prevent clogging and ensure long-term function, pretreatment is essential. This can be achieved with vegetated filter strips along the banks or by using a level spreader where runoff enters as concentrated flow. Riprap or other hard armoring is recommended to dissipate energy and prevent erosion from water flowing out of point sources like pipes.

Check dams

Check dams are small barriers made of stone or other materials built across the channel. They slow the flow of water to prevent erosion and create small pools that promote infiltration and sediment settling. From a regulatory perspective, the inclusion of check dams is critical: it creates the quantifiable surface ponding that allows the practice to be classified as retention-based under the WMO and used to meet volume control requirements.

TECHNICAL SNAPSHOT

CHECK DAMS

TGM Reference Article: 5.3.10.7, Appendix C (Bioswale Detail Sheet 2)

The TGM allows for slopes greater than 4% if check dams are used to reduce flow velocity. While not a specific TGM requirement, check dams are also a best practice for controlling erosion when flow velocities are expected to exceed 1 ft/s.

- **Height:** Maximum of 2 feet at the center.
- **Spillway:** The center of the dam must be at least 6 inches lower than the outer edges to channel high flows safely.
- **Spacing:** The top of a downstream check dam should be at the same elevation as the bottom (toe) of the upstream one. This creates a series of stepped pools along the swale.

Storage and drainage

While simple grass channels offer minimal storage, the capacity of a retention-based bioswale is significantly increased by designing dedicated storage zones and ensuring proper drainage. For retention-based bioswales designed to meet WMO requirements,

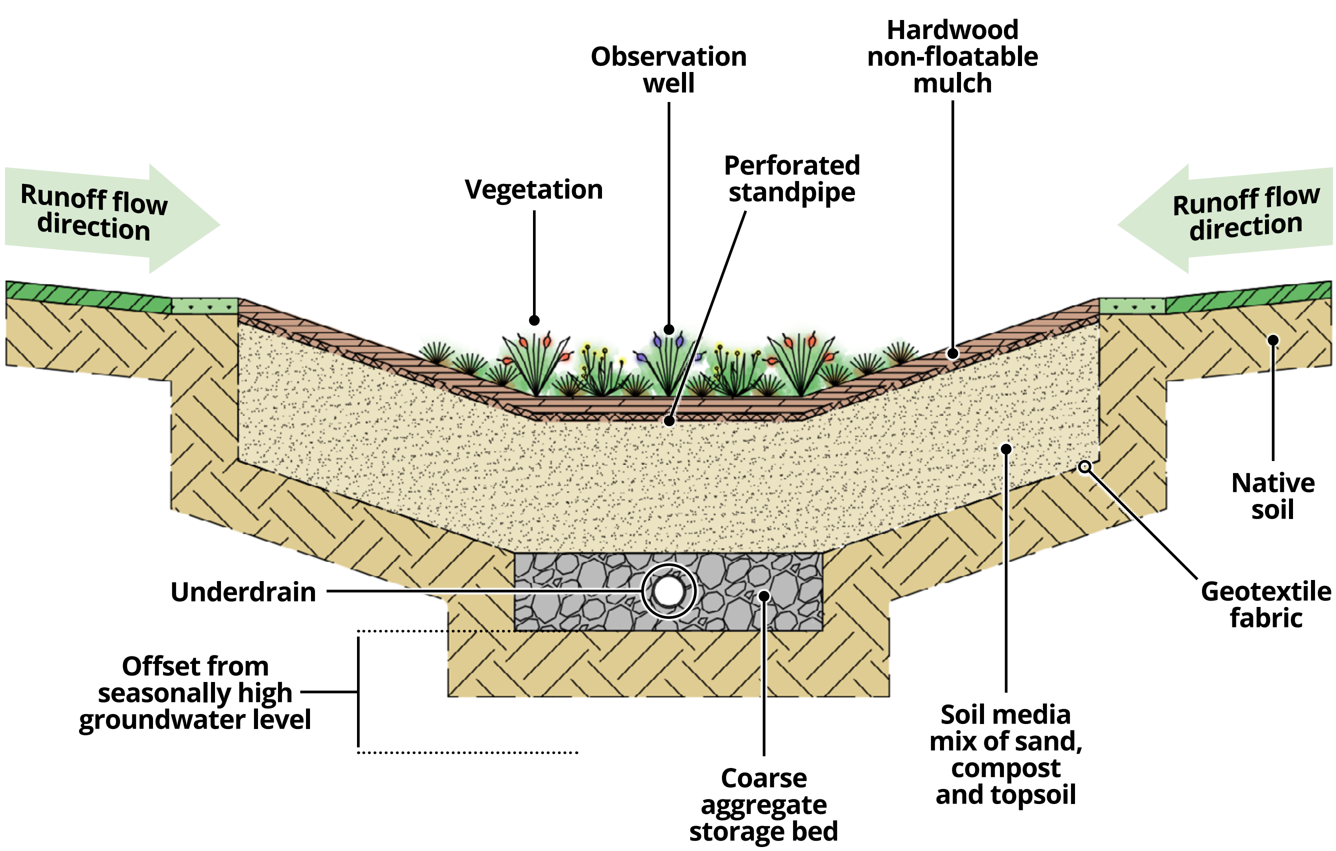


FIGURE 3.6 A typical cross section illustrates the layers for filtering and optional subsurface storage. See *TGM Appendix C* (Bioswale Detail) for detailed specifications and dimensions.

the storage and drainage components are nearly identical to those for bioretention. See ***Storage and drainage*** in Chapter 2, page 33. An underdrain is typically required in the clay soils common to Cook County to ensure the facility drains within 72 hours. Storage volume is calculated based on the surface ponding behind check dams and the void space within the growing media and aggregate layers (reference the volume table in the *Bioswale Detail* in ***TGM Appendix C***).

Growing media

The soil used in a bioswale depends on its function. A simple flow-through swale may only require 6 inches of quality topsoil. A retention-based bioswale requires a specialized, permeable growing media mix (typically sand, compost and topsoil) to support healthy plants while allowing water to filter through to the storage layer below. Refer to the ***Technical Snapshot: Growing Media Mix*** in Chapter 2, page 34 for detailed requirements.

Vegetation

Plants are a critical component, helping to slow flow, stabilize the soil and remove pollutants. Plant selection should prioritize deep-rooted native species that can tolerate both wet and dry conditions. Because bioswales are conveyance channels, erosion control blankets and the use of live plant plugs are often necessary to stabilize the soil while vegetation becomes established.

TECHNICAL SNAPSHOT

PLANT SELECTION

- **Plant type:** Primarily dense, erosion-resistant grasses, sedges, and rushes. Hardy wildflowers can be added for diversity.
- **Key characteristics:** Choose plants with strong, fibrous root systems to anchor the soil. The ability to tolerate both ponding (especially behind check dams) and dry conditions is crucial.
- **Turf grass:** May be used on side slopes but is not suitable for the base of a swale with check dams, as it does not tolerate frequent ponding.
- **Trees:** Trees should not be planted in the base of narrow swales (less than 6 feet wide) where they could obstruct flow.
- **Native plants:** For the base of the swale, robust sedges and rushes like fox sedge and soft rush are ideal. On the drier side slopes, use grasses like switchgrass or little bluestem. For swales with significant ponding, obligate wetland plants may be needed in the deepest spots. A diverse mix of native grasses and perennials is ideal.
- **Establishment:** Native plants can take up to three years to fully establish from seed. Using live plugs at the base of the swale is recommended for faster establishment and immediate soil stabilization.

Refer to ***Appendix A*** for recommended native plants suitable for bioswales.

Construction

CONSTRUCTION COMPLEXITY

Proper construction sequencing is vital. The primary goals are to achieve the correct grades and to prevent compaction of the underlying soils. A preconstruction meeting is essential to review grading plans, soil handling, erosion control and protection of the bioswale area. The site must be stabilized before the final growing media and plants are installed to prevent clogging from construction-site sediment. For detailed requirements, refer to the ***Technical Snapshot: Construction Sequencing & Protection*** on page 35 of Chapter 2. During construction, use a consistent checklist (see page 104 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Bioswales require regular landscape care to function properly and maintain their appearance. The goal is to ensure water flows through the system as designed without causing erosion, and to keep the vegetation healthy.

Maintenance activities

Typical maintenance tasks are very similar to those for any landscaped area.

- **DEBRIS REMOVAL** Regularly inspect and remove trash, sediment and leaf litter, especially from behind check dam.
- **WEED CONTROL** Remove invasive species to allow native plants to thrive.
- **MOWING/PRUNING** Mow turf on side slopes as needed. Cut back native perennial vegetation once a year in late fall or early spring.
- **EROSION REPAIR** Promptly fix any damage from erosion, especially around inlets and check dams.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- **EROSION** Look for rills or gullies forming on the side slopes or washouts around check dams.
- **SEDIMENT BUILDUP** Check for excessive sediment accumulation, which can smother vegetation and impede flow.
- **VEGETATION HEALTH** Bare ground covering more than 10% of the surface.
- **STANDING WATER (SURFACE)** Water should not pond on the surface for more than 72 hours after a storm.
- **SLOW DRAINAGE (SUBSURFACE)** For retention-based swales, check the observation well after a storm. If water has not drained from the aggregate base within 72 hours, the underdrain may be clogged.

Use the maintenance checklist on page 123 of this guide's ***Appendix C*** to guide monitoring and maintenance activities. Use ***Appendix A.6*** on page 98 to help identify invasive and aggressive plants.

Cost

RELATIVE COST

The cost of a bioswale is highly variable based on its design complexity (flow-through vs. retention-based), size and location. Retention-based bioswales with amended soils, check dams and subsurface storage are more expensive than simple grass channels. Placement is also a key factor; construction in open spaces is less costly than in a constrained right-of-way with existing utilities.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	Volume per unit area (gal/sq ft)	Cost per unit volume ($/gal)
$13 to $43	4.6 to 7.1	$2.80 to $6.08

NOTE These ranges are for planning purposes only. See page 132 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

The true value of a bioswale is realized when its multiple benefits are considered.

- **INFRASTRUCTURE SAVINGS** Bioswales can be a less expensive conveyance alternative to storm sewers.
- **LANDSCAPING CREDIT** They can be designed to help meet local open space and landscaping requirements.
- **LAND USE EFFICIENCY** By integrating conveyance, treatment and storage into a single feature, bioswales can reduce the need for separate stormwater facilities. This can free up valuable land and potentially increase the site's developable area.

4 Constructed Wetlands

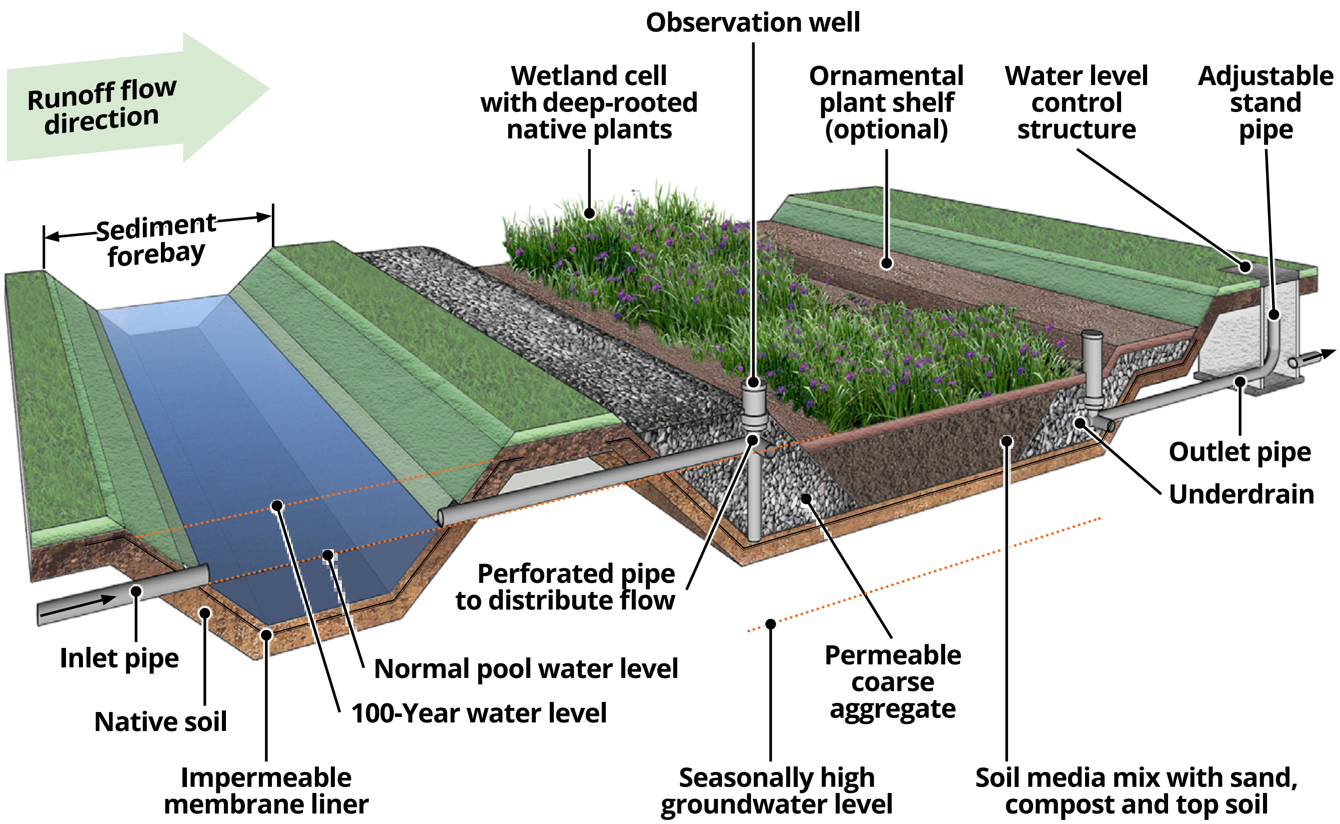
Constructed wetlands are engineered ecosystems that mimic natural wetlands to treat and store stormwater runoff. Unlike bioretention facilities that are designed to infiltrate water into the ground, constructed wetlands are designed to hold water on the surface for longer periods, creating a habitat for wetland vegetation and wildlife.

Under the MWRD's TGM, a basic constructed wetland may be considered a flow-through practice. To qualify as a retention-based practice and provide quantifiable storage to meet WMO requirements, a constructed wetland must be designed with specific components, including a sediment forebay, deepwater zones, and micropools.

Why use a constructed wetland?

For projects with available land, constructed wetlands offer the highest level of ecological function and water quality improvement of any green infrastructure practice. They transform traditional stormwater basins from single-purpose gray infrastructure into vibrant community assets that are both functional and beautiful.

FIGURE 4.1 A perspective illustration of a constructed wetland, showing its key components.



Key benefits

- » **EXCEPTIONAL HABITAT CREATION** Among all green infrastructure practices, constructed wetlands provide the highest quality habitat for a wide array of wildlife, including birds, butterflies, amphibians and other pollinators.
- » **SUPERIOR WATER QUALITY IMPROVEMENT** The combination of slow-moving water, specialized soil media, and aquatic plants is highly effective at removing sediment, nutrients and other common urban pollutants.
- » **SIGNIFICANT STORMWATER STORAGE** Designed as large basins, they can store substantial volumes of stormwater, making them highly effective for flood control and reducing peak flows to the sewer system.
- » **ENHANCED AESTHETICS AND RECREATION** These systems can be designed as beautiful landscape features, often integrated with walking trails, boardwalks, and educational signage to create recreational and learning opportunities.
- » **NATURAL GOOSE CONTROL** The tall, dense vegetation along the water's edge can deter Canada geese, which prefer open sightlines and easy access to water.
- » **IMPROVED SAFETY** The dense vegetation and shallow wetland shelves create a natural buffer that discourages access to deeper water, improving safety compared to traditional detention ponds with steep side slopes.

Example applications of constructed wetlands for different land uses are shown in **Figures 4.2 to 4.5**.

Key benefits

- STORAGE CAPACITY
- WATER QUALITY IMPROVEMENT
- HABITAT VALUE

FIGURE 4.2 In a residential setting, a large wetland provides flood storage while creating a natural amenity for the community.

FIGURE 4.3 In a commercial area, a wetland can meet storage and landscaping requirements while treating parking lot runoff.

FIGURE 4.4 In parks, wetlands create opportunities for large-scale habitat restoration and passive recreation.

FIGURE 4.5 On a school or corporate campus, a wetland can serve as an outdoor classroom and a visible commitment to sustainability.

Suitability and placement

Constructed wetlands are best suited for larger sites where land is not a major constraint. A feasibility study is critical to assess site conditions. Because they are designed to hold water, they do not have the same infiltration requirements as bioretention, but proper placement is still important to ensure they function correctly and safely. As a retention-based practice, a constructed wetland's placement requirements are similar to those of a bioretention facility.

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles 5.3.4, 5.3.5.2

Designers should follow specific criteria outlined in the TGM.

Practice type: Constructed wetlands can be designed as flow-through practices, but to provide quantifiable storage, they must be designed as retention-based practices with forebays, deepwater zones and micropools.

Key separation distances:

» 10 feet from a building foundation (unless waterproofed).

» 100 feet from potable water wells or septic tanks.

Key siting constraints:

» Should not be installed on slopes greater than 5:1 (20%) to prevent erosion and ensure stability.

» Prohibited within a floodway.

» Should not be located directly above utilities if avoidable.

Additional considerations:

» **Safety:** The design should include safety benches and gradual slopes, especially in public areas.

» **Maintenance access:** A clear, stable access route for maintenance vehicles is required.

Key design elements

DESIGN DIFFICULTY

A constructed wetland is a carefully designed system that typically includes a sediment forebay to capture coarse sediment, a main wetland cell with varying water depths (deepwater zones and micropools) and to support diverse vegetation, and a control structure to manage the water level.

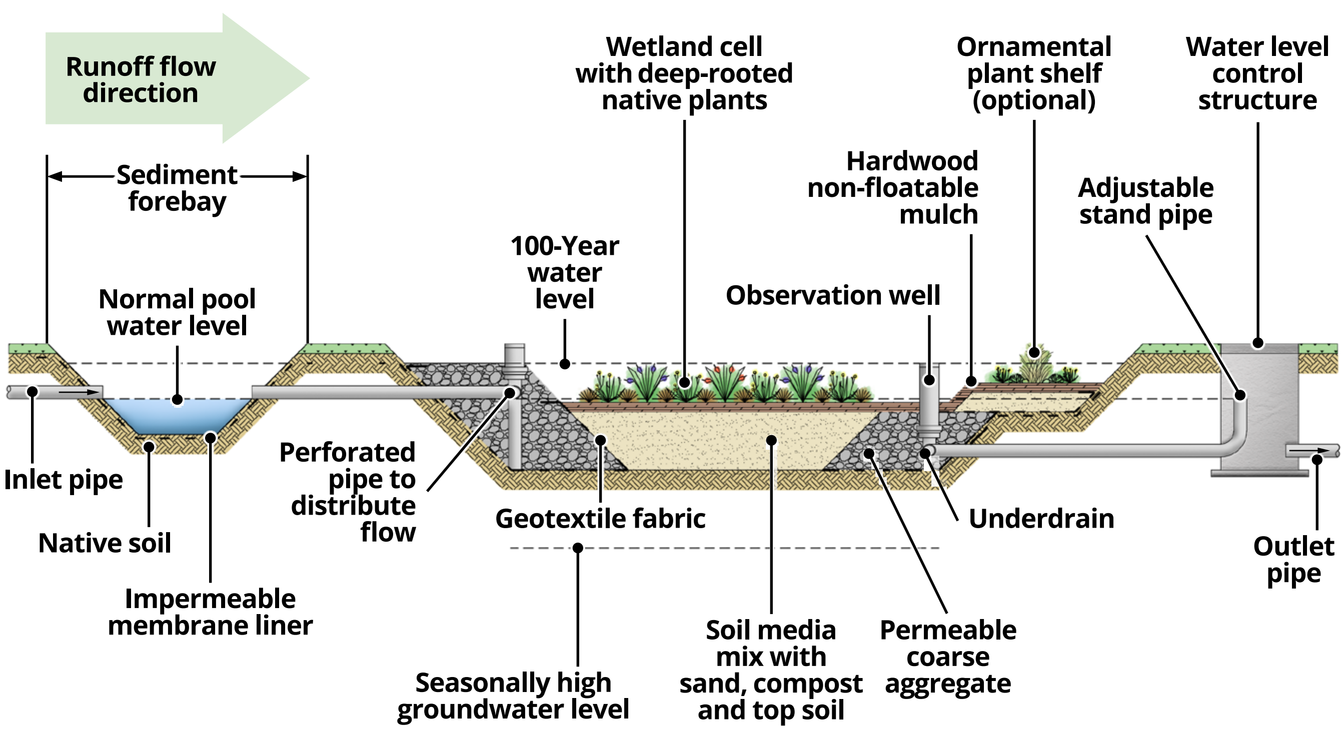
Pretreatment

A sediment forebay is a required pretreatment component. It is a small, deep pool at the inlet that slows incoming runoff, allowing sand, gravel and other heavy sediments to settle out before they can enter the main wetland area. This protects the wetland from being smothered by sediment and concentrates maintenance in one easily accessible location.

Storage and drainage

Constructed wetlands are designed to have a permanent pool of water, which provides reliable hydration for wetland plants and creates aquatic habitats. The storage volume for flood control is provided above this permanent pool level. An inlet with a perforated pipe is used to distribute the flow from the forebay across the width of the wetland cell. An outlet control structure with an adjustable riser or weir is used to set the permanent water level. Using an underdrain connected to the outlet control structure, the temporary storage volume provided above the permanent pool must be able to drain within 72 hours to be available for subsequent storms. The underdrain, used in combination with the adjustable riser, also allows the facility to dewater for maintenance.

FIGURE 4.6 A typical constructed wetland cross section displays the sediment forebay, main treatment cell and outlet structure. See ***TGM Appendix C*** (Constructed Wetland Detail) for detailed specifications and dimensions.



TECHNICAL SNAPSHOT

QUANTIFYING STORAGE VOLUME

TGM Article 5.3.7.2.1; TGM Appendix C (Constructed Wetland Detail)

Designers should follow TGM guidance for calculating storage volume.

» **Storage components:** Volume is calculated from the surface ponding area between the permanent pool elevation and the high-water elevation. Additional storage can be provided in a subsurface aggregate layer if included.

» **Drainage:** The permanent pool is not required to drain, but the temporary storage volume above it must drain within 72 hours.

Growing media

The soil in a constructed wetland must support robust aquatic plant growth while also helping to filter pollutants. If the native soil is unsuitable, an engineered growing media — typically a mix of sand, compost, and topsoil — can be used. Refer to the ***Technical Snapshot: Growing Media Mix*** on page 34 of Chapter 2 for detailed requirements.

Vegetation

Plants are the living engine of a constructed wetland, responsible for most of the water quality treatment. A diverse community of native wetland plants is recommended to create a resilient and effective ecosystem. The design should include zones for different types of plants based on water depth.

TECHNICAL SNAPSHOT

PLANT SELECTION

Plant type: A diverse community of aquatic and semi-aquatic plants, including emergent, submergent, and shoreline species.

Key characteristics: Plants must be adapted to saturated soils or living directly in shallow water. Different species are chosen for different water depths.

Zoned approach:

» **Deep water zones (>12 in.):** Use submerged plants (like sago pondweed) and floating plants (like water lilies).

» **Shallow water zones (0-12 in.):** Use emergent plants like rushes, sedges, cattails and common arrowhead that grow in standing water.

» **Shoreline/upland zones:** Use facultative wetland (FACW) species like swamp milkweed and Joe Pye weed that tolerate occasional inundation but also drier conditions.

Establishment: Live plant plugs are recommended for establishing vegetation within the permanent pool area, as seeds will not germinate underwater. Waterfowl exclusion fencing is often needed to protect new plugs.

Refer to ***Appendix A*** on page 92 of this guide for recommended native plants. Select species from the obligate and facultative-wet sections and the aquatic plants section.

Construction

CONSTRUCTION COMPLEXITY

Construction of a wetland requires careful grading to achieve the specified elevations for different planting zones and water depths. Protecting the area from construction site runoff is critical to prevent the new wetland from being clogged with sediment before it is even established. A preconstruction meeting is essential to review the plans, material specifications, and a construction sequence.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING & PROTECTION

1. **Protect area:** Fence off the wetland footprint to prevent soil compaction and premature sediment loading.
2. **Excavation & grading:** Excavate the basin and carefully grade the forebay, micropools, and planting benches to the design elevations.
3. **Install outlet & underdrain:** Install the outlet control structure and any underdrain piping.
4. **Place soil & media:** Place and grade the growing media.
5. **Stabilize site:** Ensure all tributary drainage areas are fully stabilized with vegetation before allowing runoff to enter the wetland.
6. **Planting:** Install live plugs, seed, and erosion control blankets.
7. **Initial fill:** Slowly fill the wetland with water to the permanent pool elevation to hydrate the plants and soils.

During construction, use a consistent checklist (see page 106 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Constructed wetlands are dynamic, living systems that require ongoing maintenance to ensure their health and functionality. The primary goals are to manage invasive species, maintain the structural integrity of inlets and outlets, and remove accumulated sediment over the long term.

Maintenance activities

Typical maintenance tasks include:

- **WEED CONTROL** Aggressively manage invasive species like phragmites and reed canary grass, especially during the first few years of establishment.
- **DEBRIS REMOVAL** Regularly inspect and clear the inlet and outlet structures to prevent clogging.
- **VEGETATION MANAGEMENT** Prune or remove vegetation as needed to maintain sightlines or prevent encroachment on structures. An annual mowing or prescribed burn of upland buffer areas may be required.
- **SEDIMENT REMOVAL** The sediment forebay will need to be cleaned out every 5-10 years, or when it is 50% full.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- » **INVASIVE SPECIES** Dominance by one or two aggressive species (e.g., cattails, Phragmites).
- » **CLOGGED OUTLET** The water level is significantly higher than the permanent pool elevation during dry weather.
- » **EROSION** Scouring is visible at the inlet or outlet, or on side slopes.
- » **VEGETATION HEALTH** Large areas of bare ground or stressed vegetation.

Use the maintenance checklist on page 124 of ***Appendix C*** to guide monitoring and maintenance activities. Use ***Appendix A.6*** on page 98 to help identify invasive and aggressive plants.

Cost

$ RELATIVE COST

The cost of a constructed wetland is primarily driven by its size and the amount of earthwork required. While they have a higher initial cost than a simple dry detention basin due to the need for soil media and extensive planting, they are often more cost-effective than traditional wet ponds when their superior water quality and habitat benefits are considered.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	Volume per unit area (gal/sq ft)	Cost per unit volume ($/gal)
$9 to $32	9.0 to 9.3	$0.95 to $3.42

NOTE These ranges are for planning purposes only. See page 137 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

The true value of a constructed wetland is realized when its multiple benefits are considered.

- » **REDUCED INFRASTRUCTURE** By providing both water quality treatment and flood storage in one facility, wetlands can reduce the need for separate downstream infrastructure.
- » **LANDSCAPING CREDIT** The facility can often be counted toward a development's open space or landscaping requirements.
- » **AMENITY VALUE** As a valuable aesthetic and recreational feature, a well-designed wetland can increase surrounding property values.
- » **REGULATORY VALUE** In some cases, large-scale constructed wetlands can be used to mitigate off-site wetland impacts from a development.

5 Urban Stormwater Trees

Urban stormwater trees are specialized planting systems that integrate healthy, mature trees into hard-to-plant urban areas like sidewalks and plazas. More than just a tree in a pit, these systems are engineered to capture and treat stormwater runoff from adjacent pavement, using specially designed soils and subsurface storage.

They are a critical tool for bringing the benefits of green infrastructure to the most densely developed parts of a community. By creating dedicated space for roots to thrive under pavement, these systems allow large, healthy trees to grow in environments where they would otherwise struggle, all while managing stormwater, beautifying the streetscape and improving public health.

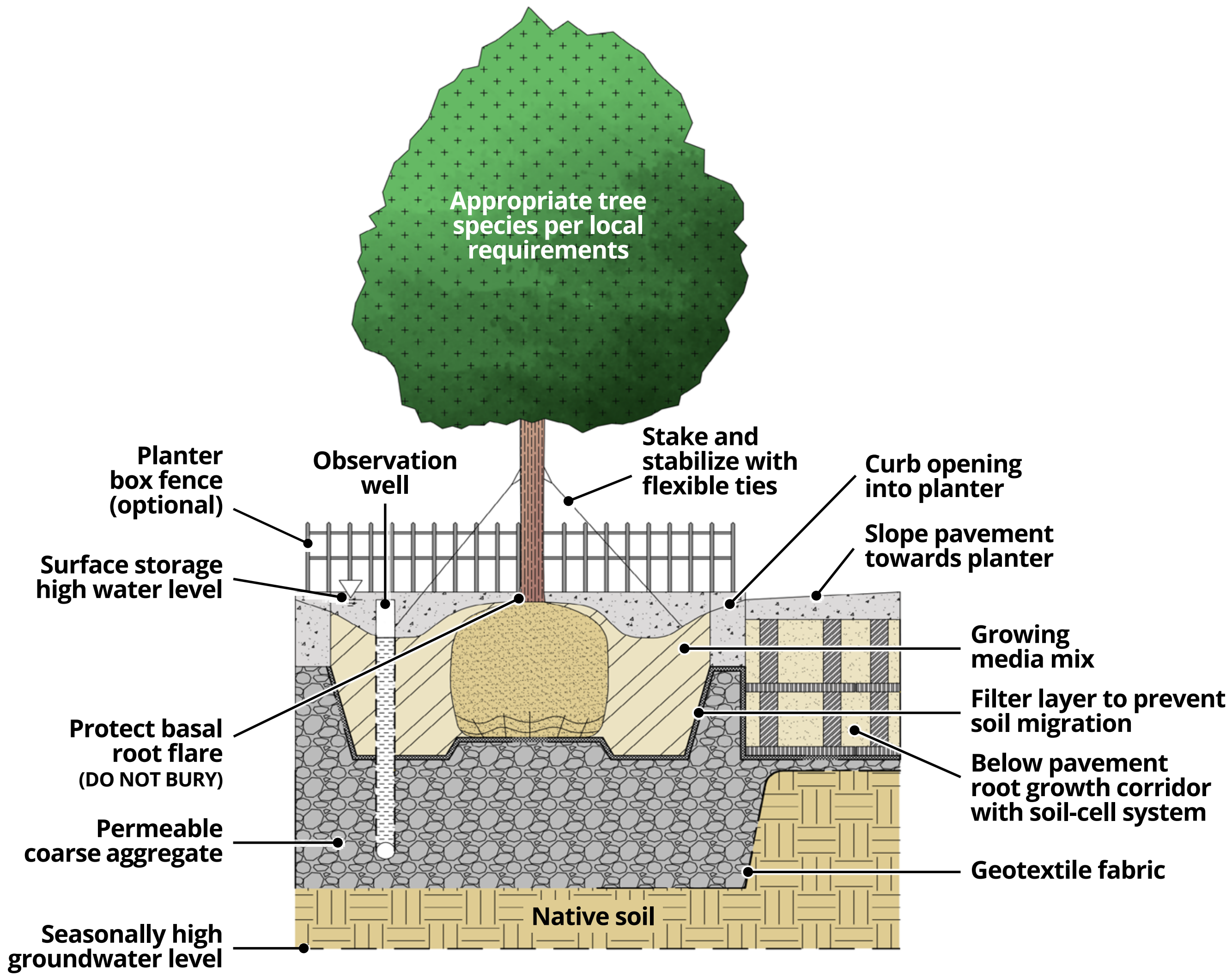


FIGURE 5.1 A cross section of a typical urban stormwater tree planter. See ***TGM Appendix C*** (Urban Tree Stormwater Planter Box Profile View) for detailed specifications and dimensions.

