APPENDIX 4D: GI Future Demand

Purpose

This appendix provides additional details for Chapter 4 of the 2050 Facilities Plan (2050 FP) 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 MMSD's 2050 FP, which outlines the overall facilities plan for all of MMSD's asset systems.

4 Future Demand

4.1 Purpose

The purpose of the information presented in this chapter is to document how future demand was evaluated for the GI Asset System. Future demand for the GI Asset System is different from the other asset systems in that the focus is primarily upon the desire to achieve the key performance indicator (KPI) target of 740 MG of GI storage by 2035. Future demand for the GI Asset System is also different from the other asset systems because MMSD will not fully own the future GI assets. Rather, MMSD's practice has been to fund projects and – in return – own a temporary easement of 10 to 20 years to protect the asset and continue to reduce the flows and loads that enter the Conveyance and Storage Asset System and volumes that must be treated by the water reclamation facilities. Therefore, the discussion centers more upon the demand for future GI assets by other entities rather than the demand placed on existing MMSD assets (as of 2017).

There are a number of drivers that can impact future demand for the GI Asset System, as discussed below. A general description of each factor is provided in Section 4.2 of the overall 2050 FP. The projected demand trends for the GI Asset System resulting from changes in these demand drivers are discussed in Section 4.3. Programs MMSD already has in place to manage demand are discussed in Section 4.4. The specific impacts to the GI Asset System due to baseline and future demand are assessed in Chapter 5.

4.2 Factors Affecting Demand

There are a number of factors that influence demand on the GI Asset System and thereby affect the ability to meet the level of service targets identified in Chapter 3 of the 2050 FP. These factors are listed below along with a discussion of how they are anticipated to change.

- Service and Planning Area Changes, including economic growth and industrial user changes
- Climate Change
- Permit Changes
- Operating and Maintenance Contract Changes
- Changes in Customer Expectations
- Changes in Technology
- Conservation Efforts

Service and Planning Area Changes

Service and planning area growth are presented in Chapter 4 of the 2050 FP. No additional details specific to the GI Asset System were developed, although it should be noted that this GI appendix is based on a subset of the MMSD service area defined as the 20 municipalities participating in the GI program as of February 2019 (Figure 4D-1). This area is referred to as the “GI service area” in this appendix.

At the time of drafting the 2050 Facilities Plan, the municipalities that are not currently participating in MMSD’s GI program are Brookfield, New Berlin, Germantown, Menomonee Falls, Caledonia, Butler, Elm Grove, and Thiensville. These municipalities and others that may be added to MMSD’s GI service area in the future may decide to participate in MMSD’s GI program at a later point in time, which would thereby grow the GI service area.

