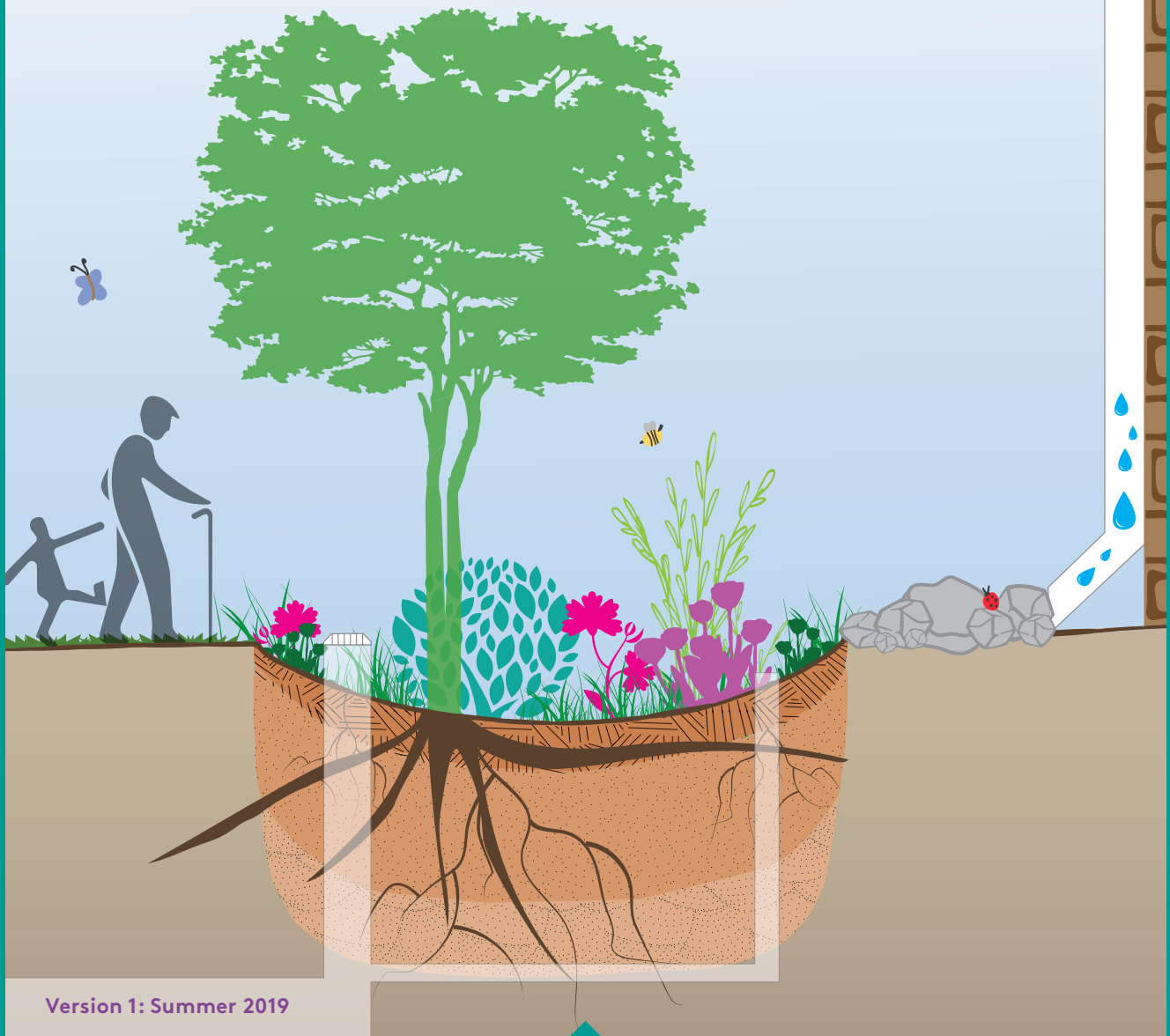



A Detroit Property Owner's Guide to Bioretention

How to manage stormwater on
your non-residential property and
get DWSD drainage credit



Acknowledgements

This guide is brought to you by: 

Land + Water WORKS Coalition Members:



Coalition webpage: <https://detroitfuturecity.com/our-programs/land-water-works-coalition/>

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For more information or for help with your project, contact: stormwater@detroitfuturecity.com or call (313) 259-4407.

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Introduction

Who is this guide for?

Have you tried to understand stormwater management in Detroit? Are you interested in installing a Green Stormwater Infrastructure (GSI) practice on your property, but need more information about how to get the project done? Would you like to invest in a GSI practice that could beautify your property and potentially improve your bottom line through a DWSD drainage credit? If so, this guide is for you.

The information here will be particularly useful for **small business owners, nonprofits and faith-based organizations in Detroit** who are looking to retrofit or add a GSI practice to their existing property. This guide will provide details on how to plan for and implement a bioretention basin on your non-residential property to better manage stormwater runoff.

****DISCLAIMER:** The information in this document was created as a general guideline to be educational in nature and to help people better understand the DWSD Drainage charges, and the overall process of attempting to receive credits, site conditions, stormwater management, bioretention practices, hiring consultants and contractors, etc. The information contained herein is not intended to replace, dispute, or contradict any DWSD program documents and regulations. In all instances, any questions or clarifications regarding DWSD policies and programs should be directed to DWSD directly, or their documentation and guides published on their website. This document is only supplemental to any DWSD documentation.



What is Stormwater Runoff and Green Stormwater Infrastructure (GSI)?

Stormwater runoff is rain and snowmelt that flows over roads, parking lots, building roofs and other hard surfaces that don't allow water to soak into the ground. During heavy rain storm events and spring snow melts, this water can flow into nearby bodies of water without undergoing treatment. The runoff can cause flooding and, when untreated, it can flow into our rivers, resulting in pollution of our rivers and the Great Lakes.

Detroit has a combined sewer system, meaning both sewage and stormwater runoff flow through its treatment plants. According to the Detroit Water and Sewerage Department (DWSD), *"During wet weather, too much stormwater can overload the combined system. This might cause basement backups, street flooding, and polluted wastewater to flow into the Rouge River, the Detroit River, and eventually, Lake Erie. These overflows of both stormwater and sewage waste are called combined sewer overflows, or CSOs. CSOs are a last resort to prevent sewer backups and basement flooding."*

In the past, we have used costly "gray", or conventional stormwater infrastructure to move, store and treat stormwater, but there is a better way. Green Stormwater Infrastructure allows us to manage stormwater where it falls, using vegetation, soils, and other elements to filter, absorb and slow down stormwater runoff. GSI can be a cost-effective, resilient approach to managing rain more naturally while also delivering environmental, social, and economic benefits. GSI can help reduce the combined sewer overflows into the Detroit and Rouge Rivers, keeping these important bodies of water healthy and safe for people and wildlife.

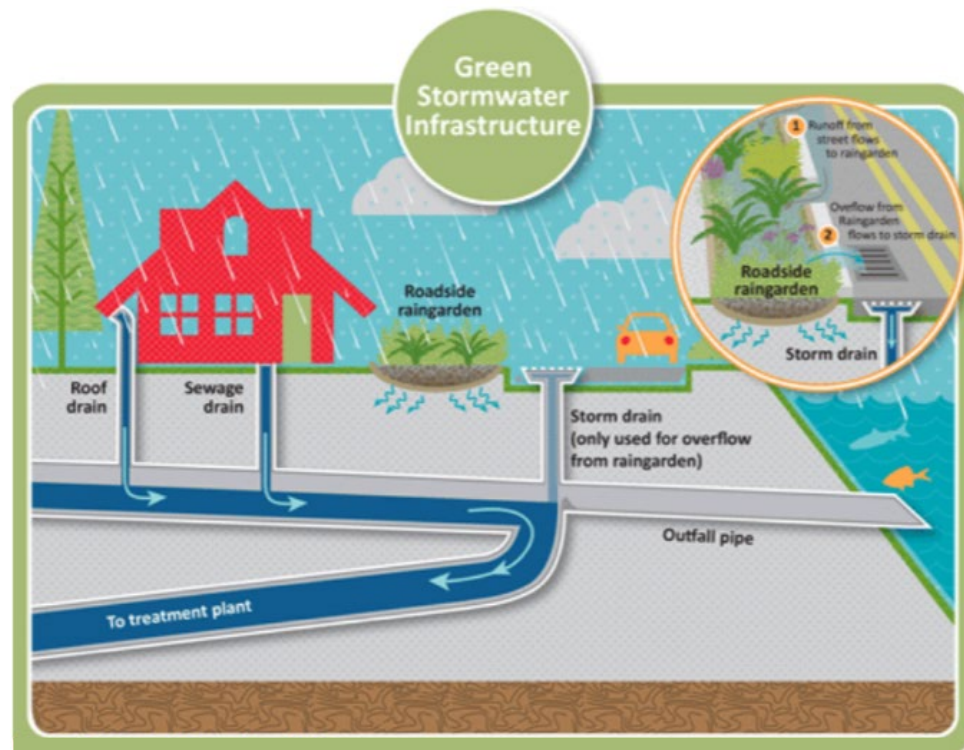


Combined Sewer Overflow pipes directed into the Detroit River¹



Land + Water WORKS tour visiting a bioretention practice installed by the City of Detroit at Viola Liuzzo Park in Northwest Detroit²

Green Infrastructure: How It Works



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The Detroit Water and Sewerage Department (DWSD) has built \$1.5 billion in wet weather management systems to keep our water safe and reduce CSOs. The drainage fee that it charges to property owners supports the installation and maintenance of that system. Detroit property owners can now get a credit on their drainage charge for installing certain types of GSI on their properties. This guide will give basic information on implementing GSI practices (with more detail specifically on bioretention practices) for DWSD drainage charge credit. A full explanation of drainage fees and credits is on DWSD's website at: www.detroitmi.gov/drainage

We can all do our part to help maintain the health of our water resources by installing GSI.

What happens:

1. Water runs off of impervious "hard" surfaces (roofs, parking lots, streets) to "soft" surfaces (plants, grass, trees)
2. Pervious "soft" surfaces soak up the water
3. With large amounts of rainwater, roots of plants, grass, and trees help water return to the ground by increasing porosity.
4. Green infrastructure keeps rain water out of the sewer system and from overflowing.
5. Thus the treatment facility doesn't cause overflows or backups into homes.

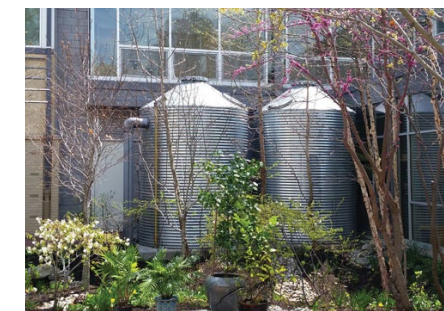
Types Of GSI Practices

When making a plan to manage stormwater runoff from your property, you should be aware of and consider all types of Green Stormwater Infrastructure (GSI) practices, including: bioretention, cisterns and rain barrels to store and reuse rainwater, green roofs, permeable pavement, permeable pavers, and subsurface storage systems. Deciding which of these GSI practices is most suitable depends on your site conditions and constraints, budget, and goals for your building and landscape.

See the [DWSD GSI Starter Guides^A](#) for more information on these other types of GSI practices.



Porous pavement (with permeable pavers)⁴



Above-ground cistern⁵



Green roof⁶



Constructed wetland⁷



Subsurface storage⁸



Stormwater detention basin⁹

See chart on page 22 showing the potential DWSD drainage credits available for different types of GSI practices.

Bioretention is one of just three GSI practice types that have the potential to achieve both volume and peak flow credits.



Bioretention¹⁰



What are Impervious and Pervious Surfaces?

An impervious surface is any surface that prevents or significantly slows stormwater from flowing into the soil and causes the water to “run off” the surface rather than soak into it. Such surfaces include rooftops, compacted gravel, asphalt or concrete paving, driveways and parking lots, walkways and sidewalks, patio areas, storage areas, or other surfaces that similarly affect the way that water is absorbed into the ground.

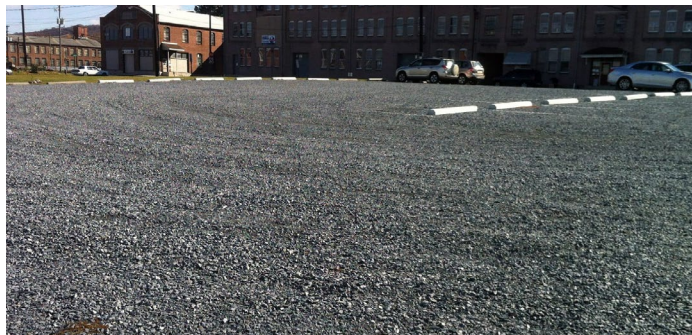
Examples of Impervious Surfaces



Rooftop¹¹



Typical parking lot¹²



Compacted gravel parking lot¹³



Pavers¹⁴



Surfaces such as lawn, landscaped beds, ponds, green roofs, swimming pools, and non-compacted gravel walks are considered pervious surfaces. Pervious surfaces allow the stormwater to infiltrate into the underlying soil rather than running off the surface into the City sewer system.

Examples of Pervious Surfaces



Grass¹⁵



Mulched garden bed¹⁶



Grass and trees¹⁷



Stone pathway¹⁸

Bioretention Basics

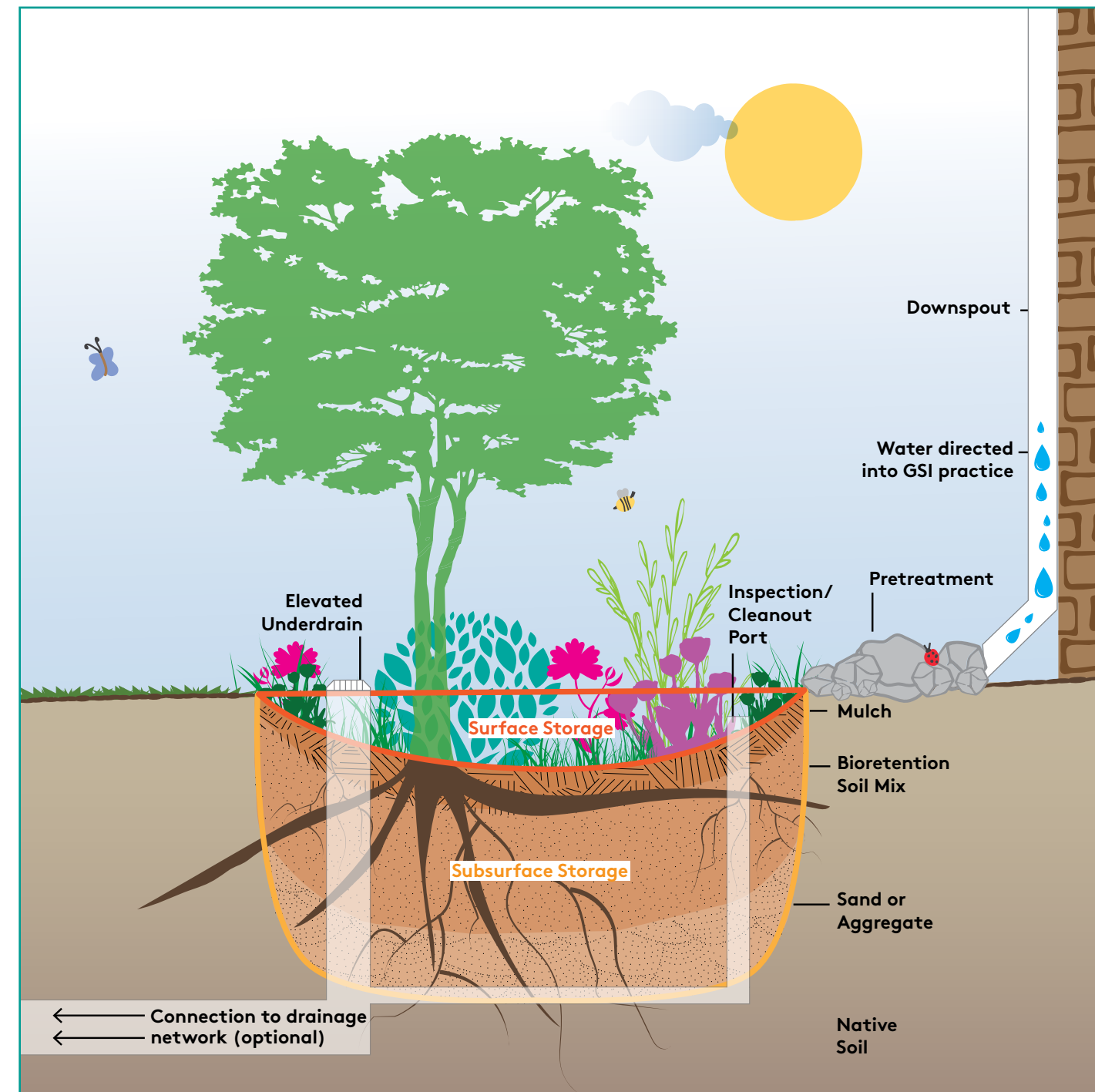
This guide is focused on bioretention because it is typically the **most cost-effective** GSI practice to implement and maintain over time. It also is the most commonly implemented type of GSI practice in Detroit, in part because we have more open space available than many other cities. Bioretention practices can be relatively easy and less expensive to construct than other types of GSI practices. Bioretention also has other important benefits. For example, its planted areas can **beautify your property** and introduce other ecological **benefits for birds and pollinators**. It can also be used to create or enhance community gathering spaces.