Why use an urban stormwater tree?

In dense urban cores, where every square foot matters, stormwater trees offer a way to add high-performing green infrastructure without sacrificing valuable space. They are a smart, efficient solution for greening streets, calming traffic and managing runoff in the public right-of-way.

Key benefits

- **IMPROVED TREE HEALTH AND CANOPY** By providing uncompacted soil and consistent moisture, these systems allow street trees to grow larger and live longer, maximizing benefits like shade, air quality improvement and carbon sequestration.
- **ENHANCED STREETSCAPE AND ECONOMIC VITALITY** A healthy urban tree canopy is proven to increase property values, attract shoppers to commercial districts, and create a more welcoming and walkable environment.
- **EFFECTIVE STORMWATER MANAGEMENT** The engineered system captures and filters runoff, removing pollutants and reducing the volume of water entering the sewer system, which is critical in highly impervious areas.
- **TRAFFIC CALMING AND PEDESTRIAN SAFETY** When placed along streets, stormwater trees create a physical and visual buffer between sidewalks and roadways, which can help slow traffic and improve pedestrian safety.
- **AIR QUALITY AND HEAT ISLAND REDUCTION** Mature trees are highly effective at filtering air pollutants and providing shade, which helps cool surrounding pavement and combat the urban heat island effect.

Example applications of urban stormwater trees for different land uses are shown in **Figures 5.2 to 5.5**.

Key benefits

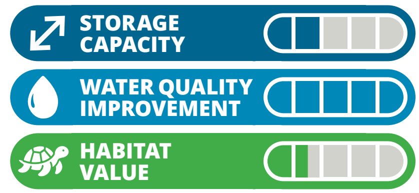


FIGURE 5.2 In a dense residential setting, stormwater trees enhance aesthetics and manage sidewalk runoff.

FIGURE 5.3 In high-density commercial areas, stormwater trees provide critical runoff management while enhancing walkability and aesthetic appeal for local businesses.

FIGURE 5.4 Stormwater trees optimize the public right-of-way by treating runoff underground. The trees utilize infrastructure like the modular soil cells shown here to reduce sewer strain while supporting a healthy urban canopy.

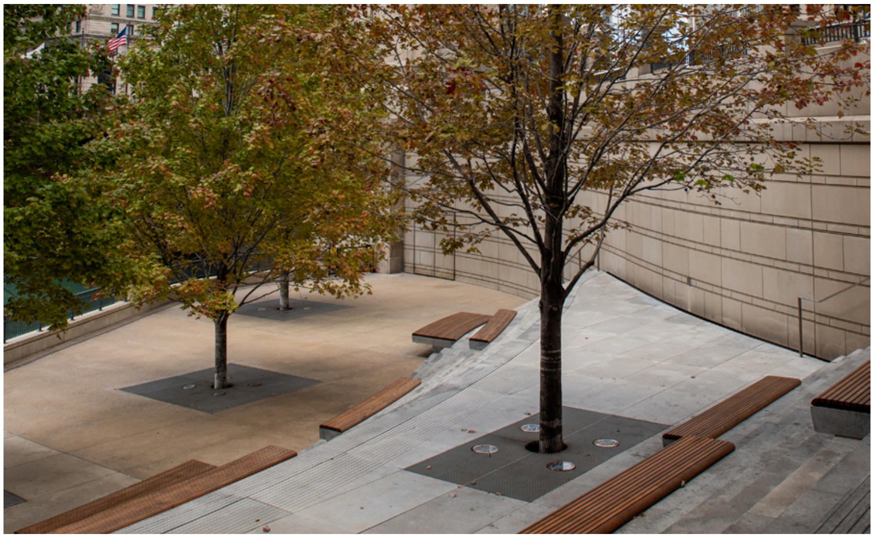


FIGURE 5.5 In an urban plaza, trees create comfortable, shaded public spaces while managing runoff from surrounding pavement.

Suitability and placement

Urban stormwater trees are specifically designed for constrained, ultra-urban sites. A feasibility study is critical to assess site constraints, particularly the presence of underground utilities, which is a common challenge in dense areas. Because they function as a specialized form of bioretention, their placement requirements under the TGM are identical to those for bioretention facilities.

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles 5.3.4, 5.3.5.2

Designers should follow specific criteria outlined in the TGM.

Practice type: While not explicitly named in the TGM, urban stormwater trees are designed as a form of bioretention and are considered a retention-based practice with quantifiable storage.

As a retention-based practice, an urban stormwater tree should follow the same placement, separation, and siting criteria as a bioretention facility. Refer to the ***Technical Snapshot: Placement Requirements*** on page 31 of Chapter 2 for detailed requirements.

Additional considerations:

- **Soil volume:** A minimum of 1,000 cubic feet of uncompacted soil volume per tree is recommended for healthy growth.
- **Pedestrian access:** In high-traffic areas, a tree grate or low fencing is required to protect the soil from compaction and ensure pedestrian safety.
- **Parking:** Maintain at least a 2-foot offset from the back of the curb for safe passenger egress from parked vehicles.
- **Branch clearance:** The selected tree species and its placement must accommodate clearance requirements for vehicles and pedestrians.

Refer to page 152 of this guide's ***Appendix E.2*** for further guidance for placing an urban stormwater tree within a street right-of-way.

Key design elements

DESIGN DIFFICULTY

An urban stormwater tree system is a self-contained unit. Runoff enters through a curb cut or grate, ponds temporarily, and filters through an engineered growing media. The filtered water is stored in a subsurface aggregate layer before it is slowly released to the sewer system via an underdrain. The key innovation is providing a large volume of uncompacted soil, often using structural cells. These structural cells are modular plastic frameworks (see **Figure 5.4**) that can support the weight of a sidewalk while holding uncompacted soil in their open spaces, creating a robust, load-bearing rooting zone for the tree.

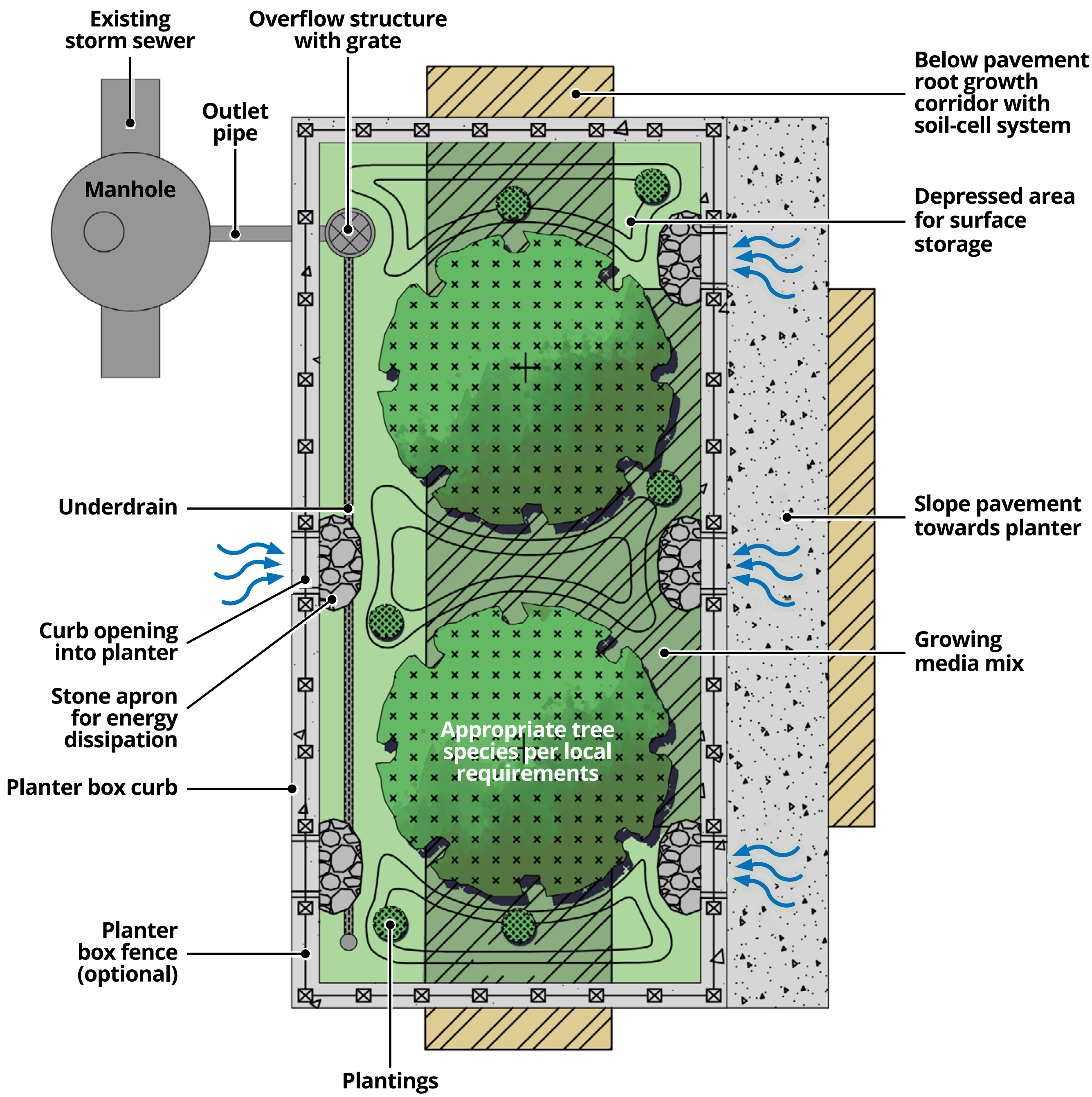


FIGURE 5.6 A plan view of a typical urban stormwater tree planter. See *TGM Appendix C* (Urban Tree Stormwater Planter Box Plan View) for detailed specifications and dimensions.

Pretreatment

Pretreatment is essential to prevent trash, coarse sediment and winter salt from damaging the tree and clogging the system. This is often achieved with a small, rock-lined or paved sump area near the inlet where debris can collect for easy removal.

Storage and drainage

Like a bioretention facility, storage is provided by the surface ponding area and the void space within the growing media and aggregate base. An underdrain is required to ensure the system drains within 72 hours. An overflow structure is also critical to safely convey flows from larger storms into the sewer system. Refer to ***Storage and drainage*** on page 33 of Chapter 2 for discussion on underdrains, observation well and quantifying storage volume. To quantify volume control storage, also reference the volume table in the Urban Tree Stormwater Planter Box Profile View in ***TGM Appendix C***.

Growing media

The growing media should support vigorous tree growth while also being able to filter pollutants and drain properly. The mix is similar to that used for bioretention. Refer to the ***Technical Snapshot: Growing Media Mix*** on page 34 of Chapter 2 for detailed requirements. When extending the growth corridor under adjacent pavement without a modular soil-cell system, a structural soil should be specified to provide support for the overlying pavement. Structural soil typically consists of coarse aggregates with the pore space filled by the growing media mix.

Vegetation

Plant selection is critical. The chosen tree species must be tolerant of urban conditions, including road salt, restricted root zones and occasional inundation. The tree's mature size, form and branching structure must also be compatible with the surrounding infrastructure.

TECHNICAL SNAPSHOT

PLANT SELECTION

Plant type: A single, hardy, medium-to-large shade tree. Companion perennials or grasses can be used as a groundcover within the planter.

Key characteristics: The tree must be tolerant of road salt, air pollution, restricted root zones and occasional flooding. It should have an upright, columnar form to avoid conflicts with pedestrians, vehicles or adjacent buildings.

Root system: Select species that are less prone to developing large surface roots that can damage sidewalks.

Refer to ***Appendix A*** on page 92 of this guide for a list of recommended trees and companion plants suitable for urban stormwater planters.

Construction

CONSTRUCTION COMPLEXITY

Construction within a dense urban public right-of-way is complex and may require careful coordination with multiple jurisdictions and utility stakeholders. The presence of existing utilities is the biggest challenge and must be thoroughly investigated before design begins. A preconstruction meeting is essential to coordinate with all parties and review the detailed construction sequence, especially if it involves sidewalk closures or traffic control.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING & PROTECTION

1. **Utility location:** Perform extensive utility investigation (e.g., ground-penetrating radar, vacuum excavation) prior to excavation.
2. **Excavation:** Excavate the planter pit and install the planter box walls or structural cells.
3. **Install infrastructure:** Install the underdrain, overflow structure and any irrigation lines.
4. **Backfill:** Carefully place the aggregate and growing media in lifts, avoiding compaction.
5. **Install tree:** Plant the tree, ensuring the root flare is not buried and at the correct elevation.
6. **Install surface:** Install the tree grate and/or pour the final sidewalk surface.

During construction, use a consistent checklist (see page 114 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Urban stormwater trees require regular care to ensure their long-term health and the proper function of the stormwater system. Maintenance is more intensive than for a typical landscape bed.

Maintenance activities

Typical maintenance tasks include:

- **DEBRIS REMOVAL** Regularly remove trash, leaves, and sediment from the surface and inlet/outlet structures.
- **PLANT HEALTH CARE** Water the tree regularly, especially during periods of drought, during the first two years of establishment. Prune the tree as needed to maintain structural integrity and required clearances. Monitor for pests and diseases.
- **WEED CONTROL** Remove weeds from the planter surface.
- **GRATE ADJUSTMENT** As the tree trunk grows, the opening in the tree grate will need to be expanded to prevent girdling.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- » **CLOGGED INLET** Water from the street is bypassing the planter.
- » **STANDING WATER** Water ponds on the surface for more than 72 hours after a storm.
- » **TREE STRESS** Signs of wilting, yellowing leaves or pest infestation.
- » **SOIL COMPACTION** The surface soil is visibly compacted from foot traffic.

Use the maintenance checklist on page 125 of this guide's ***Appendix C*** to guide monitoring and maintenance activities.

Cost

$ RELATIVE COST

Urban stormwater trees are one of the more expensive green infrastructure practices on a per-unit basis, largely due to their construction in complex urban environments and the use of specialized materials like structural cells and tree grates.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	Volume per unit area (gal/sq ft)	Cost per unit volume ($/gal)
$107 to $213	12.3	$8.76 to $17.28

NOTE These ranges are for planning purposes only. See page 139 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

Despite the high initial cost, the long-term value and multiple co-benefits can make stormwater trees a wise investment.

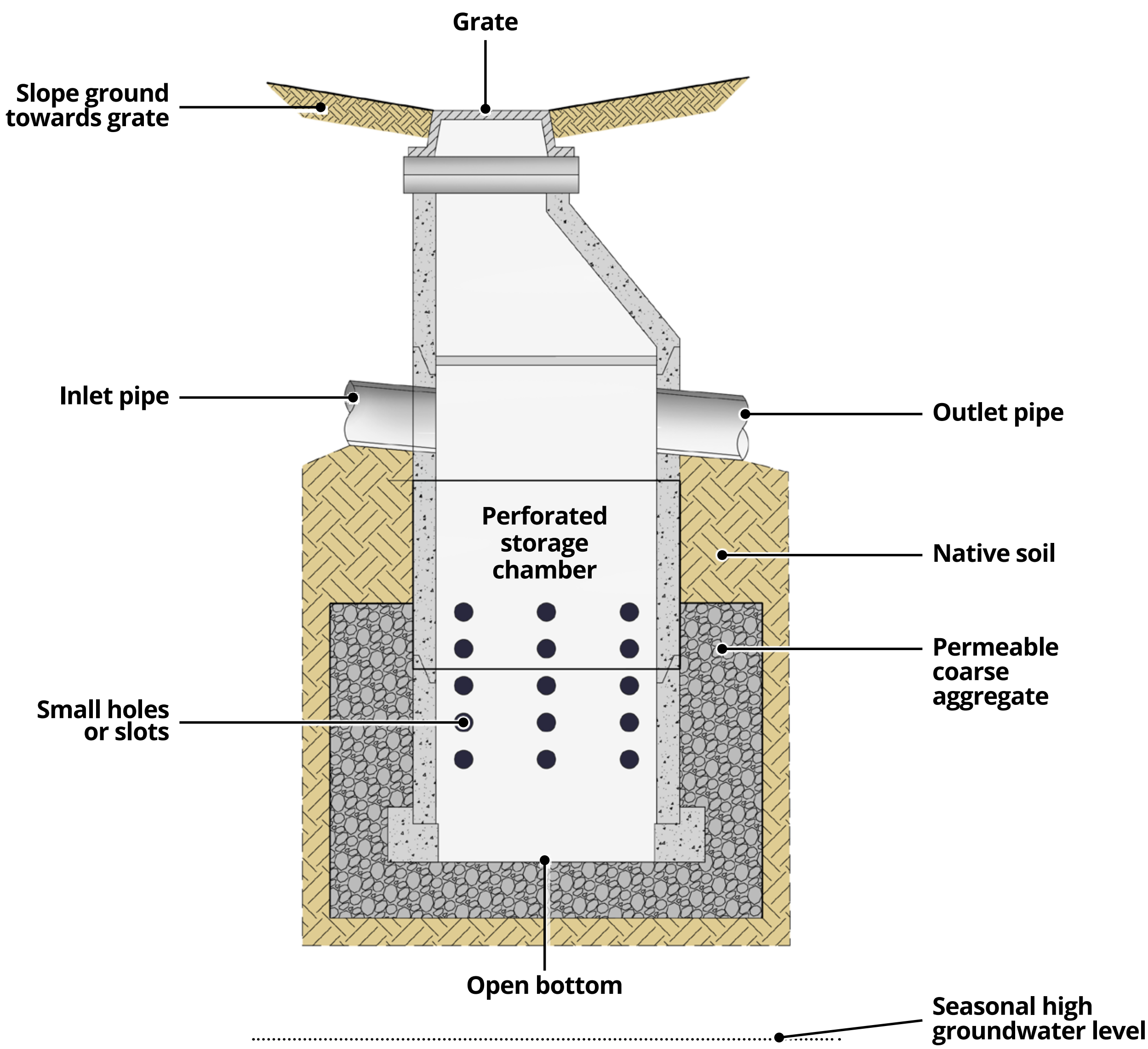
- » **REDUCED INFRASTRUCTURE COSTS** A distributed network of stormwater trees can reduce the required size of downstream pipes and storage facilities.
- » **INCREASED PROPERTY VALUES** Healthy street trees are consistently shown to increase residential and commercial property values.
- » **PUBLIC HEALTH SAVINGS** The benefits of improved air quality and reduced heat island effect can lead to measurable public health savings.
- » **GRANT FUNDING** As highly visible and effective green infrastructure, these projects are often strong candidates for grant funding.

6 Dry Wells

Dry wells are underground structures designed to collect stormwater runoff and allow it to soak into the surrounding soil. Typically consisting of a perforated chamber surrounded by gravel, they function like a drain, efficiently moving water from the surface to the subsurface.

As a completely buried system, dry wells are an ideal solution for managing stormwater in locations where surface space is limited or where a visible green infrastructure feature is not desired. They are a space-efficient, low-maintenance tool for reducing runoff volume and recharging groundwater, particularly on sites with well-draining soils.

FIGURE 6.1 Cross section of a typical dry well using a perforated precast reinforced concrete catch basin. See ***TGM Appendix C*** (Drywell Detail) for detailed specifications and dimensions.



Why use a dry well?

Dry wells are a practical and cost-effective solution for managing stormwater invisibly. Their key advantage is their ability to provide significant storage capacity in a very small footprint, making them perfect for dense urban and suburban sites where space is at a premium.

Key benefits

- **SPACE EFFICIENCY** Because the entire system is underground, dry wells require no surface space, freeing up valuable land for other uses like parking, landscaping or buildings.
- **GROUNDWATER RECHARGE** By infiltrating stormwater directly into the soil, dry wells help replenish local groundwater aquifers, a critical benefit for community water supply and environmental health.
- **COST EFFECTIVE** Dry wells typically have lower installation and long-term maintenance costs compared to more complex green infrastructure practices, especially those involving extensive landscaping.
- **EASE OF INSTALLATION** Construction is relatively straightforward and can often be completed quickly with standard excavation equipment.
- **REDUCED FLOOD RISK** By capturing runoff from roofs and pavement, dry wells can help reduce localized ponding and relieve pressure on the traditional sewer system during storms.

Example applications of dry wells for different land uses are shown in **Figures 6.2 to 6.5**.

Key benefits

STORAGE CAPACITY

WATER QUALITY IMPROVEMENT

HABITAT VALUE

FIGURE 6.2 In a residential setting, a dry well can manage runoff from a roof or driveway, eliminating soggy spots in the yard.

FIGURE 6.3 In a public right-of-way, dry wells can be installed to capture street and sidewalk runoff without disrupting pedestrian flow. In the photo, dry wells are integrated within a bioretention area to create a hybrid system.

FIGURE 6.4 In a commercial site, a series of large dry wells can be installed under parking lots or landscaped areas to meet storage requirements.

FIGURE 6.5 In parks or open spaces, a series of smaller dry wells can be used to address localized drainage issues without disturbing large areas.

Suitability and placement

The success of a dry well depends almost entirely on the infiltration capacity of the underlying soil. They are only suitable for sites with sandy or loamy soils that can absorb water relatively quickly. A feasibility study, including soil testing, is essential. Because they inject water directly into the ground, they must be positioned carefully to avoid impacts to building foundations, wells and areas of high groundwater.

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles 5.3.4, 5.3.5.2

Designers should follow specific location and separation criteria outlined in the TGM. As a retention-based practice, the requirements are similar to those for bioretention.

Practice type: Dry wells are a retention-based practice with quantifiable storage.

Soil requirement: The TGM requires a soil infiltration test to be performed. The underlying soil infiltration rate must be between 0.5 and 2.41 inches per hour.

Key separation distances:

» 10 feet from a building foundation (unless waterproofed).

» 20 feet from a gravel road shoulder.

» 100 feet from potable water wells or septic tanks.

» 2 feet minimum separation between the bottom of the facility and the estimated seasonal high groundwater table when discharging to a waterway (3.5 feet when discharging to MWRD facilities).

Key siting constraints:

» Should not be installed on slopes greater than 5:1 (20%).

» Prohibited within a floodway.

» Should not be located directly above utilities if avoidable.

» Should not be installed on top of fill material.

Key design elements

DESIGN DIFFICULTY

A dry well is a simple system. Runoff is directed to the facility through an inlet pipe. It fills a buried chamber — either a precast perforated structure or a pit filled with coarse aggregate — and is stored temporarily in the void spaces. The stored water then gradually infiltrates out of the open bottom and perforated sides into the surrounding soil.

Pretreatment

Pretreatment is critical for preventing the dry well from clogging with sediment and debris. For runoff from roofs, filter screens on downspouts are required. For runoff from pavement, an upstream sump catch basin or manhole with a trash rack is required to capture coarse sediment and trash before they can enter the dry well.

Storage and drainage

The storage volume of a dry well is calculated from the space within the chamber and the surrounding aggregate. An overflow outlet should be included in the design to safely convey flows that exceed the dry well's storage capacity. The system should be designed to drain completely within 72 hours to be ready for the next storm. Unlike bioretention, an underdrain is not a standard component, as this practice is only suitable for sites with soils that can infiltrate water without assistance.

TECHNICAL SNAPSHOT

QUANTIFYING STORAGE VOLUME

TGM Article 5.3.7.2.1; TGM Tables 5.5 & 5.6; TGM Appendix C (Drywell)

Designers should follow TGM guidance for calculating storage volume.

Storage components: Volume is calculated from the void space below the overflow outlet within the chamber and the surrounding coarse aggregate (see ***TGM Appendix C*** *Drywell)*.

Porosity values: Use TGM Table 5.5 for material porosity (e.g., Coarse aggregate = 0.36) unless specific material data is available. (See page 5-33 of ***TGM Article 5***.)

Construction

CONSTRUCTION COMPLEXITY

Dry well construction is straightforward but requires careful attention to soil protection. It is critical to prevent smearing and compaction of the soils at the bottom and sides of the excavation, as this will reduce the system's infiltration capacity. A preconstruction meeting is important to review material specifications and the construction sequence.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING & PROTECTION

1. **Excavation:** Excavate the pit to the design dimensions. Avoid over-excavating.
2. **Protect soils:** Do not allow heavy equipment to drive in the bottom of the pit. The sides and bottom of the excavation should be scarified (raked) just before placing the aggregate to remove any smeared soil.
3. **Place aggregate & chamber:** Place the bottom layer of washed aggregate, set the precast chamber (if used), and then backfill with aggregate around the sides.
4. **Install geotextile:** Wrap the top and sides of the aggregate with non-woven geotextile fabric to prevent fine soil from migrating into the system.
5. **Connect pipes:** Connect the inlet and overflow pipes.
6. **Backfill:** Backfill over the system with native soil and restore the surface.

During construction, use a consistent checklist (see page 112 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Dry wells require minimal maintenance, focused primarily on ensuring that the pretreatment measures are clean and functional. Because the system is buried, regular inspection of the dry well is the primary way to assess its performance.

Maintenance activities

Typical maintenance tasks include:

- **PRETREATMENT CLEANING** Regularly (at least twice a year) clean out leaves and debris from downspout filters and sump catch basins.
- **INLET/OUTLET INSPECTION** Ensure the inlet pipe is clear of obstructions.
- **DRAWDOWN MONITORING** After a large storm, check the dry well to ensure the system drains within 72 hours.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- » **SLOW DRAINAGE** Water remains in the dry well for more than 72 hours after a storm. This indicates clogging of the soil or aggregate.
- » **SURFACE PONDING** Water is backing up at upstream end of the inlet pipe and/or ponding on the surface, indicating the system is full or clogged.

Use the maintenance checklist on page 126 of this guide's ***Appendix C*** to guide monitoring and maintenance activities.

Cost

$ **RELATIVE COST**

The cost of a dry well is highly dependent on its size, depth, and local costs for excavation and aggregate. While the cost is the highest among all green infrastructure practices, they can be a cost-effective option if the underlying soil is suitable and limited disturbance to the project site is desired.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	**Volume per unit area** (gal/sq ft)	**Cost per unit volume** ($/gal)
$149 to $364	2.7 to 7.9	$32.83 to $76.09

NOTE These ranges are for planning purposes only. See page 144 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

The primary cost offset for a dry well is the value of the land it preserves.

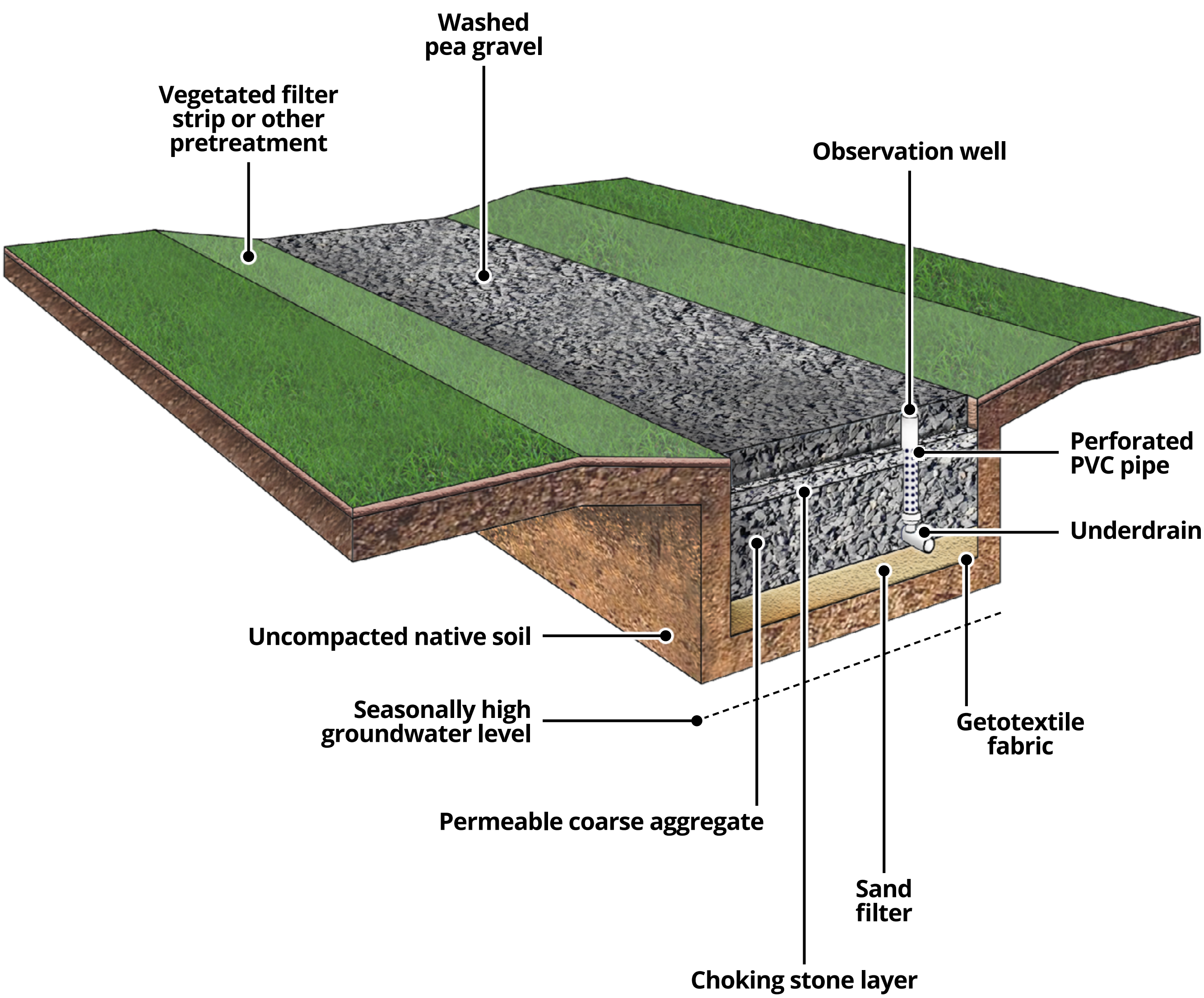
- » **LAND SAVINGS** By placing stormwater management entirely underground, dry wells free up valuable surface area for development, parking, or amenities, which can be a significant financial benefit on constrained sites.
- » **REDUCED PIPED INFRASTRUCTURE** A distributed system of dry wells can help reduce the size and cost of downstream storm sewer pipes.
- » **LOW MAINTENANCE COSTS** The minimal long-term maintenance needs result in significant life-cycle cost savings compared to landscaped green infrastructure.

