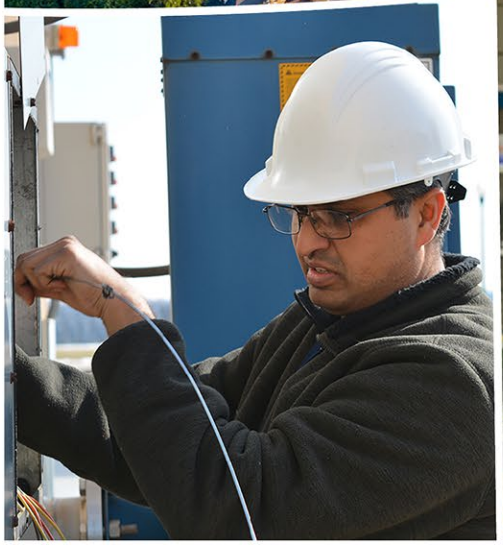
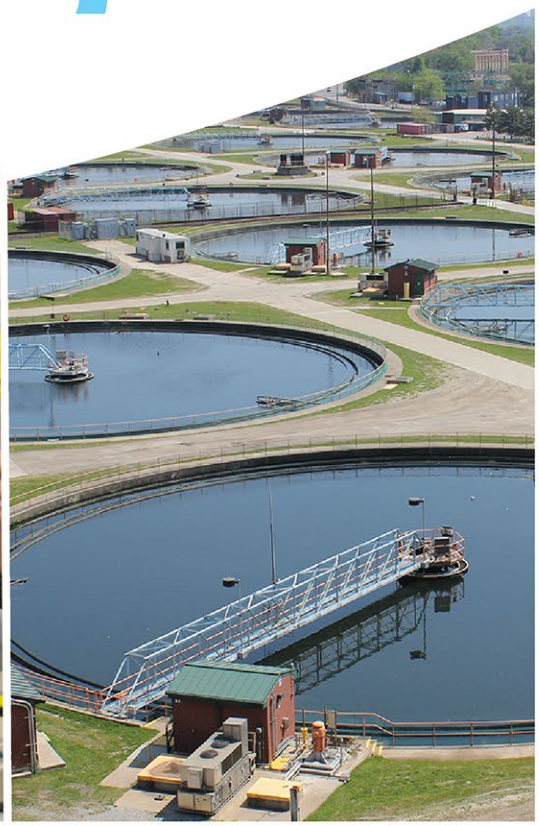
SAMP

Strategic Asset Management Plan

November 19, 2019

GLWA
Great Lakes Water Authority





GLWA
Great Lakes Water Authority

Office of the Chief Executive
735 Randolph Street, Suite 1900
Detroit, Michigan 48226

Our mission as the Great Lakes Water Authority (GLWA) is "to exceed our member partners' expectations by utilizing best practices in the treatment and transmission of water and wastewater, while promoting healthy communities and economic growth." Our Vision is that "through regional collaboration, GLWA strives to be the provider of choice dedicated to efficiently delivering the nation's best water and wastewater services in partnership with our member partners."

These are not easy undertakings. They require inclusion of our member partners, comprehensive planning, strategic implementation, ongoing reevaluation and refinement. They require our focus on our responsibility to ensure that we deliver great services while optimizing the value obtained from the systems that we have, regardless of the age of the assets. They require us to keep our focus on our priorities, beginning with assuring our results are effective as we work to be as efficient as possible. The result should be that we deliver high value in our services to our member partners. Adopting asset management as an organizational way of doing business will help us accomplish our Mission.

GLWA's asset management journey will be one of continuous improvement. In order to do asset management well, it must be part of our DNA — embedded in how each of us approaches our daily work. Asset management must be central to how we decide to allocate resources so that we gain the greatest benefit from the assets we are managing, as well as provide the best services from the system as a whole.

This Strategic Asset Management Plan (SAMP) presents GLWA's asset management vision, policy and objectives, which are consistent with the initiatives and the policies of the Board. The SAMP is our strategic, living document that provides the foundation for asset management. It lays out the distinct strategies and improvement initiatives needed to carry out our vital mission and the means to make significant progress, over the next ten to fifteen years, toward achieving our asset management vision.

The SAMP also recognizes other trends and issues in the water service sector and in the State of Michigan. Addressing our infrastructure needs will take place in a financial setting challenged by increasing costs and increasing sensitivity to rising charges. Prudent care of our infrastructure will require paying greater attention to maintenance, to making risk-based asset renewal investments as well as to considering the infrastructure improvement needs and plans of other systems. It is my intent that the SAMP will also provide assurance to our member partners that we are striving to be as collaborative and transparent as possible and accountable for obtaining the great results that they have come to expect.

I am confident in our ability to continue to deliver great service to our member partners and to meet the challenges before us. We will do so largely guided by the strategies in this plan.

I want to thank our skilled and dedicated team members for their unwavering commitment to GLWA and to the member partners we serve.

Sincerely,

Sue F. McCormick
Chief Executive Officer

Document History and Status

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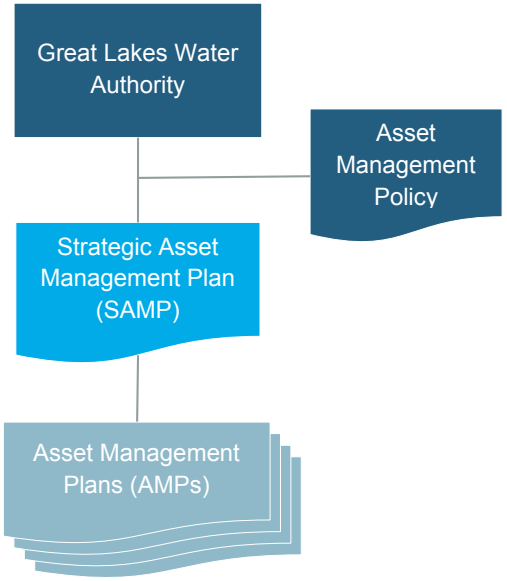
1 Executive Summary



At Great Lakes Water Authority, our assets exist for one reason—to allow us to achieve our core purpose of providing water and wastewater services to the region. As an infrastructure-intensive organization, we have substantial investments in physical assets, some of which were placed into service more than a century ago. Therefore, we must make smart decisions to determine the right time and best approach to manage our aging assets to maintain and sustain reliable service. We must also realize the maximum value from our asset portfolio throughout the lifecycle of the assets.

This initial version of our Strategic Asset Management Plan (SAMP) has been prepared with an internal GLWA focus intended to document and communicate vision, policy, objectives, and near term actions. It describes the drivers for asset management and links our organizational context with our asset management strategy and objectives. It brings our Asset Management Policy to life and establishes the framework for our Asset Management Plans.

We are implementing asset management consistently across all business units so that team members, processes, and tools work together to ensure we make well-informed and balanced decisions regarding three interrelated imperatives:

1. Understanding and achieving community desires
2. Delivering services while managing risk within the existing infrastructure and system configuration
3. Investing as required to continue delivering services to meet community needs

Our vision for asset management is to become a leader in infrastructure management by making decisions informed by risk, regional needs, and lifecycle considerations. This SAMP will help us accomplish our vision by defining and guiding the following interconnected elements:

Alignment. We will conduct our asset management activities in alignment with our Vision, Mission and Policy.

Service Levels. We will collaborate with the region to establish service levels that safely reflect the desires of member partners, end users, the public, the environment, and regulators.

Asset Lifecycle. We will manage our infrastructure assets using a holistic approach that considers all stages of the asset lifecycle and the interconnected nature of the stages.

Asset Management Framework. We will use the SAMP as a framework for our asset management activities and will update it at least every five years. We will execute our asset management roadmap and provide quarterly and yearly updates.

Asset Management Plans. We will develop asset management plans for types of assets (e.g., water treatment assets) to manage the reliability, activities, resources, and timescales required to achieve asset management objectives. We will establish defined cross-functional teams to develop the asset management plans and update them at least every three years.

Risk. We will manage enterprise, operational, project execution, and asset risks. We will identify, analyze, and treat risk using a systematic approach and will proactively seek to treat risks before impacts occur.

Data and Information. We will maintain up-to-date and accurate asset data, treating data as an asset and considering the data lifecycle in our business processes. We will use data to make informed decisions about asset maintenance priorities, risk treatments, and financial investments.

Performance. We will manage, measure, and report our performance in meeting our established service levels and asset management objectives.

People. We will treat our team members as asset management enablers and support them with communications, engagement, competency development, and change management strategies.

Continuous Improvement. We will continuously improve our asset management journey using tactics such as benchmarking, industry engagement, networking, innovation, and measuring and reporting.

This SAMP also describes our Asset Management Policy and the eight principles by which we will make decisions.

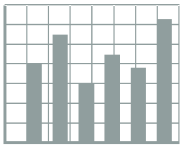
Member-Focused

Safety

Lifecycle Approach

Forward-Looking

Managed Risk



Data-Driven

Transparent

Innovative

Woven together within the SAMP are the tasks and activities we have determined to be most needed at this time to achieve our asset management objectives. For example, our framework for managing risk, enhancements regarding data and our information systems, and the enablers necessary for successful asset management. We have about 50 of these improvement initiatives for which we plan to begin implementation in the next three to five years; they are grouped into the following seven categories.

People	Governance & Decisions	Service Levels & Performance Management
Improve readiness for organizational change and make sure attention is given to the people-side of asset management.	Ensure that decisions are made by the right people at the right time, that there is clarity of decision-making protocols, and that decisions are carried-out.	Improve performance and ensure that targets are based on the desires of member partners, end users, and the public.

Risk	Data & Technology	Maintenance & Reliability	Other
Make sure funding decisions are based on achieving service level targets and that risk is considered in decision-making.	Provide availability of accurate and useful data and ensure that technology systems support asset management.	Improve reliability through maintenance optimization.	Other activities needed for achievement of asset management desired outcomes.

Additional improvement initiatives are expected to be identified periodically. We will prioritize new improvement initiatives along with the others and make decisions annually regarding which to implement.

This SAMP provides a framework for implementing our commitment to holistic asset management. We recognize that adopting and instilling asset management best practices is a journey that will take time, effort, and resources. We intend to apply an agile approach wherein we will learn from successes and failures, respond to issues and needs as they arise, and make course corrections as needed based on changing internal and external drivers. In addition, we will continue to involve team members, collaborate across functional areas, provide opportunities for input and learning, ask and answer difficult questions, encourage innovation and creative engagement, and communicate progress along the way.

We expect this journey to lead us to achieve our vision and reach asset management maturity. While it may take ten to fifteen years to become fully mature, our improvement initiatives will establish the shorter-term projects that will result in immediate benefits and result in the ultimate achievement of our asset management vision. This SAMP and our improvement initiatives will evolve as we move along our journey to asset management maturity.

Development of this SAMP has been possible because of the tremendous input from GLWA team members. Members of the Asset Management Leadership Team (AMLT) as well as the Asset Management Strategic Organization (AMSO) Satellite Teams and the six SAMP Teams have contributed many, many hours to developing SAMP content. SAMP development activities also improved asset management understanding throughout GLWA and identified best practices from around the world; these activities include the Water Services Association of Australia (WSAA) Asset Management and Customer Value (AMCV) Assessment, Institute of Asset Management (IAM) training, Certified Reliability Leader (CRL) training, and the Blue Ribbon Panel.

2 Introduction

To achieve its vision and mission, the Great Lakes Water Authority (GLWA or the Authority) depends on the knowledge, experience, and coordination of its team members to gain the most value from the $4 billion (net of accumulated depreciation) of infrastructure assets it operates and maintains. GLWA leadership has committed to adopting leading asset management practices throughout the Authority to ensure that its team members learn, understand, and employ the strategies and tactics necessary to attain and maintain asset infrastructure that effectively and efficiently delivers reliable and sustainable services to its member partners.

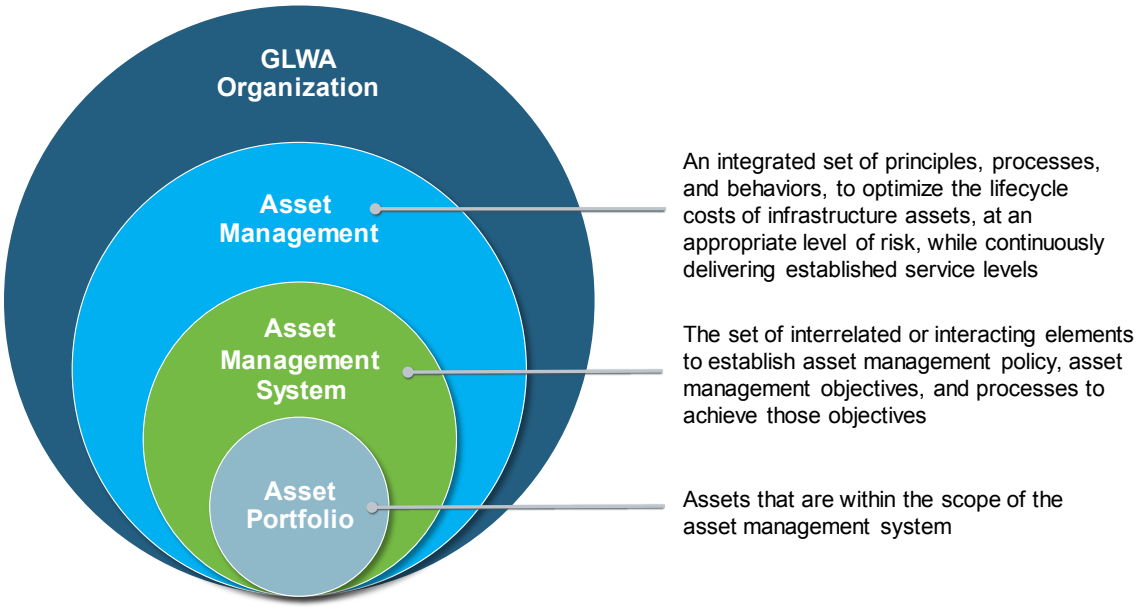
2.1 Purpose of the SAMP

The purpose of this Strategic Asset Management Plan (SAMP) is to establish GLWA's asset management framework through clear and concise delivery of the following:

- Asset management vision, policy, and objectives
- Line-of-sight that begins to link each team member's asset management contributions to GLWA's organizational objectives
- Asset management governance, roles and responsibilities, and principles for decision-making
- GLWA's commitment to align with the water service sector's best practices
- Asset management implementation plan with improvement initiatives
- Expectations for development of Asset Management Plans (AMPs)

The SAMP is the foundation of GLWA's Asset Management System (AMS). The AMS is the set of interacting and interrelated elements that guide the development and implementation of asset management activities. GLWA's AMS includes the SAMP, AMPs, Asset Management Policy, the Asset Management Objectives, and the needed leadership, governance, and processes to achieve those objectives and help accomplish GLWA's mission, vision, and organizational goals. The AMS also includes the asset portfolio and how the assets in the portfolio are to be managed throughout their lifecycles as guided by AMPs, which focus on a set of assets having a similar purpose or similar characteristics. Figure 2-1 illustrates how the AMS relates to GLWA's organization, its overarching asset management activities, and its asset portfolio.

Figure 2-1: The Asset Management System as an Element of Asset Management

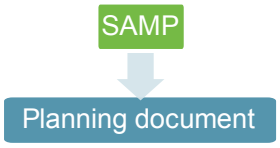


Adapted from Asset Management – An Anatomy [1]

The AMS should not be confused with an asset management information system (AMIS), which is a combination of processes, data, software, and hardware, such as a computerized maintenance management system (CMMS), that is used to enable the essential outputs for effective asset management.

The SAMP serves as a direct link between the organizational strategy and the asset management activities, resources and timeframes specified in AMPs. However, the SAMP must also align with other planning endeavors undertaken by GLWA. Some of these other planning efforts may lie within the AMS, while others may lie outside. For those inside of the AMS, the SAMP should be the influencing document. For example, future master plans should base rehabilitation and replacement of assets on the risk framework contained in this SAMP. On the other hand, updating of GLWA's Financial Plan, which lies outside of the AMS, should be coordinated with the asset management strategies presented in the SAMP, but financial constraints identified in the Five-Year Financial Plan should also influence future updates of the SAMP and AMPs. Table 2-1 provides some examples of plans that should be influenced by the contents of the SAMP and others that should be carefully coordinated with the SAMP to maintain consistency and avoid ambiguity.

Table 2-1: Examples of Plans and Their Relationship to the SAMP



Planning Documents Influenced by the SAMP
• Asset Management Implementation Plan • Asset Management Plans • Capital Improvement Plan • Water and Wastewater Master Plans • Maintenance Strategies and Plans • Asset Management Information System Plan • Asset Management Competency Plan • Asset Management Organizational Change and Communications Plan

Planning Documents to be Coordinated with the SAMP
• Five-Year Financial Plan • Biennial Budget • Risk and Resilience Plan • Emergency Response Plan • Operational Plans • Enterprise Information Technology Plan • Enterprise Human Resources Plan • One Water Engagement Plan

2.2 Structure of the SAMP

This SAMP is structured to align with the ongoing work of GLWA's Asset Management Strategic Organization (AMSO) and GLWA's asset management vision (see Section 4.1) of becoming, "a leader in infrastructure management by making decisions informed by risk, regional needs, and lifecycle considerations." GLWA team members throughout the organization, including members of GLWA's Executive Leadership Team, were actively engaged in developing this SAMP over a period of 10 months. While achieving ISO 55001 [2] certification in asset management is currently not being considered by GLWA, the ISO 55000 suite of standards was used as a guide in structuring this SAMP, along with other well-recognized asset management reference documents such as the International Infrastructure Management Manual [3], Asset Management – An Anatomy [1], and the Asset Management Landscape [4]. Table 2-2 presents the structure of the SAMP.

Table 2-2: Structure of the SAMP

SAMP Section		Description
1.	Executive Summary	A succinct overview of the SAMP including a brief explanation of its purpose, key issues and highlights covered, and an abridged version of any recommendations.
2.	Introduction	The purpose of the SAMP, its alignment with other planning activities of GLWA, how the SAMP was developed and structured, and the scope of the SAMP (i.e., assets within the AMS).
3.	Asset Management in the Organizational Context	A brief history of GLWA, its organizational structure, service area, asset management drivers and stakeholders, as well as GLWA's approach for identifying and treating organizational risks.
4.	Asset Management Strategy and Objectives	Presentation of GLWA's asset management vision, asset management policy, asset management objectives, and asset lifecycle strategies; how they relate and interact.

SAMP Section		Description
5.	Performance Management	GLWA's approach to measuring and reporting performance, establishing service levels and performance indicators, and approach for future adjustments.
6.	Asset Management Plan Framework	Requirements of an AMP and an AMP's alignment to the SAMP; recommended asset groupings for each AMP and a typical outline for an AMP; also, the asset risk framework.
7.	Asset Data and Asset Management Information Systems	Importance of current and accurate data for asset management, GLWA's asset hierarchy, the use of technology systems and decision-making tools; also, information needed to understand and optimize asset performance.
8.	Asset Management Enablers	The key resources that will enable GLWA to institutionalize asset management, including asset management governance, asset management competencies and training, organizational change management, and communications.
9.	Framework for Continuous Improvement	Guidance for GLWA to continuously improve on its asset management journey, including approaches to benchmarking, engagement and networking, innovation, and measuring and reporting.
10.	Asset Management Implementation Plan	Describes GLWA's asset management current state and maturity level, GLWA's asset management desired state, and the plan to move from the current to the desired state.
	Appendix A	Acronyms and Abbreviations
	Appendix B	Glossary of Terms and Definitions
	Appendix C	References (Note: these are source documents for citations in parentheses)
	Appendix D	GLWA Asset Management Policy
	Appendix E	Asset Risk Process and Scoring Matrices
	Appendix F	Enterprise Risk Process and Scoring Matrices
	Appendix G	Improvement Initiative Swim Lanes

2.3 Improvement Initiatives

Improvement initiatives (IIs) are the tasks and activities GLWA has determined to be most needed to achieve its asset management objectives. IIs are identified throughout the document with color-coded callout boxes (see Figure 2-2 and Figure 2-3); the complete list of IIs is located in Section 10.5.

Figure 2-2: Improvement Initiative Callout Box

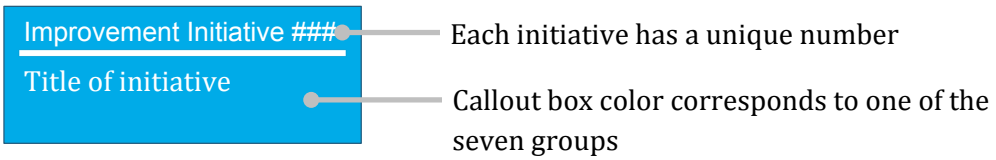


Figure 2-3: Improvement Initiative Color Codes

People	Governance & Decisions	Service Levels & Performance Management
Improve readiness for organizational change and make sure attention is given to the people-side of asset management.	Ensure that decisions are made by the right people at the right time, that there is clarity of decision-making protocols, and that decisions are carried-out.	Improve performance and ensure that targets are based on the desires of member partners, end users, and the public.

Risk	Data & Technology	Maintenance & Reliability	Other
Make sure funding decisions are based on achieving service level targets and that risk is considered in decision-making.	Provide availability of accurate and useful data and ensure that technology systems support asset management.	Improve reliability through maintenance optimization.	Other activities needed for achievement of asset management desired outcomes.

Additional IIs will be periodically identified and prioritized with the other IIs. Decisions will be made annually regarding which IIs to implement.

2.4 SAMP Updates

GLWA views the SAMP as a "living document." It must be valid in the current context of the organization and appropriate to GLWA's contemporary external environment of stakeholders and drivers. Consequently, the AMSO has established the review and updating schedule for the SAMP as follows:

- Annually concurrent with the development of the capital improvement plan and operations budget, the SAMP will be reviewed and revised to address any inconsistencies found within the document. Refinements to reflect changes in the asset portfolio, clarifications to the risk framework, updates to data management and technology used should be noted.
- Every five years the SAMP will undergo a comprehensive review and update, including a reconsideration of the asset management vision, asset management policy, and asset management objectives. The update should reflect advances in the discipline of asset management, asset management standards and guidance, lessons learned from implementing asset management practices, and gaps in best practices as identified through benchmarking and networking. The asset management improvement plan should be revisited, including the development of any new improvement initiatives and an updated roadmap for implementing those initiatives.
- A significant change in circumstances impacting GLWA, such as a substantial modification to the organizational strategy or a new regulatory requirement

affecting the approach to managing assets, may require a comprehensive review and update to the SAMP prior to the five-year timeframe. Such a decision will be made by the Asset Management Leadership Team (AMLT).

- Updates to the SAMP will be initiated and coordinated by the Enterprise Asset Management Group (EAMG) under the direction of the AMLT, and will be coordinated with AMSO members as appropriate.
- All updates of the SAMP must be approved by the AMLT. Once approved, the update should be published by AMSO and communicated throughout GLWA.

In addition, new Improvement Initiatives (IIs) are expected to be identified periodically. EAMG will maintain the master list of IIs. These will be prioritized along with the others and decisions will be made annually regarding which to implement. Activities to prioritize and resource IIs will be conducted as part of AMSO governance.

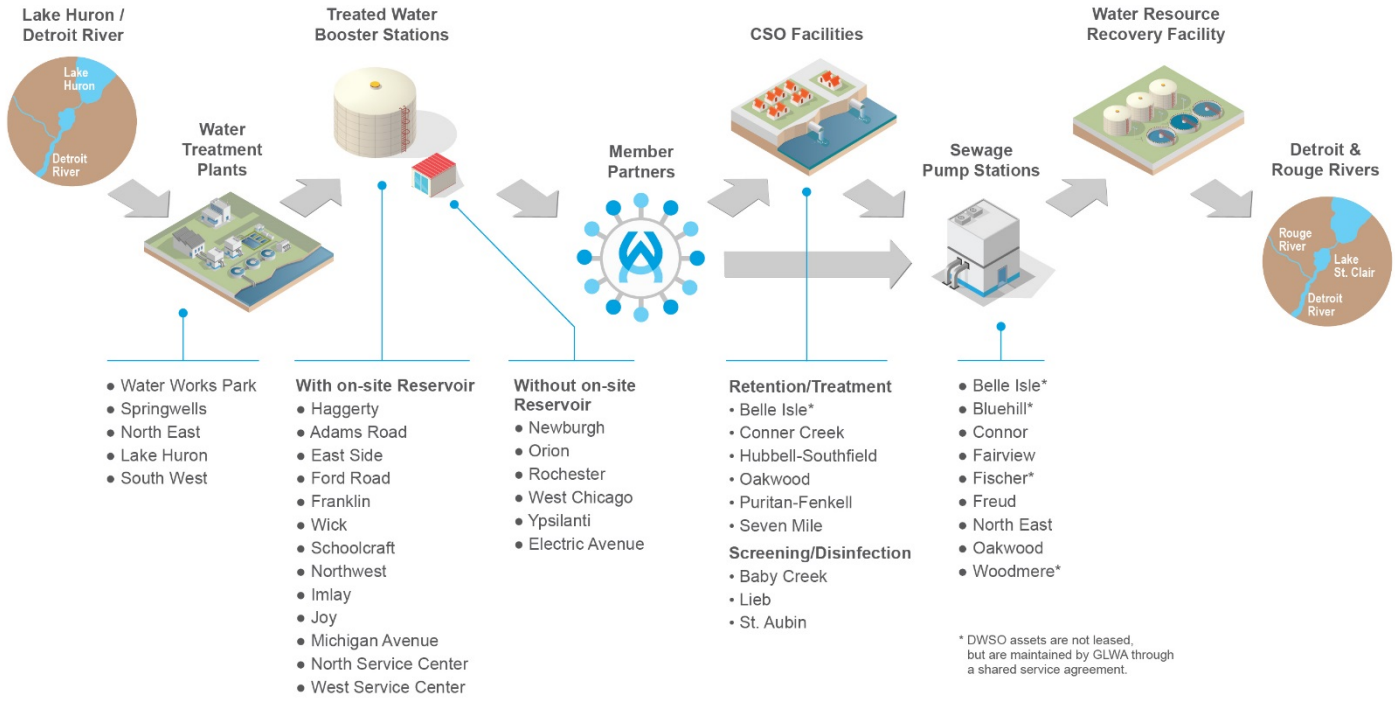
2.5 The Asset Portfolio

GLWA provides water and wastewater services through $4 billion (net of accumulated depreciation) of infrastructure assets [5]. These assets are the responsibility of GLWA pursuant to a 40-year Regional Water Supply System Lease, and a 40-year Regional Sewage Disposal System Lease from the City of Detroit (City). Both leases were executed on June 12, 2015.

In accordance with the terms of these leases, GLWA must operate, maintain, renew, and upgrade all components of the water and wastewater systems to provide wholesale water and wastewater services to the communities previously served by the Detroit Water and Sewerage Department (DWSD) and now served by GLWA (currently referred to as "member partners"). Along with the infrastructure assets that directly provide water and wastewater services, the leases also transferred responsibility from the City to GLWA for real property (including easements), portions of the DWSD headquarters building, and portions of the DWSD Central Services Facility, both along with furnishings. Numerous light and heavy vehicles, as well as heavy equipment from DWSD, were also transferred to GLWA through the leases.

Figure 2-4 is a schematic of GLWA's *One Water* System, beginning with withdrawing source water, treating the water, pumping and transmitting the treated water to member partners, then conveying wastewater through pipes and pump stations, treating the wastewater and stormwater during wet weather and dry weather, and returning clean water back to its sources.

Figure 2-4: GLWA's One Water System



2.5.1 Water System

Major components of GLWA's water system include three intake facilities, 23 miles of raw water tunnels with sizes ranging from 120 to 186 inches in diameter, five treatment plants, 18 remote water booster stations, and a conveyance system of approximately 810 miles of water transmission main with an average age of 70 years. In addition, there are 30 water storage reservoirs, 14 of which are located at the water treatment plants (WTPs), and 16 located at booster stations. The maximum rated treatment capacity of the system is 1,720 million gallons per day (MGD) with a firm high service pumping capacity of 2,400 MGD. Water system flow and pressure are monitored and controlled remotely from the Systems Control Center located at the Central Services Facility.

Table 2-3 through Table 2-5 and Figure 2-5 through Figure 2-8 provide information on the major components of the water system. The quantities and other values related to assets change over time as new assets are added and others are decommissioned. Therefore, many of the quantities and other values shown in these tables and figures are based on the best information available at the time this SAMP was prepared.

Table 2-3: Raw Water Intake Facilities

Facility	Placed In-Service	Source	Treatment Plants Served
Belle Isle	1931	Detroit River	Water Works Park Springwells Northeast
Fighting Island	1964	Detroit River	Southwest
Lake Huron	1974	Lake Huron	Lake Huron

Table 2-4: Water Treatment Plants

Treatment Plant	Placed In-Service	Rated Capacity (MGD)	Finished Water Storage	Major Unit Processes
Springwells	1931 (first train) 1958 (second train)	540	3 Reservoirs 60 MG total	Rapid mix, coagulation, flocculation, sedimentation, filtration, and chlorination (Note 1)
Northeast	1956	300	2 Reservoirs 30 MG total	Rapid mix, coagulation, flocculation, sedimentation, filtration, and chlorination (Note 1)
Southwest	1964	240	3 Reservoirs 30 MG total	Rapid mix, coagulation, flocculation, sedimentation, filtration, chlorination, and residuals handling
Lake Huron	1974	400	3 Reservoirs 44 MG total	Rapid mix, coagulation, flocculation, sedimentation, filtration, and chlorination, and residuals drying lagoons
Water Works Park	2003	240	3 Reservoirs 28 MG total	Rapid mix, coagulation, flocculation, sedimentation, ozonation, filtration, chlorination, and residuals handling

Notes:

1. Raw water is chlorinated, fluoridated and screened at Water Works Park WTP before flowing to this WTP.

Table 2-5: Treated Water Booster Stations

Booster Station	Rated Capacity (MGD)	Finished Water Storage
Adams Rd.	109	1 Reservoir 10 MG
Eastside	30	1 Reservoir 10 MG
Ford Rd.	109	1 Reservoir 10 MG
Franklin	164	1 Reservoir 10 MG
Haggerty	91	1 Reservoir 10 MG

Booster Station	Rated Capacity (MGD)	Finished Water Storage
North Service Center	271	2 Reservoir 20 MG total
Northwest	50	1 Reservoir 10 MG
Orion	17	None
Rochester	72	None
Schoolcraft	80	1 Reservoir 10 MG

Booster Station	Rated Capacity (MGD)	Finished Water Storage
Imlay	575	1 Reservoir 18 MG
Joy Road	94	2 Reservoirs 10 MG total
Michigan Avenue	29	1 Reservoir 3.3 MG
Newburgh	52	None

Booster Station	Rated Capacity (MGD)	Finished Water Storage
West Chicago	19.1	None
West Service Center	266	2 Reservoirs 20 MG total
Wick Road	72	1 Reservoir 10 MG
Ypsilanti	54	None

Figure 2-5: Miles of Water Transmission Main by Pipe Diameter

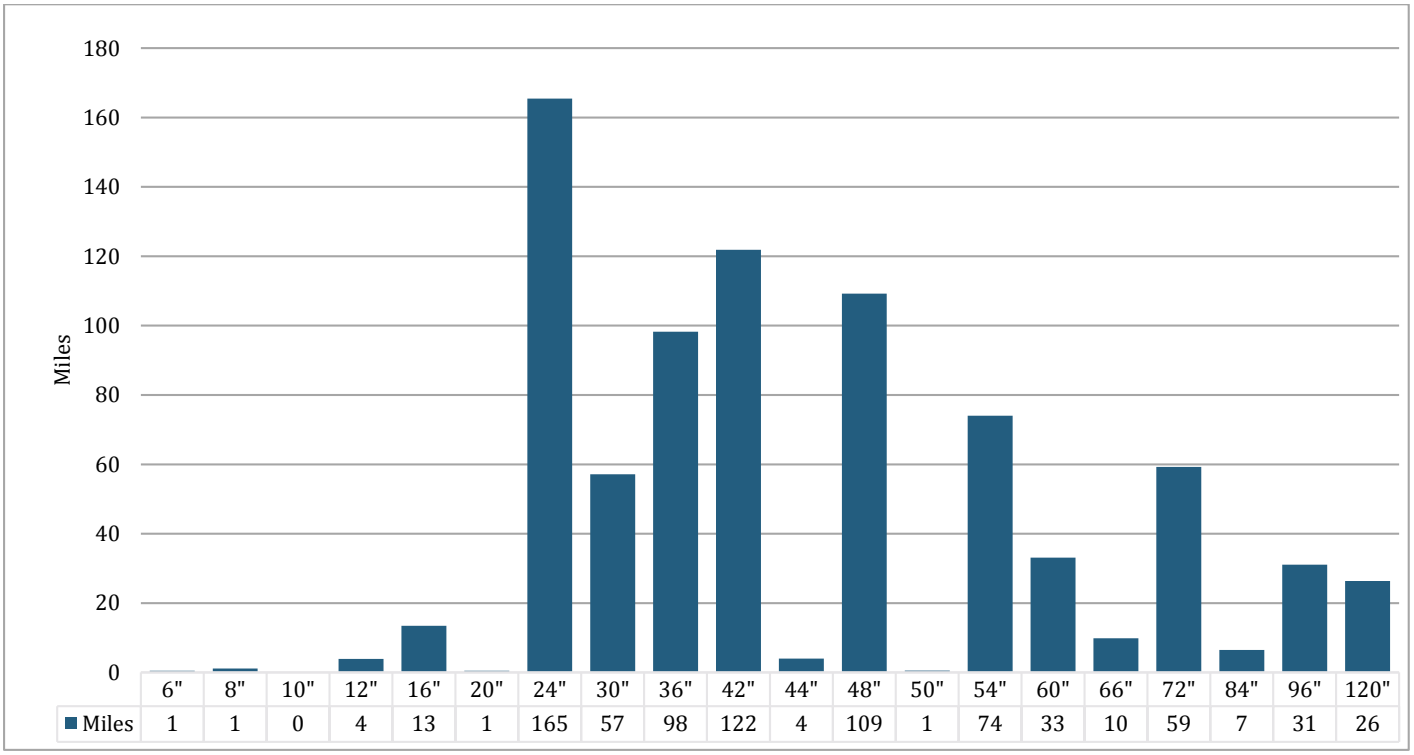


Figure 2-6: Miles of Water Transmission Main by Decade Installed

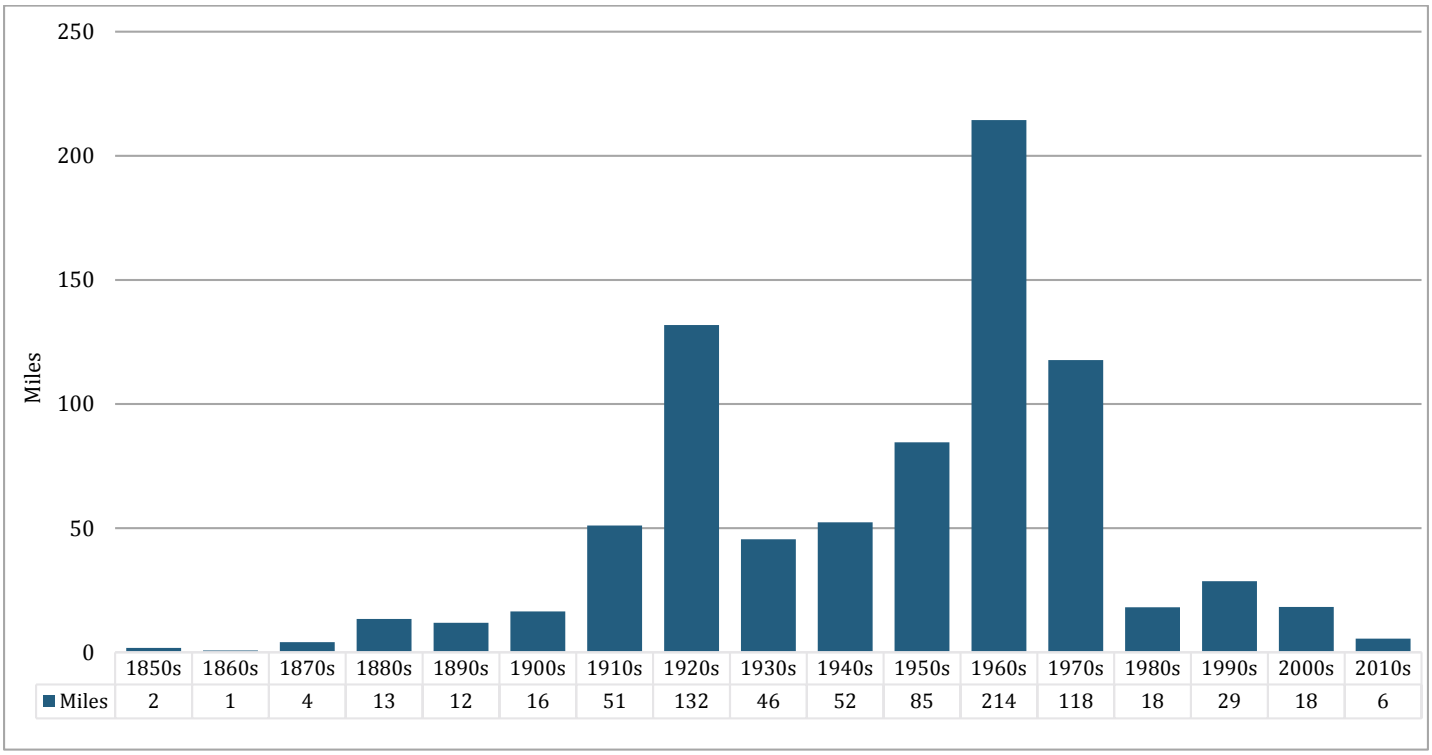


Figure 2-7: Miles of Water Transmission Main by Age (in years) as of the Year 2020

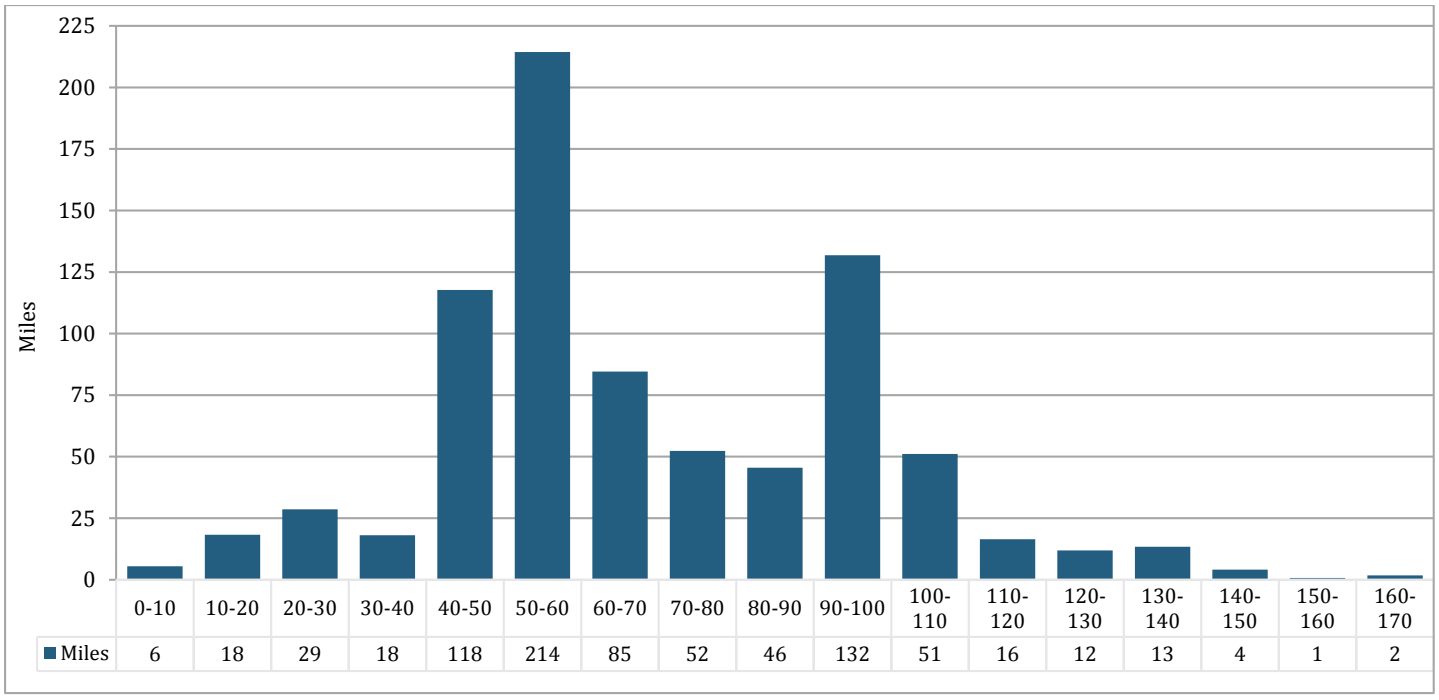


Figure 2-8: Pipe Material by Percent of Water Transmission System

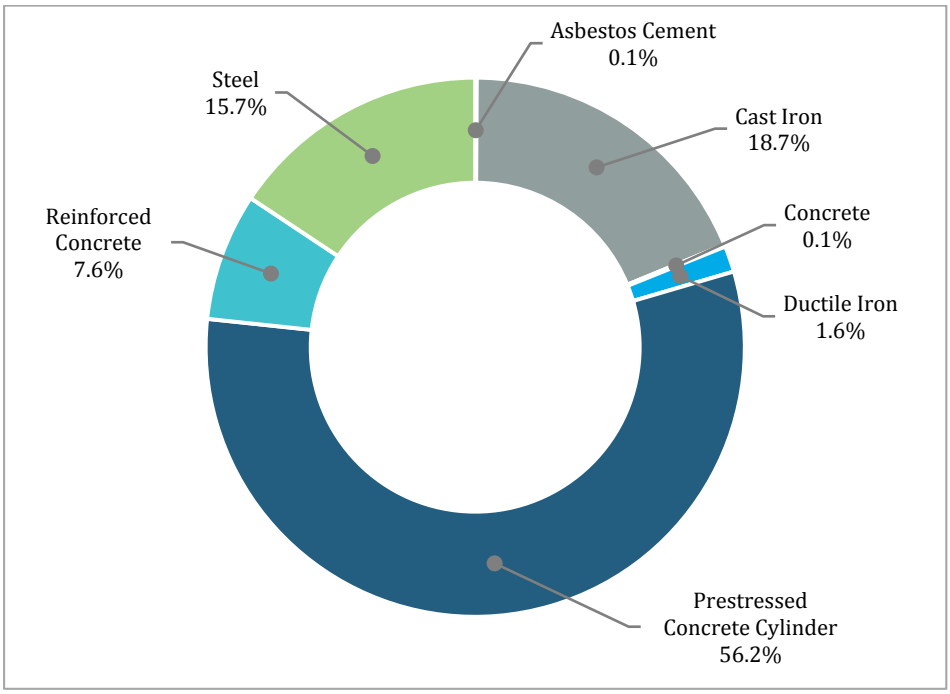


Table 2-6 lists the quantities of several ancillary assets of the water transmission system.

Table 2-6: Water Transmission System's Ancillary Assets

Asset Type	Quantity
Air Relief Valves	2,800
Blowoff Valves	2,000
Control Valves	78
Hydrants	260
Isolation Valves	4,800
Pressure Monitoring Sites	99
Member Partner Water Meter Sites	290

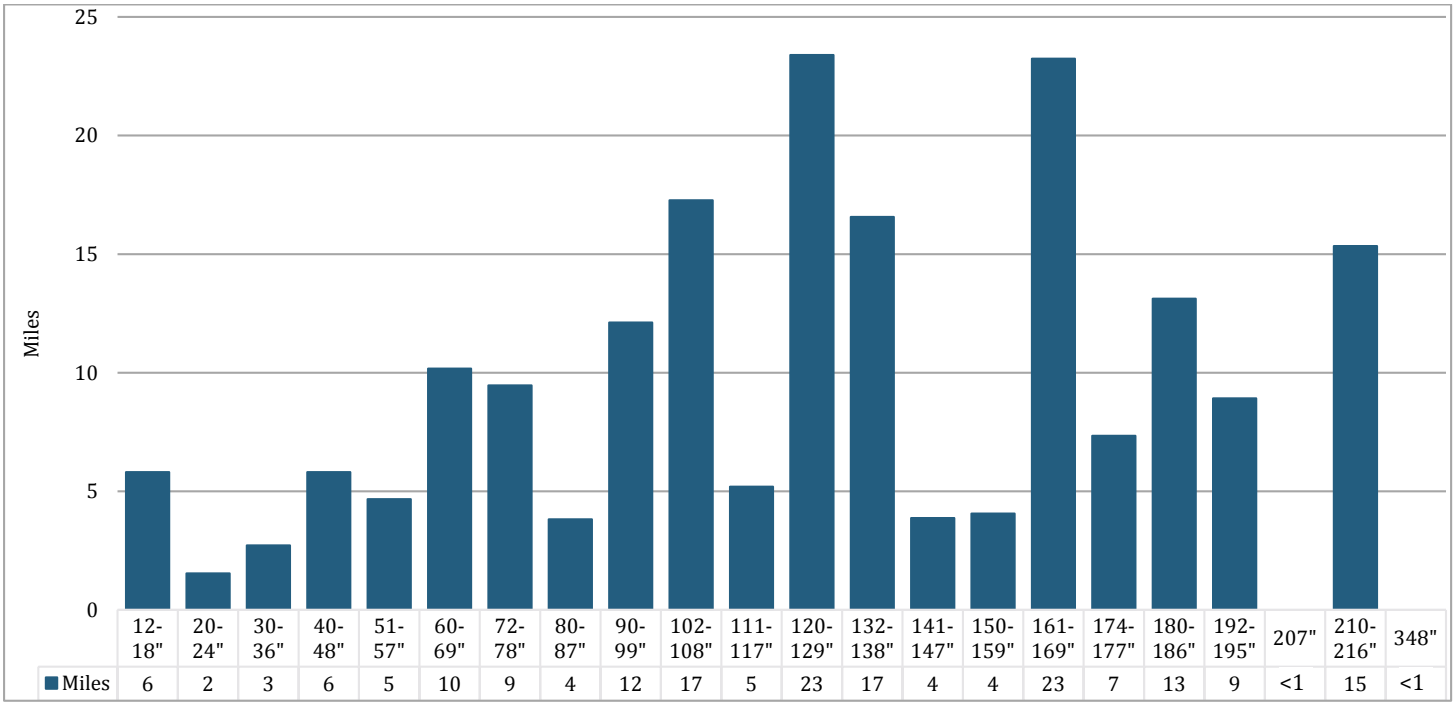
2.5.2 Wastewater System

Major components of GLWA's wastewater system include a combined sewage conveyance system of approximately 200 miles of gravity pipelines with an average age of 79 years. There are nine sewage pump stations plus nine Combined Sewer Overflow (CSO) control facilities. Three of the nine pump stations and one of the nine CSO control facilities are operated and maintained by GLWA but not leased from the City. Six of these CSO control facilities are referred to as Retention Treatment Basins (RTB). RTBs capture, store, and treat excess flow during wet weather that cannot be accommodated by the conveyance system and would otherwise be discharged, untreated, into surface waters. The other three

CSO control facilities are referred to as Screening and Disinfection Facilities (SDF). The SDFs provide treatment of combined sewage when the flow exceeds the capacity of the conveyance system, but SDFs do not store the excess flow, rather discharging the treated combined sewage into surface waters. The conveyance system, including the pump stations, RTBs and SDFs are remotely monitored and controlled from the Systems Control Center located at the Central Services Facility.