This guide will go into detail on the process to plan, build and maintain a bioretention basin to manage runoff from a non-residential property.

Bioretention is a type of GSI practice that uses soils and plants to collect, filter, and slow down stormwater runoff from roofs, parking lots, or roadways. It cleans water by using plant materials to filter things like oil and dirt from the rain water picked up from roofs and driveways. Bioretention refers to how the GSI practice retains, or keeps, stormwater from leaving the site by holding it and allowing the stormwater to infiltrate into the ground on-site. Additionally, a bioretention practice can also be designed to detain, or temporarily keep, stormwater on-site and slowly release it into the sewer system via a controlled connection pipe. This additional component would technically turn it into a Bioretention with Detention practice, and can increase the stormwater management capacity of the practice. However, adding a connection to the sewer system also increases the complexity and cost to implement the practice.



Basic Components of a Bioretention Practice





Examples of Bioretention Practices



Residential rain garden²⁰



Street bioswale²¹



Park bioswale²²



Street bioswale²³



Parking lot bioretention²⁴



Bioretention basin²⁵

At the end of 2018, over 100 bioretention practices were documented in Detroit. The three most common types found in Detroit are rain gardens, bioretention basins and bioswales.

Rain Garden

Rain gardens are an example of a small bioretention practice, usually installed on residential properties. As the name suggests, it can also double as a beautiful garden.

Bioswale

A bioswale has the same function as a bioretention basin, but is more linear in shape and is usually installed along public streets and in parking lots. It can also be used to move stormwater runoff from one place to another, while filtering and absorbing it along the way.

Bioretention Basin

A bioretention basin is essentially a larger and more highly designed and engineered rain garden that has increased stormwater management capacity. Bioretention basins are typically installed on commercial and institutional scales.

This guide will go into more detail on the process to plan, build and maintain a bioretention basin on **non-residential** property. It is focused on practices that manage stormwater runoff from the **same property**, rather than the street or neighboring properties. However, here is some information to help you if you just want to do a simple rain garden, or if you are planning a more complex bioretention project!

Residential Rain Gardens

If you are interested in simply building a rain garden on your residential property, there are many resources available to support you. A good place to start is with the Friends of the Rouge and Sierra Club's Rain Gardens to the Rescue program. For more information, please visit: therouge.org/rain-gardens-to-the-rescue/

Please note that a residential rain garden will typically not be large enough to allow a homeowner to receive any drainage credit from DWSD beyond the 25% residential credit that DWSD automatically gives to residential properties.



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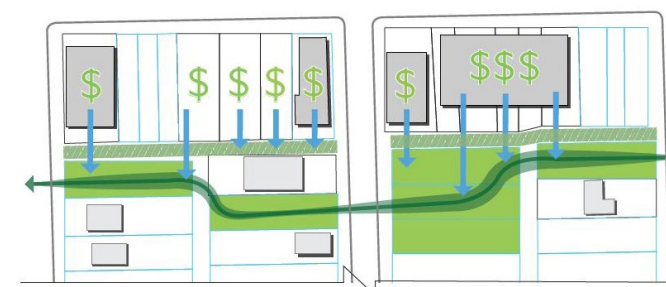
Managing Runoff From The Street

It is possible to install a GSI practice on your private property that manages stormwater runoff from a public street or other public right-of-way, but these types of projects can be more complicated to design, acquire permits, and potentially obtain drainage credits for.

The Eastside Community Network recently installed a GSI practice that manages runoff from a public street, as part of the Hamilton Outdoor Learning Lab. For more information on this project, please visit: www.ecn-detroit.org/hamilton-outdoor-learning-lab



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- Non-Residential Shared GSI Scenario
- Occupied Parcels
- Vacant Properties
- Buildings
- Shared Green Infrastructure
- Properties Investing in GSI
- Alley Conveyance
- Greenway
- Stormwater Runoff

Shared Stormwater Practices

It is also possible for multiple property owners to direct runoff from their impervious surfaces into a shared green stormwater practice. In this situation, the property owners might share the cost of implementation and maintenance. Each property owner would receive drainage credit from DWSD according to how much of their total stormwater runoff is being directed into the GSI practice.

The Detroit Collaborative Design Center (DCDC) recently did an in-depth study on shared stormwater management practices. For more information on this study, please visit: www.dcdc-udm.org/community/stormwater.html



Will Bioretention Work On My Site?

To determine if bioretention is the ideal GSI practice for your property, follow this simple checklist to get started:

- ❑ Does your building roof have external downspouts?
- ❑ Do you have an open, unpaved area on your lot, at least 10 feet from your building (or an area where pavement can be removed)?
- ❑ Can water be easily directed from the downspouts or paved surfaces towards the open area?
- ❑ Would you enjoy having a planted garden area on your property, and are you willing to maintain it?

There are more detailed site conditions and considerations that a landscape architect or engineer will review before determining the best GSI practice for your property and the potential cost and benefits of these practices, but these are a good start.

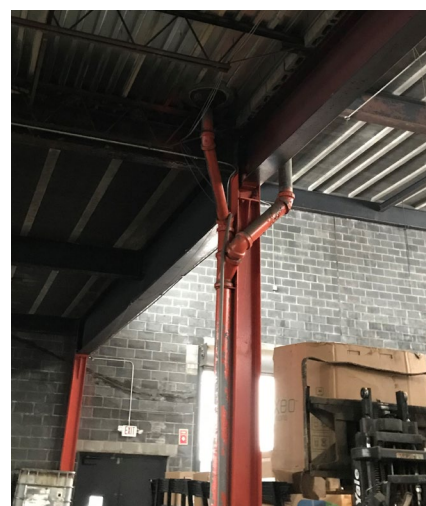
Bioretention needs to be located near a downspout, or water needs to be able to be directed towards it in some way, whether through grading or routing the water through a gutter or pipe system. If you have a parking lot on your property and there are already catch basins in the center of it, it will be more expensive (but not impossible) to disconnect them and direct the water towards a bioretention practice. It is possible to reroute and re-pitch gutters, and add trench drains or pipes to direct water towards a bioretention practice.

Know your Roof Drains!

If you have internal downspouts, you should have a commercial plumber look at the building to assess how much it would cost to reroute some or all of the downspouts to the exterior. If it is very expensive, it may not make sense to do a bioretention project. You could focus on capturing runoff from your parking lot or other paved surfaces using bioretention or another type of GSI practice.



External downspout²⁹



Internal downspout³⁰



Depaving: A Quick Fix!

Do you have excess parking or other paved surfaces on your property that you don't need? Think about de-paving it! If you remove impervious surfaces from your property, you will reduce your drainage charge. This approach is not considered a 'credit', but simply an adjustment to the amount of impervious surface from which the drainage charge is calculated.

DWSD has a useful starter guide for property owners interested in doing a depaving, or "[Impervious Cover Removal](#),"^B project. The organization Depave, based in Portland, Oregon, has a detailed guide, titled "[How to Depave: The Guide to Freeing Your Soil](#)"^C available for free on its website. Detroit Future City and the Land + Water WORKS Coalition are planning a pilot depaving project in Detroit in 2019.

PLEASE NOTE! 

You need to remove at least 435 square feet of impervious surface in order to qualify for a drainage charge adjustment from DWSD. This is about the size of a two-car garage.

You could simply do a depaving project and establish grass or other site material in the depaved area, or you could also incorporate a bioretention practice in the depaved area for a drainage charge credit.



Depaving project³¹

DWSD Drainage Charge and Credit Program Basics

DWSD = Detroit Water and Sewerage Department

All parcels throughout the city are subject to drainage charges, regardless of their zoning, land-use, size, or classification. Drainage charges are billed on all parcels regardless of whether the property has active water service.

How does DWSD calculate how much each parcel is charged? In simple terms, it is the total area (in acres) of impervious surface on the property multiplied by a rate per "impervious acre." The part of this equation that is important to understand is that the amount that each parcel is being charged is directly proportional to the total impervious surface area that is on the property. The more impervious surface area on the property, the higher the drainage charge on the water bill. Also, the impervious acre rate is approved annually by the Board of Water Commissioners and is subject to change each year, depending on DWSD's revenue requirements. In DWSD's fiscal year 2019 (July 2018-June 2019), the impervious acre rate was \$598; in fiscal year 2020, the impervious acre rate is \$602.

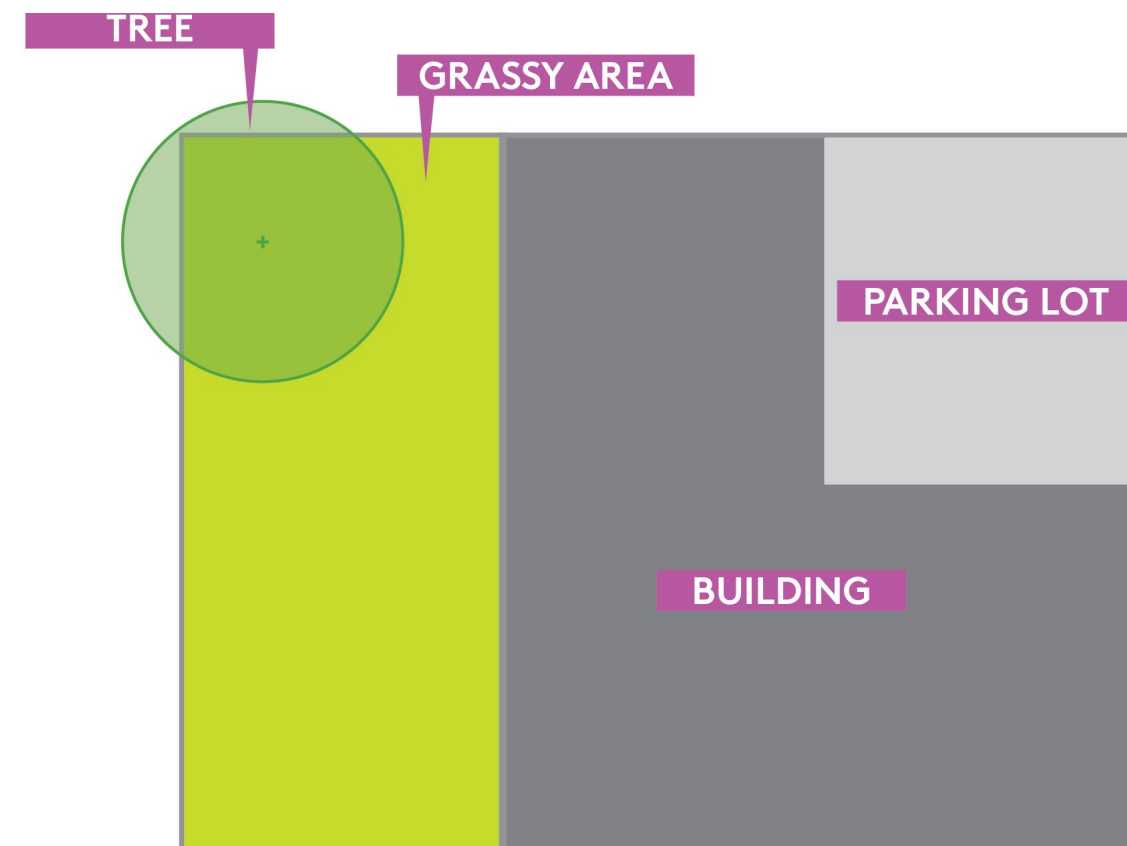
You can check to see how much impervious surface DWSD has estimated on any parcel in Detroit through the [Parcel Viewer^D](#).

Visit the website to confirm that the impervious surface data for your property is correct. If it is not, submit a Drainage Charge Adjustment Application to DWSD.

For more detailed information, see the Detroit Water and Sewerage Department's (DWSD) [A Guide to the Drainage Charge^E](#).

**** DISCLAIMER:** The information in this document was created as a general guideline to be educational in nature and to help people better understand the DWSD Drainage charges, and the overall process of attempting to receive credits, site conditions, stormwater management, bioretention practices, hiring consultants and contractors, etc. The information contained herein is not intended to replace, dispute, or contradict any DWSD program documents and regulations. In all instances, any questions or clarifications should be directed to DWSD directly, or their documentation and guides published on their website. This document is only supplemental to any DWSD documentation.**

How are Drainage Charges Calculated for Each Property?



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$$0.15 \text{ Acre Building} + 0.05 \text{ Acre Parking Lot} = 0.2 \text{ Acre, Total Impervious Area}$$

$$0.2 \text{ Acre Total Impervious Area} + 0.1 \text{ Acre Grassy Area} = 0.3 \text{ Acre, Total Site Area}$$

To calculate a property's monthly drainage charge, multiply
Total Impervious Area, in acres X **DWSD Impervious Acre Rate** (currently \$598)

So this property's monthly drainage charge,
0.2 Acre, Total Impervious Area X **\$598** = **\$119.60 monthly drainage charge**

Multiply monthly charge times 12 (months) to get the annual drainage charge,
\$119.60 X 12 = **\$1,435.20 annual drainage charge**



Drainage Charge Credits

The Detroit Water and Sewerage Department (DWSD) offers an opportunity for customers to reduce the drainage charge for their property through Drainage Charge Credits. Credits are a reduction in the drainage charge based on the successful implementation and operation of a Green Stormwater Infrastructure (GSI) practice. These practices, if properly installed and operated, are intended to reduce stormwater flow into the sewer system and therefore protect against flooding and sewer overflows.

See DWSD's ["A Guide to Drainage Charge Credits"](#)^E for some examples and descriptions of common Stormwater Management Practices.

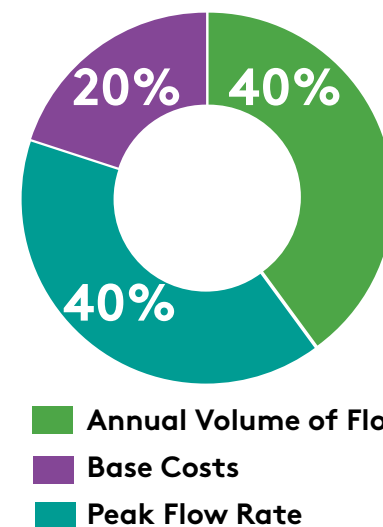
Also see the chart "Drainage Credits for GSI Practices" in the appendix page 22 to see which GSI practices are eligible for volume and/or peak flow credits. Bioretention is one of three different GSI practice types that have the potential to receive both volume and peak flow credits.

Two different types of drainage credits can be achieved, and when added together could potentially result in a maximum of 80% total site credit. A site credit is equivalent to the percent at which a property's drainage charge is reduced.

The two types of credit are called "Volume Credits" and "Peak Flow Credits." Volume-based drainage charge credits are determined based on the average annual stormwater volume reductions that result from managing stormwater on-site. In other words, the higher volume of water a practice keeps on the property and out of the sewer system on an annual basis, the higher the credit that will be awarded. Typically, the maximum credit that can be achieved through volumetric control is 40% (one-half of the potential 80% credit that can be earned).



Credit Breakdown



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Peak flow-related credits are based on the ability of the site to control peak flows (heavy rain events) by reducing the rate, or speed, at which the stormwater enters the sewer system. Practices that control peak flows receive credits by controlling the water on-site and slowly releasing the water into the sewer through a controlled outlet. Typically, the maximum credit that can be achieved through peak flow control is 40% (one-half of the potential 80% credit that can be earned).

Each practice, whether volumetric, peak flow, or both; receives an individual credit in the form of a percentage. Each practice credit applies to the area that is draining to the stormwater management practice. When added together, the sum of all the practice credits equals the total site credit for a property. The total site credit is the percentage at which a property's drainage charge is reduced.

Please note, an 80% site credit is rare, and only possible if 100% of a property's impervious surface is managed by GSI that is designed to manage the amount of stormwater runoff created from a 100-year storm event. In many cases, it is very difficult to redirect the flow of stormwater runoff to the desired areas on an existing site. Also, designing for a 100-year storm event doesn't always make sense because of the high cost of building such a practice and the additional space required to do so.

See Tables 2 and 3 in ["A Guide to Drainage Charge Credits"](#)^E for more information on calculating drainage credits.



This chart shows the potential credits available for different types of GSI practices. Bioretention is one of just three GSI practice types that have the potential to achieve both volume and peak flow credits.

This chart is based off Table 1 in [DWSD's "A Guide to Drainage Charge Credits"](#) for credits for commonly used stormwater management practices.

Drainage Credits for GSI Practices

Practice Type	Volume Credit	Peak Flow Credit	Potential Credit for Area Managed (%)
Downspout disconnection	X		0-40%
Disconnected impervious area	X		0-40%
Bioretention	X	X	0-80%
Detention basins		X	0-40%
Subsurface detention storage		X	0-40%
Permeable pavements	X	X	0-80%
Green roof	X		0-30%
Water harvesting*	X	X	0-80%

*For water harvesting, peak flow volume evaluated on a case-by-case basis.