7 Infiltration Trenches

Infiltration trenches are simple, underground structures designed to manage stormwater runoff. They are essentially long, narrow trenches filled with stone that collect runoff and allow it to infiltrate into the surrounding soil.

Often referred to as "French drains," these systems are a straightforward and effective way to manage runoff from impervious surfaces like roads and parking lots. Their linear shape makes them particularly well-suited for placement along the edges of pavement or in narrow green spaces. As a subsurface practice, they provide significant storage and infiltration benefits without taking up valuable surface area.

FIGURE 7.1 A perspective illustration of an infiltration trench.



Why use an infiltration trench?

Infiltration trenches are a versatile and cost-effective tool for managing stormwater, especially in linear settings like road corridors or the perimeters of developments. They are an excellent option when the goal is to maximize infiltration and storage with a simple, low-maintenance system.

Key benefits

- » **EFFICIENT INFILTRATION** The long, linear shape provides a large surface area for infiltration, making them effective at getting water into the ground quickly on sites with suitable soils.
- » **SPACE-SAVING DESIGN** Trenches can be easily integrated into narrow or underutilized spaces, such as road shoulders, utility corridors or landscape buffers, making them ideal for retrofits and sites with limited space.
- » **COST EFFECTIVE** With a simple design and common construction materials, infiltration trenches are often less expensive to install than more complex green infrastructure practices.
- » **VERSATILE SURFACE TREATMENT** The surface of the trench can be covered with turf, river rock, or even integrated beneath permeable pavement, allowing for flexible aesthetic and functional uses.
- » **SNOW MANAGEMENT** Infiltration trenches located adjacent to parking lots can serve as ideal locations for snow storage, allowing meltwater to infiltrate directly into the soil rather than running off into the sewer system.

Example applications of infiltration trenches for different land uses are shown in **Figures 7.2 to 7.4**.

Key benefits

STORAGE CAPACITY

WATER QUALITY IMPROVEMENT

HABITAT VALUE

FIGURE 7.2 In a residential common area, a turf-covered trench manages runoff invisibly while preserving open space.

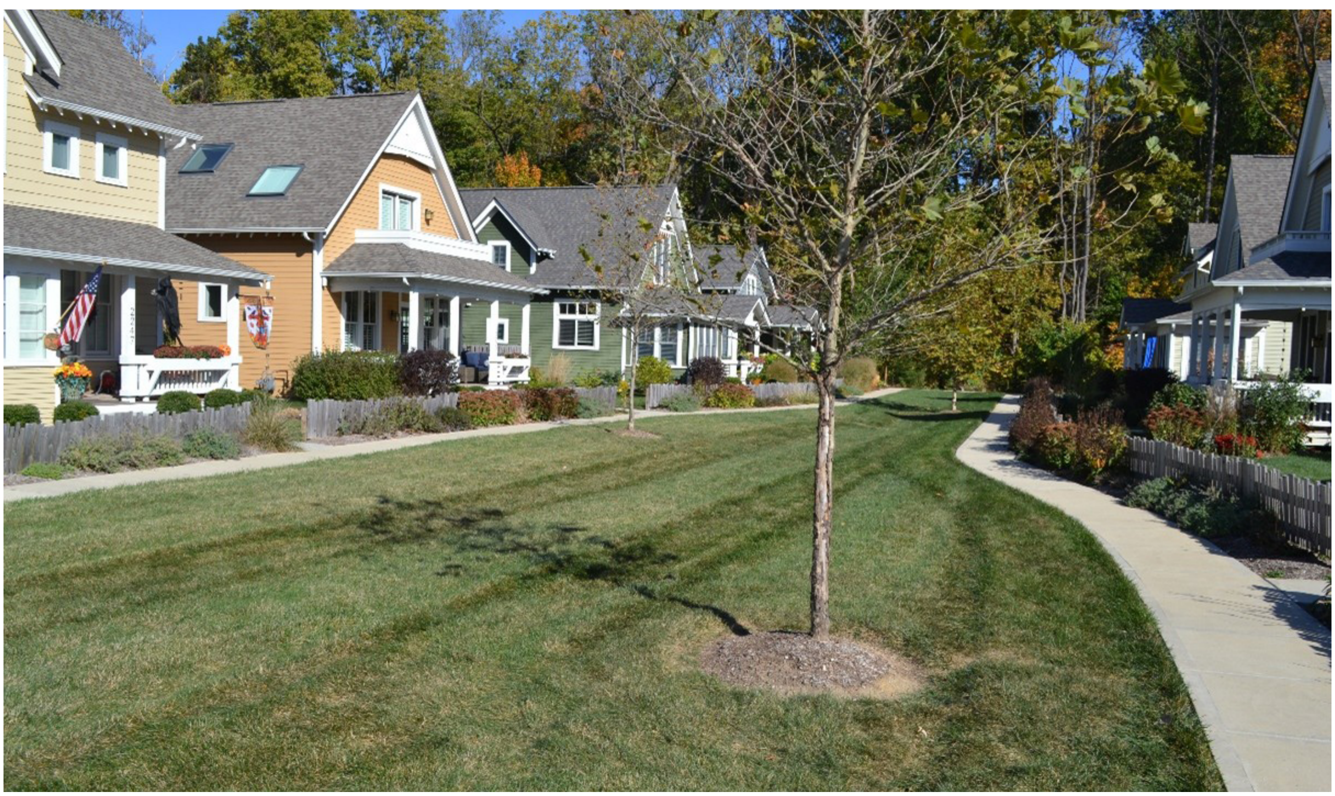


FIGURE 7.3 Located at a light industrial site, this infiltration trench captures and treats runoff from the adjacent parking lot and public right-of-way.

FIGURE 7.4 As part of a larger system, trenches can connect other green infrastructure practices to maximize site-wide infiltration. In this example, a network of infiltration trenches was installed beneath perimeter buffer bioswales, parking lane pavers, and common area bioretention areas.

Suitability and placement

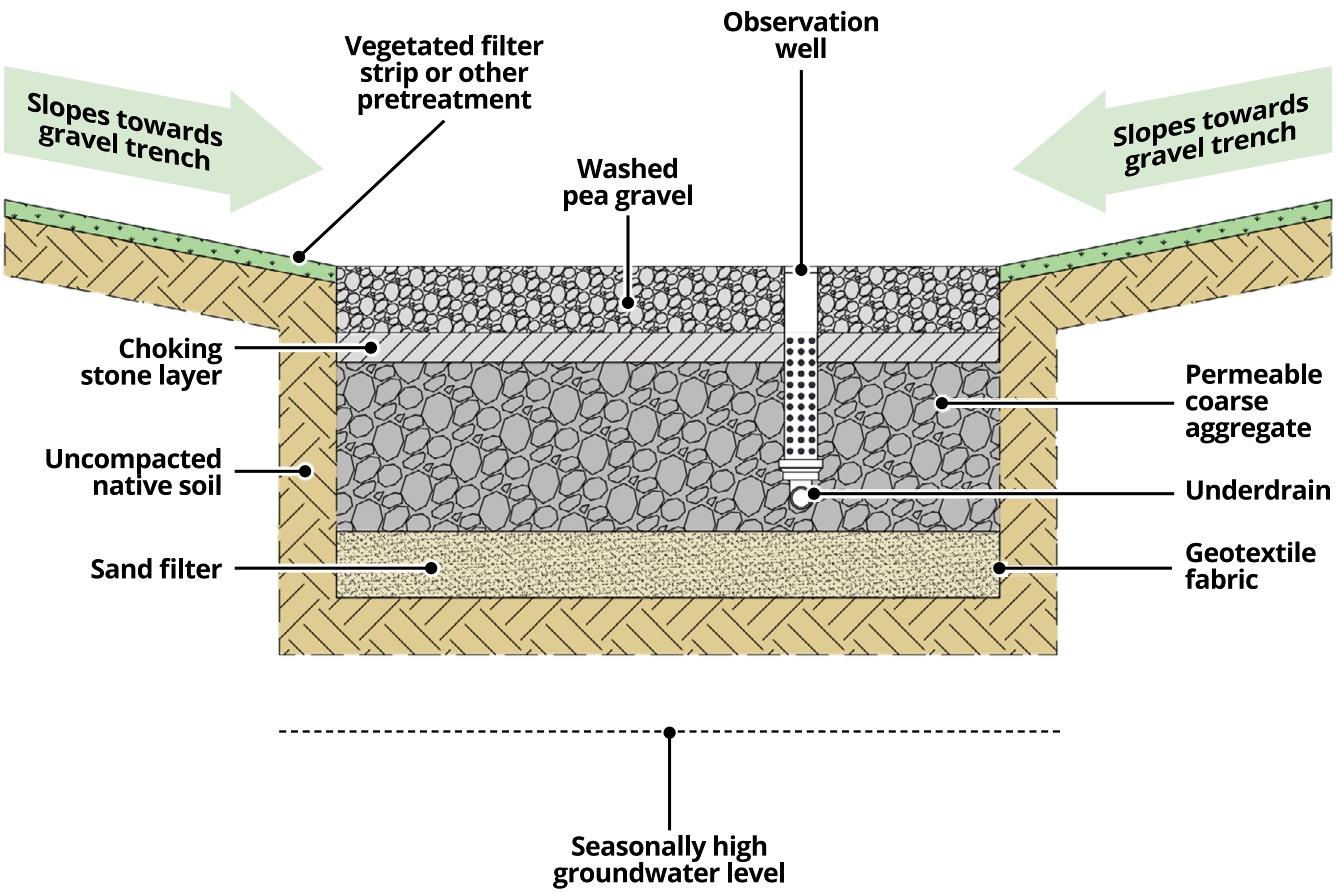
Like dry wells, the effectiveness of an infiltration trench is highly dependent on the infiltration rate of the native soils. They are best suited for sites with sandy or loamy soils. A feasibility study, including soil testing, is required to confirm suitability. Their placement must also consider setbacks from buildings and the location of the seasonal high groundwater table. Placement considerations are similar to those for dry wells. Refer to the *Technical Snapshot: Placement Requirements* on page 66 of Chapter 6 for detailed requirements.

Key design elements

DESIGN DIFFICULTY

An infiltration trench is a layered system designed for efficient water storage and infiltration. Runoff enters the trench, typically as sheet flow from an adjacent surface, and passes through a surface layer of gravel or topsoil. The water is stored in the void spaces of a large aggregate base layer and then slowly soaks into the native soil through the bottom and sides of the trench.

FIGURE 7.5 A typical infiltration trench cross section. See *TGM Appendix C* (Infiltration Trench Detail) for detailed specifications and dimensions.



Pretreatment

Pretreatment is critical to prevent the trench from becoming clogged with sediment over time, which is the most common cause of failure. A vegetated filter strip or grass channel running parallel to the trench is the most common and effective form of pretreatment. This grassy buffer slows the runoff and filters out sand and sediment before the water reaches the trench.

Storage and drainage

The storage volume of the trench is provided by the void space in the aggregate layers. As a retention-based practice designed to meet WMO requirements, the storage and drainage components are similar to those for bioretention. An underdrain is required if the native soil infiltration rate is less than 0.5 inches per hour to ensure the facility drains within 72 hours. An observation well is required to monitor the drawdown rate. Refer to ***Storage and drainage*** on page 33 of Chapter 2 for discussion on underdrains, observation well and quantifying storage volume. To quantify volume control storage, also reference the volume table in the *Infiltration Trench Detail* in ***TGM Appendix C***.

Construction

CONSTRUCTION COMPLEXITY

Construction is similar to that of a conventional utility trench but requires extra care to avoid compaction and preserve the infiltration capacity of the native soils. A preconstruction meeting is essential to review the construction sequence, erosion control measures and material specifications.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING AND PROTECTION

1. **Excavation:** Excavate the trench to the design width and depth.
2. **Protect soils:** Avoid soil compaction. Do not allow heavy equipment to drive in the bottom of the trench. Scarify the bottom and sides of the excavation just before placing aggregate.
3. **Install geotextile:** Line the top and sides of the excavated trench with non-woven geotextile fabric to separate the aggregate from the native soil. Geotextile fabric should not be placed on the bottom of the trench, as it is prone to clogging and will reduce infiltration performance over time.
4. **Place aggregate and underdrain:** Place the aggregate in lifts, installing the underdrain (if required) at the specified elevation.
5. **Install observation well:** Install the observation well, ensuring it is plumb and extends to the bottom of the trench.
6. **Place surface layer:** Place the final surface layer of choking stone, topsoil or decorative gravel.

During construction, use a consistent checklist (see page 108 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Infiltration trenches require little maintenance, focused primarily on keeping the surface and pretreatment areas clean and free of debris.

Maintenance activities

Typical maintenance tasks include:

- » **PRETREATMENT MAINTENANCE** Mow the vegetated filter strip and remove any accumulated sediment along the edge of the trench.
- » **SURFACE INSPECTION** Rake the surface gravel as needed to remove leaves and debris. If the surface is turf, maintain it as a typical lawn area.
- » **DRAWDOWN MONITORING** After a large storm, check the observation well to ensure the system drains within 72 hours.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- » **SLOW DRAINAGE** Water remains in the observation well for more than 72 hours after a storm, indicating clogging.
- » **SURFACE PONDING** Water ponds on the surface of the trench or bypasses it altogether.

Use the maintenance checklist on page 127 of this guide's ***Appendix C*** to guide monitoring and maintenance activities.

Cost

RELATIVE COST

Infiltration trenches are one of the more cost-effective retention-based practices. The use of common materials and simple, linear construction keeps installation costs relatively low.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	Volume per unit area (gal/sq ft)	Cost per unit volume ($/gal)
$20 to $83	12.0 to 21.1	$1.70 to $3.94

NOTE These ranges are for planning purposes only. See page 146 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

The primary cost benefits of infiltration trenches come from their efficiency and simplicity.

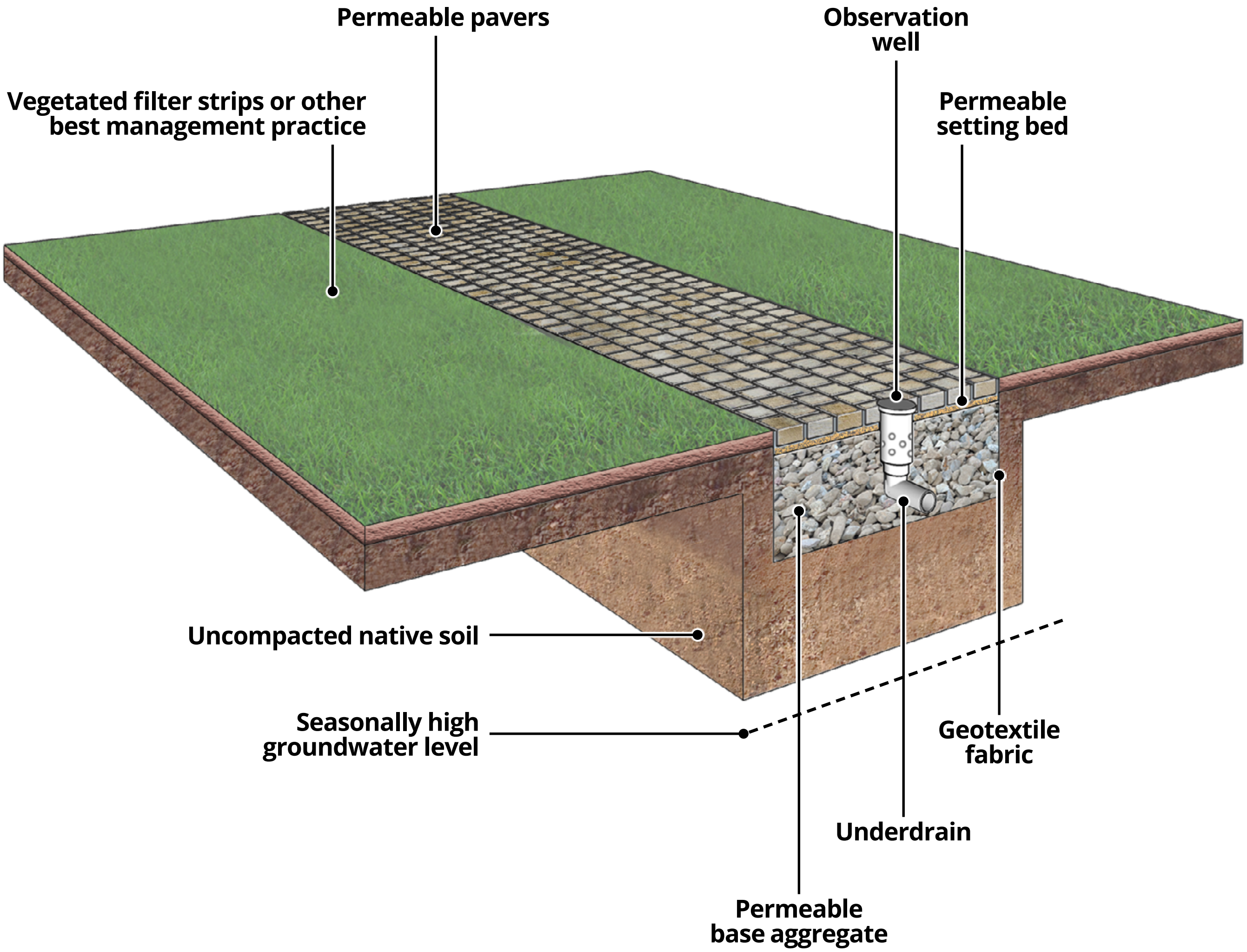
- » **LAND USE EFFICIENCY** Their ability to be placed in narrow corridors allows developers to make more efficient use of a site's developable area.
- » **REDUCED PIPED INFRASTRUCTURE** By managing runoff at its source, trenches can significantly reduce the size and length of traditional storm sewer pipes needed for a project.
- » **LOW MAINTENANCE COSTS** The minimal long-term maintenance needs result in significant cost savings over the life of the project.

8 Permeable Pavements

Permeable pavements are specially designed surfaces that look and function like traditional pavement but allow rainwater to soak through them instead of running off. This innovative category of green infrastructure includes a range of materials, such as interlocking concrete pavers, pervious concrete and porous asphalt. Permeable pavers are commonly used in Cook County.

Beneath the surface, these systems feature a deep base of open-graded stone that provides structural support while also serving as an underground reservoir for stormwater. By turning the entire paved surface into a stormwater management facility, permeable pavements transform parking lots, alleys, sidewalks and low-traffic streets from sources of runoff into tools for infiltration and storage.

FIGURE 8.1 A perspective illustration of a permeable paver system.



Why use permeable pavement?

Permeable pavements are one of the most effective ways to manage stormwater in ultra-urban and suburban environments where paved surfaces are dominant. They offer a unique, multi-benefit solution that integrates stormwater management directly into the built environment, maximizing land use and reducing the volume need for separate, land-intensive facilities like detention ponds.

Key benefits

- **MAXIMUM LAND USE EFFICIENCY** By combining the functions of pavement and stormwater management, these systems reduce the storage volume needed for detention basins, freeing up valuable land for development, green space or additional parking.
- **SIGNIFICANT RUNOFF REDUCTION** Permeable pavements can be designed to capture and infiltrate nearly all the rainfall from a typical storm, reducing runoff volumes and peak flows to the sewer system.
- **IMPROVED WATER QUALITY** The stone base acts as a filter, trapping sediment and pollutants before the water soaks into the ground.
- **ENHANCED SAFETY AND REDUCED WINTER MAINTENANCE** The surface drains quickly, reducing ponding and ice formation. This often leads to a significant reduction in the amount of salt needed for de-icing in the winter.
- **AESTHETIC APPEAL** Permeable interlocking concrete pavers, in particular, offer a wide range of colors, shapes and patterns, allowing for the creation of attractive and distinctive surfaces.

Example applications of permeable pavements are shown in **Figures 8.2 to 8.5**.

Key benefits

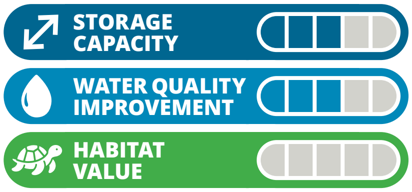


FIGURE 8.2 In a residential setting, permeable pavers in a parking lane, driveway or alley can manage runoff while enhancing the aesthetics of the neighborhood.

FIGURE 8.3 In a commercial area, a fully permeable parking lot maximizes stormwater storage and reduces runoff, capturing water on location and protecting area water quality.

FIGURE 8.4 In a public right-of-way, permeable pavements are an effective solution for low-traffic residential streets.

FIGURE 8.5 Permeable walkways and patios are ideal for parks and plazas, reducing runoff while providing durable, attractive surfaces.

Suitability and placement

Like other infiltration-based practices, permeable pavements are best suited for sites with well-draining soils. A feasibility study, including soil testing, is essential. They are not suitable for high-traffic/high-speed roadways or industrial sites where there is a risk of hazardous material spills. Careful consideration of the site's slope and drainage patterns is also critical. Placement considerations are similar to those for dry wells and infiltration trenches. Refer to the ***Technical Snapshot: Placement Requirements*** on page 66 of Chapter 6 for detailed requirements.

Key design elements

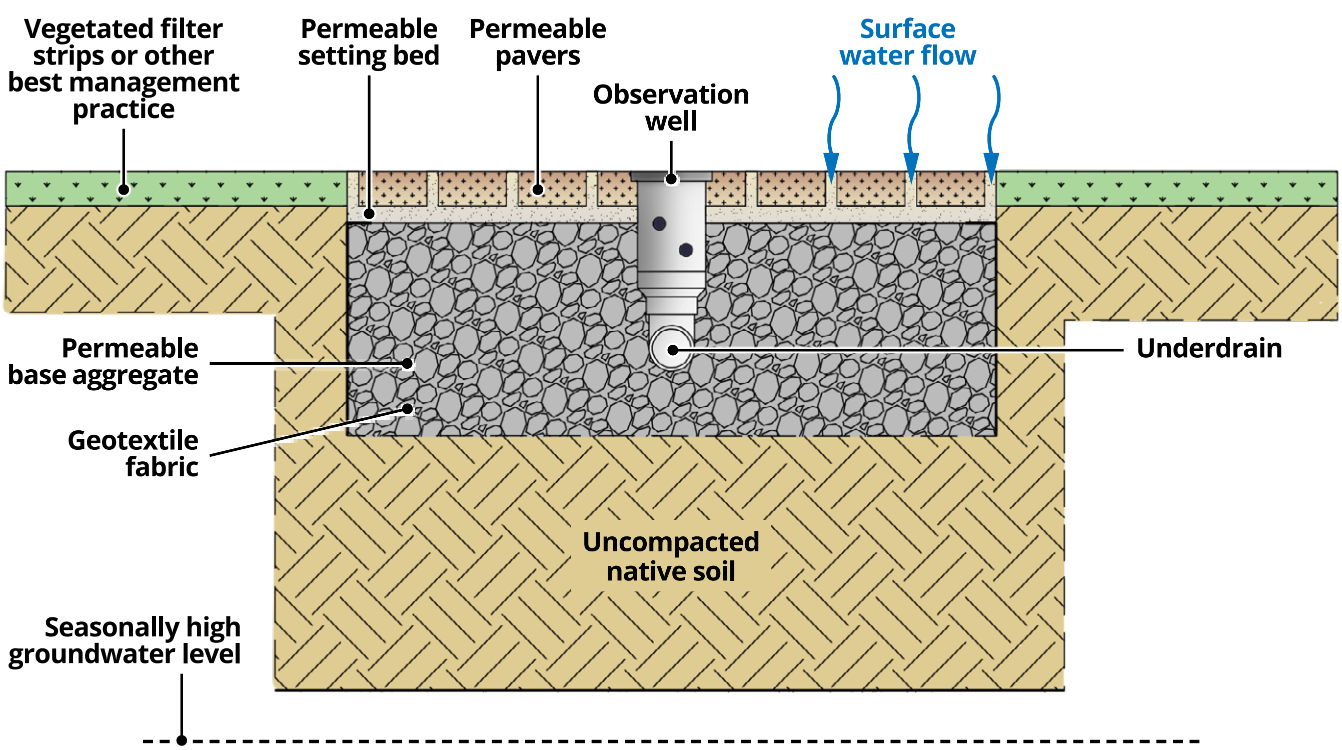
DESIGN DIFFICULTY

A permeable pavement system is a multi-layered structure. Rainwater passes through the permeable surface and a bedding layer of small stones into a deep base of open-graded, washed aggregate. This aggregate base serves as both the structural foundation for the pavement and the stormwater reservoir. The stored water then slowly infiltrates into the native soil below or discharges to a sewer via an underdrain.

Pretreatment

The best form of pretreatment for permeable pavement is preventing sediment from reaching it in the first place. This means ensuring that all surrounding landscaped areas are fully stabilized and that runoff from adjacent impervious surfaces is treated before it flows onto the permeable pavement. For this reason, permeable pavements should be designed to only accept direct rainfall whenever possible.

FIGURE 8.6 A typical permeable pavement cross section. See ***TGM Appendix C*** (Permeable Pavers Detail) for detailed specifications and dimensions.



Storage and drainage

The storage volume is provided by the void space in the deep aggregate base. As a retention-based practice designed to meet Watershed Management Ordinance requirements, the storage and drainage components are similar to those for bioretention. An underdrain is required if the native soil infiltration rate is less than 0.5 inches per hour to ensure the facility drains within 72 hours. An observation well is required to monitor the drawdown rate. Refer to ***Storage and drainage*** on page 33 of Chapter 2 for discussion on underdrains, observation wells and quantifying storage volume. To quantify volume control storage, also reference the volume table in the *Permeable Pavers* in ***TGM Appendix C***.

Construction

CONSTRUCTION COMPLEXITY

Proper construction techniques are critical to the success of permeable pavements. The most important step is protecting the underlying native soil from compaction during excavation. A preconstruction meeting is essential to ensure the contractor understands the unique requirements of this type of construction.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING AND PROTECTION

1. **Protect subgrade:** The native soil subgrade should be protected from compaction at all times. All excavation should be done from the sides of the installation area, not from within it.
2. **Excavation:** Excavate the area to the design depth. The bottom of the excavation should be level.
3. **Install geotextile:** Line the sides of the excavation with non-woven geotextile fabric. Do not place fabric on the bottom, as it can clog over time.
4. **Place aggregate and underdrain:** Place the aggregate base in lifts, compacting each lift. Install the underdrain (if required) at the specified elevation.
5. **Install edge restraints:** Install concrete curbs or other heavy-duty edge restraints to contain the pavers/permeable surface materials.
6. **Install permeable surface:** Place the bedding course and then lay the permeable pavers/permeable surface materials according to the manufacturer's specifications.
7. **Fill joints (if pavers are used):** Sweep fine aggregate into the joints between the pavers.

During construction, use a consistent checklist (see page 110 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Permeable pavements demand a dedicated and specialized maintenance program to function long term. Unlike traditional pavement that is simply swept, these surfaces must be cleaned periodically with a vacuum or regenerative air sweeper to remove fine sediment from the joints or the pores of the permeable surface. Failure to commit to this regimen will lead to clogging and system failure. Conventional sand-based winter maintenance must be strictly prohibited as it will clog the system.

Maintenance activities

Typical maintenance tasks include:

- **ROUTINE CLEANING** Regularly sweep or use a regenerative air sweeper to remove surface dirt and debris.
- **INTENSIVE CLEANING** Periodically (every 1-3 years), use a vacuum street sweeper to remove fine sediment from the paver joints/the pores of the permeable surface.
- **WEED CONTROL** Remove any weeds that may grow in the paver joints or permeable surface.
- **JOINT REFILL (FOR PAVERS ONLY)** After vacuuming, replenish the fine aggregate in the joints.
- **WINTER MAINTENANCE** Use minimal salt. Sand should never be used, as it will clog the system.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- **CLOGGING** Water ponds on the surface for an extended period after a storm.
- **WEED GROWTH** Excessive weed growth in the joints or permeable surface can indicate clogging with organic matter.
- **STRUCTURAL FAILURE** Rutting or settling of the pavers or permeable surface indicates a problem with the underlying aggregate base.

Use the maintenance checklist on page 128 of this guide's ***Appendix C*** to guide monitoring and maintenance activities.

Cost

$ RELATIVE COST

The initial construction cost of permeable pavement is typically higher than that of traditional asphalt or concrete. However, when the cost of the required stormwater management system for a traditional pavement is factored in, permeable pavements are often cost-competitive. The cost ranges in the below table are estimated assuming permeable pavers are used as the permeable surface. In general, the cost for pervious concrete is lower than that for permeable pavers; while pervious asphalt is the most affordable.