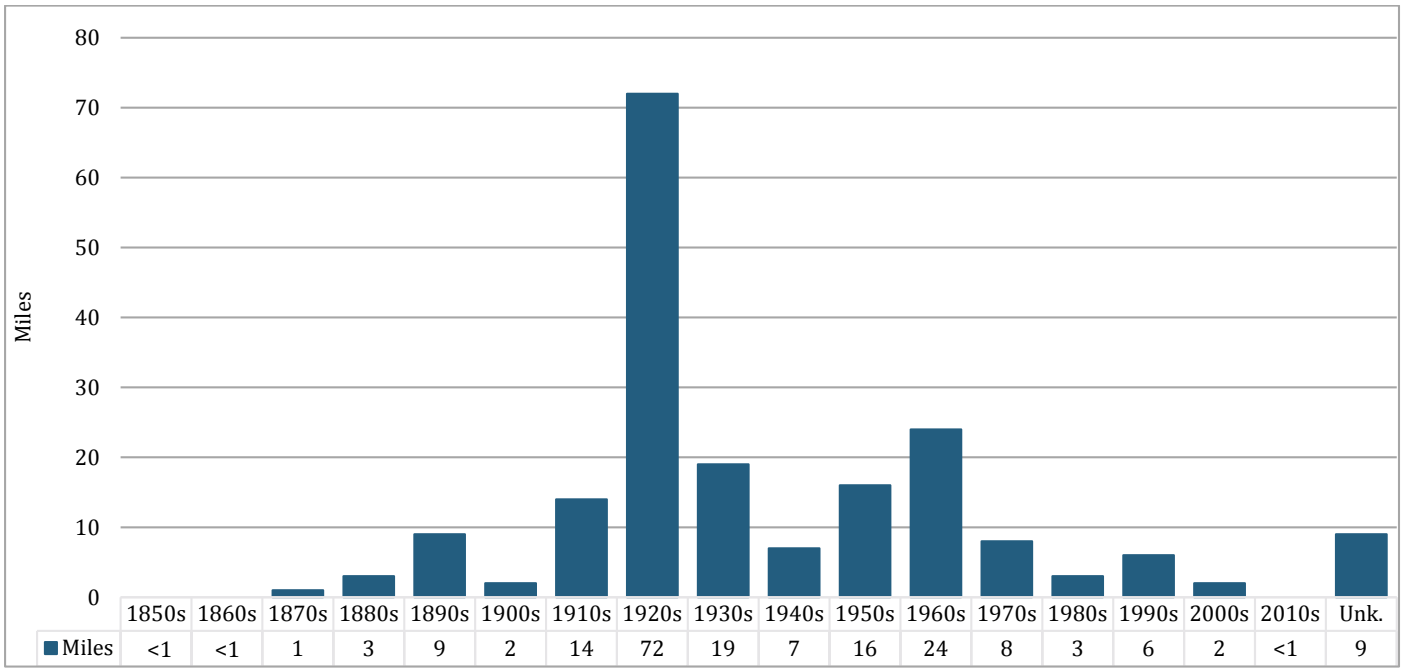
GLWA's Water Resource Recovery Facility (WRRF) has a dry weather capacity of 930 MGD (secondary treatment) and wet weather capacity of 1,700 MGD (primary treatment). The facility is the largest wastewater treatment facility in the State of Michigan and the largest single-site facility in the United States. Originally constructed as a primary treatment facility, it began operation in 1940. It was expanded and upgraded to secondary treatment in the 1960s and 1970s. The Biosolids Drying Facility (BDF), with a capacity of producing 316 dry tons per day of Class A biosolids, was placed in service in 2016. The BDF is a public-private partnership with New England Fertilizer Company (NEFCO). Improvements to the WRRF continue to be made to increase treatment effectiveness and efficiency, including reducing the level of phosphorus in the effluent discharged to the Detroit River and Rouge River. Figure 2-9 through Figure 2-12 and Table 2-2 through Table 2-10 provide information on the major components of the wastewater system. The quantities and other values related to assets change over time as new assets are added and others are decommissioned. Therefore, many of the quantities and other values shown in these tables and figures are based on the best information available at the time this SAMP was prepared.

Figure 2-9: Miles of Sewers by Diameter



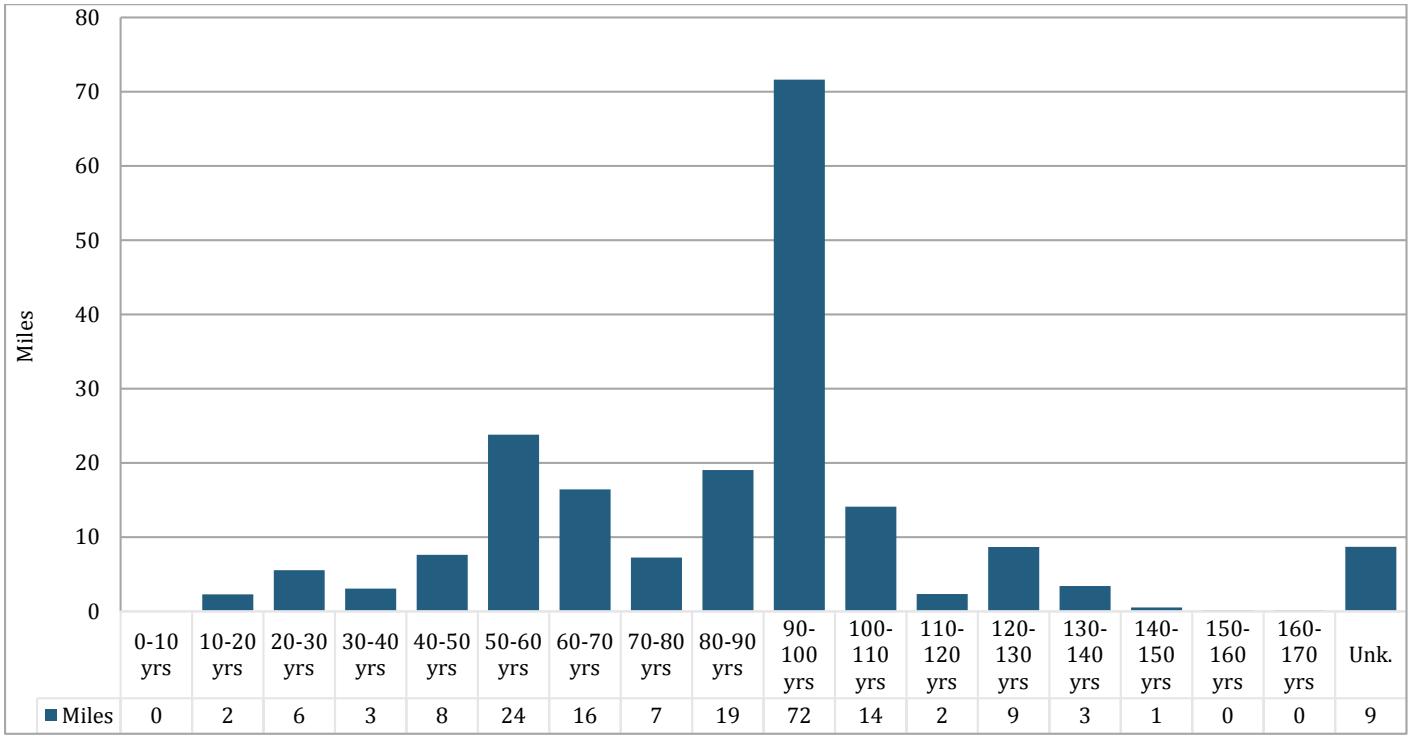
	12-18"	20-24"	30-36"	40-48"	51-57"	60-69"	72-78"	80-87"	90-99"	102-108"	111-117"	120-129"	132-138"	141-147"	150-159"	161-169"	174-177"	180-186"	192-195"	207"	210-216"	348"
Miles	6	2	3	6	5	10	9	4	12	17	5	23	17	4	4	23	7	13	9	<1	15	<1

Figure 2-10: Miles of Sewer by Decade Installed



	1850s	1860s	1870s	1880s	1890s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010s	Unk.
Miles	<1	<1	1	3	9	2	14	72	19	7	16	24	8	3	6	2	<1	9

Figure 2-11: Miles of Sewer by Age (in years) as of the Year 2020



	0-10 yrs	10-20 yrs	20-30 yrs	30-40 yrs	40-50 yrs	50-60 yrs	60-70 yrs	70-80 yrs	80-90 yrs	90-100 yrs	100-110 yrs	110-120 yrs	120-130 yrs	130-140 yrs	140-150 yrs	150-160 yrs	160-170 yrs	Unk.
Miles	0	2	6	3	8	24	16	7	19	72	14	2	9	3	1	0	0	9

Figure 2-12: Pipe Material by Percent of Wastewater Conveyance System

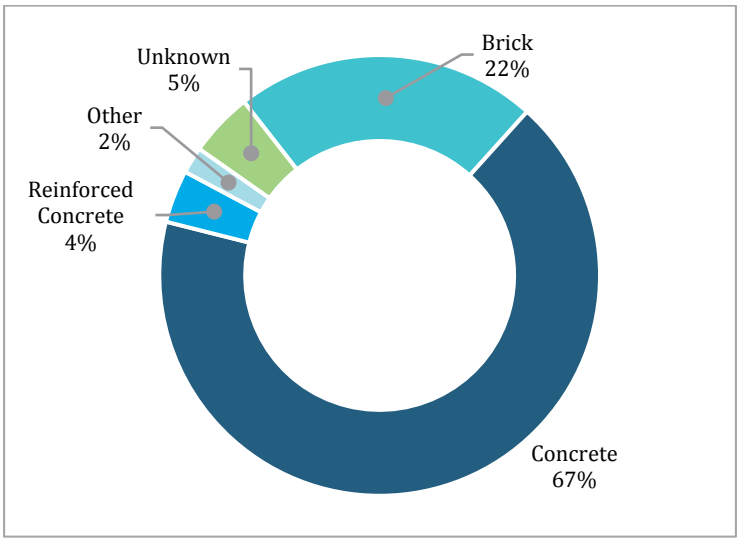


Table 2-7: Wastewater Conveyance System's Ancillary Assets

Asset Type	Quantity
Manholes	1,400
In-System Storage Devices	15
Valves/Regulators – Remotely Operated	19
Member Partner Sewer Metering Sites	21
System Metering Sites	14
Level Sensors	29
Precipitation Gauges	36

Table 2-8: Sewage Pump Stations

Pump Station	Placed In-Service	Last Major Rehabilitation	Dry Weather Pumps / Capacity	Wet Weather Pumps / Capacity
Belle Isle (Note 1)	1920s	2000	2 pumps 4 MGD total	3 pumps 33 MGD total
Blue Hill (Note 1)	1947	2013	2 pumps 6 MGD total	4 pumps 865 MGD total
Conner Creek	1928	2009	4 pumps 336 MGD total	8 pumps 2, 560 MGD total
Fairview	1913	1995	4 pumps 336 MGD total	0
Fischer (Note 1)	1963	2013	2 pumps 14 MGD	0
Freud	1954	2011	2 pumps 40 MGD total	8 pumps 2,320 MGD total

Pump Station	Placed In-Service	Last Major Rehabilitation	Dry Weather Pumps / Capacity	Wet Weather Pumps / Capacity
Northeast	1969	2013	6 pumps 335 MGD total	0
Oakwood	2012	N/A	4 pumps 26 MGD total	8 pumps 1,256 MGD total
Woodmere (Note 1)	1958	2013	2 pumps 10 MGD total	3 pumps 495 MGD

Notes:
1. DWSD assets are not leased, but are maintained by GLWA through a shared service agreement.

Table 2-9: Combined Sewer Overflow Facilities

Facility	RTB	SDF	Placed In-Service	Storage		Treatment
				Retention	In-System	
Belle Isle (Note 1)	✓		2008	0.3 MG	0	Fine screens, carbon absorption odor control, flushing gates, forced air ventilation, sodium hypochlorite disinfection
Conner Creek	✓		2005	30 MG	32 MG	Bar screens, carbon absorption odor control, flushing gates, forced air ventilation, sodium hypochlorite disinfection
Hubbell-Southfield	✓		2000	22 MG	4.4 MG	Bar screens, scrubber odor control, flushing nozzles, forced air ventilation, sodium hypochlorite disinfection
Oakwood	✓		2012	9 MG	0	Perforated plate screens, carbon absorption odor control, flushing gates, forced air ventilation, sodium hypochlorite disinfection
Puritan-Fenkell	✓		1999	2.8 MG	2.5 MG	Bar screens, scrubber odor control, tipping bucket flushing, forced air ventilation, sodium hypochlorite disinfection
Seven Mile	✓		1999	2.2 MG	1.9 MG	Bar screens, scrubber odor control, tipping bucket flushing, forced air ventilation, sodium hypochlorite disinfection
Baby Creek		✓	2007	40 MG in effluent conduit		Fine screens, sodium hypochlorite disinfection
Leib		✓	2002	9.9 MG in disinfection channel		Fine screens, sodium hypochlorite disinfection
St. Aubin		✓	2002	2.4 MG in disinfection channel		Fine screens, sodium hypochlorite disinfection

Notes:
1. DWSD assets are not leased, but are maintained by GLWA through a shared service agreement.

Table 2-10: WRRF Partial List of Major Assets by Treatment Process

Treatment Process	Major Assets	Quantity
Preliminary Treatment	Influent pump stations	2
	Bar screens	16
	Grit chambers	16
Primary Treatment	Primary clarifiers	18
	Sludge pumps	24
	Scum pumps	7
	Scum concentrators	6
	Scum storage tanks	6
Secondary Treatment	Intermediate pumping stations	2
	Aeration bays	36
	Oxygen gas delivery pipeline	1
	Liquid oxygen storage tank	1
	Final clarifiers	25
	Return activated sludge pumps	25
Disinfection	Chlorine Evaporators	16
	NaHSO4 Evaporators	14
	Hypochlorite Pumps	9
	Bisulfite pumps	6
Solids Treatment	Primary thickeners	6
	Secondary thickeners	6
	Thickened sludge pumps	16
	Sludge storage tanks (circular)	4
	Sludge storage tanks (rectangular)	2
	Sludge pumps	6
	Belt filter presses	22
	Sludge cake pumps	4
	Polymer feed systems	4
	Centrifuges	12
	Biosolids drying facility	1

2.6 Other Facilities, Equipment and Vehicles

Pursuant to the Regional Water Supply System Lease and the Regional Sewage Disposal System Lease, GLWA is also the lessee of several areas of both the DWSD headquarters building on Randolph Street and the Central Services Facility on Huber Avenue. The leases also provided GLWA with several hundred items of personal property from DWSD, including equipment and vehicles needed to maintain the water and wastewater systems and ancillary assets. Table 2-11 lists GLWA's rolling stock by the type and number of vehicles and heavy equipment.

Table 2-11: Vehicles and Heavy Equipment

Type	Vehicle	Quantity
Light Vehicles	Cars	16
	Pick-ups	52
	Step vans	7
	Sport utility vehicles (SUVs)	27
	Vans	156
Heavy Vehicles	Debris hopper	1
	Dump trucks	9
	Flusher truck	1
	Madvac® litter vacuum	1
	Off-road vehicles	7
	Stake trucks	6
	Sweeper trucks	2
	Tanker truck	1
	Utility trucks	29
	Vacuum loaders	5

3 Asset Management in the Organizational Context

3.1 History and Overview of GLWA

3.1.1 Creation of GLWA

In July 2013, the City of Detroit filed for bankruptcy having been found insolvent with an accumulated deficit of $327 million and an outstanding debt estimated at $19 billion. Approximately $4 billion of the debt was attributed to the City's water and wastewater systems. Through court-ordered mediation between the City and its creditors, a plan was developed in January 2014 to bifurcate the City's water supply and wastewater disposal systems (not including distribution mains or local sewers) into a regional authority. Subsequent negotiations resulted in the execution of a memorandum of understanding by the mayor of the City; the chief executives of Wayne, Oakland, and Macomb counties; and the governor of the State of Michigan to form the Great Lakes Water Authority. On November 26, 2014, GLWA was officially incorporated under Michigan State Statutes by the City and three of the eight counties to which the City had been providing wholesale water and wastewater services, the counties of Macomb, Oakland, and Wayne.

GLWA was incorporated under Michigan Public Act 233 of 1955. The articles of incorporation state that GLWA was created "for the purpose of acquiring, owning, leasing, improving, extending, financing, refinancing and operating" the water and wastewater systems. The articles of incorporation also require GLWA to lease the City's water supply and wastewater disposal systems, which had been under the control of the City. As such, on June 12, 2015, the City and GLWA executed the Regional Water Supply and Sewerage Disposal System Leases, transferring the water supply and wastewater disposal systems from the City to GLWA. The initial term of the lease is 40 years. GLWA and the City also entered into a Water and Sewer Services Agreement, pursuant to which GLWA provides water and wastewater capacity to the City; the City then supplies these services to the City's retail customers through its water distribution and local sewer systems.

With the leases and the services agreements executed, and both parties meeting several pre-conditions, GLWA became responsible for the prudent management of assets necessary to provide regional water and wastewater services to member partners within southeast Michigan on January 1, 2016.

3.1.2 Governance and Leadership Structure

GLWA's articles of incorporation established a Board of Directors (Board), consisting of six voting members. Two of the Board's members are appointed by the Mayor of the City; one member is appointed by each of the three counties that signed the Articles of Incorporation (Wayne, Oakland, and Macomb); and one member from outside of the three counties, but within GLWA's service area is appointed by the Governor of the State of Michigan. All Board members are appointed by their respective governments and serve a four-year term.

The board adopted a committee structure of four committees: Audit, Capital Planning, Operations and Resources, and Legal. The establishment of the Audit Committee was required by the Articles of Incorporation; the other three committees were initiated by the board. The Articles of Incorporation also require the board to appoint a Treasurer. Currently, GLWA's Chief Financial Officer serves as the Treasurer.

Management of GLWA is led by the Chief Executive Officer (CEO). Together with the CEO, 10 chief-level executives make up the Executive Leadership Team (ELT) for GLWA as illustrated in Figure 3-1 and listed below:

- Chief Executive Officer
- Chief Administrative and Compliance Officer
- Chief Financial Officer / Treasurer, Financial Services
- Chief Operating Officer – Water and Field Services
- Chief Operating Officer – Wastewater Operating Services
- Chief Organizational Development Officer
- Chief Planning Officer
- Chief Public Affairs Officer
- Chief Information Officer
- Chief Security and Integrity Officer
- General Counsel

In late 2016, GLWA established the AMSO team, under the executive sponsorship of the Chief Planning Officer, to develop and integrate asset management across the Authority. Currently, the AMSO team is comprised of an Asset Management Leadership Team (AMLT) and four satellite teams: 1) Asset Management Plan Team, 2) Asset Management Services Team, 3) Geographic Information System (GIS) Governance Team, and 4) Water Asset Management (WAM) Governance Team. Further information on the AMSO team and asset management governance can be found in Section 8.1.

Figure 3-1: GLWA's Influencer Chart

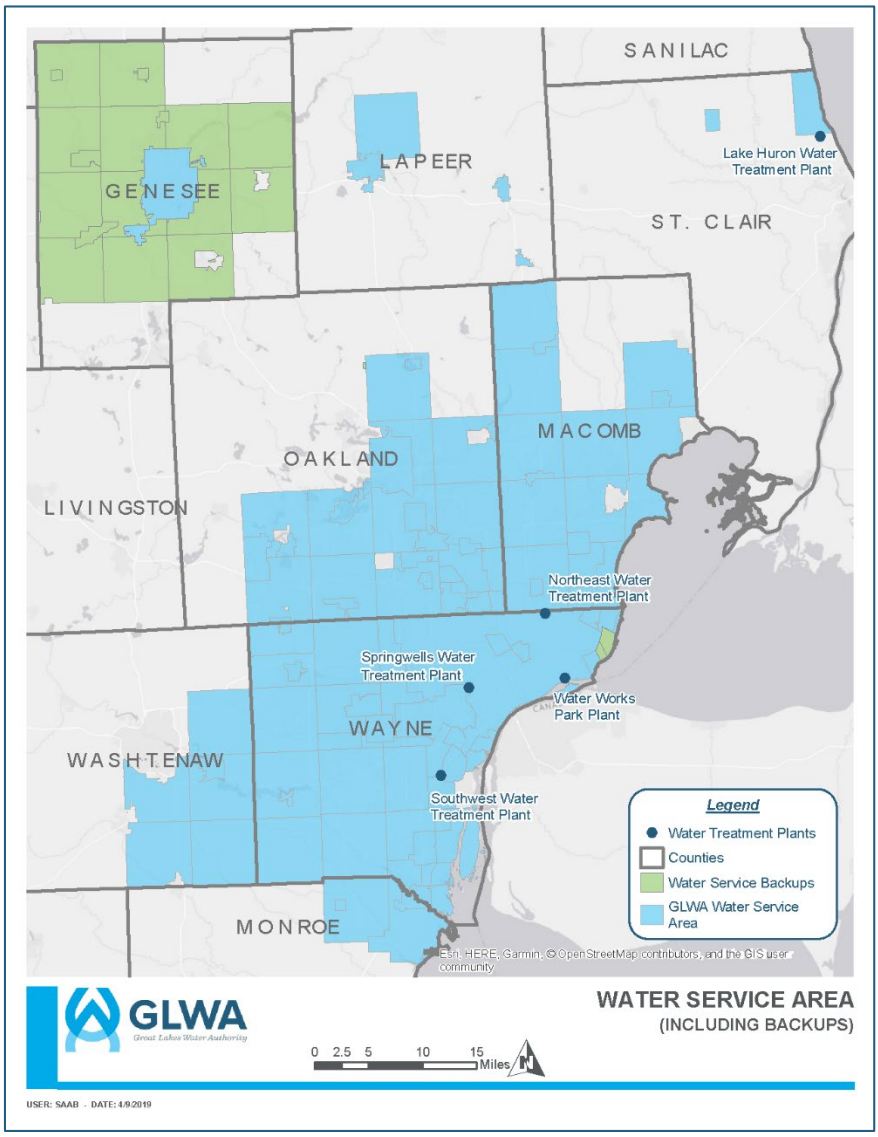
3.1.3 Service Area and Customer Base

3.1.3.1 Water System

GLWA is the largest water provider in the State of Michigan, serving nearly four million people, approximately 39 percent of the state's total population [5] [6]. Water service is provided on a wholesale basis to 127 member partners in all or a portion of eight counties. Member partners account for approximately 82 percent of the total population served by GLWA, while the City's retail water customers make up the other 18 percent [7]. Water service to these member partners is provided in accordance with 87 wholesale water service contracts with municipalities and other public entities. Model contracts, with an initial term of 30 years, are in effect for 80 of the 87 wholesale customers, while six are served under a former contract structure and one is served under an emergency service contract [7]. GLWA also provides water service to the City under the provisions of the Water and Sewer Services Agreement.

Although not contiguous, GLWA's service area spans approximately 1,700 square miles, as shown in Figure 3-2.

Figure 3-2: GLWA's Water Service Area

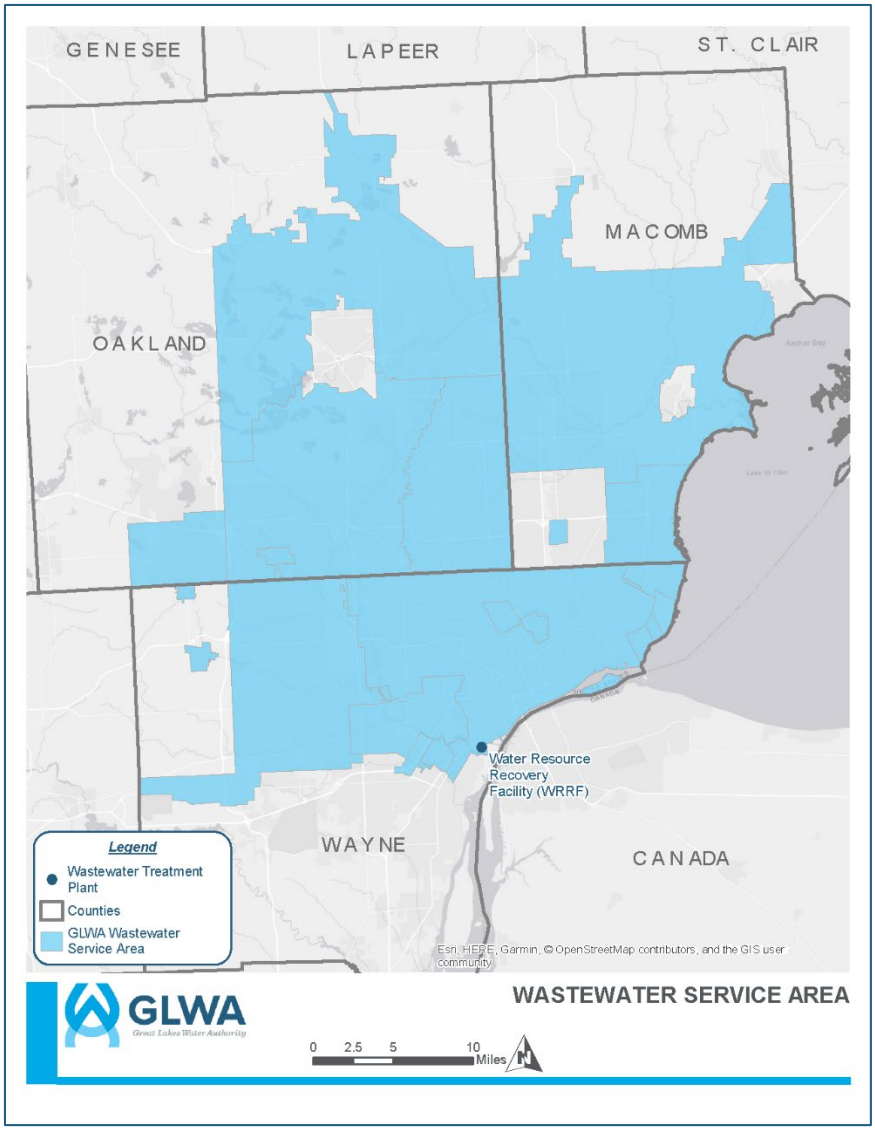


3.1.3.2 Wastewater System

GLWA is the largest provider of wastewater conveyance and treatment in the State of Michigan, serving an estimated 2.8 million people or 28 percent of the state's total population in a 977-square-mile area. Its 87 member partners account for approximately 77 percent of the total population served by GLWA, while the City's retail customer class makes up the other 23 percent [8].

GLWA provides wastewater conveyance and treatment to the City under the provisions of the Water and Sewer Services Agreement. The City is considered a retail customer class rather than a wholesale customer [8]. While GLWA maintains interceptors and trunk sewers within the City, DWSD maintains the local collection system. Figure 3-3 illustrates GLWA's wastewater service area.

Figure 3-3: GLWA's Wastewater Service Area



3.2 Organizational Drivers and Stakeholders

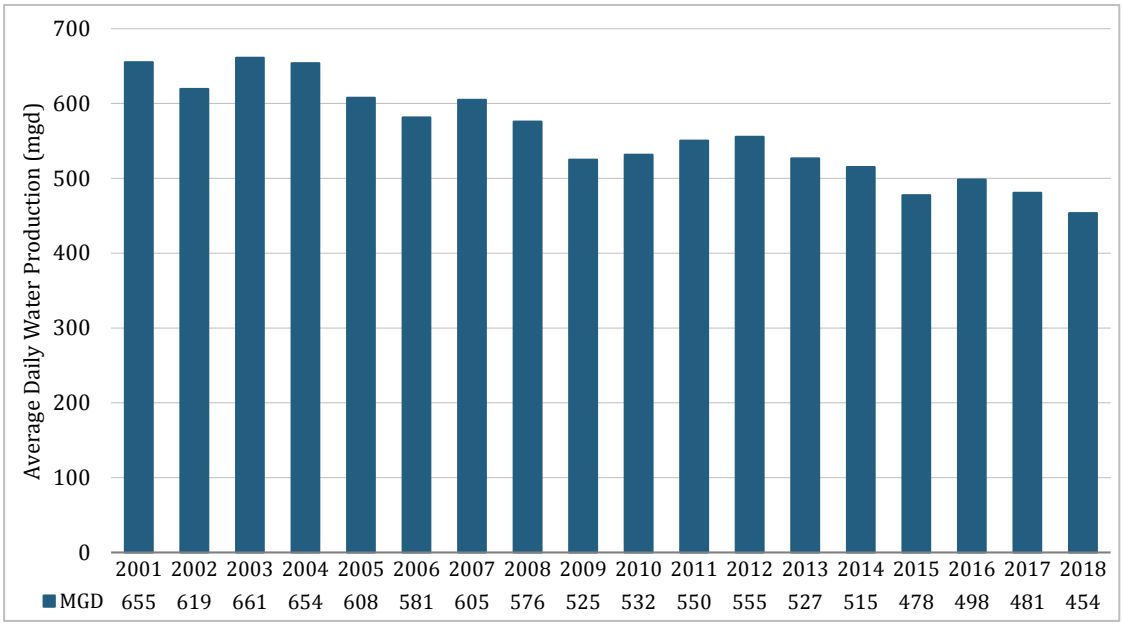
Numerous influences contribute to the decision-making process for investing in infrastructure, including capital investment for new, replacement or rehabilitation, and investments to gain value by optimizing operations and maintenance. Traditionally, these influencers (or drivers) have been future demand increases, regulatory compliance, and aging infrastructure. However, new drivers have emerged over the past few decades, including climate resiliency, security, technology, and workforce demographics. This section discusses both the traditional and emerging drivers to be considered by GLWA.

3.2.1 Future Demand

3.2.1.1 Water

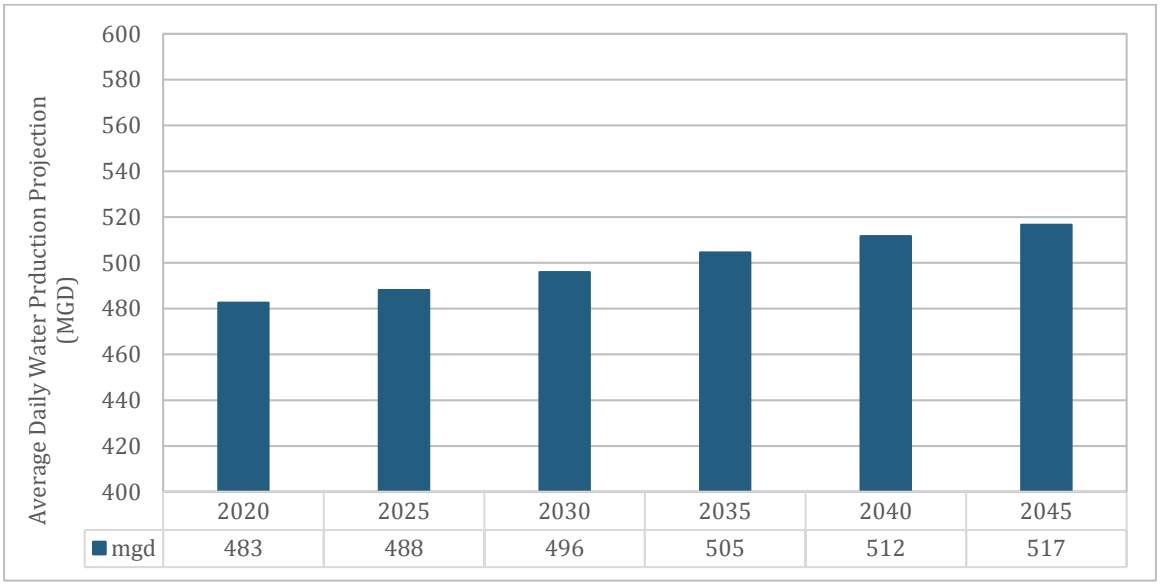
From 2001 through 2018, there has been a substantial decline in the quantity of water produced by the five treatment plants (operated by the City prior to January 2016). As shown in Figure 3-4, the decline in production was fairly consistent except for a significant drop between FY 2014 and FY 2015, which may be attributed to communities in Genesee County coming off the system at the end of FY 2014. The overall declining trend over the years is likely due to a combination of factors, such as regional economic change and net negative migration in the early portion of the period, a general downward trend in water use, and a reduction in leakage [6][9].

Figure 3-4: Average Daily Water Production from 2001 to 2018



Looking ahead, the Southeast Michigan Council of Governments (SEMCOG) forecasts a steady increase in population of 7.1 percent from 2020 to 2045, and job growth of 3.3 percent during the same period. Figure 3-5 shows an extrapolation of water production needs through 2045, based on the mean of the past four years of actual production using population growth as estimated by SEMCOG, and assuming no change in non-revenue water.

Figure 3-5: Average Daily Water Production Projection from 2020 to 2045



The 2015 Water Master Plan [10] projected water demand out to 2035 based on the forecasted demographics of each wholesale member partner and the City. This approach resulted in a projected demand of 493 MGD in 2035, including water sales, fire flow requirements, and non-revenue water, which is equivalent to the needed water production. As such, the 2035 average production need of 505 MGD projected using SEMCOG's population growth compares favorably to the Water Master Plan's projection of 493 MGD.

When projecting water production needs, consideration must be given to maximum day and peak hour demands. The 2015 Water Master Plan presented a weighted maximum day multiplier of 2.05 to the average day, and a peak hour factor of 1.2 multiplier to the maximum day. Additionally, unknowns at this point include how the quantity of non-revenue water will change over time, and how temperatures and precipitation will impact production needs.

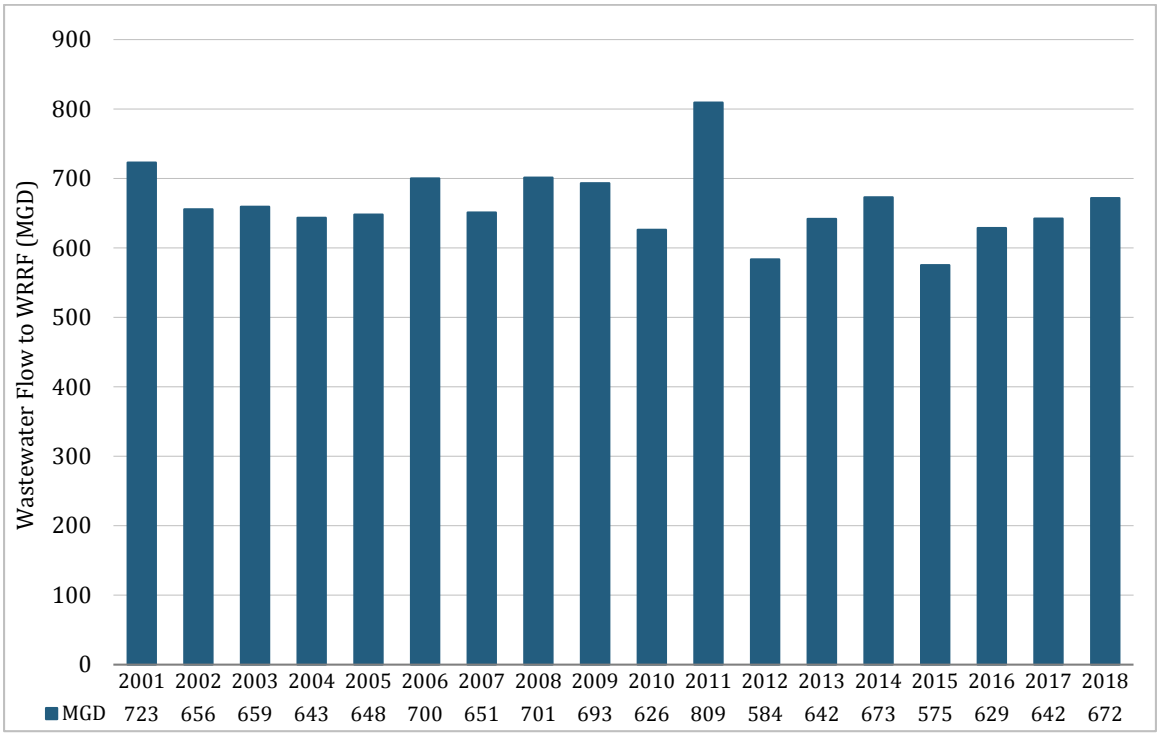
Currently, GLWA's total rated treatment capacity is 1,720 MGD and its firm high service pumping capacity is 2,400 MGD. Although current capacities are sufficient for the projected demands, it is crucial to determine how the demand will be distributed through the system to ensure remote pumping capacities and pipe sizes are appropriate for the quantity of water to be delivered to the wholesale customers. The most appropriate approach to any

changes needed to the system because of a change demand will be identified through asset management plans and collaboration with the master planning process.

3.2.1.2 Wastewater

From 2007 through 2018, there has been a slight downward trend in the quantity of wastewater treated at the WRRF, which was operated by the City prior to January 2016. As with all combined or mostly combined sewer systems, GLWA experiences wide variations in wastewater flow depending on precipitation. Precipitation, along with high ground water tables, also contributes to the high flows though infiltration. As shown in Figure 3-6, average daily flows during the 18-year period varied from a high of 809 MGD in 2011 to a low of 575 MGD in 2015.

Figure 3-6: Average Daily Wastewater Flow from 2001 to 2018



The WRRF has a secondary treatment capacity of 930 MGD and peak capacity of 1,700 MGD with primary treatment. Consequently, with an estimated population increase of 7.1 percent through 2045, it appears that there will be sufficient capacity at the WRRF for the next 25 years. However, since combined sewer systems are subject to wide variations in flow, minor increases in population such as those estimated for the wastewater service area will have a minimal impact on the amount of influent to the WRRF as compared with increased precipitation. Consequently, a robust analysis must be undertaken to consider changes in storm intensity and duration, variation in infiltration, and population growth. Further, since wastewater treatment effectiveness and efficiency are dependent upon organic and

inorganic loadings along with flow quantity, projections must include impacts from new industry that may connect to the system in the coming years.

Currently, a Wastewater Master Plan is being developed by GLWA and its partners in the region. It is expected that both the quantity and quality of wastewater over the next few decades will be projected for not only the WRRF, but also for the pump stations, CSO facilities, interceptors and trunk sewers. This new information should be incorporated into future versions of this SAMP in accordance with Section 2.4, SAMP Updates.

3.2.2 Regulations and Permit Conditions

GLWA has successfully maintained compliance with both state and federal regulations since its creation in January 2016. The water quality meets both primary and secondary drinking water standards, and its WRRF consistently achieves secondary standards and other required permit conditions. While CSOs can still be a concern, GLWA is well along its journey in meeting its Long-Term Control Plan, making major investments in the inspection of its interceptors, and has completed all the core projects required by the Michigan Department of Environment, Great Lakes and Energy (EGLE) consent agreement, including the Rouge River Outfall.

GLWA is also in compliance with EGLE Rule 1606 of the Administrative Rules of Act 399 requiring water utilities to implement an asset management program and to submit specified documentation describing the program [11]. Additionally, for the wastewater system, GLWA complies with similar asset management requirements specified in its Michigan EGLE National Pollutant Discharge Elimination System (NPDES) permit.

While continuing to maintain compliance, attention must also be given to upcoming regulations, as well as laws which may eventually translate into regulatory requirements that affect GLWA's planning, constructing, operating, and maintaining of its vertical and linear infrastructure assets. In addition, the recently created Michigan Water Asset Management Council (chaired by GLWA's CEO, Sue McCormick), along with the Michigan Infrastructure Council, will be working to, "lead, guide, and assist communities in the development and/or enhancement of their drinking water, wastewater, and storm water asset management programs" [12]. These councils may provide valuable information and tools to assist GLWA in achieving its asset management objectives, as well as requirements to create asset management plans.

Table 3-1 lists several federal regulations that are expected to be finalized within the next few years. Many of them will likely be promulgated by the Environmental Protection Agency (EPA) pursuant to America's Water Infrastructure Act of 2018 [13].

Table 3-1: Examples of Anticipated Federal Regulations that May Affect GLWA

Subject	Description	Timeframe	Water	Wastewater
Consumer Confidence Report	Dissemination of a Consumer Confidence Report twice a year; electronic delivery acceptable; possible for understandability and accuracy; information about corrosion control	2020	✓	
Contractual Arrangements	Expands safe harbor from penalties when partnering with a non-compliant system to improve the troubled system's compliance	Not available	✓	
Involuntary Consolidation or Sale	Federal authority to require consolidation or sale of noncompliance water system	2020	✓	
Risk Assessment and Emergency Response Plan	Risk assessments and emergency response plans required; periodic update of emergency response plans every five years	2019	✓	
Release Notification	Notification of any release of all chemicals identified in 40 CFR 302 and 355 to source waters	Not available	✓	✓
Access to Emergency Planning and Community Right-to-Know Act (EPCRA)	Access to data on hazardous materials within a source water protection area identified through Safe Drinking Water Act (SDWA) source water assessment	Not available	✓	✓
Perfluoroalkyl Management Plan	Strategy to address Perfluoroalkyl substances (PFAS)	Not available	✓	✓
Perchlorate Drinking Water Standard	Establishment of a maximum contaminant level goal	2019	✓	
Reduction of Lead	Finalizing a rule to implement the 2011 Reduction of Lead in Drinking Water Act	2019	✓	
Revisions to Long-Term Lead and Copper Rule	Including corrosion control, lead service line replacement, and proactive communication with customers about the risk posed by lead in water	Not available	✓	
Blending	Revisions to the court-vacated blending and mixing zone rules	Not available		✓
Waters of the United States	Replacement rule defining "Waters of the United States"	Not available		✓

3.2.3 Aging Infrastructure

Aging infrastructure is a ubiquitous challenge for water service sector utilities across the country and a major impetus for utilities engaging in asset management to improve decision making by balancing cost, risk, and performance. GLWA is no exception. GLWA's transmission water mains have an average age of 70 years, with 32 percent installed prior to 1940; interceptors and trunk sewers have an average age of 79 years, with 55 percent installed prior to 1940 [14].

Traditionally, many utilities have rehabilitated or replaced assets based on their remaining useful life as determined by subtracting their age from a "textbook" design life found in an industry reference. However, the physical failure of an asset is primarily a function of an

asset's condition, which may not be directly related to its age. As such, condition inspections are crucial to determining whether assets should be rehabilitated, replaced, or have their maintenance strategy altered.

Since vertical assets can be more easily accessed and inspected, an asset's age should not be a significant factor in renewal decisions, except in the case of obsolescence. Instead, the asset's physical condition from inspection combined with the asset's performance should be used to determine the asset's likelihood of failure. Together with considering the consequences of failure, the risk of failure can then be determined. It is the risk of failure that should inform renewal decisions, as described in Section 3-4.

Nevertheless, for long-term forecasting of renewal needs, estimating the remaining useful life of assets can be helpful. Table 3-2 shows an example of how to determine the remaining useful life of a vertical asset based on its condition and adjusted design life. Table 3-3 lists several factors to be considered to adjust the textbook design life of a vertical asset.

Table 3-2: Remaining Useful Life as a Function of Asset Condition [15]

Condition Grade / Rating	Description of Condition	Remaining Useful Life as a % of Adjusted Design Life
1 / Very Good	Excellent physical condition. Observable deterioration is insignificant. No adverse service reports. In the absence of any other information the asset will be at Condition Grade 1 at an age of less than 20% of the design useful life.	80 to 100
2 / Good	Observation and/or testing indicates that the asset is meeting all service requirements. Sound physical condition; minor deterioration/minor defects observed. In the absence of any other information the asset will be at Condition Grade 2 at an age of between 20% and 50% of the design useful life.	50 to 80
3 / Fair	Moderate deterioration evident; minor components or isolated sections of the asset need replacement or repair now, but not affecting short term structural integrity. In the absence of any other information the asset will be at Condition Grade 3 at an age of between 50% and 80% of the design useful life.	20 to 50
4 / Poor	Serious deterioration and significant defects evident affecting structural integrity. Asset is now moving into zone of failure. In the absence of any other information, the asset will be at Condition Grade 4 at an age of between 80% and 95% of the design useful life.	5 to 20
5 / Very Poor	Failed or failure imminent. Immediate need to replace most or all of asset. Asset is unable to support the target level of service though may still be providing some level of service.	0 to 5

Table 3-3: Factors and Percentages for Adjusting Textbook Design Life [16]

Factor	Description and Percent Adjustment to Textbook Design Life				
Design Standards	Excellent or high standards used	Good design standards used	Average design standards	Only nominal standards followed	None or very little design completed
	0% to +10%	0% to +5%	0%	0% to -5%	0% to -10%
Construction Quality	Excellent quality and supervision	Good quality and supervision	Average workmanship / quality assurance (QA)	Poor quality workmanship / QA	Very poor workmanship / QA
	0% to +25%	0 to +10%	0% to -10%	0% to -35%	0% to -50%
Material Quality	Excellent materials used	Very good materials used	Average materials used	Poor quality materials used	Inappropriate materials used
	0% to +15%	0 to +5%	0% to -5%	0% to -10%	0% to -15%
Operational Stresses	Asset operated below working specifications	Sometimes overloaded	Average overloading	Asset regularly overloaded	Asset extensively over stressed
	0% to +20%	0 to +5%	0% to -5%	0% to -10%	0% to -35%
Maintenance History	Well or over maintained	Reasonable maintenance	Average maintenance	Poor maintenance for most of life	Never maintained over life
	0% to +20%	0 to +10%	0% to -5%	0% to -20%	0% to -30%
Asset Working Environment	Very good environment (stable)	Good operating environment	Average operating environment	Humid, salty or some ground movement	Freezing, high humidity, aggressive atmosphere, geology
	0% to +10%	0% to -10%	0 to -20%	0% to -30%	0% to -40%
External Stresses	No external stresses	Only minor external stresses	Above average external stresses	High external stresses experienced	Severe external stresses experienced
	0% to +10%	0% to -10%	0 to -10%	0% to -15%	0% to -20%

Unlike vertical assets, many linear assets cannot be easily assessed for condition. Mechanical or electronic means must be employed to identify corrosion, tuberculation, cracks, leakage, joint separation, and other anomalies. Where such condition assessments cannot be performed efficiently or effectively, a history of breaks and determination of remaining useful life based on textbook design life may be used to identify linear assets that may need to be rehabilitated or replaced. However, because of the significant cost of renewing large pipe, inspection by mechanical or electronic means should be performed prior to making final decisions.

3.2.4 Climate Resilience

Although southeast Michigan is not commonly associated with climate change impacts, climate models predict increases in temperature and precipitation throughout the 21st century. The frequency and intensity of storms is also likely to increase over the next several decades. The water levels in the Great Lakes and tributary surface waters are expected to fluctuate more than in the past and the water is expected to warm, increasing the likelihood for algal blooms. Table 3-4 summarizes some of the changes projected for Detroit and vicinity for the period 2041–2070 compared to the period 1971–2000.

Table 3-4: Projected Change in Temperature and Precipitation [17]

Category	2041–2070 Compared with 1971–2000
Average annual temperature	Increase of 4.5 - 5.0 degrees F
Number of days per year over 90 degrees F	Increase of 40 - 50 days
Number of days per year over 95 degrees F	Increase of 10 - 15 days
Number of nights per year falling below 32 degrees F	Decrease of 25 - 35 nights
Average total precipitation per year	Increase of 3 - 4 inches per year
Average number of heavy precipitation days (Note 1)	Increase of 1 - 1.5 days
Number of consecutive dry days per year	Increase of 0 - 1 day

Notes:
1. Heavy precipitation is defined as the 2% heaviest precipitation events in a given area

Changes in climate may impact GLWA in several ways. An overall increase in precipitation, especially the increase in the intensity and frequency of storms, will cause surges in stormwater runoff, inflow, and infiltration. As a result, the frequency and volume of CSOs may increase. Planning of new or replacement interceptors and trunk sewers should consider this escalation in flow. Similarly, the capacities of CSO Retention Treatment Facilities (RTFs) and Screening and Disinfection Facilities (SDFs) will need to be evaluated to determine their effectiveness in handling higher flow volumes. With respect to the water system, treatment processes may be affected by increased algal blooms in the source waters and possibly by increases in water temperatures.