Transition Credits

This chart shows how DWSD is phasing in the drainage charge rates over five years for property owners that were previously not being billed for drainage (such as a parking lot with no water service) or those that were previously billed based on their meter size. This information is based on a DWSD presentation from January 2019, but projected rates are subject to Board of Water Commissioner approval. For official information, contact DWSD.

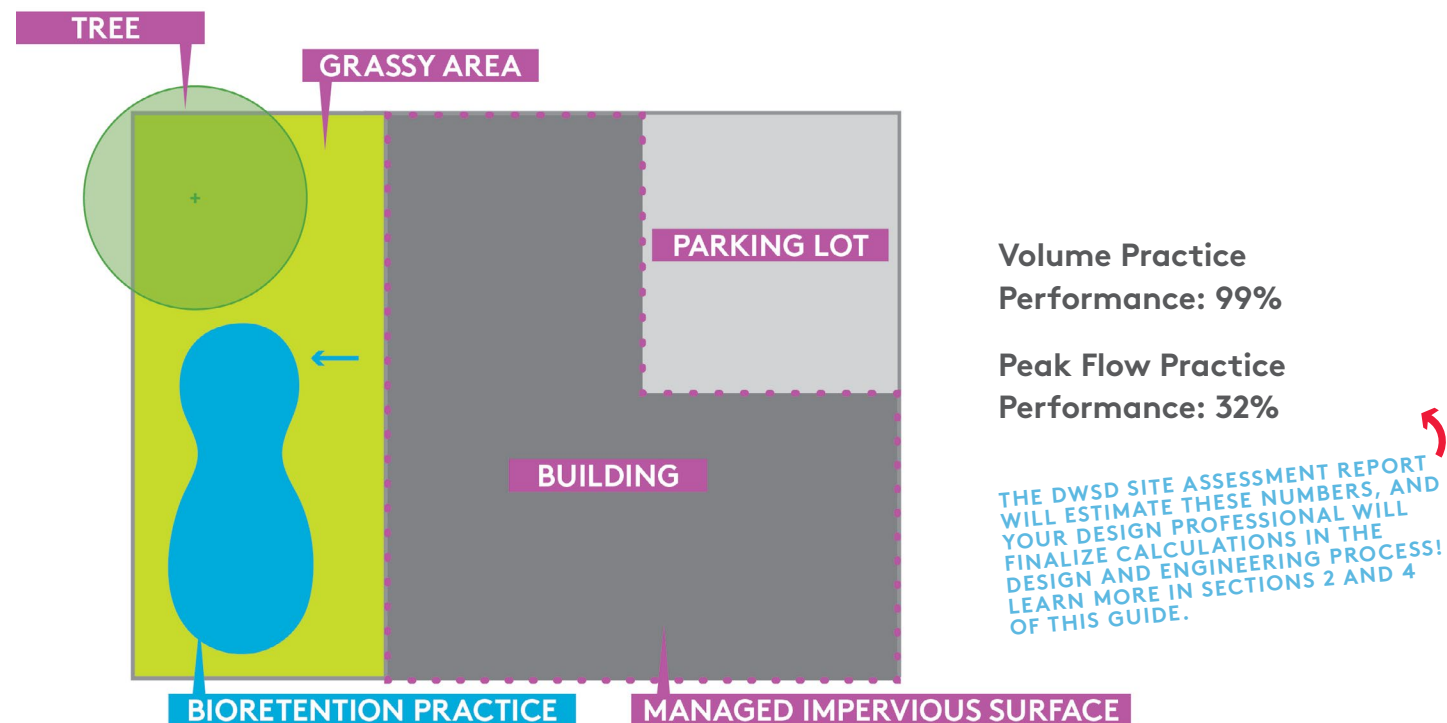
Five Year Rate Phase-in for Meter-Billed and Newly Billed Customers

Date	Impervious Acre Rate*	Industrial Rate*	Commercial & Exempt Rate*	Faith-Based Rate*
		Meter-Billed and Newly-Billed Customers		
July 1, 2015	\$852	N/A	N/A	N/A
July 1, 2016	\$750	\$125	\$125	N/A
July 1, 2017	\$661	\$250	\$250	N/A
July 1, 2018	\$598	\$375	\$375	\$125
July 1, 2019	\$602	\$500	\$500	\$250
July 1, 2020	\$626	\$625	\$625	\$375
July 1, 2021	\$651	\$677	\$677	\$500
July 1, 2022	\$677	\$677	\$677	\$625
July 1, 2023	\$677	\$677	\$677	\$677

Rate billed will be based on previous billing method, classification, and tax status.

*For discussion purposes only. Projected rates are subject to Board of Water Commissioners approval

Sample Credit Calculation



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Each practice can achieve up to 40% volume and up to 40% peak flow credit for the impervious surface area it is managing. A practice that has 100% volume practice performance and 100% peak flow practice performance (meaning it is sized to retain and detain a 100-year, 24-hour storm), for example will have a 40% volume credit and a 40% peak flow credit for the practice.

Volume Practice Credit = 99 x .4 = 39.6%

Peak Flow Practice Credit = 32 x .4 = 12.8%

Total Practice Credit = 52.4%

The bioretention practice only manages the runoff from the building (0.15 acres) and not the parking lot (0.05 acres). Thus, the practice is only managing 75% of the site's total impervious area.

To calculate the site credit, multiply the total practice credit x the percentage of the impervious area managed:

52.4% x .75 = 39.3% Site Credit

In this example, the bioretention practice provides a **39.3%** site credit, which will reduce the **\$119.60** monthly property drainage charge by **\$47.00** per month. Over the course of a year, the drainage charge will be reduced by **\$563**.

\$119.60 x .393 = \$47.00 Monthly Drainage Charge Reduction

\$47 x 12 months = \$563 Annual Drainage Charge Reduction

Original Annual Property Drainage Charge: \$1,435.20

New Annual Property Drainage Charge: \$871.20 (after installation of bioretention practice)

The report produced from your DWSD site assessment (discussed in Section 2 of this guide) will give you estimates on potential credits for GSI practices that could work on your site, as well as conceptual cost estimates.

In Section 3: Determining Project Feasibility, this guide discusses how to estimate a return on investment for a bioretention project, taking into account the cost of the project and the potential cost savings expected from the drainage credit.

Next, we will walk you through the steps of installing a typical bioretention practice.

Introduction Links

- A. "Nonresidential Drainage Credits": <https://detroitmi.gov/departments/water-and-sewerage-department/drainage-charge/nonresidential-drainage-credits#starterguides>
- B. "DWSD Drainage Program Guide: Green Stormwater Infrastructure (GSI) Best Management Practice: Impervious Cover Removal": https://detroitmi.gov/Portals/0/docs/DWSD/DCCP%20Site%20App%20-%20Impervious%20Cover%20Removal_WEB.pdf?ver=2017-08-09-164458-853
- C. "How to Depave: A Guide to Freeing Your Soil by Depave in Portland, Oregon": <https://depave.org/learn/how-to-depave/>
- D. "Detroit Water and Sewerage Department Parcel Viewer for Impervious Surfaces": <https://www.arcgis.com/apps/webappviewer/index.html?id=ce1eaf8deee347439687dcafe822372c>
- E. "DWSD Drainage Guides and Forms" <https://detroitmi.gov/departments/water-and-sewerage-department/drainage-charge/drainage-guides-and-forms>



Introduction Photo Sources

1. Combined Sewer Overflow pipes directed into the Detroit River, Photo Credit: Sarah Hayosh
2. Land + Water WORKS tour visiting a bioretention practice installed by the City of Detroit at Viola Liuzzo Park in Northwest Detroit, Photo Credit: Andrew Potter
3. "Green Infrastructure How It Works", King County Seattle Water Department, <https://kingcounty.gov/services/environment/wastewater/cso/about/natural.aspx>
4. Porous pavement (with permeable pavers), Philadelphia Water via Flickr, <https://www.flickr.com/photos/philadelphiawater/15894506417/>
5. Above-ground cistern, Decoridea, <http://decoridea.me/showcase/>
6. Green roof, Philadelphia Water Department, <https://www.pwdplanreview.org/manual/chapter-4/4.3-green-roofs>
7. Subsurface storage, PizzaPlex, Hamp Mathews & Associates
8. Stormwater detention basin, Atlanta BeltLine, John Becker, <https://beltline.org/parks/historic-fourth-ward-park/>
9. Constructed wetland, Milliken State Park, Photo Credit: City and County of Denver, <https://www.denvergov.org/content/dam/denvergov/Portals/711/documents/capital-projects/upper-montclair-march2017-meeting-boards.pdf>
10. Bioretention, Visitation Church Rain Garden, courtesy of Vireo Kansas City/Omaha, <https://www.bevireo.com/>
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12. Typical parking lot, Cathedral City Economic Development, <http://www.ccedd.org/de-update/public-investment-presentation/>
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30. Internal downspout, Detroit Future City
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32. How are Drainage Charges Calculated for Each Property?, Detroit Future City
33. Credit Breakdown, A Guide to Drainage Charge Credits, Detroit Water and Sewerage Department
34. Sample Credit Calculation, Detroit Future City

Project Process, at a Glance



SECTION 1: Getting Started, page 30

- Confirm ownership and account information. If it is not correct, contact City Assessor's Office: (313) 224-3035.
- Visit the Detroit Water & Sewerage Department (DWSD) Online Parcel Viewer and confirm that the impervious surface data is correct. If it is not correct, submit a Drainage Charge Adjustment Application to DWSD.
- Request a site assessment. Go to www.detroitmi.gov/drainage and fill out the Non-Residential Customer Site Assessment form. This is a free service, with no obligation!

SECTION 2: Getting a DWSD Site Assessment (optional), page 32

- Prepare information. Collect all of the information you have about your property, including: list of parcels you own, copies of water bills, zoning information, plumbing and sewage system on the site, or any existing studies or plans.
- Secure DWSD Field Team Site Assessment.
- Receive Preliminary Engineering Analysis Report.

SECTION 3: Determining Project Feasibility, page 35

- Review conceptual budgets and return on investment estimates from the site assessment
- Determine how much money you are willing or able to invest in the GSI project.
- Take stock of other potential resources available to fund your project: loan financing, grant funding, and the DWSD Capital Partnership Program.
- Move forward with planning if the project is determined to be feasible at this initial stage!

SEE THE PAYING FOR
BIORETENTION SECTION
ON PAGE 74 FOR MORE
INFORMATION

SECTION 4: Hiring a Design Professional, page 36

- Interview design professionals (a Professional Engineer or Registered Landscape Architect).
- Determine a scope of services.
- Review project proposals and fees.
- Hire the design professional that is the best fit for your project.
- Develop and sign a contract.

SECTION 5: Reviewing Design and Construction Documents, page 39

- Meet with your design consultant about the project goals and budget.
- Site inventory and analysis, including topographic survey and soil infiltration test.
- Develop and implement a community engagement strategy.
- Schematic design.
- Preliminary permit review.
- Design development.
- Preliminary cost estimate.
- Meeting with DWSD to confirm design and credit calculations.
- Final construction documents developed.
- Maintenance plan developed.
- Final budget developed.
- Apply to Capital Partnership Program.

SEE PLANTS FOR
BIORETENTION SECTION
ON PAGE 80
FOR INSPIRATION!

SEE COMMUNITY
ENGAGEMENT SECTION
ON PAGE 73 FOR MORE
INFORMATION

Sample Project Timeline



SECTION 6: Permitting and Review, page 54

- Bid documents developed, if necessary.
- Design professional submits documents for permit review.
- DWSD Drainage Credit Application and review.
- Design professional makes necessary modifications to documents.
- Once permits are approved, landscape contractor will pick them up.

START MEETING WITH
PERMITTING OFFICIALS
DURING THE PRELIMINARY
DESIGN PHASE

SECTION 7: Hiring a Contractor, page 57

- Seek out qualified landscape contractors.
- Provide bid documents for quotes.
- Review bids and proposals.
- Select landscape contractor that is the best fit for your project.
- Develop and sign a contract.

THE BEST TIME TO REQUEST
CONTRACTOR QUOTES IS IN
LATE FALL OR WINTER

SECTION 8: Construction, page 61

- Pre-construction: planning and meeting between property owner, design professional and contractor.
- Site preparation: clearing, tree protection, sedimentation and erosion controls, materials staging.
- Construction begins.
- Quality control inspections throughout key points of construction.
- Underground infrastructure and grading verification.
- Plant material installation.
- Site cleanup.
- Post-construction inspection(s) and documentation.

MANY QUALITY CONTRACTORS NEED
AT LEAST A COUPLE MONTHS LEAD TIME
BEFORE THEY CAN BEGIN CONSTRUCTION

SECTION 9: Getting DWSD Credit Approval, page 67

- Let DWSD know when construction is finished. DWSD will schedule a time to inspect your project. Update drawings with any as-built changes required during construction.
- Once approved, DWSD will apply the drainage credit to property owner's account.

SECTION 10: Maintaining Your Project, page 69

- Water plants frequently after initial planting and regularly for first two years.
- Weed monthly during plant establishment.
- Inspect inlets, overflow connection and basin after heavy rain events.
- Stabilize any erosion and remove sediment build-up, trash and debris.
- Replace plant material that does not survive.
- Apply mulch annually.
- Prune and cut back plant material as needed.
- Recertify every three years to keep your credit!

FYI: THIS
TIMELINE
IS JUST AN
ESTIMATE!

SECTION 1: Getting Started

- ❑ **Confirm ownership and account information:** if it is not correct, contact City Assessor's Office: (313) 224-3035.
- ❑ **Visit the Detroit Water & Sewerage Department (DWSD) Online Parcel Viewer and confirm that the impervious surface data is correct:** if it is not correct, submit a Drainage Charge Adjustment Application to DWSD.
- ❑ **Request a site assessment:** go to www.detroitmi.gov/drainage and fill out the Non-Residential Customer Site Assessment form. This is a free service, with no obligation!

When confirming your account information with DWSD, you should verify service address(es), parcel(s), classification, rate and credit(s). Most of this information should be found on your water bill(s). Confirm the amount of your current drainage charge. If any ownership, account, or drainage charge rate or transition credit information is incorrect, contact the City Assessor's Office at (313) 224-3035 to make corrections. You can review rate and transition credit information in the tables on pages 22 and 23.

You can validate your drainage and property data using the [DWSD Parcel Viewer^A](#), which allows you to search for parcel information by address. DWSD uses data from the City of Detroit Assessor's Office and flyover images to determine the amount of impervious surface on each parcel. The hard, impervious surface area recorded for your property will be used to calculate drainage charges.

Open the parcel viewer and type your street address with your ZIP code. If you disagree with the data, complete the [DWSD Drainage Charge Adjustment Application^B](#). Please note, DWSD processes adjustments only if the impervious surface calculation is incorrect by more than 0.01 acre, or 435 square feet. This is about the size of a two-car garage. For more detailed information on adjusting your impervious surface or other DWSD data, see [DWSD's Drainage Charge Guide, Section 2: A guide to Drainage Charge Bill Adjustment^C](#).

The next step is to sign up for a Site Assessment through DWSD. This step is optional, but recommended for most property owners. Details on the DWSD Non-Residential Customer Site Assessment Process are described in the next section. Because the process can take a while to initiate, it is recommended to sign up for a Site Assessment as soon as possible.

Use the [online form^D](#) found at www.detroitmi.gov/drainage.

Section 1 Links

- A. DWSD Parcel Viewer - <https://detroitmi.maps.arcgis.com/apps/webappviewer/index.html?id=ce1eaf8deee347439687dcafe822372c>
- B. Drainage charge adjustment application - <https://detroitmi.gov/document/drainage-charge-adjustment-application>
- C. DWSD Drainage Guides and Forms - <https://detroitmi.gov/departments/water-and-sewerage-department/drainage-charge/drainage-guides-and-forms>
- D. Request stormwater drainage site assessment - <https://app.smartsheet.com/b/form/c4b7f6eb0af548d486eb18425210bcee>

SECTION 2: Getting a DWSD Site Assessment (optional)

- ❑ **Prepare information:** collect all of the information you have about your property, including: list of parcels you own, copies of water bills, zoning information, plumbing and sewage system on the site, or any existing studies or plans.
- ❑ **Secure DWSD Field Team Site Assessment.**
- ❑ **Receive Preliminary Engineering Analysis Report.**

Unless you are very well versed in the area of stormwater management, it can be a daunting endeavor to make an accurate assessment of your site to determine how well-suited it is for implementing GSI practices and receiving drainage charge credits. With that in mind, DWSD has developed a program to educate property owners about the drainage charge and how to make important decisions regarding the implementation of stormwater management practices on their site.

The DWSD Site Assessment Program for non-residential properties is a free service of DWSD that provides property owners with a conceptual engineering analysis of their site. The analysis will help you better understand the opportunities and constraints of any potential drainage charge credits that may be received through the implementation of GSI practices. Information on how to sign up for a DWSD site assessment is given in Section One: Getting Started.

The Site Assessment service offered by DWSD is organized into 3 phases:

- ❑ **Phase 1:** A site investigation and meeting with the property owner (or the property owner's designated representative)
- ❑ **Phase 2:** Preliminary design and calculations
- ❑ **Phase 3:** Development of the preliminary engineering analysis report and presentation to the property owner's representative

NOTE!