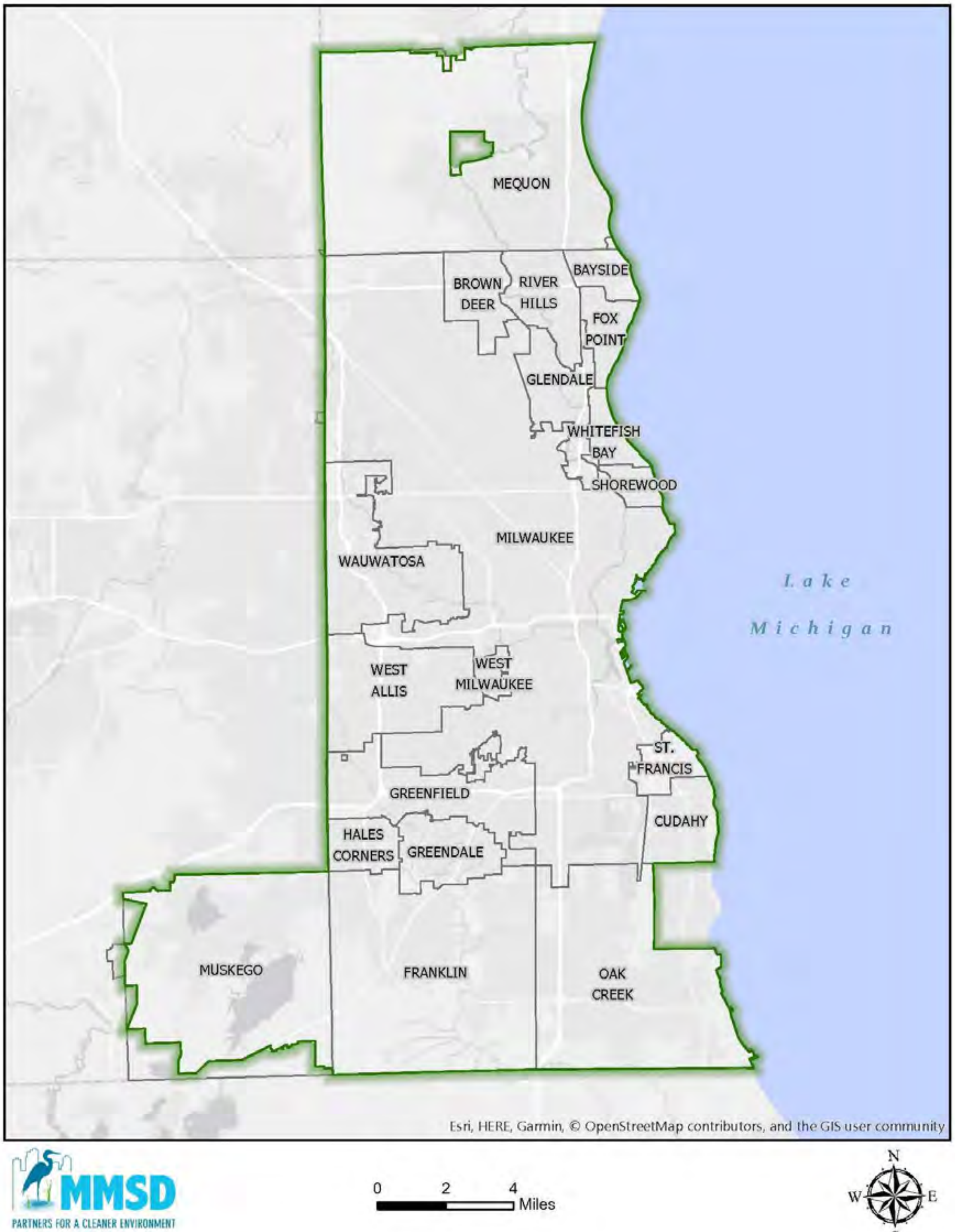


FIGURE 4D-1: MAP SHOWING THE 20 MUNICIPALITIES PARTICIPATING IN THE GI PROGRAM AS OF FEBRUARY 2019

Economic Growth

Economic changes refer to potential changes in the labor and material costs associated with installing GI. Based on information in MMSD’s SharePoint GI comprehensive asset database, the cost of GI per gallon of storage fluctuated considerably but exhibited neither an increasing nor a decreasing trend between 2003 and 2017 (Figure 4D-2). That database includes dozens of fields including owner information, GI type and size, funding information, and location. This database was used to track and report on GI for MMSD’s WPDES Permit from 2013-2018. It is difficult to predict the future costs of GI because they may decrease due to economies of scale (e.g., increased production of soil amendments or larger projects that reduce construction mobilizations), increased competition (e.g., more vendors offering GI construction services), more enlightened owner bid practices, or changes in technology (see Section 0). GI costs might also rise due to increases in raw material costs, prevailing wages, etc.