Resiliency of facilities to flooding and high winds should also be considered, as should the ability to recover from damage caused by tornados[1]. Although storm surges from Lake Huron may be remote, flood potential to the Lake Huron Water Treatment Plant should be evaluated. Similarly, flood potential from the Detroit River, Rouge River, and smaller streams and creeks throughout the service area should be examined for all treatment facilities, pump stations, RTFs, and SDFs. Many utilities are now planning to protect their infrastructure from flooding due to a 500-year storm. Further, whether or not associated with inland flooding, high water levels in the Detroit and Rouge rivers can have a significant impact on the ability of the WRRF to discharge effluent resulting in backups into the facility.

[1] From 2001 through 2018, 43 tornados occurred in the seven counties served by GLWA. [26]

Similarly, wet weather discharges from the RTBs and SDFs may be hampered if levels in their respective receiving rivers and streams rise. These issues will be addressed in the wastewater master planning effort.

Pursuant to the provisions of the America's Water Infrastructure Act of 2018, GLWA must undertake a risk and resilience assessment of its water system by March 31, 2020, with respect to both malevolent acts and natural hazards. By September 30, 2020, GLWA may need to revise its emergency response plan to incorporate the findings of the risk and resilience assessment. Section 3.2.5 provides additional information on this matter.

3.2.5 Security

Utilities made significant investments to physical securing of their water systems after the September 11, 2001 terrorist attacks and enactment of the Public Health Security and Bioterrorism Preparedness Response Act of 2002. Most of these investments were for constructing perimeter fencing and other barriers, hardening structures, converting from gas chlorination to liquid hypochlorite, and installing access control to treatment plants, pump stations, reservoirs, and other utility facilities. Some utilities also incorporated intrusion detection systems, such as video monitoring, microwave sensors, infrared detectors, and traditional alarms. Utilities with both water and wastewater systems frequently applied similar security approaches to their wastewater facilities. Some utilities also installed online contaminant warning systems to monitor their distribution systems in real-time.

GLWA will be conducting its risk and resilience assessment in accordance with America's Water Infrastructure Act of 2018 and new EPA requirements that are expected to be released in August 2019. The information and knowledge gained from the risk and resilience assessment can influence GLWA's capital improvement planning, and possibly operations. It will also be valuable to risk assessments conducted within the context of asset management because the consequences an asset failing may be the same whether that failure is due to a breakdown or due to a malevolent attack.

3.2.6 Technology

Advances in technology continue to provide the water service sector new opportunities to improve effectiveness and efficiency. Examples associated with operations and condition assessment, some of which have already been incorporated by GLWA, include the following:

- Remote monitoring of equipment condition and performance
- Remote monitoring of water levels in sewers using cellular networks
- Advanced metering infrastructure to gather flow data via radio networks
- Hand-held devices for plant and field staff to collect and transmit data wirelessly

- Online water quality monitoring of distribution systems
- Trenchless installation of large pipes in addition to installation of small pipes
- New methods and materials for lining pipes
- Assessment of internal and external condition of pipes without excavation
- Continuous remote monitoring of pipe condition

GLWA can benefit from advances in technology, but should continue to perform due diligence, including business case evaluations, before making such investments. Benchmarking, industry engagement, and networking, as presented in Section 9, are crucial prerequisites for making decisions about adopting new technology.

3.2.7 Workforce Demographics

Over the next couple of decades, GLWA will employee four generations of team members [18]:

- Baby Boomers, born between 1946 and 1964
- Generation X, born between 1965 and 1980
- Generation Y, born between 1981 and 1996
- Generation Z, born between 1997 and 2012

Integrating new team members into the organization beginning with onboarding along with effective knowledge transfer will be crucial. Consequently, it will be important to understand how each generation absorbs information and what each value from employment. Guidance from human resource professionals and training in generation diversity will be advantageous.

Some broad observations about the three generations from the International Association for Continuing Education and Training [19] are shown in Table 3-5.

Table 3-5: Generational Characteristics

Type	Generation X Born 1965-1980	Generation Y (Millennials) Born 1981-1996	Generation Z Born after 1997-2012
Personal Traits	Independent Self-reliant Resilient	Ambitious Tech savvy Give back to community	Inclusive Tech and media savvy
Work Environment	Casual Flexible	Diverse Work-life balance	Diverse Teamwork
Work Traits	Hard work Optimization	Meaningful work Stay with an employer for 2 to 3 years	Equality among team members

3.2.8 Unforeseen Circumstances

GLWA has proven to be willing and able to adapt to unforeseen circumstances as exemplified by its response to the Flint water crisis. As an independent authority having available capacity, it is more adept at responding to crises than many municipal utilities. GLWA has maintained an up-to-date emergency response plan, has trained staff on emergency response, and has participated in area-wide emergency response exercises. The risk and resiliency assessment to be undertaken prior to March 31, 2020 will help identify any gaps requiring attention in the update of the emergency response plan, contingency planning and training, as well as any future capital and operational investments needed to improve preparedness and responsiveness to currently unforeseen circumstances.

3.2.9 Recognition

As with other public and private enterprises, it is important to communicate with users of the products and services to show they are receiving value for the money they pay. In the water service sector, this extends to other stakeholders who may not pay for any services or receive any services, but benefit indirectly from the products and services the water-wastewater utility provides. Examples include environmental protection and enhancement, business and employment opportunities, and the infrastructure for economic development.

One of the ways water and wastewater utilities can demonstrate value to their community is by receiving recognition from their peers, the media, and organizations, both within the water service sector and beyond. Table 3-6 lists some of the recognition awarded to GLWA in just over the three years of its existence.

Table 3-6: Recognition Awards Received by GLWA

Award	Organization
Utility of the Future Today	Consortium of Water Service Sector Organizations (Note 1)
Gold Award for Exceptional Utility Performance	Association of Metropolitan Water Agencies (AMWA)
Grand Prize in the Intelligent Water Challenge (Note 2)	Water Environment Federation
Engineering Excellence (for Biosolids Dryer Facility)	American Council of Engineering Companies
Midwest Deal of the Year	Bond Buyer
Purchasing Agency of the Year	Michigan Public Purchasing Officers Association
Regional Award for Technology	Purchasing Officers Association

Notes:

1. National Association of Clean Water Agencies (NACWA), Water Environment Federation (WEF), Water Research Foundation (WRF) and the WateReuse Association.
2. Awarded to GLWA and the University of Michigan

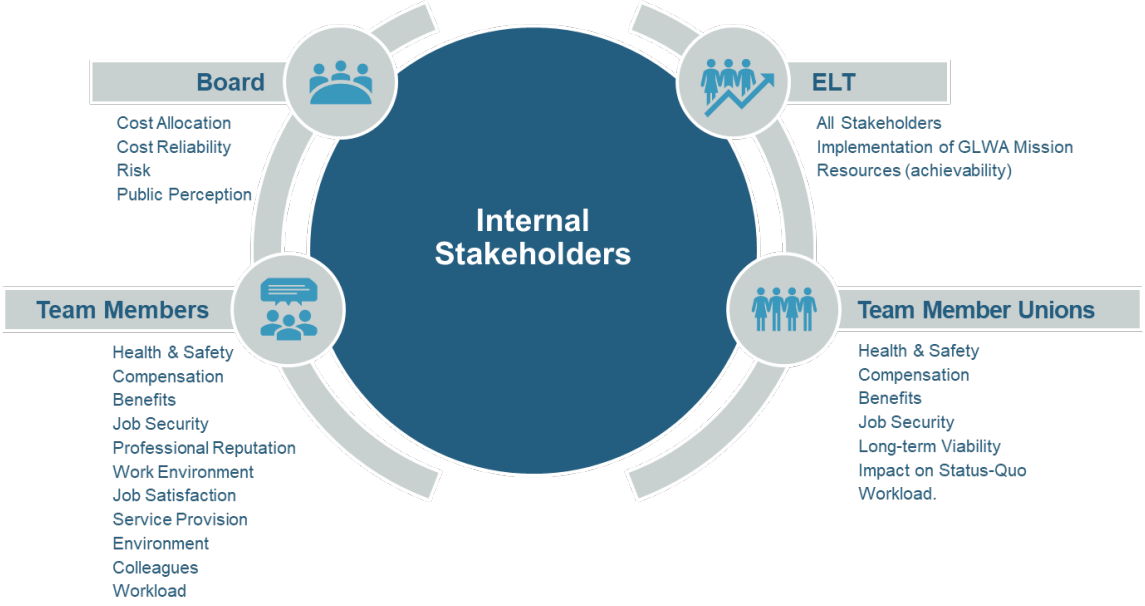
3.3 Stakeholder Expectations

Consistent with its organizational vision, GLWA places great emphasis on collaboration with its member partners, member communities, team members, and other external and internal stakeholders. GLWA provides outreach through its dedicated One Water Partnership Member Outreach Program, consisting of work groups that involve members in technical service and financial discussions that support decision-making for GLWA's water and wastewater systems. GLWA has designated team members working within the Program, which also includes a contracted third-party facilitator responsible for ensuring and sustaining the rules of collaboration and furthering the transparent exchange of information between GLWA and its members [20]. An online Member Outreach Portal is available to facilitate information sharing and ongoing communications. GLWA also holds informational workshops, hosts symposiums, and makes educational materials available to the public.

GLWA understands the importance of stakeholders' expectations, the impact stakeholders have on asset management, and how asset management decisions impact stakeholders. Accordingly, GLWA identified external and internal stakeholders, along with their interests, when developing GLWA's asset management decision-making methodology. Figure 3-7 illustrates external stakeholder and their interests with respect to GLWA, and Figure 3-8 does the same for internal stakeholders.

Figure 3-7: External Stakeholders and Their Interests

Figure 3-8: Internal Stakeholders and Their Interests



3.4 Risk Management

3.4.1 Approach

GLWA has developed a risk framework that serves as internal guidance regarding risk management. It is intended to be broadly applicable to management of all types of risk at GLWA. The risk framework communicates three things: 1) why risk management is important for GLWA as an infrastructure-intensive organization, 2) definitions of terms important to risk management, 3) instructions regarding risk management activities at GLWA.

3.4.2 Purpose of Risk Management

Improvement Initiative R3

Risk and Critical Asset Assessment Process

Understanding and managing risk are important in asset management for several reasons. With effective risk management, GLWA can:

- Minimize surprises and losses
- Identify, discuss, and manage cross-enterprise risks
- Create meaningful linkages between risk management and performance
- Prompt new and meaningful conversations
- Provide an objective new framework for day-to-day staff and management actions
- Define risk tolerance

- Identify risk treatments and align with strategy
- Seize opportunities
- Align with stakeholders and enhance external communications
- Enhance internal communications and encourage desired behaviors
- Supplement financial reporting
- Inform business decision-making

Risk management is iterative in nature, drawing on new experiences and emphasizing learning, continual improvement, knowledge, and analysis for the revision of process elements, actions, and controls at each stage of the process. Effective management of risk involves demonstrably improving the ability of the organization to meet its objectives in a repeatable fashion.

3.4.3 Types of Risk at GLWA

GLWA has chosen to define and address the four types of risk common for infrastructure-intensive organizations to manage, shown in Figure 3-9.

Figure 3-9: Four Types of Risk

1. **Enterprise risks** are those key risks facing an organization as a whole. Typically, enterprise risks may impact the financial viability or reputation of the organization. Enterprise risks are usually assessed by executive or senior management, who drive management initiatives down through the organization.

Improvement Initiative R4
Enterprise Risk Management

2. **Operational risks** arise from implementing processes and day-to-day operations and maintenance activities, including shutdowns, outages, community, team member issues, and safety. Operational risk is usually assessed by operations and maintenance managers, who drive process and procedure changes and improvements.
3. **Asset risks** are those arising from the asset base, primarily after construction or acquisition and also throughout the entire asset lifecycle. Asset risk is usually assessed by planning or operations and maintenance staff and is documented as part of Asset Management Plans (AMPs). Asset risks drive the needs for action on specific assets or

Improvement Initiative R5
Asset Risk Identification and Analysis

asset types, such as renewal, replacement, change in maintenance strategies, increase in performance monitoring or condition assessment, and contingency planning. Asset risk is described in more detail in Section 6.4.

4. **Project execution risks** arise during the planning, design, construction, and commissioning of capital projects. These risks are assessed by project managers (along with authorizers or teams) and are documented as part of Business Case Evaluations (BCE) and Project Execution/Management Plans. Project execution risks drive reserve or contingency budgeting and treatment actions as part of the project scope.

Improvement Initiative R1

Shift to Asset Risk-Driven Funding and CIP

Risks are also considered when investments are prioritized. For example, when prioritizing capital improvement projects, reduction in asset risk is an important consideration, as is reduction in enterprise and operational risk.

3.4.4 Risk Management Activities

There are three primary phases of activities in risk management, as shown in Figure 3-10.

Figure 3-10: Phases of Risk Management

1. **Risk Identification.** This phase consists of the work to seek out and describe risks.
2. **Risk Analysis.** This phase consists of quantifying and scoring for the likelihood and consequence of the event or asset failure occurring, as described in Section 3.4.4.1. The result of this phase is a relative risk score, which helps determine which risks should be treated and the priority of treatment.
3. **Risk Treatment.** This phase consists of identification of ways to address those risks GLWA is unwilling to tolerate. Creativity is important in this phase so that most cost-effective (and potentially new) solutions can be identified.

Appendix E contains a process map for the activities associated with enterprise risk management. Appendix F contains a process map for the activities associated with asset risk.

3.4.4.1 Risk Identification

Risk identification consists of the process to seek out and describe risks. For enterprise, operational, and project execution risk, this phase is optimized when there is a good understanding of the organizational environment; a thorough history of events that may

help predict future events; and knowledgeable, creative team members to consider potential future events.

For asset risk, the work of risk identification centers around understanding asset failure. This requires knowledge of GLWA service levels and an understanding of process and asset performance expectations required to support service levels. In general, the more difficult it is to achieve a given service level, the more likely it is that the service level will not be attained and the resultant risk score will be higher.

3.4.4.2 Risk Analysis

Risk analysis involves developing a risk score based on the quantification of likelihood that an event will occur and the quantification of the consequences if the event occurs.

Risk Scoring. A risk score is determined by multiplying the likelihood of failure (LoF) by the consequence of failure (CoF).

$$\text{Risk Score} = \text{LoF} \times \text{CoF}$$

Where likelihood and consequence are both scored on a scale of 1 to 5, with 5 representing the highest likelihood or consequence and 1 the lowest likelihood or consequence. Thus, a score of 25 is the highest risk score possible and represents the most severe risk.

Likelihood Scoring. For enterprise, operational, and project execution risk, this score answers the question, "What is the likelihood that the event will occur?" For asset risk, this score answers the question, "What is the likelihood the asset will fail?"

In order to ensure consistency of scoring for LoF, GLWA will use the GLWA Risk Likelihood Matrix (Appendix E), which consists of values for the frequency of occurrence. For enterprise and operational risks, the frequency value will be selected based upon published data or the best estimate of staff. For asset risks, a specific scoring matrix based on each asset type will align to frequency values. These will be developed for each asset type during the process of risk evaluation as part of AMP development.

Consequence Scoring. For enterprise, operational, and project execution risks, this score answers the question, "How bad will it be if the event occurs?" For asset risk, this score answers the question, "How bad will it be if the asset fails?"

In order to ensure consistency of scoring for CoF, GLWA will use the GLWA Risk Consequence Matrix (Appendix F), which consists of seven categories, each of which will be scored on a scale of 1 to 5. The CoF score equals the score for each of the categories multiplied by one-seventh and added together.

1. **Regulatory Compliance.** Relating to regulatory requirements, permit obligations, or enforcement actions.

2. **Impact to Service Levels.** Relating to GLWA's ability to achieve service level targets.
3. **Financial Impact.** Relating to requirements for GLWA funds or sources of funds.
4. **Health and Safety.** Relating to near- and long-term health or safety impacts on the public or GLWA team members not addressed in other categories.
5. **Public Impact.** Relating to community priorities, such as quality of life or aesthetics not addressed in other categories.
6. **Environmental Stewardship.** Relating to near- or long-term environmental impacts not addressed in other categories.
7. **Public Trust.** Relating to GLWA's image and the public confidence in GLWA.

3.4.4.3 Risk Tolerance

Risk tolerance is defined as GLWA's willingness to bear risk. Risks above the tolerance level will need to be evaluated for potential risk treatments by designated individuals or committees. While in these instances there may be a decision to accept or monitor a risk, it is likely that there will be an expectation to identify and implement a risk treatment in order to lower the risk to a level below the threshold. Figure 3-11 is GLWA's risk severity heat map, showing how risk tolerance may be visualized and communicated.

Figure 3-11: Risk Severity Heat Map

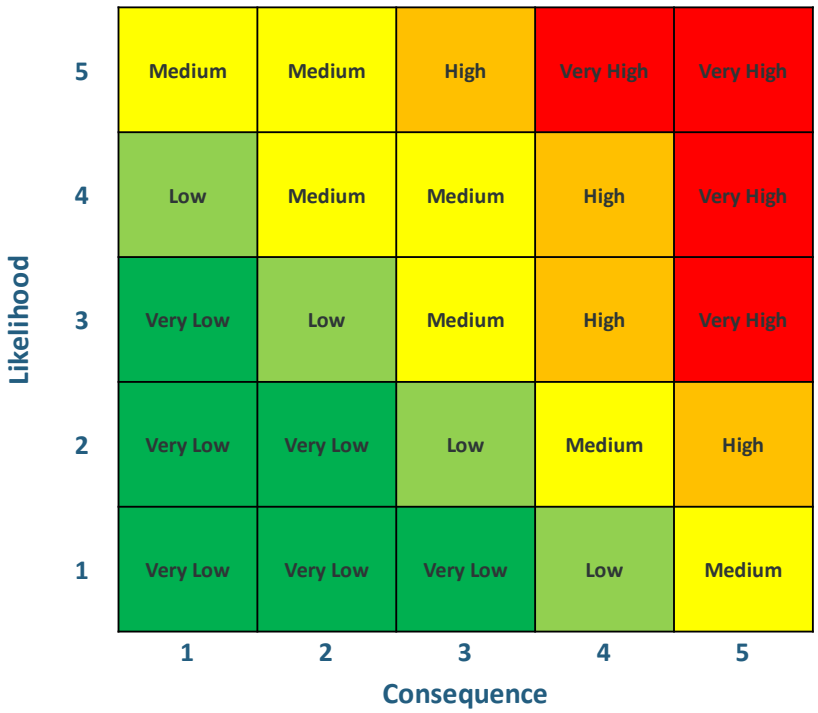


Table 3-7 is GLWA's risk governance approach that will be used for risk monitoring and for deciding risk treatments.

Table 3-7: Risk Governance

<table>
<tr><th rowspan="2">Severity of Risk</th><th colspan="4">Type of Risk</th></tr>
<tr><th>Enterprise</th><th>Operational</th><th>Asset</th><th>Project Execution</th></tr>
<tr><td>Very High</td><td colspan="4">ELT</td></tr>
<tr><td>High</td><td rowspan="4">ELT</td><td rowspan="4">TBD</td><td>AMLT</td><td rowspan="4">TBD</td></tr>
<tr><td>Medium</td><td rowspan="3">Water Asset Management Team or Wastewater Asset Management Team</td></tr>
<tr><td>Low</td></tr>
<tr><td>Very Low</td></tr>
</table>

3.4.4.4 Risk Treatment

Risks determined to be intolerable can be treated in one or a combination of ways:

- Remove the source of the risk (e.g., by eliminating a process)
- Transfer or share the risk (e.g., through outsourcing)
- Retain the risk possibly with increased monitoring
- Mitigate the risk through reduction in the likelihood or consequence of failure, with such actions as the following:
    - Capital investment
    - Modification of operations and maintenance (O&M) protocols, including maintenance strategies
    - Development/change in contingency plans
    - Other management strategies, such as improvement in work practices, procedures, and competencies

Before identifying a risk treatment, it is important to understand which side of the risk equation is driving the risk, LoF or CoF, since different risk treatments typically lower only one of the equation variables. Examples of techniques that reduce LoF include:

- Asset rehabilitation
- Asset replacement
- New redundant asset (under certain conditions)
- Clearly written O&M standards and operating procedures and training
- Improved proactive maintenance job plans and training

- Enhanced remote monitoring
- Reduction of service levels with stakeholder involvement (under certain conditions)

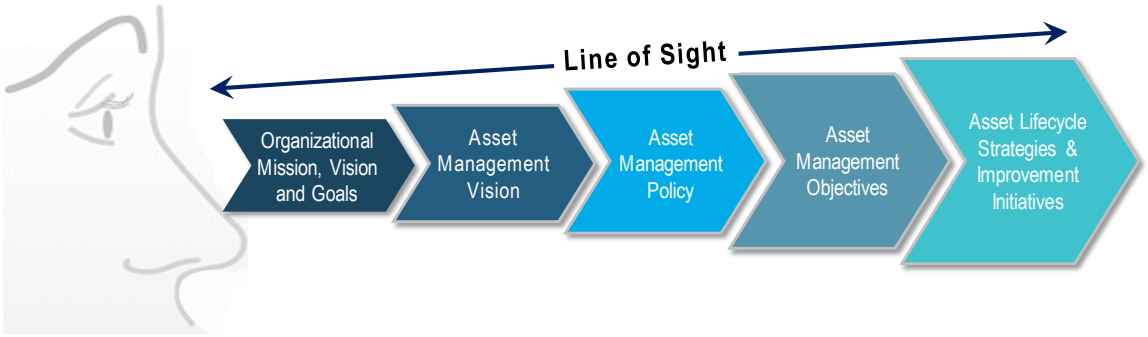
Examples of techniques that reduce CoF include:

- New redundant asset
- Improved O&M response and recovery
- Contingency planning and exercises
- Demand management
- Reduction of service levels with stakeholder involvement

4 Asset Management Strategy and Objectives

As the steward of more than $4 billion of essential public infrastructure, GLWA is committed to optimizing its investments by strategically timing infrastructure interventions, such as maintenance, rehabilitation, and replacement of assets. GLWA's asset management strategy ties back to its organizational strategy and involves creating a vision for asset management, an asset management policy with principles guiding asset management activities, asset management objectives, and asset lifecycle strategies. Figure 4-1 illustrates how these elements align to form a line of sight from the organizational strategy to the on-the-ground activities that incorporate asset lifecycle strategies.

Figure 4-1: GLWA's Asset Management Strategy



4.1 Asset Management Vision

GLWA recognizes that adopting and instilling asset management best practices throughout the Authority is a journey that will take time, effort, and resources. As such, it is important that all team members understand the destination that the asset management journey will take them. Consequently, GLWA decided to establish an asset management vision statement to clearly define the Authority's desired state of asset management maturity. Although the statement can be viewed as aspirational, GLWA believes that the vision can be achieved through effective asset management governance, adequate resources, and willingness of team members to adopt and implement asset management best practices. Based on guidance in this SAMP, subsequent AMPs, and the Asset Management Implementation Plan, the vision can be achieved.

GLWA's Asset Management Vision Statement

GLWA will be a leader in infrastructure management by making decisions informed by risk, regional needs, and lifecycle considerations.

4.2 Asset Management Policy

To formalize the expectations and direction of GLWA's approach to asset management, members of the AMSO team developed the Asset Management Policy. This policy document connects the organizational strategy to the objectives of adopting asset management practices. The policy presents the principles by which asset management decisions will be made and the requirements needed to support those decisions. Importantly, the Asset Management Policy confirms GLWA Board of Directors and executive leadership's commitment to asset management and serves as the channel by which that commitment and the principles will be communicated to team members, member partners, and other key stakeholders. The Asset Management Policy and its principles also provides the foundation for developing AMPs for the water system, the wastewater system, and any future AMPs that may focus on individual facilities, unit processes, or equipment types.

The asset management principles stipulated in the policy are as follows:

- **Member-Focused.** Meet established service levels and continue to engage with our team members, member partners and other stakeholders to obtain feedback on our performance and the services they value.
- **Safety.** Employ the necessary means and methods to protect the public from hazards involving our activities; ensure our team members are trained and they have and use the knowledge, tools, and supplies to protect them from harm.
- **Lifecycle Approach.** Consider whole-life costing when evaluating alternatives; manage all aspects of the asset lifecycle, including the full costs of planning, designing, acquiring, constructing, commissioning, operating, maintaining, renewing, and retiring our assets.
- **Forward-Looking.** Make decisions to better enable our assets to meet the social, environmental, financial and regulatory challenges of the future; consider long-term consequences of short-term activities.
- **Managed Risk.** Understand how risk changes over time; regularly assess the consequences and likelihood of asset failure so that resources and priorities can be directed to treat risks to a tolerable level.
- **Data-Driven.** Capture and leverage current and reliable data; employ sound data governance and data management procedures to support informed lifecycle decision-making.
- **Transparent.** Commit to systematic, repeatable, objective, data-driven, and auditable decision making with an open approach to sharing appropriate and meaningful information.
- **Innovative.** Implement non-traditional, innovative solutions considering people, processes, technology, project delivery, funding, resources, operations and maintenance, and other aspects of the asset lifecycle.

The Asset Management Policy, approved by the Executive Leadership Team and signed by the CEO, is attached as Appendix D. Table 4-1 illustrates the alignment of the Asset Management Policy and its principles to GLWA's organizational strategy (i.e., GLWA's vision, mission, brand house pillars, and strategic objectives).

Table 4-1: Alignment of the Asset Management Policy to GLWA's Organizational Strategy

		ASSET MANAGEMENT POLICY									
				PRINCIPLES							
		Policy Statement	Policy Purpose	Member-Focused	Safety	Lifecycle Approach	Forward Looking	Managed Risk	Data-Driven	Transparent	Innovative
Organizational Mission		✓		✓	✓		✓				
Organizational Vision			✓	✓		✓	✓				
Brand House Pillars	Quality	✓	✓	✓	✓						✓
	Fiscal Responsibility	✓	✓			✓	✓			✓	
	Service	✓	✓	✓				✓		✓	
	Innovation			✓			✓		✓	✓	✓
Organizational Strategic Objectives	High quality water	✓	✓				✓				
	Regulatory compliance	✓	✓				✓		✓		
	Maximize credit rating	✓				✓	✓	✓		✓	
	Sound financial management	✓				✓	✓		✓	✓	
	Equity and stability in customer charges			✓		✓					
	Annual revenue requirement increase ≤4%			✓		✓					
	Optimize for cost-effectiveness					✓		✓	✓		
	Customer outreach and engagement			✓						✓	
	Achieve member partner satisfaction of at least 90%		✓	✓	✓					✓	
	Team member engagement and retention	✓		✓	✓						✓

4.3 Asset Management Objectives

Asset management objectives identify the key outcomes desired from the adoption of asset management practices in compliance with the Asset Management Policy and its principles. Progress toward the objectives will be periodically monitored and reported. While it is preferable for objectives to be quantifiable, it is not necessary as long as the objectives can be measured through descriptions.

GLWA selected the following six asset management objectives:

- Continuously deliver established service levels at the lowest lifecycle cost while maintaining an acceptable risk profile.
- Make safety a forethought by anticipating and eliminating hazards, or mitigating their risk, when elimination is not reasonably practicable, throughout all phases of the asset lifecycle.
- Improve reliability by increasing proactive maintenance and reducing the need for unplanned reactive maintenance.
- Make informed and defensible decisions on capital and operational investments to achieve organizational objectives through strategic business case evaluations and consideration of long-term costs vs. benefits.
- Have timely access to trusted and relevant data and information.
- Develop and retain a competent and highly skilled workforce through continual learning opportunities.

As with the Asset Management Policy, asset management objectives provide a link between the organizational strategy to asset management strategy and activities. Table 4-2 illustrates the alignment of the asset management objectives to GLWA's organizational strategy (i.e., GLWA's vision, mission, brand house pillars, and strategic objectives). Improvement initiatives developed as part of the Asset Management Implementation Plan are prioritized and tracked partly based on how well they help to achieve asset management objectives (see Section 10).

Table 4-2: Alignment of the Asset Management Objectives to GLWA's Organizational Strategy

		ASSET MANAGEMENT OBJECTIVES (Note 1)					
		Continuously deliver established service levels at the lowest lifecycle cost while maintaining an acceptable risk profile.	Make safety a forethought; anticipate and eliminate hazards or mitigate risk throughout all phases of the asset lifecycle.	Improve reliability by increasing proactive maintenance and reducing the need for unplanned reactive maintenance.	Make informed and defensible decisions on investments to achieve org. objectives consideration of long-term costs vs benefits.	Have timely access to trusted and relevant data and information.	Develop and retain a competent and highly skilled workforce through continual learning opportunities.
Organizational Mission		✓		✓	✓		
Organizational Vision		✓		✓	✓		
Brand House Pillars	Quality	✓	✓	✓	✓	✓	
	Fiscal Responsibility	✓		✓	✓	✓	
	Service	✓		✓	✓		
	Innovation			✓	✓		✓
Organizational Strategic Objectives	High quality water	✓	✓	✓			
	Regulatory compliance	✓		✓	✓	✓	
	Maximize credit rating	✓		✓	✓		
	Sound financial management	✓		✓	✓	✓	
	Equity and stability in customer charges	✓		✓	✓		
	Annual revenue requirement increase ≤4%	✓		✓	✓		
	Optimize for cost-effectiveness	✓		✓	✓	✓	
	Customer outreach and engagement	✓			✓		
	Achieve member partner satisfaction of at least 90%		✓				
	Team member engagement and retention		✓				✓

Note 1: Some objective statements in the table are truncated for spacing purposes. See text for complete objective statements.

4.4 Asset Lifecycle Strategies

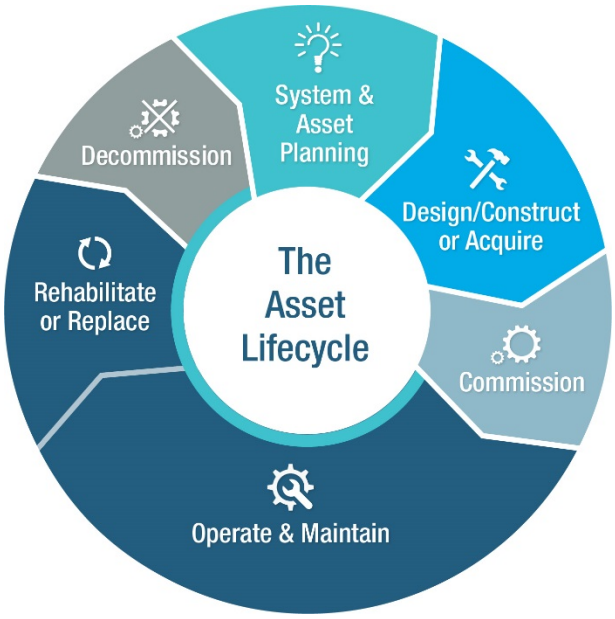
An asset is defined as an item, thing or entity that has potential or actual value to GLWA. An asset's lifecycle is the period from asset creation to asset end-of-life. Effective asset management requires attention to all stages of the asset lifecycle. Activities occurring during each stage require cross-functional team-based collaboration and decision-making. Open and transparent communications must occur in order to ensure that decisions at each stage consider implications on later stages. At each stage of the asset lifecycle, team members should make decisions that will best achieve asset management objectives.

Improvement Initiative P6
Business Process Master Map

4.4.1 Asset Lifecycle Stages

There are six stages of the asset lifecycle as illustrated in Figure 4-2.

Figure 4-2: The Asset Lifecycle



As indicated by the teal line circling the inside of Figure 4-2, the activities that are part of the System & Asset Planning stage can also occur during other lifecycle stages (such as Operate & Maintain, Rehabilitate or Replace and Decommission). The Operate & Maintain stage and the Rehabilitate or Replace stages are represented by the same color because the timing of the stages overlaps even though they consist of different activities.

Improvement Initiative O4
Commissioning

Table 4-3 describes the typical activities occurring in the six stages of the asset lifecycle. These activities may vary depending on the type of asset and other considerations.

Improvement Initiative O5

Asset Decommissioning and Salvage Process

Table 4-3: Typical Activities of the Six Stages of the Asset Lifecycle

Lifecycle Stage	Asset Management Best Management Practices	Examples Illustrating Importance to Asset Management
• System and Asset Planning *For existing assets, activities occur prior to acquisition of replacement assets or during the operations and maintenance stage.*	• Assess asset risk • Forecast demands and anticipate new regulations • Model system performance • Establish service levels • Identify critical equipment through a consequence of failure analysis • Conduct condition assessments • Identify needs and prepare Business Case Evaluations • Prioritize based on objective and repeatable criteria • Conduct risk-based design, hazard and operability analysis, and consider value engineering • Review and update design standards • Draft asset management plans	Determination, confirmation, or modification of service levels (with input from stakeholders) ⇨ Leads to strong relationships with member partners, end users, and the public Clarity of service levels ⇨ Leads to effective risk-based system planning, asset design, and maintenance strategies Understanding asset condition ⇨ Leads to knowledge of asset risk Knowledge of asset risk ⇨ Leads to objective and transparent decisions regarding asset acquisition and renewal
• Design / Construct or Acquire	• Maximize value, including lifecycle considerations • Consider alternate project delivery and construction methods • Award contracts based on lifecycle considerations • Standardize equipment • Require robust submittal review and inspection processes • Maintain spares for high-risk assets	Equipment standardization ⇨ Leads to increased safety, simplified spares management, and streamlined maintenance

Lifecycle Stage	Asset Management Best Management Practices	Examples Illustrating Importance to Asset Management
• Commission	• Operate all equipment under load • Ensure calibration of instruments • Pressure test force mains and valves • Clean and video gravity pipelines • Perform inspections (including appurtenances) • Onboard asset data, including upload to the Asset Management Information System (AMIS) • Receive preventive maintenance (PM) job plans and validate • Prepare baseline risk and performance information for asset(s) • Establish maintenance strategy • Conduct Failure Modes and Effects Analysis (FMEA) for high-risk assets • Conduct operation and maintenance (O&M) training • Receive and review O&M manuals • Ensure all warranty documents are in order	Testing new processes and assets prior to transition to operations and maintenance ⇨ Leads to reduction in design or construction-related problems and resolution prior to operations Onboarding of asset data prior to operations and maintenance ⇨ Leads to reduction in maintenance problems and potential for failure during initial months of operations Transmittal of manuals and training of operations and maintenance team members ⇨ Leads to reduction in safety incidents
• Operation and Maintenance	• Continue activities listed in the System and Asset Planning Stage • Comply with regulations and permit conditions • Monitor for service-level compliance • Track performance indicators • Conduct ongoing training for O&M staff • Optimize operations through assessment of chemicals, power, labor, materials, etc. • Optimize PM job plans based on Failure Modes and Effects Analysis (FMEA) • Employ technology for monitoring and control • Use risk-based approaches	Timely tracking of asset performance and condition as well as maintenance performance indicators ⇨ Leads to performance and condition based proactive maintenance planning and ability to make corrective actions based on data Tracking data regarding failures ⇨Leads to the ability to develop maintenance strategies based on understanding failure modes
• Rehabilitate or Replace (occurs in the same timeframe as operation and maintenance)	• Monitor condition and performance to identify appropriate time to rehabilitate • Use statistical methods for estimating rehabilitation needs for sewers and force mains • Monitor condition and performance for equipment and pipelines • Follow Scheduled Replacement Program (SRP) or modify the SRP • Track risk and make investment decisions based on risk • Prepare Business Case Evaluations (BCEs) as appropriate	Use of statistical methods for predicting asset failures ⇨ Leads to precision in planning for asset renewals Tracking likelihood of failure (LoF) and consequence of failure (CoF) and the resultant asset risk score ⇨ leads to risk-based decision-making, and tracking real-time changes in LoF and CoF results in just-in-time adjustments to strategies

Lifecycle Stage	Asset Management Best Management Practices	Examples Illustrating Importance to Asset Management
• Decommission	• Sell, auction, reuse, repurpose, or dispose • Ensure hazardous materials are properly handled and disposed of • Evaluate the pros and cons of abandoning and filling sewers in-place or removing • Properly indicate abandoned/removed assets from AMIS and financial system(s) • Evaluate total cost of ownership and reliability of the disposed asset	Proper disposal of hazardous materials ⇨ Leads to reduced risks Complete data regarding total cost of ownership ⇨ Leads to improved decision-making for future asset decisions

4.4.2 Managing the Asset Lifecycle

To achieve GLWA's asset management vision, it is important to understand and manage the entire lifecycle of an asset. There are several reasons for this.

Improvement Initiative P7
Asset Management Business Processes

- Risks are introduced at each stage of the asset lifecycle. Often these risks are not well understood. Risk events or asset failures occurring during one stage of the asset lifecycle may not be fully realized until a future stage. Unless there is a full understanding of the importance of each stage of the lifecycle, it is difficult to avoid or treat risks. One example of this is capital project decision making. If asset lifecycle costs, benefits, and risks are not considered at the time of initial project scoping, then hidden costs may materialize during the later stages of the asset lifecycle.
- It is estimated that 60-80 percent[2] of the total lifecycle cost of an asset is expended after construction and commissioning. For example, the actual cost of maintenance, operations, renewal, decommissioning, and salvage is largely dependent on how the asset is designed, built, and its operating conditions. Cost-cutting measures and other factors as shown in Table 3-3 (e.g., design standards, quality of materials and construction, operational stresses) cause higher failures and increase the costs incurred post-construction.
- Opportunities to optimize the total cost of asset ownership are greatest during the initial stages of the asset lifecycle. For example, care taken during asset design to minimize maintenance requirements, reduce risk, or improve safety can pay off with decades of lower-cost maintenance and operations. Also, modifications made during or following construction are much costlier than those initially planned and designed.

Improvement Initiative M6
Formal Process for Engaging O&M Team

[2] The actual amount varies depending on the type of assets and other considerations.

Figure 4-3 and Figure 4-4 illustrate the importance of the early stages of the asset lifecycle in terms of overall cost of asset ownership and risk management.

Figure 4-3: Relative Cost by Year During the Asset Lifecycle

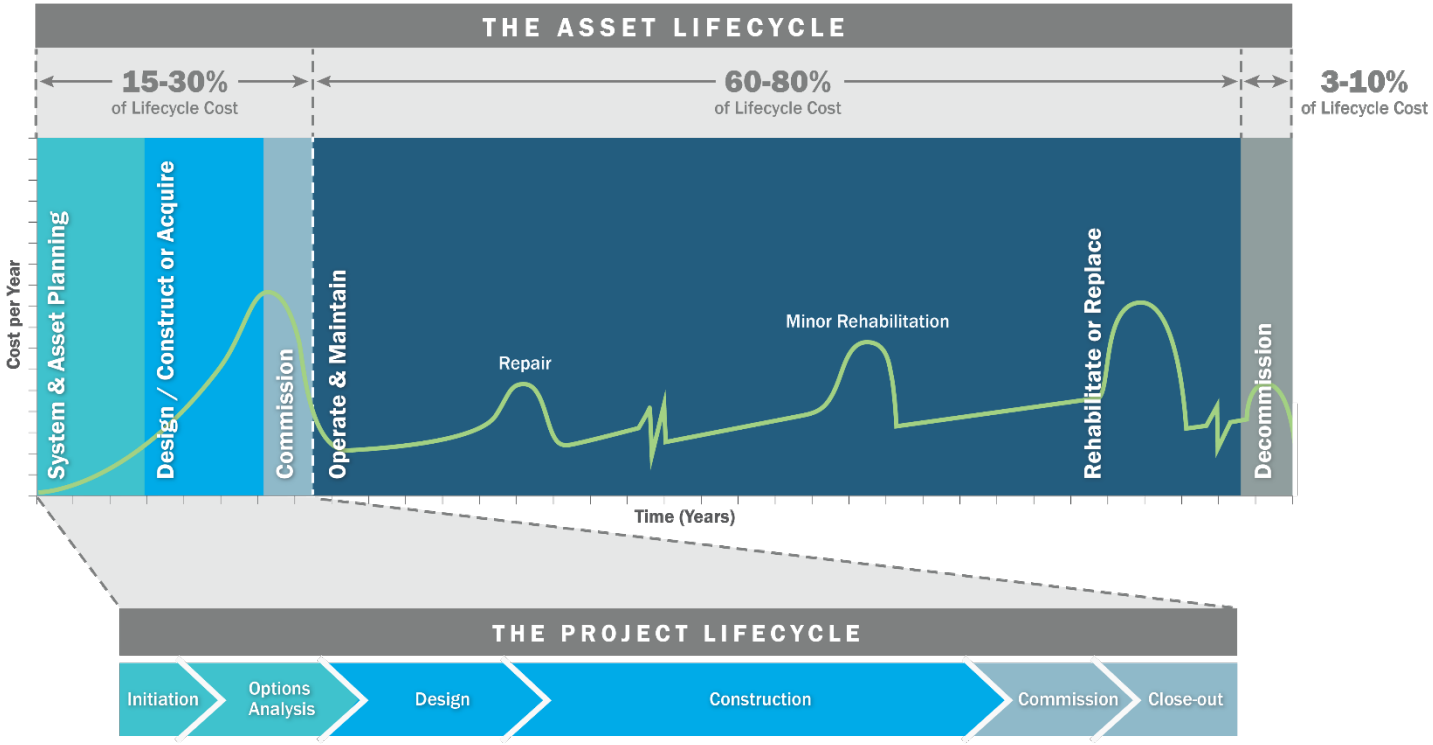
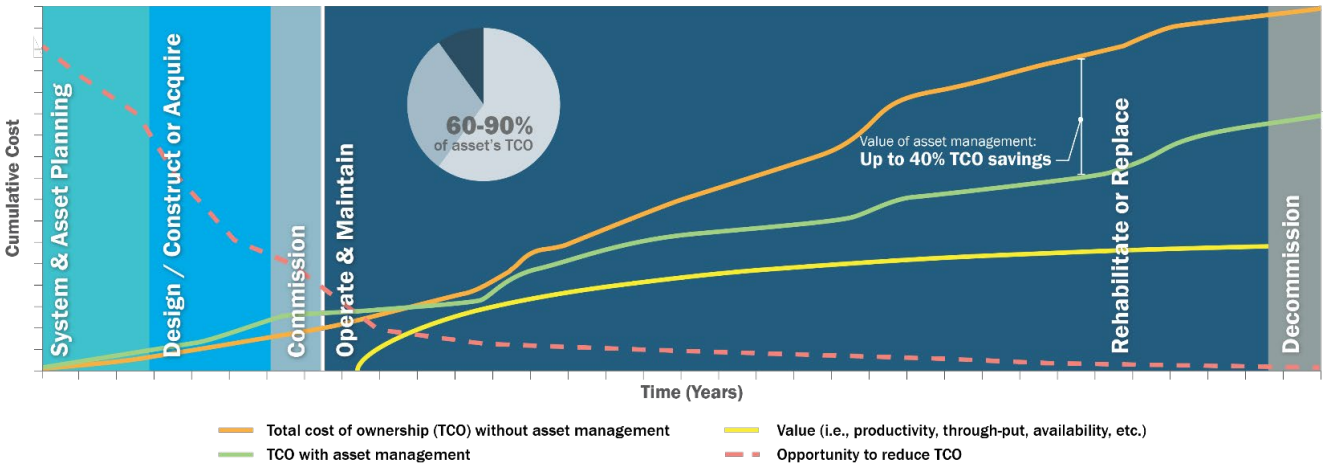


Figure 4-4: Cumulative Cost During the Asset Lifecycle



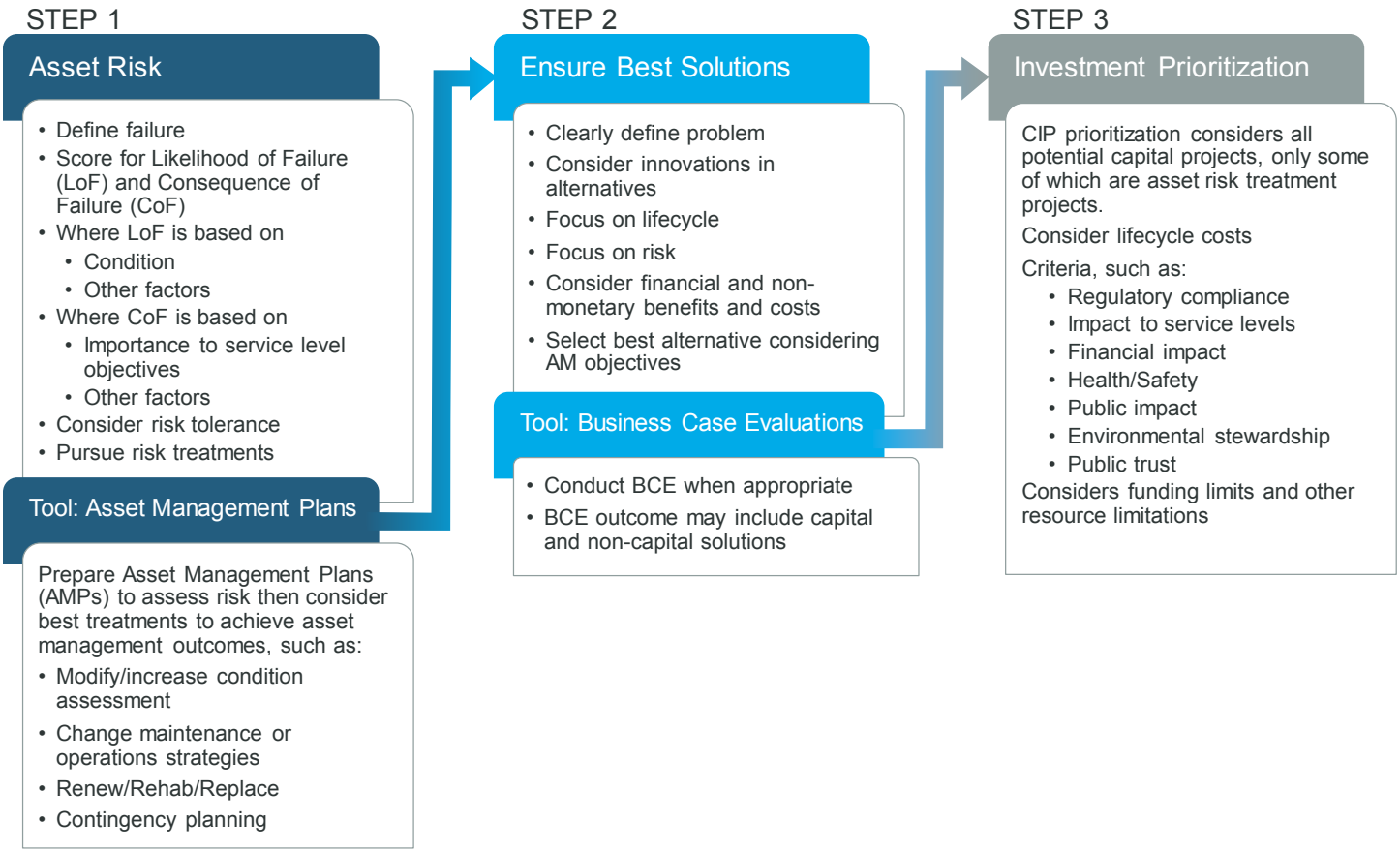
4.4.3 Three Key Steps to Effective Investment Decision-Making

There are three distinct steps to determine and prioritize asset investments. The first step has to do with understanding asset risk. This activity is primarily conducted and updated with AMPs. The second step is Alternatives Analysis, which is conducted to determine the most cost-effective way to treat risks, or to address a need or opportunity for improvement. The third step is project prioritization. Figure 4-5 illustrates the three key steps, which are further described in the subsections that follow. The financial analysis aspect of conducting a BCE is described in Section 4.4.4.

Improvement Initiative R1

Shift to Asset Risk-Driven Funding and CIP Prioritization

Figure 4-5: Three Key Steps to Effective Investment Decision-Making



4.4.3.1 Step 1: Asset Risk Assessment

Asset risk can be conducted on its own or as part of an AMP. Asset risk management is described in Section 3.4 and in Section 6. The inherent value of this step is making sure GLWA is aware of and addressing the right asset risks.

