GREEN INFRASTRUCTURE MAINTENANCE ANALYSIS & LESSONS LEARNED FOR MUNICIPALITIES

Project ID: G98007P24

Prepared for:
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MARCH 2020

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EXECUTIVE SUMMARY

As the number of green infrastructure (GI) strategies and installations is growing, so have the topics surrounding their maintenance. Failed design, construction, and maintenance are all common experiences that cause people to hesitate about trying anything new or out of the typical "engineer's toolbox," and this is no different when it comes to GI. These types of failures or hurdles can also be the stepping-stones that lead to success. The goal of this project is to use experiences and realities to guide the practice of maintenance. There is, and will continue to be, an increase in GI strategies, therefore the understanding of maintenance requirements, specifically as it relates to municipalities, needs to increase as well.

Goals of Project & Report

Municipalities and other governmental agencies have encountered various barriers and successes regarding maintenance of GI through different project phases including planning, budgeting, design, construction, and post-construction. The goal of this report is to illuminate these barriers and successes, summarize the lessons learned, and ultimately prescribe recommendations regarding maintenance needs to both municipalities and the Milwaukee Metropolitan Sewerage District (MMSD).

Throughout the interviews, various lessons were discovered by all municipalities. Each interview provided new pieces of information which included efficiencies, good tracking measures or approaches towards maintenance, funding sources, existing maintenance partnerships, and unsuccessful stories, or stories that help shape future improvements. These findings are outlined in detail in the Case Studies section of the report.

Recommendations

This report contains two sets of recommendations: both to municipalities or governmental agencies, and to MMSD. Recommendations to municipalities include:

- Tracking. Begin tracking the locations and types of GI as well as their associated maintenance frequency.
- Design. Encourage municipal and consultant design staff to "design with maintenance in mind." Each municipality or agency has a preferred or accepted aesthetic that works in their community as well as a gauge on what they have the capacity to maintain. This should be considered throughout all installations beginning in the design phase. MMSD has developed a Planting Selection Tool and Standard GI Plans and Specifications for this purpose that are available at http://www.freshcoastguardians.com/resources/sizing-your-project.

Recommendations for MMSD include:

- Focus on additional training and education sessions. This includes training specific to various levels and audiences, including private property owners, consultants (engineers, landscape architects, planners, etc.), landscape/maintenance staff, and municipal designers/ reviewers.
- Promote Green Vendor List. The Green Vendor list is useful to municipalities or agencies when they're looking for maintenance assistance, but it could also be beneficial to promote this to

other landscapers who could see this as a business growth opportunity for those who do not consider themselves "green" yet. Municipalities work with traditional landscapers on both public and private property, and specific training or promotion could be directed at them to become "green" certified.

- Promote the use of the MMSD tools, including the Planting Selection Tool and Standard GI Plans and Specifications, and solicit improvements to them as needed.

Thank you to all the various municipalities and agencies that participated in the survey and interviews, specifically the Village of Bayside, Village of Brown Deer, City of Cudahy, Village of Fox Point, City of Franklin, City of Glendale, Village of Greendale, City of Greenfield, Village of Hales Corners, City of Mequon, City of Milwaukee, Milwaukee County, City of Muskego, City of Oak Creek, Village of River Hills, Village of Shorewood, City of St. Francis, City of Wauwatosa, City of West Allis, Village of West Milwaukee, Village of Whitefish Bay, and the University of Wisconsin-Milwaukee. Your input has not only helped formulate this report, but also exposed the challenges you have experienced to guide the subsequent recommendations of this report. Every response, interview, and conversation provided new and different perspectives that we hope can be used toward future successes!

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INTRODUCTION AND BACKGROUND

The project team led by Stormwater Solutions Engineering, LLC was contracted by the Milwaukee Metropolitan Sewerage District (MMSD) under project number G98007P24, Green Infrastructure Maintenance Analysis and Lessons Learned for Municipalities, to interview local governmental staff, develop a green infrastructure lessons learned document, and identify current maintenance needs and issues. The team was joined by Ruekert & Mielke, Inc., Waterstone Engineering from New Hampshire, and Birchline Planning in Vermont. This document is intended to improve decision making through illuminating potential barriers to green infrastructure success and project efficiencies. The other component of this project is to develop GI operation and maintenance (O&M) standards.

Green Infrastructure (GI) strategies are an important component used to manage stormwater runoff, particularly to meet MMSD's 2035 Vision for zero basement backups, zero overflows, and improved water quality. However, some communities are reluctant to implement GI based upon their perceptions about its long-term effectiveness and cost. This study compiles experiences, solutions, perceptions, and questions about GI maintenance for municipalities, MMSD, and other partners to better understand municipal needs regarding routine and long-term maintenance of GI strategies to better ensure the successful implementation of future GI strategies.

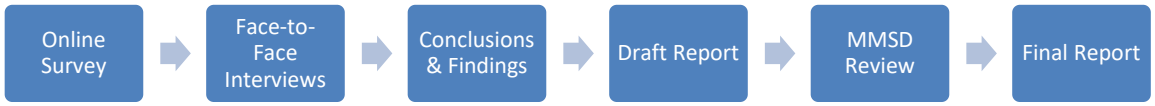
Ensuring the seasonal and long-term functionality of GI strategies is essential. This includes strategies constructed by municipalities on municipal property or constructed and paid for by a private property owners or developers that becomes the responsibility of the municipality. Different types of GI strategies require different, although sometimes similar, regular and occasional maintenance. GI strategies need to be recognized for their function and maintained as an extension of the storm sewer system. Standing alone or paired with traditional grey infrastructure, these strategies can provide multiple benefits including flood reduction, improved water quality, increased habitat, and other triple-bottom-line (economic, social, and environmental) benefits.

APPROACH

To begin the study, a list of maintenance-related questions was developed by the project team and MMSD. These questions were then sorted into a set of questions that would be distributed via survey, and a set that were to be used in follow-up interviews. The survey set (Attachment D) was compiled and digitally distributed to 24 different local governmental units, which included the 20 municipalities that received Green Solutions funding, three separate Milwaukee County agencies, and the University of Wisconsin-Milwaukee.

The survey questions were mostly multiple choice and focused around general GI maintenance. They also uncovered what types of GI are most frequently installed, the level they are being maintained, and whether agencies have the correct equipment, personnel, and/or training to maintain these features.

Face-to-face interviews were scheduled after an agency responded to the survey, occasionally scheduling some interviews without a survey response. The survey questions were developed to not only set the framework for the project, but also to guide the in-person interviews and conversations. Most interviews were scheduled in groups of two to three, with the intent of generating conversations and sharing experiences. The group interviews were comprised of municipalities or agencies that were either in similar geographic locations, are involved in other group agreements (i.e., permit groups), or have similar size or development patterns. The face-to-face questions were developed to build on the questions asked in the survey, but given the nature of conversations, the directions or outcomes of the questions varied dramatically between the interviews.



ANALYSIS OF SURVEY RESULTS

Out of the 24 surveyed local governmental units, 20 responded, which is not directly equivalent to the number of interviewees, as some agencies were interviewed without responding to the survey. Survey respondents are listed in Attachment E.

Types of Green Infrastructure

As shown in Figure 1, the most common types of GI installed in communities are: permeable/porous pavement, rain gardens, bioswales, and native landscaping (note that many communities use more than one GI strategy). The strategies they use correlate to the necessary equipment municipalities or agencies have to maintain these strategies. These four types of strategies account for 71% of the GI located within communities. The use of these four strategies correlates to what is seen in the region, as these strategies tend to be the most familiar and therefore more frequently funded and installed. They can be more easily incorporated into urban design to achieve larger capacity goals. The footprint of these strategies also fits well into retrofits of standard municipal-owned property, such as permeable pavers for parking lots or parking lanes, bioswales in medians, rain gardens at downspouts, and native landscaping in the these "green" strategies, or in place of other standard landscaping. Considering this is coming from a municipal or government agency viewpoint, it is expected that strategies such as rain barrels would be less prevalent, as those are typically used on residential installations. Green roofs are generally less common because of the initial cost of installation, and design for roof capacity. Constructed wetlands are also less common, especially in urban settings, because of the footprint needed to install.

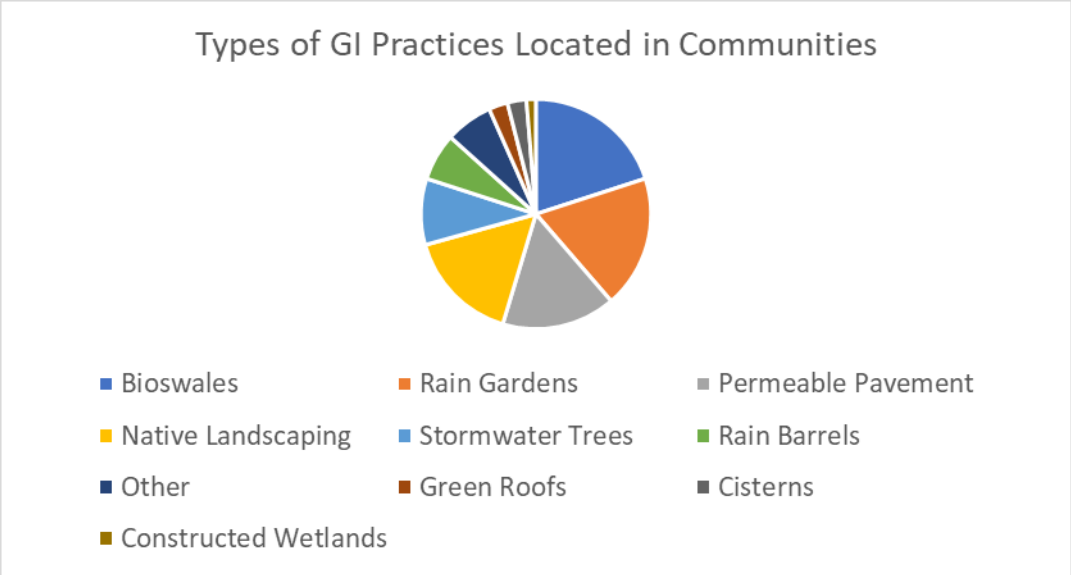


Figure 1. Types of GI practices located in communities

Additional strategies noted that were installed, but not included in the list of GI (listed as Other in Figure 1), were wet and dry detention ponds, floating islands, subsurface infiltrations, and StormGUARDens™.

Equipment

As previously mentioned, the most common types of GI strategies installed correlate to the necessary equipment the municipalities or agencies must have to maintain those specific strategies. All municipalities or agencies stated that they have standard landscaping equipment, including shovels, garden rakes, wheelbarrows, skid loaders, hand tools, lawn mowers, pickup trucks, etc., to complete landscaping-related activities. This is likely why GI strategies such as bioswales, rain gardens, and native landscaping appeared under "having the necessary equipment to maintain." Of the 12 agencies that marked having permeable or porous pavement located within their community, eight agencies (67%) noted they have the necessary equipment to maintain it. This included street and vacuum sweepers, regenerative air sweepers, hydrovacs, and plows with rubber or nylon blades.

The maintenance issues that arise from the landscaped GI features, such as bioswales, rain gardens, and native landscaping, are not related to lack of equipment, but more the training or expertise on specific plantings. Sometimes planting plans can be too complicated for staff to maintain, not related to a lack of expertise but rather because of over-zealous or over-complicated designs.

Figure 2. Elgin® Megawind® can be used for general street sweeping, leaf removal, catch basin cleaning, and permeable paver sweeping/vacuuming

Expertise and Training

There is a strong correlation between the types of GI installed in communities and the equipment and expertise available to maintain them, as shown in Figure 3. Several communities said that more training is needed for identification of plant materials, mostly for bioswales, rain gardens, and native plants. Stormwater trees were listed less than expected as a type of GI strategy installed in communities. Those who noted having stormwater trees as a type of GI strategy in their community also indicated they had both the equipment and knowledge/expertise to maintain them, likely because stormwater trees are viewed less as a type of GI, and more as a part of standard landscaping.