To-date (as of 2019), MMSD has been successful at developing and managing a GI program that typically leverages outside funding as a cost-share for GI implementation, keeping MMSD’s cost-share at approximately 50 percent or below for most projects. As MMSD continues to prioritize placement for GI, it may need to consider amending the to-date program strategies to include a higher cost-share for GI projects that are not property owner driven but are identified by MMSD as being the most effective and efficient placement of GI for system function and water quality. Additionally, for projects where MMSD would be the “driving” entity, it will need to consider ongoing maintenance and replacement costs. At this time, MMSD’s GI program puts all maintenance responsibility on the property owner and reserves only a conservation easement on the property. If MMSD were to take a larger role in the daily operations and maintenance and replacement of GI, MMSD’s share of funding for GI (capital, maintenance, and replacement) would increase.

With the possibility of additional capital and repair/replacement costs for GI on the horizon, MMSD’s cost-share per gallon may increase over time. MMSD can continue to work towards cost efficiencies to reduce the average cost of GI per gallon of storage through economies of scale, promotion of less expensive GI strategies, and continued adoption of GI as part of capital improvement projects. More on this topic is discussed in Chapter 6.

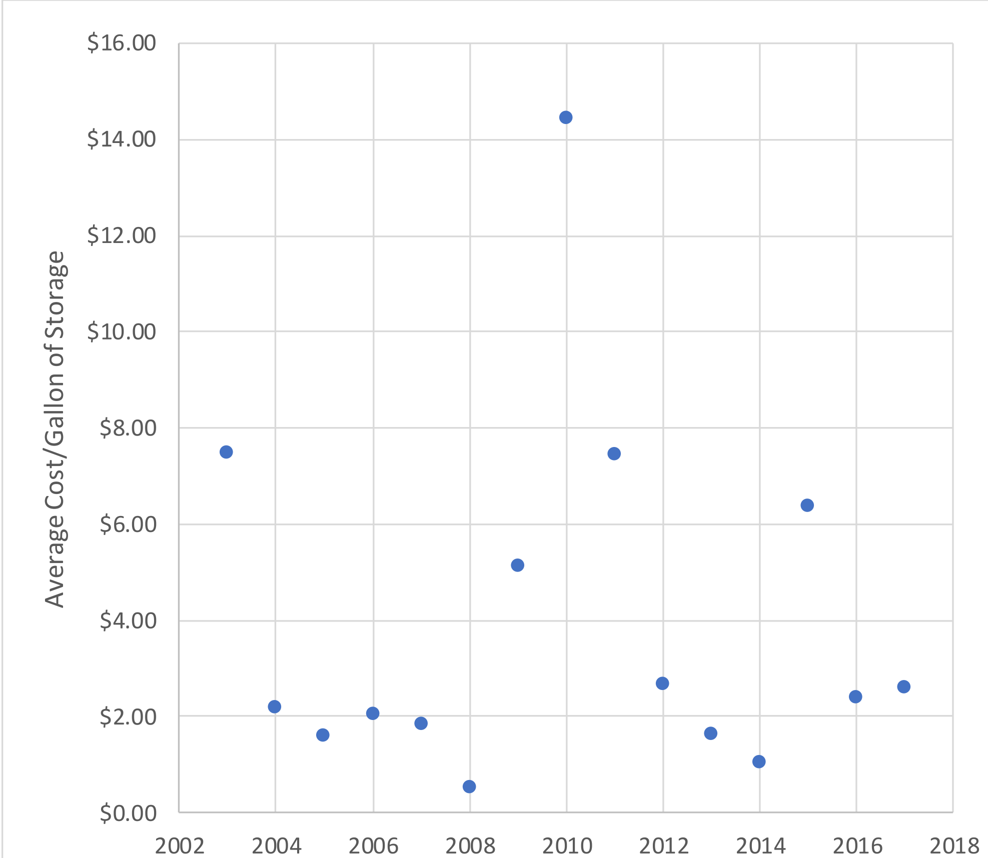


FIGURE 4D-2: AVERAGE TOTAL COST PER GALLON OF STORAGE IN THE MMSD SERVICE AREA, 2003 TO 2017

Industrial User Changes

Demand for GI in the region is increasing, as well as the need for maintenance activities. Although MMSD does not have an established GI maintenance fund at present, it is an option in the future as the GI program expands and will begin targeting specific GI sites. Should MMSD create a GI maintenance fund, the addition or loss of a major industrial user would be anticipated to have a significant impact on the GI asset system, as maintenance activities would be funded through MMSD's O&M budget. Additionally, a loss of a major industrial user could cause the GI asset system and MMSD's grey asset system to compete for adequate maintenance funds and reduce public outreach efforts associated with GI.

Climate Change

Climate change is predicted to have multiple negative impacts on water resources within MMSD's GI service area, and GI can help to mitigate these impacts. The demand for GI assets is therefore expected to increase because of the effects of climate change although it is difficult to predict the specific extent.

The Climate Change Vulnerability Analysis [1] uses data that predicts an average summer temperature increase of 5 degrees Fahrenheit (°F) in the MMSD service area by 2050 compared to the historical record baseline condition (1940-2004). The number of days with temperatures exceeding 90 degrees is predicted to increase from 12 to 25 per year. Climate change scenarios show a pattern of increasing precipitation intensity in a few larger events and a decrease in the size and frequency of many of the smaller events (e.g., more drought periods). The proportion of winter precipitation events is expected to shift to more rain or freezing rain rather than snow. Impacts on water resources are expected to include the following:

- Combined sewer overflow (CSO) frequencies were simulated to increase by 17 percent and the simulated annual CSO volume was simulated to increase by 24 percent.
- One hundred-year flows will increase up to 16 percent and 10-year peak flows will increase from 6 percent to 13 percent.
- Higher temperatures and extended drought periods may lead to decreased average and low flows in jurisdictional watercourses, resulting in a degradation of aquatic habitat and water quality, and a decrease in aquatic species viability.

In addition, recent studies done elsewhere predict a connection to climate change, urban precipitation patterns, and storm intensification. [2] If findings from elsewhere are transferable to Milwaukee, rainfall events could be further troublesome.

The climate change modeling performed in support of the 2050 FP was also assessed to determine potential future impacts. Key findings that impact the GI Asset System include the following:

- Annual precipitation is predicted to slightly increase under the 90th percentile mid-century climate scenario. Monthly changes are variable, with a tendency for more precipitation in the winter and less in the summer. Therefore, precipitation volume will be about the same; however, the way it falls is different and will impact how the system responds.
- Annual potential evapotranspiration (PET) is predicted to increase dramatically. Monthly PET increases in all months, with the biggest changes in the summer and fall.
- While annual precipitation does not change appreciably, the most intense rainfall events increase significantly, so larger storm events will become even larger and have greater impacts on flooding. Higher peak runoff from more intense precipitation events may result in a decrease in the level of protection provided by flood management facilities.
- Annual surface runoff from impervious surfaces identified in the Conveyance Baseline Conditions hydraulic modeling is predicted to change very little whereas runoff from pervious surfaces is predicted to significantly decrease, especially for interflow and baseflow. This is consistent with the higher PET.

Working in concert with grey infrastructure, GI can help mitigate the negative impacts to water resources that are likely to be caused by climate change. In a recent national study of the impacts of climate change upon stormwater infrastructure, U.S. EPA [3] concluded that stormwater management that combines both grey and GI elements have the best combined cost resiliency. In other words, the increase in cost of maintaining baseline performance under future climate conditions is less than for conventional-only or GI-only approaches, which indicates combined conventional/GI approaches are better equipped (i.e., more resilient) for adaptation. This greater resilience likely reflects the combined advantages of having practices that better address large flooding events (such as wet ponds and detention basins) with GI practices that provide the most holistic treatment of volume and pollutants. Adding dispersed GI to an already built-out site to address larger future storm events may also be considerably easier and less expensive than resizing hard structures associated with conventional stormwater treatment.