Improvement Initiative G3

Asset Renewal Decision Making

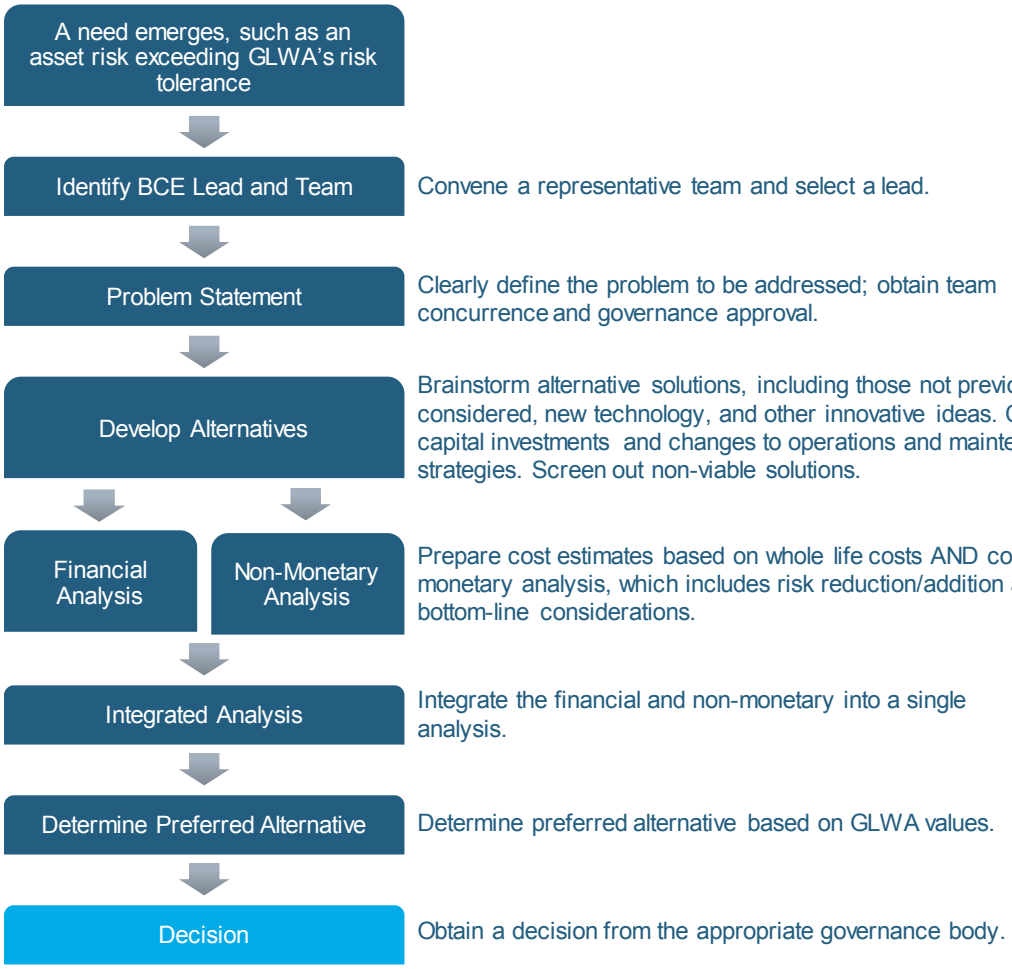
4.4.3.2 Step 2: Ensuring Best Solutions

Improvement Initiative R2

Enhanced Business Case Evaluation Process

Upon determination of asset risk scores, and based on consideration of GLWA's risk tolerance, a key step in decision-making is conducted with Business Case Evaluations (BCEs). BCEs can be developed for investment needs driven by risk reduction or for needs driven by other factors, such as regulations, growth, efficiency enhancements, or new technologies. BCEs are used to establish a formal, unbiased, and uniform process to analyze and document key issues so that alternative selection can be made based on objective information and those decisions are formally documented. The inherent value of this step is objectivity, transparency, and confidence that GLWA has selected the right solution. Figure 4-6 illustrates the process flow for conducting a BCE. Financial analysis is described in Section 4.4.4.

Figure 4-6: Business Case Evaluation Process Flow



4.4.3.3 Step 3: Investment Prioritization

Currently, GLWA uses the following decision criteria in prioritizing projects in the Capital Improvement Program (CIP):

- Condition
- Performance (Service Level/Reliability)
- Regulatory (Environmental/Legal)
- Operations & Maintenance
- Public Health & Safety
- Public Benefit
- Financial
- Efficiency & Innovation

Prioritizing proposed capital projects has been conducted by project managers using a scoring system as part of GLWA's current BCE process. However, moving toward the three-step process shown in Figure 4-5, beginning with a determination of asset risk, followed by a rigorous Alternatives Analysis as shown in Figure 4-6, will result in a more objective and repeatable prioritization with greater certainty that the best solutions are identified. In addition, revisiting the prioritization criteria based on the asset management objectives described in Section 4.3 will help ensure best outcomes. The inherent value of effective investment prioritization is objectivity, transparency, and confidence that GLWA is spending limited capital dollars on the highest priority needs.

4.4.4 Lifecycle Financial Analysis

Financial analytics are performed as part of asset renewal decision-making and as part of BCEs.

4.4.4.1 Lifecycle Cost Estimating

A financial analysis of the developed alternatives is a key step in the BCE process and is performed by calculating the Net Present Value (NPV) of each alternative. Calculation of NPV is performed by estimating capital costs, determining asset lifecycles, applying future costs including maintenance, operations, asset renewals, and other costs over those lifecycles and returning all costs to present-day dollars. To convert future costs to present day dollars, a real discount rate is applied. It is important to note that when applying a real discount rate, inflation is not to be applied to future costs. Cost estimates used to determine capital costs for each alternative should include the following capital and future costs.

Capital Costs:	Future Costs:
Planning	Operations and maintenance
Permitting,	Periodic major maintenance
Property acquisition	Renewal
Design	Rehabilitation
Construction	Replacement
Commissioning	Decommissioning/disposal

These costs are not inclusive, and other BCE-specific costs should be considered and included as merited.

Based on time value of money, annual net cash flows (*CF*) are projected over the life of each alternative and discounted back to present value. The formula for calculating the NPV is:

$$NPV = CC + \frac{CF_1}{(1+d)^1} + \frac{CF_2}{(1+d)^2} + \frac{CF_3}{(1+d)^3} + \cdots + \frac{CF_n}{(1+d)^n}$$

Where *CC* is initial capital cost, *d* is the real discount rate, and *n* is the last year in the analysis (the last year of the lifecycle).

4.4.4.2 Estimating Precision

Capital costs for BCEs are typically prepared using a Class 4 (study or feasibility) or Class 5 (concept screening) estimate based on the American Association of Cost Estimators estimating classification system. Class 3 (budget authorization) or Class 2 (control) estimates are generally not preferred for BCEs because there is a high cost to generate that level of cost estimate, and it is unnecessary to expend such funds prior to making a well-informed, BCE-based decision regarding the preferred alternative.

4.4.4.3 Determination of Appropriate Lifecycle

Determination of the lifecycle of the alternatives can take two forms. Ideally, the lifecycle will be the least common denominator (LCD) of the individual lifecycles of all assets for all alternatives, but this approach can become impractical with high lifecycle periods. Typically, lifecycle values should not exceed maximum cycles of 100 years, although in circumstances with adequate validation, that value can be exceeded. If the LCD approach is determined to be impractical, a remaining useful life calculation should be performed.

Examples of LCD and remaining useful life calculations:

> **Least Common Denominator.** Assume the useful lives of three project alternatives are 18, 24, and 36. The LCD method would result in use of a 36-year lifecycle as the timeframe for the NPV analysis. The projects with the 18 and 24-year useful lives would be extended out to match the 36-year lifecycle alternative.

Remaining Useful Life. Assume the useful lives of three project alternatives are 25, 50 and 60 years, which would require an analysis period of 300 years if the LCD method were to be used. An analysis period this long is not useful for decision makers. A simple way to address this situation is to set the period for analysis at, say, 50 years, and apply a "credit" (make it a negative number) to the 60-year alternative in year 60, equal to the value of this alternative from years 51-60. A simple way to calculate this credit is to apply $1/6^{th}$ of the original cost of this alternative in year 60. Again, this should be entered as a negative number. This approach recognizes that the 60-year alternative has 10 more years of value than the 25 and 50-year alternatives.

Future costs include future capital costs and operations and maintenance costs. Future capital costs might consider replacement of an asset or large-scale rehabilitation, whereas maintenance and operations costs could include operations labor, power, chemicals, maintenance labor, and periodic major maintenance. These lists of potential costs are not inclusive, and each BCE should be evaluated individually for costs particular to its developed alternatives. To ensure that future costs are adequately captured, increases or decreases above or below the rate of inflation should be escalated accordingly.

4.4.4.4 Key Economic Terms

Several key economic terms, useful to understanding the financial analytics in BCEs are defined below:

Discount Rate. Rate of return that investors would charge to compensate for the risks of lending their money.

Nominal Discount Rate. Discount rate with impacts from inflation included. This is the interest rate a business, government agency or individual pays to borrow in the marketplace.

Real Discount Rate. Discount rate that does not include inflation. For the purposes of preparing BCEs, costs should be prepared excluding the effects of inflation, and a real discount rate should be used in the present value calculations. The real discount rate should be consistent across all BCEs as specified by the Chief Financial Officer, and does not change frequently. In 2019 the real discount rate is 3.0%. The real discount rate can be approximated as follows: Real Discount Rate = Nominal Discount Rate – Inflation Rate.

$$Real\ Discount\ Rate = Nominal\ Discount\ Rate - Inflation\ Rate$$

Escalation Factor. Factor used to adjust future costs expected to increase or decrease above or below the general rate of inflation. For example, if the general rate of inflation is expected to be 4%, but electricity prices are expected to increase by 6%, the escalation factor for energy would be 2%. Escalation factors should also be provided by the CFO, or if proposed by others, approved by the CFO.

The terms below help provide context for the terms that are used and address potential confusion when performing BCEs.

Inflation. Inflation is a measure in the price of a "basket of goods" such as staple household goods or fuel prices. The Bureau of Labor Statistics and the Federal Reserve prepares a wide range of inflation measures or price indices, including utilities. Economists advise NOT to incorporate inflation in calculating BCE costs or revenues for two reasons. First, expressing costs or revenues in current dollars is easier for decision makers to understand. Second, a BCE that incorporates inflation requires that the discount rate used for NPV calculations be the nominal rate of interest rate, not the real discount rate. Nominal interest rates vary over time much more than the real discount rate (which has been in the range of 2-3% consistently over time), because of variations in inflation rates. To conduct a BCE with inflation reflected in costs (revenues) requires the BCE team to predict variation in inflation and interest rates over time. This increases assumption thereby decreasing accuracy and creating the potential for both intentional and unintentional misrepresentation of the financial analysis.

Depreciation and Depreciation Rate. Depreciation is a method of cost allocation reflecting the reduction in an asset's value over time due to use and general wear and tear. Depreciation rate is a function of the reduction in value as it relates to time over the lifecycle of the asset and can take various forms depending on the application. Depreciation costs are calculated by subtracting residual value from initial costs. Cash flows from depreciation are accounting cash flows, are not real, and thus would not be included in a financial analysis. In BCEs, an engineering estimate of the salvage value and/or disposal cost of the asset(s) is used in the place of a depreciation rate.

4.4.5 Project Lifecycle

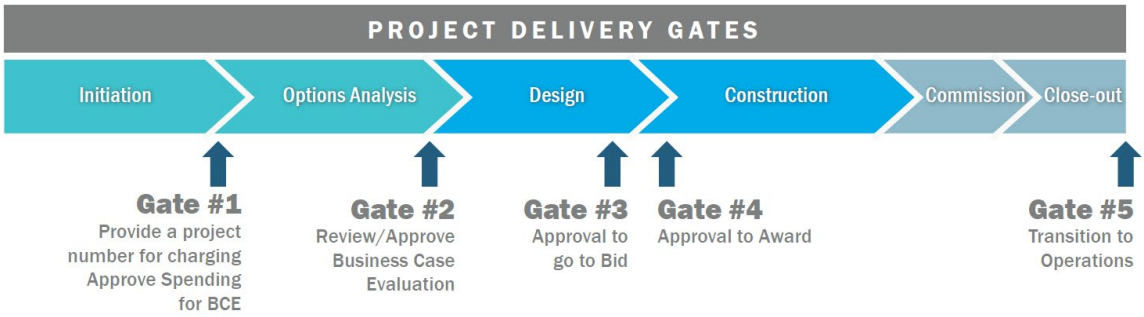
The project lifecycle, shown in Figure 4-7, is a foundational element of the complete asset lifecycle. Many important decisions are made during the project lifecycle, and these decisions can either help or hinder the ability to effectively manage the costs, risks, schedules, and outcomes across the whole asset lifecycle. Project execution risks, as discussed in Section 3.4.3 are identified initially during the initiation phase of the project lifecycle, then incrementally during the latter phases of the project lifecycle, and are managed as part of project management activities.

Figure 4-7: Project Lifecycle

Improvement Initiative G5
Stage Gates

While GLWA has protocols for making decisions during the project lifecycle, incorporating more clearly defined project delivery stage gates will help GLWA effectively manage and govern the project lifecycle. Stage gates define points in the project lifecycle during which approvals are sought in order to proceed to the next phase. This provides for appropriate check-ins by virtue of review by governing individuals or committees and, if needed, off-ramps if project criteria are not met or adequate funding is no longer available. Stage gates also provide for consistency in cost estimating, procedures for project execution risk management, and application of project reserves (sometimes referred to as contingency) and cost estimating ranges. Figure 4-8 depicts how stage gates can be applied at GLWA.

Figure 4-8: Possible Stage Gates for the Project Lifecycle



The inherent value of stage gates is the discipline created for capital planners, project managers, design staff, and construction staff during the project lifecycle. The process also provides an audit trail of the decisions made across project stages.

5 Performance Management

Managing performance is fundamental to the success of any program, project, operation, or activity. Performance management is a broad topic that consists of initial development and effective communication of desired outcomes and specific goals, two-way conversations about desired outcomes and goals, the ability of the organization to achieve desired outcomes, reporting against these targets and goals, and making course corrections. GLWA needs to have a common understanding of the meaning of success; clear and deliberate strategies, governance, training, mentoring, and understanding of team member capabilities; meaningful performance indicators that are tracked routinely and modified as-needed. Action should be taken when desired outcomes are achieved or not achieved (i.e., celebrating successes and addressing deficiencies).

It is important to set up a performance management system that fosters learning and continual improvement. This consists of making adjustments when warranted, listening to new ideas, undertaking new approaches, and creating an organizational environment that encourages questioning of the status quo and the desire to achieve high performance.

Effective performance management can help justify financial and other resource investments and improve communications among internal and external stakeholders. Consistent and uniform performance management and the associated performance measurements provide information necessary to continually improve processes and outcomes.

When GLWA has effectively addressed the items important to performance management, a high-performance culture will result. While a high-performance culture does not necessarily mean the organization is achieving peak performance, it does mean it's on the right course.

5.1 Performance Measurement

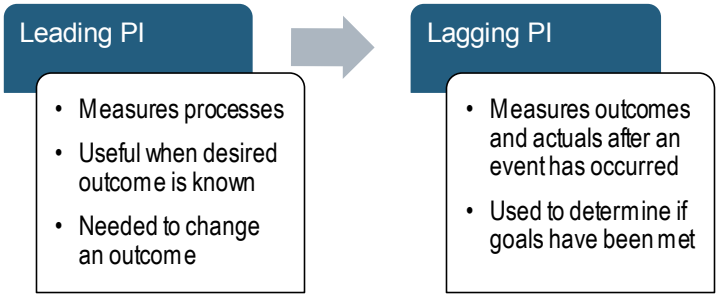
Performance measurement may be quantitative or qualitative. Quantitative performance indicators (PIs) use metrics and are objective and data driven (e.g., the cost of energy). Qualitative PIs may be expressed using numbers, but the input is subjective (e.g., a survey of member partners may indicate that 90 percent are satisfied with the services provided, but the determination of satisfaction is subjective).

A PI is typically expressed as a ratio (e.g., the cost of energy per million gallons of wastewater treated). Other ratios indicate performance of a system (e.g., number of sanitary sewer overflows per 100 miles of pipe) or condition of a system (e.g., number of water main breaks per 100 miles of pipe). PIs can indicate the effectiveness of an activity, such as proactive maintenance (e.g., mean time between failures), whereas resource/activity indicators metrics can be used to access workload and resource allocation (e.g., miles of water main replaced).

PIs can be "leading" or "lagging." A leading PI measures a process, while lagging PIs measure outcomes (see Figure 5-1). Leading PIs are useful when the desired outcomes are known for the processes being measured. For example, the number of miles of video-inspected sewer per year may measure the productivity of a work crew, but whether the video inspections add value cannot be determined exclusively with this PI. Similarly, measuring the number of planned maintenance work orders compared to the total number of work orders may help understand whether GLWA has achieved a desired goal, but these values themselves are only helpful to the extent there is an understanding of the relationship to GLWA's desired outcomes.

Lagging indicators measure outcomes and actuals that can only be measured after an event has occurred (e.g., the number of sewer overflows per 100 miles of pipe, or percent of days in full compliance with drinking water standards). Generally, if there is a desire to change an outcome, something must change with a leading indicator. If no leading indicator has been established related to the outcome, one or more should be established as part of an improvement process.

Figure 5-1: Types of Performance Indicators



A key performance indicator (KPI) measures performance having a significant impact on the primary goals of GLWA. KPIs may change from time to time depending on changing priorities, areas needing attention, or other reasons at the discretion of the Chief Executive Officer (CEO). There should be many PIs throughout the organization, but relatively few KPIs in order to convey importance and sense of urgency.

Data used for calculating performance indicators, including those chosen as KPIs, must be consistently and systematically measured to ensure accuracy and repeatability. Calculations must be clearly defined and unambiguous. If performance will be compared with other utilities, it is crucial to determine whether the data are accurate, the calculations are the same, and characteristics of what is being measured are similar enough to make comparisons between utilities.

Although sector comparisons of PIs can be useful, the most advantageous use of PIs is tracking performance within the organization, especially in tracking improvements. Target values for PIs should be established so that achievement of a performance goal is clear to stakeholders. However, it is just as important to understand the trend of a PI. In some cases,

understanding how and why a PI is trending may be more important than setting an actual target value. The direction of the trend and its rate of change provide valuable information for identifying whether a process is working and how it may be improved.

Reporting of PIs is important to process improvement and asset management. Communicating PIs, targets, and trends to the workforce can encourage improvement in work practices. It is common to report KPIs monthly. PIs may be established for individuals and become part of personal performance plans, and they may be established to report on accomplishment of projects or improvement initiatives. PIs may be reported daily, weekly, or monthly depending on the activity and the need to improve performance.

To be of value, KPIs and PIs must have the following characteristics:

- **Specific.** Describes a specific attribute of service or activity
- **Measurable.** Information/data is available or can be obtained easily
- **Meaningful.** Provides a clear picture of performance relevant to stakeholders
- **Time-bound.** Measured over a specific timeframe
- **Consistent.** Measurements use the same methods and tools so they are repeatable by others
- **Useful.** Provides a clear direction for improvement

5.1.1 Selection of Asset Management Objectives

As described and listed in Section 4.3, GLWA has established asset management objectives to identify key outcomes desired from the adoption of asset management practices. Progress toward the objectives will be periodically monitored and reported using PIs.

Improvement Initiative S2

Line-of-Sight Performance Management System

5.1.2 Selection of Performance Indicators

Hundreds of PIs are used in the water and wastewater sector (see Figure 5-2). Numerous PIs from the asset management industry are also commonly used by water and wastewater utilities. Most of these focus on maintenance management and reliability. These PIs are important in monitoring and improving maintenance activities and optimizing proactive maintenance work orders.

Figure 5-2: Performance Indicators Used in the Water and Wastewater Sector

Currently, GLWA tracks about 33 KPIs and EUM metrics monthly in a report provided to the Board and available to the public on the GLWA website. In addition, a quarterly Construction Work in Progress report tracks actual progress of spending compared to budgeted amounts. Reporting is also provided to water and wastewater regulators to give evidence that GLWA is meeting requirements.

Improvement Initiative S0

Line-of-Sight Performance Management System

GLWA intends to use a combination of the following approaches to develop a comprehensive set of PIs:

- Following development of service level objectives, determine the performance required to track service levels and establish PIs accordingly.
- Through the process of preparing Asset Management Plans (AMPs), determine PI necessary for that grouping of assets.
- Seek input from management and staff regarding performance that should be tracked to achieve organizational goals and establish PIs accordingly.
- As it makes sense relative to GLWA's needs, adopt PIs from water and wastewater sector organizations and asset management industry.

Improvement Initiative S0

Improved Performance Reporting

In all instances, tracking PIs involves a cost. Decision makers at GLWA need to be sure the value of having the information exceeds the cost of collection and reporting. GLWA also needs to be aware that establishing PIs and their associated targets communicates a message to team members regarding desired performance; each message has the effect of creating priorities.

5.2 Service Levels

Service levels are statements of desired performance outcomes that reflect high priorities from member partners, end users, the public, the environment, or are required by regulators. Service levels have been established by GLWA, are largely within the control of GLWA, and have performance-level data that can be accurately and consistently collected and audited.

Service levels are important in asset management decision making because they form the "target" for maintenance strategies and capital investments. PIs are used to track and measure service levels, providing a line-of sight to the Asset Management Policy and to the organizational strategy.

GLWA does not currently have a comprehensive set of service levels as defined above; however, many desires of member partners, end users, and the public are represented in GLWA's KPIs.

5.2.1 Purpose and Use of Service Levels

Service levels are important to GLWA because they:

- Establish clarity and transparency regarding GLWA's core business
- Clarify GLWA objectives for provision of service to member partners and the public
- Create a target for maintenance and operations strategies, renewal and rehabilitation plans, and infrastructure improvements
- Provide a way to prioritize and optimize activities (including projects) and justify financial and other resource investments
- Create a path toward improved cost-effectiveness of service delivery
- Support focus on performance and accountability (including quality and quantity)
- Provide information that can be used to help understand performance relative to other similar organizations
- Provide information to observe progress toward stated goals (continuous improvement)
- Provide a means of communicating goals, strategies, and targets to team members

In addition, service levels are key to effective asset risk management because they provide a starting point for defining failure of processes and assets. Service levels allow GLWA to have informed conversations about risk and better manage risk, including treating risks associated with unplanned events, and based on this, creating or modifying service levels or business processes to help reduce unplanned events. GLWA's approach to risk management is described in Section 3.4.

Finally, when established based on an understanding of the member partner, end user, and the public's desires (regarding costs and services), service levels provide targets that help GLWA balance the desires of the public and the investments in infrastructure. When achieved, this signifies a successful outcome for GLWA.

GLWA intends to use service levels for various aspects of asset management planning, including:

- Asset and risk analysis (i.e., to create clarity regarding "failure")
- Maintenance and operational strategies, renewal and rehabilitation plans, and infrastructure improvements
- Business case evaluations
- CIP prioritization

GLWA will continue to engage member partners in discussions regarding service levels in order to understand their desires, to inform final service level objectives, and to provide input for target-setting. Similar discussions may also occur with representatives of the end users, the public, and other stakeholders. GLWA intends to communicate outcomes (actual performance) to member partners, end users, and the public.

5.2.2 Service Levels Objectives

GLWA has established service level objectives for water and wastewater as follows:

> Improvement Initiative S1
> Refined Service Levels

Water System Service Levels

- Provide water that is of unquestionable quality
- Provide water at a pressure that satisfies commitments
- Provide water with minimal disruptions

Wastewater System Service Levels

- Convey and treat wastewater to protect public health, the environment, and recreation
- Convey wastewater to maximize treatment and minimize untreated overflows
- Minimize detrimental wastewater service disruptions
- Provide wastewater services that satisfy commitments

Engaging GLWA's member partners is a crucial step towards developing meaningful service level objectives. At the One Water Partnership meeting held on September 19, 2019, GLWA presented draft service level objectives and asked member partner representatives present to discuss their thoughts regarding whether the statements above correctly represent the interests of member partners. Member partner concepts were as follows:

- Costs should be weighed against service levels to understand the tradeoffs
- "Minimal service disruptions" is subjective; determine a performance indicator for this to set members' expectations
- Consider adding to Water System Service Levels:
    - Minimizing non-revenue water
    - Security of water systems
    - Pressure objectives, noting that member communities have opposing concerns relating to pressure objectives.
- Consider adding to Wastewater System Service Levels:
    - Using a watershed approach in decision-making
    - Avoiding basement backups

Given that the SAMP is a high-level strategic document and the nature of the input received, no modifications to the service level objectives were identified at this time. Each of the concepts noted above will be considered further during future evaluation of enterprise-wide service level objectives and when developing performance indicators.

5.3 Measuring Progress Toward Asset Management Maturity

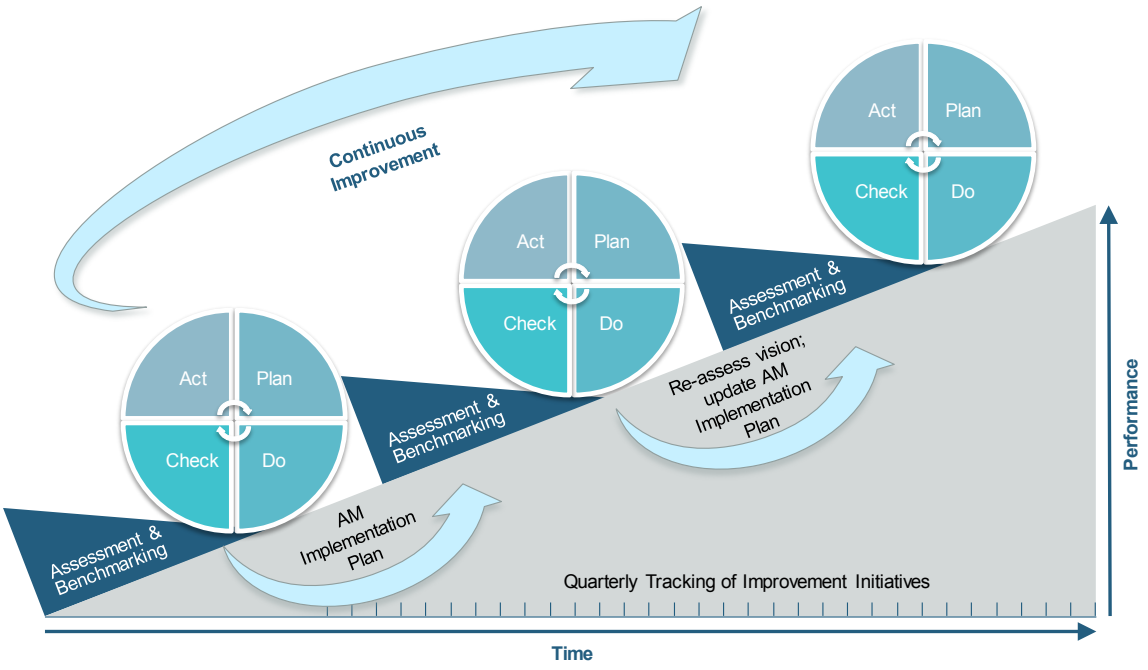
In order to effectively measure GLWA's progress toward asset management maturity, a holistic set of measures needs to be developed. Four different aspects should be tracked.

1. **Service Levels.** Tracking service level actuals and comparing them to targets will help GLWA understand how well it is meeting the needs of member partners, end users, and the public.
2. **Asset Management Objectives.** Measuring achievement of asset management objectives helps track GLWA's overall progress toward maturity.
3. **Performance indicators.** PIs should be balanced—leading and lagging, quantitative and qualitative—and track performance across all functions supporting asset management at GLWA.
4. **Progress on improvement initiatives.** Upon determination, endorsement, and resourcing of improvement initiatives, progress should be routinely tracked.

When tracking each of these aspects of asset management, successes should be acknowledged and celebrated, and course corrections should be developed if desired outcomes are not achieved.

Periodic benchmarking will also be conducted to gauge overall progress and update the asset management roadmap and implementation plan, as discussed in Sections 9 and 10 and shown in Figure 5-3.

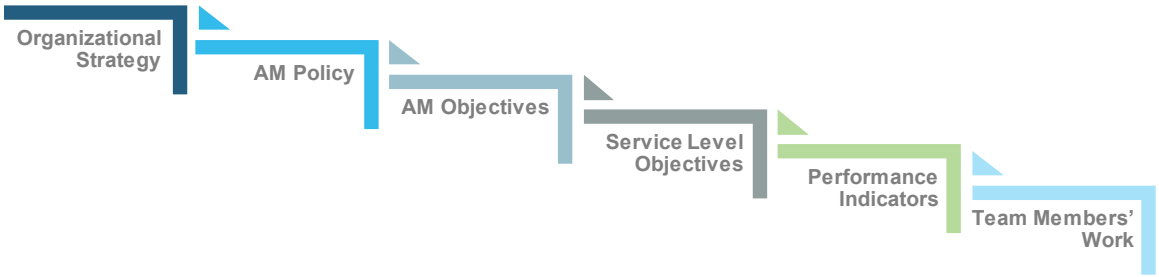
Figure 5-3: Journey to World Class Asset Management



5.3.1 Tracking Service Levels

A service level actuals report should be developed. After establishing service level objectives, GLWA should facilitate discussion to determine the performance required to track service levels and accomplish desired outcomes. Each team member or contractor in the organization should see clearly how their work supports achievement of service levels or other organizational goals. In this way the PIs should "cascade" down from service levels to each team member.

Figure 5-4: Performance Indicators Cascade



5.3.2 Tracking Progress of Asset Management Objectives

A report to track achievement of asset management objectives (as listed in Section 4.3) should be developed and tracked periodically. Some of the asset management objectives can be tracked with objective data with establishment of Performance Indicators. However, some of the asset management objectives can only be measured with subjective data (for example, "Have timely access to trusted and relevant data and information") and for these a survey tool should be developed to obtain input from team members, using repeatable questions that lead to an understanding of the level of achievement of the objectives.

Improvement Initiative S3
Improved Performance Reporting

5.3.3 Tracking Performance Indicators

PIs can be developed anywhere within GLWA, and in general, should be routinely tracked at the unit where they are established. In addition, a dashboard may be considered to create transparency regarding PIs. While PI's can be established and tracked at the unit level, having a central process owner for performance management helps to ensure consistency, prioritize across the organization, identify issues to resolve, and standardize reporting and tools.

Upon development of organizational processes to support asset management, GLWA will need to establish a system to audit compliance with process requirements and to continuously improve processes as appropriate, train staff and management, and track outcomes.

Improvement Initiative P7
Asset Management Business Process

5.3.4 Monitoring Progress with Improvement Initiatives

Improvement initiatives (IIs) are actions needed, typically sets of tasks and activities determined necessary in order to transition from GLWA's current asset management state to the desired state. Upon selection and resourcing of the improvement initiatives, a team will be established and its initial assignment will be to develop a scope, schedule, and statement of desired outcome for the II. Following approval of this by the AMLT or a satellite team to the AMLT, progress will be monitored each quarter.

New improvement initiatives are expected to be identified periodically and these will be prioritized along with the others. Decisions will be made once a year regarding which IIs to implement.

6 Asset Management Plan Framework

Improvement Initiative O1

Asset Management Plans

While this SAMP provides the strategic direction for GLWA's asset management journey, the transitioning of the strategy into operational planning is fulfilled, in part, by Asset Management Plans (AMPs). An AMP specifies the activities, resources, and timescales required for a grouping of assets to achieve GLWA's asset management objectives. AMPs are particularly beneficial to those team members involved in the AMP's development, as well as those team members who will incorporate the practices and activities contained in the AMPs, some of which are shown in Figure 6-1.

Figure 6-1: Example Practices and Activities Contained in an AMP

6.1 Overview of an Asset Management Plan

An AMP balances lifecycle cost with delivery of established service levels and thorough risk treatment strategies. AMPs also clearly identify the line-of-sight between GLWA's asset management strategy and the daily activities of operating and maintaining assets. AMPs are scalable and incremental in nature.

- **Scalable.** An AMP can be prepared for an entire system such as a water system or wastewater system, or at a smaller scale for a single category of assets such as pump stations or watermains. (See Section 6.5 for more information on asset groupings.)
- **Incremental.** AMPs can also be prepared incrementally, using information and data that is available at the time the AMP is prepared, and subsequently updating the

AMP as more information and data becomes available. It is not necessary to have all the related asset management activities in place or have a complete set of data before creating an AMP. Rather, each element of the AMP should document the current understanding of the assets with the best information and data available. This provides a baseline to develop a list of improvement initiatives needed to mature processes and obtain better data.

Improvement Initiative M8

Reliability Analysis Program with Reliability Engineers

An AMP clearly demonstrates the relationship between service levels, the existing asset base, maintenance, rehabilitation, and replacement strategies, as well as the investment levels needed to treat risks and meet future demands. In an AMP, the relationship between these aspects of asset management should balance with the concept of asset risk. Asset risk is a construct that allows GLWA to weigh decisions about how to best apply investments and manage its aging infrastructure (See Section 6.4 for more information on asset risk).

Future iterations of AMPs are informed by more complete and current information and data that includes asset performance, condition, criticality, and other factors that are used to determine the likelihood and consequence of asset failure leading to better decision making. In addition, AMPs should document the improvements made (i.e., the benefits and the return on investment) from one subsequent AMP to the next, which will help develop support and justification for the continued resourcing of AMPs.

6.2 Objectives of an Asset Management Plan

The ultimate goals of an AMP are to optimize resources and demonstrate responsible management of the assets covered in the AMP, showing that GLWA is paying appropriate attention to member partner expectations and the long-term stewardship of its assets. AMPs also document current and future asset management strategies and serve to communicate and justify funding needs.

Specific objectives of an AMP include the following:

- Documents the assets within the asset group, their current condition, performance, and value
- Documents the relevant service levels, regulatory requirements, and desired performance of the assets
- Provides short- and long-term forecasts of demand and the impact of changes in demand upon the assets
- Documents the risk associated with the assets, including likelihood of failure and consequence of failure
- Documents how GLWA treats risks, such as maintenance, rehabilitation, and replacement strategies, redundancy and contingency planning

- Determines resources required for the risk treatment strategies and projected changes in demand, including long-term capital projections, capital outlay, O&M expenditures, and staffing
- Documents the currency, quality, and completeness of data required for effective management of the assets
- Stipulates PIs for the assets addressed in the AMP, establishes targets for PIs, and identifies resources for PI tracking and reporting
- Identifies and plans for asset management improvement initiatives and updates to the asset management roadmap, obtains resource commitments, establishes timeframes and roles and responsibilities for improvement initiatives.

6.3 Developing Asset Management Plans

6.3.1 Roles

In accordance with the AMSO governance structure, described in Section 8.1, the appropriate Asset Management Team (Water or Wastewater) will lead the development of an AMP. It is anticipated that the development of an AMP will be completed in a six-month time period or less. Additional members of the AMP Development Team will be selected jointly by the Enterprise Asset Management Director, the Asset Management Team leader, and the Chief Operating Officer who is the "owner" of the assets to be covered in the AMP. Table 6-1 presents a list of recommended roles in an AMP Development Team.

Table 6-1: Key Roles in an AMP Development Team

Role	Expectations	Notes
Executive Sponsor	• Ensure adequate resources are allocated, assist in resolution of conflicts, and advocate for final approval of the AMP • Work with Asset Management Team Leader (see below) to identify team members • Ensure the findings and results of the AMP are implemented	• This role will be determined based on governance decisions. For the first few AMPs, this individual may be at the executive leadership team level (i.e., Chief Operating Officers). However, for subsequent AMPs it may be appropriate for this role to report to the Chief Operations Officers.
Member of the Enterprise Asset Management Group	• Establish expectations and provide training and coaching for AMPs • Act as internal asset management consultant for the team	• The member of the Enterprise Asset Management Group, along with the Executive Sponsor, serves as a liaison to the AMLT.

Role	Expectations	Notes
Co-Leaders of the AMP Development Team	AMP Development Team Co-Leaders have shared responsibilities: • Serve in the role of project manager for the AMP development process • Responsible for scope, schedule, budget, and team management • Responsible for team chartering, including establishing role clarity, decision-making protocols, and ground rules • Responsible for ensuring clear expectations of the team and accountability of team members	• The Enterprise Asset Management Group Co-Leader should be selected by the Asset Management Director and should be knowledgeable regarding development of AMPs. • The Business Unit Co-Leader should be selected by the Executive Sponsor and should be someone from the business unit with operational responsibility for the grouping of assets covered in the AMP.
Facilitator (optional)	• Assist the Co-Leaders • Responsible for meeting scheduling and facilitation, as well as data and document management	• This role may be more important for the first few years of AMP development at GLWA. This individual could serve in this role for AMPs across several business units because the important competencies are knowledge of AMP processes and team facilitation. • This individual must have a solid understanding of asset management principles.
Asset Management Analyst or Economist	• Develop asset risk profile based on input from team • Conduct analytics regarding best risk treatments for the assets and the capital program for the assets • Conduct long-term funding needs assessment based on input from the team	• This role may be fulfilled by another member of the team if there are appropriate qualifications. • Qualifications for the person filling this role include: experience with lifecycle analytics; net present value; triple bottom line analytics; multi-objective decision analytics; risk analytics; return-on-investment; financial forecasting; CIP prioritization; rates and charges; revenue requirements; and decision models. • The work of this individual will be done in partnership with the Finance representative.
Team Members	• Engage in development of the AMP • Ensure appropriate interests are represented • Take ownership of outcomes	• Team members to be selected based on their areas of expertise relating to the assets and covered in the AMP (e.g., operations, maintenance, planning, engineering, regulatory compliance, safety). • At least one member shall have the knowledge and capability to extract data from GLWA asset data systems.

The process for developing an AMP can be considered as important as the document itself. The process brings team members together with the shared commitments of achieving service levels, identifying risks, selecting cost-effective risk treatment measures, and optimally managing aging infrastructure. AMP Development Team members will be instrumental in forming an asset management culture at GLWA as they work to develop the initial AMPs.

Each AMP Development Team member brings an important perspective to the discussion. Each are expected to add value to the creation of the AMP and uphold synergy within the team. The team should focus on member partner and community expectations and the role assets have in helping GLWA achieve desired outcomes. While the roles may vary for each

AMP, there must be a deliberate process to engage key interests within GLWA (including, as appropriate, those outside the AMP Development Team) to conduct a cross-functional assessment of asset performance, risk and risk treatments, operations and maintenance strategies, as well as renewal strategies.

To fully understand asset risk and identify the most appropriate risk treatment strategies, individuals must share their experiences, observations, and concerns in an open and non-threatening environment. All ideas regarding asset failure likelihood, failure consequence, and risk treatment need to be introduced and discussed. These include new ideas not previously considered, old ideas previously discarded, or ideas that may seem unusual or ill-considered. Team members must be willing to discard pre-conceived notions, challenge the status quo, question business-as-usual, and be encouraged to identify new solutions. They must be open to new ideas from others, be able and willing to listen intentionally to one another, seek new ideas from outside GLWA, stretch out of their comfort zone, and take risks. Contributions of all members must be valued, and respectful conflict should be encouraged.

Improvement Initiative P1

Dedicated AM Team Members within Business

All AMP Development Team members must be committed to the work. Each must have or make time for team discussions and completion of assignments. If such commitment is a problem due to other work obligations, then the team member's supervisor should be consulted to identify a solution. All AMP Development Team members are expected to advocate, promote, defend, and uphold asset management best practices. They should be provided resources to learn about and research best practices. In addition, they will define roles, responsibilities, and skill levels needed to coordinate and execute the asset management activities resulting from the AMPs and work to continuously improve outcomes by eliminating non-value-added steps, optimizing technology and effectively coordinating and executing all work around the asset lifecycles.

6.3.2 Review and Approval Process

Prior to submitting an AMP, members of the AMP development team must reach consensus on the content and presentation of the AMP, including improvement initiatives noted in the AMP. The AMP will then be reviewed and approved by the Wastewater Asset Management Team or Water Asset Management Team[3], as appropriate, to ensure compliance with the SAMP and AMP framework. Once the AMP has been approved, it will then be submitted to the AMLT for a concurrence vote.

GLWA recognizes that AMPs will be implemented and "owned" by the appropriate business unit. Approval by each business unit is inherent within the AMLT's concurrence vote due to

[3] Until these teams are established, the review and approval will be done by the Asset Management Plan Team

the Chief Operating Officer's membership on the AMLT. The approval process is summarized in Figure 6-2.

Figure 6-2: AMP Approval Process

GLWA recognizes that it is in its initial stage of its asset management journey. The development of AMPs should allow GLWA to have a better understanding of the resource needs for improvement initiatives, risk treatments, maintenance strategies, and capital investments, and the associated lifecycle benefits and costs. This improved understanding should inform business case evaluations or funding requests backed by AMPs as being of an inherently higher quality than those without this backing.

6.3.3 Updating Asset Management Plans

AMPs are living documents and a crucial reference for GLWA team members. AMPs will need continual updating because infrastructure will continue to age; customer expectations will evolve; assets, technology, and condition assessment techniques will continue to improve; and drivers such as regulations and the environment will continue to change.

Improvement Initiative M9

Strategic Maintenance and Reliability Program

As asset management becomes more mature at GLWA, more granular AMPs may be developed, and portions of the overarching AMPs (e.g., Water System AMP, Wastewater System AMP) may be superseded by these more granular AMPs. However, to ensure GLWA continues its asset management journey on a consistent and constant course, GLWA will publish updated AMPs no less frequently than every three years, subject to internal and external drivers.

A successful AMP facilitates GLWA team members in making defendable business cases, where there is full consideration of investment needs and an understanding of the risks of not funding the strategies. It should allow decisions to be made and should allow the impacts of these decisions (and the impacts they have on services to our member partners) to be evident to all layers of the organization. An AMP should inform the capital investment planning process as well as the capital outlay and operating budgeting discussions. Likewise, an AMP should be consulted and used during master planning efforts to better inform the current state of the assets and strategies being utilized. The AMP also needs to include updated improvement initiatives to assist in a continuous improvement process of maturing GLWA's asset management system.

6.3.4 Regulatory Requirements

The Michigan Department of Environment, Great Lakes, and Energy (EGLE), stipulates that water systems must submit an AMP. GLWA's National Pollution Discharge Elimination System (NPDES) permit also requires that a wastewater asset management program update be submitted annually, including the new permit requirement for sufficiency in staffing. In addition, the Michigan Infrastructure Council (MIC) and its Water Asset Management Council (WAMC) are currently developing more detailed asset management guidelines. AMPs should account for any regulatory changes and guidelines from the State.

6.3.5 ISO Requirements

Although GLWA does not plan to obtain International Standards Organization (ISO) 55001 certification in the near future, the AMPs it develops will generally conform to the requirements of ISO 55001 [2]. This will ensure that GLWA develops high-quality and realistic AMPs and will minimize the effort needed to prepare for an ISO audit should GLWA desire to pursue certification in the future.

6.3.6 Successful Implementation of AMPs

GLWA plans to invest in AMPs in order to help accomplish its asset management objectives, which in turn leads to improved compliance to service levels at a lower lifecycle cost. Upon completion of each AMP and implementation of its asset management activities, GLWA will be better able to achieve its asset management objectives.

Each subsequent AMP should show improvement in management of assets and outcomes. If AMPs are successful, GLWA should show progressive improvement in achieving asset management objectives, and as performance indicators are established, GLWA should show improvement in achieving targets.

GLWA can consider AMPs successful when:

- Through development of AMPs, team members are learning, the AMPs are being used, and they are living, useful documents
- GLWA can demonstrate improvement in achievement of service levels
- GLWA can demonstrate improvement in accomplishment of performance indicators
- GLWA can demonstrate responsible management of the grouping of assets covered in the AMP, including risk management
- GLWA can demonstrate decreased lifecycle cost of owning, operating, and maintaining assets; i.e., expectations of the grouping of assets are being met in the most effective and efficient manner

- GLWA can demonstrate that due regard is being given to the long-term stewardship of the grouping of assets covered in the AMP
- GLWA is making well-informed decisions on a daily basis and can develop defendable business cases
- GLWA can justify the near- and long-term funding requirements for the grouping of assets
- GLWA has confidence that regulatory compliance will be achieved in groupings of assets
- AMPs are widely understood and supported at GLWA, appropriate resources are available for their development, and AMPs form the basis for funding decisions for asset capital and O&M needs

6.4 Asset Risk Framework

Section 3.4 defines four types of risk addressed by GLWA; AMPs focus on asset risks, which are those arising from the group of assets addressed in the AMP. Such risks primarily occur after construction or acquisition and throughout the entire asset lifecycle. The risk framework described in Section 3.4 is the basis for identifying, analyzing, and treating asset risks, and should be followed in an AMP.

Improvement Initiative R8

Condition Assessment Program for Vertical

Improvement Initiative R7

Condition Assessment Program for Horizontal

6.4.1 Asset Risk Process

A process map for the activities associated with asset risk is attached in Appendix F. This diagram provides the process steps—including risk identification, risk analysis, and risk treatment—that are to be conducted as part of AMP development. The asset risk identification and risk analysis typically start at the facility level of the asset hierarchy and eventually apply to the equipment level of the hierarchy.

6.4.1.1 Risk Identification

For asset risk, the work of risk identification centers around understanding asset failure. This requires knowledge of GLWA service levels and an understanding of process and asset performance expectations required to support service levels. Failure should be defined for whichever level of the asset hierarchy the risk assessment is being conducted on. Asset failure should be considered to have occurred if the asset does not meet expectations considering the operating context.

6.4.1.2 Risk Analysis

Risk analysis involves developing a risk score based on the quantification of likelihood that an event will occur and the quantification of the consequences if the event occurs.

Risk Scoring. A risk score is determined by multiplying the likelihood of failure (LoF) times the consequence of failure (CoF).

$$\text{Risk Score} = \text{LoF} \times \text{CoF}$$

Where likelihood and consequence are both scored on a scale of 1 to 5, with 5 representing the highest likelihood or consequence and 1 the lowest likelihood or consequence. Thus, a score of 25 is the highest risk score possible and represents the most severe risk.

Likelihood Scoring. For asset risk, this score answers the question, "What is the likelihood the asset will fail?"

In order to ensure consistency of scoring for LoF, GLWA will use the GLWA Risk Likelihood Matrix (Appendix F), which consists of values for the frequency of occurrence.

There are several factors that may help predict asset likelihood of failure:

- Remaining useful life
- Performance
- History of reliability
- Physical condition
- Adherence to O&M strategy
- Other considerations

If good information is available for remaining useful life, then this would lead directly to the likelihood of failure score. However, remaining useful-life information is generally just an estimate and is not helpful in scoring likelihood of failure. Therefore, GLWA will apply one or more of the other factors. The factors to apply to the likelihood of failure determination are based directly on the type of assets in consideration.

Consequence Scoring. For asset risk, this score answers the question, "How bad will it be if the asset fails?"

In order to ensure consistency of scoring for CoF, GLWA has determined that seven categories of consequence will be applied and for each a score of 1 to 5 is selected. The CoF score equals the score for each of the categories multiplied by one-seventh and added together.

1. **Regulatory Compliance.** Relating to regulatory requirements, permit obligations, or enforcement actions.
2. **Impact to Service Levels.** Relating to GLWA's ability to achieve service level targets.