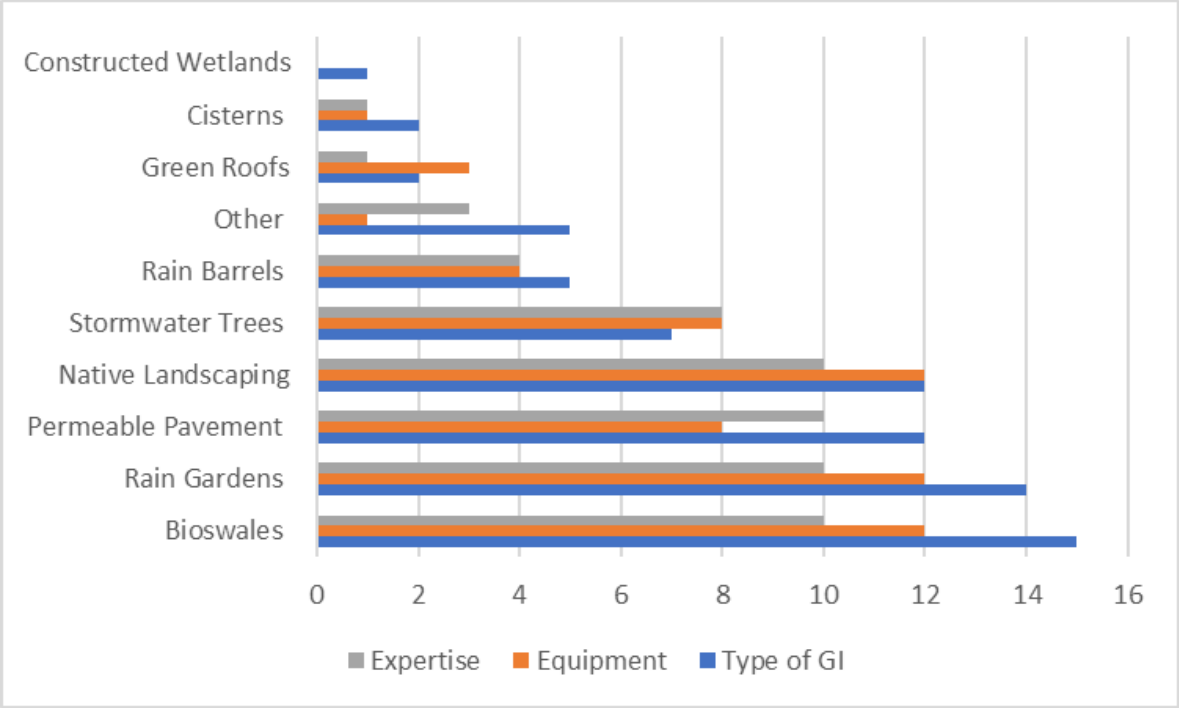


Figure 3. The expertise and equipment the agencies have to maintain each type of GI

Out of the 20 respondents, 70% indicated that they would be interested in both a GI maintenance training workshop or course, and a training manual. The follow-up interviews indicated that this percentage may be higher, especially as it relates to training on multiple levels. Forty-five percent indicated they would find assistance with contracting out the maintenance activities helpful. This included resources such as technical specifications, performance standards, levels of service, contract documents, bidding, and inspection.

Additional green infrastructure maintenance training, support, and resources would be widely accepted by municipalities and agencies.

SUMMARY OF INTERVIEWS

Twenty out of the 24 surveyed governmental units participated in in-person interviews (listed in Attachment C).

Prior to interviews, the responses to the survey were reviewed and used to guide the conversations. Along with the survey questions, a list of face-to-face questions was also developed and covered during the interviews.

Face-to-Face Questions:

- Do you have an inventory of the green infrastructure strategies located within your community? If so, how are you tracking?
- What types of maintenance and inspection are you performing and how frequently? Are you tracking how and/or when strategies are being maintained?
- Do you have the appropriate equipment to maintain these facilities, if not what do you need?
- Do you have the staff capacity to maintain these facilities? Does your staff have the proper training, knowledge or skill to maintain these facilities?
- How is maintenance being planned for, both current and future?
- Do you expect more green infrastructure opportunities in the future (i.e. redevelopments, alleys, streets, etc.)?
- Are you interested in a regional maintenance entity, or other maintenance cooperative (outside or inter-municipal)?
    - Includes, but is not limited to, on-call services, regular maintenance and inspection, shared staff personnel and/or equipment, etc.
- Are there any other items you would like to see developed? I.e. standards, guidance, training, etc.

Drivers for Installing and Maintaining Green Infrastructure

The installations and subsequent maintenance of GI strategies aid the communities in meeting multiple goals, including flood risk reduction, improved water quality meeting MS4 permit requirements, and other co-benefits including habitat re-establishment and triple-bottom-line benefits. Financial or regulatory drivers are usually the main reasons for installing GI, but these installations also allow communities to meet other goals and benefits, making it more appealing to install these strategies.

Financial Drivers

Green Solutions

A common theme driving installation of new GI strategies is MMSD's Green Solutions Program. The funds in this program are dedicated solely to GI improvements (including de-paving if another form of GI is installed in its place) and is the primary reason many new GI strategies are being installed in these municipalities. Without this funding, the number of new GI installations on municipal-owned properties may significantly decrease in many municipalities.

Regulatory Drivers

MS4 Permit

All the municipalities interviewed during this project are included in the Wisconsin Department of Natural Resources' WPDES Municipal Separate Storm Sewer System (MS4) storm water permit program, which includes several permit requirements that could be met through GI installation and maintenance activities.

The MS4 permits require municipalities to operate a post-construction stormwater permitting program that requires stormwater quality controls to be constructed for new and redevelopment projects over a minimum threshold. These strategies are required to be inspected and maintained by the private property owner, with documentation provided to the municipality. A lack of inspections or maintenance results in the municipality conducting this work with the option of charging back the private property owner. In some cases, the municipalities have found it easier or more efficient to conduct the inspections and provide those inspections and the needed maintenance activities to the private property owner.

In addition, the MS4 permit has distinct requirements for the municipalities to inspect and maintain publicly-owned stormwater facilities, including GI strategies used to improve water quality, as well as ensuring inspections and maintenance of privately-owned facilities are also being completed. An inventory of the public and private stormwater facilities is required through the recently re-issued MS4 permits in 2019 and is anticipated to be a standard permit requirement for the MS4 permits yet to be reissued in late 2019 and 2020.

TMDLs

The MS4 permits also require EPA-approved Total Maximum Daily Load (TMDL) studies to be implemented. The MS4 permitted municipalities that are located within the boundaries of the Milwaukee River Basin TMDL have total suspended solids (TSS), phosphorus, and bacteria reductions to meet over the course of multiple five-year permit terms. The MS4 permit requirements for the TMDL require specific mapping, modeling, and planning tasks. GI strategies are included in the alternatives that may help meet TMDL load reduction goals. Due to the relatively recent nature of the TMDL approval (EPA approved the Milwaukee River basin TMDL in March 2018), the municipalities are currently in the analysis and planning stages of TMDL implementation. Construction of additional stormwater control (including GI) facilities is not anticipated to significantly increase until a few years after the planning process has been completed. At that time, it is expected, and will be required in the MS4 permit, that any new GI strategies will be maintained on a routine basis, with occasional maintenance efforts such as sediment removal and/or filter media replacement occurring after the strategy has stopped performing as designed.

MMSD Chapter 13

MMSD's updated Chapter 13 updated regulations require GI on any new impervious surface of between 5,000 square feet to one-half acre. These regulations were discussed by a few municipal representatives as drivers for GI strategies on private developments, but this was not the primary driver for publicly-owned GI projects. However, the maintenance requirements for GI strategies installed on private property as part of the Chapter 13 permitting process ultimately add strategies and potential inspection and maintenance responsibilities to the list of GI strategies the municipalities are responsible for.

Inventory and Tracking System for Strategy Maintenance

Prior to the use of GI, communities were required to use stormwater management practices to meet local and MMSD stormwater peak runoff rates, volumes, and water quality rules for new and redevelopment projects, and to meet the MS4 permit requirements. Some communities developed tools to map locations and manage maintenance and inspection frequencies on the stormwater management practices for DNR MS4 reporting. These tools have been easily retrofitted to include GI tracking. The GI and other stormwater facilities are being tracked on a community-to-community basis. An overall watershed or region-wide inventory and maintenance tracking system does not exist for GI and other stormwater practices. This is primarily because a single regional entity to manage stormwater and/or GI such as a watershed district, consortium, or service area does not currently exist. In addition, the municipalities in the MMSD service area are permitted through the Wisconsin Department of Natural Resources (WDNR) Municipal Separate Sewer System (MS4) Permit program, which requires the municipalities to track and report on the stormwater facilities within their own boundaries. This has led to several different systems or methods being utilized by the different municipalities including spreadsheets, databases, geographic information systems (GIS), maps, traditional paper filing systems, and other creative solutions that meet the needs of the individual municipality.

The municipalities that use GIS inventory to track inspections and maintenance activities appear to have the most complete understanding of the GI strategies and the stormwater system as a whole. The addition of a spreadsheet or database to record communications, letters, inspection reports, the status of needed maintenance activities and more, helps consolidate the information and organizes the individual strategy information for multiple staff to view and use long-term. A visual inventory of the strategies along with up-to-date records allow changes in personnel or responsibilities related to GI and stormwater facilities to share information easily with less chance of tasks and records slipping through the cracks.

Other tools, including spreadsheets, development of standard letters and notifications, mail-merge tools, calendar notifications, and filing systems, provide organized approaches to operating the GI and other stormwater facility inspection and maintenance programs. Training on the technical and communication aspects of these systems and processes is key to an efficient and accurate system. Depending on the number of existing and potential strategies to be installed, these systems may be sufficient or there may be improvements that will streamline and simplify the administration component of GI maintenance.

The GIS and/or other tracking systems require dedicated staff time to complete and operate these systems. A universal concern among the municipalities interviewed for this project was the lack of staff time available to complete GI related work. To maintain accurate records on the inspection and maintenance of the GI strategies, staff need dedicated time to complete this work. With the ever-increasing number of stormwater and specifically GI strategies, both public and private, the amount of maintenance-related activities is also increasing. However, the staff time and department budgets do not see a correlated increase. This puts the GI tasks in competition with other traditional public works activities and budget items, with the traditional programs typically outweighing the more unfamiliar and newer GI work. The development of the framework for a tracking/maintenance system, with processes clearly documented, can allow for a summer intern or seasonal staff to perform updates, produce inspection notices, and inspect strategies to keep municipal costs to a minimum without requiring much competition from traditional public works activities.

Resource Needs for Strategy Maintenance

The most common maintenance-related issues were less about equipment and expertise, but more about time and subsequently, money. Many municipalities have found creative ways to handle maintenance responsibilities, but there is a concern that additional strategies will spread the existing resources too thin. Municipal budgets are constrained as it is, and the addition of new responsibilities and/or new strategies to maintain GI is a concern to department leaders. They have limited staff and limited hours to complete the variety of municipal activities that are required of them.

Sharing Resources for Strategy Maintenance

The cost of equipment and staffing, and the lack of staff time to complete inspection and maintenance activities on ever-increasing numbers of GI strategies, in addition to existing workloads, makes the concept of shared resources appealing to many municipalities. Areas of GI maintenance that could potentially be shared include:

- Specialized equipment to maintain facilities
- Seasonal staff to complete inspection and maintenance activities
- Trained interns to complete inspection and maintenance activities
- Contracts to complete maintenance work on GI strategies in multiple municipalities

Municipal staff had mixed opinions on the actual structure to implement a shared resources approach. Some municipalities have existing informal agreements that could be expanded to include GI maintenance activities. The Menomonee River Watershed Permits Group and the North Shore Group are examples of municipalities that are already grouped together and covered under the associated group MS4 permits; these groups may be a natural driver for municipalities to work together to complete the required inspection, maintenance, and reporting activities in a cost-effective and efficient manner. Other partnerships between smaller groups or municipalities exist for borrowed equipment, emergency management assistance, combined staff outreach and training sessions, and more.

The issue of how to coordinate or manage activities within a group of municipalities was raised as a concern among some municipal representatives. New efforts to combine resources may lead to new contracts, bids, staffing, scheduling, budgeting, inter-municipal agreements and explanations to elected officials and decision makers on why these new efforts are being done and why staff should spend time on these efforts. Municipalities already run tight budgets with existing staff dedicated to current workloads. Finding staff time and fair and equitable measures to implement a shared resource program may be a hurdle for some municipalities.

Many municipalities suggested having a third party organize and operate a shared resource program, so long as the municipality maintains the right to “opt-in or opt-out” of the program. Ideas for this included:

- Having MMSD run a program that ensures the inspections and maintenance activities are being completed across the MMSD service area or at least for the municipalities that are a part of the Green Solutions program.
- Having a non-profit organization operate a regional GI inspection and maintenance program.
    - A local non-profit has a model in place to meet the information and education portion of the MS4 permits for many municipalities, with a fee based upon population size.

- Having a regional entity such as a watershed district, a stormwater utility, or other consortium of municipalities operate a regional inspection and maintenance program.

Many municipalities suggested having a third party organize and operate a shared resource program.

Desired or Needed Trainings

The majority of municipalities interviewed expressed a need for additional information and outreach efforts addressing GI strategies in general, as well as more specific information related to maintenance of these strategies. There is a basic lack of understanding about what GI strategies are and why/how they function. A broader understanding of these structures would provide more support for municipal staff in charge of funding and maintaining them on a regular and occasional basis.

The municipal respondents identified the following target audiences for increased education and information regarding GI:

- General Public
- Elected and Public Officials
- Municipal Staff responsible for maintaining these strategies
- Private Contractors and Landscapers, starting with supervisors and managers, then crews who complete maintenance activities for both current GI landscapers and standard landscapers who desire to become "green"
- Private Developers and Engineers
- Inspectors
- Design Engineers

General Public

There is a general agreement among most of the interviewed municipalities that an increased level of knowledge regarding GI is needed at this time. The general public has mainly heard about rain gardens and rain barrels as they can be installed in small areas on private properties relatively easily.

> The Village of Hales Corners hosted a workshop for members of local homeowners' associations (HOAs) regarding stormwater facilities. Guest speakers from SEWRPC presented information on the purpose, design, and maintenance needs of stormwater facilities. These associations are required to inspect the stormwater facilities on their properties, and to maintain the facilities as needed. Attendees were able to ask questions to the speakers about specific maintenance and management options to learn about alternatives to help manage their stormwater facilities.