You are not required to go through the DWSD Site Assessment Program in order to achieve drainage credit on your GSI practice. If you are already sure that you want to implement GSI on your property and have funding to do so, you could skip this step and hire your own engineer to do the initial analysis. This could possibly expedite the initial site analysis and design process. However, the DWSD Site Assessment Program is free and offers a good starting point for property owners to understand the possibilities for GSI on their site to determine if it is even feasible and cost-effective.

Phase 1: Site Investigation and Meeting:

This first step is an opportunity for the team of DWSD-assigned design professionals to gather information about and better understand the property in question. The team members will meet with you on site and will also walk the property and pick up as much data and information as possible to assist with their design recommendations.

Phase 2: Preliminary Design and Calculations:

During the second step, the design team works with all the information gathered in Phase 1, and develops a preliminary stormwater management plan specific to the site. The site plan will include recommended improvements that the property owner can implement to help them obtain drainage charge credits. Preliminary stormwater calculations and potential credit determinations are included as a part of the plan, as well as cost estimating to help the property owner better understand their potential return on investment timeline.

Phase 3: Preliminary Engineering Analysis Report and Presentation:

The final deliverable for the property owner is the Preliminary Engineering Analysis Report. The report includes information regarding the property and the preliminary stormwater management plan. The information serves to help you make educated decisions and develop a strategic plan for managing the stormwater on your property and reduce your drainage charge through credits. The report will be presented to you or a property owner's representative that you may designate in a meeting facilitated at DWSD's central operations facility. Any questions that you have about the report, or otherwise, can be addressed at this meeting.



It usually takes several weeks from signing up for a site assessment until you have a site visit. Once you have a site visit, it will usually take between 6-8 weeks for a final report presentation to the owner. The advantage to taking part in the DWSD Site Assessment Program is that in the end, you are presented with a very thorough preliminary design and report document that can inform your property management decisions in the future. The document is an official DWSD document that has been reviewed, and approved for distribution to you, as the property owner. It is a tool that you can then reference during discussions with DWSD or other design professionals to provide essential information related to your site and its stormwater management potential.

You are under no obligation to implement any or all of the recommendations in the report. It should also be noted that although the report provides a lot of information to inform the property owner's decision on whether to implement GSI on their property, its recommendations are still preliminary in nature. You cannot simply hire a contractor to install the GSI practices recommended in the Preliminary Engineering Analysis Report. Even if you were to decide that you want to implement exactly what is recommended in the report, you will still need to hire a design professional to do more detailed design work and construction drawings before hiring a contractor to build it.



SECTION 3: Determining Project Feasibility

- ❑ Review conceptual budgets and return on investment estimates from the site assessment.
- ❑ Determine how much money you are willing or able to invest in the GSI project.
- ❑ Take stock of other potential resources available to fund your project: loan financing, grant funding, and the DWSD Capital Partnership program.
- ❑ Move forward with planning if the project is determined to be feasible at this initial stage!

 THIS IS A BIG DECISION!

At this point you should decide if you plan to move forward with the investment of hiring a design professional to design and engineer a GSI practice for your site. The DWSD Site Assessment Report and its initial recommendations are very useful to determine initial project feasibility at this stage and for ballpark cost estimates.

Examine the DWSD conceptual budget and the Return on Investment (ROI) timeframe. The ROI estimates tell you how many years it will take to “make back” your initial investment in the GSI practice, taking into account the cost-savings expected from building the practice and reducing your drainage fees. Keep in mind that the conceptual budget may not show the full cost of the project, as it doesn't include things like soil testing, surveying, and permitting, and the engineering fees are underestimated in DFC's experience. Determine how much money you are willing or able to invest in the project. This investment could be a combination of out-of-pocket capital expenditures, loan financing, grant funding (especially if you are a nonprofit or the project will have larger community benefits), and the DWSD capital partnership program. More information on these items, as well as a table with guidelines for budgeting, can be found in the “Paying for Bioretention” section on page 74. If you decide to move forward, refer to Section 4: Hiring a Design Professional.

SECTION 4: Hiring a Design Professional

- ❑ Interview design professionals: (a Professional Engineer or a registered Landscape Architect).
- ❑ Determine a scope of services.
- ❑ Review project proposals and fees.
- ❑ Hire the design professional that is the best fit for your project.
- ❑ Develop and sign a contract.

Before GSI practices and sites can become eligible to receive stormwater credits, they must go through a review and approval process by DWSD, and any City of Detroit regulating agency that may pertain to the construction of the GSI practice. Depending on the scope of the project, reviewing agencies may include Buildings, Safety Engineering and Environmental Department (BSEED), Planning and Development Department, Department of Public Works, or any other department as deemed necessary by the City. DWSD reviews proposed projects to determine if the practices meet the required standards and whether the credits requested are approved.

GSI practices that are located within Detroit and that receive credits are considered to be a part of DWSD's overall stormwater management program. Because of this, the process by which DWSD reviews engineered designs and awards credits is very specific, detailed, and comprehensive. DFC strongly recommends that property owners consult with and retain a design professional such as a Professional Engineer or a Landscape Architect to prepare all the plans, calculations, and supporting documents that must be submitted for review and approval by DWSD and BSEED. Design professionals such as these have the knowledge and resources to provide the reviewing agencies with the documentation required. They can also engage in technical discussions as needed to work through any sticking points related to the proposed GSI and site design.

DWSD has a list of engineering and landscape architecture firms that have had staff participate in their technical seminars related to the drainage change. The list can be found here: <https://detroitmi.gov/departments/water-and-sewerage-department/drainage-charge/nonresidential-drainage-credits>

As a matter of policy, DFC and DWSD do not recommend or endorse any design professional firms or individuals as preferred consultants related to the Drainage Charge Program. All design professionals must follow the same DWSD program requirements and be subject to the same review and approval process as one another. However, that does not necessarily mean that all design professionals are well-versed in GSI design, or the DWSD Nonresidential Drainage Credit Program.

INTERVIEWING DESIGN PROFESSIONALS

DFC recommends that property owners screen potential design professionals to see if they are the right fit for their project. Questions to ask potential candidates may include:

- ❑ Have they ever designed and implemented a GSI practice within Detroit? If so, did they apply for drainage credits through the DWSD Nonresidential Drainage Credit Program?
- ❑ Are they familiar with and well-versed in the program's goals, opportunities for credits, and fundamental requirements?
- ❑ Have they ever met with DWSD staff or their consultants, to discuss aspects of the Drainage Charge Credit program related to a specific project, or to generally get a better understanding of the program's opportunities and constraints?
- ❑ Do they have any existing relationships with anyone in the DWSD Stormwater Management Group?
- ❑ Are they familiar with the City's review and permitting process through BSEED?
- ❑ Are they familiar with the submittal requirements for drainage charge credit determinations?
- ❑ What is their typical GSI or site design process from initial site investigation through construction documents?
- ❑ Are they willing to meet with DWSD on your behalf to work through any questions or clarify any information that DWSD may have during the review process?
- ❑ What is their specific scope of work and will it include:
 - Topographic survey
 - Standard City of Detroit details
 - Opinion of construction cost
 - Planting plan (if necessary)
 - Meetings as needed with DWSD or other City agencies, and anticipated timeline for meetings
 - Reproduction of plans for submissions
 - All calculations and testing required by DWSD for review and credit determination
- ❑ How do they structure their fees? Can they provide a breakdown of how their fee is constructed? How will they handle any requested tasks that fall outside of their scope of work?
- ❑ Are they willing to provide a proposal with a scope of work outlining specific deliverables?
- ❑ Will they provide construction inspection and/or observation (oversight) services if requested?



You may also choose to hire a landscape contractor to install your project. Both the design professional and the landscape installation team are “contractors.” As property owner, you will be signing a contract or agreement for services rendered. The design professional will create an accurate set of drawings and specifications (called construction documents) that the landscape installation contractor will use to construct the GSI practices and other site improvements. Inevitably, contractors will have questions they need answered and additional information that they need in order to provide the most accurate pricing available. Make sure that the design professional includes in their scope of work that they will respond to all contractor questions or requests for information during the bidding process.

If you have never hired a design professional or a contractor before, it is a good idea to ask someone you trust who has experience to assist in your decision by reviewing any cost proposals or contracts before signing them. A trusted friend or advisor can help explain how the process normally works to get a quote for services: You share project information, the contractor or design professional will do a site visit, you will discuss the project and requested services in more detail, and the contractor or design professional will provide a quote based on the information gathered. If you have additional questions, or if you need more details, this is the time to ask them so there is a clear understanding of what services will be provided for the anticipated fee. You will sign the contract once you both agree on the scope of services and cost.

More information specific to hiring and working with a landscape installation contractor is outlined in Section 6.



SECTION 5: Reviewing Design and Construction Documents

- ❑ Meet with your design consultant about the project goals and budget.
- ❑ Site inventory and analysis, including topographic survey and soil infiltration test.
- ❑ Develop and implement a community engagement strategy (See page 73 for more information).
- ❑ Schematic design.
- ❑ Preliminary permit review.
- ❑ Design development.
- ❑ Preliminary cost estimate.
- ❑ Meeting with DWSD to confirm design and credit calculations.
- ❑ Final construction documents developed.
- ❑ Maintenance plan developed.
- ❑ Final budget developed.

TO GET HELPFUL
INFORMATION UPFRONT
FROM THE PERMITTING
OFFICIALS, WHICH MAY
IMPACT FURTHER DESIGN

ALSO, NOW IS A GOOD TIME
TO APPLY TO THE CAPITAL
PARTNERSHIP PROGRAM!

After the owner has decided that they would like to implement a GSI practice to manage stormwater on their site, and a design professional has been selected, the next steps are to get working on the preliminary design and eventually the final design construction documents.

Exploration, or information gathering, is the first step in the design process. This is explained in more detail in the Inventory and Analysis section below. After all the information that is important to inform the GSI design is obtained, then the design professional can work toward a site design that focuses on practice locations and sizing – always making sure that the design recommendations are consistent with the property owner’s goals and findings in the Inventory and Analysis stage.



The design stage is a process that involves a lot of “checks and balances” to make sure that sizing of the GSI practices is correct, that design recommendations are realistic and within budget, and that there are no potential negative impacts on the day-to-day operations of the property.

Milestone dates should be established for the property owner and design professional to meet and discuss the progress of the design. Discussion topics should include estimated budget, timeline, major/minor changes to the site, design alternatives, and basis or rationale of the design.

The GSI recommendations and designs are documented or drawn on site plan sheets (construction documents) and include important information such as depths and dimensions of practices, specific materials needed, any demolition or removals, data and calculations related to stormwater being managed and drainage areas.



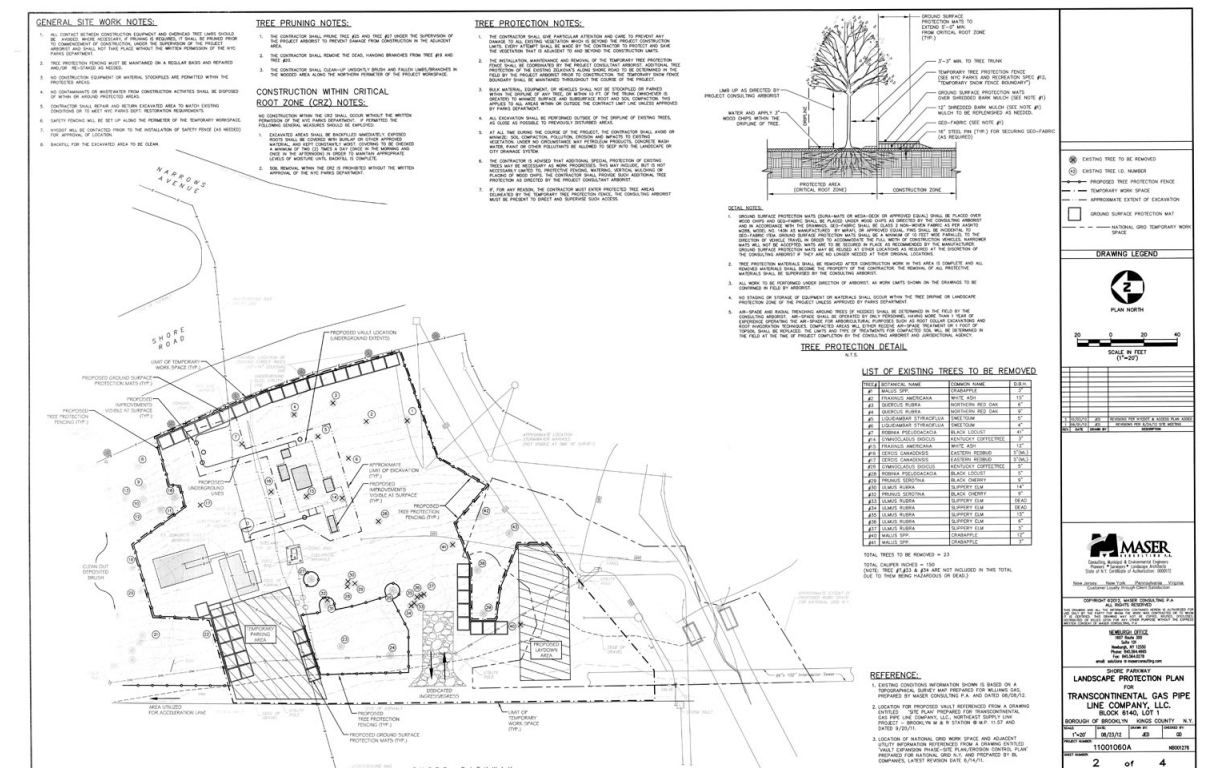
Photo of surveyors¹



Inventory and Analysis

During the site inventory and analysis phase, the design professional will examine existing site conditions, talk about your goals, and use this information to create a preliminary design. The design professional will be looking at certain things that will help give them an idea of some opportunities to take advantage of, and some constraints to perhaps stay away from. The design professional can use the Preliminary Engineering Analysis Report from the DWSD site assessment process as a starting point.

During the inventory and analysis, they will look at many things, including impervious surface area, topography, utilities, hydrology (flow of water), existing vegetation, how the site or business functions, surrounding areas, soils, and any other aspects of the site that could give them a clue of how to best incorporate GSI practices into the site. At this stage, it is important for you and your design professional to develop clear goals and priorities for the project, and for them to understand how you currently use the site and your future plans and needs for the site beyond the bioretention project.



Construction drawing²



The first thing that is usually looked at are opportunities to remove impervious surfaces, therefore reducing the need to manage that surface. Removing impervious surface that is not critical to daily operations, or that will never be used, is a great way to immediately reduce the drainage charge tied to the property. Remember, the charge is based on the flat rate multiplied by how much impervious surface is on the site in acres. Lower that number of acres, and the charge becomes lower.

How Does Water Flow on Your Site?

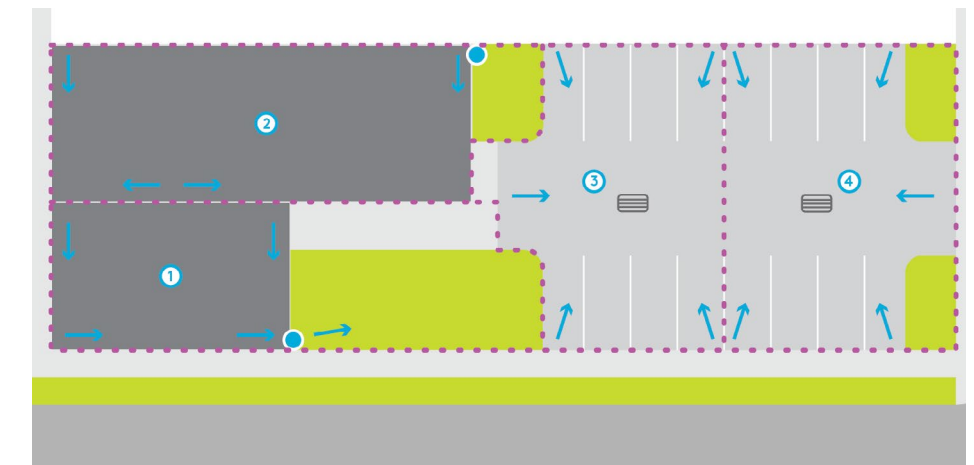
Typically, the next step is to understand the high and low points (including rooftops) of the site, which gives them an idea of the water flow patterns. This is also called the “hydrology” of the site. The best way to understand the hydrology is to have a licensed surveyor perform a topographic survey of the site. A topographic survey is a map that engineers and landscape architects use to understand the elevations on the site – which will make it evident where the water is flowing. If a topographic survey is not performed, the hydrology of the site can still be roughly understood through field investigations and verification. A topographic survey typically does not document the rooftop drainage, so if your roof is complex with lots of slopes, your design professional will have to map that out as well.