GI can also better address some of the predicted negative impacts of climate change than can conventional stormwater facilities. For example, GI, with its ability to infiltrate water and replenish groundwater supplies, can help sustain decreasing streamflows that are predicted to occur in the future. [1]

U.S. EPA [4] also identifies how GI can improve climate resiliency because of its ability to:

- Reduce the urban heat island effect by shading structures, deflecting solar radiation, and releasing moisture into the atmosphere
- Lower building energy demands by shading structures, acting as windbreaks, and evapotranspiration
- Reduce energy needs to manage water by reducing stormflow into stormwater conveyances, recharging aquifers, and conserving water

Although GI is expected to help address the predicted negative impacts of climate change, MMSD and partners may also need to adapt GI strategies to account for the following:

- GI design might need to be adapted to include vegetation that performs well under warmer or drier future conditions.
- GI vegetation might also need to be selected for salt tolerance since the increased occurrence of freezing rain may lead to increased road salting.
- GI maintenance requirements might increase due to more frequent droughts that stress vegetation and due to higher pollutant loadings associated with more frequent large storm events.

Permit Changes

In 2012, MMSD received the first Wisconsin Pollutant Discharge Elimination System (WPDES) permit in the country with a GI requirement in the body of the permit. The permit had the following provisions:

- MMSD, working with partners as appropriate, must ensure that GI practices are put in place in the MMSD service area.
- Each year 1 million gallons of design retention capacity must be installed. That was subsequently amended to a goal of at least 12 million gallons of GI capacity added by 2017.
- Up to 75 percent of the total GI retention capacity requirement can be met through capture at GreenSeams® parcels.
- At least 25 percent of the GI retention capacity requirement must be met through implementation of other GI strategies such as rain gardens, permeable pavement, bioswales, etc.
- Any GI practices/control measures that are put in place must be maintained.

MMSD's permit was updated in April 2019 and includes a target to achieve an additional 50 MG of GI retention capacity within the term of the permit; at least 20 MG of the GI retention capacity should be within the combined sewer service area (CSSA). The term of each WPDES permit is five years and therefore it is assumed that within the regulatory time period of 2020 to 2040, MMSD's permit would be renewed another three times. If each new permit includes an additional 50 MG of GI capacity, that would result in a total of 200 MG of GI by 2040. It is reasonable to expect that the conditions in each permit will continue to become more stringent; therefore, permit changes will create a strong demand for new GI assets.

Permits for municipal separate storm sewer systems (MS4s) will also continue to be updated between now and 2050 and could spur the increased use of GI. For example, the Wisconsin Department of Natural Resources (WDNR) will be encouraging the use of GI in MS4 permits to meet the wasteload allocations in the Milwaukee River basin total maximum daily loads (TMDLs).

The demand for GI in the GI service area is also expected to increase because of new regulatory requirements in MMSD's Chapter 13 rule.[1] Those requirements for GI apply to development / redevelopment that adds between 5,000 SF and 0.5 acre of new impervious cover. A planning-level analysis completed as part of the 2050 FP indicates that the revisions to lower the area threshold, for when the rule becomes applicable, would add approximately 1 MG of GI storage per year beginning in 2019 (refer to Chapter 6, Alternative Analyses).

Operating and Maintenance Contract Changes

Veolia Water Milwaukee, LLC's (Veolia) contract to provide management, operation, and maintenance services to MMSD does not include significant work related to GI (according to the 2016 extension to the agreement); therefore, it is not expected to affect future demand. [5] The only reference to GI is related to the requirement to provide at least $1.5M in funding for research and development activities, with GI being one of the seven topic areas allowed to be funded. Funding may be provided to local universities, nonprofit organizations, or business incubators and MMSD would receive a license to use any technologies, software, or data that is developed by a funded project.