Elected and Public Officials

Elected officials, committee members, managers, administrators, and other decision makers have a direct impact on the level of effort municipal staff can provide to maintain GI strategies. Elected and public officials should be encouraged or targeted to attend other potential training seminars that discuss the benefits and importance of GI and their associated maintenance. This includes education on what GI (specifically GI strategies like bioswales and rain gardens) and/or plantings look like throughout their various phases of growing. This is also important for residents or general public who are not generally informed or aware about the time it takes for some of these strategies to fully establish.

Municipal Staff

Department of public works crews, parks and forestry staff, planners, landscape architects, municipal engineers, and economic development staff all have a role in the successful implementation and long-term maintenance of GI strategies. Municipal engineers often engage in design or hire consultant engineers to design GI to be placed within the right-of-way. A standardized set of GI design details has been developed by MMSD, but more promotion of the existence of these documents is needed along with training and workshops to promote designing with maintenance basics in mind.

Private Contractors and Landscapers

There are many private contractors who currently provide routine services to municipalities in related fields such as landscaping, street sweeping, and more. GI maintenance training to the owners of these businesses provides a future growth opportunity in GI, specifically on how to maintain the various GI strategies that have been constructed in the region. Training for these businesses to expand their service offerings may also incentivize these businesses to hire individuals with a baseline knowledge of GI strategies and maintenance needs. In addition to providing contractors with detailed GI information on how they function, why it is important to maintain the designed functionality and how to perform the various maintenance tasks needed to ensure this, MMSD should inform businesses about regional efforts to train individuals on this work to find the right individuals to hire.

Private Developers, Planners, Landscape Architects and Engineers

Many of the municipal interviewees expressed a desire to see future installations of GI that are designed to simplify future maintenance activities. This can range from having knowledge of the type of street sweeper that the municipality has available to maintain porous pavement systems to creating planting plans for biofilters. Planting plans would address a minimal number of different species, clusters, or groups that would allow future maintenance crews to distinguish between the desired plants and invasive species easier. More outreach/education on existing documents is also needed. Future workshops could share the MMSD vegetation planting plans, GI Plans and Specifications, and successful installations of GI in the region. Workshops could also include examples of successful planting plans, species that grow well in biofilters and rain gardens, examples of improper site locations for GI, ideas to provide access, and the appropriate legal documentation to allow for future maintenance activities.

Inspectors

Training for municipal and contracted inspectors should focus on details of GI strategy types. Details that need to be conveyed to those performing the maintenance should be specific, with the location of the needed repairs also being identified in the inspection reports. The MMSD GI O&M Standards should begin to provide a baseline for the type of work that needs to be performed and what inspectors should be looking for during their visits. Inspectors should be encouraged to use this document and apply it to their respective municipalities. The GI O&M Standards can be found on the Fresh Coast Guardian website.

Design Engineers

There are many design engineers working with public and private property owners on new GI strategies around the area. Details included in the designs can help minimize or streamline the on-going maintenance activities. These details may be site-specific (depending on site conditions, future uses of the site, and anticipated maintenance resources), municipality-specific (depending on staff experiences, general community perceptions and expectations, and available equipment to maintain these strategies), or based on new technologies and designs used in other areas of the country but not common practice in the immediate area. Again, promoting the use of MMSD's Planting Selection Tool and GI Plans and Specifications may assist in designing with maintenance basics in mind.

Privately Owned Green Infrastructure Strategies

Privately-owned GI strategies are important components of the overall stormwater conveyance and control system. These initial containment and/or treatment systems often discharge to the local municipal storm sewer. The municipal storm sewer system receives the discharge from these privately-owned strategies. If the privately-owned strategies are not functioning appropriately, the downstream receiving sewers and water-bodies will be impacted.

Highly concentrated sediment and nutrients from privately-owned strategies that are not being maintained may discharge to the municipal storm sewer, creating a capacity issue where sediment accumulates in the pipes. Organic debris and plant matter that is not removed in a timely manner may block the outlet of a strategy, causing the water to fill up and back up onto the street or drainage area, creating localized flooding problems.

Most GI strategies were designed and implemented using newer technologies and have been constructed recently, fitting into existing review and approval programs at the municipalities that also require long-term maintenance agreements, maintenance plans, and have prescribed inspection frequencies to ensure long-term performance of the strategies. However, some strategies do not have these agreements in place, making access to these strategies on private land difficult. A lack of understanding of what is required in the inspection, who to contact to get the inspections completed, how much an inspection will cost, and the general importance and functionality of these strategies all combine to result in many private property owners who do not submit the required inspection information to the municipality.

The owners of GI strategies are often not familiar with the required routine and occasional

maintenance needs. Commercial properties, business and industrial parks, and subdivisions and condominium complexes all have responsible parties designated to oversee the inspections and maintenance of the designed and constructed GI strategies. Many of the parties who inherit these responsibilities are not aware of this or are not aware of what constitutes an inspection and what type of maintenance is typical for these structures.

Some municipalities have requirements for these private strategy owners to submit the inspections within a designated time frame. Reminder notifications and deadlines result in a higher number of calls and inquiries than normal. This requires municipal staff to be available to answer the calls and questions. Detailed documentation on frequency and type of maintenance, along with inspections and the ability for the municipality to have ultimate access to maintain the strategy if needed, can be used to satisfy MS4 permit requirements, thereby lessening overall TMDL efforts in the future. Encouraging the municipalities to engage in the initial effort of documenting and inspecting could result in long-term multiple benefits. This could be another subject for training and education.

CASE STUDIES

Local Municipal & Private Property Owner Cooperation

The Village of River Hills works cooperatively with residential property owners who are interested in installing native plantings or butterfly gardens on private property adjacent to municipal right-of-way (ROW). Specifically, the Village has received requests from some residents to protect areas of roadside swales where native plants are installed in conjunction with larger areas on individual front lawns. Village staff have accommodated these requests by documenting the individual sites on public works maps and training staff to avoid these areas during routine mowing of the vegetated swales. The native plants in front lawns and in the roadside swales provide improved habitat for butterflies, birds and other animals, improves the aesthetic appearance of the roadside swales, and provides improved water quality and infiltration benefits as well. Towards the end of the year, around fall, the residents contact the municipality, and the municipality mows the landscaping along with their other swales. Positive relationship and communication between municipal staff and property owners has resulted in these site-specific improvements throughout the Village.

Good Tracking Approaches

The City of Wauwatosa, Greenfield, and Milwaukee all use GIS to track their GI inventory. The City of Greenfield tracks their GI strategies through the overall stormwater facility tracking system. A combination of GI and an Access database allows for spatial tracking of over 150 different stormwater facilities (including GI) and a detailed listing of owners, addresses, facility types, maintenance needs, past inspections, contacts, and more. The City of Greenfield has an active private stormwater facility maintenance program, which they acknowledge is a difficult program to implement. Many letters, reminders, and conversations about privately- owned stormwater (and GI) facilities are involved to ensure that the privately-owned stormwater facilities are being inspected and maintained. These contacts with the private-property owners are documented in the system. While the initial development of this system was difficult and time consuming to set up, the operation of the system is now easy and streamlines the documentation and reporting of this program.

The City of Milwaukee goes one step further and requires that private development re-certify their stormwater management facilities every five years. The recertification process must be completed by an outside professional engineer or surveyor. This inspection ensures that private facilities are being maintained, or if not, are not compliant with their requirements until the prescribed maintenance is performed.

The municipalities of Wauwatosa, Greenfield, and Milwaukee have a GIS manager or dedicated staff member that is trained in GIS. This is typically the most efficient way to track GI inventory, as well as routine maintenance and inspections on both public and private facilities.

Efficiencies

The City of Oak Creek Engineering and Public Works departments and staff cooperatively work together, help each other short and long-term, work together on equipment purchases and maintenances, and give "ownership" of facilities to staff, which gives them incentive to care and maintain more.

The City of Cudahy uses permeable pavement in alleys to treat stormwater runoff pollutants and to alleviate urban flooding concerns in highly developed residential areas. Individual homes are being encouraged to discharge their sump pump into the alley's permeable pavement system. The alley permeable pavement system is connected to the underground stormwater sewer system. This prevents the recirculation of sump pump water discharging onto homeowners' lawns, infiltration, and causing sump pumps to run continuously. This leads to higher than normal electric bills for residents due to sump pumps operating.

Throughout municipalities and agencies, the best efficiencies are found when departments and staff are working collaboratively, sharing ideas, innovations, and streamlining systems.

Funding Sources

There are various types of ways that municipalities or agencies fund GI design, construction, and maintenance. Depending on the stage, installation versus maintenance, the funding can differ.

Stormwater Utilities: use to fund design, construction, and maintenance (by way of staff and equipment). The following municipalities have a Stormwater User Charge and are able to direct some of these funds for strategy maintenance: Village of Brown Deer, City of Cudahy, Village of Fox Point, City of Glendale, Village of Greendale, City of Greenfield, City of Hales Corners, City of Milwaukee, Oak Creek, St. Francis, City of Wauwatosa, City of West Allis and Village of West Milwaukee. There are more municipalities that have stormwater utilities but do not use it for maintenance.

Green Solutions: to fund design and construction – municipalities that receive this funding would like to be able to use it for maintenance if they will be installing more and more.

Private Developments: when development occurs, it typically triggers stormwater management or green infrastructure regulations. Though this is not exactly considered a funding source, it is a common method that municipalities use to meet permit requirements. If the municipality has a maintenance agreement with the private developer, the municipality is able to count the facilities towards their permit requirements, which inevitably saves the municipality money.

The survey noted that only 14% of agencies track their GI maintenance costs separate from their grey infrastructure costs, reiterating the fact that most agencies treat GI as a part of their overall stormwater system.

Maintenance Partnerships

Some neighboring municipalities already have partnerships in place to tackle other public works and maintenance issues other than green infrastructure maintenance. Some of these agreements are formal,

and others are informal. A formal example of this is that the City of Mequon and the Villages of Brown Deer and Shorewood who share a sewer televising truck. The breakdown for maintenance allocation of this piece of equipment is specific to usage by municipality. A more informal example of a partnership is the North Shore Shared Services Group. The DPW Directors meets quarterly to share information, discuss current issues, and work together to find solutions including sharing equipment when opportunities arise (i.e., after severe storms, when one community is involved in a special event, etc.). This gives the municipalities an opportunity to perform the necessary work in a cost-effective manner.

Training and Outreach

The City of Franklin held a training and outreach session for local homeowners' associations (HOAs) a few years ago regarding privately-owned stormwater ponds, which could be a good template for future sessions on privately-owned GI strategies. The evening event featured stormwater and invasive species staff from the Wisconsin Department of Natural Resources, who explained how stormwater ponds function and why they need to be maintained, and the associated concerns for invasive species issues related to these ponds. Future training and outreach sessions for HOAs, property management companies, and private businesses that have maintenance responsibilities for GI strategies might follow this model of having guest speakers (professionals) provide technical information in a facilitated municipal setting.

All municipalities noted that training of various staff and departments is critical, especially with new ideas.

Stories with Unhappy Endings

Plantings and Public Impressions

In the cities of Cudahy and St. Francis, local residents generally prefer traditional manicured landscaping, including seasonal annuals as opposed to native landscaping. The vegetation in municipal-owned GI strategies has been modified or supplemented with annuals to carry over a familiar landscaping approach to accommodate residents' spoken desires. The City of St. Francis also installed native vegetation in a roadside bioswale a few years ago only to learn that at maturity, the plants were tall enough to create visual barriers to drivers. The drivers could not see clearly beyond the vegetation, which resulted in the plants being cut shorter than the plants would normally grow.

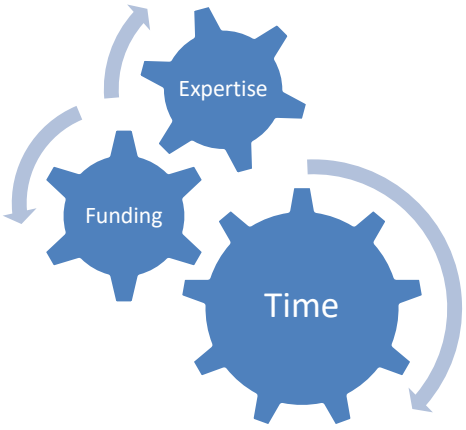
Even though all the municipalities interviewed were within miles of each other, each municipality and its residents prefer different aesthetics.

Volunteer Groups

Multiple municipalities or agencies have had similar experiences related to volunteer groups; the groups are usually excited or energetic in the first few years, then individuals (which typically tend to be the champions) change, priorities change, and the municipality inevitably inherits the maintenance responsibility of the GI strategy.

CONCLUSIONS

Most communities do not have the time, expertise, or funding to maintain their GI. Lack of time was the most common theme from the interviews. If inspection and/or maintenance of strategies, including but not limited to GI, continues to grow then municipalities will need to start looking at additional or outside resources to alleviate some of the workload. Considering that experience in GI inspection and maintenance is less familiar than other facility or system maintenance, this may be an area that municipalities are willing to accept assistance. This includes the idea of some form of regional maintenance, as well as additional GI training, outreach, and education.