Sites are never perfectly flat, and they very rarely slope in one direction. So, designers need to look at the various high and low points on the site to determine the drainage areas. Water always flows downhill, so the common point is usually the low point of the drainage area. The low points on sites with a lot of impervious surface usually have stormwater inlets to the sewer. There are usually multiple drainage areas on a site, and they essentially act as bowls. When a drop of water falls into a bowl, it always flows to the lowest point of the bowl. It never flows up the side and out the top of the bowl. When all the drainage areas are defined, then the design professional knows where all the water is flowing. This is a major step toward designing GSI practices for the site.



Drainage Area Diagram

- Legend**
- Downspout
 - ☰ Storm Inlet
 - Flow of Water
 - Ⓜ Drainage Area
 - ⋯ Drainage Area Limits



3

A site can have multiple drainage areas. By definition, a drainage area is an area of land from which stormwater runoff drains to a common point. The common point is often a low point on the property, but it can also be an area off the property. If a site has multiple high and low points, then it will have multiple drainage areas. Roofs and parking lots are typically divided into two or more drainage areas depending on their design and grading, respectively.

The design phase begins by looking for ways to reduce impervious surfaces on site, and at proposed areas for GSI practices. In order for GSI practices to be eligible for credits, the stormwater needs to flow into them. Since the designers now know the hydrology of the site, they can start to locate GSI practices where water is already flowing, or they can look at ways to reroute stormwater into GSI practices in a cost-effective manner. Throughout the design phase, the design professionals should be looking at any feasible, realistic opportunity to direct stormwater to the GSI practices. The more water managed in GSI practices, the higher the drainage charge credit for the property owner.



Internal vs. External Downspouts

A large percentage of a site's impervious surface is often the rooftops of buildings. Those rooftops are the highest points of a site, where water starts its journey to the low points of the site. Water that falls on roofs either drains toward the exterior edges of the roofs (in the case of a pitched or gabled roof), or it flows toward internal roof drains (in the case of flat roofs). On typical buildings, once the stormwater reaches either the edge of the roof or the internal roof drain, the water is then conveyed via a downspout to the ground where it either discharges to the surface of the property (disconnected downspout) or it continues underground via pipe to the City sewer (a connected downspout.)

Downspouts that are located on the exterior of the building are a huge advantage to a property owner when it comes to a stormwater management plan. The designer can track where the rooftop stormwater is flowing from beginning to end, and they can propose to reroute the gutters or downspouts and direct water toward a GSI practice.

Roof drains that are located toward the middle of flat roofs are much more difficult to work with from a stormwater management standpoint. Internal downspouts are typically much harder, more expensive, and often out of the question to reroute to the exterior of the building. They almost always connect directly to the City sewer. Because of this, it often isn't feasible to manage the rooftop stormwater or qualify for drainage charge credits in that particular drainage area.

In some instances, industrial and warehouse style buildings have internal downspouts that are exposed (not located behind walls or pillars) and a contractor could gain access to them. If there is also enough clearance within the ceiling rafters, the vertical pipe can be rerouted horizontally and through an external wall to convey the water to a downspout on the outside of the building. From there the water can be directed to the GSI practice. This scenario is not very common, but if you have it, you can get quotes from a commercial plumber to relocate the internal downspouts to the exterior of the building.



What Size Should the Bioretention Practice Be?

The next questions to ask are "how big do these bioretention practices need to be?", and "where will they be located on my site?" The design professional that you are consulting with will make recommendations for both of those questions. But, it will also help to understand the reasons behind these recommendations.

Bioretention sizing is a factor of the type of soils that the site sits on, the amount of impervious surface within the area draining to the bioretention practice, and the available/ useable space on the property. Further explanation of the importance that soils play in stormwater management is in the Soils section of this document. But, the general rule of thumb is that the more sand in your soils, the smaller your practices can be; and the more clay in your soils, the larger the practices need to be. Sandy soils can drain a deeper depth of water than clay soils. The deeper the water is allowed to pool in the practice, the less surface area it needs to take up. The reverse is true for sites with clay soils. Practices on sites with clay soils need to be shallower and larger. A DWSD regulation for above-ground GSI practices is that all surface water (water pooling above the soil surface) needs to soak into the soil in 24 hours. See [A Guide to Drainage Charge Credits^A](#) for additional information.

If each individual practice is designed to hold and infiltrate all the stormwater in the drainage area within 24 hours, then the maximum practice volume credit can be obtained. If site constraints limit an individual bioretention practice ability to be constructed to a size that will hold and infiltrate all of the stormwater in a drainage area within 24 hours, then a partial practice credit can still be obtained. Typically, sizing and location of the practices are dictated by available area on the site and existing site conditions. Unfortunately, practices can't always be sized and located in the optimal location. Your design professional will help you work through those decisions.



Where Should the Bioretention Practice(s) be Located?

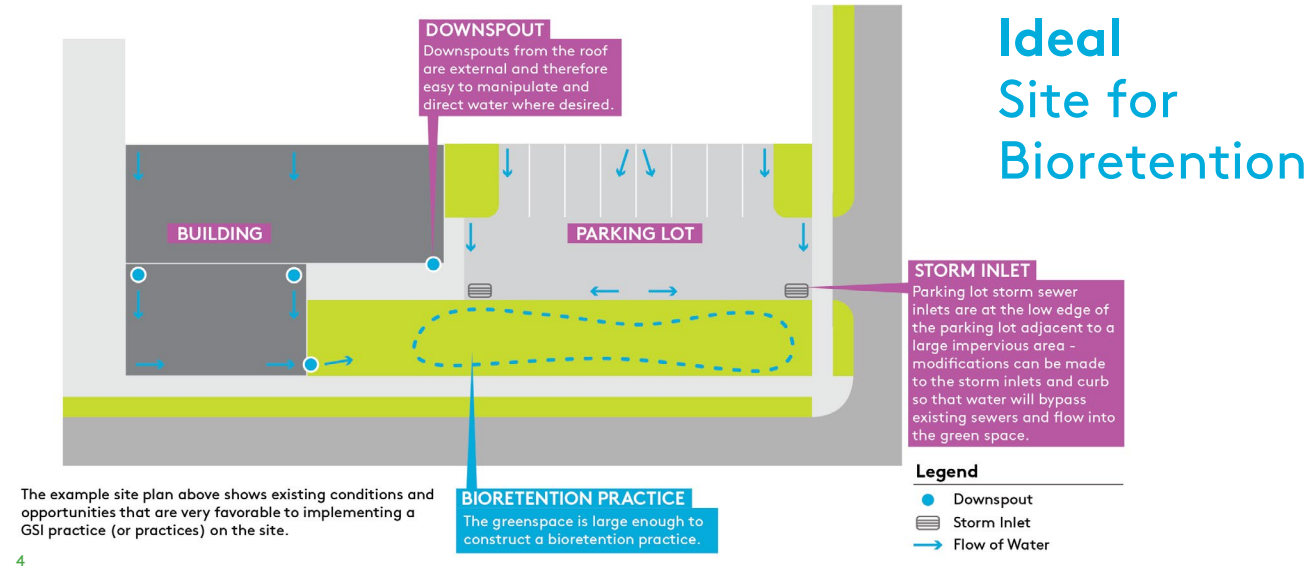
When implementing GSI on or near an existing building, you often have to work with existing conditions that can't easily be changed. The site conditions largely determine where bioretention practices will be located.

The detailed list below outlines some of the major variables to consider when selecting locations for GSI practices. Although there are no limits to the amount of construction and improvements that can happen on a site to manage stormwater, this obviously has cost implications directly related to the total amount of work being performed. Taking advantage of existing favorable site conditions when locating practices, rather than creating favorable site conditions through construction can save you a lot of money. The design goal should be a solution that provides the largest credit possible, within your budget. You will need to advise the design professional on what your budget is.

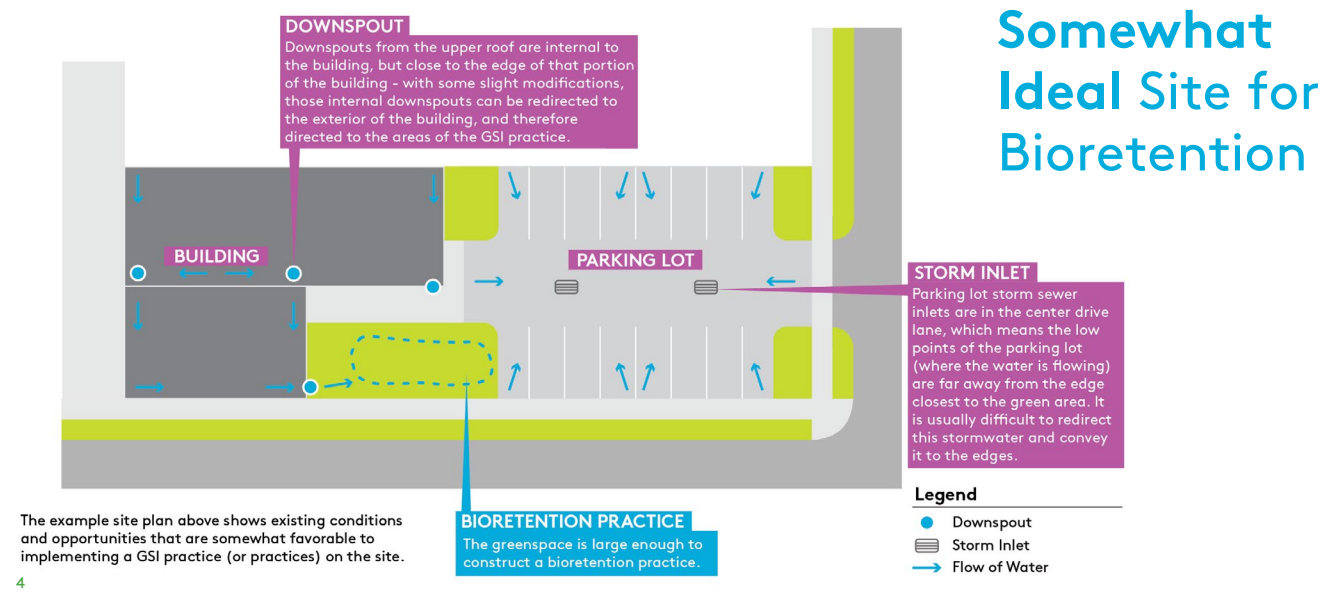


Below is a list of key items on site that will be assessed by the design professional to identify the right locations on site for a bioretention practice:

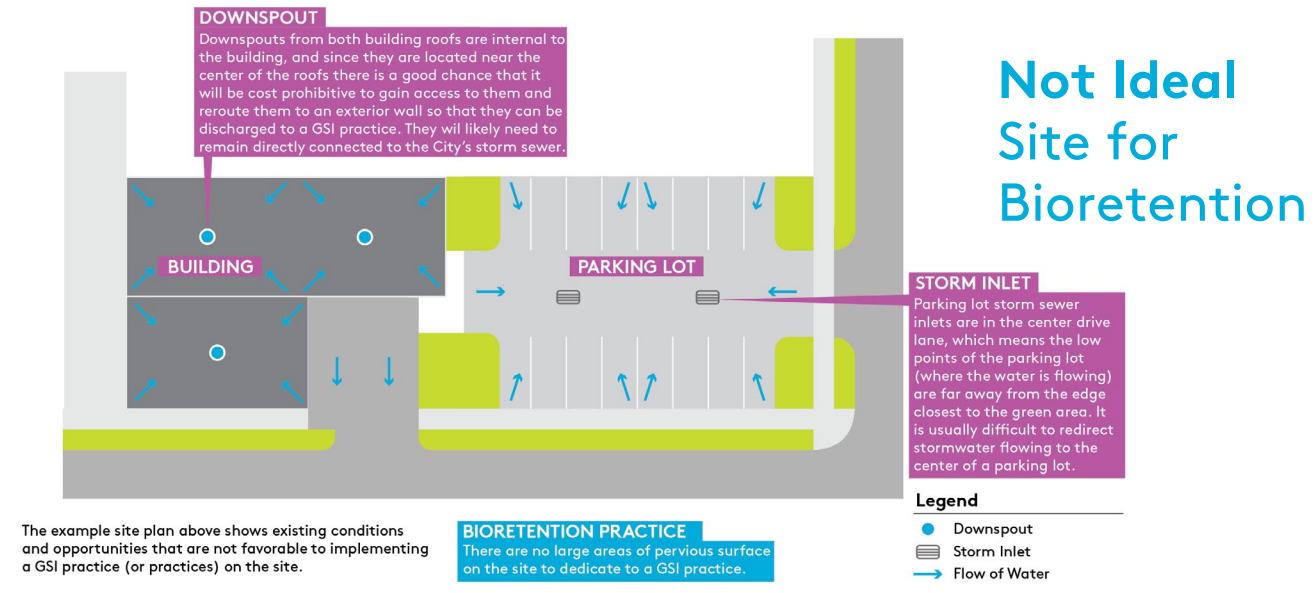
- ❑ Determine if the building roof drains externally or internally. If external and easy to access, then a GSI practice could possibly be located close to where the water discharges, allowing the water to flow directly into it.
- ❑ Identify the availability of any unused, open, pervious (grass or other vegetation) areas that are in low areas of the site. These areas (paved or not paved) can be turned into bioretention practices since water is already flowing to them.
- ❑ If the parking lot has existing catch basins or stormwater inlets located at the edges, it means that water is already being directed to these locations, and modifications could be made to allow the water to continue past the inlet to a bioretention practice adjacent to the parking lot.
- ❑ If the parking lot has catch basins or stormwater inlets located in the middle of parking bays, there may be an opportunity to remove some parking spaces and install a practice in their place, or reroute water to a GSI practice adjacent to the parking lot.
- ❑ Identify the general direction in which the site drains, and assess if a practice can be located in the lowest area of the site. Although all water may not be flowing there currently, since it is the lowest point on site, there may be a way to rely on gravity to get water there.



4

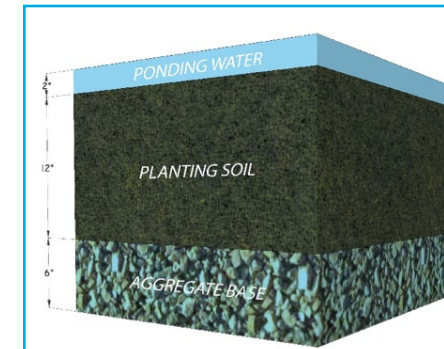


4



4

Understanding Soils



In the diagram shown, 7 inches of stormwater is the maximum depth of water that can be stored in 20" of surface and subsurface storage when the native soil infiltration rate is 0.1 in/hr.



5

The soil structure, or "makeup" of the soil, is a major factor in ultimately determining how many credits a property owner can receive. Sites that have a soil makeup with a high infiltration rate, can more easily manage a large volume of stormwater runoff. Sites that have very poor soils cannot manage a large volume of runoff. Although these sites probably won't obtain the maximum credits allowed by the program, a design professional will still be able to offer some recommendations that, when implemented, will qualify for some amount of credits.

DWSD and design professionals look at a few general principles to calculate how many credits a practice, and therefore a property owner, could possibly obtain. One of the most important factors is the infiltration rate of the existing soil on your site. Other relevant factors are the usable void ratio and the equivalent water depth, which are described in the appendix. DWSD's document, "The Guide for Credits for Commonly Used Storm Water Management Practices"^B has more information on how soils impact the stormwater management on a site.

Bioretention practices rely on the temporary storage of stormwater in the soil - very much like water is stored in a sponge. In instances where larger aggregate is used to temporarily store water in its void space, it is equivalent to filling a bucket full of marbles with water. The marbles stay in place, but the water fills the space between them.

The amount of credits a practice can receive depends on how much stormwater can be stored on or below the surface. In general, all surface water must be able to drain below finish grade within 24 hours and from soil and subsurface storage within 72 hours.

Your design professional will identify the material and depth of the materials that will be used to temporarily retain the stormwater in the practice before it drains away. There are specific calculations that can be performed by the design professional to determine the practice's potential performance.



Soil Infiltration Testing

The higher the infiltration rate of your soil, the better. If you have a high infiltration rate, water will drain out of your soil faster, and it can accommodate a greater depth of stored water. Infiltration rates are measured as vertical movement of water through soil in inches per hour. For example 0.2 in/hr. This value (whatever it may be) is the number used by the design professional in their calculations to determine the size of any proposed practices.

In order to identify the infiltration rate of your soil, an infiltration test will be performed to measure how long it takes for water to drain into the soil. Property owners that are interested in performing their own soil infiltration test(s) may utilize the [Michigan Low Impact Development \(LID\) Manual^C](#) for acceptable soil infiltration testing protocols, procedures and methodologies for measuring infiltration rates. However, DWSD accepts only soil infiltration test data that is signed and sealed by a civil engineer, or a geotechnical engineer, so the design professional (or their sub-consultant) is best-suited to perform these tests.

This guide recommends that the property owner request a soil infiltration test be performed by their design professional in locations where practices may be placed.

If you do not have an official soil infiltration test performed, DWSD will assume you have very clayey soil with a low infiltration rate and will only allow a maximum value of 0.1 in/hr infiltration rate to be used in the sizing of the practice and credit calculations.

This may be underestimating your soil's infiltration capacity and result in a lower possible credit.