Unit cost budgeting ranges

Cost per unit area ($/sq ft)	Volume per unit area (gal/sq ft)	Cost per unit volume ($/gal)
$17 to $38	1.4 to 4.0	$5.07 to $22.08

NOTE These ranges are for planning purposes only. See page 142 of this guide's ***Appendix D*** for detailed cost information.

Cost offsets

The primary cost offset is the elimination of other more expensive stormwater infrastructure.

- **REDUCED PIPED INFRASTRUCTURE** Permeable pavements can significantly reduce or eliminate the need for storm sewer pipes, inlets and manholes within the paved area.
- **LAND-USE EFFICIENCY** Permeable pavements provide stormwater management while creating paved surface for suitable for sidewalk, parking, low-volume traffic and other uses to make more efficient use of urban land.
- **REDUCED WINTER MAINTENANCE COSTS** The reduced need for salt and de-icing can result in significant material and labor savings over the life of the pavement.

9 Cisterns

Cisterns are storage tanks that capture and hold runoff, typically from rooftops. They are a key component of rainwater harvesting. This stored water can then be used for non-potable purposes like irrigation, toilet flushing or industrial processes, providing a sustainable alternative to using drinking water.

By capturing rainwater where it falls, cisterns serve a dual purpose. They provide a free, local water source while also reducing the volume of stormwater runoff that enters the sewer system. Available as both above ground and underground units, cisterns are a versatile and highly effective tool for both water conservation and stormwater management.

Why use a cistern?

Cisterns are a smart investment for any property, turning rainfall from a management challenge into a valuable resource. They are an excellent way for communities and property owners to reduce their reliance on municipal water supplies, lower utility bills, and contribute to a more sustainable and resilient water system.

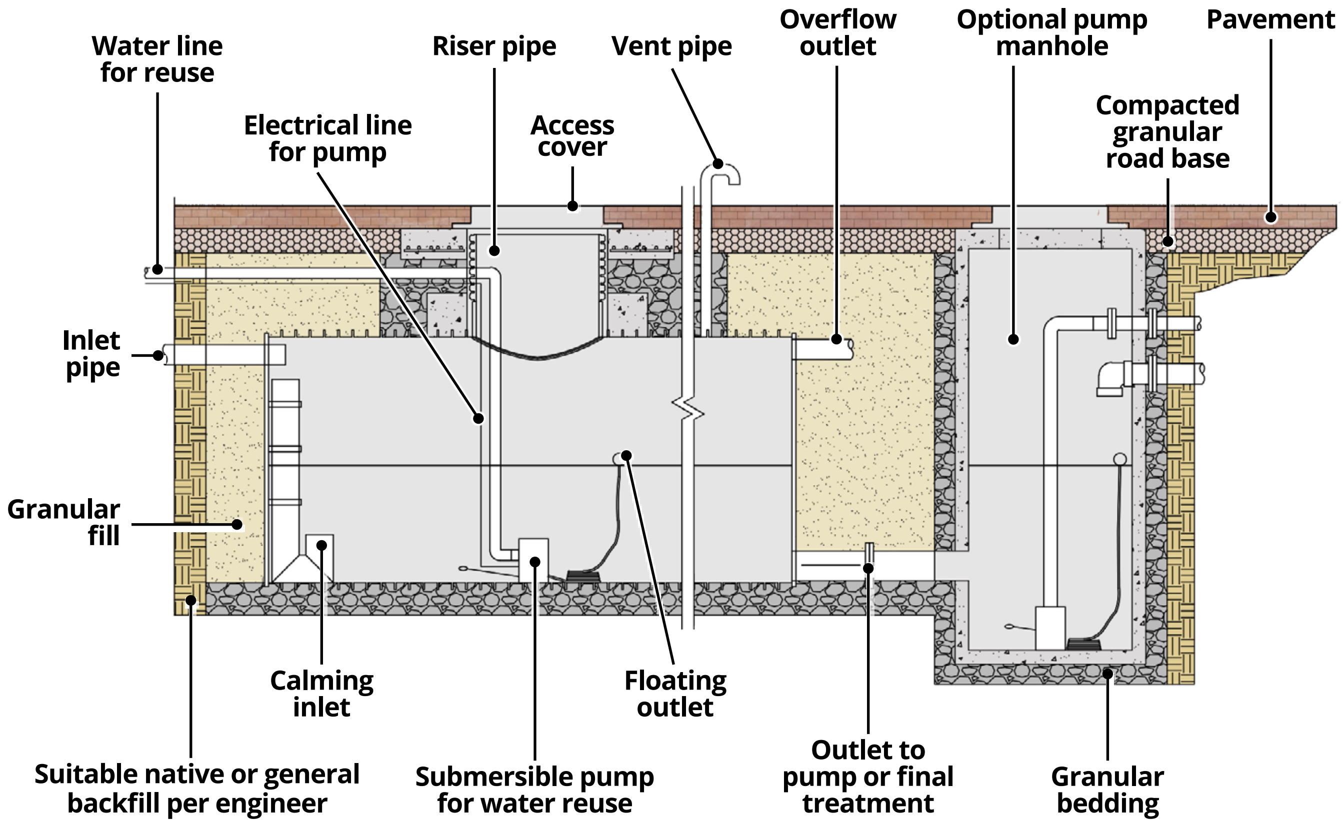


FIGURE 9.1 Cross section of a typical underground cistern system. See ***TGM Appendix C*** (Rain Cistern/ Stormwater Reuse Typical Detail) for detailed specifications and dimensions.

Key benefits

- **WATER CONSERVATION** Capturing rainwater for reuse significantly reduces demand on potable water supplies, preserving this vital resource for drinking and other essential needs. This often translates directly into lower water bills.
- **STORMWATER VOLUME REDUCTION** By storing rooftop runoff, cisterns can dramatically reduce the peak flow and volume of water entering the storm sewer, helping to prevent local flooding and combined sewer overflows.
- **VERSATILITY AND SCALABILITY** Cisterns come in all shapes and sizes from small residential rain barrels to massive underground tanks for commercial buildings. They can be installed above or below ground to fit site needs.
- **EDUCATIONAL OPPORTUNITY** Highly visible above-ground cisterns serve as excellent educational tools, demonstrating a commitment to sustainability and raising public awareness about water conservation.
- **GREEN BUILDING CREDENTIALS** Incorporating a rainwater harvesting system can contribute points toward green building certifications like LEED (Leadership in Energy and Environmental Design), enhancing a property's sustainability profile.

Example applications of cisterns for different land uses are shown in **Figures 9.2 to 9.5**.

Suitability and placement

Cisterns are a highly adaptable practice suitable for almost any site with a roof or other impervious catchment surface. The primary considerations for feasibility are the available space for the tank, the intended use for the water (which determines the required size), and the structural capacity of the proposed location to support the weight of a full tank.

Key benefits

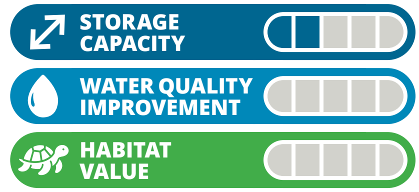


FIGURE 9.2 In a residential setting, a cistern can capture roof runoff for irrigating gardens and lawns.

FIGURE 9.3 In a commercial area, a large cistern can supply water for irrigation.

FIGURE 9.4 In the public right-of-way, large underground cisterns can be installed beneath plazas or roads to capture significant volumes of runoff.

FIGURE 9.5 In a park, a cistern can capture runoff from a shelter roof to irrigate nearby landscape beds or athletic fields.

TECHNICAL SNAPSHOT

PLACEMENT REQUIREMENTS

TGM Articles 5.3.4, 5.3.5, 5.3.10.4

Designers should follow specific location and separation criteria outlined in the TGM.

Practice type: Cisterns are a retention-based practice with quantifiable storage when designed with a dedicated water reuse application.

Catchment area: Cisterns are primarily intended to capture relatively clean runoff from rooftops. Runoff from pavement is generally not suitable without advanced pretreatment.

Key separation distances:

» Cisterns and their foundations must be located a safe distance from building foundations to prevent water damage.

» Underground cisterns must be located away from underground utilities.

Foundation: A stable, level, load-bearing foundation (e.g., a concrete pad or compacted aggregate base) is required for all cisterns to prevent settling or tipping.

Regulatory compliance: Systems connected to a building for indoor use (e.g., toilet flushing) must comply with all state and local plumbing codes, which may require backflow prevention devices and specific pipe labeling. Rainwater harvesting systems may also be subjected to additional public health rules and regulations. Consult state and local public health departments for specific requirements.

Key design elements

DESIGN DIFFICULTY

A rainwater harvesting system is composed of several key components working together. Runoff from a catchment surface is collected by a conveyance system, like gutters and downspouts. It then passes through a pretreatment system to remove debris before entering the cistern for storage. A distribution system, which may include a pump, delivers the water for its intended use. An overflow safely directs excess water away from the tank during large storms.

Pretreatment

Pretreatment is essential to keep leaves, sediment and other debris out of the tank, ensuring water quality and preventing the pump from clogging. Common pretreatment devices include leaf screens on gutters, downspout filters and a “first-flush diverter,” which diverts the initial and most contaminated runoff away from the cistern. For underground cisterns that include inflow pipes, a sump and/or trash rack should be installed at the manhole immediately upstream of the facility.

FIGURE 9.6 Installing pretreatment measures in rainwater harvesting systems is essential for ensuring long-term reliability, protecting water quality, and maintaining pump performance.

Storage and drainage

The size of the cistern is determined by the size of the catchment area, local rainfall patterns and the anticipated water demand. To qualify as a retention-based practice for Watershed Management Ordinance (WMO) volume control credit, the cistern must have a dedicated reuse application (e.g., irrigation) and an operation plan should be provided describing the dewatering schedule.

TECHNICAL SNAPSHOT

SIZING AND DRAWDOWN

TGM Article 5.3.7.2

- **Sizing for Reuse:** The required cistern volume can be estimated based on the water demand. For irrigation, a common estimate is 1 inch of water per week over the irrigated area.
- **Drawdown for Storage:** When a pump is used to dewater the system, an operation plan should be provided describing the dewatering schedule. To receive full WMO credit, the system should be designed to make the stored volume available before the next storm event through active use.

Construction

CONSTRUCTION COMPLEXITY

The complexity of construction depends on the type of cistern. Above-ground systems are relatively simple to install, while underground systems require significant excavation and careful backfilling. For all cisterns, ensuring a stable, level foundation is the most critical construction step.

TECHNICAL SNAPSHOT

CONSTRUCTION SEQUENCING AND PROTECTION

1. **Foundation:** Construct a level, stable foundation capable of supporting the full weight of the cistern (water weighs over 8 pounds per gallon).
2. **Set tank:** Carefully place the tank on the foundation. For underground tanks, backfill evenly around the tank in lifts as specified by the manufacturer to prevent structural damage.
3. **Connect piping:** Connect the inlet, outlet, overflow and distribution piping, ensuring all connections are watertight.
4. **Install components:** Install pumps, filters and any control systems.
5. **Testing:** Fill the tank with clean water to test for leaks before putting the system into service.

During construction, use a consistent checklist (see page 116 of this guide's ***Appendix B***) to monitor and document installation.

Maintenance

MAINTENANCE EFFORT

Cisterns require regular maintenance to ensure water quality and protect the system components. A dedicated maintenance plan is essential.

Maintenance activities

Typical maintenance tasks include:

- » **PRETREATMENT CLEANING** Regularly (at least twice a year) clean leaf screens, downspout filters and first-flush diverters.
- » **TANK INSPECTION** Periodically inspect the inside of the tank for sediment buildup. Sediment should be cleaned out every few years as needed.
- » **PUMP AND FILTER MAINTENANCE** Inspect and service pumps and filters according to the manufacturer's recommendations.
- » **WINTERIZATION** In cold climates, above-ground cisterns and piping must be drained and taken out of service during the winter to prevent damage from freezing.

Performance indicators

Monitoring helps diagnose problems early. Look for:

- » **CLOGGED FILTERS** Water is overflowing from gutters or downspout filters during storms.
- » **PUMP FAILURE** The pump does not turn on, or water pressure is low.
- » **OVERFLOW** The cistern is overflowing during small storms, indicating it is not being drawn down properly.
- » **LEAKS** Visible leaks from the tank or piping connections.

Use the maintenance checklist on page 129 of this guide's ***Appendix C*** to guide monitoring and maintenance activities.

Cost

RELATIVE COST

The cost of a cistern system varies widely based on its size, material (plastic, fiberglass and concrete) and whether it is installed above or below ground. Above-ground plastic tanks are the least expensive option, while large, underground concrete vaults are the most expensive. The cost of pumps and controls can also be a significant factor. The estimated cost can range from $7.82 to $13.31 per gallon of storage. See page 148 of this guide's ***Appendix D*** for detailed cost information.

FIGURE 9.7 Captured rainwater can be easily put to work reducing utility costs, lowering stormwater fees, and supporting green building incentives.

Cost offsets

The primary financial benefit of a cistern is the long-term savings on water utility bills.

- **REDUCED WATER BILLS** Using free rainwater instead of purchasing municipal water for irrigation or other non-potable uses can lead to significant cost savings over the life of the system.
- **STORMWATER FEE REDUCTION** In some communities, properties with systems that reduce stormwater runoff may be eligible for credits or reductions on their stormwater utility fees.
- **GREEN BUILDING INCENTIVES** Cisterns can help projects achieve green building certifications, which may come with financial incentives or property value increases.

Caltha palustris, also known as marsh marigold

Appendix A

Plant Lists

The following plant lists have been curated specifically for the climate and conditions of Northeast Illinois, which includes the Chicago area. While many of these plants have a wider native range, for any green infrastructure (GI) project outside this region, it is important to consult local plant databases, university extension services or specialized nurseries. This will ensure you are selecting species best suited for your specific soils, climate and regulatory requirements.

"Wetland status" indicates a plant's natural preference for moisture, which is the key to matching it with the right GI practice:

- **OBL (OBLIGATE WETLAND)** These are true water-lovers, almost always found in wetlands with saturated soil or shallow standing water. They are specialists for the wettest conditions.
- **FACW (FACULTATIVE WETLAND)** These plants usually grow in wetlands but can also tolerate drier conditions. They thrive in areas that flood periodically and then dry out.
- **FAC (FACULTATIVE)** These are adaptable generalists, found equally in wetlands and non-wetlands. They are versatile and can handle a wide range of moisture conditions.
- **FACU (FACULTATIVE UPLAND)** These plants typically grow in drier, upland sites but can tolerate brief periods of wet soil. They do not tolerate prolonged "wet feet."

For more detailed information on native plants, please consult these resources:

- **USDA PLANTS DATABASE**
  plants.usda.gov
- **LADY BIRD JOHNSON WILDFLOWER CENTER NATIVE PLANT DATABASE**
  wildflower.org/plants/
- **BLUE THUMB PLANT FINDER**
  bluethumb.org/plantfinder/
- **GROW NATIVE! NATIVE PLANT DATABASE**
  grownative.org/native-plant-database/
- **NATIONAL WILDLIFE FEDERATION (NWF) NATIVE PLANT FINDER**
  nativeplantfinder.nwf.org/Plants
- **ILLINOIS WILDFLOWERS**
  illinoiswildflowers.info

A.1 Perennials and wildflowers

Swamp milkweed
Asclepias incarnata
Wetland status: OBL
Sunlight: Full sun
Height: 3-4 ft
Bloom time: Jun-Aug

GI benefits/notes: Monarch host. Deep taproot. Essential for pollinator gardens.
Salt tolerant


Marsh marigold
Caltha palustris
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 1-2 ft
Bloom time: Apr-May

GI benefits/notes: One of the earliest spring blooms, providing a cheerful yellow display.


White turtlehead
Chelone glabra
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 2-3 ft
Bloom time: Aug-Oct

GI benefits/notes: Unique flowers resemble a turtle's head. Host for Baltimore Checkerspot.


Joe Pye weed
Eutrochium maculatum
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 4-6 ft
Bloom time: Jul-Sep

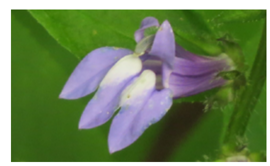
GI benefits/notes: A large, impressive magnet for butter-flies. Strong stems provide winter interest.


Blue flag iris
Iris virginica var. shrevei
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 2-3 ft
Bloom time: May-Jun

GI benefits/notes: Excellent for the wettest part of a rain garden. Spreads to form colonies.

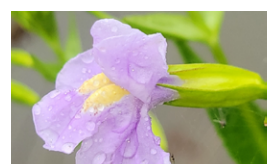

Great blue lobelia
Lobelia siphilitica
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 2-3 ft
Bloom time: Jul-Sep

GI benefits/notes: Beautiful blue spikes of flowers. Tolerates shade.
Salt tolerant

Monkey flower
Mimulus ringens
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 1-3 ft
Bloom time: Jul-Sep

GI benefits/notes: Snapdragon-like purple flowers provide mid-summer color.
Salt tolerant

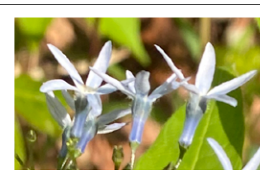



Royal fern
Osmunda regalis
Wetland status: OBL
Sunlight: Part shade
Height: 2-3 ft
Bloom time: N/A

GI benefits/notes: Large, elegant fronds provide great texture in moist, shady spots.


Eastern bluestar
Amsonia tabernaemontana
Wetland status: FACW
Sunlight: Full sun, part shade
Height: 2-3 ft
Bloom time: May-Jun

GI benefits/notes: Star-shaped, blue flowers in spring and excellent golden fall color.

Prairie blazing star
Liatris spicata
Wetland status: FACW
Sunlight: Full sun
Height: 3-5 ft
Bloom time: Jul-Aug

GI benefits/notes: Unique vertical flower spikes. Excellent for clay soil and rain gardens.


Cardinal flower
Lobelia cardinalis
Wetland status: FACW
Sunlight: Full sun, part shade
Height: 2-4 ft
Bloom time: Jul-Sep

GI benefits/notes: Brilliant red flowers attract hummingbirds. Prefers consistent moisture.


Blue vervain
Verbena hastata
Wetland status: FACW
Sunlight: Full sun
Height: 2-6 ft
Bloom time: Jun-Sep

GI benefits/notes: Tall, slender spikes of purple flowers are a pollinator favorite.
Salt tolerant


Common ironweed
Vernonia fasciculata
Wetland status: FACW
Sunlight: Full sun
Height: 2-4 ft
Bloom time: Jul-Sep

GI benefits/notes: Tough plant with vibrant purple flowers that bloom late in the season.


Golden Alexander
Zizia aurea
Wetland status: FAC
Sunlight: Full sun, part shade
Height: 1.5-3 ft
Bloom time: May-Jun

GI benefits/notes: An important early-season nectar source for beneficial insects.
Salt tolerant


Wild ginger
Asarum canadense
Wetland status: FACU
Sunlight: Part to full shade
Height: 0.5-1 ft
Bloom time: Apr-May

GI benefits/notes: Excellent groundcover for shade with unique, hidden maroon flowers.


White wild indigo
Baptisia alba
Wetland status: FACU
Sunlight: Full sun
Height: 2-4 ft
Bloom time: May-Jun

GI benefits/notes: Shrub-like perennial with impressive spikes of white flowers.
Salt tolerant


Purple coneflower
Echinacea purpurea
Wetland status: FACU
Sunlight: Full sun
Height: 2-4 ft
Bloom time: Jun-Aug

GI benefits/notes: Iconic prairie flower. Extremely drought-tolerant once established.
Salt tolerant


Eastern beebalm
Monarda bradburiana
Wetland status: FACU
Sunlight: Full sun, part shade
Height: 1-2 ft
Bloom time: May-Jul

GI benefits/notes: Early blooming bee balm with pale pink, spotted flowers.
Salt tolerant


Solomon's seal
Polygonatum biflorum
Wetland status: FACU
Sunlight: Part to full shade
Height: 1-3 ft
Bloom time: May-Jun

GI benefits/notes: Arching stems provide graceful form in shaded areas.


Ohio spiderwort
Tradescantia ohiensis
Wetland status: FACU
Sunlight: Full sun
Height: 2-3 ft
Bloom time: May-Jul

GI benefits/notes: Clusters of blue-purple flowers that open in the morning.
Salt tolerant


A.2 Grasses, sedges and rushes

Sweet flag
Acorus americanus
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 2-3 ft
Bloom time: May-Jul

GI benefits/notes: Upright, iris-like leaves provide a strong vertical element.


Lake sedge
Carex lacustris
Wetland status: OBL
Sunlight: Full sun, part shade
Height: 2-4 ft
Bloom time: May-Jun

GI benefits/notes: Spreads to form dense stands, great for shoreline stabilization.
Salt tolerant


Soft rush
Juncus effusus
Wetland status: OBL
Sunlight: Full sun
Height: 2-4 ft
Bloom time: Jun-Aug

GI benefits/notes: Great for areas with standing water. Provides a strong vertical accent.
Salt tolerant


Fox sedge
Carex vulpinoidea
Wetland status: FACW
Sunlight: Full sun, part shade
Height: 1-3 ft
Bloom time: May-Jul

GI benefits/notes: A workhorse sedge for rain gardens. Forms dense clumps.
Salt tolerant


Indian woodoats
Chasmanthium latifolium
Wetland status: FACW
Sunlight: Part shade
Height: 2-5 ft
Bloom time: Jul-Sep

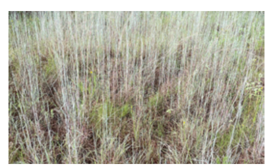
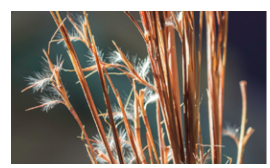
GI benefits/notes: Decorative seed heads provide great texture and winter interest.
Salt tolerant


Switchgrass
Panicum virgatum
Wetland status: FAC
Sunlight: Full sun, part shade
Height: 3-6 ft
Bloom time: Aug-Oct

GI benefits/notes: Very deep-rooted (up to 10 ft!). Provides winter structure.
Salt tolerant


Little bluestem
Schizachyrium scoparium
Wetland status: FACU
Sunlight: Full sun
Height: 2-4 ft
Bloom time: Aug-Sep

GI benefits/notes: Beautiful blue-green summer color turning to rust in fall.
Salt tolerant

Prairie dropseed
Sporobolus heterolepis
Wetland status: FACU
Sunlight: Full sun
Height: 2-3 ft
Bloom time: Aug-Oct

GI benefits/notes: Fine-textured, graceful bunch grass. Extremely drought tolerant.
Salt tolerant


A.3 Shrubs

Buttonbush
Cephalanthus occidentalis
Wetland status: OBL
Sunlight: Full sun, part shade
Size (H x W): 5-10 ft x 4-8 ft
Bloom time: Jun-Aug

GI benefits/notes: Unique, fragrant, spherical flowers. Thrives in standing water.


Red osier dogwood
Cornus sericea
Wetland status: FACW
Sunlight: Full sun, part shade
Size (H x W): 6-9 ft x 7-10 ft
Bloom time: May-Jun

GI benefits/notes: Bright red stems provide winter interest. Excellent for bank stabilization.


Kalm's St. John's wort
Hypericum kalmianum
Wetland status: FACW
Sunlight: Full sun
Size (H x W): 2-3 ft x 2-3 ft
Bloom time: Jul-Aug

GI benefits/notes: Dense, blue-green foliage with bright yellow summer flowers.


Winterberry
Ilex verticillata
Wetland status: FACW
Sunlight: Fall sun, part shade
Size (H x W): 6-9 ft x 7-10 ft
Bloom time: May-Jun

GI benefits/notes: Bright red berries persist through the winter, providing critical food for birds and exceptional winter interest.
Salt tolerant


Nannyberry viburnum
Viburnum lentago
Wetland status: FAC
Sunlight: Full sun, part shade
Size (H x W): 12-15 ft x 8 -12 ft
Bloom time: Apr-May

GI benefits/notes: Large, vase-shaped shrub with beautiful white flowers. Fabulous maroon-red fall color.
Salt tolerant


Smooth hydrangea
Hydrangea arborescens
Wetland status: FACU
Sunlight: Part shade
Size (H x W): 3-5 ft x 3-5 ft
Bloom time: Jun-Sep

GI benefits/notes: Large, round white flower clusters brighten up shady areas.


Serviceberry
Amelanchier laevis
Wetland status: FACU
Sunlight: Full sun, part shade
Size (H x W): 15-25 ft x 15-25 ft
Bloom time: Apr-May

GI benefits/notes: A small tree or large shrub. Four-season interest.


A.4 Trees

River birch
Betula nigra
Wetland status: FACW
Sunlight: Full sun, part shade
Height: 40-70 ft
Bloom time: Apr-May

GI benefits/notes: Fast-growing with beautiful peeling bark. Tolerates wet soils very well.
Salt tolerant


Swamp white Oak
Quercus bicolor
Wetland status: FACW
Sunlight: Full sun
Height: 50-60 ft
Bloom time: Apr-May

GI benefits/notes: A tough, long-lived oak that tolerates compacted soil and flooding.
Salt tolerant


Hackberry
Celtis occidentalis
Wetland status: FAC
Sunlight: Full sun
Height: 40-60 ft
Bloom time: Apr-May

GI benefits/notes: Extremely tough and adaptable urban tree. High wildlife value.
Salt tolerant


A.5 Aquatic Plants (for constructed wetlands)

Emergent Plants (for shallow water, 0-12" deep)

Common arrowhead
Sagittaria latifolia
Wetland status: OBL
Sunlight: Full sun
Height: 1-4 ft
Bloom time: Jul-Sep

GI benefits/notes: Arrow-shaped leaves are very distinctive. Thrives in shallow water.


Pickerelweed
Pontederia cordata
Wetland status: OBL
Sunlight: Full sun
Height: 2-4 ft
Bloom time: Jun-Sep

GI benefits/notes: Showy purple flower spikes are a favorite of bees and butterflies.


Softstem bulrush
Schoenoplectus tabernaemontani
Wetland status: OBL
Sunlight: Full sun
Height: 3-8 ft
Bloom time: Jun-Aug

GI benefits/notes: Excellent for water filtration and provides critical structure for birds.
Salt tolerant


Bur-reed
Sparganium eurycarpum
Wetland status: OBL
Sunlight: Full sun
Height: 2-4 ft
Bloom time: Jun-Jul

GI benefits/notes: Unique, bur-like seed heads. Spreads to form colonies for stabilization.


Submerged & Floating Plants (for deeper water, >12" deep)

White water lily
Nymphaea odorata
Wetland status: OBL
Sunlight: Full sun
Height: Floats
Bloom time: Jun-Sep

GI benefits/notes: Large, fragrant flowers. Provides shade that limits algae growth.


Hornwort
Ceratophyllum demersum
Wetland status: OBL
Sunlight: Full/part sun
Height: Submerged
Bloom time: N/A

GI benefits/notes: Excellent underwater habitat for invertebrates and small fish. Oxygenates water.


Sago pondweed
Stuckenia pectinata
Wetland status: OBL
Sunlight: Full sun
Height: Submerged
Bloom time: N/A

GI benefits/notes: An important food source for waterfowl and provides underwater structure.
Salt tolerant


A.6 Invasive and aggressive species

The plants below are aggressive and can quickly overtake a GI practice, choking out desirable native plants and reducing stormwater function. Diligent identification and removal of these species, especially during the first few years of establishment, is crucial for long-term success.

Below is a list of high-priority invasive species to control and remove from GI projects in the Chicago area and Northeast Illinois.

For more detailed information on identification and control methods, please consult these local and regional resources:

- **CHICAGO BOTANIC GARDEN**
  chicagobotanic.org/research/invasive_species
- **THE MORTON ARBORETUM**
  mortonarb.org/plant-and-protect/tree-plant-care/plant-care-resources/invasive-trees-and-plants/
- **UNIVERSITY OF ILLINOIS EXTENSION**
  extension.illinois.edu/invasives/invasive-plants

Ailanthus altissima, also known as Tree of Heaven

Trees and shrubs

Common buckthorn
Rhamnus cathartica
A small tree or large shrub with dark green, oval leaves that have prominent veins and finely serrated edges. The bark is dark and rough; a cut branch reveals a distinctive orange inner bark (cambium). It produces clusters of black, berry-like fruits that are widely dispersed by birds. Buckthorn is one of the first shrubs to leaf out in spring and the last to lose its leaves in fall, making it easy to spot.


Amur honeysuckle and other invasive bush honeysuckles
Lonicera maackii, L. tatarica, L. morrowii
These are multi-stemmed, deciduous shrubs with opposite, simple, oval-shaped leaves. They produce fragrant, tubular flowers (white, pink, or yellow) in spring, which later develop into red or orange berries in the fall. The center of older stems is hollow, which is a key identification feature.


Tree of heaven
Ailanthus altissima
A fast-growing tree with large compound leaves composed of many leaflets. The leaflets have smooth edges except for one or more teeth near the base. When crushed, the leaves and twigs emit a strong, unpleasant odor often compared to rancid peanut butter. It produces large clusters of papery, winged seeds (samaras) that are easily spread by the wind.


Multiflora rose
Rosa multiflora
A thorny shrub that can climb like a vine or form dense, impenetrable thickets. It has compound leaves, typically with 5-11 toothed leaflets. A key feature is the fringed stipules at the base of each leaf stalk. It produces clusters of small, fragrant white or pinkish flowers in late spring, followed by small, hard, red fruits (rose hips) that persist through winter.


Grasses and perennials

Common reed
Phragmites australis
A very tall, perennial grass that forms dense, uniform stands in wet areas. It has hollow, rigid stems, long flat leaves, and large, feathery, purplish-brown flower plumes that appear in late summer and persist through winter. It spreads aggressively through rhizomes.


Reed canary grass
Phalaris arundinacea
An aggressive, perennial grass that thrives in moist soils. It has hairless stems and wide, flat, rough-textured leaves. A key diagnostic feature is a long, membranous ligule where the leaf blade meets the stem. The flower heads are dense and spike-like, initially purplish and turning beige as they mature.


Garlic mustard
Alliaria petiolata
A biennial herb. In its first year, it forms a low rosette of kidney-shaped, scalloped leaves. In its second year, it grows a 1-4 foot stalk with triangular, toothed leaves and clusters of small, white, four-petaled flowers. When any part of the plant is crushed, it emits a distinct garlic odor.