Regional Maintenance

The survey indicated that 45% of municipalities or agencies would be interested in a partnership with neighboring communities, and 35% would be interested in a partnership with a regional entity. These survey responses were confirmed in face-to-face interviews, with at least 50% of the interviewees expressing interest in some form of maintenance cooperation. Full commitment to this will be based on the structure and management of this program. Medium-sized communities (between 7,000 to 31,000 acres) were the most interested in sharing maintenance resources. One important caution regarding a regional entity managing maintenance is the ability to "opt-in or out" thereby maintaining control of when and where municipal funds are to be spent. Communities echoed that this program would have to be designed with continuous input from municipalities to make sure the regional entity was meeting their specific needs. Some of the biggest concerns about a multi- or inter-municipal approach had to do with the overall program coordination such as the advertisements/ bids, contract negotiations, interviews, weekly coordination of what needs to be done where, etc.

Future GI Installations & Maintenance

Installing more GI, both public and private, results in more GI maintenance-related activities, at least in the form of staff time and resources to ensure inspections and maintenance are being completed, if not coordinating and completing the actual maintenance activities. What is the tipping point where municipalities have too many strategies to maintain? Some have hit that tipping point, forcing them to outsource maintenance activities, others have struggled to make-do, and some others feel they have a good handle on it and may never hit that point. Some communities are already walking away from potential funding and grants to install more GI because of concerns regarding future maintenance. As the cost for maintenance of multiple GI strategies rises, municipalities can search for ways to lower the cost per strategy through creative resource sharing and clustering of maintenance activities. However, even with creative cost-reduction measures, a dedicated source of funding is needed to ensure the long-term performance and functionality of these strategies.

Though municipalities are aware that GI can help meet permit requirements (MS4/TMDL), some are still walking away from GI funding for various reasons:

- Some municipalities are waiting until their permits are issued to focus on their requirements and how they will meet them. Others already know they are close to or if not already meeting their TMDL load allocations.
- Some are choosing to roll their funding over and plan to use it for larger capital improvement projects in the future.
- Depending on the community's resources, historical development patterns, existing site constraints, and conditions, there may be more opportunities for underground improvements such as underground storage systems, proprietary devices and/or retrofitting storm inlet and catch basins with sumps. These more traditional stormwater structures can be easier to maintain as the appropriate equipment is already in-house.
- Some communities may be evaluating pollutant trading or other regional pollutant reduction options rather than investing in additional site-specific GI strategies.
- To address the overall goals of the TMDL and to address the actual impairments of the waterways on the WDNR's Impaired Water List, some communities may opt to complete site-specific waterway improvements, including physical in-stream modifications, in areas where the impairment is listed as degraded habitat or degraded biological community where clear habitat conditions cannot be corrected by pollutant reductions alone.
- There may be more opportunities and need for GI strategies to be installed to meet the bacteria reductions listed in the TMDL. Additional information, including research, costs, and performance, will be needed on the impact GI strategies may have on bacteria to convince public or private owner/operators to install these strategies.
- While the TMDL requirements in the MS4 permits address TSS, phosphorus, and bacteria loadings, the MS4 permit is a WPDES permit focusing on pollutant discharges, not water quantity or flooding controls. A different motivator for communities to install GI in the near future may be resiliency initiatives including climate change and resiliency planning for stormwater quantity and quality controls. Resiliency planning has the potential to be a stronger motivator for communities to install GI rather than the pollutant reduction requirements for small storms in the TMDL.

While the primary motivators for GI installation are dependent on the municipality, the drive to inspect and maintain remains similar, not only for aesthetic purposes, but mainly regulatory requirements, especially as it relates to MS4 and TMDL permit compliance.

Volunteer groups are not a long-term solution. They may be engaged at the beginning, but member turnover and other reasons diminish their ability to provide maintenance for GI strategies. In the absence of committed volunteers, the maintenance of individual strategies either falls to the local municipality or is just not completed. This leads to more complaints and misconceptions of the unkept nature of GI strategies.

Most public comments focus on aesthetics, specifically the look of native vegetation. Innovative approaches to landscaping GI strategies are needed. A broader cross-section of industry experts, including landscapers, landscape architects, sustainability experts, and stormwater engineers/GI designers, should be engaged in aesthetically pleasing, low-maintenance planting plans. Recommendations from an integrated team of experts across these different industries could be developed with alternatives that would provide the desired functionality and also meet the visual expectations of the public. Different communities have different styles and tastes, so the typical landscaping styles of one community may differ greatly compared to another. A consistent, manicured look can be achieved in GI strategies as well as a variety of native plantings in a more mixed, natural appearance. In some areas, shorter plantings are desired, while in other areas, a structured, layered mix of plant species will be appropriate and accepted. Information on how to achieve these different planting styles would be very helpful to design project teams, as well as an understanding of what the generally accepted styles in the area are.

Hosting annual training seminars or workshops to address these issues and provide design tips or recommendations as well as promote and educate the use of the MMSD's previously developed Planting Plans, Plant Selection Tool, and GI Plans and Specifications.

There are concerns and uncertainties for future large-scale maintenance activities such as replacing biofilter media and vegetation (recent estimates on this type of work have come in incredibly expensive). This is especially prevalent in the early GI installations, both bioswale and permeable pavement systems, where maintenance on the systems has been largely neglected. Future uncertainties include not only the replacement of the biofilter media, but how will the disposal of this media be treated (i.e., detention pond dredging and testing the media for contaminants). A pilot study of older strategies could aid in educating GI owners of when biofilter media needs replacement. This might include chemical analysis of the media for disposal reasons and costs for having this work done.

GI is becoming widely accepted and seen as an asset to assist with stormwater quality and control, meeting regulation requirements, and overall stormwater education. As more strategies are installed and require maintenance, more creative funding mechanisms for maintenance will need to be explored as well as increased training and education to all throughout all project phases.

RECOMMENDATIONS

There are two sets of recommendations, one set directed to municipalities and the other to MMSD. In summary, the recommendations to municipalities include tracking GI installations, similar to how other stormwater facilities are tracked. This will not only assist in future permit requirements but will also help streamline inspections and maintenance needs. The other recommendation for municipalities (or any engineering, developer, governmental agency, etc.), is to design with maintenance in mind. Recognize up front, in design stages, what the maintenance capabilities are and how each specific community will recognize the aesthetic.

The most prevalent theme and recommendation to MMSD is to focus on additional education training workshops or seminars. These trainings should be audience specific and vetted through municipalities and the DNR to explore if it is feasible for these trainings to count towards permit requirements. Along with new/additional trainings, MMSD should focus on promoting their existing tools and services (possibly through TAT meetings). This could be built into the additional training workshops. Municipalities would also like more flexibility in their Green Solutions funding, and though this a recommendation to MMSD, municipalities should also bring their ideas to MMSD. Lastly, it is largely recognized that as development and GI installations increase, so will the need for maintenance. The idea of a well-organized regional maintenance entity was largely accepted. This concept and structure need to be well vetted through municipalities and governmental agencies who would "opt-in" to this type of service.

Recommendations for Municipalities

Tracking

Begin tracking GI installations, including sizes and locations, as well as the estimated frequency of maintenance. This is not only helpful as it applies to some permit conditions, but also to estimate the necessary staff time it takes to maintain these features. This will be especially helpful to gauge the needs of municipalities and governmental agencies as GI installations and their subsequent maintenance increases. Based on municipality or agency staff size and capabilities, a variety of different tracking devices have been used including basic Excel spreadsheets, Google Map referencing, and slightly more complex geographic information systems (GIS) tools. Proprietary maintenance software packages are available and may be a topic at a future maintenance workshop.

Design with Maintenance in Mind

It was discussed several times in the interviews that specific maintenance recommendations are necessary, like how to maintain a product given the capacity or equipment of the municipality. One municipality noted that they have a landscape architect on staff who reviews all planting plans for bioswales on proposed or redevelopment projects. Realizing not every agency has that kind of staff capacity but reiterating the point that maintenance cannot be an afterthought and should be considered during the design of every project. Considering the knowledge, expertise, equipment, and time dedicated staff will have to maintain these features, MMSD Planting Plans can be used as a guide to reduce the amount of species, as well as segment "pockets" of flowers, so it is easier to identify weeds during inspection and maintenance. MMSD's GI Plans and Specifications may assist in designing with maintenance basics in mind.

Recommendations for MMSD

Training and Education

GI maintenance training and tools are desired by everyone interviewed. This includes references such as field-style "flipbooks" for field crews, technical standards, vegetation identification information, and lists of companies that provide maintenance services. Training, not only directed at the staff and crews performing the maintenance, but also training for planners and designers to learn how to design GI that allows for lesser maintenance, recognizes suitable strategies, and generally more information on different types of GI that helps the engineering communities become more comfortable with different types of GI strategies. Also, more standard education or information should be available to the public explaining what GI is, why it is important, and what people should expect it to look like throughout its various stages.

Another common theme was to provide GI and native vegetation maintenance training for local and/or small landscaping companies, starting with companies that currently work with municipalities on other traditional landscaping projects. Some landscaping companies that provide routine lawn mowing and landscape maintenance services may not have the expertise to manage GI strategies comprised of native plantings or other GI components such as engineered soil mixes. By offering training on GI strategy maintenance and native plantings, in particular, many small to medium size landscape companies may be able to expand their services for existing and potentially new clients. Training sessions could be targeted towards supervisors and crew leaders who could provide this information to new or seasonal field staff, or brief, introductory or refresher training sessions could be held at the beginning of every season for seasonal field staff. Municipalities with contractors for traditional landscaping needs may otherwise have to contract out to a separate business for a single or for a few particular GI sites or find alternative businesses to complete the overall landscaping needs.

A training on GI and native vegetation maintenance could start with landscape companies that municipalities already use, as they already have the business' contact information. Completion of this training could lead to expanded services for smaller, local companies and potentially to hiring additional crews as the body of work and expertise grows.

Increased training and education on GI for private property owners is needed due to the number of existing GI strategies that have been constructed and the potential for more GI strategies in the future, especially considering updates to Chapter 13 and increased development. Homeowners Associations (HOAs), private management companies, and private businesses have areas of private property that have been dedicated to the capture and treatment of stormwater through GI strategies; however, many of these owners are not aware of the need for inspections and maintenance to ensure proper functioning of these strategies. General education and outreach about the need and purpose of GI strategies, how they function, how they should be maintained, and what ramifications of poorly or non-functioning strategies are to the immediate and surrounding properties should be shared with the general public, but specifically with GI strategy owners. Targeted mailings, newsletter articles, and standardized GI strategy information that could be distributed on municipal websites would provide a foundation for more detailed information about specific GI strategies and designs after that. General information about GI strategies could be

wrapped into overall stormwater education and outreach programs to the general public, explaining how GI strategies provide relief from both a stormwater runoff and quantity and quality perspective, especially as it relates to MMSD's 2035 Vision and goals. Additional training programs and workshops could also assist municipalities in meeting the education requirements of their MS4 permits. This would not only help permit requirements, but also alleviate some of the issues associated with limited staff and resources.

The concept of designing GI strategies for maintenance should be promoted through new and additional training and continuing education for private engineers, landscape architects, developers, and other technical consultants. Information could include recent developments and other research regarding the benefits of GI strategies, siting these strategies in the best/common sense locations on a new or redevelopment site, the thought process behind using GI strategies instead of traditional stormwater control structures, improved landscaping and native planting plan approaches, and how to develop maintenance plans that will be clear to a non-technical GI strategy owner. Maintenance of GI strategies in years after construction or installation could be much simpler than what exists in many situations today, with consideration of local resources and constraints to routine maintenance activities. Additional measures that could promote the consideration of maintenance activities during design may be information from local municipalities provided during the plan review and approval process about the type of GI strategies that are routinely installed and maintained in a particular municipality, as opposed to GI types that are not easy to maintain based on resource constraints.

Another recommendation is the need to increase efforts to promote and distribute MMSD's Fresh Coast Resource Center's Green Vendor List. Municipal staff with the responsibility of ensuring maintenance for publicly-owned GI strategies will find valuable information regarding what businesses are available to provide the various services related to GI maintenance through the Green Vendor List. Private property owners with the responsibility of inspecting and maintaining GI strategies can also use this list as a starting point to find businesses suited to GI needs. This existing list contains 33 businesses that offer a range of services related to GI including design, engineering, construction, plumbing, downspouts/gutters, landscaping, and maintenance. Municipal staff involved in active inspection and maintenance programs for private GI strategies can use this as a resource to share with private property owners who ask how to find appropriate companies to do GI maintenance work. A renewed effort to distribute and make municipal staff and other private GI owners aware of the Green Vender List will also highlight the need for maintenance of these strategies.

Implementation Scale

To facilitate the installation of larger strategies, a strategy or plan identifying the sites that could benefit from these structures would be essential. Larger GI strategies cannot be designed and constructed as a retrofit as easily as smaller strategies can. Identifying sites that could provide regional treatment would help structure the future maintenance needs among large and small strategies in a particular area.

Green Solutions Funding

Communities would like more flexibility on how they can spend their Green Solutions funding. Most frequently, communities noted that they would like to be able to spend a portion of their Green Solutions funding on maintenance related activities and programs. A review of the regulations regarding what Green Solutions funding can be spent on would be helpful from the community's perspective regarding maintenance.