Types of soil⁶



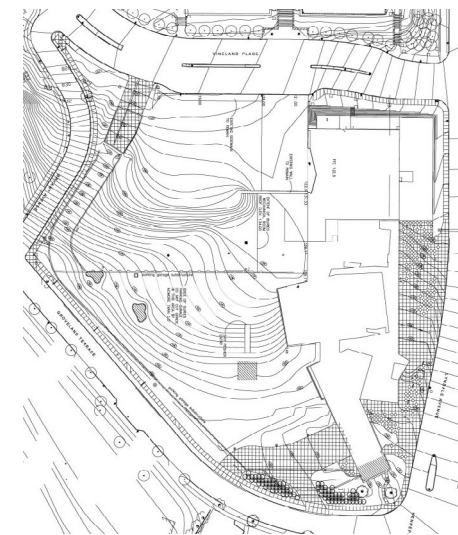
Soil infiltration testing⁷



Designing for a Good Return on Investment

The designer's goal is to find a cost-effective way to manage the stormwater from every drainage area on a site. Design professionals can get creative to come up with stormwater solutions to capture every last drop if that is what is desired. But there becomes a point where the potential credits don't justify the possible construction costs of practices when there are a lot of site modifications required to direct water to them. The property owner should ask the design professional to demonstrate a breakdown of cost versus potential credits so the owner can make an informed decision about how they want to move forward.

Understanding Topographic Surveys



Site topographic surveys help the design professional and property owner understand the topography of the site, and therefore the hydrology of the surface. The topography is the undulation and change in elevation of the surface of a site. A survey also identifies stormwater inlet structures and their elevations. If requested, underground stormwater utility information (that can't be obtained or identified from the surface), such as pipe size, invert elevations, and direction of flow can also be obtained, so the design professional can make a more informed decision. This will hopefully translate to more credits through the course of the design and calculations.

Topographic surveys identify all the features on a site and assign an elevation to them. It is critical to have this level of detail and information for a site to make accurate and informed design decisions. It is also a very important baseline of existing conditions when the time comes for cost estimating. A basic survey will identify all curbs, buildings, sidewalks, parking lots, and transition points, including paved to non-paved surfaces, posts, trees, utility-related features on the site, and other miscellaneous features.



Engineering design professionals often have in-house survey crews that can include a survey as a part of their overall fee. If surveying services are not provided by the design professional's company, they often work very closely with a surveying company, since it is often critical to most projects that they work on. This should be discussed with the consultant prior to signing an agreement with them.

The cost of a survey is almost always directly related to the size of the property. A smaller, non-residential property could probably expect to pay anywhere between \$3,000 - \$6,000, depending on the complexity of the site and any additional underground investigations that might be requested.

Lead-times also vary for a survey crew to mobilize and get out to a site. There is no way of knowing how backed up a survey crew may be, it may take weeks or even months for surveyors to fit your site into their schedule.



Section 5 Links

- A. "DWSD - A Guide to Drainage Charge Credits": <https://detroitmi.gov/Portals/0/docs/DWSD/A%20Guide%20to%20Drainage%20Charge%20Credits%20-%20Web.pdf?ver=2016-09-06-093601-287>
- B. "DWSD - A Guide to Credits for Commonly Used Storm Water Management Practices": https://detroitmi.gov/Portals/0/docs/DWSD/A%20Guide%20for%20Credits%20for%20Commonly%20Used%20Storm%20Water%20MgmtPractices_WEB%20READY.pdf?ver=2016-11-16-173244-490
- C. "Michigan Low Impact Development (LID) Manual": <https://semcog.org/Reports/LID/files/assets/basic-html/page-1.html>

Section 5 Photo Sources

1. Photo of surveyors, <https://rekordeast.co.za/48695/a-building-for-the-people/>
2. Construction Drawing, NYC Department of Parks and Recreation, <https://www.nycgovparks.org/permits/construction>
3. Drainage Area Diagram, Detroit Future City
4. Ideal Site For Bioretention, Somewhat Ideal Site for Bioretention, Not Ideal Site for Bioretention, Detroit Future City
5. Equivalent Water Depth Diagram, Detroit Future City
6. Types of Soil, Soils Alive, <https://soilsalive.com/north-texas-soil-types-d1/>
7. Soil Infiltration Testing, A&Y Associates, https://www.ayassociates.com.au/our_services/geotechnical-engineering/
8. Topographic survey, Project Groundwork, Metropolitan Sewer District of Greater Cincinnati, http://www.projectgroundwork.org/green_solutions/index.htm

SECTION 6: Permitting and Review

- ❑ Bid documents developed, if necessary.
- ❑ Design professional submits documents for permit review.
- ❑ DWSD Credit Application and review.
- ❑ Design professional makes necessary modifications to documents.
- ❑ Once permits are approved, Landscape Contractor will pick them up.

Complete engineered drawings stamped by a registered Professional Engineer or Landscape Architect must accompany the drainage charge credit application. Some of the information used in the Capital Partnership Program application will be useful in the credit application. Additional required documentation is found on the application and can be downloaded from www.detroitmi.gov/drainage.

Depending on your project, the following permits and approvals may be required. Contact the following offices and/or the individual permitting departments for more information.

- ❑ **Building permit/Development Resource Center (BSEED):** (313) 224-2372, drc@detroitmi.gov, Coleman A Young Municipal Center Suite 434 Woodward Avenue, Detroit, MI 48226. Website: <https://detroitmi.gov/departments/buildings-safety-engineering-and-environmental-department>
- ❑ **Plumbing permit (BSEED):** Plumbing Inspector, Steve Jar, (313) 224-3158, jars@detroitmi.gov
- ❑ **Zoning approval, parking lot requirements (BSEED):** Zoning Manager, Jayda Philson, (313) 224-1317, philsonj@detroitmi.gov
- ❑ **Right-of-Way permit (DPW):** Janice Rutledge, (313) 224-6538, rutledgej@detroitmi.gov
- ❑ **Sewer tap permit (DWSD):** Mohamed Boudali, (313) 964-9236, boudalim@detroitmi.gov
- ❑ **Stormwater management plan approval (DWSD Stormwater Management Group):** (313) 267-8000, swgroup@detroitmi.gov
- ❑ **Erosion and Sediment Control permit (Wayne County):** Wayne County DPS Engineering Division's Permit Office, (734) 595-6504 x2008

For most small-scale bioretention projects without a sewer tap, the permitting requirements will be minimal.

1.0 PRELIMINARY PLAN REVIEW

1.1 Attend a preliminary plan review meeting at BSEED's Development Resource Center (DRC). In this meeting you and your design professional can expect to learn what permits your project will need. BSEED representatives will walk you through the expected permitting process required for your specific project.

2.0 PRE-REVIEW

2.1 Schedule a meeting with DWSD's Stormwater Management Group (SMG) to review draft plans and for a drainage credit estimate.

2.2 Attend office hours with BSEED's Plumbing Inspector for detailed plumbing requirements.

***2.3 If you plan to do a sewer tap in the Right-of-Way (ROW), confirm with DWSD that site conditions allow for a ROW sewer tap.** Your contractor must be bonded with a \$2,500 surety bond with the City of Detroit. This bond must be completed before any work is done in the ROW. Expect a charge of \$400/day (x1.5 on Saturdays and x2 on Sundays) while work is being done in the ROW. For more information, contact DPW.

2.4 If you are required to submit any permits, move to Step 3. For most small-scale bioretention projects, you may not need any City permits. Confirm this after meeting with BSEED and skip ahead to Step 4.0.

*Steps 2.1 and 2.2 are optional, but highly recommended.

3.0 SUBMIT FOR PERMITS

3.1 Submit plans via BSEED's online portal for licensing, building and trade permits. Accela Citizen Access (ACA) is BSEED's online portal for plan submission. BSEED's eLAPS (online Licensing And Permits System) is accessed through the ACA portal (<https://aca3.accela.com/DETROIT/Default.aspx>).

If your project involves new construction of a building or parking lot rather than a retrofit of existing structures/parking lots, you will be required to submit plans to BSEED's Special Land Use/Zoning for site plan review.

If your project requires a conditional use permit, you will need to go through a separate permitting process, including a land use hearing, with BSEED (approximately 12 weeks and \$1160).

Design professional develops near-final drawings before moving on to Step 3

Applications must be submitted online, Plan Review no longer accepts paper plans for all commercial properties, sign permits, and temporary permits.

For details on registering for an Accela Citizen Access Account, visit BSEED's homepage (<https://detroitmi.gov/departments/buildings-safety-engineering-and-environmental-department>) provides a link to a "How to Create an Account" PDF (<https://detroitmi.gov/document/how-create-account>).

*Upon submission, plans are automatically sent to DWSD's SMG for simultaneous review.

***3.2 If tapping into sewer in ROW, apply for a sewer tap permit with DWSD and a ROW permit with DPW.**

4.0 REVIEW PERIOD

4.1 Receive comments or approval from BSEED and DWSD (5-20 day turnaround time.)

4.2 Design professional receives comments, makes changes, and resubmits through BSEED submission portal. This timeline will vary, dependent on the schedules of design professionals, and potentially, property owners. Design professionals typically are able to turn around a new plan within two weeks after receiving comments from BSEED and DWSD, but it may take longer. Check with your design professional for more details on their turnaround capacity and estimated timeline.

5.0 PERMIT APPROVAL

5.1 Contractor picks up and pays for approved permits. Once approved, your design professional will pay for the permits, while your contractor will be the one to collect the permits from BSEED.



SECTION 7: Hiring a Contractor

- ❑ Seek out qualified Landscape Contractors.
- ❑ Provide bid documents for quotes.
- ❑ Review bids and proposals.
- ❑ Select Landscape Contractor that is the best fit for your project.
- ❑ Develop and sign a contract.

When all of the design decisions are made, and you have final design documents in hand, it is time to hire a landscape contractor to install your project. DWSD has compiled a [list of contractors^A](#) that have completed a course on constructing and maintaining GSI projects.

As a reminder, DFC and DWSD do not endorse, certify or approve contractors or product vendors.



Crew backfilling with small tractor¹

INTERVIEWING LANDSCAPE CONTRACTORS

Important questions to ask potential installation contractors include:

- ❑ Are they licensed and insured in the State of Michigan and bonded to do work in the City of Detroit?
- ❑ Do they have any experience constructing GSI practices within the City of Detroit or elsewhere? Can they provide specific locations of previous projects to visit?
- ❑ Are any of the GSI practices they have constructed receiving drainage charge credits?
- ❑ Does their contract spell out who is responsible for any damage to existing buildings, structures, utilities, pavement, etc., during the course of construction due to construction activity?
- ❑ Will they provide a detailed quote for the work proposed?
- ❑ Will they apply for and pull permits for the work they are proposing?
- ❑ How will change orders, and any unforeseen site conditions or circumstances be handled? Will they request owner authorization before completing anything outside of their original scope of work? (They should.)
- ❑ Will they provide a list of any sub-contractors that will be working on the project?
- ❑ How long do they anticipate the project taking?
- ❑ Can they provide their standard contract for your review?
- ❑ Will they warranty their work and materials (plant materials or other)?

Both the design professional and the installation contractor require that the construction documents are accurate and communicate exactly what needs to be done. It is important that GSI sizing and calculations are accurate to obtain the highest credit possible. It is also important that the drawings are accurate so that it is very clear what the installation contractor is responsible to construct.

During construction, it is very common for the installation contractor to have questions regarding the plans, or to need clarification of field conditions while installing GSI practices. The design professional and the installation contractor should both budget time to communicate frequently to clear up any questions.

Typically, once the design professional has completed their construction documents, the plans and specifications can go out to installation contractors for bid. The installation contractors will look over the plans and specific instructions, and prepare a price to implement what is shown in the plans. This price is also called a "bid." It is recommended that the design professional develop what are called "bid documents." You will give this set of documents to the installation contractor so that they can prepare the most accurate price possible. The documents often include a list of all the items the contractor should be bidding on. However, sometimes they are set up so that the contractor can give one lump sum for all the work described in the construction documents. In both instances, it is the design professional's responsibility to include all the information needed for the contractor to develop a price.

After you receive and evaluate all bids, you can select an installation contractor for the construction stage. This process described above is called "design-bid-build."

Design-Bid Process

Another option is to contract with a design-build firm. This process is similar to the design-bid-build, except there isn't an official bidding process between multiple contractors. The design-build firm would still develop the design, calculations, and plans. But the bidding process would be eliminated because the design firm also has a construction division that can install what they design.

The property owner typically receives more accurate pricing (not necessarily lower) through the design-build process. This is because design and construction information can be easily shared between parties for accurate pricing. Design-bid-build could ultimately gain the property owner lower pricing because there are multiple contractors bidding on the job. But the trade-off is that there isn't the internal communication between the designers and contractors.



Prior to, and throughout the course of construction, it is important for you to identify what work the installation contractor is responsible to execute as a part of their contract. The contract documents – which include drawings, specifications, and the signed agreement – should all be very thorough and indicate the contractor's exact scope of work. Sometimes, something unexpected or unforeseen comes up during the course of construction, and the contractor needs to work outside of their agreed upon scope of work. This happens, and the best way to handle it is to ask the contractor for the estimated price to perform the additional work.

The proposal for additional work usually comes in the form of a change order. The contractor will use a form to describe the additional work and the fee to complete the additional work. As the property owner, you will discuss the change order with the contractor and make a decision regarding authorizing the contractor to perform the additional scope of work for additional money.

Because the original contract or agreement is specific to the work to be completed, there should be an understanding that no additional work outside of the original scope of work shall be performed without the owner's authorization. If the contractor is authorized to perform additional work, they should be paid for it. You should always ask questions regarding why the additional work is required, or if there are alternate solutions to the problem.

Section 7 Links

A. "Local Green Stormwater Infrastructure Contractors":
<https://detroitmi.gov/departments/water-and-sewerage-department/drainage-charge/nonresidential-drainage-credits#starterguides>

Section 7 Photo Sources

1. Image of crew backfilling with small tractor, Detroit Future City

SECTION 8: Construction

- ❑ Preconstruction: planning and meeting between property owner, design professional, and contractor.
- ❑ Site Preparation: clearing, tree protection, sedimentation and erosion controls, materials staging.
- ❑ Construction begins.
- ❑ Quality control inspections throughout key points of construction.
- ❑ Underground infrastructure and grading verification.
- ❑ Plant material installation.
- ❑ Site cleanup.
- ❑ Post-construction inspection(s) and documentation.

Below is a list of key steps to expect in a typical bioretention construction process, adapted from [The Chesapeake Stormwater Network's Bioretention Construction Sequence^A](#) and [Minnesota Stormwater Manual – Construction Specifications for Bioretention^B](#).

- ❑ The proposed site should be checked for underground utilities prior to any excavation. In addition to having MISS DIG inspect the site, it is recommended for your contractor to have a private utility locating service inspect for underground utilities.
- ❑ The design professional and the contractor should have a preconstruction meeting on site. They should double-check the boundaries of the managed impervious surface area and critical elevations of any inlets and overflow structure to ensure they conform to original design. The design professional should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the contractor and the plan review/inspection authority.



Downspout modified, trench drain installed¹



- ❑ A plan will need to be made regarding where any excavated soil or debris will be temporarily piled and/or transported to, as well as where any material inputs, such as gravel, sand, and soil mix will be placed during construction. The materials staging plan and sequencing timeline is especially important on tight urban sites where there is not a lot of extra room to store materials and move equipment and machinery around. Parking spaces or the public right-of-way may have to be used temporarily. If any material needs to be stored in the public right-of-way, a permit may need to be obtained from the Department of Public Works (DPW).
- ❑ The site will need to be cleared of any existing materials that the property owner wishes to salvage or relocate, such as brick pathways, raised garden beds, or plant material.
- ❑ The site will need to be staged for construction, including installation of barricades to protect the root zone of any trees that are to remain on site, or other sensitive areas from any damage or soil compaction, due to heavy machinery or materials storage.
- ❑ Temporary erosion and sediment controls are needed during construction to divert stormwater and sediments away from the bioretention area until it is completed, and also to ensure any inlets, outlets or catch basins do not get clogged with sediment during construction.
- ❑ Construction begins. It is highly recommended that prior to beginning the installation, sufficient material quantities are on site to complete the installation, and stabilize exposed soil areas without delay. It is highly recommended that excavation, soil placement, and rapid stabilization of perimeter slopes be completed before the next rainfall.



Materials staging²



Site clearing³



Erosion control⁴



Excavation from the side⁵



Basin bottom leveled⁶



Filter fabric installed, aggregate backfill⁷



Soil backfilling⁸

- ❑ Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area, which would compact the soil.
- ❑ The bottom basin should be level, grades and elevations confirmed. It may be necessary to loosen the bottom soils to a depth of six to twelve inches to promote greater infiltration into the native soil.
- ❑ While the retention basin is being constructed, additional erosion and sedimentation control measures should be taken to ensure that any inlets are blocked or diverted so water does not flow into the GSI practice during construction. Temporary fencing may need to be installed to prevent surface flow of water and sediment from entering the basin in the case of a storm. An ill-timed storm on an unprotected site could ruin the bioretention basin before it is fully constructed.
- ❑ Filter fabric may be installed on the sides of GSI practice, if specified.
- ❑ Aggregate or sand layer is backfilled. An underdrain and clean-out-pipes, if specified, will be installed. Slope on underdrain should be verified. Outlet control structures will be installed. Aggregate or sand layer will be backfilled to specified depth.
- ❑ Bioretention soil mix layer is installed. Should be verified first to ensure it meets specified standards. Should be added in 1-foot lifts, allow for 10% settlement, rake out to final ponding depth a few days later.