Teasel
Dipsacus species
A biennial plant that forms a basal rosette of leaves in its first year. In the second year, it sends up a tall, prickly stalk topped by a distinctive, spiny, egg-shaped flower head. The flowers are typically purple or white and bloom in a band around the head. The dried flower stalks often remain standing for a year or more.


Purple loosestrife
Lythrum salicaria
A wetland perennial easily recognized by its tall spikes of vibrant purple-magenta flowers that bloom from mid-summer to early fall. It has a distinctly square-shaped stem, and its leaves are lance-shaped, typically arranged in opposite pairs or in whorls of three around the stem.


Appendix B

Construction Inspection Checklists

The following checklists can be used by construction inspectors to confirm that the installation of best management practices (BMPs) is occurring, according to construction documents and project specifications. They provide ready reminders of the critical aspects of each BMP that must be executed correctly in order for the BMPs to function properly.

CONSTRUCTION INSPECTION CHECKLIST

VEGETATED FILTER STRIPS

PROJECT ____________________

LOCATION ____________________

SITE STATUS ____________________

DATE ____________________ **TIME** ____________________

INSPECTOR ____________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Upstream watershed stabilized?	❑ S ❑ U	
2 Excavation		
Have compacted soils been tilled and power raked?	❑ S ❑ U	
Filter strip slopes >5% blanketed?	❑ S ❑ U	
3 Structural Components		
Level spreader (if any) installed per plans	❑ S ❑ U	
4 Vegetation		
Complies with planting specs	❑ S ❑ U	
Topsoil complies with specs in composition and placement	❑ S ❑ U	
Soil properly stabilized for permanent erosion control	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

BIORETENTION FACILITIES

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Runoff diverted	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes completely level	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	
3 Structural Components		
Stone diaphragm installed per plans	❑ S ❑ U	
Outlets installed per plans	❑ S ❑ U	
Underdrain installed to grade	❑ S ❑ U	
Pretreatment devices installed per plans	❑ S ❑ U	
Soil bed composition and texture conforms to specifications	❑ S ❑ U	

4 Vegetation		
Complies with planting specs	❑ S ❑ U	
Topsoil complies with specs in composition and placement	❑ S ❑ U	
Soil properly stabilized for permanent erosion control	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Soil/ filter bed permeability verified	❑ S ❑ U	
Effective stand of vegetation stabilized	❑ S ❑ U	
Construction generated sediments removed	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

BIOSWALES

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes completely level	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	
3 Structural Components		
Stone diaphragm installed per plans	❑ S ❑ U	
Outlets installed per plans	❑ S ❑ U	
Underdrain installed to grade	❑ S ❑ U	
Pretreatment devices installed per plans	❑ S ❑ U	
Soil bed composition and texture conforms to specifications	❑ S ❑ U	

4 Vegetation		
Complies with planting specs	❑ S ❑ U	
Soil complies with specs in composition and placement	❑ S ❑ U	
Soil properly stabilized for permanent erosion control	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Soil/ filter bed permeability verified	❑ S ❑ U	
Effective stand of vegetation stabilized	❑ S ❑ U	
Construction generated sediments removed	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

CONSTRUCTED WETLANDS

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ____________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes completely level	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	
3 Structural Components		
Stone diaphragm installed per plans	❑ S ❑ U	
Outlets installed per plans	❑ S ❑ U	
Underdrain installed to grade	❑ S ❑ U	
Pretreatment devices installed per plans	❑ S ❑ U	
Soil bed composition and texture conforms to specifications	❑ S ❑ U	

4 Vegetation		
Complies with planting specs	❑ S ❑ U	
Soil complies with specs in composition and placement	❑ S ❑ U	
Soil properly stabilized for permanent erosion control	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Soil/ filter bed permeability verified	❑ S ❑ U	
Effective stand of vegetation stabilized	❑ S ❑ U	
Construction generated sediments removed	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

INFILTRATION TRENCHES

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Runoff diverted	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes completely level	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	
3 Structural Components		
Aggregate installed per plans	❑ S ❑ U	
Outlets installed per plans	❑ S ❑ U	
Underdrain installed to grade	❑ S ❑ U	
Pretreatment devices installed per plans	❑ S ❑ U	
Soil bed composition and texture conforms to specifications	❑ S ❑ U	

4 Vegetation		
Complies with planting specs	❑ S ❑ U	
Topsoil complies with specs in composition and placement	❑ S ❑ U	
Soil properly stabilized for permanent erosion control	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Soil/ filter bed permeability verified	❑ S ❑ U	
Effective stand of vegetation stabilized	❑ S ❑ U	
Construction generated sediments removed	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

PERMEABLE PAVEMENTS

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Runoff diverted	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes 0.5% to outlet or underdrain location	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range (<5%)	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	
3 Structural Components		
Underdrain installed to grade	❑ S ❑ U	
Underdrain connections to receiving collection system verified	❑ S ❑ U	

4 Placement		
Gravel subgrade compacted and leveled	❑ S ❑ U	
Pavers placed in specified pattern, compacted, and leveled	❑ S ❑ U	
Void space aggregate placed and swept	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

DRY WELLS

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Runoff diverted	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes completely level	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range	❑ S ❑ U	
Bottom of Dry Well to be completely level and free from debris	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	

3 Structural Components		
Non-woven geotextile installed per plans	❑ S ❑ U	
Perforated pipe installed per plans	❑ S ❑ U	
Observation wells installed per plans	❑ S ❑ U	
Roof leaders connected to structures per plans	❑ S ❑ U	
Pretreatment devices installed per plans	❑ S ❑ U	
Aggregate installed per plans	❑ S ❑ U	
Soil bed composition and texture conforms to specifications	❑ S ❑ U	
4 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Soil/ filter bed permeability verified	❑ S ❑ U	
Construction generated sediments removed	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

URBAN STORMWATER TREES

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Runoff diverted	❑ S ❑ U	
Facility area cleared	❑ S ❑ U	
Soil tested for permeability	❑ S ❑ U	
Project benchmark near site	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Temporary erosion and sediment protection properly installed	❑ S ❑ U	
2 Excavation		
Lateral slopes ideally 1% to 3%	❑ S ❑ U	
Soils not compacted during excavation	❑ S ❑ U	
Longitudinal slopes within design range	❑ S ❑ U	
Stockpile location not adjacent to excavation area and stabilized with vegetation and/ or silt fence	❑ S ❑ U	
3 Structural Components		
Pretreatment devices installed per plans	❑ S ❑ U	
Woven geotextile installed per plans	❑ S ❑ U	
Aggregate installed per plans	❑ S ❑ U	
Soil bed composition and texture conforms to specifications	❑ S ❑ U	
Observation wells installed per plans	❑ S ❑ U	
Underdrain installed per plans	❑ S ❑ U	

4 Vegetation		
Complies with planting specs	❑ S ❑ U	
Topsoil complies with specs in composition and placement	❑ S ❑ U	
Soil properly stabilized for permanent erosion control	❑ S ❑ U	
5 Final Inspection		
Dimensions per plans	❑ S ❑ U	
Pre-treatment operational	❑ S ❑ U	
Inlet/outlet operational	❑ S ❑ U	
Soil/ filter bed permeability verified	❑ S ❑ U	
Construction generated sediments removed	❑ S ❑ U	
Contributing watershed stabilized before flow is diverted to the practice	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

CISTERNS

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
Pre-construction meeting	❑ S ❑ U	
Runoff diverted away from work area	❑ S ❑ U	
Facility location staked out	❑ S ❑ U	
Verification of setbacks (foundation, septic)	❑ S ❑ U	
Materials on-site match specifications	❑ S ❑ U	
2 Excavation & Foundation		
Excavation depth and dimensions per plans	❑ S ❑ U	
Base material placed (sand/gravel) per specs	❑ S ❑ U	
Base is compacted and level	❑ S ❑ U	
Side slopes stable / shoring in place (if buried)	❑ S ❑ U	
3 Structural Components		
Tank free of cracks/damage prior to setting	❑ S ❑ U	
Tank installed level and fully supported	❑ S ❑ U	
Inlet/Outlet connections sealed and watertight	❑ S ❑ U	
Pre-treatment: first flush diverter/filter installed	❑ S ❑ U	
Inlet: calming inlet installed	❑ S ❑ U	
Backfill material placed in lifts	❑ S ❑ U	
Electrical/pump grounded and wired to code (if applicable)	❑ S ❑ U	

4 Final Inspection		
Gutters and downspouts connected	❑ S ❑ U	
Manhole/lid is secure, lockable, and child-safe	❑ S ❑ U	
Safety signage (“Non-Potable”) visible on outlets	❑ S ❑ U	
Overflow discharges to stable area (no erosion)	❑ S ❑ U	
Site graded to drain away from cistern base	❑ S ❑ U	
Operational test: pump/system functions correctly (if applicable)	❑ S ❑ U	
Comments:		
Actions to be taken:		

CONSTRUCTION INSPECTION CHECKLIST

PROJECT ______________________________

LOCATION ______________________________

SITE STATUS ______________________________

DATE ______________________ **TIME** ______________

INSPECTOR ______________________________

Construction Sequence	Satisfactory (S) or Unsatisfactory (U)	Comments
1 Pre-Construction		
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
2 Excavation		
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
3 Structural Components		
	❑ S ❑ U	
	❑ S ❑ U	

4 Placement		
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
5 Final Inspection		
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	
	❑ S ❑ U	

Comments:

Actions to be taken:

Appendix C

Maintenance Inspection Checklists

The following checklists can be used by construction inspectors and to confirm that the installed BMPs are being maintained properly by the installation contractor during the warranty period. They can also be used by the owner to confirm that the installed BMPs are functioning properly. These checklists can provide guidance regarding maintenance and troubleshooting potential problems.

MAINTENANCE CHECKLIST

VEGETATED FILTER STRIPS

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ______________

- ❑ **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- ❑ **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- ❑ **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- ❑ **MOW FILTER STRIPS**
  Mowing height 3 inches or higher.

- ❑ **REMOVE INVASIVE PLANTS** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

MAINTENANCE CHECKLIST

BIORETENTION FACILITIES

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ____________

- ❑ **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- ❑ **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- ❑ **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- ❑ **MOW GRASS FILTER STRIPS AND BIORETENTION TURF COVER**
  Mowing limited to grass strips installed as part of bioretention.

- ❑ **WEED AND RAKE MULCH**

- ❑ **REPLACE DEAD OR MISSING VEGETATION** *(summer and fall only)*
  Note extent of replacement needed:

- ❑ **RE-MULCH TO MAINTAIN A THREE-INCH LAYER** *(spring and fall only)*
  Note areas of eroded or missing mulch:

- ❑ **PRUNE TREES AND SHRUBS** *(Focus on runners or dead branches.)*

- ❑ **INSPECT FOR CLOGGING OR PONDING WATER IN THE FILTER BED**
  Note days since preceding rain event:

- ❑ **REMOVE INVASIVE PLANTS** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

- ❑ **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND STRUCTURES**
  Note damage type and location:

MAINTENANCE CHECKLIST

BIOSWALES

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ______________

- [ ] **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- [ ] **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- [ ] **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- [ ] **MOW GRASS FILTER STRIPS AND BIORETENTION TURF COVER**
  Mowing limited to turf grass installed as part of bioswale.

- [ ] **WEED AND RAKE MULCH**

- [ ] **REPLACE DEAD OR MISSING VEGETATION** *(summer and fall only)*
  Note extent of replacement needed:

- [ ] **RE-MULCH TO MAINTAIN A THREE-INCH LAYER** *(spring and fall only)*
  Note areas of eroded or missing mulch:

- [ ] **PRUNE TREES AND SHRUBS** *(Focus on runners or dead branches.)*

- [ ] **INSPECT FOR CLOGGING OR PONDING WATER**
  Note days since preceding rain event:

- [ ] **REMOVE INVASIVE PLANTS** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

- [ ] **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND CHECK DAMS**
  Note damage type and location:

MAINTENANCE CHECKLIST

CONSTRUCTED WETLANDS

INSPECTOR ______________________________

LOCATION ______________________________

DATE ____________________ **TIME** ____________

- ❑ **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- ❑ **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- ❑ **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- ❑ **MOW GRASS FILTER STRIPS AND BIORETENTION TURF COVER**
  Mowing limited to grass strips installed as part of bioretention

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- ❑ **WEED AND RAKE MULCH**

- ❑ **REPLACE DEAD OR MISSING VEGETATION** *(summer and fall only)*
  Note extent of replacement needed:

- ❑ **RE-MULCH TO MAINTAIN A THREE-INCH LAYER** *(spring and fall only)*
  Note areas of eroded or missing mulch:

- ❑ **PRUNE TREES AND SHRUBS** *(Focus on runners or dead branches.)*

- ❑ **INSPECT FOR CLOGGING OR PONDING WATER IN THE FILTER BED**
  Note days since preceding rain event:

- ❑ **REMOVE INVASIVE PLANTS.** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

- ❑ **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND STRUCTURES**
  Note damage type and location:

MAINTENANCE CHECKLIST

URBAN STORMWATER TREES

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ______________

- ☐ **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- ☐ **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- ☐ **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- ☐ **MOW/TRIM GRASS** *(Mowing height 3 inches or higher.)*

- ☐ **WEED AND RAKE MULCH**

- ☐ **REPLACE DEAD OR MISSING VEGETATION** *(summer and fall only)*
  Note extent of replacement needed:

- ☐ **RE-MULCH TO MAINTAIN A THREE-INCH LAYER** *(spring and fall only)*
  Note areas of eroded or missing mulch:

- ☐ **PRUNE TREES AND SHRUBS** *(Focus on runners or dead branches.)*

- ☐ **INSPECT FOR CLOGGING OR PONDING WATER IN THE FILTER BED**
  Note days since preceding rain event:

- ☐ **REMOVE INVASIVE PLANTS.** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

- ☐ **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND STRUCTURES**
  Note damage type and location:

MAINTENANCE CHECKLIST

DRY WELLS

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ______________

- ❑ **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- ❑ **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- ❑ **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- ❑ **MOW TURF COVER** *(Mowing height 3 inches or higher.)*

- ❑ **WEED AND RAKE MULCH**

- ❑ **REPLACE DEAD OR MISSING VEGETATION** *(summer and fall only)*
  Note extent of replacement needed:

- ❑ **RE-MULCH TO MAINTAIN A THREE-INCH LAYER** *(spring and fall only)*
  Note areas of eroded or missing mulch:

- ❑ **CHECK AND CLEAN ANY DIRECTLY CONNECTED GUTTERS**

- ❑ **INSPECT FOR CLOGGING OR PONDING WATER IN THE OBSERVATION WELL**
  Note days since preceding rain event:

- ❑ **REMOVE INVASIVE PLANTS** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

- ❑ **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND STRUCTURES**
  Note damage type and location:

MAINTENANCE CHECKLIST

INFILTRATION TRENCHES

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ______________

- [ ] **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- [ ] **CHECK AND REPAIR ERODED AREAS**
  Note any recurring areas that may need supplemental erosion control measures:

- [ ] **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- [ ] **MOW TURF COVER** *(Mowing height 3 inches or higher.)*

- [ ] **WEED AND RAKE MULCH**

- [ ] **REPLACE DEAD OR MISSING VEGETATION** *(summer and fall only)*
  Note extent of replacement needed:

- [ ] **RE-MULCH TO MAINTAIN A THREE-INCH LAYER** *(spring and fall only)*
  Note areas of eroded or missing mulch:

- [ ] **INSPECT FOR CLOGGING OR PONDING WATER IN THE FILTER BED**
  Note days since preceding rain event:

- [ ] **REMOVE INVASIVE PLANTS** *(Herbicide allowable by licensed applicator.)*
  Note species (if known) and extent of invasives, and type of herbicide (if any):

- [ ] **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND STRUCTURES**
  Note damage type and location:

MAINTENANCE CHECKLIST

PERMEABLE PAVEMENTS

INSPECTOR ______________________________

LOCATION ______________________________

DATE ______________________ **TIME** ______________

- ❑ **REMOVE TRASH AND DEBRIS**
  Note unusual debris, if any, and note potential sources:

- ❑ **INSPECT FOR AND REMOVE EXCESS SEDIMENT**
  Note location and amount of sediment accumulation:

- ❑ **INSPECT FOR CLOGGING OR PONDING WATER IN THE FILTER BED**
  Note days since preceding rain event:

- ❑ **INSPECT SURFACE FOR SIGNS OF DETERIORATION OR SETTLING** *(1-2 times per year)*

- ❑ **INSPECT AND REMOVE ANY VEGETATION GROWING IN THE AGGREGATE**

- ❑ **BROOM, BLOW, ROTARY BRUSH OR SWEEP ENTIRE SURFACE** *(1-2 times per year)*
  (ALTERNATE – VACUUM ENTIRE SURFACE)

- ❑ **REPLENISH JOINT AGGREGATE MATERIAL AFTER CLEANING** *(1-2 times per year)*

- ❑ **INSPECT (AND REPAIR IF NEEDED) INLETS, OUTLETS, AND STRUCTURES**
  Note damage type and location:

MAINTENANCE CHECKLIST

CISTERNS

INSPECTOR ____________________

LOCATION ____________________

DATE ____________________ **TIME** ____________________

- ❑ **CHECK AND CLEAN GUTTERS AND DOWNSPOUTS**
  Note condition of gutters and downspouts:

- ❑ **CLEAN FIRST FLUSH DIVERTERS, SCREENS, AND/OR TRASH RACKS**
  Note amount of debris/sediment removed and condition:

- ❑ **INSPECT TANK INTERIOR FOR SEDIMENT ACCUMULATION**
  Note depth of sediment (Vacuum or clean if depth > 1 inch):

- ❑ **CHECK MOSQUITO SCREENS ON OVERFLOW PIPES AND VENTS**
  Note if screens are torn, missing, or blocked (Repair immediately if damaged):

- ❑ **INSPECT PUMP OPERATION AND ELECTRICAL CONNECTIONS** *(if applicable)*
  Note any unusual noises, vibration, cycling issues, or exposed wiring:

- ❑ **CHECK TANK FOR LEAKS OR STRUCTURAL CRACKS**
  Note location of any damp spots, bulging walls, or visible damage:

- ❑ **TEST SPIGOTS AND VALVES**
  Note if valves are stuck, hard to turn, or dripping:

- ❑ **CHECK OVERFLOW DISCHARGE AREA**
  Note any erosion or standing water at the discharge point:

- ❑ **WINTERIZATION** *(late fall only - for above ground systems)*
  Confirm tank is drained, pump disconnected, and diverter set to “bypass”:

Appendix D

Cost Considerations

The following tables can be used to obtain estimated unit costs for the major line items of each BMP. Costs are calculated using an estimation of variables such as size and design elements. Considerations for a "low storage" option versus a "high storage" option are also included. Calculations are based on the current MWRD TGM standard details for each BMP as of the publishing of this document. Please refer to the latest TGM guidelines on our website at ***mwrd.org/wmo-tgm***.

Typical construction costs for green stormwater infrastructure

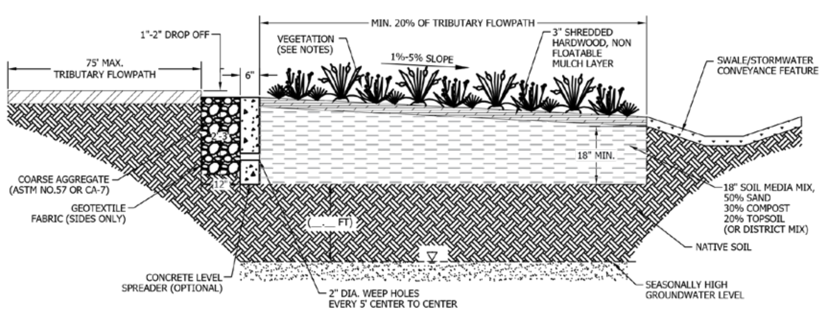
	COST PER SQUARE FOOT		GALLON PER SQUARE FOOT		COST PER GALLON	
BMP	**LOW**	**HIGH**	**LOW**	**HIGH**	**LOW (LOW UNIT / HIGH GPSF)**	**HIGH (HIGH UNIT / LOW GPSF)**
Landscape & Plant-Based GSI						
Vegetated filter strips	$11	$21	—	—	—	n/a
Bioswales	$13	$43	4.6	7.1	$2.80	$6.08
Bioretention systems	$11	$30	10.2	12.5	$1.09	$2.46
Constructed wetlands and other naturalized detention basins	$9	$32	9.0	9.3	$0.95	$3.42
Urban stormwater trees	$107	$213	12.3	12.3	$8.76	$17.28
Hardscape & Water Re-use						
Permeable pavements	$17	$38	1.4	4.0	$5.07	$22.08
Dry wells	$146	$364	2.7	7.9	$32.83	$76.09
Infiltration trenches	$20	$83	12.0	21.1	$1.70	$3.94
Underground rain cistern/ water reuse systems	—	—	—	—	$8.14	$13.31
Above-ground rain cistern/ water reuse systems	—	—	—	—	$7.82	$11.90

Assumptions and basis: Estimated using curent Union / Prevailing Wage unit price data from Chicago area in spring of 2024 following standard designs as attached to this estimate.

VEGETATED FILTER STRIPS

Quantities based on 200 LF filter strip using 75' maximum tributary flowpath or 15' width (3,000 SF).

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	195	cubic yard	$18	$95	$3,501	$18,478
Course aggregate barrier strip, w/ filter fabric, 12"x18"	200	linear foot	$12	$18	$2,400	$3,600
PCC level spreader, 6" x 18"	200	linear foot	$25	$35	$5,000	$7,000
Hardwood mulch, 3"	28	cubic yard	$35	$75	$973	$2,085
Soil media mix, 50% sand, 30% compost, 20% topsoil, 18"	167	cubic yard	$90	$150	$15,003	$25,005
Native seed & blanket	333	square yard	$4	$7	$1,333	$2,333
Native plant plugs, 8000/acre	551	each	$6.25	$9	$3,444	$4,959
				TOTALS:	**$31,654**	**$63,460**
				COST / SF:	**$11**	**$21**



NOTES:
1. MULCH LAYER SHALL BE HARDWOOD MULCH OR OTHER NON-FLOATING GROUND COVER.
2. AVOID INSTALLATION ON SLOPES GREATER THAN 3.00%. AVOID COMPACTING NATIVE SOILS. SCARIFY ANY COMPACTED SOIL.
3. LONGEST FLOW PATH OF CONTRIBUTING DRAINAGE AREA MUST NOT EXCEED 75 FEET.
4. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
5. COARSE AGGREGATE OPTIONS ARE IDOT CA-1, CA-3, CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS ARE ALLOWED.
6. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL.

NOT TO SCALE

TECHNICAL GUIDANCE MANUAL

VEGETATED FILTER STRIP (FLOW-THROUGH) DETAIL

10/11/18

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BIOSWALES

Low storage option

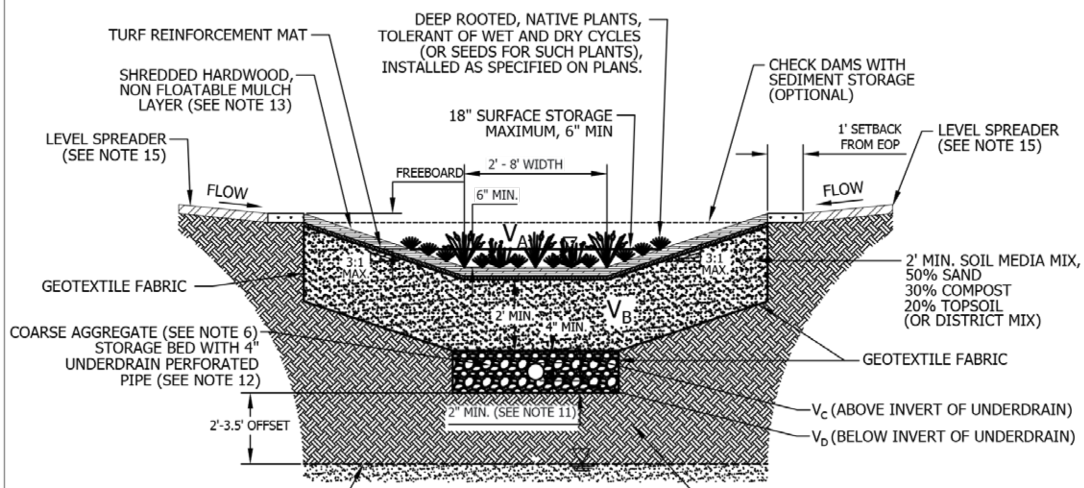
Quantities based on a 1% slope and 12" surface storage depth at downstream end. (Check spacing at 100 LF, where surface depth = zero.) 2' bottom width and 3:1 side slopes, 1,000 LF (8,000 SF).

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal, (over-excavation for soil + 12" of storage)	963	cubic yard	$18	$95	$17,333	$91,481
Coarse aggregate storage bed w/ drain & geotextile, 2' x 12"	1,000	linear foot	$25	$35	$25,000	$35,000
Check dam installation (10 each)	30	cubic yard	$145	$195	$4,350	$5,850
F&I hardwood mulch, 3"	74	cubic yard	$35	$75	$2,593	$5,556
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 24"	593	cubic yard	$75	$120	$44,444	$71,111
Native seed & blanket	889	square yard	$4	$7	$3,556	$6,222
Native plant plugs, 5000/acre	918	each	$6.25	$9	$5,739	$8,264
				TOTALS:	**$103,015**	**$223,485**
				COST / SF:	**$13**	**$28**

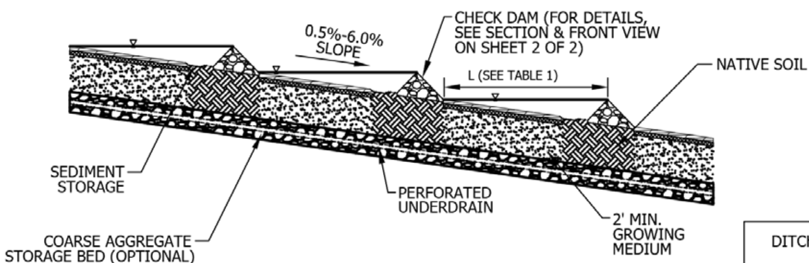
High storage option

Quantities based on a 1% slope and 12" surface storage depth at downstream end. (Check spacing at 100 LF, where surface depth = zero.) 8' bottom width and 3:1 side slopes, 1,000 LF (14,000 SF).

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal, (over-excavation for soil + 12" of storage)	1,685	cubic yard	$18	$95	$30,333	$160,093
Coarse aggregate storage bed w/ drain & geotextile, 8' x 24"	1,000	linear foot	$200	$280	$200,000	$280,000
Check dam installation (10 each)	30	cubic yard	$145	$195	$4,350	$5,850
F&I hardwood mulch, 3"	130	cubic yard	$35	$75	$4,537	$9,722
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 24"	1,037	cubic yard	$75	$120	$77,778	$124,444
Native seed & blanket	1,556	square yard	$4	$7	$6,222	$10,889
Native plant plugs, 5000/acre	1,607	each	$6.25	$9	$10,044	$14,463
				TOTALS:	**$333,264**	**$605,461**
				COST / SF:	**$24**	**$43**



CROSS SECTION VIEW (BIOSWALE)



PROFILE VIEW

Table 1

DITCH SLOPE (%)	SPACING L (feet)
1	200
2	100
4	50
6	33

SLOPES ABOVE 6% ARE NOT RECOMMENDED

NOTES:

1. THE PERIMETER OF THE VOLUME CONTROL FACILITY SHALL MAINTAIN THE MINIMUM HORIZONTAL SEPARATION DISTANCE OF: 10-FEET FROM FOUNDATIONS, UNLESS WATERPROOFED; 20-FEET FROM ROADWAY GRAVEL SHOULDER; AND 100-FEET FROM POTABLE WATER WELLS, SEPTIC TANKS/FIELDS, OR OTHER UNDERGROUND TANKS.
2. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED WITHIN THE VOLUME CONTROL FACILITY. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED BELOW THE FOOTPRINT OF THE VOLUME CONTROL FACILITY. WHEN LOCAL CONDITIONS PREVENT THE SEWER FROM BEING LOCATED OUTSIDE THE FOOTPRINT OF THE FACILITY THE SEWER SHALL BE CONSTRUCTED TO WATER MAIN QUALITY STANDARDS, OR IT SHALL BE ENCASED WITH A WATER MAIN QUALITY CARRIER PIPE WITH THE ENDS SEALED.
3. AVOID INSTALLATION ON SLOPES GREATER THAN 15 TO 1. AVOID COMPACTING NATIVE SOILS. SCARIFY ANY COMPACTED SOIL.
4. GROWING MEDIUM SHALL BE 4 INCHES DEEPER THAN LARGEST PLANTED ROOT BALL.
5. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).STONE
6. STORAGE OPTIONS ARE IDOT CA-1, CA-3, CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
7. CHECK DAMS MUST BE INSTALLED FOR VELOCITIES GREATER THAN 1 FT/S FOR THE 2-YEAR, 24-HOUR STORM EVENT. CHECK DAM SPACING PER TABLE 1.
8. CENTER OF CHECK DAM MUST BE A MINIMUM OF 6 INCHES LOWER THAN OUTSIDE EDGES TO PASS HIGH FLOWS.
9. BOTTOM OF UPSTREAM CHECK DAM SHALL BE SAME ELEVATION AS TOP OF DOWNSTREAM CHECK DAM.
10. MINIMUM DISTANCE OF 2 FEET (3.5 FEET IN COMBINED SEWER AREAS) BETWEEN BOTTOM OF BMP AND SEASONALLY HIGH GROUNDWATER LEVEL.
11. UNDERDRAINS ARE REQUIRED IN TYPICAL CLAYEY SOILS WHERE INFILTRATION RATES ARE LESS THAN 0.5 INCH/HOUR. MAXIMUM OF 1 UNDERDRAIN PER 30 FEET. PROVIDE A SOIL REPORT DOCUMENTING NATIVE INFILTRATION RATE TO FOREGO UNDERDRAINS.
12. MINIMUM UNDERDRAIN BEDDING OF TWO INCHES, MAXIMUM OF 12 INCHES.
13. ONE OBSERVATION WELL REQUIRED PER 6,000 SQUARE FEET OF SURFACE AREA.
14. MULCH LAYER SHALL BE HARDWOOD MULCH OR OTHER NON-FLOATING GROUND COVER.
15. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL.