Example of flexibility in Green Solutions funding to allow for the following expenditures:

- One-time purchase of equipment for long-term maintenance of GI strategies, such as vacuum assisted street sweepers or attachments, inspection tools for underground strategies, permeable pavement cleaning, equipment, etc.
- Replacement of soil media and plants in a bioswale after many years of use.
- Routine or occasional maintenance activities.

To make these activities possible, Green Solutions would need to be budgeted from MMSD's O&M budget (currently budgeted through the Capital Budget, which is restrictive due to statute), in order to pay for O&M activities. O&M funding is collected through user fees rather than taxing authority. It is not necessarily impossible to have a separate O&M fund for Green Solutions paid for through the O&M budget, but requests like this can be shared via Technical Advisory Team meetings; otherwise a formal request for consideration can be taken to the Green Solutions Project Manager or Director of Finance.

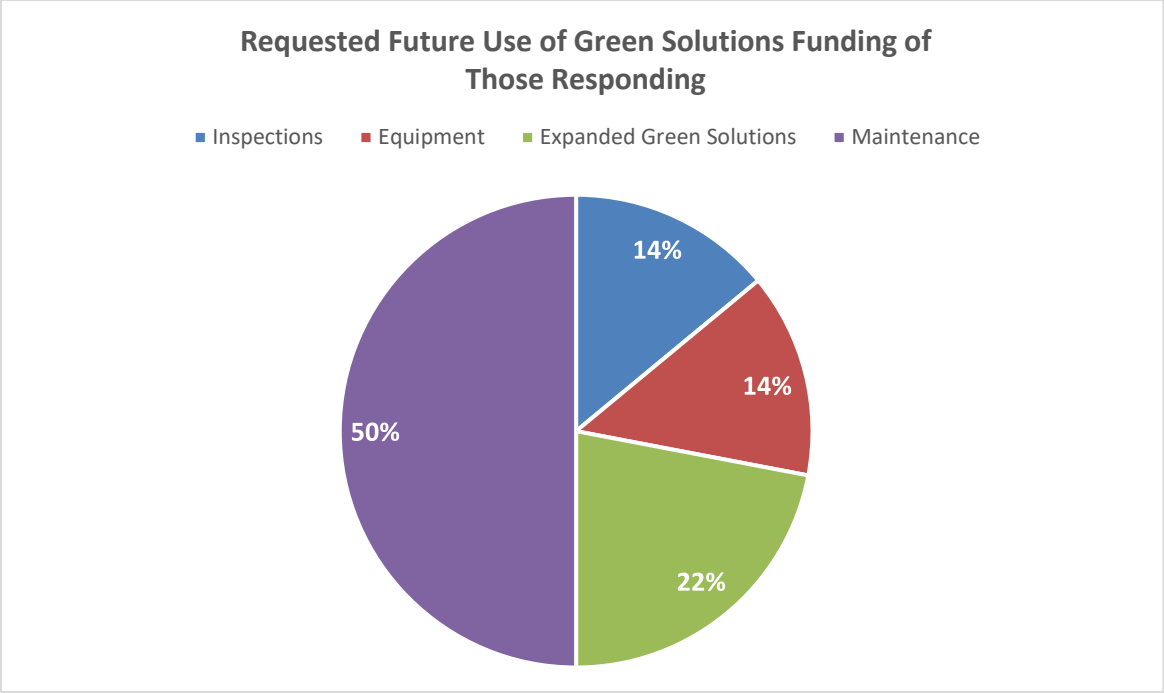


Figure 4. The main areas of improvement that communities are suggested for Green Solutions funding

The commitment from MMSD to provide Green Solutions funding to the communities for installation of new green infrastructure strategies is important but the benefits for these strategies are only sustained with long-term maintenance support.

Regional Maintenance

If a regional maintenance entity or program is created, it would have to be equitable to the municipality and agencies paying into the program. A task force or committee of municipal staff could be developed to further define a program that would be equitable and optional for all. Given the concern for a multi- or inter-municipal program being too much workload for one municipality to handle, a regional approach may be more appealing versus an inter-municipal approach. Regardless of who would potentially run the program, it would need to be designed up front so it creates less work for municipalities, and not more (i.e. by way of paperwork, coordination, etc.).

ATTACHMENT A

Municipal Needs Breakdown Table

Attachment A: Municipal Needs Breakdown Table

	Contact	Interview Date	Population of Community	Size of Community (acres)[1]	Primarily Roadside Swales or Curb & Gutter	Development Opportunities with GI	Shared Resources Options		Equipment Needs	Training/Education Suggestions	Current Staff Time/Expertise	Hurdles/Barriers
							Existing	Potential				
City of Cudahy	Mary Jo Lange	9/9/2019	18200	Small	Both	Not encouraging vegetated GI on developments	Informal contracts	Formal contracts may be difficult. Trusted 3rd party may be a good host for multi-community sharing (Sweet Water was the example)	Shared equipment	Specific planting plans	Former landscape architect on staff; seasonal employee	Community doesn't buy into GI
City of Franklin	Glen Morrow	9/5/2019	1231	Medium	Swales	No current GI	Informal contracts; Northshore Community Group	Formal contract may be difficult. 3rd party may be a good host for multi-community sharing	Future shared equipment and/or inspectors			Bad experience with permeable concrete sites
City of Glendale	Charlie Imig	9/11/2019	12779	Small	Curb & Gutter	Redevelopment is including a variety of GI BMPs; very open to GI opportunities	Northshore Community Group	Share interns	Shared equipment	GI training for muni staff and landscapers with existing contracts with munis; plant ID; SWWT; MMSD; FCRC	No staff available; landscapers	Design for easier maintenance
City of Greenfield	Jeff Tamblyn	9/16/2019	2124	Medium	Curb & Gutter	Redevelopment is including a variety of GI BMPs		Formal contracts can be cumbersome; political changes potentially make agreements difficult	DPW has vacuum assisted sweeper and most equipment	Education & outreach for private GI & SW BMP owners & checklists, info on what should be inspected/maintained is needed	Engineering and DPW staff have expertise and time to inspect/maintain current public BMPs	Ownership and enforcing private property maintenance
City of Hales Corners	Michael Martin	9/5/2019	7674	Small	Swales	Private development; common sense areas				Homeowner's Associations/ Developers		
City of Mequon	Kristin Lundeen	9/24/2019	24086	Medium	Swales		Informal agreements, none relating specifically to GI; Example of sharing sewer televising equipment	Maybe in future with more GI installations; contracting out work may be better option than handling in-house		GI education/maintenance training for private owners	No existing staff	Cannot make anybody care
City of Milwaukee	Sarah Gantt, Kurt Sprangers	9/5/2019	595047	Large	Both	Redevelopment is including a variety of GI BMPs; road and other public redevelopment projects include GI routinely		Share equipment with communities; maintenance contracts	Own equipment, including PP vac		Maintenance is contracted out each year	Utility conflict; not locate GI in front of houses
City of Muskego	Scott Kroeger	11/12/2019	24,996	Medium	Both	Have lots of land, new development can build ponds. planning to use soil amendments in all parks		Will not outsource maintenance		Need GI education for general public		
City of Oak Creek	Phil Beiermeister	9/6/2019	35881	Medium	Swales	Public redevelopment projects include GI; road and other public redevelopment		Interest in maintenance contracts and shared inspection	DPW has vacuum assisted sweeper and most equipment	Workshop for DPW; streets department; designers do maintenance	DPW staff maintains GI; lack of personnel	More permeable pavers means less salt spread in winter, private struggle to upkeep maintenance
City of St. Francis	Melinda Dejewski	9/9/2019	9466	Small	Swales		Informal contracts	Formal contracts may be difficult. Trusted 3rd party may be a good host for multi-community sharing (Sweet Water was the example)			Local gardener maintains GI; future consultants/interns inspection	Trust; lacking expertise; stealing plants; design for low maintenance

City of Wauwatosa	Maggie Anderson	9/24/2019	46396	medium	Swales	Development opportunities with GI		Most equipment, resources exist now		Need GI education for general public and staff	City forester with much GI knowledge; city landscape architect assists with development reviews & expertise	Expertise issue
City of West Allis	Rob Hutter	10/3/2019	60087	Medium	Curb & Gutter	Public and private redevelopment projects		Contractor for permeable paver maintenance; 3rd party maintain multiple communities		Need GI education for DPW; have expertise	Not enough staff and time	Not much room in ROW behind curb
Milwaukee County	Steve Keith;	8/28/2019	948201	County	Curb & Gutter	increase with development and TMDL		Future coordination between county departments may result in cost savings and efficiencies	PP vacuum		County departments maintain GI on their own sites; no coordination between departments	Funding
Milwaukee County Parks	Sarah Toomsen, Eddy Santiago	9/20/2019	N/A	County Sites	Both	Occasional park redevelopment or parking lot improvements	No	Shared intern or summer staff opportunity? Equipment sharing might work; a GI crew would be good		General GI education needed for approvals, management (not only staff); field managers should get training before seasonal staff	Minimal time to maintain GI; other priorities come first	Need additional info on benefits of depaving options
Mitchell Airport	Kim Berry, Greg Faley, Joanna Jelen	9/20/2019	N/A		Curb & Gutter		no					FAA regulations limit options; Vortechnics units are not easy to inspect
Village of Bayside	Andy Peterson,	9/3/2019	4398	Small	Swales	Not many redevelopment projects/opportunities for GI	Contracts with residents		Rent trucks and specialized equipment			WQ left out; maintenance big issue to fund over time
Village of Brown Deer	Matthew Maederer	9/3/2019	12011	Small	Both	Redevelopment is including a variety of GI practices		Inspection	Own vac-sweeper		Local native vegetation landscaper contract	No money or staff for maintenance
Village of Fox Point	Scott Brandmeier	7/1/2019	6691	Small	Swales	Not many redevelopment projects/opportunities for GI					Village DPW maintains GI; more GI BMPs may be too many to maintain	
Village of Greendale		--	14211	Small								
Village of River Hills	Randy , Tami	8/15/2019	1592	Small	Swales	Not many redevelopment projects/opportunities for GI; more residential				DPW Staff went to winter road maintenance training	DPW staff maintain GI; volunteers maintain native plantings	
Village of Shorewood	Leeann B	7/1/2019	13368	Small	Both	Not many redevelopment projects/opportunities for GI						
Village of West Milwaukee		--		Small								
Village of Whitefish Bay	John E; Spencer C	9/3/2019	13972	Small	Swales	SWMP; redevelopment is including a variety of GI Practices		Outside maintenance contracts; funding with communities TMDL	Owns vac-truck, but would rather rent			Large maintenance vs. routine maintenance
Wisconsin State Fair Park		9/20/2019		Small								

[1]Acreages based on the following; Small: 200 - 3818 acres, Medium: 7,302 - 30,050, Large: 61,960+

ATTACHMENT B

List of Interviewees

Attachment B:

Green Infrastructure Maintenance Analysis & Lessons Learned for Municipalities

List of Interviewees:

1) City of Cudahy: Mary Jo Lange
2) City of Franklin: Glen Morrow & Mike Roberts
3) City of Glendale: Charlie Imig
4) City of Greenfield: Jeff Tamblyn
5) City of Hales Corners: Michael Martin
6) City of Mequon: Kristin Lundeen
7) City of Milwaukee: Kurt Sprangers & Sarah Gantt
8) City of Muskego: Scott Kroeger
9) City of Oak Creek: Phil Beiermeister
10) City of St. Francis: Melinda Dejewski
11) City of Wauwatosa: Maggie Anderson
12) City of West Allis: Robert Hutter
13) Milwaukee County: Stevan Keith
14) Milwaukee County Parks: Sarah Toomsen & Eddy Santiago
15) Mitchell Airport: Kim Berry, Greg Faley & Joanna Jelen
16) Village of Bayside: Andy Peterson & La'Neka Horton
17) Village of Brown Deer: Matthew Maederer
18) Village of Fox Point: Scott Brandmeier
19) Village of River Hills: Randy Groth & Tammy LaBorde
20) Village of Shorewood: Leeann Butschlick
21) Village of Whitefish Bay: John Edlebeck & Spencer Charczuk

ATTACHMENT C

Green Infrastructure Inventory

Attachment C: Green Infrastructure Inventory								
Bioswales/ Biofilters	**Cisterns**	**Green Roof**	**Infiltration Devices[1]**	**Native Landscaping**	**Permeable/Porous/ Pervious Pavement**	**Rain Gardens**	**StormGUARDen™**	**Wetlands**
502,582	3,359	11,098	394,517	37,644	372,645	99,509	21	1,734,072
square feet	square feet	square feet	square feet	square feet	square feet	square feet	#	square feet
Note: The green infrastructure inventory listed above is the combination of 10 municipalities, except for StormGUARDen, which is 14 municipalities.								
Measurements of some features are approximate. Green infrastructure inventories include a public and private property (varies by municipality)								
[1] Infiltration Devices include underground storage, infiltration basins and swales, dry basins, enhanced swales								

ATTACHMENT D

List of Survey Questions

Attachment D:

Municipal Green Infrastructure Maintenance Needs Survey Questions

1. Name/Position Title
2. Name of Municipality / Agency
3. What types of GI practices are located in your community that the municipality is responsible for maintaining? Check all that apply.
    a. Green Roofs
    b. Bioswales (Bioretention)
    c. Porous/Permeable Pavement
    d. Rain Gardens
    e. Cisterns
    f. Rain Barrels
    g. Native Landscaping
    h. Stormwater Trees
    i. Constructed Wetland
    j. Other (please describe)
4. For the GI practices located in your community that your municipality is responsible for maintaining, why are you required to maintain them? Check all that apply.
    a. Municipal owned property – stormwater function and aesthetics
    b. Municipal owned property – MS4 compliance
    c. Municipal owned property – TMDL benchmarking
    d. Easement or other contractual agreement
    e. Other (please describe)
5. Which of the following GI practices does the municipality have the necessary equipment to maintain? Check all that apply.
    a. Green Roofs
    b. Bioswales (Bioretention)
    c. Porous/Permeable Pavement
    d. Rain Gardens
    e. Cisterns
    f. Rain Barrels
    g. Native Landscaping
    h. Stormwater Trees
    i. Constructed Wetland
    j. Unsure
    k. Other (please describe)
6. What types of GI maintenance equipment do you have? Please describe.
7. What types of GI maintenance equipment do you lack? Please describe.
8. Which of the following GI practices does the municipal staff have the necessary training/expertise to maintain? Check all that apply.
    a. Green Roofs
    b. Bioswales (Bioretention)
    c. Porous/Permeable Pavement

    d. Rain Gardens
    e. Cisterns
    f. Rain Barrels
    g. Native Landscaping
    h. Stormwater Trees
    i. Constructed Wetland
    j. Other (please describe)
9. What types of GI maintenance training/expertise does your municipal staff lack? Please describe:
10. If you do NOT have the necessary skills/capabilities to perform required GI maintenance, would any of the following be considered helpful for obtaining the necessary skills? Check all that apply.
    a. A GI maintenance training workshop or course
    b. A GI maintenance training manual
    c. A partnership with neighboring communities/regional entry to complete maintenance
    d. A partnership with a regional entity to complete maintenance
    e. Assistance with contracting out the maintenance activities (i.e. technical specifications, performance standards, levels of service, contract documents, bidding, inspection, etc.)
    f. Other. Please describe.
11. For required GI maintenance in your community, how are those practices being maintained? Check all that apply.
    a. We maintain the current practices with our in-house staff.
    b. By partnering with other agencies/neighboring communities.
    c. It is outsourced to a private contractor.
    d. We do general maintenance (i.e. picking up trash, keep the practices clean), but outsource specialized maintenance.
    e. We maintain some practices and outsource maintenance for other types of practices.
    f. We maintain our practices but not to the level that is required.
    g. Our practices are not currently being maintained.
12. For the Gi practices that the municipality maintains, at what frequency do you perform maintenance?
    a. We maintain our practices at regular intervals (e.g. once per year, spring and fall, etc.) as prescribed by a Gi maintenance plan, manufacturer's recommendations, etc.)
    b. We maintain our practices at regular intervals (e.g. once per year, spring and fall, etc.) according to a schedule that we developed.
    c. We maintain our practices when we observe they need it.
    d. We maintain our practices when we receive a compliant.
    e. Not applicable to our municipality.
13. What tracking and reporting methods are currently being used to ensure GI maintenance is occurring at regular intervals? Please describe:
14. Does your municipality track GI maintenance costs separate from grey infrastructure maintenance costs?
    a. Yes
    b. No

    c. Unsure
15. Please list and describe any existing tracking tools you use for stormwater or GI maintenance that you find useful for maintenance scheduling or cost tracking.
16. Do you expect your commitments regarding the operations and maintenance of GI to increase in the future?
    a. Yes, that is likely.
        i. If yes, for what reason(s)?
    b. No, that is unlikely.
    c. Unsure
17. As interest or requirements regarding the implementation of GI grow, does your community have the capability to maintain additional GI practices?
    a. Yes. Funding and equipment are available for increased maintenance needs.
    b. Somewhat. The funding is available, but we lack the necessary equipment.
    c. Somewhat. The community already owns or share the equipment, but additional funding may be needed.
    d. No. Neither funding nor equipment is available for additional maintenance needs.
18. How difficult is it for you to procure additional funding for GI maintenance costs?
    a. Very easy.
    b. Somewhat easy.
    c. Neigh easy nor difficult.
    d. Somewhat difficult.
    e. Very difficult.
19. How reliable is the source of funding used to meet your operations and maintenance obligations?
    a. Very reliable – it will always be available for Gi operations and maintenance.
    b. Somewhat reliable – it is currently available for GI operations and maintenance but may not be in the future.
    c. Somewhat unreliable – the funding source will end soon, and we will have to find another source.
    d. Very unreliable – we have trouble finding funding for Gi operations and maintenance ever year.
    e. Not applicable. We don't have GI to operate or maintain.
20. Have you received any comments on the GI in your community from the public? If so, what type? How has it been viewed? Is its purpose well understood?
21. Have you received any comments on the GI in your community from elected officials? If so, what type? How has it been viewed? Is its purpose well understood?
22. Which types of GI practices/facilities are being proposed most often in your municipality (more popular)?
23. Which types of GI practices/facilities are being proposed least often in y our municipality (less popular)?
24. Are there green infrastructure practices/facilities that you and your staff would like to see more of? Please describe:
25. Is your community responsible for maintenance inspection of GI located on any of the following? Check all that apply.

a. Public Property
b. Public Right-of-Way
c. Privately-owned Property
d. Other
e. None of the above

26. If your answer to the previous question is yes, would you consider any of the following helpful?
    a. A local or regional training class.
    b. A training manual.
    c. Other (please describe)
27. Are you aware of GI practices located in your community that the municipality is not required to maintain? Check all that apply.
    a. Green Roofs
    b. Bioswale (bioretention)
    c. Porous/Permeable Pavement
    d. Rain Gardens
    e. Cisterns
    f. Rain Barrels
    g. Native Landscaping
    h. Stormwater Trees
    i. Constructed Wetlands
    j. Other (please describe)
    k. Unsure
28. If your answer to the previous question is yes, who has the responsibility to maintain those GI practices?
    a. Private Property Owner
    b. MMSD
    c. Other (please describe)
    d. Answer option

ATTACHMENT E

Complete Summary of Survey Results

Responster

Municipal Green Infrastructure Maintenance Needs Survey

PERIOD OVERVIEW BETWEEN

2018-12-02 - 2019-12-02

PRINTED 2019-12-02 BY

Carrie Bristoll-Groll

1. Name / Position Title

Answer	Time
"Michael J. Martin, DPW Director"	2019-08-27 16:05
"Matthew Maederer"	2019-07-18 15:24
"Ben High / Consultant Engineer"	2019-07-18 12:37
"Ben High / Consultant Engineer"	2019-07-18 12:20
"Jeff Tamblyn, Environmental Engineering / GIS Technician"	2019-07-18 11:51
"Mary Jo Lange, Director of Public Works"	2019-07-10 13:46
"Charlie Imig, Director of Public Works"	2019-07-10 07:36
"Kristen Lundeen/Director of Public Works/City Engineer (Mequon)"	2019-07-09 07:18
"Melinda Dejewski, PE City Engineer/Director of Public Works"	2019-07-08 12:16
"Phil Beiermeister/Environmental Design Engineer"	2019-07-08 11:40
"Randy Groth Superintendent"	2019-07-03 13:52
"Sara Gantt Civil Engineer"	2019-07-01 07:48
"Leeann Butschlick/Director of Public Works"	2019-06-26 10:18
"Kate M. Nelson, Chief Sustainability Officer"	2019-06-25 11:30
"Scott Brandmeier, Director of Public Works"	2019-06-21 13:59
"Spencer Charczuk/Staff Engineer"	2019-06-21 11:18
"Maggie Anderson, Senior Civil Engineer"	2019-06-21 11:11
"Rob Hutter/Principal Engineer"	2019-06-21 11:00

"Christ Kowieski/Chief Operations Officer"	2019-06-21 10:54
"Stevan Keith/Director of Environmental Services"	2019-06-21 09:10
"Carrie/CEO"	2019-05-24 18:06

Total unique respondents: 21

2. Name of Municipality / Agency

Answer	Time
"Village of Hales Corners"	2019-08-27 16:05
"Village of Brown Deer"	2019-07-18 15:24
"Village of West Milwaukee"	2019-07-18 12:37
"Village of Greendale"	2019-07-18 12:20
"City of Greenfield"	2019-07-18 11:51
"City of Cudahy"	2019-07-10 13:46
"City of Glendale"	2019-07-10 07:36
"City of Mequon"	2019-07-09 07:18
"City of St. Francis"	2019-07-08 12:16
"City of Oak Creek"	2019-07-08 11:40
"Village Of River Hills"	2019-07-03 13:52
"City of Milwaukee"	2019-07-01 07:48
"Village of Shorewood"	2019-06-26 10:18
"University of Wisconsin-Milwaukee"	2019-06-25 11:30
"Village of Fox Point"	2019-06-21 13:59
"Village of Whitefish Bay"	2019-06-21 11:18
"City of Wauwatosa"	2019-06-21 11:11
"City of West Allis"	2019-06-21 11:00

"Wisconsin State Fair Park/Wisconsin State Fair Park"	2019-06-21 10:54
"Milwaukee County"	2019-06-21 09:10
"Some city, some where"	2019-05-24 18:06

Total unique respondents: 21

3. What types of GI practices are located in your community that the municipality is responsible for maintaining? Check all that apply.

Option	Respondents
Green Roofs	2
Bioswale (bioretention)	15
Porous/Permable Pavement	12
Rain Gardens	14
Cisterns	2
Rain Barrels	5
Native Landscaping	12
Stormwater Trees	7
Constructed Wetlands	1

Other (please describe)	5

Total unique respondents: 75

Follow-up question to option: Other (please describe)

3.1. Please describe:

Answer	Time
"Wet and dry detention ponds"	2019-07-08 12:16
"none"	2019-07-03 13:52
"Floating islands at Hartung Quarry"	2019-07-01 07:48
"subsurface infiltration"	2019-06-21 09:10
"StormGUARDen"	2019-05-24 18:06

Total unique respondents: 5

4. For the GI practices located in your community that your municipality is responsible for maintaining, why are you required to maintain them? Check all that apply.

	Option	Respondents
	Municipal owned property - stormwater function and aesthetics	20
	Municipal owned property - MS4 permit compliance	12
	Municipal owned property - TMDL benchmarking	4
	Easement or other contractual agreement	9
	Other (please describe)	2

Total unique respondents: 47

Follow-up question to option: Other (please describe)

4.1. Please describe:

Answer	Time
"NA"	2019-07-03 13:52
"None"	2019-05-24 18:06

Total unique respondents: 2

5. Which of the following GI practices does the municipality have the necessary equipment to maintain? Check all that apply.

Option	Respondents
Green Roofs	3
Bioswale	12
Porous/Permable Pavement	8
Rain Gardens	12
Cisterns	1
Rain Barrels	4
Native Landscaping	12
Stormwater Trees	8
Constructed Wetlands	0

	Unsure	4
●	Other (please describe)	1

Total unique respondents: 65

Follow-up question to option: Other (please describe)

5.1. Please describe:

Answer	Time
"NA"	2019-07-03 13:52

Total unique respondents: 1

6. What types of GI maintenance equipment do you have? Please describe.

Answer	Time
"Unsure, have yet to maintain a facility, they are all too new."	2019-08-27 16:05
"Laborers Street Sweeper/Vacuum Mowers Trimmers"	2019-07-18 15:24
"The Village owns equipment to perform general maintenance activities within the Village (utility trucks, street sweeper, vac-truck)"	2019-07-18 12:37
"The Village of Greendale has the equipment necessary to perform general maintenance activities (backhoe, vacuum sweeper, utility trucks)."	2019-07-18 12:20
"DPW yard with a variety of equipment depending on the need"	2019-07-18 11:51
"Sweeper, vac-all, backhoe, dump trucks, kubota,skid-steers, plows with rubber blades"	2019-07-10 13:46
"Landscaping equipment"	2019-07-10 07:36
"We use personnel and standard equipment in maintenance."	2019-07-09 07:18
"We have the typical construction equipment."	2019-07-08 12:16
"regenerative air sweeper, backhoe, hydroseeder,"	2019-07-08 11:40
"None"	2019-07-03 13:52
"We have the attachment for the hydrovac truck to clean permeable pavers, said truck also flushes any clogs out of bioswale under drains."	2019-07-01 07:48
"Typical landscape maintenance/forestry equipment; none specific to GI. "	2019-06-26 10:18
"Shovels, garden rakes, wheelbarrows, etc of manual equipment"	2019-06-25 11:30
"Lawnmowers and folks to pull weeds from the rain gardens. "	2019-06-21 13:59

"Standard landscaping equipment."	2019-06-21 11:18
"We have an Elgin Megawind for vacuum sweeping our porous pavement. We have typical landscaping equipment bioswale and rain garden care."	2019-06-21 11:11
"Nylon blade snow plow. Vacuum truck to clean permeable pavers"	2019-06-21 11:00
"Skid loaders, wheel loaders, forklifts, tractors, lawnmowers, other various landscaping equipment"	2019-06-21 10:54
"basic landscaping equipment (eg., hand tools) pickup trucks rolling broom sweeper"	2019-06-21 09:10
"A shovel and a few hands"	2019-05-24 18:06

Total unique respondents: 21

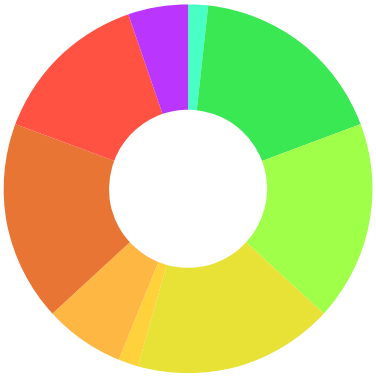
7. What types of GI maintenance equipment do you lack? Please describe.