3. **Financial Impact.** Relating to requirements for GLWA funds or sources of funds.
4. **Health and Safety.** Relating to near- and long-term health or safety impacts on the public or GLWA team members not addressed in other categories.
5. **Public Impact.** Relating to community priorities, such as quality of life or aesthetics not addressed in other categories.
6. **Environmental Stewardship.** Relating to near- or long-term environmental impacts not addressed in other categories.
7. **Public Trust.** Relating to GLWA's image and the public confidence in GLWA

A generic CoF matrix for assets has been developed (Appendix F). If the descriptions in this matrix do not provide adequate information to score CoF, a version may be prepared for the specific grouping of assets. However, the following are not to be modified:

- Scoring of CoF (and LoF) is to be conducted using a scale of 1 to 5
- Scoring of CoF is to be conducted using the seven categories
- CoF categories are not to be weighted

6.4.1.3 Risk Treatment

Risks determined to be intolerable can be treated in one or a combination of ways:

- Remove the source of the risk (e.g., by eliminating a process)
- Transfer or share the risk (e.g., through outsourcing)
- Retain the risk possibly with increased monitoring
- Mitigate the risk through reduction in the likelihood or consequence of failure through such actions as:
    - Capital investment
    - Modification of O&M protocols, including maintenance strategies
    - Development/change in contingency plans
    - Other management strategies, such as improvement in work practices, procedures, and competencies

Application of a pre-determined asset renewal decision model or development of an individual Business Case Evaluation will lead to preferred alternatives regarding risk treatment. Risk treatment investments will be prioritized, along with other GLWA investment needs.

6.5 Asset Management Plan Outline

AMPs will generally be structured as shown in Table 6-2.

Table 6-2: Table of Contents for a Typical AMP

AMP Sections	
1.	Executive Summary
2.	Introduction
2.1	Purpose of the AMP
2.2	Structure of the AMP
2.3	Expectations for Use and Future Updates of the AMP
3.	Drivers for the Assets Covered in the AMP
3.1	Regulatory Requirements
3.2	Stakeholder Expectations
3.3	Service Levels and Performance Indicators
3.4	Future Demand
4.	Asset Profile
4.1	Asset Definition
4.2	Asset Hierarchy
4.3	Data Sources
4.4	Inventory
4.5	Condition
5.	Asset Risk
5.1	Data Sources
5.2	Consequence of Failure
5.3	Likelihood of Failure
5.4	Risk
5.5	Risk Tolerance and Introduction to Treatment Strategies
6.	Operations and Maintenance
6.1	Operational Strategies
6.2	Maintenance Strategies
7.	Renewal
7.1	Asset Renewal Planning
7.2	Asset Rehabilitation Strategies
7.3	Asset Replacement Strategies
7.4	Redundancy Strategies
8.	Other Risk Treatment Activities
8.1	Condition and Performance Monitoring
8.2	Contingency Planning
9.	Funding Needs
9.1	5-Year CIP and O&M Plan
9.2	20-Year CIP and O&M Plan
9.3	Long-Term Financial Plan
10.	Improvement Initiatives
10.1	Newly identified Asset Management Improvement Initiatives

	10.2	AMP Improvement Initiatives
		10.2.1 Decision-Making Tools
		10.2.2 Data Quality and Completeness
		10.2.3 Asset Management Technology
	10.3	Newly Identified Initiatives
	10.4	Resource Needs for Implementation of Initiatives
Appendices		
	A	Acronyms and Abbreviations
	B	Glossary
	C	Resources
	D	Funding Needs Plan

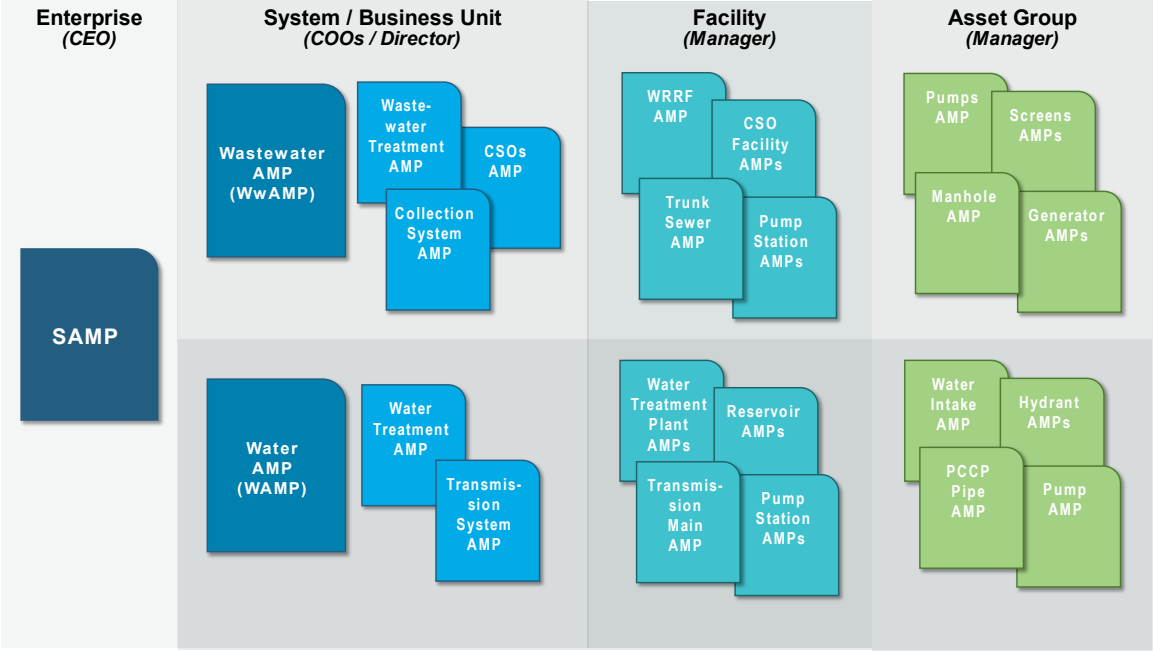
6.6 Recommended Asset Groupings

AMPs can be developed at different levels and complexity. AMPs conducted at a system level may be referred to as a "top-down" AMP. Top-down AMPs consist of broad assumptions and, subsequently, broad conclusions. Such an approach utilizes the 80/20 rule (obtain 80 percent of the benefits from the first 20 percent of effort) and can be used when there is a lack of precise data. It makes use of available, existing data, and staff experience and judgment.

AMPs conducted at a more granular level may be referred to as "bottom-up" AMPs. This type of AMP allows for more focused attention on smaller groups of assets. These AMPs can be helpful in developing maintenance strategies. It is particularly useful for a group of assets that are generally maintained in a similar way or that tend to fail in a similar manner. Bottom-up AMPs are more data-driven and provide opportunities for more hands-on ownership and deeper organizational engagement by team members who have direct responsibility for the assets covered by the AMP.

GLWA will initially conduct AMPs at the system level using the top-down approach. Future iterations will become more granular as shown in Figure 6-3. The header row in Figure 6-3 depicts the organizational level each of these documents represent, along with the corresponding Executive Sponsor. The system's Chief Operating Officer will determine if and when an asset group AMP may be needed. This AMP would focus on a similar type of asset used across different business units, such as a generator, or a type of pump.

Figure 6-3: Example of AMP Granularity



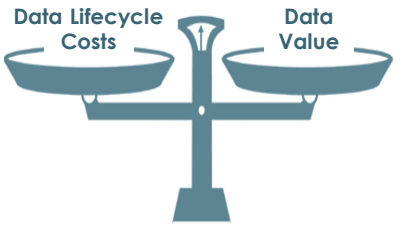
The first two AMPs developed at GLWA will be a Wastewater AMP (WwAMP) and a Water AMP (WAMP). The WwAMP will be started in early 2020 and the WAMP will be started in late 2020. These AMPs will include sections on each of the separate business units that make up each group, as depicted in Figure 6-3. The granularity of future iterations of AMPs will be determined after the initial AMPs are developed and as part of AMP Improvement Initiatives.

Improvement Initiative O1

Asset Management Plans

7 Asset Data and Asset Management Information Systems

7.1 Value of Data



Asset data and information drive asset management decision making. The value of the data is based upon the level of influence the data has over decisions; the more influential the data is over decisions, the more valuable the data. Improving the accuracy and completeness of asset data increases the confidence level in the resulting decisions made from the asset data. However, collecting, storing, and updating asset data require investments of time and effort; this is the lifecycle cost of data. An effective information strategy provides a means of balancing the value of the data against lifecycle costs.

7.1.1 Data and Information Strategy

Improvement Initiative D1

Asset Management Information Systems

A robust asset data and information strategy helps determine if the data to be captured is worth the time and effort it takes to collect and manage it. Like physical assets, data has a lifecycle cost. For data value to outweigh data lifecycle cost, data value can be maximized and data lifecycle costs minimized. The following methods, which should be included in a Data Standards document, can accomplish one or both of those objectives:

- **Capture the data at an opportune time.** Asset acquisition or installation is a good time to capture static information about the asset; asset maintenance data and any failure information will be captured as maintenance is performed.
- **Utilize an Asset Management Information System (AMIS).** An AMIS can be comprised of a Computerized Maintenance Management System (CMMS) or Enterprise Asset Management (EAM) system as well as a Geographic Information System (GIS) and other asset management-centric software systems. These systems make it easier to enter, retrieve, and analyze asset and related work management data. (See Section 7.4 for additional discussion on AMIS.)
- **Document and track the value of data.** Maintain a line of sight between the data and its value to the organization by tracking why data is valuable. This may be accomplished within an AMIS or as a separate online document. Periodic review should be performed as the value of data can change over time. For example, data that supports reports required by an Administrative Consent Order (ACO) may be less valuable after the ACO is terminated.

- **Standardize data formats.** Identify required and desired asset attributes to be included in the AMIS by asset class or by where the asset "sits" in the asset hierarchy. Table 7-1 lists the key attributes that should be attached to all assets.

Table 7-1: Key Asset Attributes

Key Data Type	Linear Asset	Vertical Asset
Identification	Unique ID	Unique ID
		Asset tag number
Asset Group	Asset class	Asset class
		Parent asset
Asset Status	Being used / available for use / unavailable for use / retired	Being used / available for use / unavailable for use / retired
Physical Description	Material	Asset name description
	Diameter or height / width	Manufacturer
	Slope (sanitary pipes)	Model number
	Pressure (water pipes)	In service date
	Manufacturer	Contract number
	In service date	
	Contract number	
Location	GIS location (X coordinate)	Physical location (facility, building, room, etc.)
	GIS location (Y coordinate)	
	GIS location (Z coordinate)	

As GLWA moves forward with acquiring new assets, performing condition assessments, completing asset audits, and determining asset risk, the key asset attributes listed in Table 7-2 should also be determined.

Improvement Initiative R6

Synchronized Asset Condition Scales

Table 7-2: Additional Asset Attributes

Key Data Type	Linear Asset	Vertical Asset
Risk	Consequence of failure	Consequence of failure
	Likelihood of failure	Likelihood of failure
	Risk of failure	Risk of Failure
Condition	Remaining useful life	Remaining useful life
	Assessment type	Assessment type
	Assessment date	Assessment date
Financial / Cost	Installation cost	Installation cost
Maintenance	Preventive maintenance (PM) history	PM history
	Predictive maintenance (PdM) history	PdM history
	Corrective maintenance (CM) history	CM History

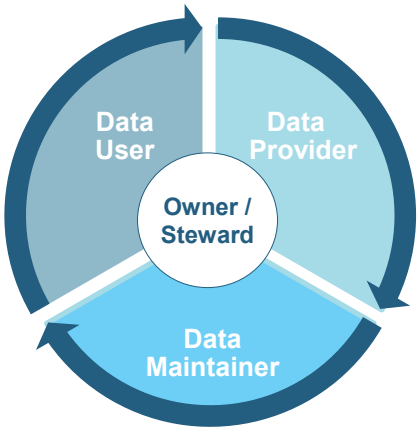
Key Data Type	Linear Asset	Vertical Asset
	In-place lining type	Warranty expiration
	In-place lining date	Rehabilitation date
Operational Information	Valve open direction	Run-time
	Valve number of turns	

Each business unit at GLWA, along with the AMP Development Team, may determine that additional asset attributes should be collected and maintained. Each business unit that owns data for the additional attributes should periodically determine what data is valuable and needed, and also evaluate the cost to maintain these additional attributes.

7.1.2 Data Roles and Responsibilities

GLWA team members should understand the importance of their role in creating and maintaining high-quality data to drive decisions by internal and external stakeholders. To ensure that data is viewed as an asset that needs to be maintained, specific roles and responsibilities must be established. These roles and responsibilities may be added to the duties of existing team members; however, time and resources need to be set aside for these roles to ensure that data (and data quality) are a priority. Figure 7-1 illustrates the broad categories of roles involved, and these roles are further explained below:

Figure 7-1: Data Roles



- **Owner/Steward.** Those responsible for defining the data and information required by a business process, including quality. The owner/steward is also responsible for supervision of information-related processes and functions and day-to-day improvements to data quality. The owner/steward will lead or be involved in asset data audits and asset tagging processes.

  Improvement Initiative D4
  Data Stewards

- **Data Provider.** Those responsible for providing data and information as a result of business and operational activities, including analysts, designers, field staff, and contractors.
- **Data Maintainer.** Those responsible for validating data and information submitted from field staff or contractors and updating the recorded information (such as drawings of record or asset data).

- **Data User.** Those using asset data and information for tactical, operational, and strategic purposes. Information users may be outside the organization, including regulatory agencies, other utilities, transportation agencies, partners, and suppliers.

The owner/steward role and the data maintainer role should be a distinct position in each business unit, and the responsibilities included in their position descriptions. However, the roles of data provider and data user may be shared by the same individual, depending on their day-to-day activities.

7.1.3 Data Quality

In order for GLWA to make decisions based on its data, team members need to have confidence in the quality of data. Categories of data quality that should be considered are as follows:

- **Accuracy.** The information is correct in all details and truly represents the asset. The data provider with the closest knowledge of the asset or attribute to be updated should be the one who requests and enters the information.
- **Completeness.** The asset information includes all of the key attribute values as intended for the particular asset class. The data maintainer should be reviewing asset data records and submitting requests for completeness.
- **Validity.** The data conforms to the established data standards. The data maintainer should review all submitted request for data standard conformity.
- **Consistency.** Asset information that is found in more than one information system is easily matched and is the same. There needs to be one information system of record for asset data that is carried through to other systems. In addition, there needs to be a unique identifier (such as an Asset ID) that is used to link data between systems.
- **Uniqueness.** There is a single representation for each asset. For example, there are not multiple records for the same asset. The data maintainer must ensure that there is only a single representation for each asset in the review of asset data and submitted requests.
- **Timeliness.** Data can be easily accessed and is up-to-date. The data maintainer needs to address submitted requests in a timely manner. If the submitted request is appropriate and meets standards, it should be processed and sent to the Data Owner for final approval as soon as possible.

For all data change or addition requests, the owner/steward needs to provide the final approval for making sure the process is followed and the data quality is improved. Review and approval need to be timely so that updates in the system can be viewed and used by the data users.

GLWA has been in the process of reviewing its current data and has been steadily improving data quality. However, this process needs to continue, and data standards need to be developed to ensure data quality in the future. To continue this, a formal asset audit process will be required as discussed below.

Improvement Initiative D7
Useful Lives of Assets

7.1.4 Quality Assurance

Quality assurance activities are a vital part of the work GLWA undertakes to monitor compliance with processes and data standards. ISO 9000 defines quality assurance as "part of quality management focused on providing confidence that quality requirements will be fulfilled" [21]. It is important that competent team members are identified who are able to undertake quality assurance activities and whose reporting lines minimize conflict of interests. Team members in the owner/steward role should focus on quality assurance activities. Assurance activities should include:

- Data audits (see Section 7.1.5)
- Ongoing measurement of data accuracy
- Reports on effectiveness on data update and onboarding processes

7.1.5 Audit Process

To ensure the consistency of data, GLWA should develop and maintain processes for improving data. This should include an audit process to ensure data quality. Audits may also include an annual audit to evaluate data accuracy. Audit processes also need to identify who is responsible for specific data audits and any necessary corrective actions.

Improvement Initiative D6
Asset Audit Program with Tagging Standards

An annual data auditing process should be established that incorporate the following key factors:

- Sample size should include enough assets and attributes to ensure that there is statistical significance in the results
- Selection of assets to audit should be random
- Auditors should be familiar with the asset classes being audited, but not necessarily with the specific assets themselves
- When data issues are found, auditors should try to determine the true root cause of the data issues and make recommendations to avoid future anomalies
- Asset tagging should be audited at the same time, including that the tag is physically present and the appropriate information is on the tag

7.2 Asset Definitions

Asset data strategies and the processes/programs that support them function best when there is a clear understanding of terminology. The terms are defined as follows.

- **Asset.** An item, thing, or entity that has potential or actual value to GLWA.[4]
- **Infrastructure Asset.** Assets that are physical items or groups of items that contribute to the production and delivery of GLWA's services, and because they meet certain criteria, must be tracked in an asset management information system. The term is used for items tracked in the AMIS. An infrastructure asset must meet at least one of these criteria: 1) has maintenance/work done upon it (or has the potential to have work done upon it; 2) has a CoF and LoF associated with it; and 3) has data collection/reporting requirements. Infrastructure assets exist in a hierarchical structure with each item in the structure being an infrastructure asset. Typically, the three criteria are applied at Level 6 - Installation or Level 7 - Equipment, of the asset hierarchy as described in Section 7.3, with higher levels existing to collect information from lower infrastructure assets in the hierarchy.
- **Maintenance Managed Item.** A subset of an infrastructure asset. For GLWA, these are typically at Level 7 – Equipment or Level 8 - Component, in the asset hierarchy, as described in Section 7.3. Maintenance managed items exist in the asset inventory, but not the asset register, and may include spare parts, small valves, and other items with low financial value that are run-to-failure without any maintenance.
- **Fixed (Capital) Asset.** A subset of an asset that has a financial definition/purpose. There is not a direct correlation between a fixed asset and an infrastructure asset. There can be many infrastructure assets to one fixed asset; likewise, there can be one infrastructure asset to many fixed assets. To be clear, an infrastructure asset may or may not also be a fixed asset.

All of the asset categories make up the **Asset Portfolio**. The assets in the portfolio selected to be managed under the umbrella of the asset management policy, principles, and practices will be included in the **Asset Register**, which unlike the asset portfolio, is a list of the assets that will be counted, tracked, and managed in an AMIS or agreed-upon system of record.

Improvement Initiative D5

Asset Register / Key Data Clean-up

[4] The definition of asset is an industry standard definition similar to those found in ISO 55000, IIMM, IAM, and ReliabilityWeb. While GLWA team members fit in this broad, high-level definition, they are considered asset management enablers, rather than assets.

7.3 Asset Hierarchy

An asset hierarchy is a representation of the relationship between assets contained in the asset register arranged as a family tree (i.e., in a parent-child format). The asset hierarchy provides context and organization to the asset register. When organizing an asset hierarchy, data can always be aggregated to higher levels from the lower levels

The key benefits of an asset hierarchy include:

- Ability to roll-up costs to higher levels in the hierarchy
- Ability to assess the impact of an asset failure on related assets
- Improved reporting capabilities (e.g., financial, performance, work order management)
- Improved decision making when data is captured at the appropriate level
- Consistency in identifying assets
- Ability to provide an overview of the system to assist in communication (staff training; stakeholder education)
- Ability to provide contractors and engineers a consistent protocol for supplying asset data to GLWA to be entered into the AMIS

Figure 7-2 depicts the GLWA asset management hierarchy, represented as parent-child relationship with examples.

Figure 7-2: Asset Hierarchy Examples

Level	Enterprise Asset Examples	Vertical Asset Examples	Linear Asset Examples
1. ENTERPRISE	GLWA	GLWA	GLWA
2. FUND	Water or Wastewater	Water System	Wastewater System
3. UNIT	Fleet & Field Services	Water Treatment	Conveyance
4. FACILITY	Construction Equipment	Lake Huron WTP	Detroit River Interceptor
5. PROCESS	Heavy Equipment	Low Lift Pumping	Sewer District
6. INSTALLATION	Skid Steer x	Pump Assembly 1	Pipe Segment
7. EQUIPMENT	--	Pump No. 1	Manhole, Level Sensor
8. COMPONENT	--	Impeller No. 1	Manhole Lid, SCADA Cabinet

7.3.1 Standards

Improvement Initiative D3

Consistent Data Standards

ISO 14224 (developed for the petroleum, petrochemical, and natural gas industries), provides useful guidance for asset hierarchies. A taxonomy is "a systematic classification of items into generic groups based on factors possibly common to several of the items (location, use, equipment subdivision, etc.)" [22]. The approach described therein is similar to the approach utilized by GLWA in the development of the data taxonomy depicted in Figure 7-2.

7.3.2 Major Considerations

As GLWA implements and applies the asset hierarchy, there are three major considerations to assist in identifying the level at which an asset will be added to an AMIS. Each of these major considerations will be described in more detail below.

1. Cost Collection
2. Risk
3. Data Tracking

Figure 7-3 provides the major use and considerations for each level of the asset hierarchy. These examples show how data and information can be rolled up and used at GLWA using the asset hierarchy.

Figure 7-3: GLWA Asset Taxonomy Represented as a Hierarchy

Level	Costs	Risk	Data
1. ENTERPRISE	Enterprise Budgeting	Enterprise Risk Management	Member Partner Agreement
2. FUND	Business Budgeting	Service Level Setting	--
3. UNIT	Business Unit Lifecycle Costs	Business Unit Utilization / Uptime	Business Unit Performance Metrics
4. FACILITY	Facility Life Cycle Costs	Facility Utilization / Uptime	Facility Drawings
5. PROCESS	Process Lifecycle Costs	Process Reliability	Process Design Capabilities
6. INSTALLATION	Renewal Costing	Typical Condition Assessments	Design Capabilities
7. EQUIPMENT	Historic O&M Expenditures	Reliability Modeling	Serial Numbers, Performance Data
8. COMPONENT	Detailed Spares and Operating Expenses	High LoF Tracking	Detailed Purchasing and Vendor Tracking

7.3.2.1 Cost Collection

Improvement Initiative D10

Asset Costing Improvements

Full asset costing refers to the ability to understand all the costs associated with ownership of the asset. It is an important goal with asset management because this information allows well-informed decisions to be made regarding asset maintenance strategies as well as asset renewal, rehabilitation, and retirement. The AMIS (in particular the EAM) serves an important purpose in collecting costs via work order tracking, but this can only be done if the assets are in the AMIS and work orders are written against them. Having knowledge of the costs needed to operate and maintain an Infrastructure Asset allows decisions to be made about how to best take care of the asset and how much budget should be allocated.

7.3.2.2 Risk

Maintenance and condition assessment tasks performed as a risk treatment generate asset information. Maintenance reduces the likelihood of asset failure, therefore decreasing the risk associated with the asset. Condition assessments provide a more accurate determination of the likelihood of failure, allowing decisions to be made to address the resultant risk. Likewise, the location of an asset, either geo-spatially or in a specific process, provides information that drives the consequence of failure and again helps to direct how to address the resulting risk. Knowing that an asset has a moderate risk can allow an organization to decide to accept this risk. Accepting risk allows an organization to focus its attention toward higher-risk assets. The decision to accept a risk should be documented and used to inform future decisions to repair or replace that asset. The ability to understand risk to an installation or component level is a hallmark of mature asset management. As such, this consideration will have more weighting as GLWA's asset management program advances.

7.3.2.3 Data Tracking

Improvement Initiative M2

Formalized Work Management Policy

An AMIS can be used to capture and track data on each asset. Data could include make, model and specification data as well as supervisory control and data acquisition (SCADA) systems, work history, or other more detailed fields.

As described in the beginning of this section, the granularity level of asset information must balance with the cost of capturing and storing the information. Considerations regarding using data and information for making decisions include how costs (via work orders) will be collected, how risk is managed, and what data should be recorded. Table 7-3 shows at which level in the asset hierarchy data should typically be captured.

Table 7-3: Where to Capture Asset Data in the Asset Hierarchy

Level	Description	Costs	Risk	Data
1	Enterprise	—	—	—
2	Fund	—	—	—
3	Unit	—	—	—
4	Facility	—	—	—
5	Process	—	Capture data	Capture data
6	Installation	Capture data	Capture data	Capture data
7	Equipment	Capture data	Capture data [2]	Capture data
8	Component	Capture data [1]	Capture data [2]	Capture data [3]

Notes:

1. The collection of this information must create more value than the cost of collecting and storing the information.
2. The risk of the asset failing at this level must be enough to warrant capturing evidence that the appropriate risk treatment has been applied.
3. The asset must be able to be uniquely identified.

Improvement Initiative M3

Improved Planning and Scheduling Function

Table 7-3 shows that infrastructure records should be created at Level 6 and lower on the hierarchy. However, GLWA plans to record infrastructure assets at Level 6 for lower cost, lower-risk, or more indistinguishable assets. Larger, riskier, or distinguishable assets will be recorded at Level 7 or potentially lower depending on the value of managing these more granular assets. For situations where there are compelling reasons to track infrastructure assets at more granular levels, the governance decision will rest with the AMLT.

7.3.3 Asset Hierarchy Implementation

Improvement Initiative D2

Asset Hierarchy

To obtain the maximum value from the asset data, the asset hierarchy will be incorporated into the AMIS. Integration into the EAM and GIS enables the impact of an asset failure on related assets to be cascaded down the hierarchy. For example, the integration of the hierarchy into the EAM system could allow GLWA to quickly identify the equipment affected by the failure of a related asset (such as a motor control center) and to determine the lifecycle costs of a specific process by rolling up work order costs to that process. Similarly, the integration of the asset hierarchy into GIS could allow GLWA to quickly identify the distribution mains affected by the failure of a transmission main, and the costs associated with water main breaks could be rolled up to identify the total cost associated with a geographical area.

GLWA recognizes that the success of an asset hierarchy is a direct result of constant and ongoing maintenance and improvement. GLWA recognizes that this will have costs and will assign team member time and effort to maintain this vital data structure.

7.4 Asset Management Information Systems

Many infrastructure-intensive organizations have made significant investments in asset management information systems and data capture to assist in managing their assets with improved efficiency and performance. The procurement of software tools, coupled with the optimization of data capture and information analysis processes, can provide timely, accurate, and useful asset information. As an organization's asset management practices mature, the data to support asset management becomes more complex and often requires multiple software tools to realize the benefits of using asset information to inform business decisions.

New and emerging technologies enable access to asset knowledge and information that was previously unavailable or too difficult and time-consuming to mine from legacy systems. Additionally, new and emerging technology systems offer the potential to interface and integrate across software platforms to gain a more holistic view of the organization and to better leverage data to inform decision-making processes.

Improvement Initiative D9

Asset Management Information System Training Curriculum

How different software tools are configured and integrated, coupled with the information processes implemented to ensure asset management objectives are supported, describes the AMIS. An AMIS can enable asset management practitioners to better manage asset data. However, a lack of standardized workflows and underutilization of software tools are common challenges for many utilities, including GLWA.

7.4.1 Current Information Systems

Figure 7-4 depicts the current enterprise asset management and other information systems that support asset management at GLWA, which are listed in Table 7-4. These information systems support asset management-oriented work and either have a direct role in asset management at GLWA or have an indirect role while implementing business processes that generate data that inform asset management decisions. This is not a complete list of all information systems within GLWA, only those involved in asset management.

Figure 7-4: Current Information Systems

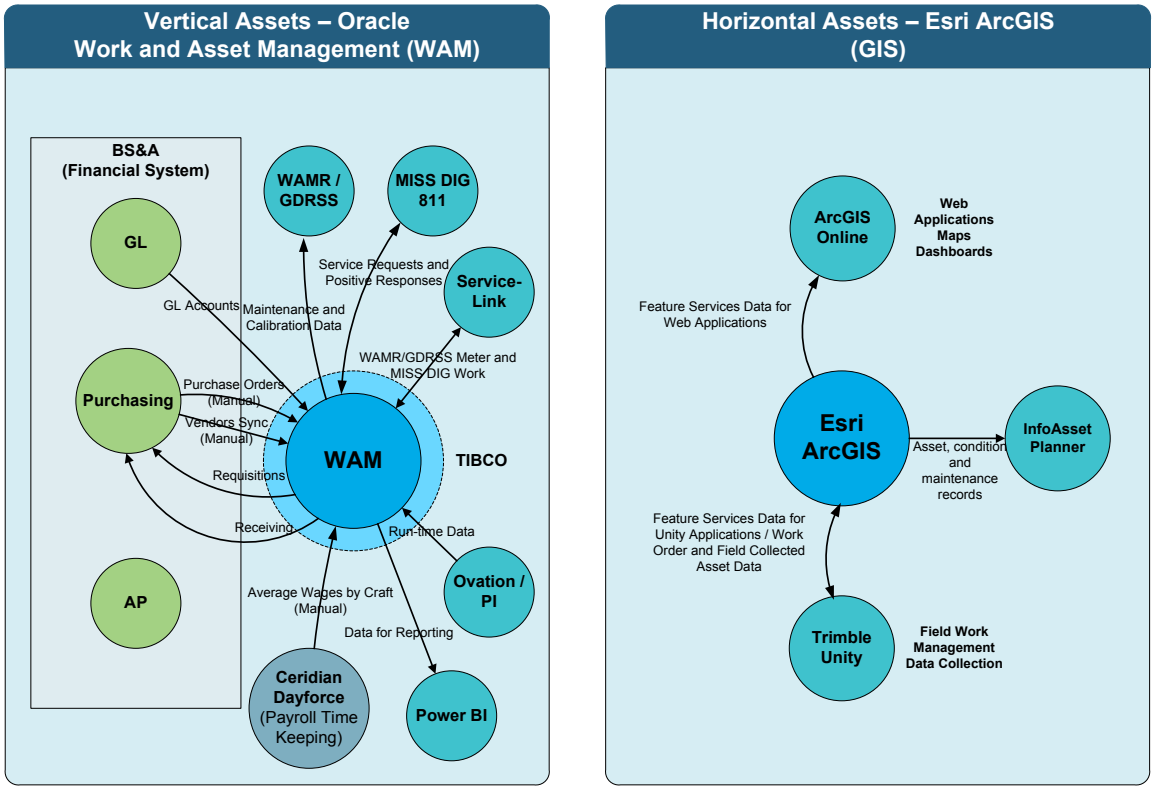


Table 7-4: Current Asset Management and Supporting Information Systems

Information System	Primary Function
Oracle Work and Asset Management (WAM)	Current enterprise asset management (EAM) and computerized maintenance management system (CMMS)
TIBCO Integrator	Integration application suite to support GLWA business needs between asset management-related applications
Service-Link	Mobile workforce application used for master meter (WAMR and GDRSS) and MISS DIG locate work order completion
Greater Detroit Regional Sewer System (GDRSS)	Sewer meter database and web portal
Wholesale Automated Meter Reading (WAMR)	Master water meter database and web portal
MISS DIG 811	Michigan's 811 system for utility locates
Esri ArcGIS	GLWA's horizontal asset system of record and includes ArcGIS Online with web applications, maps and dashboards
Trimble Unity	Mobile suite of applications used for field work management (captures labor hours and work order costs), GIS and data gathering, and improving the use of GIS and related horizontal asset information in the field
Innovyze InfoAsset Planner	ArcGIS Desktop add-in for horizontal sewer and water transmission data and risk analytics and decision-making processes
Microsoft Power BI	Business intelligence tool for analytics and reporting using data from various applications

Information System	Primary Function
Oracle Business Intelligence (BI)	Business intelligence tool for analytics and reporting using data specific to Oracle WAM
Ovation	Process control system and database for water and wastewater treatment and conveyance operations
OSISoft PI	Operational intelligence platform that captures Ovation data for reporting and analyses within PI and to interface the information to other systems (e.g., Power BI, GIS, and WAM)
AquaSight	Water resource recovery facility process optimization platform
Hyland OnBase	An electronic document management system
Microsoft SharePoint	Cloud-based content management system and collaboration platform
Smartsheet	Cloud-based database platform used for a variety of data and information collection, sharing and tracking purposes
Ceridian Dayforce	Human resources management system for averaged wage rates for labor costing and team members details in EAM
BS&A	GLWA's primary financial and accounting system of record
Bigtime	Timesheet and time data entry tool for DWSD shared services
SDS Pro	Web-based safety data sheet access
Capturis	GLWA's utility billing platform
Cornerstone	GLWA's learning management system

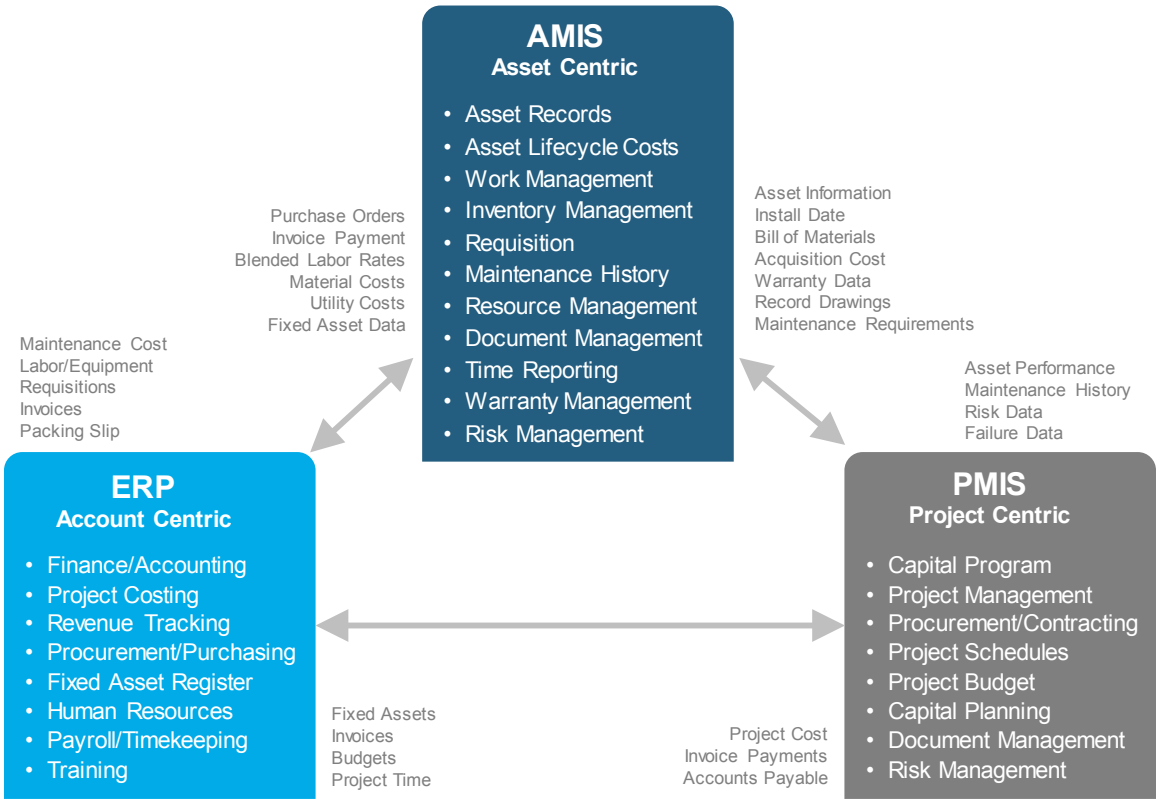
7.4.2 Future Information Systems

GLWA is in the process of updating and replacing a number key asset management-oriented systems. These systems include the Enterprise Asset Management (EAM) system, Enterprise Resource Planning (ERP) system, and Project Management Information System (PMIS).

- **EAM.** The Enterprise Asset Management system is an asset management information system used to manage the maintenance of physical assets throughout each asset's lifecycle, including the planning, optimizing, executing, and tracking of the maintenance activities with the associated priorities, skills, materials, equipment, and information.
- **ERP.** The Enterprise Resource Planning system is an integrated information management system consisting of core business processes and software, often in real-time, to support financial, legal, procurement, and human resource functions.
- **PMIS.** The Project Management Information System is a centralized tool for monitoring and evaluating the physical, financial and outcome parameters of the capital program and associated projects under a defined governance framework.

The key functions of each enterprise system and the typical data that are interfaced between systems are outlined in Figure 7-5. In simple terms, the ERP is the financial and HR system that is generally an 'account centric' tool (financial account, client account, people account), an EAM is an 'asset centric' tool, and a PMIS is a 'project centric' tool.

Figure 7-5: Key Enterprise Systems Diagram



The EAM is an essential and central component of the AMIS portfolio. Additional systems and applications will be implemented, as needed, as part of the future strategy to support the asset management objectives at GLWA. Examples include improved GIS data, services, and applications for horizontal assets; business intelligence and analytics platforms; asset portfolio decision-support and optimization; and asset performance management systems. Interfaces between these three core and additional supporting systems will be developed on an on-going, as-needed basis and as part of the overall asset management information system strategy and implementation plan.

7.4.3 Decision Support Tools

Improvement Initiative D8

Failure Codes and Work Order Types

As GLWA's asset management matures, additional decision-support software tools can help to achieve the vision of the asset management program. These tools will not replace GLWA's current systems, but can provide better access and analysis of existing data. These tools can help to mine the data in GLWA's existing systems and provide advanced algorithms for data analytics.

These decision-support tools may include systems that deliver lifecycle cost analysis, failure analytics, predictive maintenance trending, condition monitoring tools, risk determination

and modeling tools, asset performance tracking, business case evaluations, and asset decay modeling. Table 7-5 provides additional information on these types of tools that GLWA should evaluate in the future.

Table 7-5: Decision Support Tools

Decision Support Application/Tool	Purpose	Benefit
Asset & Maintenance Management Assessment Tools	Quickly review an organizations alignment to asset management principles, capture where progress has been achieved and develop new improvement initiatives	Provides a quick assessment of asset management alignment and guidance for annual planning and AMP development.
Asset Condition & Performance Monitoring Systems	Stores and analyzes asset condition and performance on all types of assets. Ability to include static and real-time information.	Tracks asset condition and performance. Some tools also have the ability to estimate remaining useful life based on standardized criteria using condition and performance data.
Asset Lifecycle Cost / Decay Model	Determines the remaining asset life based on standardized decay models. Also incorporates asset installation, operation and maintenance data to calculate the asset lifecycle cost.	Provides a standard approach to determine remaining useful life of an asset based on existing data, along with the lifecycle cost for that asset.
Asset Replacement Model	Models calculated risk score of an asset based on its age and annualized maintenance spending	Optimizes capital replacement prioritization, including asset replacement schedule
Asset Risk Model	Increases the efficiency of data gathering and improves the detailed asset risk calculation, analysis, and prioritization.	Utilizes and analyzes existing data to provide a more robust and real-time risk scoring and prioritization method.
Business Case Evaluation Tool (could be part of a Project Management Information System)	Evaluates projects on the basis of capital and lifecycle costs	Optimizes the prioritization of projects utilizing existing data from other systems.
Capital Planning Tool (could be part of a Project Management Information System)	Provides systematic, objective way to identify the capital projects across multiple asset classes that provide the greatest value in addressing priority goals for the utility.	Helps to identify the highest priority projects that should be funded immediately as well as capital planning time frames. Ability to run multiple capital improvement scenarios to determine the long-term effect on budget, risk and service levels.
Enterprise Risk Analysis Tool	Assesses enterprise risk for an organization and tracks the risk in a centralized location.	Documents the enterprise risk associated with the operation of a utility
Preventative Maintenance Optimization Tool	Mines PM data to be able to easily view and effectively optimize PM tasks	Optimized PM work orders to remove unnecessary PMs and focus maintenance efforts on critical assets

Decision Support Application/Tool	Purpose	Benefit
Reliability Analytics Tool	Supports reliability functions such as failure analysis, RCM or FMEA; uses existing data from the EAM to provide more detailed analytics.	Provides a more detailed analysis of existing maintenance and reliability data. Some tools can assist in implementing recommended changes from an RCM, FMEA or similar type of analysis.

7.5 Reporting Needs

The ultimate purpose of utilizing an AMIS to collect and maintain data is to be able to inform decisions based on information derived from available data. Accurate and timely data is needed to drive information availability and decision making. Information is needed to better understand and optimize asset performance including operations, maintenance, and lifecycle (repair and renewal) decisions. The primary route for utilizing data for these asset management information systems is the use of reports, either directly in the system or from third-party reporting tools. At GLWA, there are three primary types of reports: standard reports, custom or ad-hoc reports, and key performance indicator (KPI) or performance indicator (PI) reports.

Currently at GLWA, asset management reports are primarily developed through the WAM reporting and business intelligence functionality. Other systems, such as with GIS and Service-Link, have some reporting capabilities focused around spatial and field-collected data. However, due to the lack of integrations and interfaces with other key technology systems (e.g., Ovation, PI, etc.), these reports are sometimes limited. Microsoft Power BI has recently been utilized to pull data from different systems and sources to present more useful reports and dashboards. The development of holistic reports and near-real-time dashboards that provide GLWA team members with actionable information across various systems is key to making well-informed and timely decisions.

7.5.1 Future Reporting Requirements

Reporting and dashboard requirements must meet the needs of team members across GLWA. Future improvements may include a new EAM, other key enterprise systems, and the continued use and expansion of Power BI. To deliver useful reports and dashboards, GLWA team members must be able to clearly describe the requested report's purpose, metrics, filters, and logic. Reports and dashboards should be implemented and provided to the widest audience possible to maximize benefit to the organization.

Continual improvement through team member feedback is critical to the process of developing and improving valuable reports or dashboards. Having reporting and dashboard champions within the business areas will effect positive change and forward progress through measurement and tracking of asset performance and service levels.

Effective reporting and dashboards can deliver the following benefits to GLWA:

- Bring data quality issues to the surface
- Manage asset lifecycle maintenance, operation, and renewal costs and strategies
- Improve asset performance and failure identification
- Track metrics for increased team member productivity and utilization
- Automate and deliver PI and KPIs from data sources without manual effort
- Inform leadership of areas of excellence and improvement opportunity
- Provide the ability to drill into dashboard results to see what is driving the numbers

The requirements for future reports must be able to handle the following:

1. Multiple system data interfaces
    a. **Standard/Canned Reports.** Basic reports that are prefabricated and come with the system; they address general data needs common across organizations that purchase the system. These reports will generally have some simple visual aspects (e.g., pie charts, bar charts, etc.).
    b. **Custom Report Building.** For system power users with more specific data needs. These are essentially drag-and-drop grid report building, where users can add specific data fields and add multiple filters on different data fields to generate a desired dataset. Users can save created custom reports and schedule data refresh and emailing.
    c. **Power BI Integration.** Connects Power BI directly to a system database for analysis without having to warehouse data in separate database for reporting.
    d. **Developer/BI Analyst Data Interface.** Preferably a Web application programming interface (API) configured to access all system data. This could also be direct database access, but that becomes more problematic (if not impossible) when the system is cloud based without dedicated static server resources due to replication of data across many instances. This is why most mature cloud-based software systems come with a comprehensive API either out of the box or available for purchase.
2. Integration with low-level asset process data
    a. Prebuilt (out of the box or for purchase; not custom) integration with OSIsoft's PI product or direct integration/data feed with Ovation/waterfall.
    b. Capability for GLWA to work with vendor to build custom data feed so low-level asset process data can be incorporated into the system.

3. Service level and KPI / PI support
    a. Capability of asset data that rolls up to the associated reports on PIs, KPIs and service levels.
    b. Service level dashboard that easily shows the status of existing service levels and how the actual data is trending against the target established.
    c. KPI reports for the GLWA Board and Executive Leadership Team that can be quickly run and updated. These reports should be developed to require minimal input from users to generate.
    d. PI reports for management of specific business units. Like KPI reports, these reports should require minimal input from users to generate. These reports should ultimately be displayed in a dashboard for managers and other team members to quickly see these indicators.
4. Interactive dashboards
    a. Maintenance metrics
    b. Asset performance
    c. Asset condition
    d. Map-based
    e. Failure trends
    f. Data quality auditing
5. State of the asset report
    a. Report that rolls up business unit and asset class data to have an overall accounting of GLWA's assets on an annual or semi-annual basis
    b. Report would include a rolled-up condition grade, performance, maintenance trends, and potential future renewal projection and costs

Improvement Initiative G6

State of the Assets Reports

7.5.2 Data Marts or Warehouses

To more efficiently deliver reports across asset management information systems and other supporting systems, a strategy to create data marts or warehouses should be considered. Having data marts built for reporting of categories of data (e.g., asset, maintenance, operations, finance, etc.) with a common identifier between them is useful in preparing and bringing the data together into reports and dashboards. The incremental data mart approach and establishment of relationships (unique common identifier) between data from disparate systems, with the help of subject matter experts from various business units,

will facilitate the eventual implementation of an enterprise data warehouse. Additional items to consider for data organization for reporting include:

Time series data vs. static data. Time series data captures system operations changes over distinct time steps. This information (e.g., equipment status, vibration, temperature, pressure, etc.) is common within water sector utilities. Storing and organizing this type of data compared to static data, such as asset or maintenance data, takes additional planning and implementation to allow for responsive access as the size and quality of the data can complicate its application for information and decision-making purposes.

Due to the sampling rates necessary to gain meaningful insights into operational process data and the volume of data this produces, GLWA is exploring the deployment of a database product that specializes in storing this type of time series data. GLWA may also explore front end tools specifically designed for consuming and visualizing time series and spatial data. Depending on the data translation and metrics needed for transforming raw data into decision supporting information, GLWA will continue to support the expansion of scripting, decision trees, machine learning, and artificial intelligence toolsets.

ETL processes. Extract, Transform, Load (ETL) processes and tools are critical aspects of establishing reliable reporting sources due to the necessity of refreshing data from multiple sources at agreed upon intervals. Different ETL tools may be better suited for certain ETL processes depending on several factors including source format, volume, refresh rate, and transformation.

Power BI for ad-hoc reports and dashboards. The need for creating ad-hoc reports and dashboards to support asset management exists within the GLWA organization. Strategic allocation of Power BI Pro licenses to "power users" within GLWA will meet this need by allowing them read access to relevant data marts and the ability to publish reports created to either the Power BI Web application (viewable to others with Pro licenses) or the Power BI Report Sever (in a designated area for ad-hoc reporting).

Power BI Report Server for formal reports, dashboards, and KPIs. Publishing reports, dashboards, and KPIs to the Power BI Report Server instance provides a venue for formal reporting for asset management purposes. An additional level of rigor and review is put into report development and quality control to ensure that they are accurate and meet the needs of a wider audience. Access to reports, dashboard, and KPIs published to the report server is governed with permissions and access can be restricted to a desired audience at the group or user level. An area can be designated for ad-hoc reports created by power users from different business areas to keep them separate from formal reports, dashboards, and KPIs.

Other tools. Other databases, platforms and programming toolsets (e.g., Insights for ArcGIS, Python, DAX, machine learning, artificial intelligence, etc.) may be used to deliver needed information and insights.

8 Asset Management Enablers

For asset management principles and practices to be successfully and sustainably ingrained in how GLWA does business, how its team members make decisions, and how they perform their day-to-day work, the purpose of asset management and its benefits must be understood and promoted. Further, asset management activities must be consistent and coordinated throughout the Authority. Team members must also have the knowledge, skills and willingness to adopt new methods of executing their work. The organizational practices and frameworks that GLWA uses to support the adoption and effective implementation of asset management are the asset management enablers described in this section.

8.1 Asset Management Governance

Asset management governance ensures that the roles and responsibilities for enterprise-wide asset management activities are clear and followed in a way that allows for continual improvement and articulates the roles and responsibilities of the teams and team members who are responsible for developing and sustaining asset management at GLWA. The key roles and responsibilities include:

Attributes of "Good Governance"

The following are characteristics of an effective governance structure.

- Adherence to Policy
- Transparency
- Responsiveness
- Consensus Orientation
- Effectiveness and Efficiency
- Accountability
- Engagement
- Data-Driven
- Consistent and Predictable

- Developing the asset management policy and procedures
- Continuously monitoring the proper implementation of asset management policy and procedures
- Keeping the SAMP and AMPs up to date
- Ensuring compliance with the Asset Management Policy, SAMP, AMPs and their principles
- Driving continuous improvement to GLWA's asset management capabilities in part by ensuring delivery of approved improvement initiatives

8.1.1 Principles and Benefits of Governance

Governance is the process of making and implementing decisions using a defined and agreed-upon framework of structures, authorities, roles, and responsibilities to ensure GLWA obtains the best value from its assets. Governance drives organizational and functional coordination, communication, and decision-making. The governance framework may include both teams and sub-committees, as well as individual positions. Governance can have a direct impact on organizational culture. For example, if governing bodies behave

in a collaborative manner, staff are more likely to do the same. Similarly, if governing bodies ask challenging questions and are comfortable with conflict, staff also learn to be comfortable with posing challenging questions. Effective governance is particularly important with asset management because of the need to consider the interests of multiple stakeholders. It is necessary to positively manage business process change across the organization while still insisting upon a consistent application of principles. Collaboration among many parts of GLWA is necessary, along with astute mentoring and continuous improvement. With the proper governance and leadership, a culture of innovation and continual improvement can be developed, allowing team members to daylight issues and make suggestions without fear of reprisal.