NOT TO SCALE

TECHNICAL GUIDANCE MANUAL		10/2/18
BIOSWALE DETAIL (SHEET 1 OF 2)		STD. DWG. NO.2
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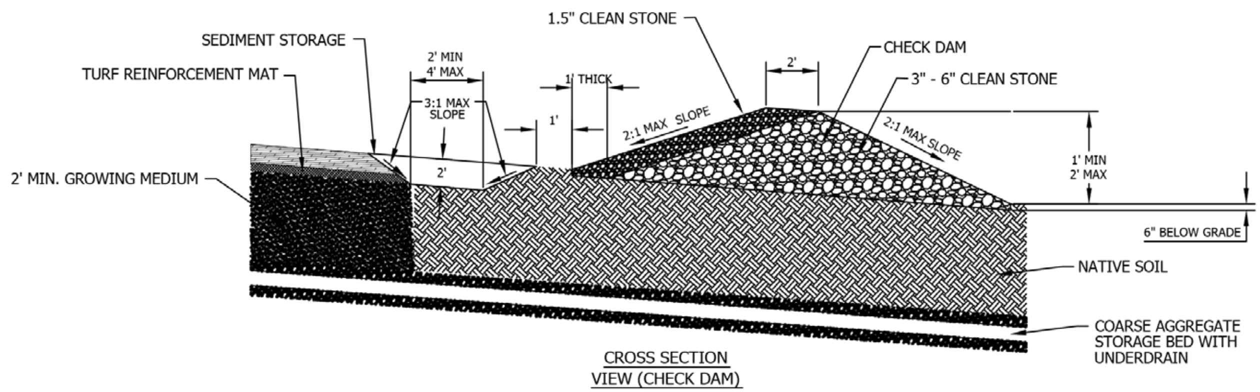
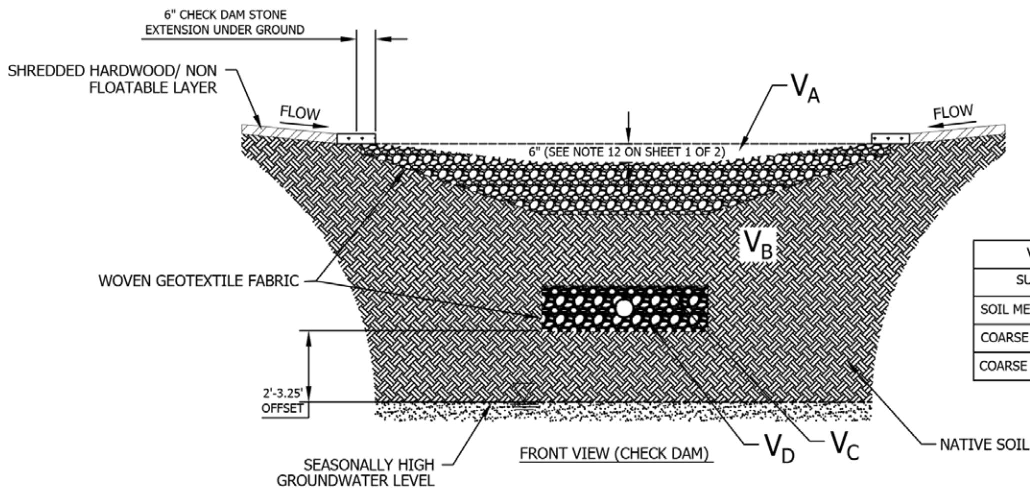


CROSS SECTION VIEW (CHECK DAM)



FRONT VIEW (CHECK DAM)

TABLE 2

VOLUME TYPE	POROSITY	MEDIA VOLUME	STORAGE VOLUME	VOLUME PROVIDED
SURFACE STORAGE	1.00	V_A	$1.00 \times V_A$	
SOIL MEDIA MIX	0.25	V_B	$0.5 \times 0.25 \times V_B$	
COARSE AGG. (ABOVE INVERT)	0.36	V_C	$0.5 \times 0.36 \times V_C$	
COARSE AGG. (BELOW INVERT)	0.36	V_D	$0.36 \times V_D$	
			TOTAL	

NOT TO SCALE

TECHNICAL GUIDANCE MANUAL

BIOSWALE DETAIL (SHEET 2 OF 2)

7/1/15

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BIORETENTION FACILITIES

Low storage option

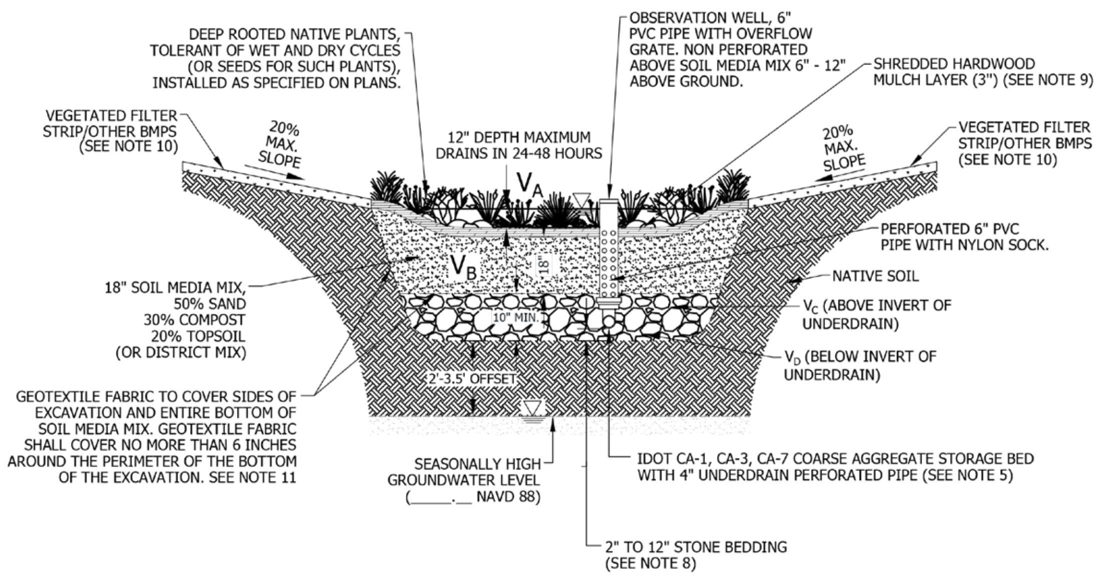
Quantities based on a 1/2 acre facility (21,780 SF) with 12" storage depth above the surface.

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal, (over-excavation for soil + 1' of storage)	2,689	cubic yard	$18	$95	$48,400	$255,444
Coarse aggregate storage bed w/ geotextile, 10"	672	cubic yard	$90	$120	$60,500	$80,667
Observation well installation	1	each	$3,500	$4,500	$3,500	$4,500
F&I hardwood mulch, 3"	202	cubic yard	$35	$75	$7,058	$15,125
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 18"	1,210	cubic yard	$75	$120	$90,750	$145,200
Native seed & turf reinforcement mat	2,420	square yard	$7	$10	$16,940	$24,200
Native plant plugs, 5000/acre	2,500	each	$6.25	$9	$15,625	$22,500
				TOTALS:	**$242,773**	**$547,636**
				COST / SF:	**$11**	**$25**

High storage option

Quantities based on a 1 acre facility (43,560 SF) with 12" storage depth above the surface.

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal, (over-excavation for soil + 1' of storage)	5,916	cubic yard	$18	$95	$106,480	$561,978
Coarse aggregate storage bed w/ geotextile, 20"	2,689	cubic yard	$90	$120	$242,000	$322,667
Observation well installation	1	each	$3,500	$4,500	$3,500	$4,500
F&I hardwood mulch, 3"	403	cubic yard	$35	$75	$14,117	$30,250
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 18"	2,420	cubic yard	$75	$120	$181,500	$290,400
Native seed & turf reinforcement mat	4,840	square yard	$7	$10	$33,880	$48,400
Native plant plugs, 5000/acre	5,000	each	$6.25	$9	$31,250	$45,000
				TOTALS:	**$612,727**	**$1,303,194**
				COST / SF:	**$14**	**$30**



BOTTOM OF THE FACILITY:	ELEV. ______
SEASONALLY HIGH GROUNDWATER:	ELEV. ______
SEPARATION:	FEET ______

VOLUME TYPE	SURFACE AREA	DEPTH	POROSITY	STORAGE VOLUME	VOLUME PROVIDED
V_A : SURFACE STORAGE			1.00	1.00 X V_A	
V_B : SOIL MEDIA MIX			0.25	0.50 X 0.25 X V_B	
V_C : COARSE AGGREGATE (ABOVE INVERT)			0.36	0.50 X 0.36 X V_C	
V_D : COARSE AGGREGATE (BELOW INVERT)			0.36	0.36 X V_D	
				TOTAL	

NOTES:

1. THE PERIMETER OF THE VOLUME CONTROL FACILITY SHALL MAINTAIN THE MINIMUM HORIZONTAL SEPARATION DISTANCE OF: 10-FEET FROM FOUNDATIONS, UNLESS WATERPROOFED; 20-FEET FROM ROADWAY GRAVEL SHOULDER; AND 100-FEET FROM POTABLE WATER WELLS, SEPTIC TANKS/FIELDS, OR OTHER UNDERGROUND TANKS.
2. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED WITHIN THE VOLUME CONTROL FACILITY. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED BELOW THE FOOTPRINT OF THE VOLUME CONTROL FACILITY. WHEN LOCAL CONDITIONS PREVENT THE SEWER FROM BEING LOCATED OUTSIDE THE FOOTPRINT OF THE FACILITY THE SEWER SHALL BE CONSTRUCTED TO WATER MAIN QUALITY STANDARDS, OR IT SHALL BE ENCASED WITH A WATER MAIN QUALITY CARRIER PIPE WITH THE ENDS SEALED.
3. AVOID INSTALLATION ON SLOPES GREATER THAN 3.00%. AVOID COMPACTING NATIVE SOILS. SCARIFY ANY COMPACTED SOIL.
4. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
5. STONE STORAGE OPTIONS ARE IDOT CA-1, CA-3, CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
6. MINIMUM DISTANCE OF 2 FEET (3.5 FEET IN COMBINED SEWER AREAS) BETWEEN BOTTOM OF BMP AND SEASONALLY HIGH GROUNDWATER LEVEL.
7. UNDERDRAINS ARE REQUIRED IN TYPICAL CLAYEY SOILS WHERE INFILTRATION RATES ARE LESS THAN 0.5 INCH/HOUR. NO MORE THAN 1 UNDERDRAIN EVERY 30 FEET ON CENTER. PROVIDE A SOIL REPORT DOCUMENTING NATIVE INFILTRATION RATE TO FOREGO UNDERDRAINS. NO FILTER FABRIC COVER/SOCK.
8. MINIMUM UNDERDRAIN BEDDING OF 2 INCHES, MAXIMUM OF 12 INCHES.
9. MULCH LAYER SHALL BE HARDWOOD MULCH OR OTHER NON-FLOATING GROUND COVER.
10. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL.
11. CHOKING STONE MAY BE SUBSTITUTED FOR GEOTEXTILE FABRIC, PER APPROVAL BY THE ENGINEER.

NOT TO SCALE

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	BIORETENTION FACILITY DETAIL	STD. DWG. NO.1 PAGE NO.1

CONSTRUCTED WETLANDS

Low storage option

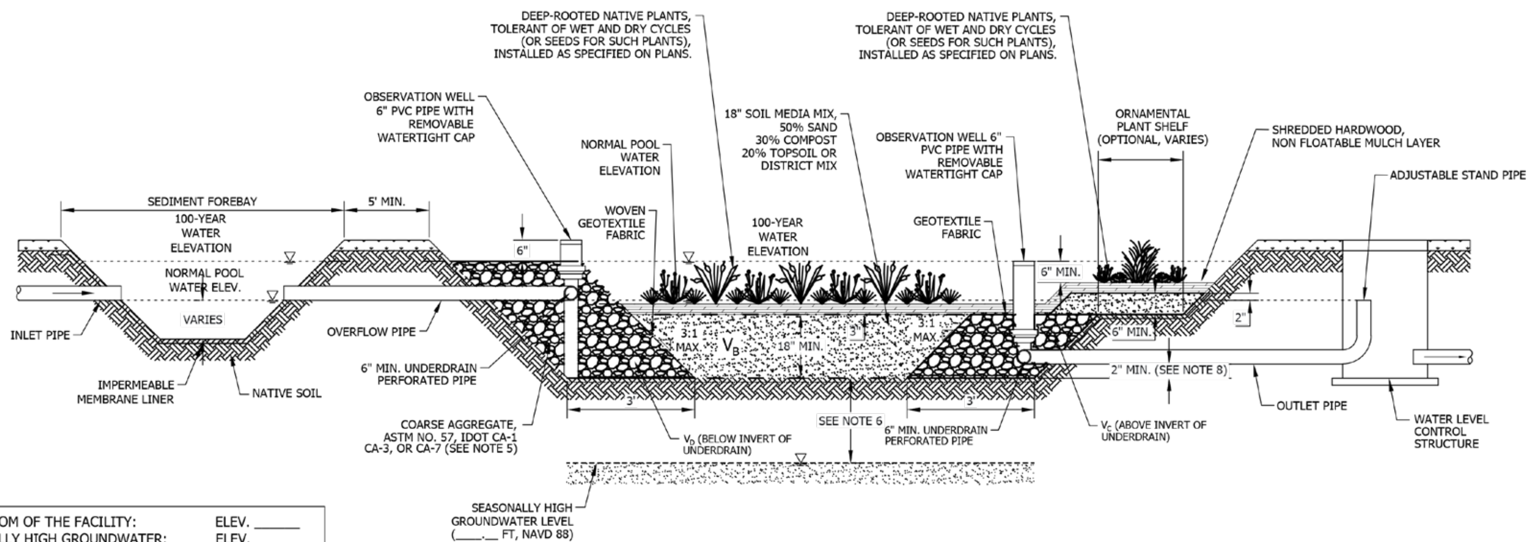
Quantities based on a 2 acre facility (87,120 SF) with 12" storage depth above the surface.

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal, (over-excavation for soil + 1" of storage)	8,419	cubic yard	$18	$95	$151,550	$799,847
Coarse aggregate storage bed w/ geotextile	353	cubic yard	$90	$120	$31,750	$42,333
Observation well installation	4	each	$3,500	$4,500	$14,000	$18,000
F&I hardwood mulch, 3"	807	cubic yard	$35	$75	$28,233	$60,500
Overflow piping system	1	each	$20,000	$35,000	$20,000	$35,000
Sediment forebay w/ membrane liner (.15 acre)	1	each	$35,000	$50,000	$35,000	$50,000
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 18"	4,840	cubic yard	$75	$120	$363,000	$580,800
Native seed & blanket	9,680	square yard	$4	$7	$38,720	$67,760
Native plant plugs, 5000/acre	10,000	each	$6.25	9	$62,500	$90,000
				TOTALS:	**$744,753**	**$1,744,241**
				COST / SF:	**$9**	**$20**

High storage option

Quantities based on a 2 acre facility (87,120 SF) with 48" storage depth above the surface.

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal, (over-excavation for soil + 1' of storage)	18,593	cubic yard	$18	$95	$334,680	$1,766,367
Coarse aggregate storage bed w/ geotextile	847	cubic yard	$90	$120	$76,200	$101,600
Observation well installation	4	each	$3,500	$4,500	$14,000	$18,000
F&I hardwood mulch, 3"	807	cubic yard	$35	$75	$28,233	$60,500
Overflow piping system	1	each	$20,000	$35,000	$20,000	$35,000
Sediment forebay w/ membrane liner (.15 acre)	1	each	$35,000	$50,000	$35,000	$50,000
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 18"	4,840	cubic yard	$75	$120	$363,000	$580,800
Native seed & blanket	9,680	square yard	$4	$7	$38,720	$67,760
Native plant plugs, 5000/acre	10,000	each	$6.25	9	$62,500	$90,000
				TOTALS:	**$972,333**	**$2,770,027**
				COST / SF:	**$11**	**$32**



BOTTOM OF THE FACILITY: ELEV. ______
SEASONALLY HIGH GROUNDWATER: ELEV. ______
SEPARATION: FEET ______

VOLUME TYPE	SURFACE AREA	DEPTH	POROSITY	STORAGE VOLUME	VOLUME PROVIDED
V_A : SURFACE STORAGE			N/A	1.00 X V_A	
V_B : SOIL MEDIA MIX			0.25	0.50 X 0.25 X V_B	
V_C : COARSE AGGREGATE (ABOVE INVERT)			0.36	0.50 X 0.36 X V_C	
V_D : COARSE AGGREGATE (BELOW INVERT)			0.36	0.36 X V_D	
				TOTAL	

NOTES:
1. OFFSET A MINIMUM OF 10 FEET FROM FOUNDATIONS UNLESS WATERPROOFED, 20 FEET FROM SANITARY SEWERS, 20 FEET FROM ROADWAY GRAVEL SHOULDER AND 100 FEET FROM POTABLE WATER WELLS OR SEPTIC TANKS.
2. AVOID INSTALLATION ON SLOPES GREATER THAN 3.00%. AVOID COMPACTING NATIVE SOILS. SCARIFY ANY COMPACTED SOIL.
3. WETLAND LENGTH TO WIDTH RATIO SHOULD RANGE FROM 2 TO 3.
4. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.55 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
5. STONE STORAGE OPTIONS ARE IDOT CA-1, CA-3, CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
6. MINIMUM DISTANCE OF 2 FEET (3.5 FEET IN COMBINED SEWER AREAS) BETWEEN BOTTOM OF BMP AND SEASONALLY HIGH GROUNDWATER LEVEL.
7. UNDERDRAINS ARE REQUIRED IN TYPICAL CLAYEY SOILS WHERE INFILTRATION RATES ARE LESS THAN 0.5 INCH/HOUR. MAXIMUM OF 1 UNDERDRAIN PER 30 FEET. PROVIDE A SOIL REPORT DOCUMENTING NATIVE INFILTRATION RATE TO FOREGO UNDERDRAINS.
8. MINIMUM UNDERDRAIN BEDDING OF TWO INCHES, MAXIMUM OF 12 INCHES.
9. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL.

NOT TO SCALE

TECHNICAL GUIDANCE MANUAL

CONSTRUCTED WETLAND DETAIL

10/11/18

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URBAN STORMWATER TREES

Low storage option

Quantities based on a single planter system with two trees, 35' x 5' footprint (175 SF).

ITEM	QUANTITY	UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	32 cubic yard	$300	$550	$9,722	$17,824
Coarse aggregate storage bed w/ geotextile, 24"	13 cubic yard	$90	$120	$1,167	$1,556
Tree installation, 2.00" caliper	2 each	$950	$1,400	$1,900	$2,800
Observation well installation	1 each	$800	$1,500	$800	$1,500
Under drain installation	30 linear foot	$25	$40	$750	$1,200
PCC planterbox curb	80 linear foot	$30	$50	$2,400	$4,000
Energy dissipation aprons	6 each	$75	$125	$450	$750
Soil media mix, under sidewalk	0 cubic yard	$125	$200	—	—
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 24"	13 cubic yard	$125	$200	$1,620	$2,593
			TOTALS:	**$18,809**	**$32,222**
			COST / EACH:	**$107**	**$184**

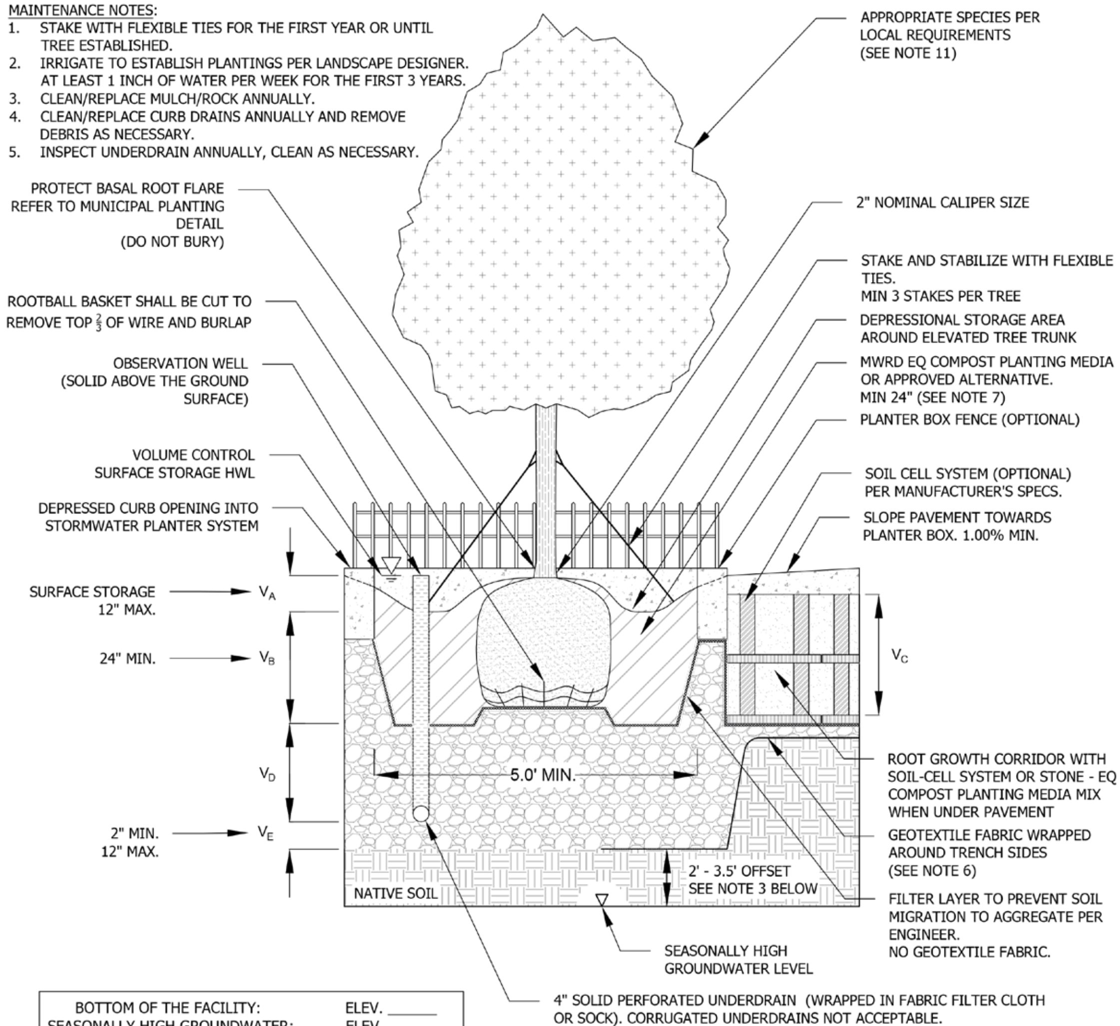
High storage option

Quantities based on a single planter system with two trees, 35' x 10' footprint (350 SF).

ITEM	QUANTITY	UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	91 cubic yard	$300	$550	$27,222	$49,907
Coarse aggregate storage bed w/ geotextile, 24"	52 cubic yard	$90	$120	$4,667	$6,222
Tree installation, 2.00" caliper	2 each	$950	$1,400	$1,900	$2,800
Observation well installation	1 each	$800	$1,500	$800	$1,500
Under drain installation	30 linear foot	$25	$40	$750	$1,200
PCC planterbox curb	90 linear foot	$30	$50	$2,700	$4,500
Energy dissipation aprons	6 each	$75	$125	$450	$750
Soil media mix, under sidewalk	13 cubic yard	$125	$200	$1,620	$2,593
F&I soil media mix, 50% sand, 30% compost, 20% topsoil, 24"	26 cubic yard	$125	$200	$3,241	$5,185
			TOTALS:	**$43,350**	**$74,657**
			COST / EACH:	**$124**	**$213**

MAINTENANCE NOTES:

1. STAKE WITH FLEXIBLE TIES FOR THE FIRST YEAR OR UNTIL TREE ESTABLISHED.
2. IRRIGATE TO ESTABLISH PLANTINGS PER LANDSCAPE DESIGNER. AT LEAST 1 INCH OF WATER PER WEEK FOR THE FIRST 3 YEARS.
3. CLEAN/REPLACE MULCH/ROCK ANNUALLY.
4. CLEAN/REPLACE CURB DRAINS ANNUALLY AND REMOVE DEBRIS AS NECESSARY.
5. INSPECT UNDERDRAIN ANNUALLY, CLEAN AS NECESSARY.



BOTTOM OF THE FACILITY:	ELEV. ______
SEASONALLY HIGH GROUNDWATER:	ELEV. ______
SEPARATION:	FEET ______

VOLUME TYPE	SURFACE AREA	DEPTH	POROSITY	STORAGE VOLUME	VOLUME PROVIDED
V_A : SURFACE STORAGE			1.00	1.00 X V_A	
V_B : MWRD EQ COMPOST PLANTING MEDIA MIX			0.25	0.50 X 0.25 X V_B	
V_C : SOIL - CELL SYSTEM OR STONE MIX			n - SEE NOTE 8	0.50 X n X V_C	
V_D : COARSE AGGREGATE (ABOVE INVERT)			0.36	0.50 X 0.36 X V_D	
V_E : COARSE AGGREGATE (BELOW INVERT)			0.36	0.36 X V_E	
				TOTAL	

NOTES:

1. THE PERIMETER OF THE VOLUME CONTROL FACILITY SHALL MAINTAIN THE MINIMUM HORIZONTAL SEPARATION DISTANCE 10-FEET FROM FOUNDATIONS, UNLESS WATERPROOFED; AND 100-FEET FROM POTABLE WATER WELLS, SEPTIC TANKS/FIELDS, OR OTHER UNDERGROUND TANKS.
2. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED BENEATH THE VOLUME CONTROL FACILITY.
3. MINIMUM DISTANCE OF 2 FEET (3.5 FEET IF TRIBUTARY TO MWRD'S FACILITIES) BETWEEN BOTTOM OF VOLUME CONTROL FACILITY AND SEASONALLY HIGH GROUNDWATER LEVEL.
4. DO NOT INSTALL ON SLOPES GREATER THAN 3.0%.
5. COMPACT AGGREGATE BELOW TREE ROOT BALL. AVOID COMPACTING NATIVE SOILS, SOIL CELL SYSTEM AND PLANTING MEDIA MIX. SCARIFY COMPACTED FILL.
6. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
7. MWRD EQ COMPOST PLANTING MEDIA (OR APPROVED ALTERNATIVE): TYPICALLY COMPOSED OF A MEDIA MIX (50% SAND, 30% COMPOST, AND 20% TOPSOIL). ASSUME A POROSITY OF 0.25 FOR STORMWATER STORAGE OR SPECIFY.
8. USE n=0.25 FOR STONE-EQ COMPOST PLANTING MEDIA MIX. FOR SOIL CELL SYSTEM, USE POROSITY AVAILABLE FOR STORMWATER STORAGE, PER MANUFACTURER.

NOTES CONTINUED ON PAGE 2 OF THE URBAN TREE STORMWATER PLANTER BOX DETAIL.

NOT TO SCALE

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	URBAN TREE STORMWATER PLANTER BOX (1 OF 2) PROFILE VIEW	STD. DWG. NO. 43
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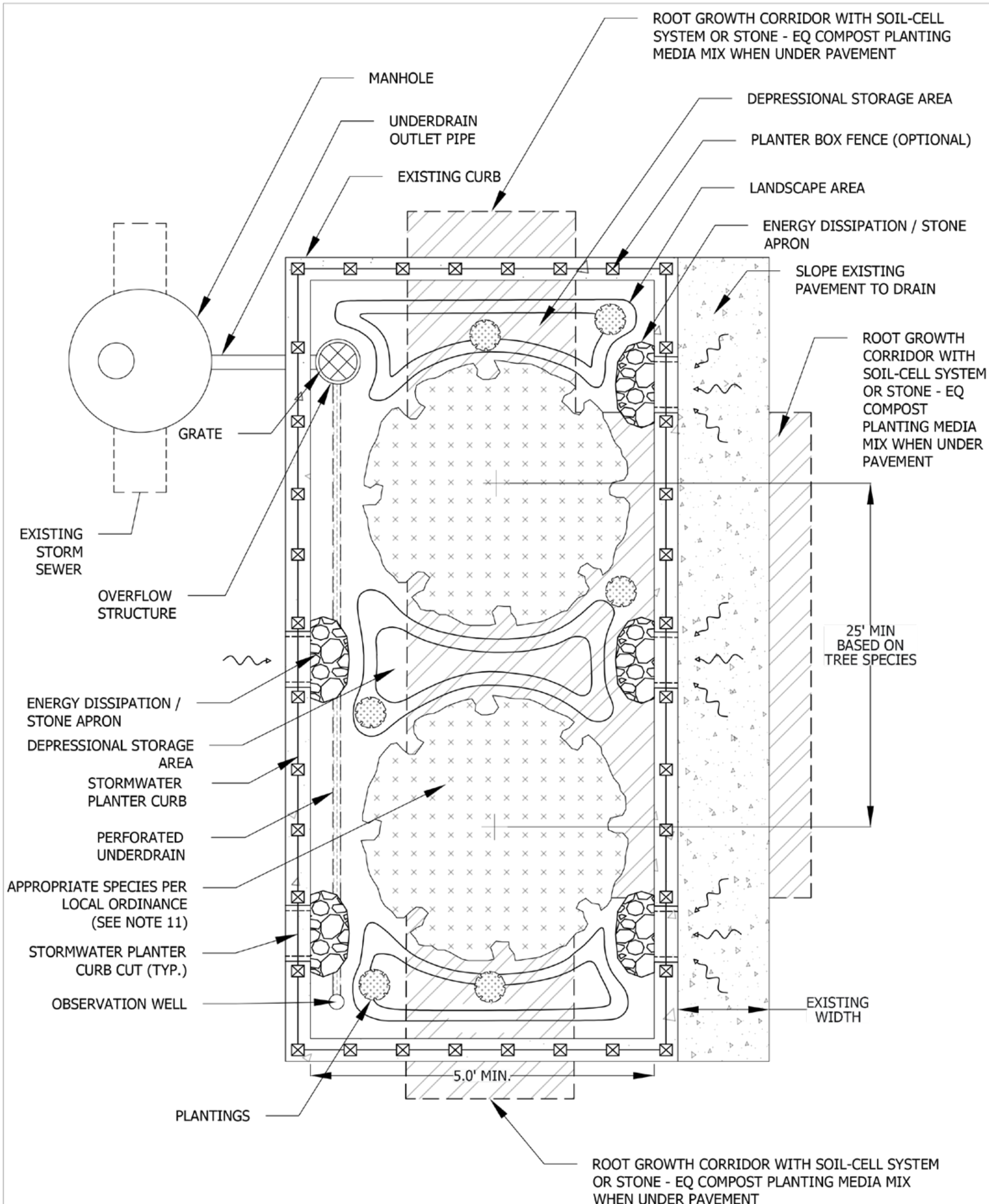

NOTES CONTINUED:

9. STONE STORAGE OPTIONS ARE IDOT CA-1, CA-3, CA-7, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
10. UNDERDRAINS ARE REQUIRED IN TYPICAL CLAYEY SOILS WHERE INFILTRATION RATES ARE LESS THAN 0.5 INCH/HOUR. NO MORE THAN 1 UNDERDRAIN EVERY 30 FEET ON CENTER. MINIMUM UNDERDRAIN BEDDING OF 2 INCHES, MAXIMUM OF 12 INCHES.
11. SELECTED SPECIES SHALL BE SALT TOLERANT.