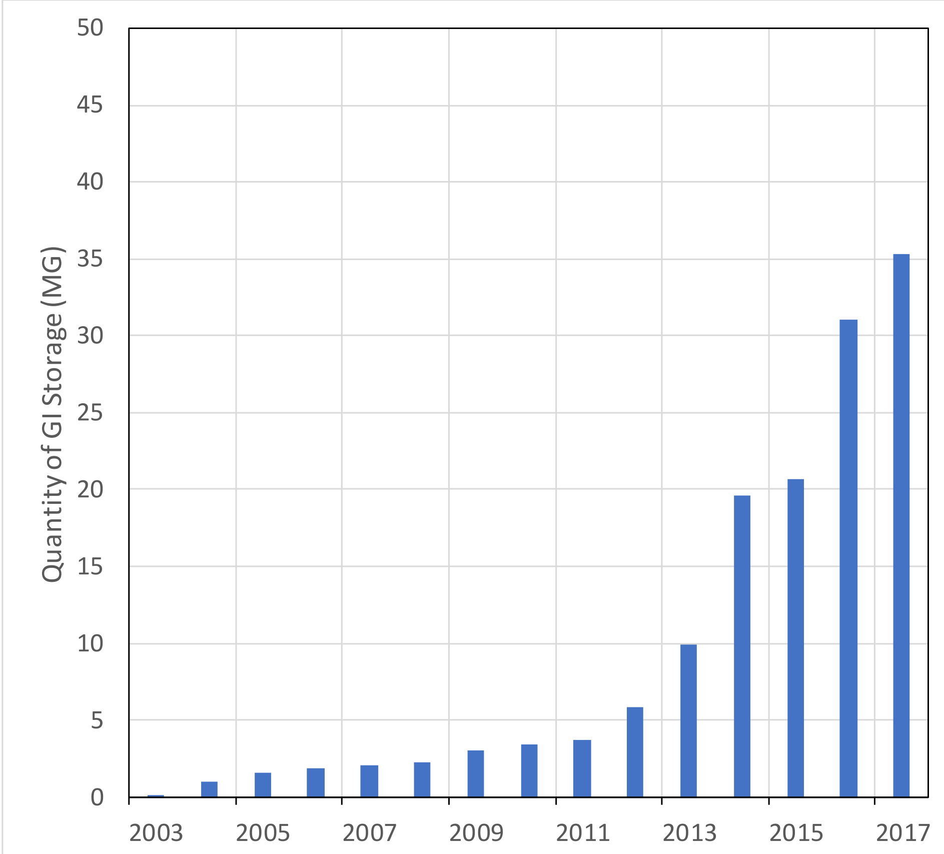
Although the operations contract as of 2016 does not provide management, operation, or maintenance of GI, as MMSD grows its GI infrastructure system, the dispersed method of operations and maintenance of GI utilized by MMSD to-date (as of 2019) may become too burdensome with MMSD's internal staff capacity. MMSD may want to develop new GI operating contracts to ensure the GI system is being adequately operated and maintained to complement the grey system as intended and meet permit conditions.

Changes in Customer Expectations

Changes in customer expectations are anticipated to result in a significant increase in the demand for GI. Over the past two decades in both the US and internationally, GI has evolved from being an experimental approach to stormwater management to becoming an accepted and integrated approach to landscape and water resources planning. [6] This trend is expected to continue as more and more decisionmakers become familiar with GI and it becomes a "de facto" component of urban planning and design. For example, worldwide spending on GI and related watershed investments grew on average approximately 12 percent per year between 2013 and 2015. [7] GI has also experienced exponential growth locally in the MMSD GI service area between 2003 and 2017, as shown in Figure 4D-3.[2]

[1] Chapter 13 refers to MMSD's surface water and stormwater rules.

[2] Based on data in MMSD's GI Sharepoint database dated 7/23/2018. See Chapter 5 for more information.