Answer	Time
"Unsure"	2019-08-27 16:05
"Enough People & Time!"	2019-07-18 15:24
"I am not sure if the Village lacks any of the required maintenance equipment."	2019-07-18 12:37
"Unsure of what other equipment the Village is missing."	2019-07-18 12:20
"Unknown"	2019-07-18 11:51
"large backhoe for wetland & pond maintenance"	2019-07-10 13:46
"Specialized tools"	2019-07-10 07:36
"Unsure how to answer. . ."	2019-07-09 07:18
"None."	2019-07-08 12:16
"unsure"	2019-07-08 11:40
"NA"	2019-07-03 13:52
"None to my knowledge"	2019-07-01 07:48
"vacuum sweeper"	2019-06-26 10:18
"Whatever is needed to clean above and below ground cisterns"	2019-06-25 11:30
"N/A"	2019-06-21 13:59
"Vac for porous pavers."	2019-06-21 11:18
"none."	2019-06-21 11:11

"If there is a better way to maintain the permeable pavers (rather than a vacuum truck), we lack that. We would like an easier way to do it."	2019-06-21 11:00
"unsure"	2019-06-21 10:54
"vacuum designed for permeable pavement cleaning"	2019-06-21 09:10

Total unique respondents: 20

8. Which of the following GI practices does the municipal staff have the necessary training/expertise to maintain? Check all that apply.



	Option	Respondents
	Green Roofs	1
	Bioswale (bioretention)	10
	Porous/Permeable Pavement	10
	Rain Gardens	10
	Cisterns	1
	Rain Barrels	4
	Native Landscaping	10
	Stormwater Trees	8
	Constructed Wetlands	0

Other	3

Total unique respondents: 57

Follow-up question to option: Other

8.1. Please describe:

Answer	Time
"No formal training"	2019-08-27 16:05
"NA"	2019-07-03 13:52
"You should have an answer that reads "little to no experience" and that would fit the bill. In reality, we are planning to use volunteers to identify invasive species within the rain gardens; the bioswales will be maintained by mowing and leaf blowing."	2019-06-21 13:59

Total unique respondents: 3

9. What types of GI maintenance training/expertise does your municipal staff lack? Please describe:

Answer	Time
"Unsure of needs, No formal training"	2019-08-27 16:05
"We lack the time and manpower!"	2019-07-18 15:24
"The municipal staff is able to maintain the existing GI practice that exists in the Village."	2019-07-18 12:37
"The municipal staff has the knowledge to maintain what is currently present in the Village."	2019-07-18 12:20
"Unsure"	2019-07-18 11:51
"Wetland maintenance"	2019-07-10 13:46
"Bioswale maintenance"	2019-07-10 07:36
"We only have trained staff maintain GI. Therefore staff is limited who can maintain the GI, but I would argue that does not constitute a lack of training/expertise."	2019-07-09 07:18
"Native plants in bioretention areas"	2019-07-08 12:16
"annual training for DPW staff"	2019-07-08 11:40
"NA"	2019-07-03 13:52
"Since we contract out the work for bioswales staff is trained on how to instruct the contractor. I am not sure if any staff is trained to do maintenance on the permeable pavers."	2019-07-01 07:48
"unknown"	2019-06-26 10:18
"All of it. Little understanding of plants, function, and strategies."	2019-06-25 11:30
"Identification of plant materials - weeds versus appropriate plants for a rain garden. "	2019-06-21 13:59

"I do not have official GI Inspection Certification but have been in contact with Jay Feiker so that the next time it is offered I will take the course."	2019-06-21 11:18
"Our staff could benefit from additional guidance on permeable pavement maintenance."	2019-06-21 11:11
"Bioswale maintenance. We are also not 100% sure how to maintain the permeable pavers. Some kind of guidelines or training on that would be good."	2019-06-21 11:00
"We need training in all areas, and lack expertise in all areas except rain gardens."	2019-06-21 10:54
"green roofs permeable pavement"	2019-06-21 09:10
"No certification."	2019-05-24 18:06

Total unique respondents: 21

10. If you do NOT have the necessary skills/capabilities to perform required GI maintenance, would any of the following be considered helpful for obtaining the necessary skills? Check all that apply.

	Option	Respondents
	A GI maintenance training workshop or course	14
	A GI maintenance training manual	14
	A partnership with neighboring communities/regional entity to complete maintenance	9
	A partnership with a regional entity to complete maintenance	7
	Assistance with contracting out the maintenance activities (i.e. technical specifications, performance standards, levels of service, contract documents, bidding, inspection, etc.)	9

Other. Please describe.	2

Total unique respondents: 55

Follow-up question to option: Other. Please describe.

10.1. Please describe:

Answer	Time
"NA"	2019-07-03 13:52
"operational funding to perform"	2019-06-26 10:18

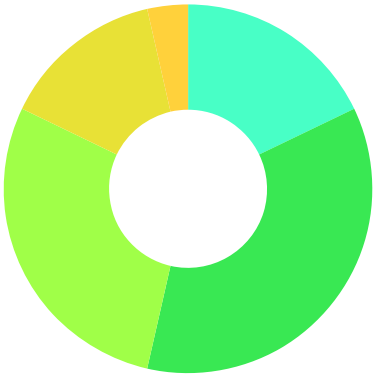
Total unique respondents: 2

11. For required GI maintenance in your community, how are are those practices being maintained? Check all that apply.

	Option	Respondents
	We maintain the current practices with our in-house staff.	12
	By partnering with other agencies/neighboring communities.	3
	It is outsourced to a private contractor.	3
	We do general maintenance (i.e., picking up trash, keeping the practice clean), but outsource specialized maintenance.	5
	We maintain some practices and outsource maintenance for other types of practices.	6
	We maintain our practices but not to the level that is required.	2
	Our practices are not currently being maintained.	4

Total unique respondents: 35

12. For the GI practices that the municipality maintains, at what frequency do you perform maintenance?



Option	Respondents
We maintain our practices at regular intervals (e.g., once per year, spring and fall, etc.) as prescribed by a GI maintenance plan, manufacturer's recommendations, etc.)	5
We maintain our practices at regular intervals (e.g., once per year, spring and fall, etc.) according to a schedule that we developed.	10
We maintain our practices when we observe they need it.	8
We maintain our practices when we receive a complaint.	4
Not applicable to our municipality.	1

Total unique respondents: 28

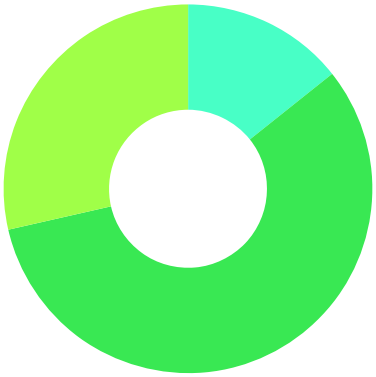
13. What tracking and reporting methods are currently being used to ensure GI maintenance is occurring at regular intervals? Please describe:

Answer	Time
"NONE"	2019-08-27 16:05
"None."	2019-07-18 15:24
"The Village's consultant engineer inspects the Village owned bmps on an annual basis. The results of these inspections are then shared with the Village."	2019-07-18 12:37
"The Village's consultant engineer inspects the Village's bmps on an annual basis. The inspection information is then relayed to the municipality."	2019-07-18 12:20
"Various databases and GIS data"	2019-07-18 11:51
"Cartegraph work order system & reporting"	2019-07-10 13:46
"Scheduled maintenance"	2019-07-10 07:36
"Paper and annual reporting requirements."	2019-07-09 07:18
"NA"	2019-07-08 12:16
"emails, inspection reports, scheduled maintenace intervals"	2019-07-08 11:40
"NA"	2019-07-03 13:52
"We recently started using a ArcMap application on an iPad that is supplied to the contractor"	2019-07-01 07:48
"spreadsheet record"	2019-06-26 10:18
"Initial contracts (hardly fulfilled), my review of the GI health, past internship reports"	2019-06-25 11:30
"No specific paperwork at this time but the plan, in the future, is to incorporate the information into our GIS."	2019-06-21 13:59

"None"	2019-06-21 11:18
"We use spreadsheets to track our maintenance but are currently developing a Collector app within our ArcGIS online platform."	2019-06-21 11:11
"Tracking it through a spreadsheet/work order"	2019-06-21 11:00
"When fall comes the rain gardens die. When spring comes they grow again."	2019-06-21 10:54
"We perform regular inspections and reports of our storm water best management practices and provide those reports to WDNR and to owners"	2019-06-21 09:10
"A fancy new software"	2019-05-24 18:06

Total unique respondents: 21

14. Does your municipality track GI maintenance costs separate from grey infrastructure maintenance costs?



	Option	Percentage	Respondents
	Yes.	14 %	3
	No.	57 %	12
	Unsure.	29 %	6

Total unique respondents: 21

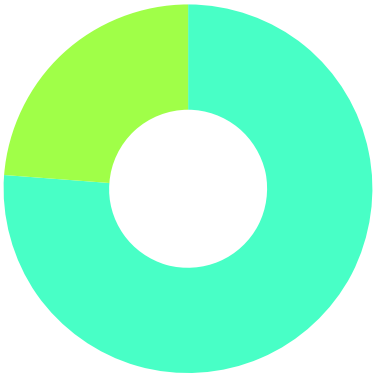
15. Please list and describe any existing tracking tools you use for stormwater or GI maintenance that you find useful for maintenance scheduling or cost tracking.

Answer	Time
"NONE"	2019-08-27 16:05
"None."	2019-07-18 15:24
"I am not sure if the Village uses any tracking tools for storm water related maintenance."	2019-07-18 12:37
"Unsure if the Village tracks maintenance costs for GI."	2019-07-18 12:20
"Access Database, PubWorks program, GIS system"	2019-07-18 11:51
"Cartegraph"	2019-07-10 13:46
"N/A"	2019-07-10 07:36
"MUNIS, for any external costs. None for internal."	2019-07-09 07:18
"None."	2019-07-08 12:16
"arcpad, spreadsheets"	2019-07-08 11:40
"NA"	2019-07-03 13:52
"We currently just use an Excel spreadsheet to track costs"	2019-07-01 07:48
"none"	2019-06-26 10:18
"Intern reports"	2019-06-25 11:30
"N/A "	2019-06-21 13:59
"None. I could develop a reporting method within our GIS."	2019-06-21 11:18
"We use excel to schedule and track."	2019-06-21 11:11

"Our tracking is pretty remedial as far as scheduling and cost."	2019-06-21 11:00
"We contract with Synchreon to monitor our stormwater discharge during the annual state fair. We have worked to improve and comply with the requirements of the WI DNR."	2019-06-21 10:54
"none"	2019-06-21 09:10
"Gis"	2019-05-24 18:06

Total unique respondents: 21

16. Do you expect your commitments regarding the operations and maintenance of GI to increase in the future?



Option	Percentage	Respondents
Yes, that is likely.	76 %	16
No, that is unlikely.	0 %	0
Unsure.	24 %	5

Total unique respondents: 21

Follow-up question to option: Yes, that is likely.

16.1. If yes, for what reason(s)?

Answer	Time
"GI still new, no major maintenance required at this time"	2019-08-27 16:05
"We are adding more because the WDNR MS4 permit will require it."	2019-07-18 15:24
"Increaseing regulatory requirements"	2019-07-18 11:51
"We operate a storm water utility that is not subject to State or PSC regulations that allows us to increase rates to finance these programs"	2019-07-10 13:46
"Adding bioswales"	2019-07-10 07:36
"Addition of more GI"	2019-07-09 07:18
"The cost of everything in live increases due to all kinds of economic factors but mainly that landscaping in gerneral is labor intensive and the pay for labor increases every year becasue we want to pay our employees a livable wage."	2019-07-08 12:16
"more GI in the City"	2019-07-08 11:40
"We will continue to design and construct GI projects"	2019-07-01 07:48
"TMDL compliance"	2019-06-26 10:18
"We can do more. Currently procuring services with an alumni who is helping to mentor students in an internship here."	2019-06-25 11:30
"Plan to do more."	2019-06-21 13:59
"As we continue to install more practices."	2019-06-21 11:11
"We will continue to have more GI projects to maintain."	2019-06-21 11:00

"adding more GI to comply with TMDLs"	2019-06-21 09:10

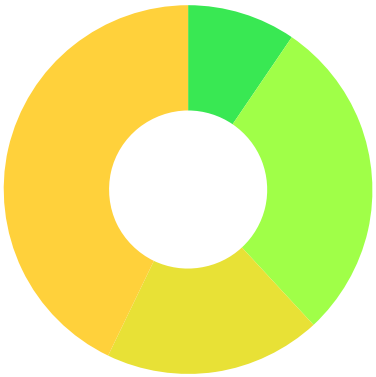
Total unique respondents: 15

17. As interest or requirements regarding the implementation of GI grow, does your community have the capability to maintain additional GI practices?

