APPENDIX 5D: GI Assessment of Existing Facilities and Risks

Purpose

This appendix provides additional details for 2050 Facilities Plan (2050 FP) Chapter 5 that are specific to Milwaukee Metropolitan Sewerage District's (MMSD's) Green Infrastructure (GI) Asset System. This appendix is not a stand-alone document; it should always be used in conjunction with the 2050 FP, which outlines a coordinated facilities management plan for all of MMSD's asset systems.

5 Assessment of Existing Facilities and Risks

5.1 PURPOSE

This chapter provides an overview of the Green Infrastructure (GI) Asset System, including details on the components of the asset system and descriptions of the asset information used to assess possible asset system failures.

Assets were evaluated by four possible failure modes. The intent of the failure mode analysis—and the primary output of Appendix 5D—is to provide a summary of identified GI Asset System risks. Each failure mode analysis describes the dataset that was used and includes an estimated time period when each risk is predicted to occur. The risk evaluation is presented for a planning period from 2020-2050; therefore, assets identified to fail beyond 2050 have generally not been included in the potential risks presented. This assessment of existing facilities is also presented in MMSD's initial Asset Management Plan (AMP), which MMSD intends to update and refine on a regular basis

The analysis in this chapter is based on two primary sources of information: data available to assess asset risks and staff knowledge of asset system risks. For this 2050 FP, data availability and quality are at varying levels depending on the failure mode being evaluated. Therefore, some failure modes, such as physical mortality, have data available to use for evaluation while other failure modes, such as level of service failures, have minimal existing data that have been tracked at the asset level. Because of this, identified risks have been developed based on both available data as well as institutional knowledge gathered from MMSD.

Intent of Risk Assessment

Risks are defined as anything that MAY prevent MMSD from managing its assets systems to meet organization goals. The risk assessment process serves as an essential tool to help an organization prioritize its investments and identify the best practices to mitigate risk. The risks discussed in this chapter were identified by MMSD and 2050 FP project team staff and are informed by engineering judgment. When reading these assessments, it is important to note that these are identified as ***potential*** risks. The projected timing of each risk is based on the risk assessment. Not all of the risks outlined in this chapter are actually occurring, nor may they ever occur. The risks identified are further analyzed in Chapter 6, which outlines recommended projects to mitigate the potential risks and includes a recommended timeframe for project implementation.

5.2 GREEN INFRASTRUCTURE SYSTEM OVERVIEW

Background

MMSD's GI Asset System is relatively new and was not fully integrated into MMSD's AssetView system as of the writing of this document. MMSD started supporting the implementation of GI assets as part of the predecessor to the GI Asset System, the Best Management Practice (BMP) Partnership Program, in 2002. [1] However, the first full year of tracking of the existing GI Asset System was in 2012 after the adoption of the 2035 Vision in 2011.

MMSD's management of GI assets is different than management of other asset types for several reasons. First, MMSD has funded the installation of much of the GI, but does not own the GI assets. Currently, GI maintenance and repair are the responsibility of the property owner, who might be an individual homeowner, a commercial entity, or a municipality.[1] Second, GI assets are continuously being added to the GI service area. As a result, the future number of GI assets in the GI service area is expected to grow exponentially in the coming years. The key performance indicator (KPI) target is to install 740 MG of GI storage by 2035. A subset of the 740 MG GI KPI target is to install 200 MG of GI to meet projected GI goals in the 2019 and future WPDES permits. The 2050 FP assesses both existing GI assets and the projected growth of GI assets in the GI service area; in fact, a major focus of the 2050 FP is addressing the various risks that threaten the ability to meet the 740 MG target.

Current Assets

MMSD promotes and tracks GI assets, as documented in MMSD Commission Policy Resolution 12-106-7. [2] Several GI asset included in the MMSD Commission policy resolution are not addressed in detail in the 2050 FP. For example, greenways; green alleys, streets, and parking lots; and removal of structures/pavement are made up other GI assets and are therefore not tracked separately. Table 5D-1 summarizes the GI assets inventoried in the July 23, 2018 version of the GI SharePoint database (note that this version of the database does not include projects funded in 2018). There are nearly 500 individual GI assets with an average age of 4.2 years and the capacity to capture 35.3 MG of stormwater runoff. Table 5D-2 summarizes the gallons of storage associated with these GI assets by watershed and indicates that more than half of the 35.3 MG of storage capacity is in the Milwaukee and Menomonee River watersheds, with the remaining storage divided among the other watersheds.

Note that both Table 5D-1 and Table 5D-2 exclude the 105 Greenseams® projects that are included in the database. Although the Greenseams projects cumulatively store more than 220 MG of stormwater, they are not included in the assessment of GI assets for the following reasons:

- Greenseams projects are intended primarily to preserve existing flood storage capacity, and MMSD is only counting new capacity towards the 740 MG target.
- Many of the Greenseams projects are located outside of the GI service area.
- MMSD funds Greenseams projects separately from GI projects.

Flood management projects, such as the 30th Street Corridor basins and the acquisition of homes along the Kinnickinnic River, are counted towards the 740 MG target because they accomplish many of the same objectives of GI, such as infiltrating stormwater, improving water quality, and creating new storage for runoff

[1] *MMSD requires funding recipients to provide maintenance for 20 years through maintenance agreements (prior to 2017 this requirement was 10 years and prior to 2012 there were no requirements for maintenance).*

from impervious areas. Therefore, the gallons associated with these flood management projects are included in Table 5D-1 and Table 5D-2. These projects are funded separately from the GI program, even though the two programs are not mutually exclusive (i.e., many flood management projects include GI and vice versa). Of the 35.3 MG of existing GI storage, approximately 75 percent has been funded through the GI program, with 25 percent funded by the Watercourse or other programs.

TABLE 5D-1: SUMMARY OF MMSD GREEN INFRASTRUCTURE ASSETS FUNDED THROUGH 2017

Category	# of Assets	Average Age (Yrs)	Total Gallons of Storage
Bioswales	84	4.0	16,008,936
Constructed Wetlands	8	3.8	9,387,135
Green Roof	73	6.4	499,893
Impervious Surface Removal	2	2.0	5,000
Native Landscaping	40	2.6	1,440,686
Other	56	3.8	302,735
Permeable Pavement	87	4.2	2,828,100
Rain Garden	45	5.0	889,938
Rainwater Catchment	65	3.7	3,845,270
Soil Amendments	5	3.0	9,640
Stormwater Trees	28	2.2	60,200
Total / Average	**493**	**4.2**	**35,277,533**

TABLE 5D-2: TOTAL STORAGE PROVIDED BY GI ASSETS BY WATERSHED

Watershed	Total Gallons of Storage
Direct Lake Drainage	1,732,014
Kinnickinnic	1,678,879
Menomonee	7,132,316
Milwaukee	15,197,233
Oak Creek	3,752,660
Rock River	1,807,740
Root River	3,976,691
Total	**35,277,533**

5.3 RISK-BASED APPROACH

In general, the assessment of the GI Asset System followed a risk-based approach as described in Chapter 5. The following methodologies were used to assess the GI Asset System: the asset-level risk assessment and the Risk Register, as noted below.

Asset-Level Risk Assessment

Asset-level risk assessments were performed on the GI Asset System using available spreadsheet data and MMSD planning documents.

Risk Register

The risks in the GI Risk Register were generally developed based on input from MMSD staff familiar with the assets and systems, who provided guidance on developing the likelihood of failure (LOF) and consequence of failure (COF) ratings, which were used to develop the overall risk level of each risk. The 2016 GI Risk Register was used for this 2050 FP and is provided in Appendix 5D-1. The COF definitions are presented in Appendix 5D-2.[2] MMSD has also incorporated the GI Risk Register into its AssetView system and continues to update it.

5.4 ASSESSED FAILURE MODES

An overview of the capacity, physical mortality, level of service and economic efficiency failure modes is described in Chapter 5.

As noted in other chapters, the GI Asset System is different from other components of MMSD's system because, in most cases, these assets are not directly owned or operated by MMSD, but MMSD assists in paying for these assets and retains a conservation easement. Therefore, the assessments are approached differently as noted below and costs are included because most of the desired assets do not yet exist and the funding necessary to create them is a foundational part of the discussion.

In the case of GI Asset System, asset level data were available for physical mortality and, to a lesser extent, for level of service analyses. The GI Risk Register was used for level of service and economic efficiency, and a summary table of the GI Risk Register is provided as Appendix 5D-1, a summary of the level of service risks is provided as Appendix 5D-3, and the economic efficiency risk summary is provided as Appendix 5D-4. Specifically, the following data sources were used as the basis for analysis for each failure mode in the GI Asset System:

- Capacity: Because GI is a newer asset system, capacity data are not readily available, especially for assets installed prior to 2012. In addition, capacity risk for GI is expected to be very low because the flow and load demands placed upon GI assets are not expected to change significantly. Therefore, no detailed analysis was performed. The capacity failure mode analysis is presented in Section 5.5, Capacity Failure Mode.
- Physical mortality: Information on assets from MMSD's GI SharePoint database and planned future GI assets were used as the primary basis of analysis. The physical mortality failure mode analysis is presented in Section 5.6, Physical Mortality Failure Mode.
- Level of service: Limited asset level data were available to relate asset performance to the key performance indicators and performance indicators identified in Chapter 3. Therefore, the primary basis

[2] *The LOF definitions, which are defined in Chapter 5, are the same across all asset systems.*

for risk analysis was the GI Risk Register developed by the 2050 FP project team in 2016 and discussions and input from MMSD personnel. The level of service failure mode analysis is presented in Section 5.7, Level of Service Failure Mode.