SIZING:
MINIMUM 1000 FT^3 OF PLANTING MEDIA PER TREE.

NOT TO SCALE

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	URBAN TREE STORMWATER PLANTER BOX (2 OF 2) PLAN VIEW	STD. DWG. NO. 43 PAGE NO. 45

PERMEABLE PAVEMENTS

Low storage option

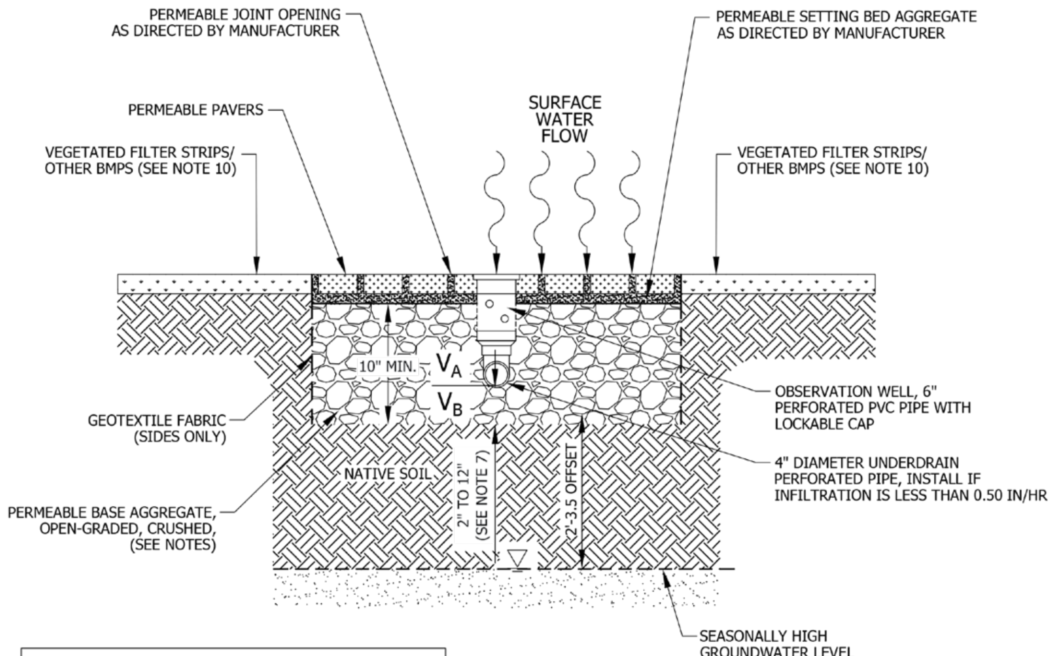
Quantities based on a 1/2 acre facility (21,780 SF).

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	925	cubic yard	$18	$95	$16,653	$87,890
Vegetated filter strips, 5' perimeter	3,090	square foot	$10.55	21.15	$32,600	$65,354
Coarse aggregate storage bed w/ geotextile, 10"	673	cubic yard	$90	$120	$60,556	$80,741
Observation well installation	2	each	$3,500	$4,500	$7,000	$9,000
Permeable paver w/ setting bed	21,800	square foot	$10.75	18	$234,350	$392,400
Perimeter filter strip, 15' width	1,030	square yard	$10	$21	$10,300	$21,630
				TOTALS:	**$361,458**	**$657,014**
				COST / SF:	**$17**	**$30**

High storage option

Quantities based on a 1 acre facility (43,560 SF).

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	3,731	cubic yard	$18	$95	$67,155	$354,429
Vegetated filter strips, 5' perimeter	4,452	square foot	$10.55	21.15	$46,969	$94,160
Coarse aggregate storage bed w/ geotextile, 10"	3,227	cubic yard	$90	$120	$290,400	$387,200
Observation well installation	2	each	$3,500	$4,500	$7,000	$9,000
Permeable paver w/ setting bed	43,560	square foot	$10.75	18	$468,270	$784,080
Perimeter filter strip, 15' width	1,484	square yard	$10	$21	$14,840	$31,164
				TOTALS:	**$894,634**	**$1,660,033**
				COST / SF:	**$21**	**$38**



BOTTOM OF THE FACILITY:	ELEV. ______	
SEASONALLY HIGH GROUNDWATER:	ELEV. ______	
SEPARATION:	FEET ______	

VOLUME TYPE	SURFACE AREA	DEPTH	POROSITY	STORAGE VOLUME	VOLUME PROVIDED
V_A : COARSE AGGREGATE (ABOVE INVERT)			0.36	$0.50 \times 0.36 \times V_A$	
V_B : COARSE AGGREGATE (BELOW INVERT)			0.36	$0.36 \times V_B$	
				TOTAL	

NOTES:

1. THE PERIMETER OF THE VOLUME CONTROL FACILITY SHALL MAINTAIN THE MINIMUM HORIZONTAL SEPARATION DISTANCE OF: 10-FEET FROM FOUNDATIONS, UNLESS WATERPROOFED; 20-FEET FROM ROADWAY GRAVEL SHOULDER; AND 100-FEET FROM POTABLE WATER WELLS, SEPTIC TANKS/FIELDS, OR OTHER UNDERGROUND TANKS.
2. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED WITHIN THE VOLUME CONTROL FACILITY. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED BELOW THE FOOTPRINT OF THE VOLUME CONTROL FACILITY. WHEN LOCAL CONDITIONS PREVENT THE SEWER FROM BEING LOCATED OUTSIDE THE FOOTPRINT OF THE FACILITY THE SEWER SHALL BE CONSTRUCTED TO WATER MAIN QUALITY STANDARDS, OR IT SHALL BE ENCASED WITH A WATER MAIN QUALITY CARRIER PIPE WITH THE ENDS SEALED.
3. AVOID INSTALLATION ON SLOPES GREATER THAN 3.00%. AVOID COMPACTING NATIVE SOILS. SCARIFY ANY COMPACTED SOIL.
4. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
5. STONE STORAGE OPTIONS ARE IDOT CA-1, CA-3, CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
6. MINIMUM DISTANCE OF 2 FEET (3.5 FEET IN COMBINED SEWER AREAS) BETWEEN BOTTOM OF BMP AND SEASONALLY HIGH GROUNDWATER LEVEL.
7. UNDERDRAINS ARE REQUIRED IN TYPICAL CLAYEY SOILS WHERE INFILTRATION RATES ARE LESS THAN 0.5 INCH/HOUR. MAXIMUM OF 1 UNDERDRAIN PER 30 FEET. PROVIDE A SOIL REPORT DOCUMENTING NATIVE INFILTRATION RATE TO FOREGO UNDERDRAINS.
8. MINIMUM UNDERDRAIN BEDDING OF TWO INCHES, MAXIMUM OF 12 INCHES.
9. ONE OBSERVATION WELL REQUIRED PER 6,000 SQUARE FEET OF SURFACE AREA.
10. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL.
11. MAINTENANCE REQUIREMENTS INCLUDE ANNUAL VACUUMING AND LOW-PRESSURE POWER WASHING OF PAVEMENT SURFACE. ADJACENT VEGETATED AREAS SHALL BE WELL-MAINTAINED. BARE SPOTS AND ERODED AREAS SHALL BE REPLANTED AND STABILIZED IMMEDIATELY. DO NOT SEALCOAT OR APPLY DE-ICING SAND/GRAVEL/SALT. APPROPRIATE SIGNAGE REQUIRED FOR FACILITY, REFER TO THE TYPICAL SIGNAGE FOR PERMEABLE PAVEMENT DETAIL.

NOT TO SCALE

	TECHNICAL GUIDANCE MANUAL	8/24/18
	PERMEABLE PAVERS DETAIL	STD. DWG. NO.9 PAGE NO. 10 – FC

DRY WELLS

Low storage option

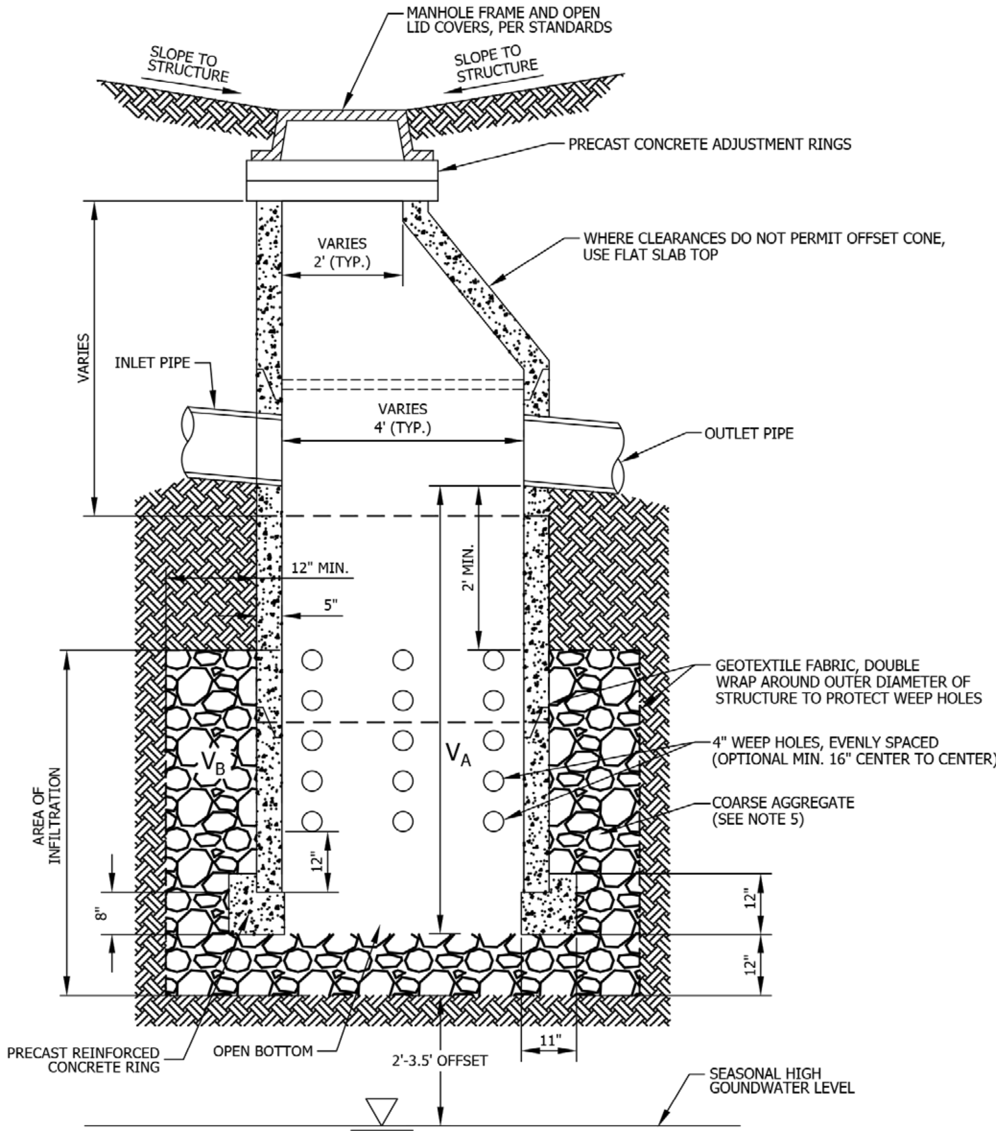
Quantities based on a single dry well, low storage: 4' diameter x 7' depth.

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	7	cubic yard	$250	$450	$1,833	$3,299
Manhole installation with aggregate	1	each	$5,500	$7,000	$5,500	$7,000
				TOTALS:	**$7,333**	**$10,299**
				COST / SF:	**$146**	**$205**

High storage option

Quantities based on a single dry well, high storage: 8' diameter x 10' depth.

ITEM	QUANTITY		UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	29	cubic yard	$250	$450	$7,272	$13,090
Manhole installation with aggregate	1	each	$13,000	$15,500	$13,000	$15,500
				TOTALS:	**$20,272**	**$28,590**
				COST / EACH:	**$258**	**$364**



VOLUME TYPE	POROSITY	MEDIA VOLUME	STORAGE VOLUME	VOLUME PROVIDED
MANHOLE VOL. BELOW SEWER	1.00	V_A	1.00 x V_A	
COARSE AGGREGATE	0.36	V_B	0.36 x V_B	
			TOTAL	

NOTES

1. INSTALLATIONS SHALL BE LIMITED TO SITE LOCATIONS WITH WELL DRAINING SOILS THAT HAVE A PROVEN HIGH RATE OF INFILTRATION. PRIOR TO APPROVAL, AN IN-SITU SOILS INFILTRATION TEST MUST BE CONDUCTED AT THE PROPOSED BOTTOM ELEVATION OF THE DRY WELL AS SPECIFIED IN TECHNICAL GUIDANCE MANUAL SECTION 5.3.5. CALCULATIONS MUST BE SUBMITTED DEMONSTRATING HOW THE VOLUME CONTROL STORAGE WILL INFILTRATE WITHIN 72 HOURS.
2. AVOID INSTALLATION ON AREAS OF COMPACTED FILL.
3. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
4. STONE STORAGE OPTIONS ARE IDOT CA-1, CA-3, CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
5. AGGREGATE BASE OF ONE FOOT (MINIMUM) BELOW PRECAST REINFORCED RING AND SHALL PROVIDE ADEQUATE STRUCTURAL STABILITY PER SOIL CONDITIONS.

NOT TO SCALE

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO	TECHNICAL GUIDANCE MANUAL	12/20/24
	DRYWELL DETAIL	STD. DWG. NO.4
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INFILTRATION TRENCHES

Low storage option

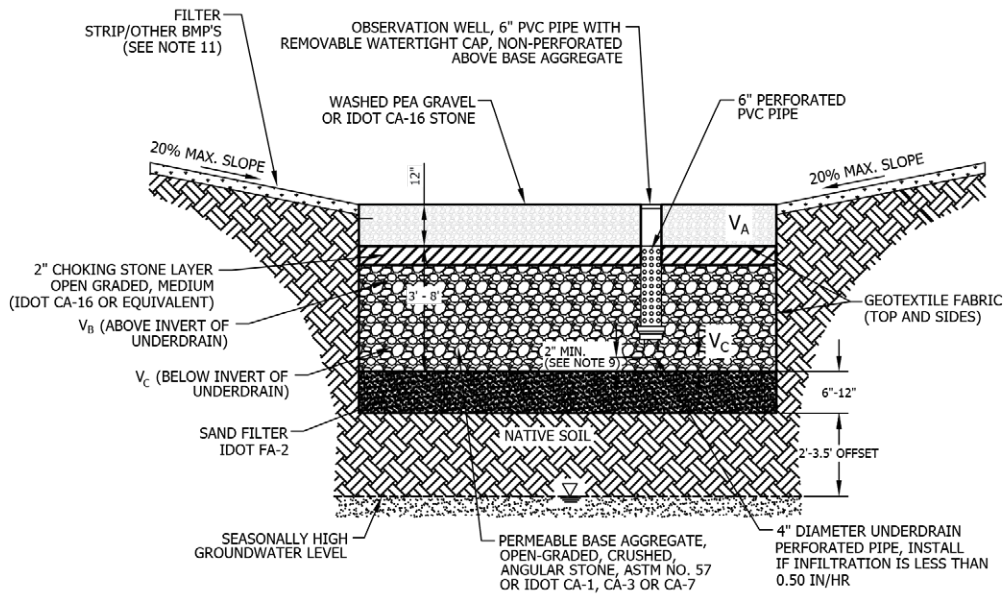
Quantities based on 200 LF trench 8' wide with a 3' depth and 12" bedding (1,600 SF).

ITEM	QUANTITY	UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	306 cubic yard	$18	$95	$5,511	$29,086
Sand filter w/ filter fabric, 12"	59 cubic yard	$55	$85	$3,259	$5,037
Choking stone layer, ca-16, w/ fabric, 2"	10 cubic yard	$150	$250	$1,481	$2,469
Permeable base aggregate, 3'	178 cubic yard	$90	$120	$16,000	$21,333
Washed pea gravel, 12"	59 cubic yard	$50	$75	$2,963	$4,444
Perimeter filter strip, 15' width	333 square yard	$10	$21	$3,333	$7,000
			TOTALS:	**$32,548**	**$69,370**
			COST / SF:	**$20**	**$43**

High storage option

Quantities based on 200 LF trench 8' wide with a 8' depth and 12" bedding (1,600 SF).

ITEM	QUANTITY	UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	602 cubic yard	$18	$95	$10,844	$57,235
Sand filter w/ filter fabric, 12"	59 cubic yard	$55	$85	$3,259	$5,037
Choking stone layer, ca-16, w/ fabric, 2"	10 cubic yard	$150	$250	$1,481	$2,469
Permeable base aggregate, 8'	474 cubic yard	$90	$120	$42,667	$56,889
Washed pea gravel, 12"	59 cubic yard	$50	$75	$2,963	$4,444
Perimeter filter strip, 15' width	333 square yard	$10	$21	$3,333	$7,000
			TOTALS:	**$64,548**	**$133,074**
			COST / SF:	**$40**	**$83**



BOTTOM OF THE FACILITY:	ELEV. ______
SEASONALLY HIGH GROUNDWATER:	ELEV. ______
SEPARATION:	FEET ______

VOLUME TYPE	SURFACE AREA	DEPTH	POROSITY	STORAGE VOLUME	VOLUME PROVIDED
V_A : PEA GRAVEL			0.25	0.50 X 0.25 X V_A	
V_B : COARSE AGGREGATE (ABOVE INVERT)			0.36	0.50 X 0.36 X V_B	
V_C : COARSE AGGREGATE (BELOW INVERT)			0.36	0.36 X V_C	
				TOTAL	

NOTES:
1. THE PERIMETER OF THE VOLUME CONTROL FACILITY SHALL MAINTAIN THE MINIMUM HORIZONTAL SEPARATION DISTANCE OF: 10-FEET FROM FOUNDATIONS, UNLESS WATERPROOFED; 20-FEET FROM ROADWAY GRAVEL SHOULDER; AND 100-FEET FROM POTABLE WATER WELLS, SEPTIC TANKS/FIELDS, OR OTHER UNDERGROUND TANKS.
2. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED WITHIN THE VOLUME CONTROL FACILITY. SANITARY OR COMBINED SEWERS SHALL NOT BE LOCATED BELOW THE FOOTPRINT OF THE VOLUME CONTROL FACILITY. WHEN LOCAL CONDITIONS PREVENT THE SEWER FROM BEING LOCATED OUTSIDE THE FOOTPRINT OF THE FACILITY THE SEWER SHALL BE CONSTRUCTED TO WATER MAIN QUALITY STANDARDS, OR IT SHALL BE ENCASED WITH A WATER MAIN QUALITY CARRIER PIPE WITH THE ENDS SEALED.
3. AVOID INSTALLATION ON SLOPES GREATER THAN 3.00%.
4. AVOID COMPACTING NATIVE SOILS. SCARIFY COMPACTED FILL.
5. GEOTEXTILE FABRIC SHALL MEET REQUIREMENTS OF IUM MATERIAL SPECIFICATION 592. FOR WOVEN: APPARENT OPENING SIZE OF 0.50 MM (TABLE 1, CLASS I). FOR NON WOVEN: APPARENT OPENING SIZE OF 0.30 MM (TABLE 2, CLASS II).
6. STONE STORAGE OPTIONS ARE IDOT CA-1, IDOT CA-7, DISTRICT VULCAN MIX, OR APPROVED ALTERNATE. NO RECYCLED MATERIALS.
7. MINIMUM DISTANCE OF 2 FEET (3.5 FEET IN COMBINED SEWER AREAS) BETWEEN BOTTOM OF BMP AND SEASONALLY HIGH GROUNDWATER LEVEL.
8. UNDERDRAINS ARE REQUIRED IN TYPICAL CLAYEY SOILS WHERE INFILTRATION RATES ARE LESS THAN 0.5 INCH/HOUR. MAXIMUM OF 1 UNDERDRAIN PER 30 FEET. PROVIDE A SOIL REPORT DOCUMENTING NATIVE INFILTRATION RATE TO FOREGO UNDERDRAINS.
9. MINIMUM UNDERDRAIN BEDDING OF TWO INCHES, MAXIMUM OF 12 INCHES.
10. ONE OBSERVATION WELL REQUIRED PER 6,000 SQUARE FEET OF SURFACE AREA.
11. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL.

NOT TO SCALE

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	INFILTRATION TRENCH DETAIL	STD. DWG. NO.6 PAGE NO. 7

RAIN CISTERN / STORMWATER REUSE

High storage option

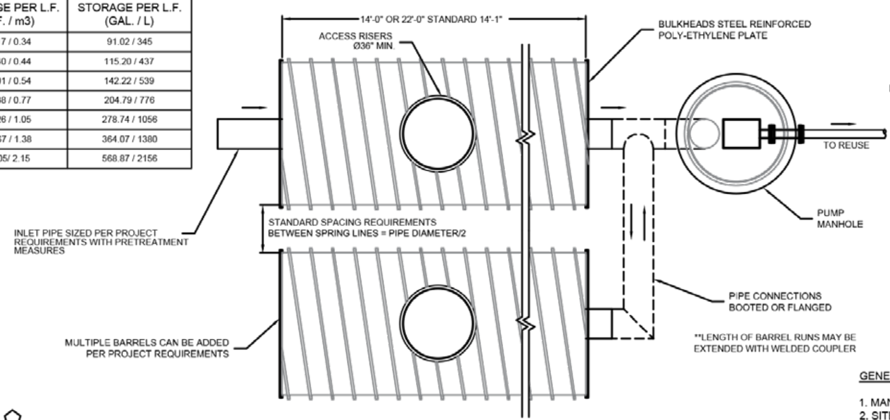
Quantities based on 72" cistern 15' long (3,072 gal capacity).

ITEM	QUANTITY	UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Excavation to disposal	23 cubic yard	$20	$150	$469	$3,521
Provide bedding & backfill stone	7 cubic yard	$55	$90	$398	$651
Supply cistern and appurtenances	1 each	$10,500	$16,000	$10,500	$16,000
Supply pump manhole	1 each	$1,525	$2,550	$1,525	$2,550
Installation complete	1 LSUM	$12,000	$18,000	$12,000	$18,000
Pea gravel filter strip, 12"	2 cubic yard	$55	$90	$100	$163
			TOTALS:	**$24,992**	**$40,884**
			COST / GAL:	**$8**	**$13**

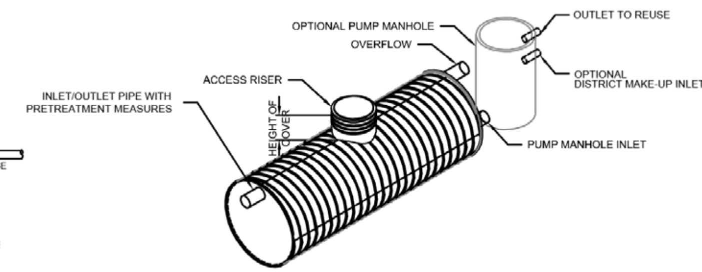
Above ground, same size

ITEM	QUANTITY	UNIT (LOW)	UNIT (HIGH)	TOTAL (LOW)	TOTAL (HIGH)
Supply cistern and appurtenances	1 each	$10,500	$16,000	$10,500	$16,000
Supply pump manhole	1 each	$1,525	$2,550	$1,525	$2,550
Installation complete	1 LSUM	$12,000	$18,000	$12,000	$18,000
			TOTALS:	**$24,025**	**$36,550**
			COST / GAL:	**$8**	**$12**

STORAGE AVAILABILITY PER DIAMETER		
DIAMETER (IN / mm)	AVAILABLE STORAGE PER L.F. (C.F. / m3)	AVAILABLE STORAGE PER L.F. (GAL. / L)
48 / 1200	12.17 / 0.34	91.02 / 345
54 / 1350	15.40 / 0.44	115.20 / 437
60 / 1500	19.01 / 0.54	142.22 / 539
72 / 1800	27.38 / 0.77	204.79 / 776
84 / 2100	37.26 / 1.05	278.74 / 1056
96 / 2400	48.67 / 1.38	364.07 / 1380
120 / 3000	76.05/ 2.15	568.87 / 2156

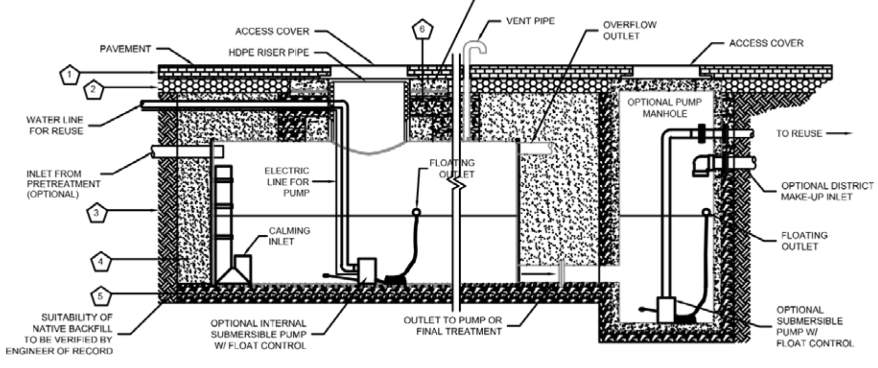


PLAN VIEW



ISOMETRIC VIEW

KEY
1. RIGID OR FLEXIBLE PAVEMENT.
2. GRANULAR COMPACTED ROAD BASE.
3. ANY SUITABLE NATIVE OR GENERAL BACKFILL, SEE ENGINEER PLANS.
4. WELL GRADED GRANULAR FILL. ASTM D2321 CLASS I, II, III, OR EQUIVALENT. COMPACT TO MIN. 90% STANDARD DENSITY PER AASHTO T99. MAY INCLUDE ROAD BASE.
5. RELATIVELY LOOSE GRANULAR BEDDING, ROUGHLY SHAPED TO FIT BOTTOM OF BARREL, 4" TO 6" DEPTH, PER ASTM D2321 CLASS I, II, III, OR OTHER SUITABLE GRANULAR MATERIAL.
6. CRUSHED STONE FILL UNDER COLLAR AND AROUND RISERS.



ELEVATION VIEW

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE, CAPACITY AND BACKFILL DETAILS, TO BE PROVIDED BY MANUFACTURER.
3. ALL ELEVATIONS, DIMENSIONS AND LOCATIONS OF RISERS AND INLETS SHALL BE VERIFIED BY THE ENGINEER OF RECORD.
4. PRIOR TO INSTALLATION OF THE SYSTEM A PRE-CONSTRUCTION MEETING SHALL BE CONDUCTED. THOSE REQUIRED TO ATTEND ARE THE SUPPLIER OF THE SYSTEM, THE GENERAL CONTRACTOR, SUB-CONTRACTORS AND THE ENGINEER.
5. THE CISTERN IS MANUFACTURED FROM STEEL REINFORCED POLYETHYLENE PLASTIC.
6. SYSTEM TO MEET AASHTO HS20/HS25 LIVE LOADING, PER AASHTO LRFD SECTION 12.
7. ACCESS COVERS TO MEET AASHTO M306 LOAD RATING.
8. MINIMUM COVER IS EQUAL TO PIPE DIAMETER/5 AND NO LESS THAN 12-INCHES FROM TOP OF PIPE TO BOTTOM OF PAVEMENT. Ø72" AND Ø84" PIPE MINIMUM COVER IS 18-INCHES, Ø96" PIPE MINIMUM COVER IS 24-INCHES, Ø120" PIPE MINIMUM COVER IS 36-INCHES.
9. FOLLOW THE REQUIRED PRETREATMENT MEASURES LISTED ON THE VOLUME CONTROL PRETREATMENT MEASURES DETAIL (PAGE 17).

INSTALLATION NOTES

A. INSTALLATION GUIDE TO BE REVIEWED BY CONTRACTOR PRIOR TO INSTALLATION.
B. CONTRACTOR TO PROVIDE, INSTALL AND GROUT ALL INLET AND OUTLET PIPES.
C. CONTRACTOR TO PROVIDE AND INSTALL ALL BEDDING AND BACKFILL MATERIAL.
D. PRIOR TO PLACING BEDDING, THE FOUNDATION MUST BE CONSTRUCTED TO A UNIFORM AND STABLE GRADE. IN THE EVENT THAT UNSUITABLE FOUNDATION MATERIALS ARE ENCOUNTERED DURING EXCAVATION, A GEOGRID SHALL BE UTILIZED OR UNSUITABLE MATERIAL SHALL BE REMOVED AND BROUGHT BACK TO GRADE WITH FILL MATERIAL AS APPROVED BY THE ENGINEER OF RECORD. ONCE THE FOUNDATION PREPARATION IS COMPLETE, THE BEDDING MATERIAL CAN BE PLACED.
E. STONE EMBEDMENT MATERIAL SHALL BE INSTALLED TO 95% STANDARD PROCTOR DENSITY AND PLACED IN 6-INCH TO 8-INCH LIFTS SUCH THAT THERE IS NO MORE THAN A TWO LIFT DIFFERENTIAL BETWEEN ANY OF THE BARRELS AT ANY TIME. GRANULAR BACKFILL MATERIAL SHALL BE COMPACTED TO 90% SPD. BACKFILLING SHALL BE ADVANCED ALONG THE LENGTH OF THE BARRELS AT THE SAME RATE TO AVOID DIFFERENTIAL LOADING AND DISPLACEMENT OF THE BARRELS. THE MINIMUM PIPE SPACING MUST BE MAINTAINED.
F. REFER TO INSTALLATION GUIDE FOR TEMPORARY CONSTRUCTION LOADING GUIDELINES.
G. IT IS ALWAYS THE RESPONSIBILITY OF THE CONTRACTOR TO FOLLOW OSHA GUIDELINES FOR SAFE PRACTICES.
H. GENERAL INSTALLATION METHODS AND MATERIALS TO BE IN ACCORDANCE WITH ASTM D2321.