Note: THIS FIGURE DOES NOT INCLUDE GREENSEAMS® PROGRAM STORAGE VOLUMES

FIGURE 4D-3: CUMULATIVE QUANTITIES OF GI STORAGE IN THE MMSD SERVICE AREA, 2003-2017

In the late 1990s through mid-2000s, GI was relatively uncommon even though it was being used in a handful of locations in the U.S., including Milwaukee. In the mid-2000s through mid-2010s, use of GI in landscape planning expanded and it began to be incorporated as a more holistic approach to water resources management. [6] From the mid-2010s through today, GI has become generally accepted for its ability to provide triple bottom line benefits (i.e., environmental, economic, and social). [6]

Growth in GI is partly due to the social benefits it creates by making places more inviting and attractive. For example, one national study investigated public perceptions about the role of trees in revitalizing business districts. [8] The study found that amenity and comfort ratings were approximately 80 percent higher for a tree-lined sidewalk compared to a non-shaded street. Quality-of-product ratings were 30 percent higher in districts having trees over those with barren sidewalks. Another study assessed how green space amenity values relate to customers' price valuation, and survey participants consistently priced goods significantly higher in landscaped districts. Prices on average were 12 percent higher in landscaped versus non-landscaped areas. [8] Similarly, Ward et al. [9] found that property values rose 3.5 to 5 percent for properties adjacent to GI compared to those farther away in King County (Seattle), Washington. Locally, the University of Wisconsin-Milwaukee Center for Economic Development found that property values of residential properties in the Lincoln Creek neighborhood were 20.4 percent higher than they otherwise would have been due to MMSD investments in stream restoration and stormwater improvements. This study also determined that GI played an instrumental part in improving the quality of redevelopment efforts in the Menomonee Valley and surrounding the Pabst Brewery complex, both of which experienced significant increases in property values. [10] Looking to the future, it is anticipated that customer expectations in MMSD's GI service area will continue to result in more GI. Drivers are likely to include the following, several of which are further discussed in Chapter 5:

- Municipal use of GI as a strategy for implementing the Milwaukee River basin TMDLs
- Municipal use of GI to reduce CSOs
- Municipal use of GI to treat re-directed downspouts as part of private property infiltration/inflow (PPI/I) programs
- Municipal use of GI in concert with conventional stormwater treatment for flood management
- Residential/commercial use of GI to receive credits on stormwater utilities
- Residential/commercial use of GI for "goodwill" (e.g., to improve water quality, increase urban biodiversity)
- Residential/commercial use of GI to improve aesthetics and increase property values

Changes in Technology

As described in Section 0, GI continues to grow worldwide and there are several changes in technology that could affect its future demand. Each of these is expected to result in an increased demand for GI due to increased performance or lower costs.

- As the demand for GI grows, vendors are developing innovative technologies to reduce costs. For example, in the past, the labor costs to install permeable pavers was typically significant because each paver had to be placed individually. However, some vendors now offer installation options in which entire pallets of pavers are installed at the same time via the use of specialized equipment. This can reduce the cost of installation from approximately $6/square foot to less than $4/square foot. [11] Other examples include the use of modular systems to allow for less expensive installation of green roof systems and the use of compost blowers to decrease the time and cost of applying compost to amend a lawn.
- Recently, technology has been developed that allows for the automatic control of the timing and rate of stormwater flow through existing (as of 2017) and new facilities, enabling operators to plan, observe, and respond to storm events predictively. Sometimes referred to as "smart water" systems, sensors can be deployed to monitor the status of GI strategies (e.g., storage volume available) and compare that to real-time weather predictions. Software is then used to optimize GI performance by increasing storage volumes in anticipation of a storm event.

Conservation Efforts

No additional details specific to the GI Asset System were developed, although efforts to conserve water might lead to increased demand for GI through use of cisterns and rain barrels.