- Economic efficiency: The primary basis for risk analysis was the GI Risk Register developed by the 2050 FP project team in 2016. The economic efficiency failure mode analysis is presented in Section 5.8, Economic Efficiency Failure Mode.

Words of Caution

To better evaluate several of the risks identified in the Risk Register, the 2050 FP projected the potential MMSD costs for building and maintaining the future GI assets associated with the 740 MG GI KPI target. All forecasting models rely on historical data and relationships to produce a best estimate about future circumstances. It is important to note that forecasting is an uncertain business and the presence of uncertainty is inherent when making planning, management, or policy decisions. Forecasts invariably turn out to be different than the actual numbers that occur and these forecast errors increase with increased length of the forecast horizon.

Therefore, when reading these projections, it is important to remember that the presented numbers are ***estimates*** of future demand conditions at the time of publication of this 2050 FP based on assumptions and—where noted—on planning judgment and should not be considered precise expectations of future conditions. Actual conditions will almost certainly deviate from these estimates.

5.5 Capacity Failure Mode

An asset can fail if the demand for the asset exceeds its design capacity, which can be caused by growth and system expansion. The purpose of this assessment is to identify the risk of failure due to gaps between capacity and future flows and loads.

Prior to 2012, partner reporting requirements were not as detailed as they were in 2018 during 2050 FP development; therefore, capacity assessments for each GI asset were not completed. Capacity risk for GI is expected to be very low because the flow and load demands placed upon GI assets are not expected to change significantly. As explained in Chapter 4, climate change might result in increasing precipitation intensity in a few larger events, which might result in additional stress on existing GI assets. However, the consequences of this happening are not expected to be significant because most larger GI assets are already designed with underdrains so that excess water is simply diverted to the storm system when this occurs. Therefore, no detailed capacity assessment was conducted for this 2050 FP. It is important to note that MMSD understands GI is a beneficial supplement to the existing grey infrastructure system. Although the capacity risk for GI is considered low, MMSD has committed to using GI to supplement the grey system and recognizes the other triple bottom line benefits that GI brings to the region.

5.6 Physical Mortality Failure Mode

Physical mortality assessments are designed to identify the risk of failure due to asset deterioration. The timing of the replacement or rehabilitation of an asset can be determined based on an asset's expected remaining life, which is typically adjusted based on the criticality or COF of the asset.

Mortality risk for GI assets was addressed at the system level rather than at the individual asset level because the condition ratings of current assets is limited due to their age and the in-progress integration of the GI SharePoint database into MMSD's asset management system. Therefore, the timing of the replacement or rehabilitation of the GI assets was determined based solely on expected remaining life and does not consider COF. Physical mortality risk was evaluated both for the existing GI assets as well as the ones that are expected to be built to reach the Regional GI Plan and 2035 Vision goals.

The following data were used to conduct the GI physical mortality assessment:

- MMSD's GI SharePoint database (dated July 23, 2018, which includes GI assets as of 2017) is an Excel spreadsheet that includes information on GI projects funded by MMSD between 2003 and 2017.[3] The 2050 FP project team loaded the spreadsheet into an Access database and then queried the database to obtain the summary statistics presented herein. The spreadsheet is actively maintained by MMSD and includes the following information about each funded project:
    - Title, Location, Contact Information
    - Source of Project Funding (e.g., Greenseams, Green Infrastructure Partnership Program, Green Solutions)
    - Year Funded, Year Installed
    - Cost (both for MMSD and for project partners)
    - Total Gallons Stored by the project
    - Size (e.g., Square Feet) and Gallons Stored by GI Strategy[4] (e.g., Permeable Pavement, Rain Garden)
- The MMSD Regional GI Plan was used to obtain information on the planned types and quantities of GI expected by the year 2035. [3] It should be noted that the Regional GI Plan was used as a foundational element of the 2050 FP; however, it will be approximately six years old at the time the 2050 FP is completed, and significant progress has been made compared to the assumptions in the Regional GI Plan. Therefore, there are some differences between the recommendations of the Regional GI Plan and the 2050 FP, which are noted where they occur. Additionally, it is recommended that the Regional GI Plan be updated upon completion of the 2050 FP.
- The MMSD Green Infrastructure Operations and Maintenance Implementation Framework was used to provide background information on future maintenance activities. [4]
- The MMSD Green Infrastructure Standard Specifications and Plan Templates report was used to obtain information on expected maintenance costs and life expectancies by type of GI asset. [5]

Figure 5D-1 shows how many gallons of storage have been installed by type of GI asset from the first project in 2003 through 2017, and Table 5D-3 presents the life expectancies for the various GI assets. The physical mortality assessment discussed in the following sections addresses the need to replace these existing GI assets as well as the future GI assets that must be added to reach the 740 MG target. The assessment therefore is

[3] *Information on assets funded in 2018 will be entered once those projects are completed. The GI SharePoint database is in the process of being migrated to the AssetView database to ensure consistency with the other asset systems. This conversion was not completed in time to be used to support the analysis provided in this appendix.*

[4] *Gallons stored in database are derived from the MMSD Regional GI Plan and are also referenced in the WDNR permit.*

based on the assumption that all GI assets will be installed by 2035 but also includes the need for replacement and maintenance costs through 2050. This is not to say that no additional GI will need to be built after 2035, but that it is expected that the practice of using GI will become commonplace and MMSD will reduce its capital subsidy of the practice accordingly.

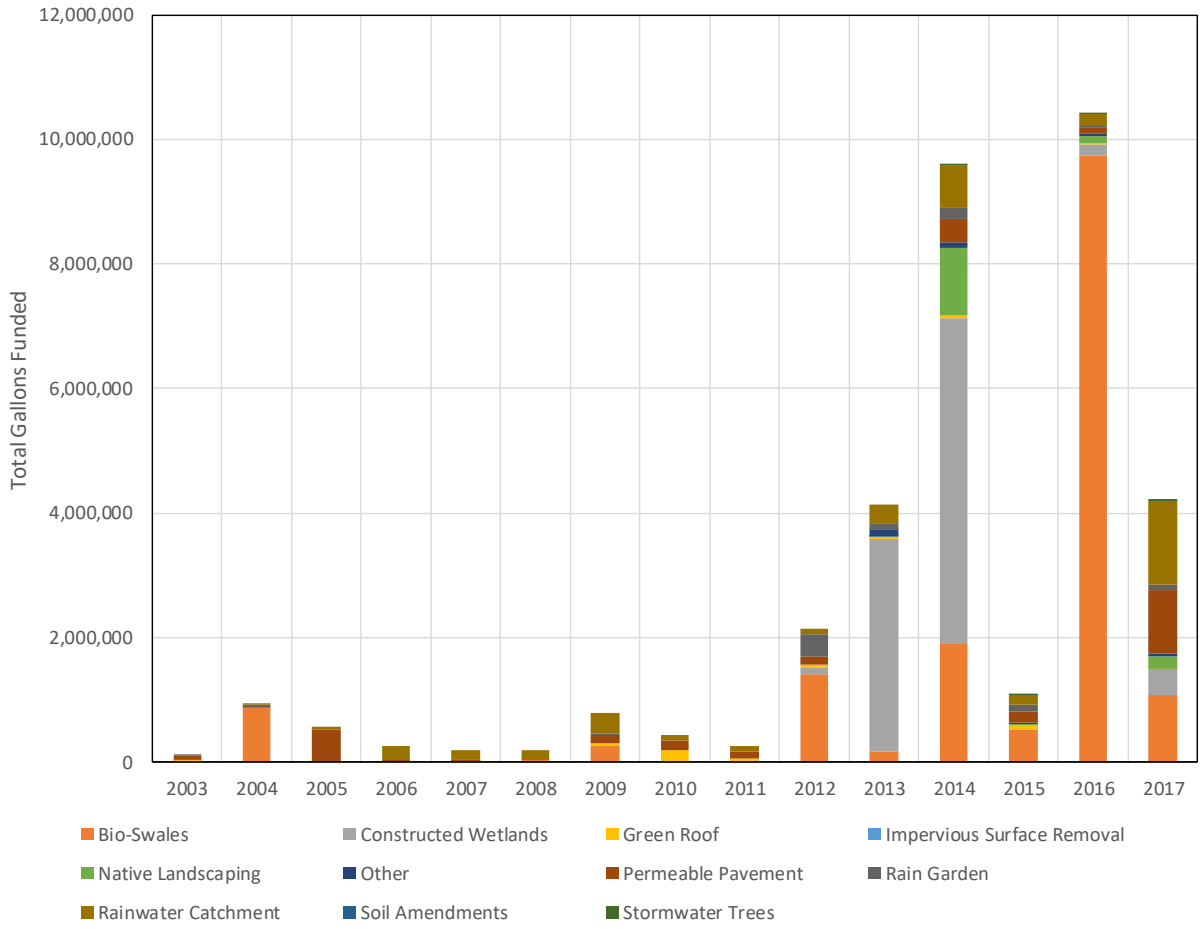

FIGURE 5D-1: TOTAL GALLONS OF GI FUNDED BY YEAR AND BY ASSET TYPE

TABLE 5D-3: ANNUAL O&M COSTS AND LIFE EXPECTANCIES FOR THE MMSD GI ASSET TYPES

GI Asset Type	Percent of 740 MG Storage[1]	Annual O&M Costs (% of Capital Costs)[1]	Useful Life Expectancy (Years)[2]
Bioswale/Bioretention	25%	5%	20 years
Cistern	1%	5%[3]	20 years[4]
Green Roof	9%	5%[3]	30 to 50 years[3]
Native Landscaping	25%	5%	20 years
Porous Pavement	20%	4%	20 years
Rain Barrel	1%	3%[3]	10 years[4]
Rain Garden	13%	5%	20 years
Soil Amendments	3%	3%	2 years[4]
Stormwater Trees	3%	10%	20 years for media; 50 to 100 years for tree
Total/Weighted Average[6]	**100%**	**4.9%**	**20**