OPERATION NOTES

1. PROPERTY OWNER MUST INSPECT AND EXERCISE ANNUALLY.
2. THE STORAGE MUST DEWATER IN 72 HOURS OR 12 HOURS BEFORE STORM EVENT.
3. CISTERN MUST BE PROTECTED FROM FREEZING EFFECTS.

TECHNICAL GUIDANCE MANUAL

RAIN CISTERN/STORMWATER REUSE TYPICAL DETAIL

7/1/15

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Appendix E

Placement of Facilities in a Street Right-of-Way

E.1 Bioretention facility

The suitability table and the accompanied figure below provide further guidance for placing bioretention in the challenging environment of a street right-of-way (ROW).

Suitability factors for placement of bioretention in street right-of-way.

Category	Parameter		Notes	
Availability of land	Street lawn width	>12 feet	✔	Very suitable; concrete walls not required
		9 to 12 feet	▲	Suitable; concrete borders may or be needed
		0 to 9 feet	✘	Less suitable; concrete borders likely needed
	Edge of pavement to edge of ROW	>15 to 23 feet	✔	Very suitable
		8 to 15 feet	▲	Suitable
		<8 feet	✘	Less suitable
	Street lawn elevation	Below	✔	Very suitable
		At	▲	Suitable
		Above	✘	Less suitable
Parking	Off-street parking	Off-street only	✔	Very suitable
		Both on-street and off-street available	▲	Suitable
		Limited off-street	▲	Suitable
	Extent of on-street parking	No parking	✔	Very suitable
		One side	▲	Suitable
		Both sides	✘	Less suitable
	Bus stops	No	✔	Very suitable
		Yes	✘	Less suitable
Slope	Adjacent street slope	<2%	✔	Very suitable
		2% to 4%	▲	Suitable
		>4%	✘	Less suitable
Physical adjacency	Existing street trees	None	✔	Very suitable
		Dead or to be removed	✔	Very suitable
		Small	▲	Suitable
		Mature	✘	Less suitable
Physical adjacency	Existing buried utilities	No	✔	Very suitable
		Yes	✘	Less suitable

» **Street lawn width** refers to the distance between the back of curb and the sidewalk. This represents the potential area available for bioretention without encroaching on existing streets or necessitating the relocation of existing walks.

» **Edge of pavement to edge of right-of-way** represents the maximum area available for GI practices beyond the existing street in residential settings. Placing bioretention areas on private residential property is discouraged because homeowners may choose to fill them in or alter the landscaping within the bioretention area.

» **Street lawn elevation** is described in relation to the existing street elevation. Lawns below the street already receive runoff and can be easily converted to bioretention. Lawns at or near street elevation typically require excavation but may still be suitable for conversion. Lawns above street grade are generally not suitable for conversion to bioretention, and a limited selection of GI practices, such as pervious pavement in the street, may offer better alternatives.

» **On street parking** can be displaced during construction or may necessitate step-outs for passenger entry and exit from parked vehicles, thus limiting the width available for bioretention areas.

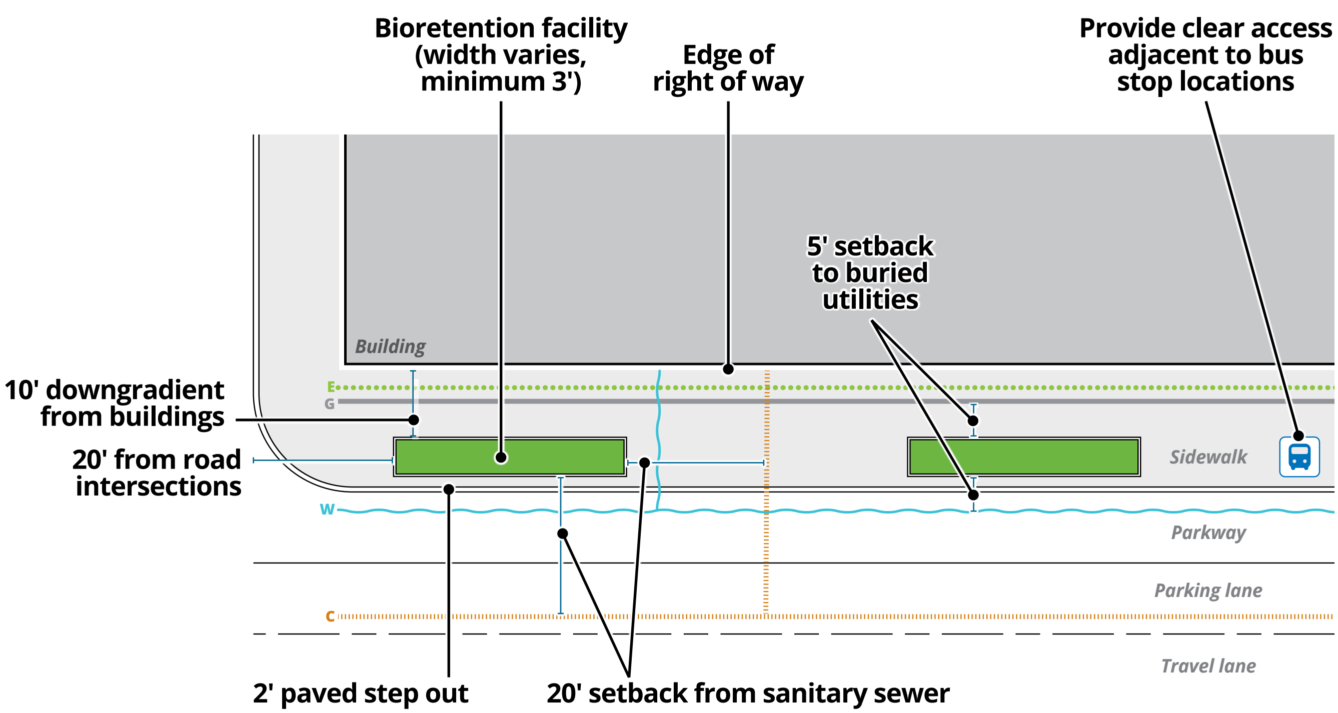
» **Bus stops** present opportunities for public outreach but also demand special design considerations when adjacent to bioretention facilities to prevent structural damage to the bus stop.

» **Street slopes** can affect the storage capacity of bioretention facilities. Steeper slopes can be accommodated but may require baffles or other modifications to maintain storage efficiency within the bioretention area.

» **Street trees** play an important role in rainfall interception. Removing large trees might negate the runoff management benefits provided by bioretention. Therefore, areas without trees or with recently planted small trees are preferable to areas that have large, mature trees.

» **Buried utilities** may require maintenance or replacement trenching, which can disrupt the soil media, drainage system, and vegetation of a bioretention cell located above. Repairing bioretention areas after such disruption can be challenging.

FIGURE A.2 Bioretention facility placement in the street right-of-way.



E.2 Urban stormwater trees

The suitability table below provides further guidance for placing urban stormwater trees in the challenging environment of a street right-of-way.

Suitability factors for placement of urban stormwater trees in street right-of-way.

Category	Parameter		Notes	
Parking	**Off-street parking**	High risk of pedestrian soil compaction	✔	Very suitable
		Low risk of pedestrian soil compaction	✘	Less suitable
	Extent of on-street parking	Both sides	✔	Very suitable
		One side	▲	Suitable
		No parking	✘	Less suitable
	Bus stops	No	✔	Very suitable
		Yes	✘	Less suitable
Slope	**Adjacent paving slope**	1% to 3%	✔	Very suitable
		<1% or >3%	▲	Suitable
Physical adjacency	**Existing street furnishings and utility poles**	None	✔	Very suitable
		Relocatable	▲	Suitable
		Fixed	✘	Less suitable
	Existing buried utilities	No	✔	Very suitable
		Yes	▲	Suitable to less suitable
	Existing street trees	None	✔	Very suitable
		Dead or to be removed	✔	Very suitable
		Small	▲	Suitable
		Mature	✘	Less suitable
Area available	**Soil volume**	>1,000 CF/tree	✔	Very suitable
		<1,000 CF/tree	✘	Less suitable

- On street parking results in soil compaction from pedestrians walking from their vehicles to the sidewalk. Tree planter boxes allow for more paving to support pedestrians while protecting tree root zones from compaction.
- Bus stops can be shaded by nearby trees, but larger or columnar trees may be necessary to avoid branch impact with buses.
- Pavement slope can affect the utility of planter boxes. Slopes less than one percent may not drain adequately into planter boxes. Slopes greater than three percent may require special design consideration to ensure water is adequately captured rather than bypassing the planter box.
- Street furnishings and utility poles that can't be relocated will prevent the installation of planter boxes. The relocation of these elements will add to the cost of installing planter boxes.
- Buried utilities may require maintenance or replacement excavation that can disrupt the planter box components. Proper repair can be very difficult. Questionable buried utilities should be repaired prior to the installation of planter boxes since it may be impossible to avoid installing planter boxes over them in dense urban areas.
- Existing street trees play an important role in rainfall interception. The removal of large existing trees might negate the runoff management improvements provided by planter boxes. Therefore, areas with no trees or recently planted small trees are preferable to areas that have large, healthy, mature trees.
- Soil volume determines how fast and large an urban tree will grow. Research suggests the ideal soil volume per tree should be 1,000 cu. ft. A stone/soil mix (structural soil) does not meet this criterion by volume.

Appendix F

GI Practice Selection Tools

This appendix provides tools to help you compare green infrastructure practices and select the best options for your project. It includes a detailed comparison matrix and a step-by-step decision-making guide.

F.1 Detailed comparison matrix

GI practice	WMO practice type	Primary function	Ideal locations
Vegetated Filter Strip	Flow-through	Pretreatment filtering	Edge of pavement, landscape buffers
Bioretention Facility	Retention	Storage, infiltration & treatment	Landscaped islands, residential yards, parkways
Bioswale	Flow-through or retention	Conveyance & treatment (Storage if designed as retention)	Roadside ditches, parking lot islands, linear corridors
Constructed Wetland	Flow-through or retention	Storage, extended treatment & habitat creation	Large open areas, parks, large developments
Urban Stormwater Tree	Retention	Storage & treatment in ultra-urban space	Sidewalks, plazas, dense urban right-of-way
Dry Well	Retention	Subsurface infiltration & storage	Areas with limited surface space
Infiltration Trench	Retention	Subsurface infiltration & storage	Road shoulders, utility corridors, narrow green spaces
Permeable Pavement	Retention	Infiltration & storage integrated into pavement	Parking lots, alleys, plazas, low-traffic streets
Cistern	Retention	Rooftop runoff capture & reuse	Adjacent to buildings (residential, commercial, industrial)

GI practice	Storage capacity	Water quality improvement	Habitat value
Vegetated Filter Strip	Poor	Good	Poor to fair
Bioretention Facility	Very good	Very good	Good
Bioswale	Fair to good	Very good	Fair to good
Constructed Wetland	Excellent	Excellent	Excellent
Urban Stormwater Tree	Fair	Excellent	Poor to fair
Dry Well	Good	Poor	N/A[2]
Infiltration Trench	Good	Fair	N/A[2]
Permeable Pavement	Good	Good	N/A[2]
Cistern	Fair	N/A[1]	N/A[2]

GI practice	Design difficulty	Construction complexity	Maintenance effort	Relative cost	Cost per gallon
Vegetated Filter Strip	Low	Low	Moderate-low	Low	N/A[3]
Bioretention Facility	High	High	Moderate-high	Moderate-low	$1.09 - $2.46
Bioswale	Moderate to high	Moderate-high to high	Moderate to moderate-high	Moderate	$2.80 - $6.08
Constructed Wetland	High	High	Moderate	Moderate-low	$0.95 - $3.42
Urban Stormwater Tree	Moderate	Moderate	Moderate	Moderate-high	$8.76 - $17.28
Dry Well	Moderate	Moderate	Moderate-low	High	$38.83 - $76.09
Infiltration Trench	Moderate	Moderate	Moderate-low	Moderate-low	$1.70 - $3.94
Permeable Pavement	Moderate-high	Moderate-high	High	High	$5.07 - $22.08
Cistern	Moderate-low	Moderate-low	Moderate-high	Moderate	$7.82 - $13.31

[1] Direct pollutant removal is not the primary function of rain cisterns.
[2] This practice does not include vegetation and provides minimal to no habitat value.
[3] Vegetated filter strips do not provide significant storage. Per-square-foot cost ranges from $11 to $21.

F.2 Decision-making guide

Use these questions to narrow down the most suitable GI practices for your project.

1. What is your primary goal?

- ✓ **If flood control / runoff volume reduction is the priority.**
  Focus on practices with **high storage capacity** such as bioretention and constructed wetlands.
- ✓ **If water quality improvement is the priority.**
  Focus on practices with **high water quality improvement** such as bioretention, bioswales, constructed wetlands, and urban stormwater trees.
- ✓ **If habitat creation and aesthetics are the priority.**
  Focus on practices with **high habitat value** like bioretention and constructed wetlands.

2. What are your main site constraints?

- ✓ **If you have limited surface space.**
  Consider subsurface or integrated practices such as dry wells, infiltration trenches, permeable pavements, urban stormwater trees, or underground cisterns.
- ✓ **If you have poorly draining soils like clay.**
  Infiltration-based practices (e.g., bioretention, bioswales) will likely require an underdrain to function correctly. Constructed wetlands are also a strong choice as they are designed to hold water.
- ✓ **If your site is a highly constrained urban space (e.g., sidewalk, no or limited parkway).**
  An urban stormwater tree is specifically designed for this context.
- ✓ **If your site is a linear corridor (e.g., a roadside or parking lot edge).**
  Bioswales and infiltration trenches are ideal.

3. What is your budget and maintenance capacity?

- ✓ **If you need the lowest initial cost.**
  Consider vegetated filter strips for pretreatment; consider bioretention, constructed wetlands and infiltration trenches for retention-based practices.
- ✓ **If you need the lowest long-term maintenance effort.**
  Consider subsurface systems like infiltration trenches and dry wells, which require minimal landscape care. Vegetated filter strips also have very low maintenance needs.

F.3 Benefits rubric

Rating	**STORAGE CAPACITY** *Volume reduction & infiltration*	**WATER QUALITY IMPROVEMENT** *Primary metric: TSS removal*	**HABITAT VALUE**
	This criterion assesses a practice's ability to manage stormwater quantity by storing runoff, promoting infiltration, and reducing peak discharge rates.	*This criterion evaluates a practice's effectiveness in removing key stormwater pollutants, with a primary focus on Total Suspended Solids (TSS) as a benchmark indicator, supplemented by performance for nutrients and other contaminants.*	*This criterion assesses a practice's potential to create, restore, or enhance ecological habitat for native flora and fauna, contributing to urban biodiversity and ecosystem resilience.*
0 *None*	The practice has no inherent storage function.	Provides no pollutant removal function and is explicitly assigned a 0% TSS removal rate in design manuals.	The practice has no vegetative or ecological component.
1 *Poor*	The practice provides minimal volume reduction; its primary function is conveyance or filtration with negligible storage.	Achieves less than 40% TSS removal. Or effectiveness is significantly impacted by pretreatment and the characteristics of the surrounding soil.	Supports only simple vegetation, such as a monoculture of turfgrass, with minimal ecological value beyond that of a conventional lawn.
2 *Fair*	The practice offers a noticeable but limited capacity for volume reduction; storage is a secondary function.	Achieves 40-60% TSS removal, primarily targeting coarse sediments. Or effectiveness is impacted by pretreatment and the characteristics of the surrounding soil.	Incorporates vegetation that offers some limited habitat value, often with low species or structural diversity.
3 *Good*	The practice reliably captures and manages the volume from common design storms (e.g., 1- to 2-year event), providing significant local runoff reduction.	Achieves 60-80% TSS removal with some removal of other pollutants.	Supports a community of diverse native plants, providing notable value for specific faunal groups like pollinators.
4 *Very good*	The practice provides a high degree of volume reduction and peak flow control at the site or neighborhood scale, reliably managing design storms.	Achieves 80-85% TSS removal with moderate to high removal rates for other pollutants.	Establishes a structurally diverse plant community that provides significant habitat resources (food, cover) for a wide range of fauna, including birds and pollinators.
5 *Excellent*	The practice is designed to manage runoff from large drainage areas and significant storm events, providing substantial volume reduction and peak flow attenuation that can serve regional flood control objectives.	Achieves greater than 85% TSS removal and demonstrates high efficacy for removing nutrients (nitrogen, phosphorus), heavy metals, and other common urban pollutants.	Creates a complex, multi-niche ecosystem (e.g., with aquatic, emergent, and terrestrial zones) that supports a high diversity of native wildlife.

F.4 Constraints rubric

Rating	DESIGN DIFFICULTY	CONSTRUCTION COMPLEXITY	MAINTENANCE EFFORT	RELATIVE COST
	This criterion evaluates the technical complexity and level of expertise required to properly design the GI practice.	*This criterion assesses the challenges and risks associated with the physical installation of the practice.*	*This criterion evaluates the type, frequency, and intensity of long-term maintenance required to ensure the practice functions as designed.*	*This criterion provides a comparative assessment of the construction cost of a practice and long-term operation and maintenance (O&M).*
1 ***Low***	The design is straightforward, follows standard guidelines, requires minimal site-specific investigation, and can be implemented by non-specialist professionals.	Involves simple earthwork and standard materials; can be installed by general contractors or landscapers with minimal specialized oversight.	Requires only infrequent (e.g., annual) inspection and simple tasks like debris removal.	Very low capital cost; ranked lowest on cost per gallon and cost per square foot. Very low O&M costs compared to other GI and conventional gray infrastructure alternatives
2 ***Moderate-low***	Requires some site-specific calculations but generally adheres to established design templates.	Requires some specialized materials or techniques but is generally straightforward.	Requires routine, non-specialized tasks performed a few times per year.	Low capital cost; ranked second lowest on cost per gallon and cost per square foot. Manageable O&M expenses
3 ***Moderate***	Requires professional design by an engineer or landscape architect, involving site-specific analysis (e.g., soil testing, hydrologic calculations).	Requires skilled labor and careful supervision to manage specific materials (e.g., engineered soil media) and avoid critical construction errors.	Requires regular, ongoing maintenance akin to standard landscaping (e.g., weeding, mowing, mulching) plus periodic structural inspections.	Moderate capital cost; ranked middle on cost per gallon and cost per square foot. Cost often offset by savings from reduced gray infrastructure, with predictable long-term O&M costs.
4 ***Moderate-high***	Involves complex engineering, including detailed geotechnical and hydrological analysis, and must address significant site constraints (e.g., high water table, steep slopes).	Involves specialized equipment, precise placement of materials in multiple layers, and a high sensitivity to construction practices (e.g., soil compaction).	Requires frequent and specialized tasks (e.g., pump servicing, filter cleaning) and is highly dependent on consistent maintenance for performance.	High capital cost; ranked second highest on cost per gallon and cost per square foot. Or significant long-term O&M costs that require dedicated funding.
5 ***Very high***	Requires highly specialized expertise, complex modeling (e.g., groundwater mounding), and rigorous attention to numerous interrelated design parameters to avoid system failure.	A complex process involving major excavation, specialized equipment, and a high risk of construction-phase errors that can lead to total system failure.	Requires frequent, intensive, and/or highly specialized maintenance (e.g., regenerative air sweeping, sediment excavation, component replacement), where neglected maintenance leads to rapid failure.	Very high capital cost; ranked highest on cost per gallon and cost per square foot. And/or Intensive, costly long-term O&M, making it one of the most expensive options.

Appendix G

Additional Resources

In addition to this guide, many supplementary resources are available on the MWRD's and other websites that may be helpful as you plan and design green infrastructure for your project or your community.

MWRD initiatives and publications

- **MWRD Green Infrastructure Program:** *mwrd.org/gi*
- **MWRD Watershed Management Ordinance:** *mwrd.org/wmo*
- **MWRD Technical Guidance Manual:** *mwrd.org/wmo-tgm*
- **MWRD publications (English and Spanish):** *mwrd.org/education/publications*
- **MWRD Green Neighbor Guide:** *mwrd.org/green-neighbor*
- **MWRD Green Neighbor Guide bilingual promotional flyer:** *mwrd.org/green-neighbor-flyer*
- **Stormwater Management homepage:** *mwrd.org/stormwater*
- **Rain barrel program:** *mwrd.org/rain-barrels*
- **Free trees:** *mwrd.org/trees*
- **Free EQ biosolids:** *mwrd.org/biosolids*
- **Community action:** *mwrd.org/community-action*
- **Business resources:** *mwrd.org/doing-business*
- **Green Infrastructure Partnership Opportunity Program for public agencies:** *mwrd.org/gipp*
- **Unwanted medicine disposal:** *mwrd.org/medication-disposal*
- **Understanding Your Sewer:** *mwrd.org/understanding-your-sewer*

City of Chicago

- **City of Chicago Green Stormwater Infrastructure Strategy:** *chicago.gov/content/dam/city/progs/env/ChicagoGreenStormwaterInfrastructureStrategy.pdf*
- **City of Chicago Sustainable Development Policy:** *chicago.gov/city/en/sites/sustainable-development-policy/home.html*
- **City of Chicago Sustainable Development Policy Handbook:** *chicago.gov/content/dam/city/depts/dcd/Projects/DRAFT_2024_SDP_Handbook.pdf*
- **City of Chicago Sewer Construction and Stormwater Management Requirements:** *chicago.gov/city/en/depts/water/provdrs/engineer/svcs/2009_sewer_constructionandstormwatermanagementrequirements.html*

Cook County

- **Cook County Climate Resiliency Planning:** *cookcountyil.gov/climateresiliency*

Regional strategy and planning

- **Chicago Metropolitan Agency for Planning:** *cmap.illinois.gov/focus-areas/climate/climate-resilience/*
- **Metropolitan Planning Council:** *metroplanning.org/projects/stormwater-management/*

State of Illinois

- **Regional pollinators:** *dnr.illinois.gov/education/pollinatormain.html*
- **Illinois EPA homepage:** *epa.illinois.gov/*
- **Illinois Urban Manual:** *illinoisurbanmanual.org/*
- **Illinois Department of Natural Resource – Coastal Management Program:** *dnr.illinois.gov/cmp.html*

Federal

- **What are BMPs?:** *epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater-public-education*
- **Pollinator protection:** *epa.gov/pollinator-protection/what-you-can-do-protect-honey-bees-and-other-pollinators*
- **Mosquito control:** *epa.gov/mosquitocontrol*
- **Your septic system:** *epa.gov/septic/how-septic-systems-work*
- **Groundwater:** *epa.gov/sites/production/files/documents/groundwater.pdf*

Planning and Design Data and Tools

- **Green Values Stormwater Management Calculator:** *greenvalues.cnt.org*
- **Natural Solutions Tool:** *web.tplgis.org/chicago_nst/*
- **EPA National Stormwater Calculator:** *epa.gov/water-research/national-stormwater-calculator*
- **Delta Institute/EPA Region 5 Environmental Finance Center Technical Assistance:** *delta-institute.org/epa-region-5-water-infrastructure/*
- **Delta Institute Pilot Program - Municipal Green Infrastructure ESG Financing:** *delta-institute.org/project/municipal-gi-financing/*

Other Resources

- **The Green Infrastructure Leadership Exchange report:** The State of Public Sector Green Stormwater Infrastructure: *giexchange.org/wp-content/uploads/2024/08/TheStateOfPublicSectorGSI.pdf*
- **Green roofs and the heat island effect:** *epa.gov/heatislands/using-green-roofs-reduce-heat-islands#types*
- **Green roofs:** *greenroofs.org/about-green-roofs*
- **Green walls:** *greenroofs.org/about-green-walls*

Glossary

Aggregate: Coarse to medium grained material used in construction, including sand, gravel, crushed stone, slag and recycled concrete. "Open-graded" describes an aggregate mixture designed to be water permeable.

Cistern: A tank for storing water, which can be above or underground.

Check Dam: A barrier in a channel to retard the flow of water especially for controlling soil erosion.

Concrete Groover: A tool, usually made of bronze or stainless-steel plate, that has a V-shaped bit underneath that cuts the groove.

Combined Sewer Area: An area drained by a sewer system that carries both sanitary sewage and stormwater runoff in a single pipe.

Distributed Storage: A stormwater management approach that uses multiple small-scale practices, particularly green infrastructure practices, spread across a site, a watershed or a sewershed to capture and hold rainwater where it falls.

Deepwater Zone: A component of a constructed wetland where water depth prevents the growth of rooted vegetation (typically deeper than 18 inches), aiding in sediment settling and providing habitat.

Depression: A sunken or hollow place in the soil or landscape.

Excavate: To extract material from the ground by digging.

Flow-Through Practice: A permanent practice primarily designed to convey and treat stormwater runoff (e.g., vegetated filter strips, bioswales). Under the WMO, these are typically used for pretreatment, but may be used as a volume control alternative only when site constraints prevent the use of retention-based practices.

Freeboard: The vertical distance between the high water level and the top of a containing structure, such as a channel or basin, providing a margin of safety against overflow.

Green (Stormwater) Infrastructure: Stormwater management practices designed to mimic the functions of the natural hydrologic cycle, including infiltration, interception, evapotranspiration, and evaporation.

Hydromulch: A slurry of seed, mulch, and fertilizer applied to slopes as an erosion control practice.

Inundation: Flooding or being covered with water.

Level Spreader: An above-or below-ground pipe or channel system to spread a singular inflow stream over a wider area to promote sheet flow and prevent erosion.

Micropool: A small, shallow pool of water in a constructed wetland, designed to enhance habitat diversity.

Native Vegetation: Plants, including trees, shrubs, grasses, and flowers, that have historically grown and evolved in a specific region. They are adapted to the local climate and soil conditions, typically requiring less irrigation and maintenance while providing vital habitat for local wildlife.

Outbuilding: A building, such as a shed, barn, or garage, on the same property but separate from a more important one, such as a house.

Pervious Concrete: A special type of porous concrete used for concrete flat work applications that allows water to pass directly through, thereby reducing runoff.

Plugs: Seedlings germinated and grown in trays of small cells, intended to be transplanted into directly into the ground.

Pollinators: Animals that assist in plant reproduction by moving pollen.. Pollinators found in Illinois include hummingbirds, butterflies, moths, bees, flies and beetles.

Porous: Having small spaces or holes through which liquid or air may pass.

Reciprocating Saw: A type of machine-powered saw in which the cutting action is achieved through a push-and-pull motion of the blade.

Rill: A small channel cut into soil by flowing water, one of the early phases of erosion.

Retention-Based Practice: A permanent volume control practice designed to capture, retain, infiltrate, and treat or reuse stormwater runoff. These are the primary practices required by the WMO (e.g., infiltration trenches, dry wells, bioretention systems, permeable pavement).

Roller Screed: A large roller used to flatten and smooth poured concrete or angled slabs.

Rototiller: A machine that uses rotating disks or teeth to turn up and cultivate soil.

Sediment: Suspended soil particles transported by water or wind after erosion has occurred.

Sediment Forebay: A small settling basin located at the inlet of a stormwater practice designed to trap coarse sediment and debris for easy removal.

Septic Field: An area where wastewater is discharged from a septic tank for further treatment and dispersal in the soil via underground piping.

Silt Fence: A temporary sediment control device, often made of synthetic fabric, used on construction sites to protect water quality in nearby water bodies from sediment-laden runoff. Also known as a "filter fence."

Soil Erosion and Sediment Control: Measures and structural controls used to limit the removal of soil by water or wind and prevent sediment from leaving a construction site.

Stormwater Best Management Practice (BMP): A technique, measure or structural control used to manage the quantity and improve the quality of stormwater runoff. In this guide, the term is considered interchangeable with Green (Stormwater) Infrastructure.

Sump Box: A container installed in the ground that receives stormwater via piping or a grated cover; also known as a catch basin.

Treatment Train: A sequence of different stormwater management methods that are linked together to progressively remove pollutants, protect water quality and manage water volume and flow.

Triple Bottom Line (TBL): A sustainable framework that evaluates benefits based on three parts: social, environmental (ecological), and financial.

Trowel: A small handheld tool with a curved scoop for lifting plants or earth.

Vibratory Plate Compactor: An engine-powered, walk-behind machine that compacts loose materials and asphalt via a bottom-mounted steel plate.

Vibratory Screed: A tool used to help smooth out and compact poured concrete.

Volume Control: The retention of a specific volume of stormwater runoff on-site to minimize the amount of water entering the sewer system.

Volume Control Practice: A permanent practice designed to capture, retain, and infiltrate stormwater runoff from impervious areas of development after permanent stabilization is achieved.

Water Table: The underground level at which the soil is completely saturated with water.

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V3 Companies
Pages 4-5, Figures 1.2, 1.3, 1.4, 1.5, 2.3, 2.4, 3.2, 3.3, 3.4, 3.5, 4.2, 4.3, 4.4, 4.5, 5.4, 6.2, 6.3, 6.4, 6.5, 7.2, 7.3, 7.4

Philadelphia Water Department
Figure 5.2

Sierra Nickel, Sunshine Coast Regional District
Figure 9.2

Buster Simpson
Figure 9.3

Town of Garner Staff
Figure 9.5

Peter Dziuk, Minnesota Wildflowers
Appendix A.5: Bur-reed (full-plant)

Metropolitan Water
Reclamation District
of Greater Chicago

100 East Erie Street • Chicago, Illinois 60611-3154

mwrd.org

Established in 1889, the MWRD is an award-winning, special purpose government agency responsible for wastewater treatment and stormwater management in Cook County, Illinois.

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