Through the implementation of its asset management governance structure, GLWA is seeking to achieve the following benefits:

- **Effective Collaboration.** Asset management processes and practices are considered, designed, and implemented with informed participation from groups and individuals throughout the organization.
- **Consistency.** Agreed-upon asset management messages, principles, and frameworks are relevant and consistently applied throughout the organization.
- **Alignment.** The asset management system, including ongoing decision-making, is aligned to organizational goals, the asset management vision and mission, as well as its brand pillars to ensure asset management work ongoingly helps GLWA to achieve its organizational purpose.
- **Availability and Efficient Use of Resources.** GLWA has the tools, financial, and human resources it needs to effectively and efficiently deliver its commitments.
- **Capabilities Improvement.** The organization and its team members steadily learn and develop the capabilities necessary to implement its asset management goals.
- **Compliance.** The organization continuously complies with its own set policies, as well as those required by regulators and other legal bodies.
- **Ability to Influence Change.** Team members become adept at making work process changes that achieve common goals, with a minimum of disruption.
- **Sustainability and Relevance of SAMP and AMPs.** The SAMP and AMPs are updated and remain meaningful and applicable to operations, serving as guides to team members in their daily work.

8.1.2 GLWA Governance

A foundational principle of an effective asset management governance is that it is not seen as a separate entity from the organization's overall governance structure. Asset management

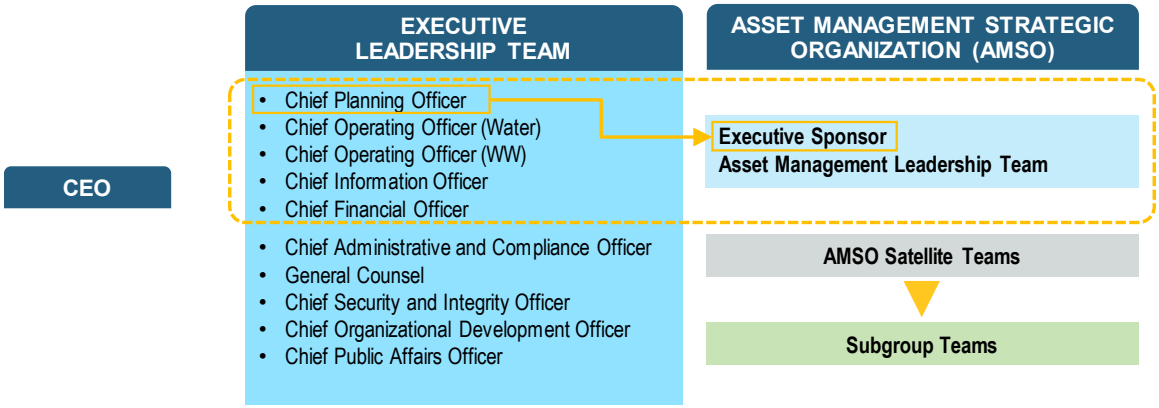
Improvement Initiative G2

Embedded Asset Management Governance

governance, in other words, is embedded into the organization—at the leadership, management, and operational levels.

As shown in Figure 8-1, members of the ELT serve as ongoing members of the AMLT, with the Chief Planning Officer serving as the executive sponsor of the AMLT. This ensures that asset management planning decisions made within the organization are imbued with the authority required to move policy to action. Members of the ELT have also served as executive sponsors of the six teams responsible for developing this SAMP, again assuring that strategies contained herein are informed by organizational policy and represent the intent of the organization to implement them.

Figure 8-1: GLWA Alignment to Asset Management Strategic Organization (AMSO)



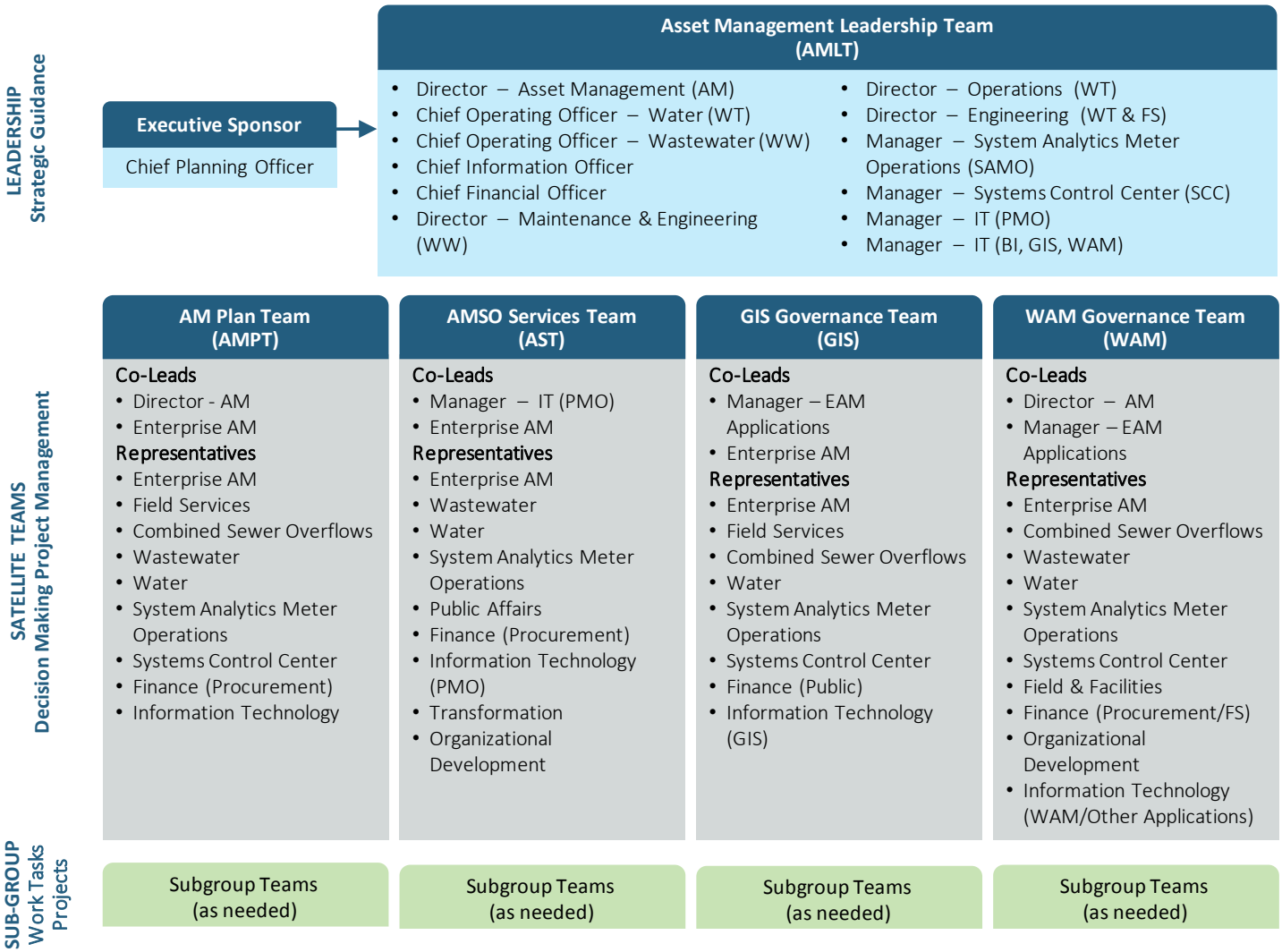
8.1.3 AMSO Structure

Governance at GLWA comprises cross functional teams organized under the AMSO team. Since its formation in late 2016, the AMSO team has provided a strong foundation for the Authority's asset management journey. It consists of individuals and teams that have been central to the progress of asset management within GLWA, to date. Its objectives are to assist both the enterprise and local asset management teams in developing programs to effectively manage assets, including the development of:

- The SAMP and related guidance documents
- Consistent processes and procedures for managing assets
- Standards and best practices in asset management
- Business process training, change management, and communications
- System and data application governance for WAM and GIS

The AMSO team currently consists of the AMLT and four standing satellite teams as shown in Figure 8-2, as well as numerous subgroup teams to support specific tasks. Note that the AMSO did not add resources to the organization as a whole. Members have participated at their own discretion, but typically are not specifically assigned duties related to AMSO.

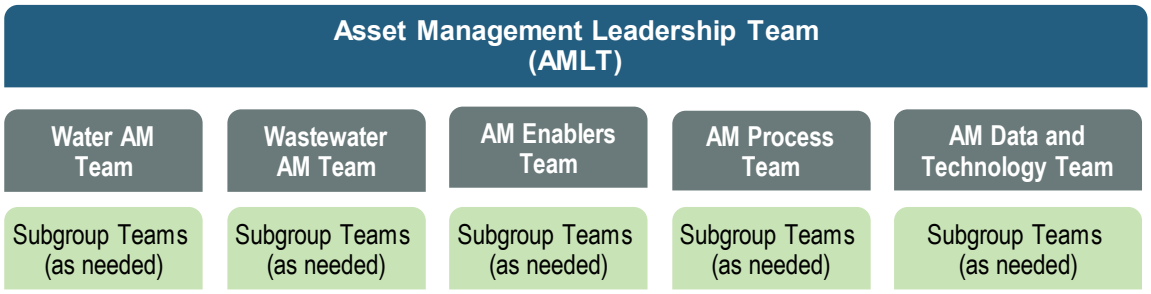
Figure 8-2: Current AMSO Structure



The AMSO team is specifically designed to provide GLWA's asset management efforts with consistency of purpose and resources, but still able to adjust its team membership and deliverable accountabilities based upon emerging asset management needs. Accordingly, in 2019, a modification to the AMSO framework is intended to further focus AMSO accountabilities and oversight of outcomes for asset management practices across the organization, especially as they relate to the AMPs. The revised AMSO structure and areas of responsibility are described in Figure 8-3.

Improvement Initiative G1
AMSO Team Coordination

Figure 8-3: Revised AMSO Structure



As shown in the figure, the original four satellite teams that comprised the AMSO team are being reconstituted to five satellite teams, with changes in their roles and responsibilities with greater authority and accountabilities. The former Asset Management Plan Team will be divided into two, the Water Asset Management Team and the Wastewater Asset Management Team. These teams will be chartered to have quarterly combined meetings to avoid silos. The AMSO Services Team will be reconstituted into two teams: Asset Management Enablers and Asset Management Process. The WAM and GIS Governance Teams will be combined into an Asset Management Data and Technology team. These five teams will report directly to the AMLT. As needed, the AMSO will form temporary, ad-hoc subgroup teams to deal with specific projects and issues as they arise and need concerted focus for resolution. At the time of their formation, the teams will be chartered to clarify the roles of each under a common AMSO vision and goals.

8.1.4 Asset Management Roles and Responsibilities

As previously stated, governance not only addresses executive and functional oversight, but also must drive cross-functional tasks to ensure consistency of practice across work groups.

Improvement Initiative P1

Dedicated Asset Management Team Members within Business Units

The Institute of Asset Management (IAM) and the Global Forum on Maintenance & Asset Management (GFMAM) organizes asset management into six subject groups, together having 39 asset management subjects. These subjects are intended to show what kinds of activities are required by an organization's entire asset management system. Understanding which department or group within GLWA is responsible for each of the asset management subjects not only demonstrates the Authority's commitment to operationalizing all the responsibilities associated with asset management, but also assigns a primary area of responsibility to ensure that the practices are being applied consistently and in line with asset management policy, vision, objectives, and frameworks.

Table 8-1 is adopted from the IAM's Asset Management – An Anatomy Alignment of the 39 Asset Management Landscape Subjects with the six subject groups [1]. It shows where the primary responsibility for each of the 39 asset management subjects will ultimately lie within GLWA upon full maturity of asset management planning practices. The

organizational transition to these areas of responsibly will be managed by the AMSO team, which will provide guidance for assigning responsibility of asset management subjects to a sub-team or a business unit as appropriate.

Table 8-1: AMSO Alignment to Asset Management Accountabilities

Subject	Responsible AMSO Team
Group 1 – Strategy and Planning	
Asset Management Policy	AMLT
Asset Management Strategy/Objectives	AMLT
Demand Analysis	W/WW AMTs
Strategic Planning	AMLT
Asset Management Planning	W/WW AMTs
Group 2 – Asset Management Decision Making	
Capital Investment Decisions	W/WW AMTs
Operations and Maintenance	W/WW AMTs
Lifecycle Value Realization	W/WW AMTs
Resource Strategy	AMLT
Shutdown/Outages Strategy	Asset Management Processes
Group 3 – Lifecycle Delivery	
Tech Standards and Legislations	W/WW AMTs
Asset Creation and Acquisition	W/WW AMTs
Systems Engineering	W/WW AMTs
Configuration Management	W/WW AMTs
Maintenance Delivery	W/WW AMTs
Reliability Engineering	W/WW AMTs
Asset Operations	W/WW AMTs
Resource Management	W/WW AMTs
Shutdown/Outage Management	W/WW AMTs
Fault and Incident Response	W/WW AMTs
Asset Decommissioning and Disposal	W/WW AMTs
Group 4 – Asset Information	
Asset Info Strategy	Data and Technology Team
Asset Info Standards	Data and Technology Team
Asset Info Systems	Data and Technology Team
Asset Info Management	Data and Technology Team
Group 5 – Organization and People	
Procurement and Supply Chain Management	Asset Management Processes
Asset Management Leadership	AMLT
Organization Structure	AMLT
Organization Culture	Asset Management Enablers
Competence Management	Asset Management Enablers

Subject	Responsible AMSO Team
Group 6 – Risk and Review	
Risk Assessment	W/WW AMTs
Risk Management	AMLT
Contingency Planning and Resilience Analysis	W/WW AMTs
Sustainable Development	Asset Management Enablers
Management of Change	Asset Management Enablers
Asset Performance and Health Monitoring	W/WW AMTs
Asset Management System Monitoring	AMLT
Management Review, Audit & Assurance	Asset Management Processes
Asset Costing/Valuation	Asset Management Processes
Stakeholder Engagement	Asset Management Enablers

8.2 Asset Management Competencies and Learning and Development

Improvement Initiative P4

Asset Management Competencies, Learning, and Development

Effective and sustainable asset management requires ever-evolving organizational proficiency in a wide range of disciplines including engineering, finance, operations, maintenance, information systems, management, contracting, supply-chain management, and organizational development. A Competency Management System will ensure that GLWA has a systematic process for embedding the best asset management practices to deliver established service levels to its member partners. The outcomes of an effective Competency Management System are:

- A methodical assessment process to determine the skills needed to effectively deliver water and wastewater services to GLWA member partners
- A competency framework to describe what the people involved in the management of physical assets within an organization should be able to do, in relation to asset management
- A system for evaluating GLWA's team member alignment to the competency framework, methods to resolve any skills gaps through recruitment or learning and development
- Effective feedback processes to ensure that GLWA is aware of its success in achieving the competencies in its competency framework and the effectiveness of the competency framework in delivering organizational outcomes

A key part of instilling and sustaining those capabilities at all levels of the organization is developing and maintaining a learning and development plan that is integral to the competency framework.

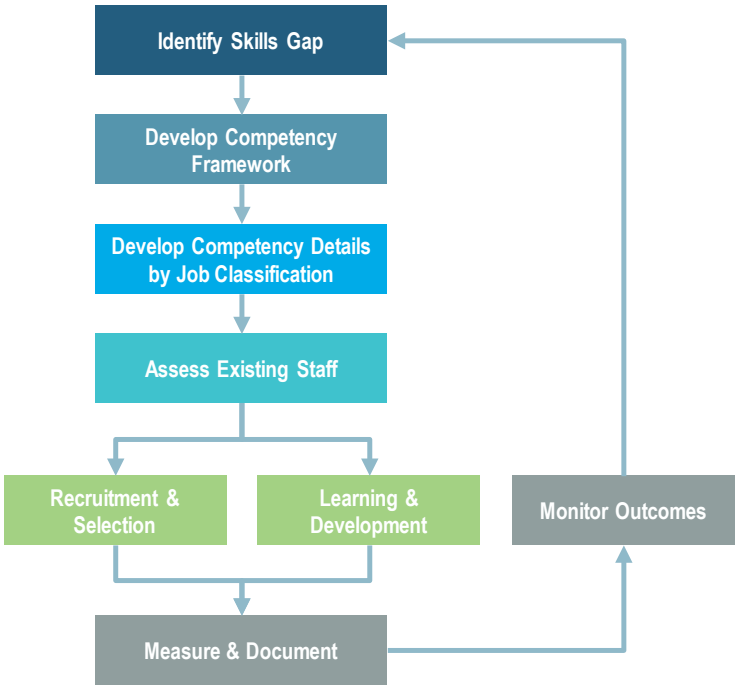
Competence, grown through relevant learning and development activities, does not necessarily guarantee good performance. Good performance, however, is impossible without competence. To be successful, an asset-management organization must ensure it has sufficient number of suitably competent people who can undertake the activities necessary to success. Understanding the number and level of proficiencies that are essential to asset management within an organization enables leadership to design and commit to a resourcing strategy for ensuring the right number and type of team members are available at all times. In short, an asset management competency framework (such as the ones described by the IAM) clarifies the capabilities that are required at all levels, so leadership can consistently define roles and responsibilities and select, develop, and review people appropriately. This ensures an organization can provide ongoing support of its asset management requirements.

8.2.1 The GLWA Competency Management System

Based on the Competencies Framework published by the IAM in 2014 [23], GLWA's Competency Management System provides a strong foundation for identifying the skills needed for asset management, developing an appropriate competency framework, and selecting, assessing, training and developing people performing asset management activities in an efficient, traceable and consistent manner.

Figure 8-4 shows the Competency Management System GLWA will use to identify required asset management competencies at all levels of the Authority, to determine the proper learning and development tools to sustain them, and to ensure GLWA's people can deliver the services to member partners. It is meant to ensure team members working in asset management are developed in accordance with the GLWA asset management strategy and objectives. A subset of this process is the competency framework.

Figure 8-4: Competency Management System



8.2.1.1 Identify Skills Gap

Improvement Initiative P5
Asset Management Job Descriptions

Working within the AMSO structure, the Asset Management Enablers Team will be responsible for managing the Authority's asset management enablers, as described in this section. The subgroup team assigned to asset management competencies will be comprised of team members with first-hand knowledge of the different levels of asset management responsibilities within the Authority, the SAMP, and GLWA's asset management objectives. The subgroup will work closely with Organizational Development and regularly engage operational team members who are involved in asset management functions on a daily basis.

The Asset Management Enablers Team will be responsible for supporting Organizational Development in the development of a competency framework, the first step of which is to determine the new skills that are required for the asset management implementation plan. These skills may include:

- Industry recognized licenses/certifications
- Competencies with equipment, software and tools, as well as soft skill competencies
- Application of various asset management frameworks
- Basic computer skills

All of the identified skills shall be linked to organizational outcomes related to facilitating the delivery of water and wastewater services at the proper service levels. The following subsections describe the process the satellite team will use to both initially develop GLWA's asset management competency framework, and to continually align organizational capabilities to asset management requirements as GLWA's program matures.

8.2.1.2 Develop a Competency Framework

Once the AMSO Asset Management Enablers Team identifies the appropriate skills, it will develop a competency framework that demonstrates how those skills will be developed from GLWA's current state, sustained, and reinforced so that the proper level of proficiency is maintained at the proper levels of the organization. Such a framework will be developed in collaboration with Organizational Development and under the One Water Institute (OWI) to drive the development of individual capabilities, just as it develops the organization's overall competency.

The GLWA competency framework will be designed to align with current job classifications, with specific, meaningful requirements provided for each job classification and defined for each level of proficiency. This allows competencies and specialty designations to be added to current job descriptions such as Management Professional, Team Leader, Engineer, and Maintenance Technician. Ultimately, competencies are aligned with progression requirements, linked to salary grades and career paths.

Table 8-2 represents asset management training for all types of jobs across GLWA. All team members will receive Level 1 in support of the need to expand asset management awareness across the organization. Team members who are tactically involved with managing and working with assets (e.g., team leaders, engineers, maintenance technician) will receive Level 2 training. Managers or team members responsible for the strategic planning of assets (e.g., asset management professionals, managers, and directors; plant managers; engineering managers) will receive Level 3 training.

Table 8-2: Examples of Asset Management Training Subjects

Level	Audience	Example Subjects
Level 1 - Organization-Wide	All GLWA team members	• Basic asset management knowledge: purpose of asset management; risk management; lifecycle optimization • Asset management communication messages
Level 2 - Tactical	Designated tactical job classifications	• Certified Reliability Leader (CRL) or similar certification • Role-specific skills
Level 3 - Strategic	Designated strategic job classifications	• IAM Certification • Principles of Asset Management • Policy, strategy, and planning • Managing assets • Management lifecycle decisions and activities • Assessing and managing Asset Management risks • Business and finance • Writing and developing AMPs

8.2.1.3 Assess Existing Staff

Once the competency framework is established, the team can assess the ability of key positions and the organization as a whole (organizational readiness) to meet the required competency levels throughout GLWA. The result is an identification of skill gaps, which can then be prioritized and addressed through learning and development strategies.

8.2.1.4 Employ Learning, Development, and Recruitment Strategies

Competencies are to be ingrained within GLWA through various training mechanisms, succession planning, mentoring, and on-the-job instruction. The major types of programs, the elements they involve, and whether they require adjustments to current programs or are in-development, are listed in Table 8-3.

Table 8-3: Components of a Competency Framework

Type	Components	New/Existing Elements
Succession Planning	Progression: Team members advance a level upon achieving competencies	• Add asset management competencies to certain job classification progression requirements.
	Apprenticeship program	• Incorporate asset management into existing programs • Expand to new programs and partnerships
	Mentorship program	• Proposed new program
	Knowledge transfer	• Proposed new program to support asset management in light of aging workforce
Internal Training	Team member orientation	• Align with OWI • Develop new training for specific asset management skills • Purchase *Uptime Elements* • Develop a GLWA Technical Training Center
	On-the-job training	
	On-the-job shadowing	
	Self-paced training	
	GLWA Technical Training Center	
External Training	Tuition reimbursement	Expand existing programs to include asset management studies
	Licensing and certification programs	
	College and university programs	

Improvement Initiative P9

Expanded Maintenance Training

In addition to aligning learning and development activities to the asset management competency framework, GLWA also works to gain asset management competencies through its recruitment and selection activities. Organizational Development, with the support of the AMSO team, is responsible for developing profiles for specific job classifications that meet asset management skills requirements and for informing the development of a strategic hiring plan and resource pool as may be required.

8.2.1.5 Document and Measure

GLWA currently employs Cornerstone's Learning Management System (LMS) and Performance System to track its learning, development, and performance activities. The AMSO team is tasked with coordinating the enhancement and expansion of GLWA's efforts in order to provide more discrete information that can better enable managers to assign work based on team member competencies, especially as they relate to asset management activities, and to identify and address emerging skills gaps. The objective here is to document competency achievements and training completion, and to ensure that competencies are sustained by creating performance indicators that measure training success and operational impact.

8.2.1.6 Monitor Outcomes for Continuous Improvement

An important fundamental of developing an asset management competency framework is its cyclical nature; that is, the framework is never complete. Asset management is an ever-expanding field and GLWA is an organism that continually learns, adapts, and responds to changes to its business environment. Similarly, the purpose of the asset management Competency Management System, as described in this section, is to ensure the skills that are nurtured within the organization are those that successfully deliver GLWA's objectives. The AMSO team, with the support of Organizational Development, is responsible for embedding a process to ensure competencies support GLWA performance, including reviewing team member evaluations of learning and development services, monitoring KPIs, and measuring how effectively GLWA delivers water and wastewater services to its member partners.

8.3 Asset Management Organizational Change Management

8.3.1 Asset Management as the Driver for Organizational Change

Improvement Initiative P2

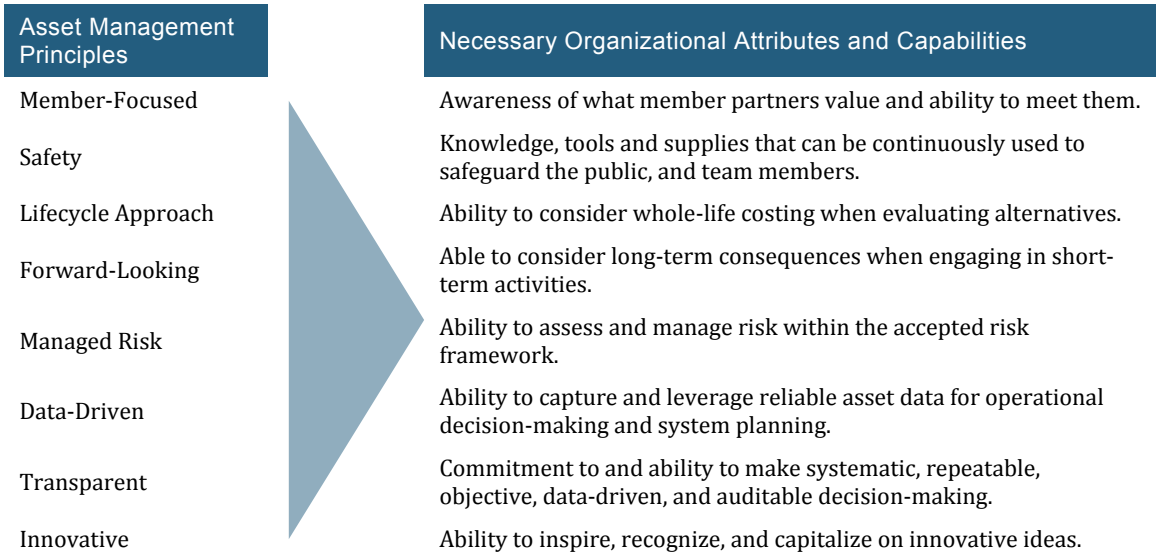
AM Change Management Plan

GLWA acknowledges that institutionalizing asset management principles and practices will require radical change in the way team members strategize, plan, and execute their work. Ensuring a successful transformation will require adopting a change management framework that engages staff at all levels. It must be led by members of GLWA's ELT who are willing and able to act as champions of organizational change.

Asset management will be a permanent and ongoing set of practices that is operationalized into the normal work of staff at all levels of the organization. In this sense, asset management is not viewed as an isolated initiative, but as an embedded way of doing business that requires the alteration of business processes and the active and ongoing collaboration of GLWA team members. Asset management will require, at a minimum, significant changes to the way GLWA manages its data, conducts financial and capital

planning, serves member partners, tracks and reports its performance, and plans, upgrades, replaces, and maintains its assets. Some of the organizational changes precipitated by the GLWA's Asset Management Policy are shown in Figure 8-5.

Figure 8-5: Organizational Changes Needed to Conform with Asset Management Principles



GLWA acknowledges that it is futile to set asset management principles and objectives without committing resources and focus to meet them. Transforming embedded and integrated ways of business to comply with its Asset Management Policy means GLWA must be willing to develop its organization in ways that supports new attributes and capabilities. An embedded change management framework, as described in this section, will allow GLWA to examine and revise its performance management structures, information sharing channels, job requirements, organizational culture, and incentives.

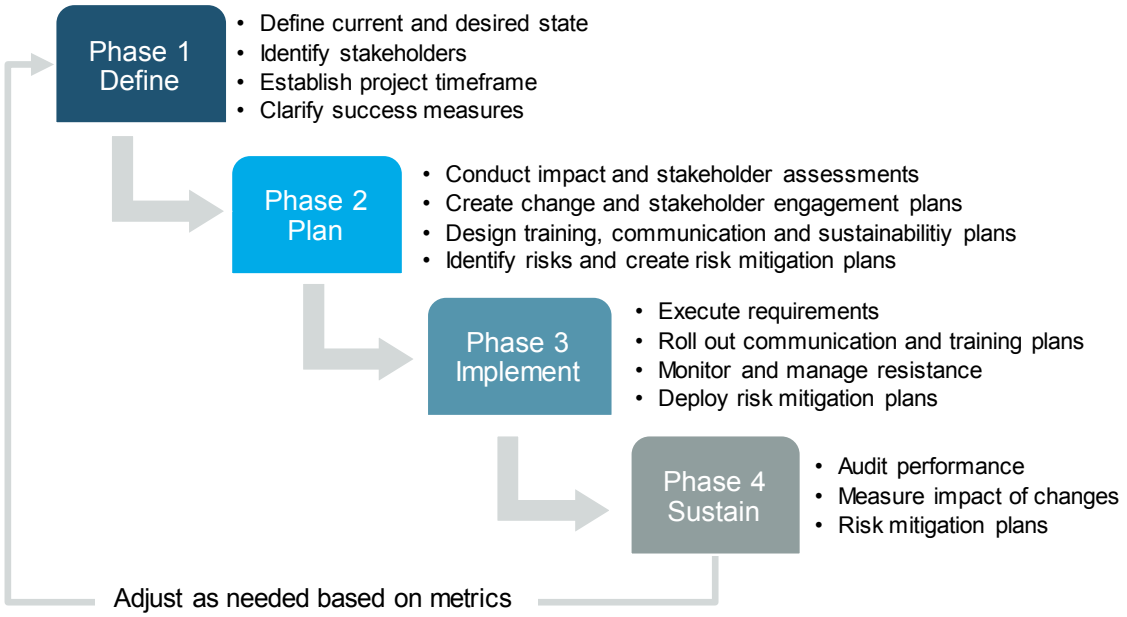
8.3.2 GLWA's Change Management Framework

In line with the requirements of transitioning to best asset management practices, GLWA has developed a framework for change that will be employed as part of the change management plan to:

- Convey the importance of GLWA executive leadership in guiding change
- Communicate the need for making radical sustainable changes to the way we work
- Build a collaborative organizational approach for ensuring enterprise-wide acknowledgment and implementation of changes

The framework uses a four-phase approach to assess and address organizational needs to change. Figure 8-6 summarizes the approach in terms of the key activities that fall into each phase.

Figure 8-6: Change Management Four-Phase Approach



This change management approach is recommended for addressing transition issues related to the acceptance of asset management practices. Currently, staff is not resourced to manage all these aspects of organizational change. Staff will therefore need to be assigned to provide guidance, change interventions, and assessment tools to help manage the change impacts related to the execution of asset management practices across the enterprise. For a successful transition, team member support will be needed from Organizational Development, the Public Affairs Group, and affected functional areas.

8.3.3 Change Management Plan

Key elements comprising the GLWA Asset Management Change Management Plan will be comprised of the four elements shown in Figure 8-7.

Figure 8-7: Elements of the Asset Management Change Management Plan

8.3.3.1 Defining the Change

The first phase of effecting change will entail an explicit definition of the changes that are needed in order to execute asset management successfully. These changes will likely include enterprise-wide attributes related to overall culture change (i.e., transitioning from risk aversion to risk treatment) as well as more specific process-related changes such as learning to access and share data in different ways.

Table 8-4 shows characteristics of organizations that have effectively adopted asset management practices and are change-agile organizations; that is, able to adapt to new and desirable processes that improve performance. In measuring the current state of GLWA and defining where and how it needs to transform itself, these characteristics will serve as a baseline for comparison.

Table 8-4: Characteristics of Organizations

Successful Asset Management Organizations	Change Agile Organizations
• Asset management policy, objectives and governance embedded into organization • Structures/frameworks that support collaboration and decision-making • The ability to make business decisions on the basis of external stakeholder knowledge • Workforce performance and skills aligned to organizational needs • Documented, standardized, and accessible business processes • Culture of innovation and willingness to continuously improve	• Visible, executive championship • Clear line-of-site from organization goals to individual goals • Multi-level involvement and motivation • Dedicated change management team • Consistent and strategic communications – both centralized and decentralized • Dedicated training and mentorship opportunities • Reinforcement program

8.3.3.2 Planning for the Change

There are many interventions that GLWA uses to increase team members' willingness, and ability to engage in identified work process changes. Methods include:

- Visible championship from organizational leaders as well as mentors throughout the Authority
- Communication
- Participation in change-impact analysis and in designing and improving work processes
- Resolution of recognized work issues
- Performance alignment (individual goal development)
- Training and mentoring
- Rewards, recognition, and incentives

Organizational Development can employ these methods and develop others, as needed, to create change plans targeted to identified enterprise-wide and functional change needs. In doing so, the following should always be integrated into the planning stage:

- **Environment, Health, and Safety (EH&S)** considerations to ensure a focus on any impacts to the environment and on integrating safety training, means and methods into changes of work practices
- **Learning and Development Plans** developed to align skills to the asset management competency framework
- **Document Management** to ensure standard operating procedures, job plans and other documents are properly created, reviewed, approved, issued and controlled, and that team members are trained to use them
- **Continuous Improvement and Sustainability** plans to ensure performance is measured and metrics are aligned with the organization's change goals and allow for course corrections
- **Change Communications** developed in partnership with Public Affairs to ensure information is disseminated throughout the Authority and allows for the sharing of ideas and input into planned changes

8.3.3.3 Collaborative Implementation

For organizational change to be accepted and sustained, participation of those it will affect is an absolute necessity. Therefore, to ensure success the implementation of GLWA change strategies will be done collaboratively between Organizational Development, other support functions, and leadership throughout all business units. Examples of the collaboration the asset management change strategy requires include:

- Organizational Development and business unit leadership working together to develop a matrix identifying a collaborative plan that supports development for team members and aligns with asset management operational objectives
- In line with Section 6 of the SAMP, which indicates input from management and staff is needed regarding performance that should be tracked, AMLT, Organizational Development, and O&M team members may review and make recommendations for KPIs to be more proactive vs. reactive
- AMLT and business unit leadership will work with the Public Affairs Group to hold town hall discussions that share status and impacts of the SAMP with a broad base of team members.

8.3.3.4 Sustaining Asset Management

Organizational Development uses measurement strategies that align with the purpose of a change initiative and can include self-reported qualitative measures, quantitative performance changes, repeated measures (before and after evaluations), participation numbers, and skills assessments. Certain measures are tied to acknowledgment, reward or recognition strategies as a way of sustaining behaviors. Other results are used to make course corrections or to disseminate effective tactics to other parts of the organization to grow the success rate of change efforts.

8.3.4 Training/Mentoring and Communication Plans

Effective change management initiatives rely on complementary learning and development and communication strategies (see Sections 8.2 and 8.4). Therefore, Organizational Development will actively partner with team members in the Public Affairs Group to execute a comprehensive strategy that allows GLWA to transform itself into a leading asset management organization.

8.4 Asset Management Communications

GLWA is not addressing asset management as a time-limited initiative. Rather, GLWA sees asset management as a way of doing business that requires the alteration of familiar business processes and the active and ongoing collaboration of team members. The Public Affairs Group at GLWA is committed to fostering the acceptance of these work-related changes with messages and media to support internal stakeholders becoming aware, willing, and capable of working in line with new asset management requirements.

GLWA sees asset management as a way of doing business that requires the alteration of familiar business processes and the active and ongoing collaboration of team members.

Improvement Initiative P3

Asset Management Communications

With guidance from Public Affairs, asset management communications will progress from gaining awareness and initial buy-in to establishing communication mechanisms that provide staff with the knowledge and reinforcement necessary to adopt asset management practices. Public Affairs will also work to provide the ongoing business tools necessary to operationalize asset management as a way of doing business over the long term. Accordingly, the Communications Plan addresses this need by providing guidance and structure that are immediately useful, and yet also flexible to allow for adjustment to new inputs as asset management matures.

8.4.1 Current State

Public Affairs is responsible for sharing the Authority's mission, vision, values and accomplishments with its stakeholders—both internal and external. Public Affairs engages these audiences through a combination of internal communications initiatives, proactive media relations, social media strategies and system-wide community outreach. The team is made up of experts in the areas of video storytelling, internal communication and team member engagement, as well as digital and social media. Its most recognized communication vehicles include: *One Water News, Water Works Magazine,* the *One Water Video News Report,* and the annual *Year in Review.* Public Affairs, however, also employs a cross-section of other tools such as video monitors, communication centers, posters, and other media for disseminating information to team members across the enterprise, many of whom do not sit at a desk every day.

The asset management benchmarking assessment, completed by Jacobs in 2019, presented results indicating GLWA has adequate processes, resources, and tools for communicating with external audiences, especially community partners, and sharing enterprise-wide information with internal audiences. The assessment also found that the greatest opportunity for improvement is to provide less-conceptual, more-detailed, relevant information about asset management, especially to team members at the operational levels.

8.4.2 Goals

The asset management communications plan will use a broad range of outreach tools and tactics to increase team member awareness and buy-in of asset management principles. In addition, planned communication activities will provide team members with the knowledge and reinforcement necessary to adopt asset management practices as a way of doing business over the long term. It will also support the sharing of performance information, stakeholder opinions and needs, as well as provide an avenue for acknowledging desired behaviors. The following are the goals of asset management communications:

- Create an understanding of asset management, GLWA's asset management vision, and the contents of the SAMP throughout the Authority
- Increase buy-in and ability to participate in asset management, helping team members transition from simple awareness to active participation
- Reinforce desired asset management behaviors by highlighting team members' behaviors and actions that are "walking the talk" of asset management at GLWA
- Incorporate asset management into the GLWA culture by:
    - Constantly reviewing communications to ensure responding to changing needs and emerging issues
    - Regularly seeking team member feedback to ensure issues are brought to the forefront in real-time

8.4.3 Audiences

Asset management communications will focus first on internal audiences and progress to external audiences as asset management practices mature within GLWA (see Table 8-5). Phase 1 will initially focus on building the interest and awareness of team members in asset management through information that is functionally specific and useful, providing the "what's in it for me" necessary for engagement. This first phase of asset management communications will then begin to address the interest areas of member partners, GLWA's Board of Directors, and regulatory agencies, conveying information that demonstrates the rationale and results of asset management as practiced within GLWA.

Table 8-5: Audiences for Asset Management Communications

Audiences - Phase I	Audiences - Phase II

Internal
• Primary
  ○ All GLWA Team Members
• Secondary
  ○ Board of Directors
  ○ Regulatory Agencies
	External
	• Member Partners
	• Community
	  ○ Southeast Michigan
	  ○ State
	• Government
	  ○ Local
	  ○ State
	  ○ Federal
	  ○ Potential New Member Partners
	• Water / Wastewater Sector
	• Media

While Phase 1 is characterized by engaging those who will be practicing asset management and those who will immediately benefit by its results, Phase 2 communications is characterized by sharing GLWA's experiences and successes with asset management to the greater community of stakeholders. These communications will strengthen GLWA's reputation and provide the opportunity to both expand its influence with potential new member partners and to engage other sector agencies in sharing leading practices.

8.4.4 Information Channels

The GLWA Public Affairs Group effectively uses numerous communication channels to share information with internal audiences. These mature and recognized vehicles can be used to disseminate asset management information to the relevant audiences described previously. In addition to its regularly-published channels, Public Affairs will deploy additional channels specifically intended to support the adoption and reinforcement of asset management practices as needed. Channels to be considered include those described in Table 8-6.

Table 8-6: Possible Information Channels

Channel	Description	Frequency & Audience
Champion Network	• Comprised of individuals from key business units, groups, and teams that will not only share information, but also will relay feedback on messaging to help keep information relevant • Provides success stories to be highlighted in Asset Management Hero Highlight (see below) • Facilitates the submittal of questions to the Asset Management Forum (see below) on behalf of colleagues • Guidance and talking points to assist in disseminating the information provided by AMSO and Public Affairs	• Ongoing • Developed to reach all relevant levels and functions
Asset Management Forum	• Forum for team members who want to share successes, concerns, challenges • AMSO team members answer questions, provide input, and monitor the forum for issues to be addressed • Deployed either in-person or via Skype or WebEx	• Monthly • Open to all team members
Ask the Asset Management Expert	• Blog post on One Water Connect • Serve as an avenue for dispersing functionally-relevant information regarding the application of asset management • Monitored and managed by AMSO team members	• Ongoing • Open to all team members
Asset Management Hero Highlight	• A recurring focus on people or groups that have successfully implemented new asset management practices • Includes a "spot reward" for “living” asset management practices	• Ongoing, through existing channels • Open to all team members

8.4.5 Key Messages

The Asset Management Policy will serve as the foundation for all core messages that leaders throughout GLWA and other team members will use when speaking about asset management and developing basic asset management-related content. Specific information that relates these overarching messages to individual audiences will be developed in line with ongoing asset management developments. Examples of key messages to be considered include the following:

- One foundational concept of asset management is how we will direct our resources to make data-driven decisions about capital and operational investments.
- Strategically timing infrastructure interventions such as maintenance, rehabilitation and replacement ensure asset lifecycles are optimized, and meet our established service levels.
- Asset management will allow us to consider the long-term consequences of short-term activities and make forward-looking decisions to enable our assets to better meet the social, environmental, financial, and regulatory challenges of the future.

- Collaboration lives at the heart of asset management. Two-way communication between our team members, member partners, and other stakeholders is crucial to understanding our performance.
- Asset management will enable us to balance our investments against risk so we can be good stewards of our financial resources and maintain established service levels.
- Embracing and implementing asset management will assist each of us in doing work that is meaningful because it contributes to asset lifecycle optimization, service value, and the overall sustainability of GLWA.

These key messages represent a framework of core ideas related to the GLWA Asset Management Policy. It is not an exhaustive list and does not represent all information that needs to be relayed about our asset management journey. The key messages are intended to be a positive guide for the way asset management facts are shared with both internal and external audiences.

8.4.6 Communication Accountability

Effectiveness of asset management communication efforts hinges upon an active and equitable partnership between the Public Affairs Group and the AMSO team. A Public Affairs team member will continue to serve on the AMSO satellite team assigned to managing the organizational enablers to asset management practices, including communication and change management. Public Affairs cannot complete the communications work on its own but will rely on the knowledge of those in asset management leadership and directly responsible for operations and maintenance who are conducting the work on a daily basis.

The Public Affairs Group will have oversight of central media used to support asset management communications, as described in this section, as well as the responsibility for ensuring consistency of message across these tools. Public Affairs will also monitor the effectiveness of the asset management media and messaging through its annual team member survey.

The information disseminated through these channels will be developed in partnership with the AMSO team. Similarly, feedback received through the two-way mechanisms will be monitored by AMSO team members.

9 Framework for Continual Improvement

Looking for opportunities to improve processes and practices is an attribute of all forward-looking organizations, including GLWA. Continual improvement is a basic precept of all management systems, including asset management. ISO 55001, in clause 10.3, states: "The organization shall continually improve the suitability, adequacy and effectiveness of its asset management and the asset management system" [2].

Improvement Initiative M4

Preventative Maintenance Optimization

Improvement Initiative M5

Maintenance Best Practices

This section of the SAMP describes the methods that GLWA will use to better understand how its current performance aligns with other infrastructure-intensive organizations and how it will stay abreast of developments in the water sector. The overall goal is to continually inspire and support internal efforts to improve its asset management practices.

9.1 Benchmarking

9.1.1 Types of Benchmarking

There are several types of benchmarking plans, which depending upon the needs and interests of the organization, will include metric benchmarking (internal and external) and performance benchmarking.

Improvement Initiative O6

Asset Management Assessments and Benchmarking

Metric benchmarking is a quantitative comparative assessment of organizational performance, normally expressed as ratios. Metric benchmarking can be external or internal.

- **Internal metric benchmarking**—comparing performance within the same organization over time—can yield benefits by identifying where improvement is continual, stagnant, or deteriorating. Section 6 of this SAMP, Performance Management, described the methodology for internal metric benchmarking by establishing performance indicators and service levels, measuring progress toward improvement, and tracking performance over time. The plan-do-check-act cycle was presented as an iterative approach to continually improve performance in a systematic way by assessing changes in metrics, planning and implementing adjustments to processes, evaluating the effects, and refining the process or procedure for improvement.
- **External metric benchmarking**—comparing an organization to similar organizations—is widely used to establish an organization's relative effectiveness and efficiency within a business sector. External metric benchmarking should be used with the caveat that organizations operate within different operating conditions. Differences in service area density, topography, climate, water resources, treatment processes, permit conditions,

and political governance may cause external metric benchmarking to result in ambiguous conclusions. Nevertheless, if carefully and deliberately employed, metric benchmarking can be a useful starting point in identifying specific areas and activities in an organization to be targeted for further evaluation.

Process benchmarking compares how an organization performs a process or activity, typically with another organization that is recognized for performing the process or activity in a highly effective and efficient manner. Process benchmarking can be time consuming and takes dedicated personnel from both the organization looking to improve and the organization that is willing to share its optimized process. Process benchmarking usually involves site visits and mapping of both the as-is process as well as the to-be process. Technical training is needed for staff to learn the new process and change management approaches are needed to ensure staff will embrace the new process. With appropriate resourcing and commitment process benchmarking can be very valuable in an organization's basket of continual improvement approaches.

9.1.2 Benchmarking at GLWA

The purpose of GLWA's asset management benchmarking efforts is to measure and track GLWA's performance against both its own previous performance and against other organizations performing similar activities. GLWA uses both metric and performance benchmarking methods to measure and progress its asset management practices and performance levels. In 2016, GLWA established key performance indicators (KPIs) using the Effective Utility Management (EUM) framework [24].

Benchmarking at GLWA is intended to align the Authority's performance across three levels, as shown in Table 9-1. For the enterprise and asset management levels of performance, GLWA uses industry-recognized frameworks from EUM [24], the Water Services Association of Australia (WSAA), and Reliability Web. These frameworks allow the Authority to set meaningful measures of performance and provide recognized panels for comparison, learning, and best practice sharing.

Table 9-1: Enterprise and Asset Management Performance

Level	Framework	Areas of Performance
Enterprise	Effective Utility Management American Water Works Association (AWWA)	• Product quality • Customer satisfaction • Employee and leadership development • Operational optimization • Financial viability • Infrastructure strategy and performance • Enterprise resiliency • Community sustainability

Level	Framework	Areas of Performance
Asset Management Practices	Water Services Association of Australia (WSAA)	• Asset capability planning • Asset acquisition • Asset operation • Asset maintenance • Asset replacement rehabilitation
Asset Management Operations	Reliability Web	• Reliability engineering for maintenance • Asset condition management • Work execution management • Leadership for reliability • Asset management business processes

As described in Section 5.2.1, GLWA is developing service levels metrics in line with member partner preferences and based on areas of performance (shown in Table 9-2) that drive their satisfaction with GLWA's water, wastewater, and stormwater service.