1) Percent of 740 MG Storage based on Regional Green Infrastructure Plan for most GI assets but adjustments made for bioswale/bioretention, native landscaping, and soil amendments based on updated expectations

2) Source for O&M costs and life expectancies unless otherwise noted is the *MMSD Green Infrastructure Standard Specifications and Plan Templates* report

3) Life expectancy of green roof from https://www.epa.gov/sites/production/files/2014-08/documents/greenroofscompendium_ch3.pdf (accessed August 19, 2019)

4) Best professional judgment

5) Life expectancy for soil amendments presented in *MMSD Green Infrastructure Standard Specifications and Plan Templates* is 50 years but 2 years is used for 2050 FP because of need to compost and aerate at least every two years to maintain performance

6) Total shown for 2nd column of table and weighted averages shown for 3rd and 4th columns; weighted averages calculated by multiplying the percent of total storage for each asset type by its O&M cost or life expectancy and then summing for all GI assets

The weighted average life expectancy for GI assets is assumed to be 20 years based on information from the Regional Green Infrastructure Plan [3], the MMSD GI Standard Specs and Plan Templates Report [5], and updates made in preparing the 2050 FP (Table 5D-3). A life expectancy of 20 years means that, on average, 4.9 percent of all GI assets will need to be replaced each year, meaning that assets installed in 2003 will need to be replaced starting in 2023. The 2050 FP assumes that replacement costs will be primarily the responsibility of the owners of the GI assets, with MMSD paying for 5 to 10 percent of replacement costs to cover situations where critical assets cannot be replaced by the owners. The rationale for the 5 to 10 percent assumption is that MMSD is expected to only have a very limited role in GI replacement as GI becomes more of a standard practice across the region. The upper end of the assumption (i.e., 10 percent) is to cover situations where MMSD might take a more active role in replacement for GI assets located on private property that are treating runoff from public area. The upper end of the assumption was used to estimate potential MMSD replacement costs, which are

shown in Figure 5D-2 and start to be incurred in 2023 when the GI installed in 2003 begins to reach the end of their useful life. The anticipated replacement costs also include those needed to replace future GI assets built after 2017. The total (non-discounted) replacement funding needed for the different time periods is as follows:

- Pre-2020: $0
- 2020 to 2024: $3.1M
- 2025 to 2029: $8.0M
- 2030 to 2039: $45.8M
- 2040 to 2049: $62M

In summary, although no physical mortality risks had yet been identified in the initial Risk Register, subsequent analysis has indicated that this is a potentially significant risk because MMSD will need to start to re-invest in GI during the 2020 to 2050 planning period. Obtaining the funding to replace GI is addressed in Chapter 6.

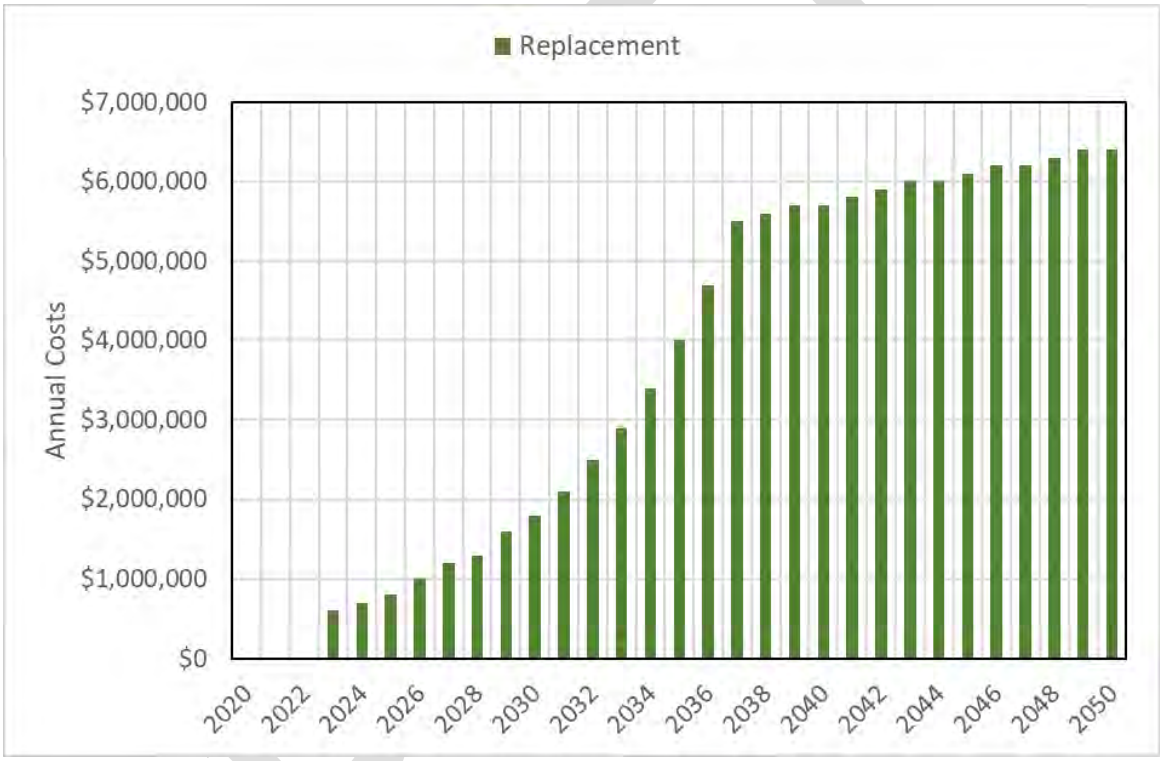

FIGURE 5D-2: PROJECTED GI REPLACEMENT COSTS OVER TIME

5.7 LEVEL OF SERVICE FAILURE MODE

Level of service expectations were developed in Chapter 3. If the service that the asset is providing no longer meets defined service metrics regarding expected performance, then it is considered to fail to meet the required level of service. This failure may be occurring now or may be projected to fail in the future. An asset can fail to meet the level of service by falling below a required condition or performance level or it may fail when the required level of service has increased to a level beyond the asset's capacity.

Limited asset level data were available to relate asset performance to the key performance indicators and performance indicators identified in Chapter 3. Therefore, the primary basis for risk analysis was the GI Risk Register developed by the 2050 FP project team in 2016. All identified level of service risks were assigned to the time period 'Before 2020.' The level of service specific risks are summarized in Appendix 5D-3, GI Risk Register – LOS Risks.

Most of the risks identified for the GI program in the Risk Register are associated with not providing the desired level of service due to an insufficient number of GI assets being built by 2035 (i.e., not meeting current and potential future permit goals as well as the KPI target of 740 MG of GI storage and therefore the 2035 Vision goal of zero overflows). This concern is based on several factors, including the following:

- As of 2017 only 35.3 MG of the 740 MG target had been achieved. The Regional GI Plan recommended that 40 MG of GI be added per year starting in 2019. That may be unrealistic given the pace of the last several years (i.e., 9 MG in 2014, 1 MG in 2015, 10 MG in 2016, and 4 MG in 2017).
- Funding programs to date have focused on an opportunistic approach where willing partners contact MMSD to assist with funding their projects. While this approach was critical to build knowledge and acceptance of GI, this path alone will not achieve the permit goals and the goals of the Regional GI Plan and 2035 Vision. A scale up in programming that focuses on targeted efforts is necessary.
- Given current average costs and the traditional proportion of GI paid for by MMSD, MMSD would need to spend about $26M/yr to add 40 MG of GI in 2019 and 2020. That amount exceeds what has been set aside for GI in the 2019 and 2020 budgets.
- In addition to increased funding for GI, MMSD needs to address a variety of other related issues. For example, there is currently a mismatch between the expected life of GI assets (typically 20 years) and the easement length of GI projects (nationally this can range from 11 years to perpetuity; MMSD attempts to get 20 years for each easement, but has to be flexible). There are also issues with the financial reporting and accounting treatment of GI.
- Reaching the goals set forth in the Regional GI Plan and the 2035 Vision is very dependent on a wide variety of stakeholders implementing GI at their homes, businesses, and on government property. However, some key stakeholders within the region are still skeptical of GI and are therefore unlikely to make the investments needed to reach the 740 MG target. Reasons for skepticism include:
    - Perception in the region that certain types of GI can have a negative impact on inflow and infiltration
    - Lack of confidence by some individuals that GI can help to reduce the frequency and volume of combined sewer overflows and separate sewer overflows
    - Concerns that GI will not be adequately maintained
    - Greater cost to install GI than other stormwater control technologies (e.g., detention ponds)

  - Perception that GI capacity is not needed outside of the combined sewer service area (CSSA)
- The regulatory environment is not as conducive to GI installation as it needs to be. For example:
  - GI is not yet as integrated into transportation and development/redevelopment design standards as it needs to be to meet the 740 MG target.
  - Some municipal codes and ordinances still pose a barrier to GI. Even though MMSD has invested significant resources to address this issue over the past several years, more work needs to be done.
  - The impact of the recently-approved total maximum daily loads (TMDLs) on GI implementation is still relatively unknown.
- Insufficient MMSD staffing could hold back program growth and implementation rates.
  - Current programs are operating at maximum capacity for what can be managed.
  - GI maintenance assessments are being completed by interns rather than by construction and fully-trained maintenance personnel.