4.3 Projected Demand Trends

The projected demand trend for GI is that 740 MG total capacity of GI assets will be created by 2035, which is the KPI target identified in Chapter 3. This storage goal was selected because it was set by the

2035 Vision and because of the various factors driving demand described in Section 4.2. The Regional GI Plan, prepared in 2013, recommended that this increase occur linearly as shown in the left panel of Figure 4D-4. [12] Based on this linear pace, approximately 40 MG/yr of GI storage capacity would need to be added each year starting in 2018. This may not be realistic given the quantities of GI that were added in 2016 and 2017 (10.4 MG and 4.2 MG, respectively) and the inconsistent nature of project delivery. An alternative approach would be for GI to increase exponentially as MMSD and project partners add capacity, reduce costs, eliminate barriers, etc. An example of this type of projection is shown in the right panel of Figure 4D-4 and was used to estimate future costs for the 2050 FP.

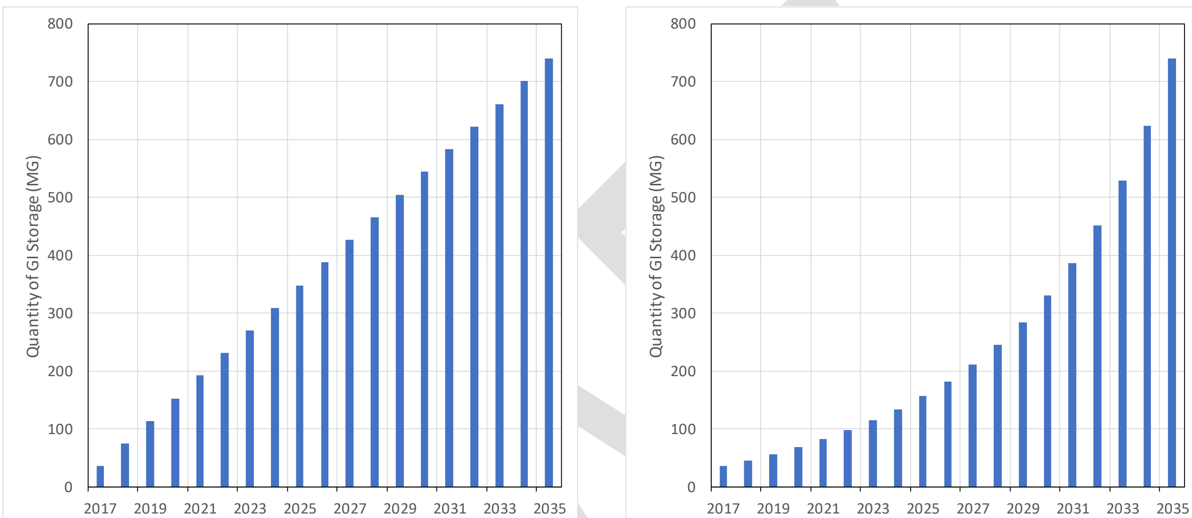


FIGURE 4D-4: PROJECTED FUTURE QUANTITIES OF GI BY YEAR BASED ON LINEAR PROJECTION (LEFT) AND EXPONENTIAL PROJECTION (RIGHT)

4.4 DEMAND MANAGEMENT

Demand management for the GI Asset System is defined as where and what type of GI infrastructure is installed. The type and location of existing GI assets installed (as of 2017) has been based primarily on which residents, businesses, or municipalities wish to install GI. As part of meeting the 740 MG GI KPI target, MMSD and the 2050 FP project team assessed the GI service area and prioritized GI for the following sewersheds:

- All of those located in the CSSA
- Those located in the separate sewer service area (SSSA) with TMDLs, with high rates of infiltration and inflow (I/I), or where GI can help promote urban biodiversity

In the CSSA, the types of GI assets focus primarily on volume control, whereas in the SSSA, the desired types of GI can vary depending on the purpose, with some optimized for reducing pollutant loads, some for I/I treatment, some for biodiversity, and some for volume control.

4.5 REFERENCES

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