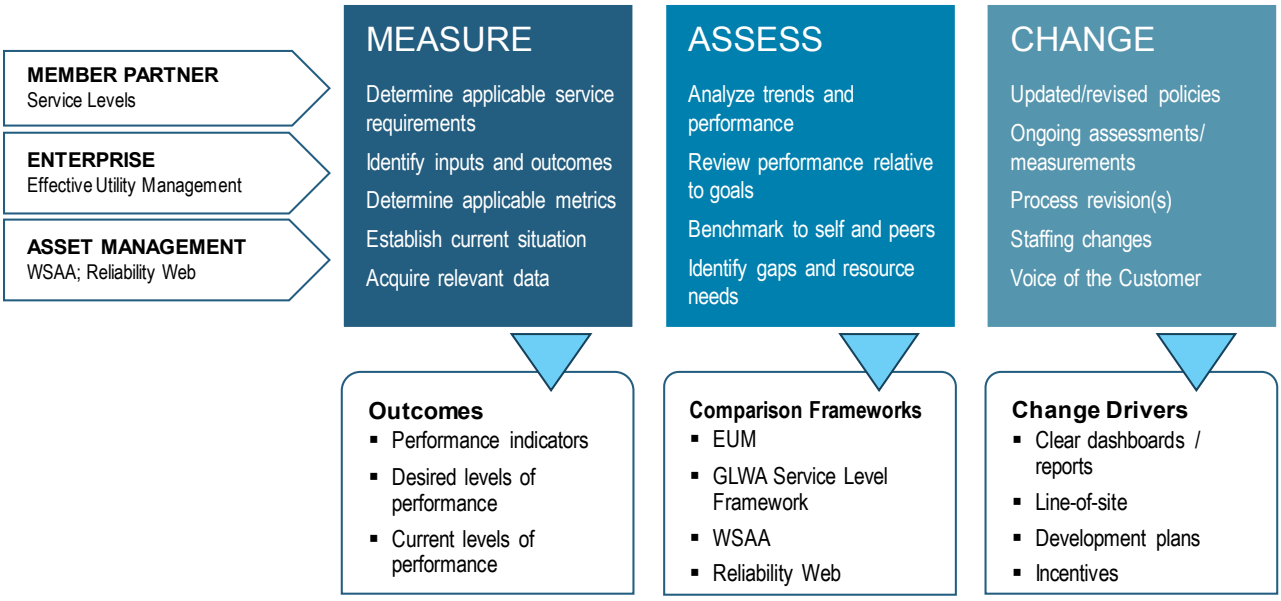
Table 9-2: Member Partner Performance

Level	Framework	Areas of Performance
Member Partner Services	Service Level	• Treatment and overflows • Wastewater service disruptions • Protection of public health, environment and recreation • Satisfy commitments to member-partners • Water quality • Water flow rate • Water pressure

9.1.3 GLWA's Benchmarking Process

GLWA's process of benchmarking is shown in Figure 9-1. With inputs from GLWA's efforts with member partners, EUM drivers, American Water Works Association (AWWA) comparisons, and results of Reliability Web and WSAA assessments, the Authority will develop meaningful and practical measures upon which to compare its performance. Regular comparisons, using the frameworks described previously, will provide insight into how GLWA performance is progressing. By clearly reporting the status of its performance with relevant stakeholders, tying performance to incentives, and to operational and organizational development plans, GLWA will steadily move the Authority toward its asset management objectives.

Figure 9-1: Benchmarking Process



9.1.4 Benchmarking Programs

In 2018, GLWA participated in the Water Services Association of Australia (WSAA) asset management benchmarking program that enabled GLWA to establish baselines and institutionalize processes that serve the following three goals:

1. Improve GLWA understanding of key performance areas related to asset management
2. Identify areas that are under-performing or over-performing peers for further study
3. Identify "leading edge" practices for evaluation and adaptation

The WSAA program is a global asset management process-benchmarking program in which participants score their performance in more than 500 practices in seven functional areas. The program has had over 60 benchmarking participants and has been applied over 200 times since its inception in 2004. The WSAA's active participants, along with continued alignment to recognized industry frameworks such as ISO 55000 and the Institute for Asset Management (IAM), ensures the program's validity and relevance to the water sector. The results of GLWA's first participation in the WSAA assessment will be used to provide baseline values for GLWA to monitor its practices and to show improvements over time.

Opportunities for metric benchmarking include the following programs:

- American Water Works Association's Benchmarking Program
- Association of Metropolitan Water Agencies' INSIGHT Utility Financial Survey
- National Association of Clean Water Agencies' Utility Financial Survey

9.2 Engagement and Networking

Improvement Initiative P8
Engagement and Networking

GLWA is intent on sharing its asset management discoveries and results with those who can benefit from them and learning from other utilities and organizations that have adopted asset management principles and practices when those opportunities fall within GLWA policy. Identifying new perspectives and approaches, as well as engaging in collaborative problem solving and sharing of lessons learned have been, and continue to be, advantageous to GLWA's continual improvement efforts.

9.2.1 GLWA Sharing and Learning

GLWA is intent on sharing its asset management discoveries and results with those who can benefit from them. The GLWA Innovation Program (Section 9.3) uses an embedded process to generate and solicit innovations from GLWA's own staff, and will share these practices with sector partners through communication, tours, town halls, conferences, workshops and webinars with external stakeholders and other like-minded water professionals.

Improvement Initiative M7
Peer Exchange on Maintenance Best Practices

Likewise, GLWA will continue to grow its asset management knowledge base by participating in tours of other facilities—both within the water sector and outside of it—to gain practical insights into asset management and reliability practices. GLWA team members will also attend and present at conferences that fall within GLWA policy and participate in asset management professional and trade associations, as well as AWWA/WEF Asset Management Committee at the State and National levels. Participation in tours, associations, and conferences will be managed to ensure they fall within GLWA policy.

9.2.2 GLWA Engagement Approaches

GLWA will employ all the communication tools and publications at its disposal to disseminate advances and lessons learned in asset management across its stakeholder groups. GLWA also welcomes opportunities to engage the academic community in the study and application of asset management principles by working with students wishing to study the impact of various practices in partnership with GLWA, and by networking with academia by visiting classrooms, holding town halls, or forums.

GLWA recognizes that not all advances in asset management come from external sources and is therefore investigating the development of an Engagement Ambassador Program to ensure that team members from every level of the organization are able to participate in the exploration and application of developments within their area of interest. Team members would be tasked with discovering emerging practices from other organizations and sharing them with work teams. Discovered innovations will be evaluated and implemented using the GLWA Innovation Program.

9.3 Innovation

9.3.1 GLWA Innovation Program

Improvement Initiative O3

Innovation Program

The GLWA Innovation Program recognizes that innovative ideas fall over a wide range of subject areas, from new technologies to new processes—and may even involve previously evaluated or passed-over ideas. The GLWA Innovation Program is designed to capture all these types of ideas and then use a standard process to evaluate, then pilot or implement as appropriate, ideas to benefit the organization. The program employs an Innovation Team under the guidance of the program's director to apply a repeatable process that respects the time commitments and job responsibilities of the relevant staff.

The primary goals of the program are to:

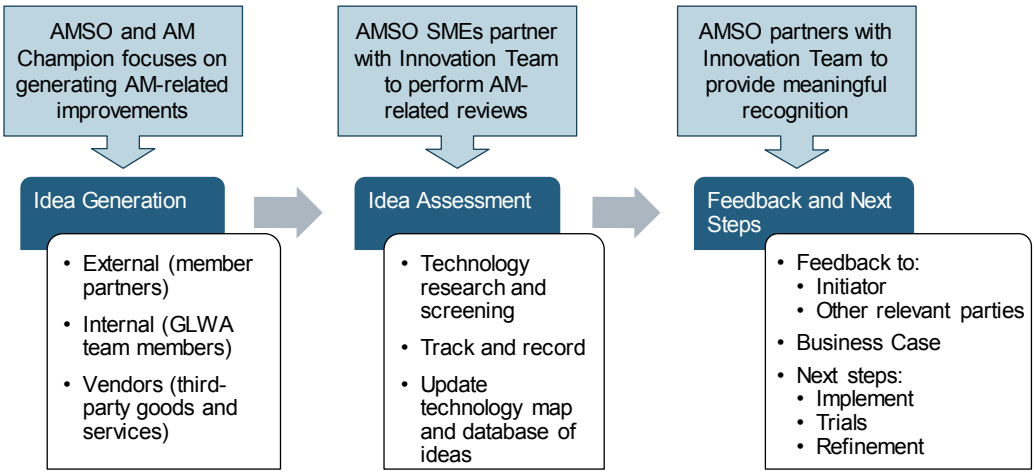
- Reduce costs and improve efficiencies and overall performance
- Harness and enable team creativity
- Develop a culture of positive performance and attitude

GLWA's efforts to drive innovation into its processes are in line with the tenets of leading asset management programs. According to the IAM, implementing an asset management approach leads organizations to question traditional ways of thinking and working, including intense reviews of an organization's accepted ways of doing business [1]. A formal innovation program, with supportive leadership and an embedded process for seeking-out and responding to innovative ideas, has the potential to transform an organization's culture, integrate its management systems, and ultimately support the continuous improvement of its asset management practices.

9.3.1.1 Innovation Process

There are three components making up the process backbone of the GLWA Innovation Program, as shown in Figure 9-2. Arrows at the top of the figure illustrate how asset management needs within the organization are addressed by GLWA's overall program for innovation.

Figure 9-2: Innovation Process



- **Idea Generation.** Ideas are generated from three primary sources. GLWA team members will submit ideas via the internal innovation SharePoint site, or via the innovation email address. The AMSO team and Asset Management Champions are tasked with generating ideas from team members that are particularly relevant to asset management. At any time, the AMSO team may request the Innovation Team to focus innovation efforts on a problem asset area, process, or operational area to speed asset management improvement where most needed.

  Member partners will also be invited to generate ideas for the program via phone and web-based survey, whereas third party vendors and service providers will provide ideas via an online form. These external stakeholders are important members of GLWA's innovation community and will be engaged in asset management continuous improvement through communication and engagement strategies described in Section 8.4.

- **Idea Assessment.** The evaluation and assessment phase covers the initial screening, internal assignment, detailed evaluation, and tracking and data gathering components of the process. Initial screening of asset management related innovations is to be conducted in partnership with the AMSO team, to ensure applicability to GLWA assets. The evaluation and assessment process will be tracked, with a method to be determined as the program matures, to ensure visibility and ease of future use. For incoming innovations related to asset management, the Innovation Team partners with subject matter experts (SMEs) from various parts of the AMSO team to perform a review that incorporates asset management principles and best practices, as well as organizational needs.

- **Feedback and Next Steps.** The feedback and next steps phase closes-out the innovation aspect of the initial process by communicating conclusions back to the originator and detailing the next steps to take if idea merits further investigation. News and results from successful, implemented asset management innovations are

disseminated throughout the organization, as part of the program's recognition program, described below, and in alignment with asset management communication channels, described in Section 8.4.

9.3.1.2 Focus of Innovations in Asset Management

In support of GLWA's organizational transition to asset management, the GLWA Innovation Program is focusing its efforts on key impact areas, including: assessing the condition of assets; asset classes most associated with identified risk; and the development of asset management competencies as described in Section 8.2. The Innovation Team relies upon the AMSO team to provide input and suggestions for such focus areas by providing it with:

- The system or asset of interest, as well as related systems
- Required review timeframe
- Appropriate asset management liaison/staff member

9.3.1.3 Sustaining Innovation

Recognition and reinforcement are fundamental to the development of an innovative culture and sustaining its benefits. The purpose of the recognition program is to motivate, recognize, and reward, both GLWA team members who submit good ideas and GLWA innovation team volunteers who help perform the evaluation and assessment. The AMSO team will suggest applicable rewards for successful innovations related to asset management and provide recognition through the Asset Management Hero Highlight (see Section 8.4), as well as through the GLWA Annual Recognition Ceremony.

9.3.2 GLWA's Commitment to Innovation

GLWA views innovation as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. The goal of innovation is to constantly feed new ideas that are stronger, better, faster, cheaper, safer, or some other measure of "better" than what is existing. The GLWA Innovation Program uses an embedded process to generate and solicit innovations from its own staff, and will share these practices through communication, tours, town halls, conferences, workshops and webinars with external stakeholders and other professionals who have an interest in asset management practices.

GLWA is committed to inspiring and capitalizing on technical, operational, and process innovations that can help the Authority to become more effective in attaining its business objectives. To demonstrate its commitment to continuous improvement, GLWA has created the permanent position of Director of Energy, Research, and Innovation. This director has the responsibility to build and manage an enterprise system for harnessing, vetting, and implementing the innovative ideas of both internal and external team members, plus third-party vendors and service providers.

10 Asset Management Implementation Plan

The work of developing GLWA's Asset Management Implementation Plan consisted of defining the GLWA's asset management current state and maturity level, defining the desired state, and developing the plan to move from the current to the desired state. This plan provides the drivers for asset management, the GLWA asset management desired state, and its current state. This plan discusses the approach to arriving at the desired state and the asset management journey ahead. It describes the Improvement Initiatives (IIs) required for achieving the desired state, along with the sequencing, pacing, agile delivery, schedule, and resources. The plan also provides important processes for measuring progress and next steps.

The schedule and resource estimates for GLWA's asset management journey are provided in a separate document.

10.1 Drivers for Asset Management

10.1.1 Asset Management Benefits

Asset management will enable GLWA to optimize value realized from assets in the achievement of its organizational objectives. The benefits of asset management include, but are not limited to the following:

- Improved return on investments and reduced costs, while preserving asset value and improving financial performance
- Better informed asset investment decisions, which will enable GLWA to effectively balance costs, risks, and performance
- Effective management of risk, which will result in reduced financial losses, improved health and safety, positive good will and reputation, minimized environmental and social impact; and can result in reduced liabilities such as insurance premiums, fines, and penalties
- Improved services and outputs based on clarity of member partner and public expectations and targeted investments (capital as well as operations and maintenance) to ensure achievement of desired performance
- Enhanced public confidence and reputation based on demonstrating risk management and focused investment decisions
- Demonstrated regulatory compliance, social responsibility, and organizational sustainability based on clarity of desired outcomes and performance reporting
- Improved efficiency and effectiveness based on review and improvement of processes and procedures

10.1.2 GLWA Business Drivers

GLWA was created in part to direct attention and resources to the region's aging water and wastewater infrastructure. This is a primary driver for GLWA's focus on asset management.

Numerous influences contribute to the decision-making process for infrastructure-intensive organizations to invest in infrastructure, including capital investment for new, replacement, or rehabilitated infrastructure, and investments to gain value by optimizing operations and maintenance. Traditionally, these influencers (or drivers) have been future demands, regulatory compliance, and aging infrastructure. However, over the past few decades, new drivers have emerged, including climate resiliency, security, technology, and workforce demographics. These drivers are discussed in detail in Section 3.2.

Based on a survey conducted among the GLWA Asset Management Leadership Team (AMLT) in October 2018 and another slightly modified version of the survey conducted among one of the SAMP Teams (Team B) in February 2019, the following drivers were identified as being *extremely important* to GLWA:

- Aging infrastructure
- Asset acquisition and capital delivery, increasing requirements
- Continuous improvement commitments
- Customer focus and invited stakeholder involvement
- Infrastructure resilience and security
- Knowledge management and decision support systems
- Maintenance optimization
- Regulatory compliance
- Reliability
- Staff skills and experience retention
- Succession planning and training
- Value for money

The following drivers were identified as being *very important* to GLWA.

- Affordability
- Asset criticality
- Business growth
- Capital expenditure
- Climate changes and environmental uncertainty
- Customer-driven, service-level improvement
- Data quality and completeness

- Industry or business structural reform
- Intergenerational equity
- Information technology and cyber systems resilience and security
- Mandated long-term asset planning
- Performance tracking and improvement requirements
- Reduction in demand for services
- Risk management approach and policy
- Safety culture
- Sourcing and recruiting
- Technology for customer interaction
- Technology for service delivery
- Total water management

The following drivers were identified as those for which GLWA is least prepared:

- Data quality and completeness
- Industry or business structural reform
- Knowledge management and decision support systems
- Performance tracking and improvement requirements
- Recruitment
- Succession planning and training
- Technology for service delivery
- Value for money

10.1.3 Business Case for Asset Management

Some benefits of asset management can be directly measured and quantified, such as the reduction in maintenance costs based on transitioning from a reactive to a proactive maintenance approach. However, many organizations (including GLWA) just starting on the asset management journey have poor-quality data, which makes it difficult to quantify the base case. In a similar manner, reduction in capital expenditure is also an outcome of asset management. However, because many organizations (including GLWA) desire to ramp up capital project delivery, it becomes difficult to measure a lower cost lifecycle solution if another investment filled in the gap. In addition, although many asset management financial benefits may be realized in the short-term, savings in the asset lifecycle may not be delivered for many years.

Many asset management benefits are important but difficult to quantify in dollars. These include benefits associated with risk management, safety, system resiliency,

standardization, communication with stakeholders, knowledge management, employee satisfaction, and public trust.

While few organizations go to the effort to generate objective cost benefit metrics for asset management implementation (primarily due to the difficulty of establishing a robust baseline), Jacobs Engineering Group Inc. has experience with organizations where reductions in operations and maintenance of 20-40% have been documented, where there has been a return on investment of $8 for every $1 spent on an asset management program, where there was a 31% reduction in reactive maintenance, where overtime was reduced by 17%, where there was a reduction of 36% in reportable accidents, where there was a reduction of 15% ($150 million) in the six-year capital program, and where rate increases were reduced over earlier projections.

The Institute of Asset Management has researched several case studies and concluded that:

> "… improving asset management capability can deliver savings up to 8% from the total cost of operations for a business over a minimum 5-year period."

These benefits are attributed to:

- Better alignment
- Enhanced processes
- Enhanced asset information to plan interventions during lifecycle decision making

10.2 Asset Management Desired State

10.2.1 GLWA Asset Management Vision Statement

GLWA has an asset management vision statement as follows:

> "GLWA will be a leader in infrastructure management by making decisions informed by risk, regional needs, and lifecycle considerations."

10.2.2 GLWA Asset Management Policy

GLWA's newly-developed asset management policy helps to define the desired state:

> "… assets will be managed to provide water and wastewater services at established service levels by using best asset management practices in a strategic, comprehensive and organization-wide manner. Asset investments will be optimized through robust and transparent decision-making considering the entire asset lifecycle. GLWA will allocate asset management responsibilities and resources to ensure Team Members are appropriately

trained and assigned to develop and implement asset management strategies, plans and procedures. GLWA is committed to providing high quality services, and measuring, tracking and reporting performance with the goal of continual improvement."

GLWA has developed asset management principles as part of the policy and these are described in Section 4.2 and Appendix D.

10.2.3 Asset Management Attributes

In order to more fully "sketch the picture" of GLWA's asset management desired state, a set of asset management attributes have been drafted to help illustrate what it will "feel" like at GLWA once asset management is fully operationalized. These statements (below) should be reviewed with a small internal focus group to help make sure they are meaningful and effectively relate to team members' day-to-day activities. Once it is more fully developed, this list of attributes can be used to communicate with team members, engaging them in a conversation regarding the principles and objectives of asset management.

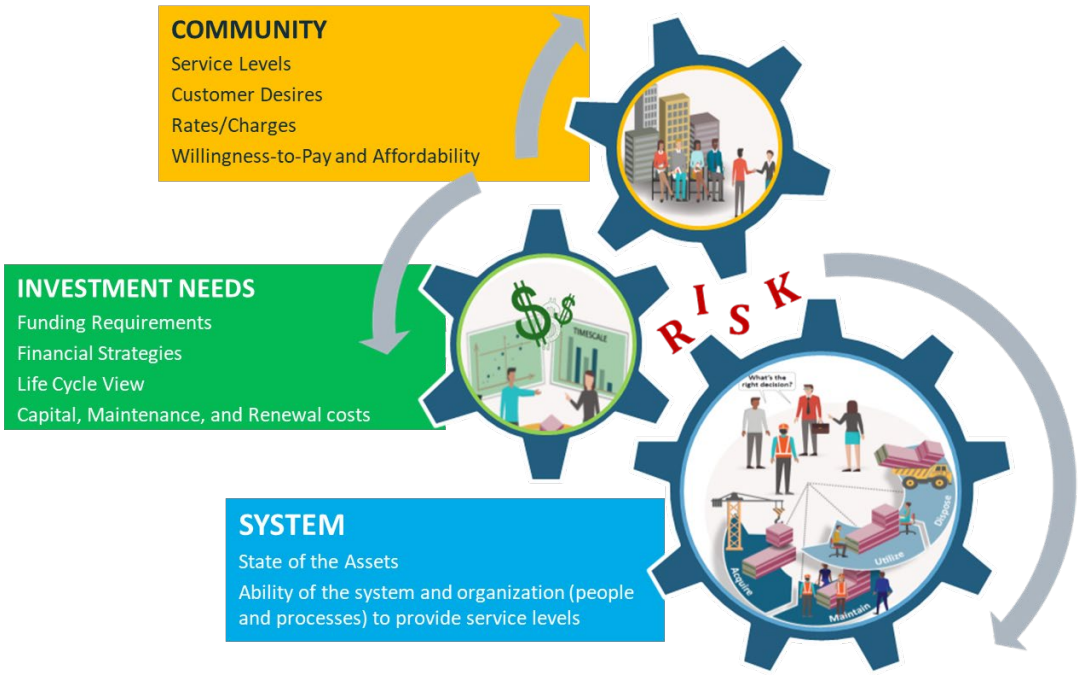
- asset management policy, objectives, and governance are embedded into the organization.
- Each team member understands their own and others' roles in the organization and how their roles relate to business objectives.
- Team members understand the concepts and principles of asset and risk management and how it applies to their job.
- Asset and system reliability expectations are documented, and appropriate investments are made to achieve reliability.
- Maintenance strategies have been developed and documented based on asset management principles; activities are conducted based on these strategies.
- Asset emergencies are tracked, and there is understanding of how asset failures and other incidents impact the ability to achieve service levels.
- Structures and frameworks are in place to support effective, efficient, deliberate, and transparent decision-making.
- Decisions are justified, documented, and made in a collaborative manner.
- Team members have good information about asset risk (including likelihood of failure and consequence of failure) and how risk may change in the future.
- Outcomes of decisions (including assumed benefits) are tracked and made available for future decision-making.
- Team members are accountable.
- Work processes are documented, and roles and responsibilities are clear.

- Effective data systems and core business software tools are in place to capture, store, and provide the data and analysis needed to make informed decisions.
- Workforce performance and skills are aligned to organizational needs.
- Team members are willing and able to cooperate across levels and functions to address identified performance issues.

10.2.4 Ultimate Goal of Asset Management

Asset management implemented at water/wastewater utilities makes them capable of balancing three imperatives: 1) understanding and achieving community desires, 2) delivering services while managing risk within the existing infrastructure and system configuration, and 3) investing as required to continue to deliver services to meet community needs. Best-in-class asset management organizations have the people, processes, and tools that work together in a coordinated way to create balance among those three imperatives.

Figure 10-1: Balanced Imperatives



10.2.5 Service Levels

At GLWA service levels are defined as:

> "Statements of desired performance outcome established by GLWA that reflect high priority to member partners, end users, the public, the environment, or required by regulators; are largely within the control of GLWA; and have performance level data that can be accurately and consistently collected and audited."

Service levels create clarity regarding GLWA objectives for provision of service to member partners and the public, and they create a target for operations and maintenance strategies, renewal and rehabilitation plans, and infrastructure improvements. Service levels are based on an understanding of the public's desires (regarding costs and services); therefore, they provide important targets that when achieved, provide confidence that GLWA has balanced the desires of the public with the investments in GLWA infrastructure. This signifies a successful outcome for GLWA. Service levels are further discussed in Section 5.2.

10.2.6 Asset Lifecycle

An important "desired state" of asset management is to pay due consideration to the whole asset lifecycle (see Figure 10-2 – Figure 10-4). There are several reasons for this, as follows:

- Risks are introduced at each stage of the asset lifecycle. Often, these risks are not well understood. Risk events or asset failures occurring during one stage of the asset lifecycle may not be fully realized until a future stage. Unless there is a full understanding of the importance of each state of the lifecycle, it is difficult to avoid or treat risks.
    - One example of this is capital project decision-making. If asset lifecycle costs, benefits, and risks are not appreciated at the time of initial project scoping, then hidden costs may materialize during the later stages of the asset lifecycle.
- While the actual amount varies depending on the type of assets and other considerations, it is estimated that 60-80% of total asset lifecycle cost is expended after construction.
    - For example, the actual cost of maintenance, operations, renewal, and salvage is largely dependent on how the asset is designed, built, and installed. Cost-cutting measures during the asset planning, design, and construction state (such as low-cost, unreliable components) cause higher failures and increases the costs incurred post-construction.
- Opportunities to optimize the total cost of asset ownership are greatest during the initial stages of the asset lifecycle.

- For example, care taken during asset design to minimize maintenance requirements, reduce risk, or improve safety can pay off with decades of lower-cost maintenance and operations. Also, modifications made during or following construction are much costlier than those initially planned or designed.

Figure 10-2: Asset Lifecycle

Figure 10-3: Asset Lifecycle Costs

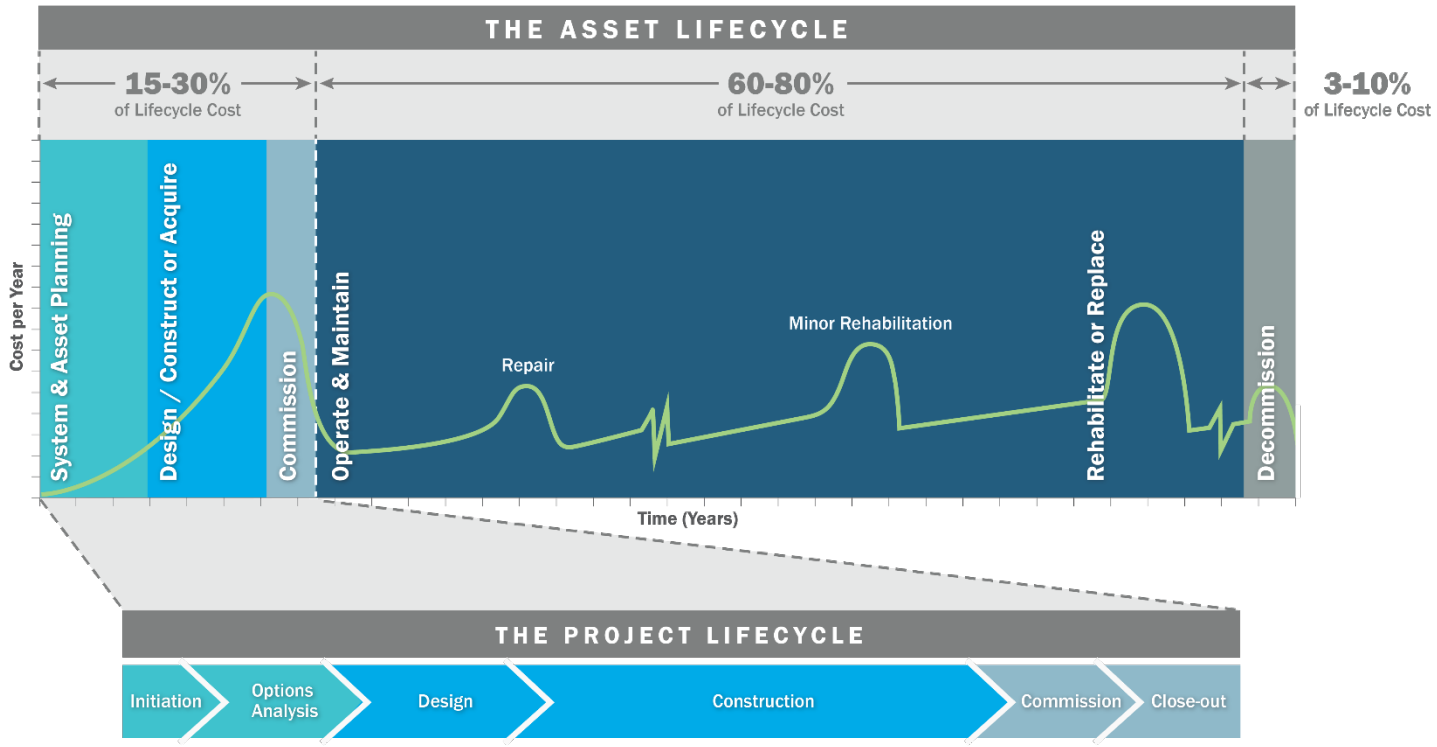
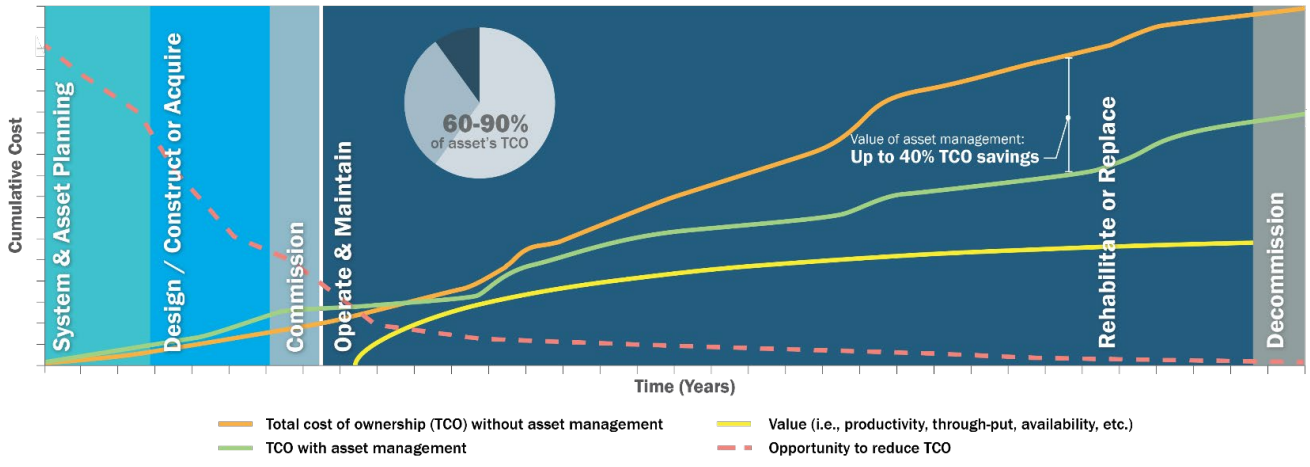


Figure 10-4: Asset Lifecycle Opportunities to Reduce Costs



The asset lifecycle and asset lifecycle strategies are further discussed in Section 4.4. Table 4-3 lists best management practices that typically occur in each of the six stages of the asset lifecycle. These activities may vary depending on the type of asset and other considerations.

10.2.7 Risk Management

At GLWA risk management is defined as:

> "A coordinated set of activities and methods that is used to direct an organization and control the many risks that can affect its ability to achieve its objectives."

Risks are defined as:

> "Effect of uncertainty on objectives."

Risk management is foundational to asset management for several reasons. Effective risk management will minimize surprises and losses, create meaningful linkages between investments and performance, and inform business decision-making. Risk management must occur at all stages of the asset lifecycle. Because it centers on timely and right-sized interventions to ensure delivery of service levels, risk management will demonstrably improve the ability of GLWA to meet its objectives. Risk management is further discussed in Section 3.4.

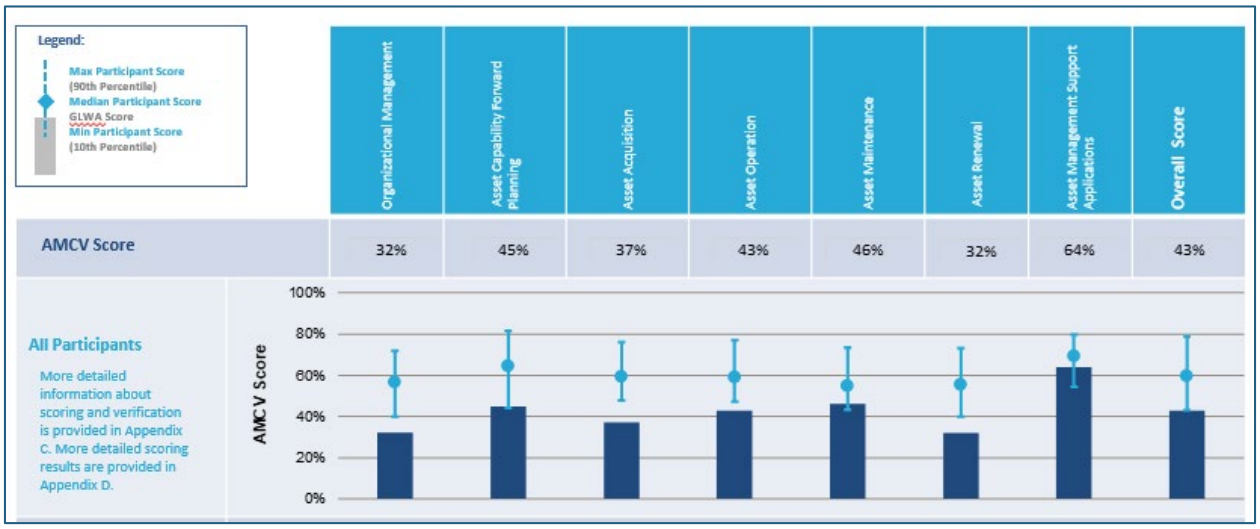
10.3 Current Asset Management Maturity

10.3.1 Results of Assessment

An assessment of GLWA's current state of asset management maturity was conducted in October and November of 2018. It is documented in the technical memo "Asset Management Assessment Summary," dated April 18, 2019.

The content of the assessment and its conclusions are largely based on self-reports and scoring from GLWA staff. It includes findings from interviews and site visits; the Water Services Association of Australia (WSAA) Asset Management Customer Value (AMCV) asset management Assessment and Benchmarking process; the tailored assessment of technology, data, and business processes; the tailored assessment of operations and maintenance programs; and the tailored organizational assessment. Each of these components is described in more detail in separate technical memos and the summary is provided in Figure 5 below.

Figure 10-5: GLWA WSAA AMCV 2018 Asset Management Assessment Results



In summary, the assessment concludes that GLWA is well-positioned for the asset management journey ahead because of their strong leadership and dedicated, engaged team members. The Asset Management Strategic Organization (AMSO) provides a solid governance structure that can be leveraged for decision making based on asset management principles. In addition, GLWA is currently making significant progress on the high-level asset management needs, including policy, principles, drivers, and objectives, and is planning to embark on development of asset management plans.

However, GLWA lacks processes to support asset management principles, objectives, and expectations. It lacks clarity of asset management roles at the local level (i.e., outside of the Enterprise Asset Management Group (EAMG)), an operationalized risk framework, and a full set of performance indicators with line-of-sight to member partner expectations. The quality and completeness of data needs to improve, along with consistent use and effectiveness of technology systems needed for asset management. Internal and external communications are effective, yet a strategic and comprehensive change management effort should be embarked upon concurrent with the asset management improvement work.

10.3.2 Readiness for Change

The fundamentals of effective change management represent an extensive area of inquiry and practice across many industries and circumstances. For its breadth of research and practical application across multiple industries, the Prosci® methodologies and tools provide a solid basis for the change readiness assessment conducted at GLWA. Since 1998, Prosci has conducted eight benchmarking studies involving over 3,400 change management leaders to identify their most successful strategies.

According to data from these studies, 70% of business change programs fail to meet intended results. The key reasons for that failure, as shown in Figure 10-6, are the inability to address employee resistance with a considered change strategy; a lack of visible leadership and active sponsorship throughout the organization; and inadequate project management support (resources, budget, strategy) for the required change. This and many other industry studies clearly show that these three essentials—leadership/sponsorship at all levels; well-resourced program management; and effective change management—are needed in equal measure to support a smooth and successful transformation.

Figure 10-6: Change Program Failures

These three essentials have behaviors, attributes, and activities that typically characterize them within the organization. Table 10-1 lists the essentials of change readiness. Where these things are lacking, or not effectively applied, will illustrate where gaps likely exist and should be addressed to support GLWA's asset management transformation process.

Table 10-1: Essentials of Change Readiness

Leadership and Sponsorship	Asset Management Project and Program Management	Change Management
• Visible, executive championship • Clear vision and expectations • Sponsorship throughout the organization • Mentoring	• Clear, measurable project goals and milestones • Progress reporting/benefits tracking • Line-of-sight of project goals to organizational goals • Project governance • Roles and responsibilities	• Clear change drivers (rationale) • Engagement opportunities throughout • Dedicated change management responsibilities/team • Consistent, meaningful communications • Training • Recognition and reinforcement (motivation for change) • Culture of innovation

From the analysis of interview comments and other qualitative data collected during the assessment process, many structures and resources were identified as strengths that will support and enable the organizational transformation. There are also recognized weaknesses or "gaps" in GLWA's change readiness. This is fairly common among GLWA's peer organizations; the recommended approach is to address those gaps as a part of

program and change management planning. With this, GLWA will pave the way for successful organizational transformation and sustainable asset management practices for the future.

10.3.2.1 Leadership and Sponsorship

The strongest advantage GLWA has relevant to its ability to successfully transform to best practice asset management lies in its leadership. Most of its executive team is familiar with asset management as a concept and is willing to be actively involved as champions in its institutionalization. In addition, most in GLWA recognize AMSO as the main governance structure for implementing asset management policies and practices. AMSO satellite teams have been chartered and have goals, regular meetings, and other constructs that aid in the ongoing work of implementing asset management across the organization.

When comparing GLWA leadership and sponsorship characteristics to best practice, the following gaps were identified:

- Executive leadership could be more effective in their sponsorship if their championship role in engaging their staff was clearer and more proscriptive.
- GLWA's asset management core "mission/vision" could be written more clearly.
- Non-AMSO participants are unclear of AMSO's roles and responsibilities.
- There is some lack of authority for AMSO members, which restricts their ability to retain resources or interest in activities.
- A rigorous network of champions throughout the organization to support AMSO activities is lacking.
- GLWA does not have a structured mentoring program, which could help push asset management awareness and leadership to the operational levels.

10.3.2.2 Asset Management Program Management

GLWA has established a program team for its asset management strategic and implementation efforts. A structure of teams that correspond to the tasks planned for developing the SAMP has been established and this forms a helpful model for future teams. The gaps that remain in this area include:

- Development of a central asset management vision that can be made meaningful to multiple levels with complementary goals
- A way to report progress and benefits as these goals are achieved

10.3.2.3 Change Management

GLWA is differentiated by its skilled communication and transformation resources. It has sophisticated and valued communication channels for disseminating information and a program for eliciting feedback and improvement opportunities from team members. Unlike many comparable utilities, GLWA has full-time organizational development practitioners. GLWA also has a desire to provide meaningful opportunities for training and development, and is actively improving its program to attract staff, as well as attract the participation of external stakeholders. GLWA itself was founded on the desire to become a "Utility of the Future," learning from its past but not constrained by it; this passion to do things better is embedded in its culture and drives a continuous improvement environment.

When comparing GLWA change management capabilities to best practice, there are some gaps.

- Transformation, training, communication, and organizational development responsibilities rest in different functions; there are no goals or structure in place to enable collaboration among staff to implement change management in support of asset management.
- Asset management communications lack a clear and compelling reason-for-change.
- A high aversion to risk and risk-based decision-making undercuts the organization's ability to innovate.
- Targeted sharing of information at a functional/work group/team level or location is not as strong as at the enterprise level.
- There is some resistance and distrust across the organization because of previous actions and initiatives.
- There is some lack of engagement due to change exhaustion and stress on team member resources.
- There is some resistance and lack of motivation from operational levels.

Section 10.3 topics are discussed further in the technical memo "Asset Management Organizational Assessment," dated March 20, 2019.

10.4 Asset Management Journey

GLWA intends to make meaningful progress toward its goal of being a leader in infrastructure management. GLWA understands that its desired state of asset management is a moving target and that asset management is best viewed as a journey not a destination. With that understanding GLWA has developed plans to achieve its desired state of asset management in ten to fifteen years. This is reasonable and can be achieved with clear expectations, focus on human resources and change management, leadership engagement

and resolve, and acknowledgement that the target will change with time due to external influences. Thus, the desired state must be one of continuous improvement. The greatest clarity of needs is provided by the IIs required in the upcoming five years.

In addition, GLWA will not achieve asset management maturity through a straight line of ascension from current to desired state. There are several reasons for this—different parts of the organization are likely to change at a pace faster or slower than others; resources needed for new systems, technologies, and processes may be available in some years and not others; external drivers such as regulatory requirements may be more influential for some parts of the organization than others; and GLWA team members serving as important change agents will jump start activities in their areas of influence while the transition in other areas may seem to stagnate without change agents. GLWA's pathway to asset management maturity may at times seem iterative and choppy. It is most important for there to be clarity of vision regarding the desired state, effective communication regarding expectations, and persistence.

10.4.1 Major Gaps

GLWA is well positioned for the asset management journey ahead based on strong leadership, dedicated and engaged team members, and the well-established AMSO.

However, several key elements are missing:

- Processes to support asset management principles, objectives, and expectations
- Clarity of asset management roles at the local level (i.e., outside of the EAMG)
- An operationalized risk framework
- A full set of performance indicators with line-of-sight to member partner expectations
- High quality and complete data, and an appreciation for data for decision-making
- Consistent use and effectiveness of technology systems needed for asset management
- A strategic and comprehensive change management effort for the asset management improvement work ahead

10.4.2 Organizational and Cultural Barriers

The biggest barrier to the organizational change required to mature with asset management at GLWA will be comfort with the status quo and resistance to change. However, a strategic change management plan will mitigate this barrier.

The approach through the work of the asset management Assessment, development of the SAMP, and development of the improvement initiatives is an important phrase heard

frequently at GLWA, that "People support what they create." This will continue to be the approach and will be accompanied by a focus on clarity of expectations and accountabilities.

In addition, there are two significant cultural norms that will require change:

1. It has not been a cultural norm at GLWA for processes to be documented and adhered to, or for process and outcome tracking to occur. Establishing clarity of processes will require focused attention and to some will feel like a distraction from core work. Communicating the importance of this at all levels will be important.
2. It has not been a cultural norm to rely on data for objective, transparent, and repeatable decision-making. While this does occur in some parts of GLWA, there is need for it to become the norm. This will require attention to quality of data, accessibility of data, and decision-making protocols.

10.5 Improvement Initiatives

10.5.1 About Improvement Initiatives

IIs are actions needed, typically sets of tasks and activities determined necessary in order to transition from GLWA's current asset management state to the desired state.

Over 200 IIs have been identified. Based on prioritization conducted by Jacobs with input from GLWA, there are about 50 IIs considered to be of high enough priority and urgency for attention at this time. The prioritization was based on the current state assessment and gaps discussed above.

10.5.2 Improvement Initiatives – First Five Years

The IIs are grouped into seven clusters (referred to as "swim lanes") due to similar topics and the close relationship of the IIs. There are also important relationships between IIs across swim lanes. Several IIs could logically be placed in more than one swim lane.

Each of these IIs will be initiated in the upcoming three to five years. Due to the importance for the II teams to have ownership and accountability, each team will propose the scope and schedule for their IIs. Coordination across each swim lane will be provided by the EAMG, with specifics of the coordination determined by the team responsible for II #02 (Asset Management Implementation Plan Management). Oversight for the IIs will be provided by the AMLT, though they may delegate some or all of this role to AMSO Satellite Teams.

The seven swim lanes, overall objectives of each, and the IIs within each are listed below.

Swim Lane: People Objective: Improve readiness for organizational change and make sure attention is given to the people-side of Asset Management	
II# P1 Dedicated Asset Management Team Members in Business Units (link)	Dedicate asset management professionals at the local level to partner with AMSO and the EAMG to develop, support, and implement Asset Management strategies.
II# P2 Asset Management Change Management Plan (link)	Develop a change management plan for asset management at GLWA. Section 8.3 describes the importance of change management at GLWA and presents a change management framework.
II# P3 Asset Management Communications (link)	Plan for communicating various aspects of asset management delivered in a way to help gain buy-in across the authority and connect asset management to GLWA team member's "day-to-day work." See Section 8.4 for discussion of current state and goals, audiences and information channels, key messages, and accountability.
II# P4 Asset Management Competencies, Learning, and Development (link)	Creation of a workforce development strategy to improve skillsets among team members for skills related to asset management. See Section 8.2 for discussion of strategies.
II# P5 Asset Management Job Descriptions (link)	Review job descriptions for GLWA positions directly supporting or closely related to asset management. Identify/add asset management competencies, specialty designations, skills, and roles.
II# P6 Business Process Master Map (link)	Identify all GLWA major business processes.
II# P7 Asset Management Business Processes (link)	Identify relevant asset management business processes, document how they relate to one another and the GLWA asset management objectives, then prioritize the processes for improvement and documentation. Where applicable, develop improved processes during collaborative team member workshops.
II# P8 Engagement and Networking (link)	Plan for asset management-related external stakeholder engagement and networking improvements. See SAMP Section 9.2 for discussion.
II# P9 Expanded Maintenance Training (link)	Deliver several maintenance training needs to team members for improving overall maintenance performance and asset reliability.

Swim Lane: Governance and Decisions Objective: Ensure that decisions are made by the right people at the right time, that there is clarity of decision-making protocols, and that decisions are carried out.	
II# G1 AMSO Team Coordination (link)	Bring in an individual to manage the AMLT meeting processes as well as the AMLT Satellite Teams, and the Wastewater and Water Asset Management Plan Teams.
II# G2 Embedded Asset Management Governance (link)	Review membership and modify the AMSO committees (AMLT and satellite teams), including re-chartering once IIs are decided upon, a strategy to communicate the new AMSO governance structure, training regarding decision-making principles used in the AMSO satellite teams, and clarification of the role of executive sponsor.
II# G3 Asset Renewal Decision Making (link)	Creation of deliberate, transparent, and repeatable processes for asset renewal decisions for situations where an asset risk score exceeds the risk tolerance level. Such documented decision models would reduce the need for individual business case evaluations.

Swim Lane: Governance and Decisions Objective: Ensure that decisions are made by the right people at the right time, that there is clarity of decision-making protocols, and that decisions are carried out.	
II# G4 Scheduled Replacement Program (SRP) (link)	Create a deliberate, transparent, and repeatable process for determining assets to be put on an SRP, and development of the SRP, most likely for assets that will be renewed based on schedule rather than condition or performance.
II# G5 Stage Gates (link)	Develop and implement a clearly defined set of check-in points during the project lifecycle.
II# G6 State of the Assets Report (link)	Prepare a regularly produced (annual or bi-annual) GLWA State of the Assets Report

Swim Lane: Service Levels and Performance Management Objective: Improve performance and ensure that targets are based on the desires of member partners, end users, and the public.	
II# S1 Refined Service Levels (link)	Continue the work of the SAMP Team B Service Levels sub-team, which will include further review and confirmation of service level objectives, plan for establishment of targets, review and confirmation of the enterprise service level categories and objectives, engagement with member partners, and assessment of service equity.
II# S2 Line of Sight Performance Management System (link)	Develop and implement a performance management system.
II# S3 Improved Performance Reporting (link)	Develop plan and implement performance and other data reporting.

Swim Lane: Risk Management Objective: Make sure funding decisions are based on achieving service level targets and that risk is considered in decision making.	
II# R1 Shift to Asset Risk-Driven Funding and Capital Improvement Program (CIP) Prioritization (link)	Define the pathway to transition from the current CIP prioritization process based in part on risks assumed to be reduced with projects to a CIP prioritization process for which projects emerge originally as the most cost-effective way to treat identified risks.
II# R2 Enhanced Business Case Evaluation (BCE) Process (link)	Modify the current BCE process, which primarily consists of preparation of project sheets that are used as part of the CIP prioritization process and are typically not a thorough exploration of the problem and development of alternatives.
II# R3 Risk and Critical Asset Assessment Process (link)	Develop a consistent approach and processes for determining the asset risk and critical asset score.
II# R4 Enterprise Risk Management (link)	Develop an enterprise risk management program, likely to consist of development of risk governance (such as a risk board), enterprise risk identification, risk scoring, assigning "risk owners" for treatments, determining treatments, development of an alternatives analysis process for determining which risk treatments should be chosen, and tracking in a risk register.
II# R5 Asset Risk Identification and Analysis (link)	Identify and analyze asset risk for all assets or on a subset of all assets based on a deliberate and informed screening.

Swim Lane: Risk Management Objective: Make sure funding decisions are based on achieving service level targets and that risk is considered in decision making.	
II# R6 Synchronized Asset Condition Scales (link)	Develop a consistent calibrated scale for asset condition, considering scales that are already in use.
II# R7 Condition Assessment Program for Horizontal Assets (link)	Develop a consistent program for assessing the condition of all horizontal asset classes across the authority.
II# R8 Condition Assessment Program for Vertical Assets (link)	Develop a consistent program for assessing the condition of all vertical asset classes across the authority, including buildings.