The risks identified for the GI program in the Risk Register are summarized in Table 5D-4, which shows that there are 1 high risk, 17 moderate risks, 4 low risks, and 2 minimal risks.

TABLE 5D-4: GI ASSET SYSTEM – LEVEL OF SERVICE RISKS

Failure Mode	High Risk	Moderate Risk	Low Risk	Minimal Risk	Total
Level of Service	1	17	4	2	24

The one high risk (G012) identified is defined as follows:

> *TMDL requirements will offer a significant opportunity for municipalities to install GI to treat stormwater to meet future load reductions. MMSD risks missing out on that opportunity by not working with municipalities to put policies in place to allow credit for both quality and quantity benefits, or by somehow having non-GI practices primarily used to reduce loads.*

Potential strategies to mitigate this risk and all of the other risks except for one are addressed in Chapter 6; the one risk that is not addressed is a minimal risk that is unrelated to all of the high and moderate risks. The other minimal risk and all of the low risks are related to the high and moderate risks so they are addressed at the same time.

To better evaluate several of the risks identified in the GI Risk Register (Appendix 5D-1), the 2050 FP projected the potential MMSD costs for building and maintaining the future GI assets associated with MMSD's 2035 Vision 740 MG target. The projection is complicated because nearly all future GI assets will not be owned by MMSD, and many factors (e.g., funding availability, cost of GI, municipal and residential attitudes toward GI, regulatory drivers) are difficult to predict. The following discussion presents the assumptions used in developing the 2050 FP, but it is strongly emphasized that there is a large degree of associated uncertainty. The use of GI continues to evolve and MMSD is constantly tracking local trends and coordinating with peer agencies across the country to identify lessons learned, investigate potential funding options, and practice adaptive management. The future types, amounts, and costs of GI may therefore end up being quite different than the assumptions used here.

One key assumption needed to estimate the future capital costs of GI assets is the average cost per gallon of storage. Information on the existing cost to install GI assets was based on data in the SharePoint database for the years 2014 to 2017; records from this time period are considered much more reliable than cost information in the database from prior to 2014. For these three years, 25.3 MG of GI storage capacity was added at a total cost of approximately $52.9M, for an average capital[5] cost of $2.09/gallon. This value is used as the starting point for estimating future capital costs, but the 2050 FP recommends that MMSD promote more cost-effective GI to reduce the average cost over time to approximately $1.75/gallon. The lower cost is used because it is believed, at this time, that the cost for GI may decrease over time, and the strategies for incorporating GI into other projects (e.g., roadway reconstruction) pose opportunities to reduce overall GI costs through economies of scale. Additionally, it is recommended that MMSD emphasize GI assets that provide more value for the dollar. Additional details about how this recommendation can be accomplished are provided in Chapter 6.

Another key assumption needed to estimate the future capital costs of GI assets is the proportion to be paid by MMSD as part of their partnership programs. The distribution of total costs for the GI assets funded between 2014 and 2017 was approximately 46 percent MMSD and 54 percent project partners. The 2050 FP recommends that the proportion of GI capital costs funded by MMSD over time be reduced, eventually reaching 35 percent by the year 2030 as shown in Figure 5D-3. The recommendation for 35 percent is based primarily on limiting MMSD's investment to a reasonable amount. This funding reduction strategy is recommended if certain regional conditions are met. Those regional conditions include GI implementation becoming standard practice for municipal capital improvements, GI is promoted among the 28 member municipalities through adoption of code and ordinance revisions, and MMSD does not see a sharp decrease in GI implementation. If any of these were to occur, MMSD might need to continue to fund a larger portion of the future GI.

Estimating the future capital costs of building GI assets also required that assumptions be made about the cost of achieving the current and future permit goals. MMSD's current WPDES permit, issued in 2019, specifies a total GI volume ['retention capacity'] goal of 50 MG by 2024. MMSD expects that the 50 MG volume will be included in future permits, such that a cumulative total of approximately 200 MG of GI will be required by the 2035 to 2040 permit cycle. The cost for achieving the 200 MG of GI was estimating using information from MMSD's new community-based GI (CBGI) delivery model, which allows MMSD to ensure that targeted amounts of GI are constructed in priority locations. MMSD's first CBGI project will cost $2.37/gallon so this value was used to estimate a total cost of $474M for the 200 MG GI permit goal. These costs start in 2020 and increase until 2035, coinciding with MMSD's 2035 Vision 740 MG target.

Finally, future capital costs include the addition of 10 MG of GI per year for the 2035 to 2050 time period through MMSD partnership programs. This assumption is made because of the expectation that the implementation of GI will decrease after the year 2035 but is unlikely to stop completely.

[5] *Capital cost is the cost of the planning, design, and construction of an asset. It does not include outreach costs, maintenance costs, or replacement costs.*

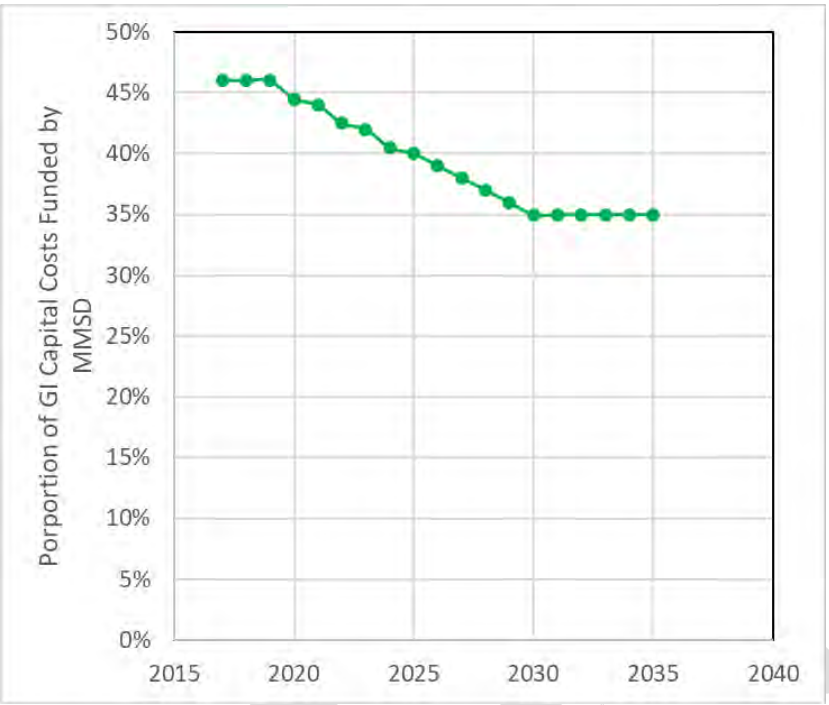

FIGURE 5D-3: PROPORTION OF GI CAPITAL COSTS FUNDED BY MMSD OVER TIME

Future GI maintenance costs were also projected. Based on feedback from project partners [4] most maintenance activities will be performed by project owners (e.g., municipalities, private property owners) with MMSD providing regional training and specialized maintenance support through the Fresh Coast Resource Center. MMSD might also need to take on a larger maintenance role for projects that treat runoff from public lands on private property. Specialized maintenance support could include maintaining larger, more complex GI assets, those that require special equipment (e.g., the use of a vacuum truck to clean porous pavement), or important GI assets that cannot be maintained by the property owner for assorted reasons (e.g., bankruptcy). For the purposes of the 2050 FP, it is assumed that maintenance costs will average 4.9 percent of total annual capital costs based on information from the MMSD GI Standard Specs and Plan Templates Report [5], which is presented in Table 5D-3. It is further assumed that MMSD will pay for approximately 10 percent of the total regional maintenance costs and project partners will pay for the rest although it is recognized that this assumption will need to undergo MMSD policy review before it becomes reality. The 10 percent value is based on best professional judgment that considers the following:

- Most maintenance activities will be performed by the owners of the GI assets.
- Some of the proposed GI may require special equipment or skills to maintain. Therefore, specialized maintenance to be provided by MMSD will only be for a small percentage of assets. For example, porous pavement (one of the types of GI that requires specialized maintenance) represents only about 8 percent of the 35.3 MG of storage constructed by 2017.
- This assumption results in approximately $6.5M/yr in maintenance costs for MMSD in peak years, which is a reasonable amount of MMSD's total operations and maintenance budget (e.g., $104.7M in 2019).