- ❑ Final surface elevations and grading should be verified.
- ❑ Erosion blanket should be installed, if specified. Mulch surface cover must be laid down to specified depth if planting is not happening within a couple weeks. Otherwise, prepare for planting.
- ❑ Planting locations should be staked or marked out following the planting plan. Plant material should be planted on a cool, cloudy day with low winds. Small holes can be cut into the erosion blanket at the planting location. Plant material should be watered immediately after planting and plant establishment care begins (see maintenance section for more detail).
- ❑ Any disturbed areas outside of the bioretention area should also be restored with plant material, likely grass seed and protective seed blanket or sod.
- ❑ Post-construction inspection performed. Contractor should correct any issues if needed.
- ❑ Plant establishment, and first season maintenance is performed, including regular plant watering and weeding, any plant replacement or reseeding necessary, removal of sedimentation at inlets, and any erosion repair.
- ❑ A final construction inspection should be performed six to twelve months after installation and after a decent rainstorm to evaluate functioning of the bioretention practice. If it is working well, any construction performance bonds or retainers can be released.



Prior to planting⁹



Plant layout¹⁰



Planting workday¹¹



Post planting¹²



Inspection Recommendations:

It is recommended that you include construction administration and quality control inspections to your design professional's scope of services. There are several points during the construction process where inspection is necessary to ensure proper installation. If inspections are not handled properly, it could result in failure of the bioretention area.

The following are key stages in the construction sequence that are important for review, according to the [Chesapeake Stormwater Network](#)^C.

- ❑ Verify the actual contributing drainage area (CDA) boundaries and that the CDA is adequately stabilized and/or secondary erosion control measures are installed around perimeter of bioretention or inlet blocked during installation.
- ❑ Confirm inlet and outlet elevations.
- ❑ Confirm inflow actually captures runoff.
- ❑ Check quality of filter media and that it meets specifications.
- ❑ Make sure stone is washed and not laden with grit and fines.
- ❑ Check underdrain elevations, slope, pipe connections, perforations, and caps.
- ❑ Confirm final ponding depth and proper grading and stabilization of side slopes.
- ❑ Conduct full inundation test to inspect underdrain/outflow function (sinking and final grades).



Section 8 Links

- A. "Chesapeake Stormwater Network Bioretention Construction Sequence Slideshow": <http://chesapeakestormwater.net/wp-content/uploads/downloads/2012/01/Session20520Bioretention20Construction20Sequence1.pdf>
- B. "Minnesota Stormwater Manual – Construction Specifications for Bioretention": https://stormwater.pca.state.mn.us/index.php?title=Construction_specifications_for_bioretention
- C. "Chesapeake Stormwater Network TECHNICAL BULLETIN No. 10 Bioretention Illustrated: A Visual Guide for Constructing, Inspecting, Maintaining and Verifying the Bioretention Practice Version 2.0 October 20, 2013": <http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/10/FINAL-VERSION-BIORETENTION-ILLUSTRATED-102113.pdf>

Section 8 Photo Sources

1. Downspout modified, trench drain installed, Hamp, Mathews & Associates
2. Materials staging, Detroit Future City
3. Site clearing, Hamp, Mathews & Associates
4. Erosion control practices, Clemson University, <http://www.clemson.edu/extension/cepsci/>
5. Excavation from the side, Hamp, Mathews & Associates
6. Basin bottom leveled, Hamp, Mathews & Associates
7. Filter fabric installed, aggregate backfill, Hamp, Mathews & Associates
8. Soil backfilling, Hamp, Mathews & Associates
9. Prior to planting, Hamp, Mathews & Associates
10. Plant layout, Southwest Detroit Business Association
11. Post planting, Southwest Detroit Business Association
12. Planting workday, Southwest Detroit Business Association



SECTION 9: Getting DWSD Credit Approval

- ❑ Let DWSD know when construction is finished. DWSD will schedule a time to inspect your project. Update drawings with any as-built changes required during construction.
- ❑ Once approved, DWSD will apply the drainage credit to property owner's account.

In order to be eligible for a drainage charge credit, the stormwater management practice must be approved by DWSD. To obtain a drainage charge credit, the property owner will need to meet eligibility requirements, apply for and receive an approval from DWSD, and fulfill ongoing operations and maintenance (O&M) requirements. The customer's name must be on the account.

Stormwater management practices must comply with the following measures to be eligible for a credit.

- ❑ Reduce annual runoff volume and/or control peak flow rate.
- ❑ Be documented in terms of design and performance in a manner acceptable to DWSD.
- ❑ Comply with all applicable City, County, State, and Federal construction, building, and stormwater codes and permits.
- ❑ Be fully installed and functioning properly.
- ❑ Not create a safety hazard or nuisance.
- ❑ Be located on a property that is geographically located within DWSD's Drainage Service Area.



In order to receive a credit towards the Drainage Charge, customers must submit the Drainage Charge Credit Application along with supporting documentation. Supporting documentation for a bioretention practice includes:

- ❑ Scaled site plan showing all parcels and surface features.
- ❑ ALTA Survey (optional).
- ❑ Roof drainage system defined (with drainage areas).
- ❑ Site drainage and sewer system defined (with drainage areas).
- ❑ Geotechnical investigation results, if applicable.
- ❑ Environmental history of site.
- ❑ Drainage areas to each practice defined.
- ❑ Practices defined - provide table for each practice indicating the: type of practice, practice area, volume, equivalent water depth (retention and detention zones), infiltration rate.
- ❑ Identification of proposed connections to DWSD Sewers, if applicable.
- ❑ Complete engineered drawings stamped by a registered Professional Engineer or Landscape Architect.
- ❑ Complete listing of permits applied for/expected.
- ❑ Photographs clearly showing existing practices.
- ❑ Maintenance Plan.

The effective date of the credit is either the date of the licensed design professional's certification of completion or the date of the credit application, whichever is later. Once approved, credit will be applied to the next billing cycle.



SECTION 10: Maintaining Your Project

- ❑ Water plants frequently after initial planting and regularly the first two years.
- ❑ Weed monthly during plant establishment.
- ❑ Inspect inlets, overflow connection, and basin after heavy rain events.
- ❑ Stabilize any erosion and remove sediment build-up, trash and debris.
- ❑ Replace plant material that does not survive.
- ❑ Apply mulch annually.
- ❑ Prune and cut back plant material as needed.
- ❑ Re-certify every three years to keep your credit!

Maintenance considerations are critical to any design. It is an often overlooked aspect of a project that can have real consequences if not anticipated and planned for. Lack of maintenance could result in lack of plant establishment or "die-off," erosion of the rain garden due to stormwater flow, slow infiltration rates into the soil, and invasive weeds or other species. Be sure to budget time and money to go towards the maintenance of your bioretention project.

There is no such thing as a "no maintenance" bioretention practice. Even if your rain garden plants are characterized as "low-maintenance," that only means they are low maintenance once they are established, which takes at least two full years after planting. Rain gardens are a collection of living plants in a living plant community, and they require maintenance to survive and function as intended. The rain garden cannot take care of or maintain itself.

It is important to have realistic expectations of the level of maintenance that you can provide. If you have limited time or financial resources for the installation and maintenance of the rain garden, work with your designer on the following recommendations.

Establishment Period Maintenance Recommendations:

- ❑ Is there a water source nearby? The closer, more convenient the water source is, the easier it will be to water it. The plants will need to be watered frequently during the first and second growing seasons to help them get their roots established in the soil. Water daily for the first few weeks after they are planted and then less frequently as time goes on and the plants show signs of growth. Check daily for the first few weeks to make sure the soil under the surface is still moist. Only water a particular area until the water starts to pool on the surface, then move on to the next area. Warmer seasons may require more water.
- ❑ You may choose to organize community workdays to help with planting and potentially save on labor costs, rather than having your landscape contractor do it. The best time to schedule a community planting for perennial plant material is in spring and fall, late April through early June, or early September through mid-October. However, if your landscape contractor does it, you may have to fit into their schedule outside of the ideal timeframes. They should give you maintenance guidelines for extra care that will need to be taken if plants are planted during the hot season or later in the fall.
- ❑ Removal of trash and debris that could reduce the infiltration of water.
- ❑ Replacing or stabilizing mulch that has moved due to erosion. Water flowing into the rain garden could cause the mulch to move and expose plant roots.
- ❑ Weeding should be performed monthly to keep the weeds from overtaking, and eventually choking out the desired plants. It is crucial that you pull weeds before they flower and set seed. Over time, the desired plants will establish themselves and the frequency of weeding can be reduced.
- ❑ Make sure that grass mowers capture the clippings. Clippings that land in the bioretention area may result in grass taking over the planting area.

Stages of Plant Establishment

Project photos provided by
InSite Design Studio



Four months after planting¹



Eighteen months after planting²



Three years after planting³

Semi-Annual Maintenance Recommendations:

- ❑ Inspect plants and vegetation to evaluate their health. Remove dead or dying plants.
- ❑ Replace dead plants as needed, following the ideal planting timeframes listed above. It is common for 10% of plants to die-off after the first season, but much more than that and your plants might not have been in good condition initially, or you may not have watered or maintained appropriately.
- ❑ Rain gardens should be inspected for sediment build-up that might get “caked up” or hardened on the surface, therefore impacting how fast the stormwater will drain down. Since the water eventually flows to the lowest point of the rain garden, and seeps into the soil there, the sediment build-up will occur in this area. Often, the solution is to scrape and remove the sediment build-up and re-mulch the area. Loosening the sediment or built-up soil will also help water infiltrate. Also inspect sediment build-up on inlets and any filter strips.
- ❑ Inspect stormwater in-flow points to make sure there is no evidence of erosion. A good time to do this is after a heavy rainfall. Re-establishing soil, plant material, and installing erosion control measures may be required. Placing large stones or “rip-rap” at the end of a drain pipe outflowing to the bioretention practice can help dissipate the energy of the flowing water and help prevent erosion.

Annual Maintenance Recommendations:

- ❑ Conduct a regular spring cleaning and inspection.
- ❑ Cut back and remove previous year's plant material that has died off to encourage new growth and minimize plant debris on floor of rain garden.
- ❑ Apply mulch to maintain a 3-inch layer.



Other Maintenance Recommendations:

- ❑ Consider if you have resources to perform maintenance on a daily, weekly, or monthly basis. Plants require a lot of TLC to help them get established and growing vigorously on their own.
- ❑ For a more complete guide to rain garden and bioretention practice maintenance, see the content from the “Minnesota Stormwater Manual” link in Section 8 Links.
- ❑ Many landscape maintenance contractors and ecologists offer maintenance services specifically related to rain garden plants and function. Consider hiring someone with experience in maintaining rain gardens if the maintenance or identification of the rain garden and its plants becomes too overwhelming to manage.

Ongoing, routine maintenance is required by DWSD. Because the GSI practice implemented on the property is a part of the DWSD stormwater management system, and the property owner is receiving credits for the volume of water that they are removing from the system on an annual basis, DWSD inspects the practices every three years to ensure they are functioning properly. If the GSI practice is not functioning as it is intended, the drainage charge credits will no longer be awarded until the practice is functional again. Since GSI practices require a significant investment up front on the behalf of the property owner, the goal of a diligent maintenance regime is to protect the owner's investment by establishing healthy, well-functioning rain gardens with plants that provide visual beauty and facilitate stormwater management through soil stabilization and improved stormwater infiltration.

Section 10 Photo Sources

1. Stages of Plant Establishment, Insite Design Studio, Inc.
2. Stages of Plant Establishment, Insite Design Studio, Inc.
3. Stages of Plant Establishment, Insite Design Studio, Inc.



Community Engagement

Any time you do work to a property it is best to talk to your neighbors before you begin the design process. Community acceptance is a common barrier to successful projects. The more that neighbors understand your project and are able to provide input, the more likely they will be to accept and support it. See the “Plants for Bioretention” and “Maintenance” sections for information on designing with [“cues for care”](#) and maintenance to increase community acceptance.

The Eastside Community Network (ECN)'s Neighborhoods First Engagement Model offers good advice on community engagement as you reach out:

Translate: Create a shared language that is accessible to everyone.

Educate: Welcome learning and open information sharing.

Facilitate: Nurture conversations and bring diverse perspectives together in safe spaces.

As ECN notes, *“Don't fly solo. Neighborhoods only change when neighbors get together and decide to talk, think, learn, and act collectively.”* If you work with your neighbors on your project, you might be more likely to convince them of the benefits of GSI, and they might even start a project, too.

For a project that is more public, even more community engagement and participation is important. As ECN notes, *“Invite different viewpoints into the discussion. Many brains and hearts will come up with better solutions.”* Listening to the needs of the community can lead to a better GSI practice that is also a community amenity or gathering place. In addition, the engagement process can help in determining what the maintenance plan will be for the project and may lead to volunteers who can help keep an eye on the project in the future. The more people involved, and the more relationships built, the more a sense of community can be a co-benefit of GSI.



Paying For Bioretention

Figuring out how to pay for bioretention or any GSI project on your property can be intimidating.

DWSD provides the following information on the typical costs of bioretention practices: *“The cost of a bioretention practice is dependent on the property’s soil type, size of the impervious area draining into the bioretention, amount of credit desired (i.e., size of the bioretention), and type of plants selected. Bioretention practices typically cost between \$15-\$45 per square foot.”*

The cost of bioretention is the responsibility of the property owner. You can build it into your capital improvement budget or you can seek support from the variety of programs created to encourage more GSI. These programs are growing and changing, so visit the websites below for the most up-to-date information.

As part of the Detroit Collaborative Design Center’s study on shared GSI practices, Zachary and Associates developed a detailed [Return on Investment Calculator^A](#), as well as [a study on potential financing and funding mechanisms for GSI practices^B](#). See these documents for more detailed information on estimating the short-term and long-term costs and benefits of GSI projects:

A. Return on Investment Calculator - <http://www.dcdc-udm.org/community/stormwater.html>

B. Potential Financing and Funding - <http://www.dcdc-udm.org/community/stormwater/GRBGSI-Report-Appendix5-040318..pdf>



Budgeting Guidelines

Preliminary DWSD Site Assessment	This is a free service through DWSD and will provide a preliminary assessment of site conditions, suggested GSI practices, and conceptual budgets.
Property Owner’s Time	Keep in mind that either you or a designated staff person or other contracted representative will have to devote time to be involved in the process. Activities may include: attending key meetings, making hiring decisions, providing feedback to the design professional and contractors, coordinating construction and maintenance activities, and more.
Design + Engineering (D+E) Fees	The design professional will have to perform site inventory and analysis. They will then create a conceptual design and continue to refine it. Depending on the complexity of your project, there may be multiple rounds of design revisions, especially as the design professional tries to design a solution that will give you the greatest return on investment. Finally, they will create a set of construction documents that can be put out to bid.
Soil Testing + Surveying Fees	If not included in D+E fees above. Early in the site inventory process, the design professional will determine if soil testing needs to be done, as well as the information that needs to be included in a site survey. If you are able to show through soil testing that your site has a high infiltration rate, you may be able to build a smaller bioretention practice and it may also increase drainage credits for your practice. See Section 5 on page 39.
Construction Costs	Your design professional should provide an “opinion of probable costs” for the project during the design process, which may need to be updated as the design changes. However, you won’t know the true construction costs until you get bids from contractors based on the construction documents. If the bids are much higher than anticipated, your design professional may have to make some design changes to bring down the estimated construction costs and put the revised design out to bid again.
Permitting Fees	Your contractor should specify if they are including permits in their construction quote or not. Permits needed and costs will vary depending on the project. See Section 6 on page 54.
Construction QA/QC	It is highly recommended that you include scope for your design professional to perform QA/QC (quality assurance and quality control) to provide oversight and inspections during the construction process to ensure everything is built according to the construction documentation, and to help troubleshoot any unexpected issues during construction.
Maintenance Costs	Maintenance during the establishment period (the first two years after installation) is especially crucial to ensure all the time, effort, and money that went into planning and construction is not lost. Following that, there will still be annual maintenance efforts and costs. Work with your design professional to determine a realistic maintenance plan with anticipated costs. You can save money if you do some of the maintenance yourself, but only if you actually have the skills and time to do it! See Section 10 on page 69 for more details.



Financing

A variety of financing tools have been assessed and compiled by the Detroit Collaborative Design Center here:

<http://www.dcdc-udm.org/community/stormwater/GRBGSI-Report-Appendix7-032718.pdf>

Michigan Saves

Michigan Saves is a nonprofit dedicated to making energy improvements easier for all Michigan energy consumers. To accomplish this, Michigan Saves operates as a green bank, making affordable financing and incentives available through grants and partnerships with private sector lenders and energy providers. Michigan Saves is piloting a Green Stormwater Infrastructure financing tool to help property owners pay for the upfront cost of installing GSI.

For more information, contact Todd O'Grady, Business Development Manager at: togrady@michigansaves.org or call (517) 331-9491.