Option	Percentage	Respondents
Yes. Funding and equipment are available for increased maintenance needs.	21 %	4
Somewhat. The funding is available, but we lack the necessary equipment	21 %	4
Somewhat. The community already owns or shares the equipment, but additional funding may be needed.	26 %	5
No. Neither funding nor equipment is available for additional maintenance needs.	32 %	6

Total unique respondents: 19

18. How difficult is it for you to procure additional funding for GI maintenance costs?



	Option	Percentage	Respondents
	Very easy.	0 %	0
	Somewhat easy.	10 %	2
	Neither easy nor difficult.	29 %	6
	Somewhat difficult.	19 %	4
	Very difficult.	43 %	9

Total unique respondents: 21

19. How reliable is the source of funding used to meet your operations and maintenance obligations?

Option	Percentage	Respondents
Very reliable - it will always be available for GI operations and maintenance.	24 %	5
Somewhat reliable - it is currently available for GI operations and maintenance, but may not be in the future.	33 %	7
Somewhat unreliable - the funding source will end soon, and we will have to find another source.	14 %	3
Very unreliable - we have trouble finding funding for GI operations and maintenance every year.	24 %	5

	Not applicable. We don't have GI to operate or maintain.	5 %	1

Total unique respondents: 21

20. Have you received any comments on the GI in your community from the public? If so, what type? How has it been viewed? Is its purpose well understood?

Answer	Time
"No comments"	2019-08-27 16:05
"Usually negative. Most folks don't like "natural" looks. They think it looks "weedy""	2019-07-18 15:24
"I am not aware of any comments the Village has received."	2019-07-18 12:37
"Unsure."	2019-07-18 12:20
"Some comments received from the public. Typically just general comments or observation about what it is, or why its there or how it works. "	2019-07-18 11:51
"The public criticize it because they think its too expensive and not necessary. They don't want to understand it. "Some see a weed - some see a flower". It's the demographics and the lack of education during their childhood years. Its hard to change people's opinion until its a major public health crisis and it affects them - like lead water pipe. GI is a pro-active approach in addressing something that will become a public health crisis in the future. Its a tough sell & most people criticize us but our jobs are to protect the public even if it means those in the future."	2019-07-10 13:46
"No comments"	2019-07-10 07:36
"We have received complaints regarding the "voluntary tax" that we have placed on our sewer users by opting into the MMSD GI program. The have suggested that GI for the City should not be funded by the sewer users."	2019-07-09 07:18
"No comments."	2019-07-08 12:16
"Its generally well received"	2019-07-08 11:40
"NA"	2019-07-03 13:52

"For the most part we do not hear about our GI practices unless there is a problem in the community. Mostly I think it is a lack of public education. We do every once and while get some positive feedback. "	2019-07-01 07:48
"generally positive on landscaping; mixed on pervious pavement"	2019-06-26 10:18
"Many compliments come in but are not well documented. A few complaints come in from blocking/falling on parking spots. Sightlines are an issue. We need healthier low-growth plants."	2019-06-25 11:30
"Not really."	2019-06-21 13:59
"We have had interest from the Whitefish Bay Garden Club and they are implementing some practices. Signage for public education has been helpful as well."	2019-06-21 11:18
"We receive generally positive feedback on the green alleys. With the help of our website and flyers, most people understand it's purpose."	2019-06-21 11:11
"Generally, it is well received by the public. Occasionally, a comment such as "what a waste of money" will be posted, but almost all comments are positive."	2019-06-21 11:00
"The rain gardens and other plantings around the park are always very well received by the public. We have information about the purpose of raingardens at one of the locations, but not all."	2019-06-21 10:54
"little comments signage has helped reduce complaints and improve community understanding of purpose"	2019-06-21 09:10
"Nope"	2019-05-24 18:06

Total unique respondents: 21

21. Have you received any comments on the GI in your community from elected officials? If so, what type? How has it been viewed? Is its purpose well understood?

Answer	Time
"No comments"	2019-08-27 16:05
"Same as previous response."	2019-07-18 15:24
"I am not aware of any comments that the Village has received."	2019-07-18 12:37
"Unsure."	2019-07-18 12:20
"Yes. Concerns about on-going maintenance costs. Defective paver complaints. Other general SWM questions."	2019-07-18 11:51
"We just tell public officials the facts: We have a requirement to meet a Federal & State law and the most feasible way to do it here is through the installation of green infrastructure. Some of our officials partake in MMSD functions so they have heard of it."	2019-07-10 13:46
"No comments"	2019-07-10 07:36
"Similar - questions as to the benefit we are receiving, or the reduction in other operations/maintenance due to the installation of GI. Unfortunately since GI is more time consuming and costly to maintain, this is hard to show. Elected officials continue to question the benefit to the City's MS4 for continued participation in MMSD GI program."	2019-07-09 07:18
"none."	2019-07-08 12:16
"Its well received "	2019-07-08 11:40
"NA"	2019-07-03 13:52
"Rarely get comments from elected officials unless they are getting calls to their office for issues. For the most part they are not for our GI projects (bioswales mostly) if they think their residents will complain."	2019-07-01 07:48

"generally positive; purpose understood"	2019-06-26 10:18
"Neutral. Some projects have received national attention/publication."	2019-06-25 11:30
"Only as it relates to me securing funding for incorporating GI into a project; then not much else is discussed once installed."	2019-06-21 13:59
"Yes. They see our efforts as effective such as the Cahill detention area."	2019-06-21 11:18
"Our elected officials continue to support GI within our capital improvement plan."	2019-06-21 11:11
"Mostly comments as to why we are doing these project. Some elected officials understand it, some do not."	2019-06-21 11:00
"Not that I am aware of."	2019-06-21 10:54
"little comments just want it to look nice functionality not a major concern"	2019-06-21 09:10

Total unique respondents: 20

22. Which types of GI practices/facilities are being proposed most often in your municipality (more popular)?

Answer	Time
"bio-retention ponds or swales"	2019-08-27 16:05
"Bio areas and porous pavement."	2019-07-18 15:24
"I am not aware of any proposed GI facilities."	2019-07-18 12:37
"I am not aware of any proposed GI practices."	2019-07-18 12:20
"bio-retention or pavers"	2019-07-18 11:51
"permeable pavers, removal of paved surfaces & replacement with turf & small bio-basins"	2019-07-10 13:46
"Bioswales"	2019-07-10 07:36
"Current parking lot project will include pervious pavers."	2019-07-09 07:18
"Bioretention."	2019-07-08 12:16
"permeable pavers"	2019-07-08 11:40
"Storm Guard"	2019-07-03 13:52
"Mostly bioswales but we are moving to more permeable pavers and stormwater trees due to lack of space."	2019-07-01 07:48
"bioswale, green alleys"	2019-06-26 10:18
"Recently, it has been recirculating rain water collection"	2019-06-25 11:30
"Bioswales "	2019-06-21 13:59
"Bioswales and rain gardens."	2019-06-21 11:18
"Green alleys and rain gardens/bioswales."	2019-06-21 11:11

"Permeable Pavers, Rain Gardens, Rain Barrels"	2019-06-21 11:00
"rain gardens and rain barrels "	2019-06-21 10:54
"bioinfiltration permeable pavement"	2019-06-21 09:10
"Porous pavement"	2019-05-24 18:06

Total unique respondents: 21

23. Which types of GI practices/facilities are being proposed least often in your municipality (less popular)?

Answer	Time
"Green Roofs"	2019-08-27 16:05
"green roofs"	2019-07-18 15:24
"I am not aware of any proposed GI facilities."	2019-07-18 12:37
"I am not aware of any proposed GI practices."	2019-07-18 12:20
"wetlands, cisterns"	2019-07-18 11:51
"small(private) rain gardens & rain barrels"	2019-07-10 13:46
"N/A"	2019-07-10 07:36
"Rain barrels - most homes have ditches and sump pumps that discharge at grade."	2019-07-09 07:18
"Green roof."	2019-07-08 12:16
"green roofs"	2019-07-08 11:40
"NA"	2019-07-03 13:52
"We do not do many cisterns. There was a project some years ago that would use the basements of vacant houses as cisterns but it did not get much support and was contracted out."	2019-07-01 07:48
"NA"	2019-06-26 10:18
"Less green roofs than there used to be (cost)"	2019-06-25 11:30
"Porous pavement"	2019-06-21 13:59
"Porous pavement(maintenance issues)"	2019-06-21 11:18

"Green roof."	2019-06-21 11:11
"Ponds, Bioswales"	2019-06-21 11:00
"green roofs"	2019-06-21 10:54
"green roofs"	2019-06-21 09:10
"Green roof"	2019-05-24 18:06

Total unique respondents: 21

24. Are there green infrastructure practices/facilities that you and your staff would like to see more of? Please describe:

Answer	Time
"Not at this moment"	2019-08-27 16:05
"None."	2019-07-18 15:24
"I am not aware of any preferences the Village has for any one type of GI."	2019-07-18 12:37
"I am not aware of any preferences for certain GI practices by the Village staff."	2019-07-18 12:20
"No preference"	2019-07-18 11:51
"Construction of coastal wetland areas at Lake Michigan outfalls."	2019-07-10 13:46
"Porous surfaces"	2019-07-10 07:36
"Anything that is low maintenance and high credit for our MS4."	2019-07-09 07:18
"No."	2019-07-08 12:16
"rain gardens"	2019-07-08 11:40
"We have room for more Storm Guards"	2019-07-03 13:52
"It would be nice to start doing more bioswales in parking lots. More public-private partnerships. Otherwise stromwater trees and I personally would like to see rain gardens on private properties for those who are interested."	2019-07-01 07:48
"NA"	2019-06-26 10:18
"Funding for natural lawn care. Longer roots, healthier soil, more water retention."	2019-06-25 11:30
"No"	2019-06-21 13:59

"Think there is a lack of use of hydrodynamic separators within the region."	2019-06-21 11:18
"No"	2019-06-21 11:11
"Curb side bioswales. Bioswales in parking lots and streets with medians."	2019-06-21 11:00
"We are open to suggestions as long as they are feasible and compatible to our operations."	2019-06-21 10:54
"blue roofs"	2019-06-21 09:10
"No"	2019-05-24 18:06

Total unique respondents: 21

25. Is your community responsible for maintenance inspection of GI located on any of the following? Check all that apply.

Option	Respondents
Public Property	14
Public Right-of-Way	14
Privately-owned Property	2
Other	1
None of the above	3

Total unique respondents: 34

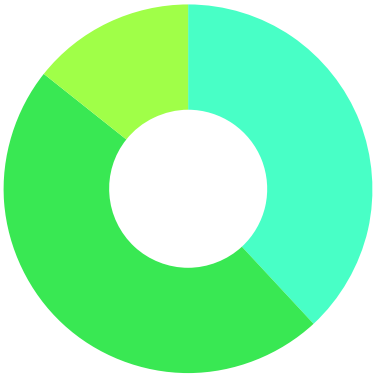
Follow-up question to option: Other

25.1. Please describe:

Answer	Time
"in easements"	2019-07-08 11:40

Total unique respondents: 1

26. If your answer to the previous question is yes, would you consider any of the following helpful?



	Option	Percentage	Respondents
	A local or regional training class.	38 %	8
	A training manual.	48 %	10
	Other (please describe).	14 %	3

Total unique respondents: 21

Follow-up question to option: Other (please describe).

26.1. Please describe:

Answer	Time
"NA"	2019-07-03 13:52
"None of above"	2019-06-26 10:18
"NA"	2019-06-25 11:30

Total unique respondents: 3

27. Are you aware of GI practices located in your community that the municipality is not required to maintain? Check all that apply.

Option	Respondents
Green Roofs	8
Bioswale (bioretention)	9
Porous/Permeable Pavement	8
Rain Gardens	11
Cisterns	7
Rain Barrels	12
Native Landscaping	7
Stormwater Trees	2
Constructed Wetlands	2

	Other (please describe)	0
●	Unsure.	4

Total unique respondents: 70

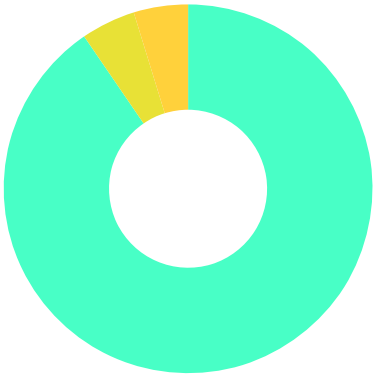
Follow-up question to option: Other (please describe)

27.1. Please describe:

No data available

Total unique respondents: 0

28. If your answer to the previous question is yes, who has the responsibility to maintain those GI practices?



Option	Percentage	Respondents
Private Property Owner	90 %	19
MMSD	0 %	0
Other (please describe)	0 %	0
Answer option	5 %	1
Answer option	5 %	1

Total unique respondents: 21

Follow-up question to option: Other (please describe)

28.1. Please describe:

No data available

Total unique respondents: 0