Combining the following key assumptions described previously results in future MMSD GI capital and maintenance costs as shown in Figure 5D-4:

- GI capacity assumed to be installed as of the end of 2019 is approximately 40 MG, based on 35.3 MG of GI by 2017 and a conservative assumption regarding additional GI installation[6]
- Addition of GI by year as shown in Figure 5D-4
- MMSD funding 200 MG of GI storage at $2.37/gallon to meet current and future permit goals
- Average cost/gallon of GI storage for partnership programs at $2.09 in 2017 and gradually decreasing to and staying at $1.75/gallon by 2028
- MMSD portion of capital funding for partnership programs decreasing from 46 percent in 2017 to 35 percent in 2030 as shown in Figure 5D-3 (subject to caveats previously mentioned)
- MMSD GI program funding 75 percent of future GI with remaining 25 percent of funding coming from other programs (e.g., Watercourse)
- Maintenance costs averaging approximately 4.9 percent of total capital costs and MMSD paying for 10 percent of GI maintenance

The total (non-discounted) MMSD funding needed for capital investment and maintenance is shown in Figure 5D-4 and the totals by planning period are:

- 2020 to 2024: $77.3M
- 2025 to 2029: $148.3M
- 2030 to 2039: $567.8M
- 2040 to 2049: $119.4M

[6] It should be noted that the methodology for counting GI gallons changed in 2019 with the adoption of updated rules in Chapter 13. The volumes of pre-2019 GI used to support development of the 2020 Facilities Plan will therefore differ somewhat from those available in the future.

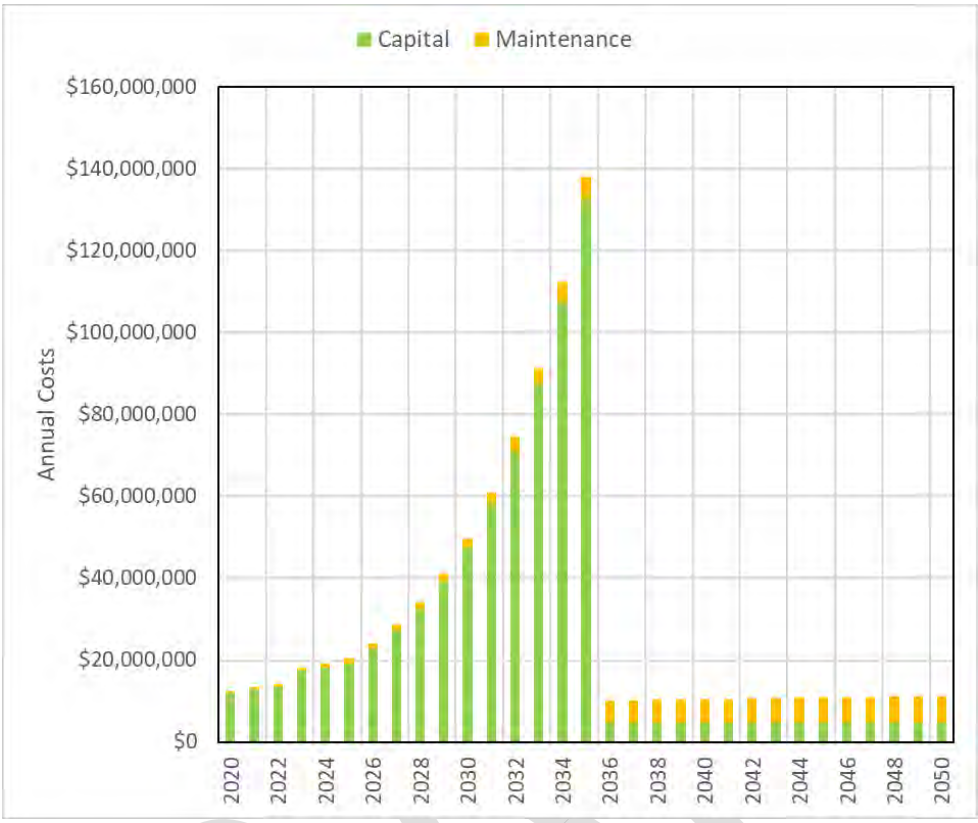

FIGURE 5D-4: PROJECTED FUTURE MMSD GI CAPITAL AND MAINTENANCE COSTS

The MMSD funding needed for capital investment and maintenance of GI is a component of several of the risks in the Risk Register, each of which is addressed in Chapter 6.

5.8 ECONOMIC EFFICIENCY FAILURE MODE

Economic assessments are designed to determine if lower cost alternatives are available to meet the required service levels. The primary basis for risk analysis for GI assets for economic efficiency was the GI Risk Register developed by the 2050 FP project team in 2016. All identified economic efficiency risks were assigned to the time period 'Before 2020.' The economic efficiency specific risks are summarized in Appendix 5D-4, GI Risk Register – Economic Efficiency Risks. One risk was identified, which is that traditional stormwater projects can store runoff more cheaply than many types of GI. For example, average costs for a detention pond are reported at $1.06/gallon [6] compared to the average cost of GI in the MMSD SharePoint database of $2.09/gallon.[7] This risk is partially offset by the following:

- GI performs much better than traditional stormwater controls on a variety of triple bottom line criteria (e.g., aesthetics, increased property values, urban biodiversity).
- Many GI assets achieve significantly better pollutant load reductions than traditional controls (e.g., some stormwater ponds have been shown to increase rather than decrease phosphorus loading [7]).

[7] *$2.09 is based only on projects from 2014 to 2017 because cost information from before this period is not considered as reliable.*

- Space constraints limit the applicability of traditional stormwater controls in high density urban areas, such as those that exist in the CSSA.

The economic efficiency risk identified for the GI program in the Risk Register is summarized in Table 5D-5, which shows that there is one moderate risk, which is addressed in Chapter 6.

TABLE 5D-5: GI ASSET SYSTEM – ECONOMIC EFFICIENCY RISKS

Failure Mode	High Risk	Moderate Risk	Low Risk	Minimal Risk	Total
Economic Efficiency	0	1	0	0	1

5.9 SUMMARY OF FINDINGS

The following summarizes the GI system risks that are evaluated in Chapter 6 to identify the recommended projects to address these risks:

- **Capacity Risks.** Capacity risk for GI is expected to be very low because the flow and load demands placed upon GI assets are not expected to change significantly. Therefore, a capacity risk assessment was not conducted for this asset system.
- **Physical Mortality Risks.** There are no physical mortality risks for the pre-2020 planning period, $3.1M for the 2020 to 2024 planning period, $8.0M for the 2025 to 2029 planning period, $45.8M for the 2030 to 2039 planning period, and $62M for the 2040 to 2049 planning period. Options for obtaining funding to replace GI are addressed Chapter 6.
- **Level of Service Risks.** Most of the risks identified for the GI program are associated with not providing the desired level of service due to an insufficient number of GI assets being built by 2035 (i.e., not meeting the 200 MG permit goal or the 740 MG GI KPI target, with only approximately 40 MG of GI installed as of the end of 2019). The funding needed for capital investment and maintenance to achieve this goal is $77.3M for the 2020 to 2024 time period, $148.3M for the 2025 to 2029 time period, $567.8M for the 2030 to 2039 time period, and $119.4M for the 2040 to 2049 time period. Twenty-four of the 25 risks in the Risk Register are level of service risks. The one high risk is associated with not taking advantage of the opportunity of the TMDL to help achieve the 740 MG GI KPI target and therefore, the 2035 Vision. Potential mitigation strategies to address these risks are evaluated in Chapter 6.
- **Economic Efficiency Risks.** There is one economic efficiency risk, which is a moderate risk. Potential mitigation strategies to address this risk are evaluated in Chapter 6.

5.10 APPENDICES

- Appendix 5D-1: GI Risk Register
- Appendix 5D-2: GI Risk Register COF Definitions
- Appendix 5D-3: GI Risk Register – LOS Risks
- Appendix 5D-4: GI Risk Register – Economic Efficiency Risks

5.11 REFERENCES

[1] CH2M Hill, "Final Energy Plan," MMSD, Milwaukee, WI, 2015.

[2] Milwaukee Metropolitan Sewerage District, "Commission Policy, Subject: MMSD Infrastructure Includes Green Infrastructure, Index: 1-11.05, Resolution 12-106-7," MMSD, Milwaukee, WI, 2015 (Revision from 2012 document).

[3] Milwaukee Metropolitan Sewerage District, "Regional Green Infrastructure Plan," MMSD, Milwaukee, WI, 2013.

[4] Milwaukee Metropolitan Sewerage District, "MMSD Green Infrastructure Operations and Maintenance Implementation Framework," MMSD, Milwaukee, WI, 2016.

[5] Milwaukee Metropolitan Sewerage District, "MMSD Green Infrastructure Standard Specifications and Plan Templates," MMSD, Milwaukee, WI, 2016.

[6] King County, WA, "Stormwater retrofit planning project for Green River Watershed," 2012. [Online]. Available: https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/green-duwamish/stormwater-retrofit-project/updated-cost-assumptions-12-2012.pdf.

[7] Center for Watershed Protection, "Phosphorus Release in Stormwater Ponds," 25 July 2018. [Online]. Available: https://www.cwp.org/phosphorus-release-stormwater-ponds/. [Accessed 13 September 2019].