Swim Lane: Data and Technology Objective: Provide availability of accurate and useful data and ensure that technology systems support asset management.	
II# D1 Asset Management Information Systems Strategy (link)	Develop the strategy for Asset Management Information Systems (AMIS), including Enterprise Asset Management (EAM), geographical information system (GIS), and other asset-centric information technology systems.
II# D2 Asset Hierarchy (link)	Further develop and implement the new asset hierarchy.
II# D3 Consistent Data Standards (link)	Develop standards for data elements, including required attribute information, processes for input, auditing, updating, and retirement of data.
II# D4 Data Stewards (link)	Define the role of data steward, and also identify and train them.
II# D5 Asset Register/Key Data Clean-up (link)	Complete the clean-up and build-out of the Asset Register for all assets and users in WAM and GIS.
II# D6 Asset Audit Program with Tagging Standards (link)	Develop a business process for asset audits to review and updating EAM/GIS elements, then conduct asset audits to confirm/add/remove assets to the respective system.
II# D7 Useful Lives of Assets (link)	Review current information regarding useful lives of assets and begin a process to update as needed.
II# D8 Failure Codes and Work Order Types (link)	Review current and develop new and optimal failure codes and work order types for use across all of GLWA.
II# D9 asset management Info System Training Curriculum (link)	Develop and deliver training curriculum for AMIS to provide additional exposure to key asset management functionality that will benefit team members.
II# D10 Asset Costing Improvements (link)	Develop processes and put system and process improvements in place in order to have data regarding the full cost of asset ownership available for decision-making.

Swim Lane: Maintenance and Reliability Objective: Improve reliability through maintenance optimization.	
II# M1 Asset Area Cleanliness (link)	Drive and monitor asset area cleanliness.
II# M2 Formalized Work Management Policy (link)	Create a formal written work management policy and accompanying procedure that documents the expectations regarding work management and use of the EAM/computerized maintenance management system, including roles, responsibilities, and activities.
II# M3 Improved Planning and Scheduling (P&S) Function (link)	Improve the P&S function by reviewing the current work management processes; documenting updated desired consistent work management procedures (including roles, responsibilities, activities); providing training for planners and schedulers, as well as others with work management roles; providing additional tools; adding more personnel to manage load; and providing mentoring.
II# M4 Preventive Maintenance Optimization (PMO) (link)	Develop and implement a program to conduct PMO in a planned, deliberate, and objective way across all parts of GLWA (or some parts based on prioritization). PMO is a process to optimize maintenance plans for existing assets.
II# M5 Maintenance Best Practices (link)	Review current maintenance practices, then identify and document maintenance best practices.
II# M6 Formal Process for Engaging Operations and Maintenance (O&M) Team Members (link)	Develop formal process for engaging O&M team members in early asset lifecycle activities; for example, alternatives analysis and design review.
II# M7 Peer Exchange on Maintenance Best Practices (link)	Arrange and conduct site visits to other organizations performing maintenance activities at a best practices level, or these could be set up as peer exchanges (for which members of the other organization also visit GLWA).
II# M8 Reliability Analysis Program with Reliability Engineers (link)	Develop an asset reliability strategy and an analysis program to reduce asset failures and their associated risks, optimize asset maintenance, ensure asset service levels, and maximize asset uptime. Includes defining the responsibilities of the reliability engineer job, drafting job description(s), and hiring into the role
II# M9 Strategic Maintenance Reliability Program (link)	Create a strategic approach to maintenance and reliability, with the objective of developing a maintenance program composed of technically correct and cost-effective tasks. This is distinguished from M8 in that it is more broadly about optimization and cost effectiveness while M8 focuses mainly on reducing failures.
II# M10 Root Cause Analysis (link)	Develop a program for conducting routine problem solving to identify root causes of faults or problems that cause failures.

Swim Lane: Other Objective: Other activities needed for achievement of asset management desired outcomes.	
II# O1 AMPs (link)	Develop Asset Management Plans. See Section 6 for discussion.
II# O2 Asset Management Implementation Plan Management (link)	Provide overall coordination across all of the IIs, including identification of the team Executive Sponsor, team leader, extended team, as well as team chartering, scoping, schedule development, establishment of performance indicators for delivery of each II, and quarterly status reporting to AMLT. In addition, this II will include the process for capturing new IIs, prioritizing them, and for celebrating successes.
II# O3 Innovation Program (link)	Continue development of GLWA's innovation program in conjunction with asset management.
II# O4 Commissioning (link)	Plan for commissioning new assets, as well as capturing and loading asset data.
II# O5 Asset Decommissioning and Salvage Process (link)	Develop a consistent process for decommissioning assets at the end of their lifecycle. The process should include failure analysis, maintenance history review, proper indication of the removed or abandoned asset in the asset data systems, total cost of ownership calculation, and ensuring that hazardous materials are properly handled and disposed of.
II# O6 Future Asset Management Assessments and Benchmarking (link)	Develop a plan for future asset management assessments. Communicate internally its intention to continue participation in industry benchmarking and to oversee future asset management assessment and benchmarking activities.

Appendix G shows a graphical representation of the IIs in swim lanes.

10.5.3 Improvement Initiatives – Beyond Five Years

Additional IIs required for achievement of the desired state are listed below. This list is likely to be modified from time to time based on GLWA team member learnings and external influences. Some may be incorporated into the IIs listed above (if approved by the AMLT) or addressed by efforts outside of this Asset Management Implementation Plan.

People

- Enhance network of champions for AMSO activities
- Expand cross-functional collaboration
- Job descriptions across all of GLWA
- Knowledge management/succession planning

Governance and Decisions

- Benefits tracking
- Decision making rules and tools (additional)
- Develop additional internal economic analysis capability
- Regional infrastructure management
- Triple bottom line assessments

Service Levels and Performance Management

- Service equity
- Affordability and willingness-to-pay studies

Risk Management

- Insource/outsource strategies

Data and Technology

- Advanced technologies
- Software upgrade management plan
- Software integration plan
- Mobile technology deployment

Maintenance, Operations, and Reliability

- Asset acceptance processes
- Configuration management policy and process
- Consumables, spares, and inventory management
- Defect elimination
- Design for reliability
- Improve lubrication management
- Improve obsolescence management
- Maintenance work groups
- O&M procedures documentation
- Operations improvements, including operator-driven reliability
- Operations monitoring
- Reliability centered maintenance

Other

- Audit and review
- Contracting, supply chain approaches, procurement best value
- Customer outreach portal
- Design standards and specification
- Document management
- Forward planning, including demand projections and scenario planning
- New product and technology review process
- Obsolescence management
- Online forms
- Planning and design change control

- Post project reviews
- Program optimization, monitoring, and reporting
- Purchasing strategy and vendor selections
- Quality management
- Supply and demand balancing

10.5.4 Success with Improvement Initiatives

The following are several keys to successful implementation of IIs:

1. **Line of Sight to Overall Organizational Vision as well as the GLWA Asset Management Vision and Objectives.** It is important for team members working on IIs and for outside observers to understand how each initiative supports GLWA's vision, strategy, and objectives.
2. **Clarity of Objectives.** It is important that the goal of each initiative is clear and for there to be clarity regarding the outcomes. That is, the team working on the II must discuss and agree upon "what is the problem we are solving" and "how will we know when we're done," and the appropriate governance body (in this case mostly the AMLT) must concur. In addition, scope management is important, since during the course of working on an II, there may be forces in play to change (increase or decrease) scope.
3. **Ownership and Accountability.** Clarity of leadership and team operations, as well as clarity and communication of milestone completion targets is important in order to predict and measure progress. Frequently, one II is dependent on others or has impact on others, so there are predecessor and successor relationships and interfaces that need to be identified and managed.
4. **Business Unit Engagement, Team Identification, and Team Chartering.** GLWA team members with knowledge of current processes and those that are likely to be impacted by changed processes must be engaged in the II. Preparation of a RACI chart (to identify those who will have responsibility, accountability, be consulted, and be informed) will be helpful. In addition, deliberate chartering of the teams to establish clear expectations will be critical.
5. **Executive Sponsorship.** The most important and broad-reaching II should have an Executive Sponsor to help provide oversight, make sure resources are available, and assist in managing challenging interfaces and external stakeholder relations. It is important that the Executive Sponsor have a sense of urgency regarding the initiative and adequate time to focus and assist the team.
6. **Resources.** Work on IIs must not be considered to be additional responsibilities beyond an individual team member's regular work duties, without appropriate time or skilled staffing being made available. There should be clarity regarding how and

how much time team members are expected to work on the IIs, and how that team member's regular work will be accomplished. While impacted team members must be engaged in IIs, there also needs to be consideration to not impact ongoing operations. At GLWA, due to high workloads of key team members, effective team management, best practice meeting operations, and overall efficient use of team member time is important.

7. **Pacing, Sequencing, and Change Management.** GLWA must be cautious to not expect too much change to occur all at once. That is, do not take on too many IIs all at once. In many cases, IIs successfully implemented will result in efficiencies. However, they generally also introduce changed processes, new tools, and new work group relationships. Taking the time to understand and manage impacts on people and to deliberately manage organizational change is important.

For major IIs, it is important to conduct similar planning, scoping, team chartering, and tracking processes that are used for best practice capital project delivery. This is referred to as "projectizing" the II, and while it may require initial up-front tasks, it will be beneficial in that it helps to increase likelihood of success.

Each of the items listed above as well as the concepts of "projectizing" must be applied at the appropriate scale. For small and straightforward IIs, more streamlined processes may be applied, or some steps may be skipped. For more complex and higher risk IIs, there is benefit to greater investment in the processes because implementation risks will be reduced. Selection of these processes should be appropriate to the need of the II.

10.6 Sequencing, Pacing, Agile Delivery, Schedule, and Resources

10.6.1 Sequencing Improvement Initiatives

For many IIs there are predecessors and successors. In some instance, predecessor IIs are helpful but not required. In many instances there can be efficiencies in team member work if IIs are planned and delivered concurrently. These considerations are being addressed in development of the asset management roadmap.

10.6.2 Pace of Change

GLWA intends to achieve the desired state in 10 to 15 years. This is somewhat aggressive when considering the amount of cultural change required. Defining and incorporating new technology tools and modifying and embedding new business processes is time consuming.

10.6.3 Agile Delivery

Many concepts of agile project management should be applied to GLWA's asset management transformation. A primarily benefit of agile project management is the ability

to learn from successes and failures, respond to issues as they arise, and make course corrections as needed based on changing internal and external drivers.

With asset management IIs there is a need to collaborate across functional areas of the organization and a general desire to implement solutions as soon as possible, which is frequently a benefit to utilizing a pilot project approach for which new processes can be developed and tested for limited work groups prior to undergoing refinement then full implementation. These features, along with examples of success in other organizations where decision-making is deliberately pushed into the organization, lead to a type of agile delivery as a good fit.

10.6.4 Schedule

The schedule for the IIs will be provided in a separate document.

10.6.5 Resources

The IIs necessary to transition from the current to the desired state of asset management will require greater resources than have historically been dedicated to asset management at GLWA. Resource estimates for GLWA's asset management journey will be provided in a separate document.

10.7 Measuring Progress

10.7.1 Interim Targets

Interim targets toward achievement of the asset management desired state will be established with a combination of two methods:

1. Upon confirmation of resourcing of the IIs, a target can be established for completion of a group of them by a certain date. For example, all of those listed above within the "First Five Years" grouping must be substantially complete by June 2024. The team assigned to II# O2 (Asset Management Plan Implementation Management) will track this.
2. Establish targets as part of II# S2 (Line-of-Sight Performance Management System). With this a combination of performance indicators and key performance indicators will be selected with targets proposed for achievement by June 2024.

Additional interim targets will be established for achievement at each fiscal year end—June 2020, June 2021, June 2022, and June 2023.

10.7.2 Overall Progress Toward Desired State

In order to track GLWA's progress toward the asset management desired state, the following will be measured routinely (monthly or quarterly):

1. Achievement of Service Level Objectives
2. Performance Indicators
3. Accomplishment of Improvement Initiatives

10.7.3 Tracking Service Levels

The only way to truly understand GLWA's progress with asset management is to track service level actuals relative to targets established with meaningful input from member partners, end users, and the public. Thus, II# S1 (Refined Service Levels) is very important. Along with this, GLWA must understand and achieve expectations regarding affordability and willingness-to-pay.

10.7.4 Performance Indicators

Performance indicators will be identified by the team working on II# S2 (Line of Sight Performance Management System), and these indicators will provide a structure to track progress.

10.7.5 Tracking Progress on Improvement Initiatives

Initial scope and schedule development for each II will be developed by each II team and reviewed. Then it must be approved by the AMLT (or a designee of the AMLT). Once this is completed and other II chartering activities are complete, the work of the II team will begin. Quarterly reports will be submitted for compilation into an II Progress Report to be reviewed by AMLT (or a designee of the AMLT). The team assigned to II# O2 (Asset Management Plan Implementation Management) will establish specifics for this process.

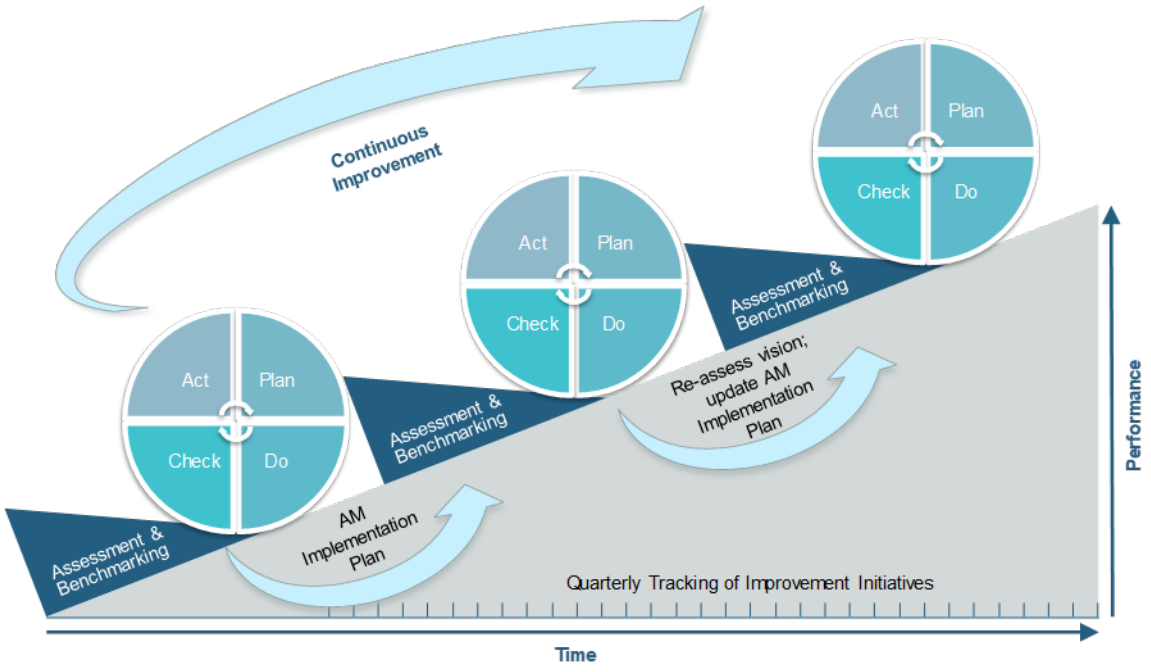
Newly identified IIs will be delivered to the EAMG, and this group will determine if immediate action needs to be taken and coordinate with AMLT for approval and resource allocation. In no less than once a year, the EAMG will arrange a process for re-prioritization of the IIs and determination of those to be initiated in the coming year. This process will happen concurrent with the GLWA budgeting process.

10.7.6 Future Asset Management Assessments

GLWA intends to participate in future WSAA Asset Management Assessment and Benchmarking, and the most desirable year for this will be 2022, 2023, or 2024. The team assigned to II# O6 (Future Asset Management Assessments and Benchmarking) will make a proposal regarding this.

The graphic below illustrates an approach wherein an assessment is conducted about once every four or five years. Following each assessment, the organization revisits the implementation plan and adjusts based on implemented improvement, learnings, and modified targets.

Figure 10-7: Asset Management Assessments Drive Improvements



10.8 Next Steps

The asset management Implementation Plan Schedule and Resource Requirements will be reviewed and approved by the AMLT, and decisions will be made regarding sponsorship. AMLT will identify leadership and team members for each II expected to be initiated in the upcoming year. Identification and chartering of the team delivering II# 02 (Asset Management Implementation Plan Management) will occur first. Upon completion of this, chartering for all of the teams intended to be initiated in the upcoming year will occur.

Status of the IIs will be tracked quarterly in an II Register. New IIs will be added to the II Tool, prioritized periodically, and resourced if determined to be urgent. About once per year there will be a strategic re-assessment of the entire list of IIs, including the prioritization criteria.

Appendix A – Acronyms and Abbreviations

Term	Definition
ACO	Administrative Consent Order
AM	Asset Management
AMIS	Asset Management Information System
AMLT	Asset Management Leadership Team
AMP	Asset Management Plans
AMS	Asset Management System
AMSO	Asset Management Strategic Organization
AMT	Asset Management Team
AMWA	Association of Metropolitan Water Agencies
API	Application Programming Interface
AWWA	American Water Works Association
BCE	Business Case Evaluation
BDF	Biosolids Drying Facility
CIP	Capital Improvement Program
CM	Corrective Maintenance
CMMS	Computerized Maintenance Management System
CoF	Consequence of Failure
CRL	Certified Reliability Leader
CSO	Combined Sewer Overflow
DWRF	Drinking Water Revolving Fund
DWSD	Detroit Water and Sewerage Department
EAM	Enterprise Asset Management
EGLE	(Michigan Department of) Environment, Great Lakes, and Energy (formerly MDEQ)
EH&S	Environmental Health and Safety
ELT	Executive Leadership Team
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERP	Enterprise Resource Planning
ETL	Extract, Transform, Load
EUM	Effective Utility Management
FMEA	Failure Modes and Effects Analysis
FP&A	Financial Planning & Analysis
GDRSS	Greater Detroit Regional Sewer System
GFMAM	Global Forum on Maintenance & Asset Management
GIS	Geographic Information System

Term	Definition
GLWA	Great Lakes Water Authority
I&E	Improvement and Extension
IACET	International Association for Continuing Education and Training
IAM	Institute of Asset Management
II	Improvement Initiatives
IIMM	International Infrastructure Management Manual
IPWEA	Institute of Public Works Engineering of Australasia
ISO	International Standards Organization
IWA	International Water Association
KPI	Key Performance Indicator
LMS	Learning Measurement System
LoF	Likelihood of Failure
MDEQ	Michigan Department of Environmental Quality (now EGLE)
MGD	Million Gallons per Day
MIC	Michigan Infrastructure Council
NACWA	National Association of Clean Water Agencies
NEFCO	New England Fertilizer Company
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OWI	One Water Institute
PdM	Predictive Maintenance
PFAS	Perfluoroalkyl substances
PI	Performance Indicators
PM	Preventive Maintenance
PMIS	Program Management Information System
ROW	Right of Way
RTB	Retention Treatment Basins
RTFs	Retention Treatment Facilities
SAMO	System Analytics Meter Operations
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SDF	Screening and Disinfection Facilities
SDWA	Safe Drinking Water Act
SEMCOG	Southeast Michigan Council of Governments
SME	Subject Matter Expert
SRF	State Revolving Fund
TCO	Total Cost of Ownership

Term	Definition
WAM	Work and Asset Management (an Oracle software product)
WAMC	Water Asset Management Council
WAMP	Water AMP
WAMR	Wholesale Automated Meter Reading
WAMT	Water Asset Management Team
WEF	Water Environment Federation
WIFIA	Water Infrastructure Finance and Innovation Act
WMAC	Water Asset Management Council (State of Michigan)
WRF	Water Research Foundation
WRRF	Water Resource Recovery Facility
WSAA	Water Services Association of Australia
WTP	Water Treatment Plant
WwAMP	Wastewater AMP
WWAMT	Wastewater Asset Management Team

Appendix B – Glossary of Terms and Definitions

Term	Definition
Asset	Item, thing or entity that has potential or actual value to GLWA.
Asset hierarchy	A representation of the relationship between assets arranged in a parent-child format
Asset lifecycle	Period from asset creation to asset end-of-life
Asset management information system (AMIS)	A combination of processes, data, software, and hardware, such as a CMMS, applied to enable the essential outputs for effective asset management
Asset management objectives	Results to be achieved with respect to asset management
Asset management plan	Documented information that specifies the activities, resources and timescales required for an individual asset, or a grouping of assets, to achieve the organization's asset management objectives
Asset management policy	A high-level statement of an organization's principles and approach to asset management
Asset management roadmap	A simple schedule that represents the intended timing to implement improvement initiatives
Asset Management Strategic Organization (AMSO)	A collection of satellite teams under the stewardship of the Asset Management Leadership Team (AMLT) that support asset management initiatives and goals at GLWA. AMSO's vision is to provide guidance for how GLWA maintains its vast array of assets, including water, wastewater, facilities, fleet, horizontal and vertical assets.
Asset management strategy	(1) A high-level action plan that gives effect to an organization's asset management policy. A strategic asset management plan is a form of, and meets the requirements for, an asset management strategy. (2) Documented information that specifies how the organizational objectives are to be converted into asset management objectives, the approach for developing asset management plans, and the role of the asset management system in supporting achievement of the asset management objectives
Asset management system (AMS)	The set of interacting and interrelated elements that guide the development and implementation of asset management activities
Asset portfolio	Assets that are within the scope of the asset management system
Asset register	The select list of assets, along with their attributes, that are managed under the umbrella of the asset management policy, principals, and practices
Authority	Great Lakes Water Authority
Business case evaluation	An evaluation of the objectives of an investment proposal and an analysis for each project alternative. It includes review of the value for money, scope, costs and benefits, risks, and schedule. The business case evaluation provides enough information such that an investment option can be chosen, based on an objective appraisal of the relative strengths and weaknesses of alternatives to meet a stated business objective, often captured in a comprehensive lifecycle cost analysis. (American Water Works Association
City	City of Detroit
Computerized maintenance management system (CMMS)	A software and information system tool for planning, coordination, scheduling of maintenance activities, the labor resources to deliver them, and other essential supporting resources

Term	Definition
Continual improvement	Recurring activity to enhance performance
Data management	The data and information held within an organization's assets information systems and the process for the management and governance of that data and information
Fixed (capital) asset	An item that has an estimated useful life of over one-year and have a value greater than or equal to $5,000
Improvement Initiatives (IIs)	Sets of tasks and activities determined necessary in order to transition from GLWA's current asset management state to the desired state
Infrastructure asset	A physical item or group of items that may include plants, equipment, buildings, property, pipelines, pumps, other infrastructure, and other items that have potential or actual value to the organization; infrastructure assets are the items that contribute to the production and delivery of the utilities' service to the community or group of customers
ISO 55000	International standard covering management of assets of any kind
Key performance indicator (KPI)	Measures performance that has a significant impact on the primary goals of GLWA
Lagging performance indicator	Measure outcomes
Leading performance indicator	Measures a process
Maintenance managed item	An asset or component that exists generally at the lowest level in the asset hierarchy and for which an owner will make management decisions to repair, rehabilitate, or typically replace instead of running to failure
Member partners	The entities with whom GLWA has a contract to provide water or wastewater services
Performance Indicator	A qualitative or quantitative measure of performance
Qualitative performance indicator	May be expressed using numbers, but the input is subjective
Quantitative performance indicator	Use metrics and are objective and data driven
Risk	Effect of uncertainty on objectives
Service level	Statements of desired performance outcome established by GLWA that reflect high priority to member partners, end users, the public, the environment, or required by regulators; are largely within the control of GLWA; and have performance level data that can be accurately and consistently collected and audited. Note that the term "level of service" refers to equipment only.

Appendix C – References

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Appendix D – GLWA Asset Management Policy

GLWA
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ASSET MANAGEMENT POLICY

Number - 205.7

Purpose

The Asset Management Policy provides the framework and principles by which the Great Lakes Water Authority (GLWA) will ensure sound stewardship of its regional assets to deliver established service levels in the most effective and efficient manner, while maintaining compliance with regulations.

Definitions

The following terms used within this policy are defined:

Asset means items, thing or entity that has potential or actual value to GLWA.

Asset lifecycle means stages involved in the management of an asset during its life. These stages include system and asset planning; design, construction, and acquisition; commissioning; operations and maintenance; renewal; and decommissioning.

Asset management means an integrated set of principles, processes, and behaviors, to optimize the lifecycle costs of infrastructure assets, at an appropriate level of risk, while continuously delivering established service levels.

Asset management plan means documented information that specifies the activities, resources and timescales required for an individual asset, or a grouping of assets, to achieve the organization's asset management objectives.

Asset Management Policy means a high-level statement of GLWA's asset management principles and approach to asset management.

Continual improvement means recurring activity to enhance performance.

Data management means the data and information held within GLWA's assets information systems and the process for the management and governance of that data and information.

Risk means effect of uncertainty on objectives.

Service levels means statements of desired performance outcomes established by GLWA that reflect high priority to member partners, end users, the public, the environment, or required by regulators; are largely within the control of GLWA; and have performance level data that can be accurately and consistently collected and audited.

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Policy

To achieve GLWA's vision and mission, it is the policy of GLWA to coordinate optimal management of the region's assets in order to provide water and wastewater services at established service levels. GLWA will use best asset management practices in a strategic, comprehensive and organization-wide manner. Asset investments will be optimized through robust and transparent decision-making considering the entire asset lifecycle. GLWA will allocate asset management responsibilities and resources to ensure Team Members are appropriately trained and assigned to develop and implement asset management strategies, plans and procedures. GLWA is committed to providing high quality service, and measuring, tracking and reporting performance with the goal of continual improvement.

GLWA will employ the following principles for managing its assets:

1. Member-Focused. Meet established service levels and continue to engage with our team members, member partners and other stakeholders to communicate outcomes and obtain feedback on our performance and the services they value.

2. Safety. Employ the necessary means and methods to protect the public from hazards involving our activities, ensure that our equipment is designed for safety, that our team members are trained and have and use the knowledge, tools, and supplies to protect them from harm.

3. Lifecycle Approach. Consider whole-life costing when evaluating alternatives; manage all aspects of the asset lifecycle, including the full costs of planning, designing, acquiring, constructing, commissioning, operating, maintaining, renewing and retiring our assets.

4. Forward-Looking. Make decisions to better enable our assets to meet the social, environmental, financial and regulatory challenges of the future; consider long-term consequences of short-term activities.

5. Managed Risk. Understand how risk changes over time; regularly assess the consequences and likelihood of asset failure so that resources and priorities can be directed to treat risks to a tolerable level.

6. Data-Driven. Capture and leverage current and reliable data; employ sound data governance and data management procedures to support informed lifecycle decision-making.

7. Transparent. Commit to systematic, repeatable, objective, data-driven, and auditable decision-making with an open approach to sharing appropriate and meaningful information.

8. Innovative. Implement non-traditional, innovative solutions considering people, processes, technology, project delivery, funding, resources, operations and maintenance, and other aspects of the asset lifecycle.

Procedure

The Asset Management Leadership Team (AMLT) is the governing body with authority over asset management practices and implementation.

AMLT will propose any future modifications to this policy and will review for concurrence any team-specific policies having to do with asset management, prior to submittal to the Organizational Development Group, and subsequent submittal to the GLWA CEO.

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Responsibility

1. Team Member

   Review, understand and comply with this policy. It is the team member's responsibility to obtain proper interpretation and clarification on this policy from Management, and/or the Organizational Development Group.

2. Management

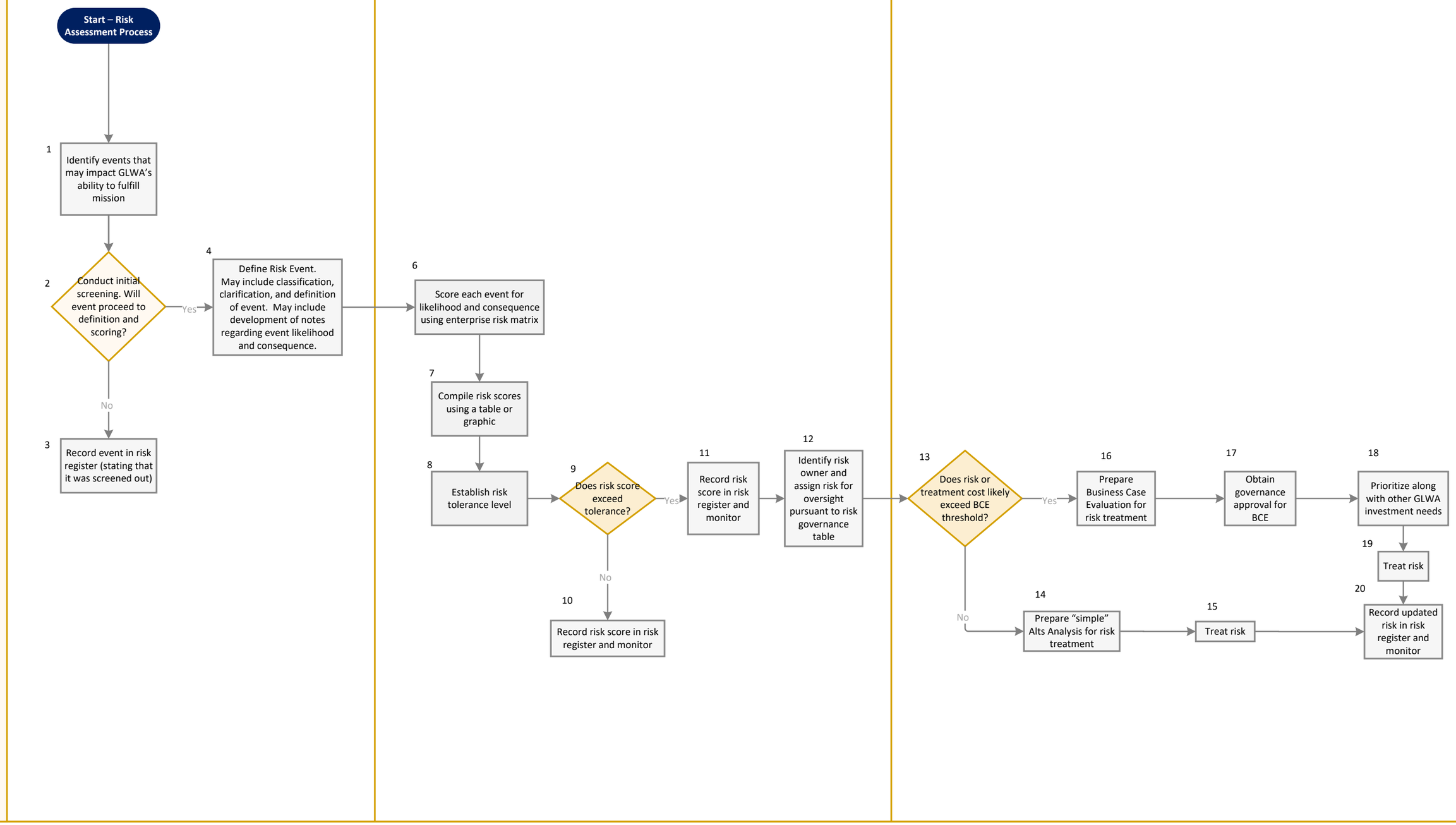
   Ensure adherence and compliance with this policy within their area(s) of responsibility.

Issued by the CEO

Sue F. McCormick

Appendix E – Enterprise Risk Process and Scoring Matrices

Business Process: Enterprise Risk Process – DRAFT



ENTERPRISE RISK CONSEQUENCE OF FAILURE (CoF) MATRIX

Consequence Score	1	2	3	4	5
Category	*Insignificant*	*Minor*	*Moderate*	*Major*	*Extreme*
Regulatory Compliance	• Event will not cause regulatory/permit violation, enforcement infraction, or unregulated discharge • No effect on mandated/enforceable program • Event results in no significant fine	• Event may have some local impact • Event will impact ability to meet expected future requirements • Event will lead to non-compliance event in the near future	• Event will cause moderate regulatory/permit violation, enforecement infraction, unregulated discharge, other non-compliance, permit violations, or significant regulatory scrutiny • Event will impact mandated/enforceable program	• Event will cause major regulatory/permit violation, enforecement infraction, unregulated discharge, other non-compliance, permit violations, or significant regulatory scrutiny • Event will impact mandated/enforceable program	• Event will cause extreme regulatory/permit violation, enforecement infraction, unregulated discharge, other non-compliance, permit violations, or significant regulatory scrutiny • Event will impact mandated/enforceable program
Impact to Service Levels	• No impact on service levels	• Event impacts one wholesale and less than 1,000 retail customers for one day or less • Event impacts no critical customers	• Event impacts one wholesale and less than 1,000 retail customers for one week or less • Or, event impacts 2-5 wholesale customers and less than 10K retail customers for one day or less • Or, event impacts one critical customers	• Event impacts one wholesale and less than 1,000 retail customers for one month or less • Or, event impacts 2-5 wholesale customers and less than 10K retail customers for one week or less • Or, event impacts 6-10 wholesale customers and less than 100K retail customers for one day or less • Or, event impacts 1-3 critical customers	• Event impacts one wholesale and less than 1,000 retail customers for more than one month • Or, event impacts 2-5 wholesale customers and less than 10K retail customers for more than one week • Or, event impacts 6-10 wholesale customers and less than 100K retail customers for more than a day • Or, event impacts more than 11 wholesale customers and more than 1M retail customers for any period of time • Or, event impacts more than three critical customers
Financial Impact	• Event can be addressed within available budgeted resources; no separately identifiable impact on service charges	• Event requires budget modification including reduction to other programs and projects; no separately identifiable impact on service charges	• Event requires unbudgeted use of improvement and extension funds and/or emergency repair and replacement funds; impacts customer charges by no more than 1%	• Event requires the advancement of the forecasted timeline for borrowing; impacts customer charges by no more than 2%	• Event requires immediate borrowing; impacts customer charges by more than 2%
Health & Safety	• Event results in use of first aid supplies but no lost time • Or, event results in a near miss to one or more team member or the public	• Event results an injury requiring treatment away from the workplace • Or, event results a team member reassignment to light duty • Or, event results in a major near miss to several team members or significant members of the public	• Event leads a team member lost time event • Or, event leads to a treatable injury to a member of the public • Or, event leads to an OSHA violation	• Event will result in one or more team member or public injury • Or, one or more team member permanent loss of ability to perform job	• Event will result in measurable team member or public health events including exposure to contaminants or hazardous materials • Event will result in one or more team member death or permanent disability
Public Impact	• Event leads to no measurable impact on City/regional/neighborhood growth plans	• Event will have minor impact on City/region/neighborhood growth • Or, event will have minor but measurable impact on economic development • Or, event will have minor but measurable impact on quality of life or aesthetics	• Event will have moderate impact on City/regional/neighborhood growth • Or, event will have moderate impact on economic development • Or, event will have moderate impact on quality of life or aesthetics	• Event will restrict planned City/regional/neighborhood growth • Or, event will have major impact on economic development • Or, event will have major impact on quality of life or aesthetics	• Event will restrict planned City/regional/neighborhood growth • Or, event will have extreme impact on economic development • Or, event will have extreme impact on quality of life or aesthetics
Environmental Stewardship	• No harm to resident biota or their habitat • Or, release of non-harmful substances • Or, if release of harmful substances, it does not exceed reportable quantities • Cleanup achieved with commonly available materials	• Event results in minor short-term reversible impacts in a localized area • Ecosystem function not significantly impared • No remediation required	• Event results in significant but reversible impacts on the environment • Or, temporary loss of ecosystem function • Or, any remediation required	• Event results in non-reversible impacts to the environment • Or, significant remediation in a localized or broad area	• Event results in environmental damage with permanent loss to ecosystem, including severe degradation of watershed or loss of habitat • Or, event results in significant death to state priority or federally endangered species
Public Trust	• Few customer complaints • No media coverage • No impact on GLWA image or relationships	• Event results in several complaints made to GLWA • Or, minor local media inqueries • Or, minor impact on GLWA image or relationships	• Event results in moderate local media coverage or editorial comment • Or, national media inqueries • Or, complaints elevated to the Board level	• Event results in significant local media coverage or editorial • Or, citizen satisfaction survey indicates unacceptable performance	• Intervention from external authorities (state or federal) • Or, daily local negative news stories and national news coverage • Lasting damage to GLWA image, existing relationships, and public confidence

ENTERPRISE RISK LIKELIHOOD OF FAILURE (LoF) MATRIX

Likelihood Score	1	2	3	4	5
	Rare	*Unlikely*	*Possible*	*Likely*	*Near Certain*
ENTERPRISE - **Description**	Event possible but unlikely to occur within the next 50 years	Event likely to occur within the next 50 years	Event likely to occur within the next 10 years	Event likely to occur within the next 5 years	Event has occurred, or high probability of event occurring within the next year
- **Likelihood in Any Given Year**	<2%	2% to 10%	11% to 20%	21% to 90%	>90%
- **Frequency**	Less than once every 50 years	Once every 10 to 50 years	Once every 5 to 10 years	Once every 1 to 5 years	At least once every year or two

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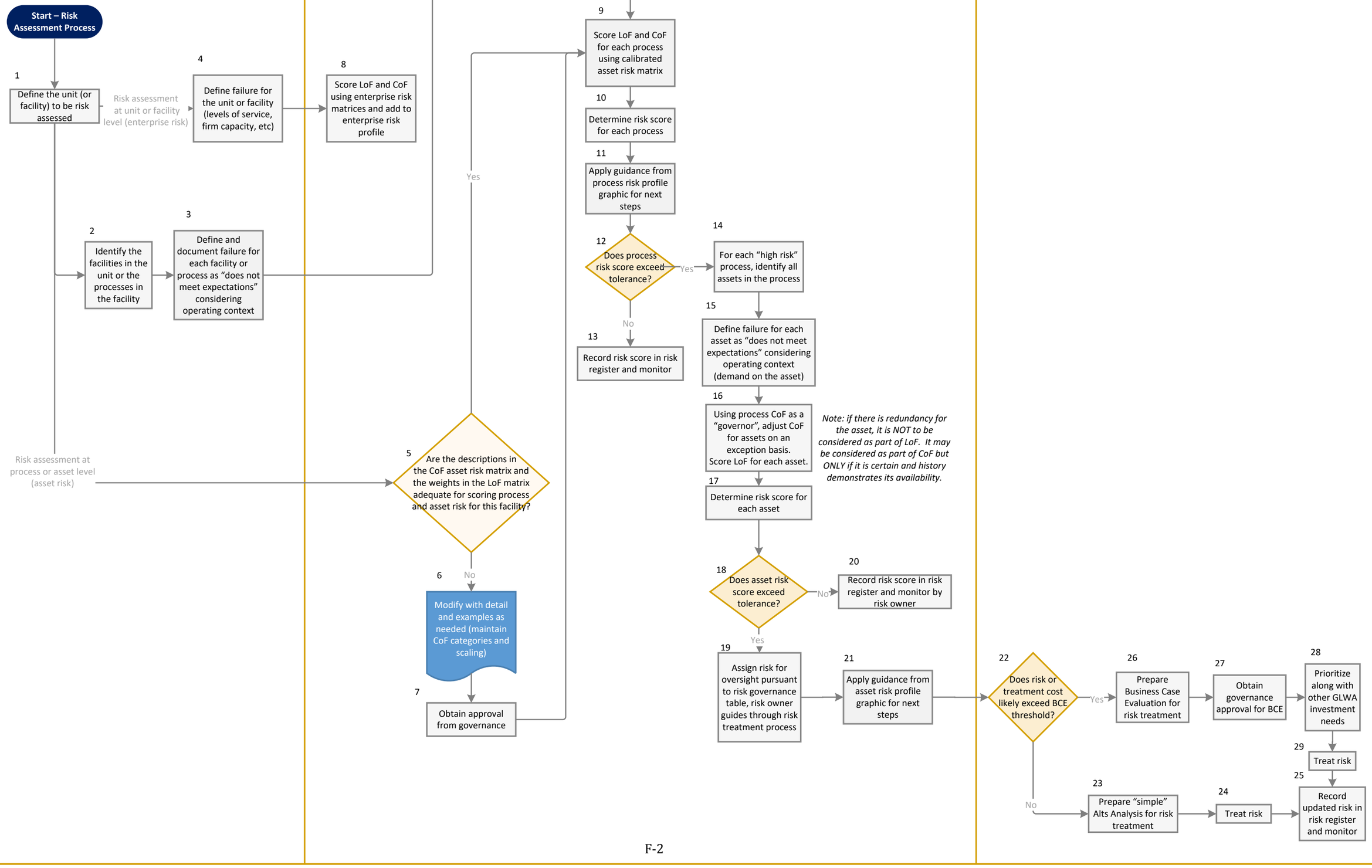
Appendix F – Asset Risk Process and Scoring Matrices

Business Process: Asset Risk Process – DRAFT

Risk Assessment Team
(may be part of an AMP Team)

Risk Identification | Risk Analysis | Risk Treatment



GLWA ASSET RISK SCORING CALIBRATION

ASSET RISK CONSEQUENCE OF FAILURE (CoF) MATRIX

Consequence Score	1	2	3	4	5
Category	*Insignificant*	*Minor*	*Moderate*	*Major*	*Extreme*
Regulatory Compliance	• Failure will not cause regulatory/permit violation, enforcement infraction, or unregulated discharge • No effect on mandated/enforceable program • Failure results in no significant fine	• Failure may have some local impact • Failure will impact ability to meet expected future requirements • Failure will lead to non-compliance event in the near future	• Failure will cause moderate regulatory/permit violation, enforecement infraction, unregulated discharge, other non-compliance, permit violations, or significant regulatory scrutiny • Failure will impact mandated/enforceable program	• Failure will cause major regulatory/permit violation, enforecement infraction, unregulated discharge, other non-compliance, permit violations, or significant regulatory scrutiny • Failure will impact mandated/enforceable program	• Failure will cause extreme regulatory/permit violation, enforecement infraction, unregulated discharge, other non-compliance, permit violations, or significant regulatory scrutiny • Failure will impact mandated/enforceable program
Impact to Service Levels	• No impact on service levels, facility levels of service, or processes	• Failure will have minor impact to service levels or facility levels of service or processes for a day or less	• Failure will have minor impact to service levels or facility levels of service or processes for up to a week or major impact for a day or less	• Failure will have minor impact to service levels or facility levels of service or processes for up to a month or major impact for up to a week	• Failure will have minor impacts to service levels or facilty levels of service or processes for over a month or major impacts for more than a week
Financial Impact	<$10,000	$10,000 to $50,000	$50,000 to $250,000	$250,000 to $1,000,000	>$1,000,000
Health & Safety	• Failure (or immediate resolution of the failure) results in use of first aid supplies but no lost time • Or, results in a near miss to one or more team member or the public	• Failure (or immediate resolution of the failure) results an injury requiring treatment away from the workplace • Or, results a team member reassignment to light duty • Or, results in a major near miss to several team members or significant members of the public	• Failure (or immediate resolution of the failure) leads a team member lost time event • Or, leads to a treatable injury to a member of the public • Or, leads to an OSHA violation	• Failure (or immediate resolution of the failure) will result in one or more team member or public injury • Or, one or more team member permanent loss of ability to perform job	• Failure (or immediate resolution of the failure) will result in measurable team member or public health events including exposure to contaminants or hazardous materials • Or, will result in one or more team member death or permanent disability
Public Impact	• Failure leads to no measurable impact on City/regional/neighborhood growth plans	• Failure will have minor impact on City/region/neighborhood growth • Or, failure will have minor but measurable impact on economic development • Or, failure will have minor but measurable impact on quality of life or aesthetics	• Event will have moderate impact on City/regional/neighborhood growth • Or, failure will have moderate impact on economic development • Or, failure will have moderate impact on quality of life or aesthetics	• Failure will restrict planned City/regional/neighborhood growth • Or, failure will have major impact on economic development • Or, failure will have major impact on quality of life or aesthetics	• Failure will restrict planned City/regional/neighborhood growth • Or, failure will have extreme impact on economic development • Or, failure will have extreme impact on quality of life or aesthetics
Environmental Stewardship	• No harm to resident biota or their habitat • Or, release of non-harmful substances • Or, if release of harmful substances, it does not exceed reportable quantities • Cleanup achieved with commonly available materials	• Failure results in minor short-term reversible impacts in a localized area • Ecosystem function not significantly impared • No remediation required	• Failure results in significant but reversible impacts on the environment • Or, temporary loss of ecosystem function • Or, any remediation required	• Failure results in non-reversible impacts to the environment • Or, significant remediation in a localized or broad area	• Failure results in environmental damage with permanent loss to ecosystem, including severe degradation of watershed or loss of habitat • Or, failure results in significant death to state priority or federally endangered species
Public Trust	• Few customer complaints • No media coverage • No impact on GLWA image or relationships	• Failure results in several complaints made to GLWA • Or, minor local media inqueries • Or, minor impact on GLWA image or relationships	• Failure results in moderate local media coverage or editorial comment • Or, national media inqueries • Or, complaints elevated to the Board level	• Failure results in significant local media coverage or editorial • Or, citizen satisfaction survey indicates unacceptable performance	• Intervention from external authorities (state or federal) • Or, daily local negative news stories and national news coverage • Lasting damage to GLWA image, existing relationships, and public confidence

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Great Lakes Water Authority

GLWA ASSET RISK SCORING CALIBRATION

ASSET RISK LIKELIHOOD OF FAILURE (LoF) MATRIX

	Likelihood Score		1	2	3	4	5
			Rare	*Unlikely*	*Possible*	*Likely*	*Near Certain*
	Category (depends on type of asset)	**Weight (may be zero)**	**BELOW EXAMPLE FOR ILLUSTRATION PURPOSES ONLY. TO BE DETERMINED AS APPROPRIATE FOR EACH ASSET TYPE. FOR MOST ASSET TYPES ONLY A FEW CATEGORIES WILL APPLY.**				
ASSET	**Remaining Useful Life**	**20%**	81% to 100%	51% to 80%	21% to 50%	6% to 20%	0% to 5%
ASSET	**Performance**	**15%**	Sufficient capacity to meet average and peak flow requirements. Appropriate utilization and function.	Under-utilized or oversized, causing O&M issues.	Meets current functional demand but limited degradation availability	-	Unable to meet current average capacity needs. Functionally Failed
ASSET	**History of Reliability**	**10%**	No unscheduled corrective work order events within 12 months	-	1-3 unscheduled corrective work order events within 12 months	-	>3 unscheduled corrective work order events within 12 months
ASSET	**Physical Condition**	**30%**	Very good. Condition Grade 1. New or nearly new. Only normal maintenance required.	Good. Condition Grade 2. Minor wear.	Fair. Condition Grade 3. Major wear impacting level of service.	Poor. Condition Grade 4. Unable to meet level of service life. Failure imminent.	Very poor. Grade 5. Requires complete rehabilitation or replacement. Failed.
ASSET	**Adherance to O&M Strategy**	**15%**	Complete, up-to-date, written, performed and reviewed at least 3 cycles	Complete, written, up-to-date, performed and reviewed at least one time	Developed but not fully vetted	Written, but out-dated	No written procedures or not being used
ASSET	**Other**	**5%**					
ENTERPRISE	**- Description**		Event or asset failure possible but unlikely to occur within the next 50 years	Event or asset failure likely to occur within the next 50 years	Event or asset failure likely to occur within the next 10 years	Event or asset failure likely to occur within the next 5 years	Event or asset failure has occurred, or high probability of occurring within the next year
ENTERPRISE	**- Likelihood in Any Given Year**		<2%	2% to 10%	11% to 20%	21% to 90%	>90%
ENTERPRISE	**- Frequency**		Less than once every 50 years	Once every 10 to 50 years	Once every 5 to 10 years	Once every 1 to 5 years	At least once every year or two

Appendix G – Improvement Initiatives Swim Lanes

Master List of Improvement Initiatives (IIs)