PACE Financing with Lean & Green Michigan

Property Assessed Clean Energy program, or PACE, is an innovative financing tool focused on energy, water and renewable energy projects. PACE offers long-term financing for nonresidential property owners to pay for these types of projects, including GSI installations. If your project is approved, the PACE lender funds up to 100% of the cost for installing GSI practices on your property. Financing lasts up to 25 years with a fixed interest rate and is paid back through a special assessment on your taxes. PACE has funded numerous projects in Detroit and across Michigan.

For more information, visit <https://leanandgreenmi.com/index>, email info@leanandgreenmi.com or call (313) 444-1474.

Capital Improvements

If you are planning to do any capital improvements or renovations to your building, you can build GSI into your budget. Investments in your parking lot, roof, or landscaping can now include GSI-based designs that benefit the environment and, with DWSD approvals, may also improve your bottom line by providing you with a green credit on your water bill.

DWSD Capital Partnership Program

DWSD offers a Capital Improvement Matching Grant to nonresidential property owners to support GSI implementation. Up to 50% of design, installation, and capital costs of GSI can be covered with a maximum of \$50,000. Approximately \$5 million dollars is available each year.

Applications can be found on the website at: <https://www.detroitmi.gov/departments/waterand-sewerage-department/drainage-charge>

Grant Funding and Volunteer Support

Grants are sometimes available for community groups, churches, and nonprofits. In addition to checking with your local Community Development Organization, see the potential opportunities listed below:

Detroit Future City Grant:

DFC's Field Guide to Working with Lots program aims to accelerate vacant land revitalization in Detroit using the "Field Guide to Working with Lots". The program encourages



community groups, faith-based institutions, nonprofits, and businesses to install one of 38 lot designs to address stormwater concerns, activate community spaces and create more attractive neighborhoods. In 2018, five applicants were granted up to \$13,000 to implement field guide lot designs that improve stormwater management and qualify for stormwater drainage credits.

Visit www.dfc-lots.com or call (313) 259-4407 for more information.

Motor City Match and Re-Store:

Motor City Match connects new and expanding businesses with Detroit's real estate opportunities, providing them with funding and tools to fuel the city's entrepreneurial revolution. Motor City Re-Store is a City of Detroit program that provides competitive matching grants to improve storefronts and upgrade commercial corridors in Detroit's neighborhoods. Existing businesses are eligible to apply for matching funding to support the design and construction of exterior improvements, including landscaping and green stormwater infrastructure projects.

For more information, visit: <http://www.motorcitymatch.com/> and <http://www.motorcityre-store.com/>

National Fish and Wildlife Federation – Southeast Michigan Resilience Fund:

Grants for shovel-ready GSI projects ranging from \$50,000 - \$300,000 are available with \$1.2 million expected to be granted annually between 2019 and 2021. The fund supports GSI solutions that can reduce flooding and other threats associated with major storm events, while also creating safe, dynamic, and enjoyable public green spaces that improve habitat values for wildlife and quality of life for residents.

Application deadlines and details can be found at: <https://www.nfwf.org/semichigan/Pages/home.aspx>



National Fish and Wildlife Federation – Sustain our Great Lakes:

Grants are available for habitat and wetland restoration as well as Green Stormwater Infrastructure.

For more information, visit: <https://www.nfwf.org/greatlakes/Pages/home.aspx>

Rain Gardens to the Rescue:

The Sierra Club, Friends of the Rouge, and Keep Growing Detroit have teamed up to help install over 300 residential rain gardens with volunteer labor and sweat equity. If you are interested in a residential rain garden, please contact Friends of the Rouge at (734) 927-4900.

More information can be found at: <https://therouge.org/rain-gardens-to-the-rescue/>

Contact your local Community Development Organization (CDO):

Your local community organization may also have resources for beautification or place-making that includes GSI or bioretention specifically. For instance, Eastside Community Network made mini-grants of \$1,500-\$3,000 available to its Chandler Park neighbors, and Southwest Environmental Vision will help you install a rain garden if you're located in the Merritt Street Improvement Area.

To find your local organization, search Community Development Advocates of Detroit's d[COM]munity online map at: <http://104.131.88.185/>



Plants For Bioretention

Native, water-tolerant plants add beauty and native habitat for birds and insects, while also increasing the stormwater management capacity of your bioretention practice over time. As the plant roots grow and extend into the ground, they help to loosen compacted soil and increase the porosity, or ability of water to flow through it. The higher the soil porosity, the faster the water will drain. Specialized rain garden plants like these will also help to remove pollutants from stormwater runoff. Typically, contaminants and pollutants that the stormwater carries infiltrate down into the soil, and eventually into the groundwater. Rain garden plants are helpful in greatly reducing the pollutants in the stormwater by absorbing them into their roots.

Work with your design professional to develop a planting plan for your bioretention practice(s). Although the end-goal is clear and achievable, there are some factors that need to be considered. Designers will be able to make overall recommendations, advise on aesthetics and maintenance requirements, and help select the correct plants for your situation.

A bioretention practice can be visually very similar to most perennial gardens. But, because it is located and shaped in a way to capture and hold water, the plant selection considerations need to be a little different than that of an average garden. Plants should be selected that can handle periodic inundation of water, or temporary flooding, and still survive. Plants located at the bottom, or basin, of the practice will need special consideration as they are likely to spend more time partially underwater and/or in saturated soils. Plants that are planted on the downward slopes of the practice won't be flooded with water as often, or for as long and can be selected accordingly. Exposure to sun and shade, and the eventual mature sizes of the selected plants should also be considered when developing a planting list. A discussion with the design professional to assure that all site conditions are studied, and specific plant characteristics are considered (size, bloom time, color, growth rate, aesthetics, etc.) should happen early in the design process.

Washtenaw County's Water Resources Commissioner website has some great resources on rain garden design, including an extensive list of rain garden plants: <https://www.washtenaw.org/DocumentCenter/View/1993/Rain-Garden-Plants-by-Sun-PDF>

PERENNIALS



False Indigo *Baptisia australis*¹



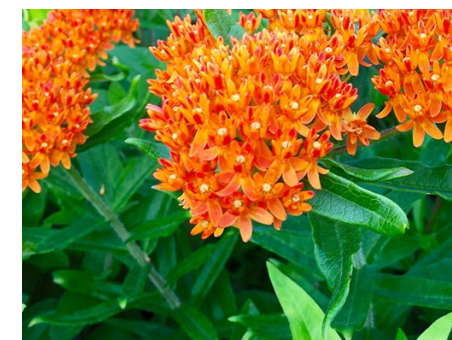
Rigid Goldenrod *Solidago rigida*²



Culver's Root *Veronicastrum virginicum*³



Blue Lobelia *Lobelia siphilitica*⁴



Butterfly Weed *Asclepias tuberosa*⁵



Blazing Star *Liatris spicata*⁶



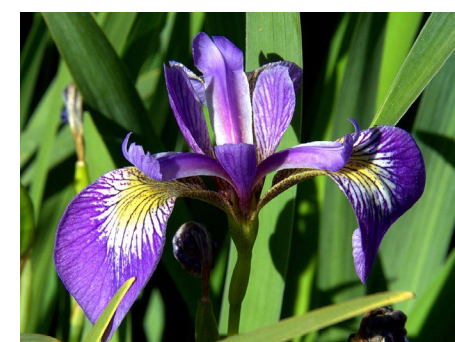
Common Cinquefoil *Potentilla simplex*⁷



Wild Geranium *Geranium maculatum*⁸



Canadian Anemone *Anemone canadensis*⁹



Blue Flag Iris *Iris virginica*¹⁰



Sensitive Fern *Onoclea sensibilis*¹¹



Common Fox Sedge *Carex stipata*¹²

SOME OF OUR
FAVORITE PLANTS!



New England Aster *Symphytotrichum novae-angliae*¹³



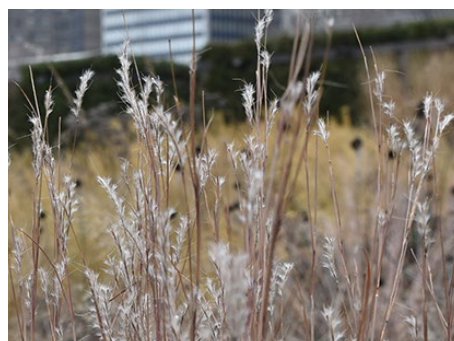
Black-eyed Susan *Rudbeckia fulgida 'Goldsturm'*¹⁴



Rattlesnake Master *Eryngium yuccifolium*¹⁵



Prairie Dropseed *Sporobolus heterolepis*¹⁶



Little Bluestem *Schizachyrium scoparium*¹⁷

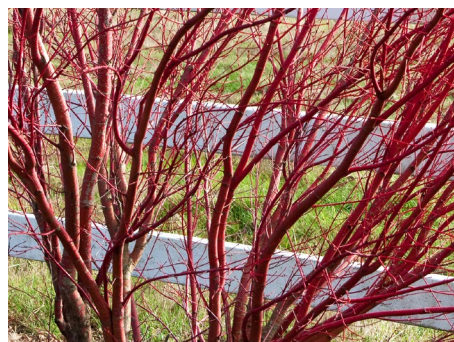


Shenandoah Switch Grass *Panicum virgatum 'Shenandoah'*¹⁸

SHRUBS AND TREES



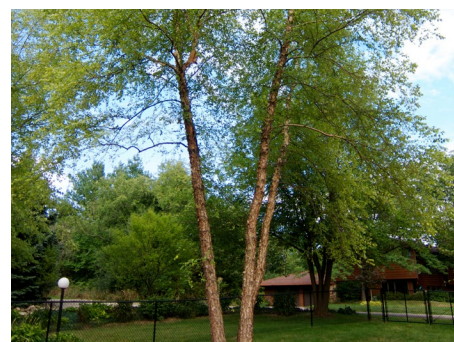
Ninebark *Physcarpus opulifolius*¹⁹



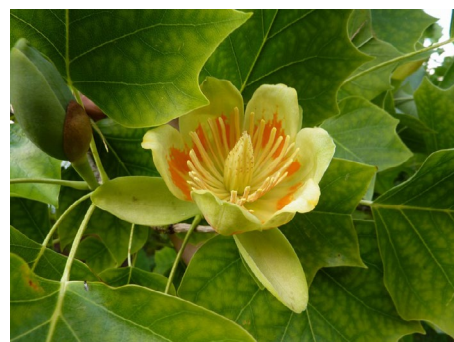
Red Twig Dogwood *Cornus sericea*²⁰



Gro Low Fragrant Sumac *Rhus aromatica 'Gro Low'*²¹



River Birch *Betula nigra*²²



Tulip Tree *Liriodendron tulipifera*²³



Swamp White Oak *Quercus bicolor*²⁴



Designing with Maintenance in Mind



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Although this mixed planting has a naturalistic meadow-like charm, it will be much harder to identify weeds and may not be appropriate for some urban settings.

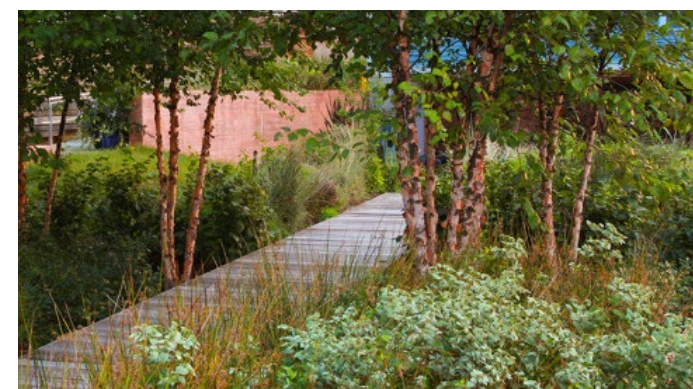
As referenced above, another aspect of the planting design that is very important, and should not be overlooked, is the initial and ongoing maintenance of the bioretention practice or rain garden. Talk with your design professional about your capacity and desired level of maintenance before they begin the planting design. They will be able to make planting design recommendations that align with your capacity and ability to perform ongoing maintenance. Consider planting numerous plants of the same species together for easier identification of plants and weeds, and keeping the quantity of plant varieties on the small side so it doesn't become overwhelming. Consider planting woody plants, such as trees and shrubs in your bioretention practice which tend to have more longevity than perennial plants, and also add aesthetic variety and structure. Also make sure that your bioretention practice has a defined edge, that will help with keeping unwanted weeds and lawnmowers out.



Clustering of plants²⁶



Clearly defined edge²⁷



Use of trees and shrubs²⁸



Use of trees and shrubs²⁹

Plant Sizing

Rain garden plants come in a variety of species and are sold in a wide range of sizes. Typically, the larger the plant container is, the older the plant is, and the more expensive it is. There are a few things to consider when working with a design professional or contractor to select the size of the plants that will be installed:

- ❑ How do you want the rain garden to look immediately after planting?
- ❑ What are the resources available to maintain the rain garden once it is installed?

When considering what plants to purchase, compare them by price and size. See the next few pages for a general comparison of factors related to plant size selection.



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Seed

Plants are sown and grown from seed.

Considerations

- ❑ Least expensive option, but most labor intensive.
- ❑ Will not be fully grown for a number of years.
- ❑ Requires a lot of watering and weeding to help plants get established.
- ❑ Weeds tend to take over if not weeded out before plants get established.
- ❑ Erosion, or movement of seed due to rainfall and stormwater flow is also a concern.
- ❑ Erosion control measures such as straw mulch blankets, or hydroseeding are recommended.
- ❑ Most mixes contain anywhere between 15 - 25 plant varieties in seed form, however it is possible to get single varieties of seed.
- ❑ Rain garden plant seeds are mixed in with temporary cover seeds such as annual rye or common oat.
- ❑ Temporary cover crop will grow in quickly and help stabilize the soil and also help keep weeds at bay while the native seeds germinate and establish themselves.

Typical Cost

- ❑ Seed is sold by the total area that needs to be seeded.
- ❑ Customer will receive a certain weight based on the total acres.
- ❑ Each seed mix has a prescribed application rate in pounds per acre.
- ❑ Most seed is sold only wholesale to contractors.
- ❑ Wholesale cost depends on the seed mix, but an acre of seed mix can range from \$600 - \$1,200, not including the labor to sow the seed.



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Plugs

Small plants that are grown in flats, typically only a few inches tall and their root system is not substantial.

Considerations

- ❑ Available in flats of 24 - 48 plants at a reasonable price.
- ❑ Require more effort to plant but are more established than seed.
- ❑ Are still susceptible to die-off if regular maintenance is not performed.
- ❑ Visually, the rain garden will look very sparse and will not look established for a few years until plants grow to full size.
- ❑ Is a cost-effective option if the property owner doesn't mind a few years of smaller plants, and a visually sparse rain garden before the plants grow together to form a dense stand of perennials.

Typical Cost

- ❑ Large flat consisting of 48 cells costs approximately \$50 - \$60 wholesale, not including labor to plant.
- ❑ Retail pricing for the flats costs approximately twice the wholesale price.



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Potted Perennials

Grown in containers that are typically 1 - 2 gallons in size.

Considerations

- ❑ More expensive than seeds or plugs, but with the least amount of on-going maintenance to get plants established.
- ❑ Rain garden will look good when plants are installed and will take 1 - 2 years to fill in.
- ❑ Because plants are more mature and larger, fewer plants will be needed.

Typical cost

- ❑ 1-gallon containers cost anywhere between \$5 - \$15 wholesale.
- ❑ Certain specialty plants can be hard to procure and more expensive.
- ❑ A safe estimate of a retail cost at a nursery would be approximately 2 - 2.5 times the wholesale cost.



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Plant Photo Sources

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2. Rigid Goldenrod Solidago rigida, Prairie Moon Nursery, <https://www.prairiemoon.com/solidago-rigida-stiff-goldenrod-prairie-moon-nursery.html>
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14. Black-eyed Susan Rudbeckia fulgida 'Goldsturm' Flickr User F.D. Richards, <https://flic.kr/p/WS7qYE>
15. Rattlesnake Master Eryngium yuccifolium, Flickr User Frank Mayfield, <https://flic.kr/p/61hrhP>
16. Prairie Dropseed Sporobolus heterolepis, Missouri Botanical Garden, <https://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=f680>



17. Little Bluestem Schizachyrium scoparium, Lurie Garden, <https://www.lurigarden.org/plants/little-bluestem-2/>
18. Shenandoah Switch Grass Panicum virgatum 'Shenandoah', Wikimedia, [https://commons.wikimedia.org/wiki/File:Panicum_virgatum_Shenandoah_-_Flickr_-_peganum_\(2\).jpg](https://commons.wikimedia.org/wiki/File:Panicum_virgatum_Shenandoah_-_Flickr_-_peganum_(2).jpg)
19. Ninebark Physocarpus opulifolius, Missouri Botanical Garden, <https://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=286432&isprofile=1&basic=ninebark>
20. Red Twig Dogwood Cornus sericea, Flickr User Shelia Sund, <https://flic.kr/p/dGmqno>
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Notes:



For more information or for help with your project, contact
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Land + Water WORKS Coalition webpage:

<https://detroitfuturecity.com/our-programs/land-water-works-coalition/>



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