APPENDIX 5D-1: GI Risk Register -

MMSD 2050 Facilities Plan
Green Infrastructure Asset System Risk Register

Risk Identification			Risk Analysis										
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G001	Codes and Ordinances a barrier to GI	Some municipal codes and ordinances do not allow or significantly limit the installation of GI. This will impact the ability to meet the 740MG goal by 2035. Will limit beneficial impact of GI.	Voluntary recommendations have been developed to change ordinances and codes by 1KF of WI and Birchline Consulting. Clean WI, Sweet Water, and Orion are working with municipalities to implement.	Very High	Already occurring.	Medium	This is one factor that will prevent reaching annual goals.	75	25	1,875	Moderate	Level of Service	Permit Requirements
G002	Inadequate O&M that causes lack of performance	Projects won't remain effective, might need replacement, won't last through entire useful life, don't meet permit goal, won't reach 2035 Vision, negative impact to reputation of GI (reduced confidence), won't realize GI co-benefits.	Conservation easements (albeit 10 years, to raise to 20 years in 2017), 5% of funding allowed for vegetation establishment, annual inspections	Very High	Need isn't well recognized, funding sometimes lacking, is already occurring.	Medium	Possible permit violation, potential decrease in local property value, and loss of goodwill.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G003	Insufficient GI installed per year to meet 2035 goals - MMSD projects	Current implementation of GI will only get to ~5% of the 2035 goal.	Incentives, both financial and technical/regulatory, are lacking to meet increased pace of GI installation that is intended to start in 2019 (per Regional GI Plan).	Very High	The average annual goal for GI adoption from 2013 to 2019 is 1.6 MG/yr. but this goal increases to an average of 40 MG/yr. in 2019. Current funding levels, incentive programs, etc. are not sufficient to meet the increased future goal.	Medium	Need to either develop plan to increase implementation, reduce goal, or extend goal	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G004	Insufficient tracking of installed GI (for performance and maintenance) - both MMSD and non MMSD projects/programs	MMSD only tracks MMSD sponsored GI. Many municipalities have GI projects and programs that are not tracked (compost application for example). Without tracking these, it is impossible to know the status of the goal achievement.	MMSD currently tracks the location, type, and ownership of all GI strategies implemented using MMSD funding.	Very High	Limited tracking occurring for GI strategies implemented without MMSD funding.	Medium	Many GI projects and activities not tracked which makes assessment of the 740 MG goal impossible	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G005	There is a perception in the region that certain types of GI can have a negative impact on I/I	The perception is that, since GI projects are designed to infiltrate more groundwater, they could potentially worsen the infiltration component of I/I	Past analysis showed that this risk is not warranted but perceived risk is still present in many circles. Recommendations for clarifying this risk are being developed as part of the 2050 project.	Very High	If focused on perception, the (miss)perception is already occurring. Research performed to date indicates this risk is perceived to be larger than it really is.	Medium	Moderate loss of reputation or long-term goodwill with customers, residents and stakeholders	75	25	1,875	Moderate	Level of Service	Customer Service, Communication and Employee Development
G006	High costs of GI in terms of type of GI and cost effectiveness of GI (e.g. -- restated -- not matching the most TBL effective GI with the site conditions)	There is a need to try and incentivize the use of the best fit GI, depending on site and context (e.g. compost vs. green roofs).	None	Very High	Already occurring.	Medium	Increasing costs for GI will make it less likely to achieve 2035 Vision and could impact permit requirements	75	25	1,875	Moderate	Level of Service	Fiscal Responsibility
G007	GI fails to perform as designed due to changes in climate and modeled rainfall events	Climate change (e.g., warmer temperatures, less summer precipitation, intense spring and summer storms) could cause GI to fail because vegetation cannot adapt, systems become overloaded, etc. Estimated performance could decrease if projected weather patterns occur.	None	Medium	Difficult to predict the extent to which this might occur.	Medium	Moderate loss of reputation or long -term goodwill with customers, residents and stakeholders.	5	25	125	Low	Level of Service	Environmental Improvements
G008	GI adopted without considering most beneficial impact locations	Adoption of GI may vary widely by municipality or watershed due to differences in funding, codes, demographics, etc.	None	Very High	Already occurring.	Medium	If some municipalities are lacking in GI, then they could jeopardize attainment of the MMSD 2035 and 2050 goals.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G010	Inadequate O&M of GI due to lack of a qualified workforce and/or a lack of understanding of standard practices	Adoption of GI throughout the service area will require an ever-increasing amount of maintenance; workforce with the right skill set and availability will be needed. This full workforce does not now exist and doesn't have the correct training.	None	Very High	Already occurring to some extent.	Medium	Possible permit violation, potential decrease in local property value, and loss of goodwill.	75	25	1,875	Moderate	Level of Service	Environmental Improvements

Risk Identification			Risk Analysis										
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G011	Available MMSD GI funding not used	Not all funding available in the recent years has been used.	Data is available to assess, and program rules have been changed to help address the issue.	Low	Already has occurred as funding has not been exhausted.	Medium	Adversely impacts the achievement of the program goal of 740 MG.	2	25	50	Minimal	Level of Service	Fiscal Responsibility
G012	Impact of TMDLs on GI implementation unknown	TMDL requirements will offer a significant opportunity for municipalities to install GI to treat stormwater to meet future load reductions. Do not want to miss out on that opportunity by having policies that do not allow credit for both quality and quantity benefits, or by somehow having non-GI practices primarily used to reduce loads.	None at this time.	Very High	No data/connection exists or is not being considered - possibly this can be done in the 2050 plan.	High	Adversely impacts the achievement of the program goal of 740 MG.	75	220	16,500	High	Level of Service	Environmental Improvements
G013	Less than optimal defensible data available to determine impact of GI on CSOs and particularly SSOs.	No well-established direct tie between GI and CSO/SSO - need to model and evaluate further.	Will do in the 2050 FP.	Very High	Modeling not complete (may need to raise consequence of failure…please check) KLSs agrees: may need to raise consequence of failure. Not establishing this link will be detrimental!	Medium	Results will impact GI program implementation.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G014	Funding - Financial issues associated with GI value, life cycle and other.	How best to tie financial analysis with AMP analysis needs to be determined.	Discussions and evaluation underway.	High	Many questions exist.	High	Will greatly influence GI program implementation.	25	220	5,500	Moderate	Level of Service	Fiscal Responsibility
G015	Financial reporting and accounting treatment of GI versus AMP treatment of GI inconsistent.	Confusion of terms, methods, data, etc. some of which is grounded in generally accepted accounting practices.	Discussions and evaluation underway.	High	TBD	High	Will greatly influence GI program implementation.	25	220	5,500	Moderate	Level of Service	Fiscal Responsibility
G017	Mismatch between life and easement length of GI projects and impact on funding sources and financial accounting.	Capital funds are intended to be used for projects that last 10 years, CWF loans require 20 years, other areas of the country require even longer easement and/or other maintenance commitments, yet current MMSD GI easements are only for 10 years.	Discussions and evaluation underway, and where possible easements in 2017+ will be for 20 years.	High	TBD	High	Will greatly influence GI program implementation.	25	220	5,500	Moderate	Level of Service	Fiscal Responsibility
G018	Poor municipal GI coordination within and across subwatersheds/watersheds.	Lack of coordination leads to duplication, inefficiencies (cost, effectiveness), and sometimes inaction.	Happens all the time.	Very High	Already happening	Low	More of a direct municipal issue than an MMSD issue, but will adversely impact the achievement of the program goal of 740 MG.	75	6	450	Low	Level of Service	Environmental Improvements
G019	Regulations need to optimally stay updated and be enforced regularly.	Regulations need to catalyze and support other programs.	Review every 5-10 years.	Low	Text Entry	Medium	Text Entry	2	25	50	Minimal	Level of Service	Environmental Improvements
G020	Public information/education doesn't change mindsets and catalyze increased GI adoption.	This is key to voluntary adoption.	There are some limited efforts underway now but they could be enhanced (e.g., use of Sparkle the dog).	Very High	Pace of GI adoption indicates more marketing/outreach is still needed.	Medium	Text Entry	75	25	1,875	Moderate	Level of Service	Customer Service, Communication and Employee Development
G021	Insufficient staffing could hold back program growth and implementation rates.	Programs across the county tend to have more staff dedicated to green infrastructure efforts, but current political climate, MMSD budget belt tightening, and lack of regulatory driver do not push more money toward staffing. Current staff can only manage so many projects.	Annual request for more staffing coincide with budget, looking at public-private partnership models, etc.	Very High	Already occurring.	Medium	Adversely impacts the achievement of the program goal of 740 MG.	75	25	1,875	Moderate	Level of Service	Customer Service, Communication and Employee Development
G022	Insufficient GI installed per year to meet 2035 Goals - Non-MMSD Projects.	This risk is related to G003 but is for non-MMSD projects. Non-MMSD projects will be critical to meeting the 2035 goal but current implementation will need to increase dramatically.	Incentives, both financial and technical/regulatory, are lacking to meet increased pace of GI installation that is intended to start in 2019 (per Regional GI Plan).	Very High	Already occurring (pace of non-MMSD funded GI projects is relatively low).	Medium	Need to either develop plan to increase implementation, reduce goal or extend goal.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G023	Insufficient GI installed in combined sewer service area because of DNR policy and municipal practice.	Current DNR practice already allows counting of 100% stormwater treatment in the CSSA, so this tends to disincentivize GI.	None at this time.	Very High	Already occurring.	Medium	Failure to install GI in the City of Milwaukee will make it very difficult to reduce CSOs through the use of GI.	75	25	1,875	Moderate	Level of Service	Environmental Improvements

Risk Identification			Risk Analysis									
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G024	Not attaining the future permit goals for GI.	Adding GI annually, per permit cycle, is a requirement of MMSD's WPDES permit. MMSD strives for 100% permit compliance. Not attaining GI goals is not consistent with MMSD's approach to permit compliance.	Consistently following the recommendations of MMSD's Regional GI Plan.	Low	Permit goal has been below recent implementation rates.	Very High	Permit non-compliance would be a serious issue.	2	1,000	2,000	Moderate	Level of Service	Permit Requirements
G025	Lack of GI integration into development and redevelopment.	GI should not be viewed only as a stand-alone project. Opportunities for GI should be considered in all development/redevelopment projects.	Chapter 13.	High	Already occurring for some development <0.5 ac.	Medium	Lost opportunities, and adversely impacts the achievement of the program goal of 740 MG.	25	25	625	Low	Level of Service	Environmental Improvements
G026	Lack of GI Integration into transportation design standards.	GI should not be viewed only as a stand-alone project. Opportunities for GI should be considered in all transportation projects.	None at this time.	High	Already occurring.	Medium	Lost opportunities, and adversely impacts the achievement of the program goal of 740 MG.	25	25	625	Low	Level of Service	Environmental Improvements
G027	GI costs more than traditional stormwater practices.	Average cost of GI is approximately $1.80/gallon whereas detention ponds can capture runoff for $0.50/gallon or less. Risk is therefore that municipalities will use non-GI practices if benefits of GI are not understood.	None at this time.	High	Already occurring	High	Lost opportunities to install GI rather than traditional stormwater practices.	25	220	5500	Moderate	Economic	Environmental Improvements

APPENDIX 5D-2: GI Risk Register – COF Definitions -

MMSD 2050 Facilities Plan
Green Infrastructure Asset System Risk Register
Risk Definitions - Consequence of Failure

Ranking	Permit / Legal Requirements	Environmental Improvements (non regulatory, resource recovery)	Energy	Customer Service, Community Economic Development and Organizational Reputation	Safety	Fiscal Responsibility	Management and Operational Effectiveness
Green Infrastructure							
Very High	• Significant (>15%) reduction in % overall capture • WPDES permit violation	NA	NA	• Significant adverse impact to freeways, hospitals, schools, numerous community buildings, major industry, or highly visible public areas • Constrains regional economic development • Significant loss of reputation or long term good will with customers, residents and stakeholders • Negative coverage at national level • Issues raised by State Government and/or multiple public officials/commissioners	Permanent disability or potential fatality.	> $10,000,000 total financial impact	• Major critical systems, facilities, or equipment unavailable for > 7 days (Key services impacted/staff unable to perform typical work) • High turnover of critical staff - organization-wide impact • Significant impact on operational efficiency, >50% impact on operational KPI's
High	• Wet weather (up to 5 year recurrence) SSO, or > 6 CSO's will occur • Non-compliance with % of permit required GI capacity • WPDES permit violation	Regional (multiple watersheds) negative impact to water quality or environmentally sensitive areas (wetland)	NA	• Significant adverse impact to arterial streets and/or multiple community or industrial buildings, or widespread residential buildings • Constrains localized economic development, and/or widespread decrease in property values • Moderate loss of reputation or long term good will with customers, residents and stakeholders • Negative coverage at state or local (TV and/or newspaper) level • Issues raised by single public official/commissioner	Temporary disability or serious illness	$1,000,000 - $10,000,000 total financial impact	• Major critical systems, facilities, or equipment unavailable for 1-6 days (Key services impacted/staff unable to perform typical work) • Extensive or prolonged adverse reaction - company-wide disengagement • Loss of key staff - impacts multiple locations/departments • High impact on operational efficiency, 25-50% impact on operational KPI's
Medium	• Moderate wet weather (approximately 6-25 year recurrence) SSO, or < 6 CSO's will occur • Moderate (5-15%) reduction in % overall capture • Possible WPDES permit violation • Possible non-compliance with % of permit required GI capacity • Non-compliance with permit required GI maintenance	• Widespread local (single watershed wide) negative impact to water quality or environmentally sensitive areas (wetland) • Significant failure to meet annual internal targets (<50% of goals achieved) for GI capacity, Greenseams acres or river buffer acres	Significant reduction (>10%) in % of carbon footprint sequestered through green space addition	• Adverse impact to collector streets and numerous residential buildings • Local decrease in property values • Minimal loss of reputation or long term good will with customers, residents and stakeholders • Issues raised by numerous residents	Injury or illness requiring medical treatment	$250,000 - $1,000,000 total financial impact	• Major critical systems, facilities, or equipment unavailable for < 24 hours (Key services impacted/staff unable to perform typical work) • Employee disengagement among business area or geographic location • Loss of key staff in single location or department • Moderate impact on operational efficiency, 10-24% impact on operational KPI's

Ranking	Permit / Legal Requirements	Environmental Improvements (non regulatory, resource recovery)	Energy	Customer Service, Community Economic Development and Organizational Reputation	Safety	Fiscal Responsibility	Management and Operational Effectiveness
Low	• SSO, or CSO will occur under only extreme wet weather (> 25 year recurrence) conditions • Minimal (<5%) reduction in % overall capture • Unlikely WPDES permit violation • Slight possibility of non-compliance with % of permit required GI capacity • Possible non compliance with permit required GI maintenance	• Limited local (sub-watershed) negative impact to water quality or environmentally sensitive areas (wetland) • Moderate failure to meet annual internal targets (50-75% of goals achieved) for GI capacity, Greenseams acres or river buffer acres	Moderate reduction (5-10%) in % of carbon footprint sequestered through green space addition	• Adverse impact to isolated residential street or residential buildings • Isolated decrease in property values • Issues raised by isolated residents	Injuries requiring first aid treatment	$50,000 - $250,000 total financial impact	• Non-critical systems, facilities, or equipment unavailable for > 7 days (Work arounds available/minor staff inconvenience) • Localized adverse impact on employee morale - single departmental location • Loss of non-critical staff in single department or location • Low impact on operational efficiency, 5-9% impact on operational KPI's
Very Low	Slight possibility of non-compliance with permit required GI maintenance	• Isolated (single point location) negative impact to water quality or environmentally sensitive areas (wetland) • Minimal failure to meet annual internal targets (76-99% of goals achieved) for GI capacity, Greenseams acres or river buffer acres	Minimal reduction (<5%) in % of carbon footprint sequestered through green space addition	• Negative response internally	Low potential for minor injury	0 - $50,000 total financial impact	• Non critical systems, facilities, or equipment unavailable for 1-6 days (Work arounds available/minor staff inconvenience) • Isolated adverse impact on employee morale – single employees • Loss of non-critical staff – single employees • Minimal impact on operational efficiency, <5% impact on operational KPI's

APPENDIX 5D-3: GI Risk Register – LOS Risks -

MMSD 2050 Facilities Plan
Green Infrastructure Asset System
Risk Register - Level of Service Risks

Risk Identification			Risk Analysis										
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G001	Codes and Ordinances a barrier to GI	Some municipal codes and ordinances do not allow or significantly limit the installation of GI. This will impact the ability to meet the 740MG goal by 2035. Will limit beneficial impact of GI.	Voluntary recommendations have been developed to change ordinances and codes by 1KF of WI and Birchline Consulting. Clean WI, Sweet Water, and Orion are working with municipalities to implement.	Very High	Already occurring.	Medium	This is one factor that will prevent reaching annual goals.	75	25	1,875	Moderate	Level of Service	Permit Requirements
G002	Inadequate O&M that causes lack of performance	Projects won't remain effective, might need replacement, won't last through entire useful life, don't meet permit goal, won't reach 2035 Vision, negative impact to reputation of GI (reduced confidence), won't realize GI co-benefits.	Conservation easements (albeit 10 years, to raise to 20 years in 2017), 5% of funding allowed for vegetation establishment, annual inspections	Very High	Need isn't well recognized, funding sometimes lacking, is already occurring.	Medium	Possible permit violation, potential decrease in local property value, and loss of goodwill.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G003	Insufficient GI installed per year to meet 2035 goals - MMSD projects	Current implementation of GI will only get to ~5% of the 2035 goal.	Incentives, both financial and technical/regulatory, are lacking to meet increased pace of GI installation that is intended to start in 2019 (per Regional GI Plan).	Very High	The average annual goal for GI adoption from 2013 to 2019 is 1.6 MG/yr. but this goal increases to an average of 40 MG/yr. in 2019. Current funding levels, incentive programs, etc. are not sufficient to meet the increased future goal.	Medium	Need to either develop plan to increase implementation, reduce goal, or extend goal	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G004	Insufficient tracking of installed GI (for performance and maintenance) - both MMSD and non MMSD projects/programs	MMSD only tracks MMSD sponsored GI. Many municipalities have GI projects and programs that are not tracked (compost application for example). Without tracking these, it is impossible to know the status of the goal achievement.	MMSD currently tracks the location, type, and ownership of all GI strategies implemented using MMSD funding.	Very High	Limited tracking occurring for GI strategies implemented without MMSD funding.	Medium	Many GI projects and activities not tracked which makes assessment of the 740 MG goal impossible	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G005	There is a perception in the region that certain types of GI can have a negative impact on I/I	The perception is that, since GI projects are designed to infiltrate more groundwater, they could potentially worsen the infiltration component of I/I	Past analysis showed that this risk is not warranted but perceived risk is still present in many circles. Recommendations for clarifying this risk are being developed as part of the 2050 project.	Very High	If focused on perception, the (miss)perception is already occurring. Research performed to date indicates this risk is perceived to be larger than it really is.	Medium	Moderate loss of reputation or long-term goodwill with customers, residents and stakeholders	75	25	1,875	Moderate	Level of Service	Customer Service, Communication and Employee Development
G006	High costs of GI in terms of type of GI and cost effectiveness of GI (e.g. -- restated -- not matching the most TBL effective GI with the site conditions)	There is a need to try and incentivize the use of the best fit GI, depending on site and context (e.g. compost vs. green roofs).	None	Very High	Already occurring.	Medium	Increasing costs for GI will make it less likely to achieve 2035 Vision and could impact permit requirements	75	25	1,875	Moderate	Level of Service	Fiscal Responsibility
G007	GI fails to perform as designed due to changes in climate and modeled rainfall events	Climate change (e.g., warmer temperatures, less summer precipitation, intense spring and summer storms) could cause GI to fail because vegetation cannot adapt, systems become overloaded, etc. Estimated performance could decrease if projected weather patterns occur.	None	Medium	Difficult to predict the extent to which this might occur.	Medium	Moderate loss of reputation or long -term goodwill with customers, residents and stakeholders.	5	25	125	Low	Level of Service	Environmental Improvements
G008	GI adopted without considering most beneficial impact locations	Adoption of GI may vary widely by municipality or watershed due to differences in funding, codes, demographics, etc.	None	Very High	Already occurring.	Medium	If some municipalities are lacking in GI, then they could jeopardize attainment of the MMSD 2035 and 2050 goals.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G010	Inadequate O&M of GI due to lack of a qualified workforce and/or a lack of understanding of standard practices	Adoption of GI throughout the service area will require an ever-increasing amount of maintenance; workforce with the right skill set and availability will be needed. This full workforce does not now exist and doesn't have the correct training.	None	Very High	Already occurring to some extent.	Medium	Possible permit violation, potential decrease in local property value, and loss of goodwill.	75	25	1,875	Moderate	Level of Service	Environmental Improvements

Risk Identification			Risk Analysis										
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G011	Available MMSD GI funding not used	Not all funding available in the recent years has been used.	Data is available to assess, and program rules have been changed to help address the issue.	Low	Already has occurred as funding has not been exhausted.	Medium	Adversely impacts the achievement of the program goal of 740 MG.	2	25	50	Minimal	Level of Service	Fiscal Responsibility
G012	Impact of TMDLs on GI implementation unknown	TMDL requirements will offer a significant opportunity for municipalities to install GI to treat stormwater to meet future load reductions. Do not want to miss out on that opportunity by having policies that do not allow credit for both quality and quantity benefits, or by somehow having non-GI practices primarily used to reduce loads.	None at this time.	Very High	No data/connection exists or is not being considered - possibly this can be done in the 2050 plan.	High	Adversely impacts the achievement of the program goal of 740 MG.	75	220	16,500	High	Level of Service	Environmental Improvements
G013	Less than optimal defensible data available to determine impact of GI on CSOs and particularly SSOs.	No well-established direct tie between GI and CSO/SSO - need to model and evaluate further.	Will do in the 2050 FP.	Very High	Modeling not complete (may need to raise consequence of failure…please check) KLSs agrees: may need to raise consequence of failure. Not establishing this link will be detrimental!	Medium	Results will impact GI program implementation.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G014	Funding - Financial issues associated with GI value, life cycle and other.	How best to tie financial analysis with AMP analysis needs to be determined.	Discussions and evaluation underway.	High	Many questions exist.	High	Will greatly influence GI program implementation.	25	220	5,500	Moderate	Level of Service	Fiscal Responsibility
G015	Financial reporting and accounting treatment of GI versus AMP treatment of GI inconsistent.	Confusion of terms, methods, data, etc. some of which is grounded in generally accepted accounting practices.	Discussions and evaluation underway.	High	TBD	High	Will greatly influence GI program implementation.	25	220	5,500	Moderate	Level of Service	Fiscal Responsibility
G017	Mismatch between life and easement length of GI projects and impact on funding sources and financial accounting.	Capital funds are intended to be used for projects that last 10 years, CWF loans require 20 years, other areas of the country require even longer easement and/or other maintenance commitments, yet current MMSD GI easements are only for 10 years.	Discussions and evaluation underway, and where possible easements in 2017+ will be for 20 years.	High	TBD	High	Will greatly influence GI program implementation.	25	220	5,500	Moderate	Level of Service	Fiscal Responsibility
G018	Poor municipal GI coordination within and across subwatersheds/watersheds.	Lack of coordination leads to duplication, inefficiencies (cost, effectiveness), and sometimes inaction.	Happens all the time.	Very High	Already happening	Low	More of a direct municipal issue than an MMSD issue, but will adversely impact the achievement of the program goal of 740 MG.	75	6	450	Low	Level of Service	Environmental Improvements
G019	Regulations need to optimally stay updated and be enforced regularly.	Regulations need to catalyze and support other programs.	Review every 5-10 years.	Low	Text Entry	Medium	Text Entry	2	25	50	Minimal	Level of Service	Environmental Improvements
G020	Public information/education doesn't change mindsets and catalyze increased GI adoption.	This is key to voluntary adoption.	There are some limited efforts underway now but they could be enhanced (e.g., use of Sparkle the dog).	Very High	Pace of GI adoption indicates more marketing/outreach is still needed.	Medium	Text Entry	75	25	1,875	Moderate	Level of Service	Customer Service, Communication and Employee Development
G021	Insufficient staffing could hold back program growth and implementation rates.	Programs across the county tend to have more staff dedicated to green infrastructure efforts, but current political climate, MMSD budget belt tightening, and lack of regulatory driver do not push more money toward staffing. Current staff can only manage so many projects.	Annual request for more staffing coincide with budget, looking at public-private partnership models, etc.	Very High	Already occurring.	Medium	Adversely impacts the achievement of the program goal of 740 MG.	75	25	1,875	Moderate	Level of Service	Customer Service, Communication and Employee Development
G022	Insufficient GI installed per year to meet 2035 Goals - Non-MMSD Projects.	This risk is related to G003 but is for non-MMSD projects. Non-MMSD projects will be critical to meeting the 2035 goal but current implementation will need to increase dramatically.	Incentives, both financial and technical/regulatory, are lacking to meet increased pace of GI installation that is intended to start in 2019 (per Regional GI Plan).	Very High	Already occurring (pace of non-MMSD funded GI projects is relatively low).	Medium	Need to either develop plan to increase implementation, reduce goal or extend goal.	75	25	1,875	Moderate	Level of Service	Environmental Improvements
G023	Insufficient GI installed in combined sewer service area because of DNR policy and municipal practice.	Current DNR practice already allows counting of 100% stormwater treatment in the CSSA, so this tends to disincentivize GI.	None at this time.	Very High	Already occurring.	Medium	Failure to install GI in the City of Milwaukee will make it very difficult to reduce CSOs through the use of GI.	75	25	1,875	Moderate	Level of Service	Environmental Improvements

Risk Identification			Risk Analysis										
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G024	Not attaining the future permit goals for GI.	Adding GI annually, per permit cycle, is a requirement of MMSD's WPDES permit. MMSD strives for 100% permit compliance. Not attaining GI goals is not consistent with MMSD's approach to permit compliance.	Consistently following the recommendations of MMSD's Regional GI Plan.	Low	Permit goal has been below recent implementation rates.	Very High	Permit non-compliance would be a serious issue.	2	1,000	2,000	Moderate	Level of Service	Permit Requirements
G025	Lack of GI integration into development and redevelopment.	GI should not be viewed only as a stand-alone project. Opportunities for GI should be considered in all development/redevelopment projects.	Chapter 13.	High	Already occurring for some development <0.5 ac.	Medium	Lost opportunities, and adversely impacts the achievement of the program goal of 740 MG.	25	25	625	Low	Level of Service	Environmental Improvements
G026	Lack of GI Integration into transportation design standards.	GI should not be viewed only as a stand-alone project. Opportunities for GI should be considered in all transportation projects.	None at this time.	High	Already occurring.	Medium	Lost opportunities, and adversely impacts the achievement of the program goal of 740 MG.	25	25	625	Low	Level of Service	Environmental Improvements

APPENDIX 5D-4: GI Risk Register – Economic Efficiency Risks -

MMSD 2050 Facilities Plan
Green Infrastructure Asset System
Risk Register - Economic Efficiency Risks

Risk Identification			Risk Analysis										
Risk ID	Risk Title	Risk Description	isting Controls to Manage the R	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	LOF Score	COF Score	Risk Score	Risk Level	Failure Mode	LOS Category
G027	GI costs more than traditional stormwater practices.	Average cost of GI is approximately $1.80/gallon whereas detention ponds can capture runoff for $0.50/gallon or less. Risk is therefore that municipalities will use non-GI practices if benefits of GI are not understood.	None at this time.	High	Already occurring	High	Lost opportunities to install GI rather than traditional stormwater practices.	25	220	5500	Moderate	Economic	Environmental Improvements