Asset Management Program

Strategic Asset Management Plan

Louisville and Jefferson County Metropolitan Sewer District

Brown and Caldwell

June 30, 2021

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Document Revision History				
Version	Summary	Editor	Date	Description of Changes
1	Initial Draft	BC	May 28, 2021	
2	Revision 1	BC	June 22, 2021	Incorporate MSD review comments

List of Abbreviations/ Definitions	
ACD	Amended Consent Decree
Asset	Something with a value of greater than $10,000 with an expected life of 5 or more years *either/or* something that is managed, operated, or maintained by MSD to provide an expected level of service to our stakeholders (includes employees and contractors, equipment, vehicles, structures, tanks, sewers, technology, and information).
Asset Management	An integrated set of processes to minimize the lifecycle costs of infrastructure assets, at an acceptable level of risk, while continuously delivering established levels of service.
AMDT	Asset Management Development Teams
AMSC	Asset Management Steering Committee: Cross-divisional steering team comprised of leadership championing the Asset Management Program.
CM	Corrective maintenance
CMOM	Capacity, Management, Operations and Maintenance
Condition	Measure of the physical state of an asset.
CMMS	Computerized Maintenance Management System
COF / Consequence	Consequence of Failure: The impact on level of service, utility, customers, or public resulting from an asset failure.
CSSA	Continuous Sewer System Assessment
Failure	The inability of an asset to provide the function for which it was installed.
GLPM	Gravity Line Preventive Maintenance
IRP	Infrastructure Rehabilitation Program
LOF / Likelihood	Likelihood of Failure: The chance of an occurrence, such as an asset failure.
Level of Service	The output or objectives the organization intends to deliver to its stakeholders (i.e., Public, Board, Rate Commission, Regulators).
Life-cycle cost	Total cost of an asset throughout its life (includes planning, design, acquisition, O&M, rehabilitation & disposal costs).
MEF	Mission Essential Functions
NMC	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
Performance	A measure of whether the asset is delivering level of service requirements.
PdM	Predictive maintenance
PM	Preventive maintenance
RCAMAd	Regulatory Compliance & Asset Management Administrator
Risk	Value represented by multiplying the consequence and likelihood of a failure scores.
Strategic Asset Management Plan	Guides overall asset management processes to ensure consistency. Includes organizational elements such as: charter vision & goals, training, communications, engineering design & construction, capital planning & financing, project justification, and key processes and templates.
Tactical Asset Management Plans	Guide asset management processes at each facility or system. Each facility or system has its own TAMP, which includes technical elements such as: level of service measures, asset inventory, risk & criticality, O&M strategies, condition assessment, capital/engineering/rehab & replacement strategies, and information management.

The development of this Strategic Asset Management Plan (SAMP) was a collaborative effort between the Louisville and Jefferson County Metropolitan Sewer District (MSD) and the Brown and Caldwell Team (Brown and Caldwell, Clear Consulting, Inc., EPIC Engineering and Consulting Group, LLC, and Gonzales Companies). We are grateful for the contributions from so many at MSD including the following development team members:

SAMP Development Team Members	
Asset Management Program Charter	Alex Novak, Brian Bingham, Dan French, David Johnson, Daymond Talley, Heather Dodds, John Loechle, Mike Brazel, Rene Lindsay, Stephanie Laughlin, and Will Cunningham
Asset Data	Andrew Foreman, Claude Rottet, Dane Anderson, Dwight Mitchell, Eric Hottel, Eric Weidner, Geary Lasley, George Anderson, Gerald Dunlap, Glen Cooper, Heather Dodds, Ibn Green, James Skinner, Joe Exely, Joey Ashby, Josh Dickerson, Keith Gallai, Lonnie Gaines, Loren Levitz, Michael Fitzner, Mike Catalano, Niccole Mardis, Noble Marks, Rick Jackson, Ryan Fisher, Steven Leong, Tony Harover, Tom O'Brien, Tony Morrison, Tony Woods, Thomas Armistead, Tonya Callahan, William Ford, and William Wright
Asset Lifecycle	Chris Gregory, Claude Rottet, Dolly Smith, Eric Hottel, Glen Cooper, Greg Powell, Heather Dodds, Jason Dempster, Jeremy Goodwin, John Kessel, Loren Levitz, Mark Sites, Randal Clifton, Ryan Fisher, Tony Harover, Wolffie Miller, and William Wright
Big Picture	Collette Easter, Dane Anderson, Dwight Mitchell, Geary Lasley, Gerald Dunlap, Heather Dodds, Joe Exely, Joey Ashby, John Kozumplik, Mike Brazel, Sharon Worley, Tony Marconi, Tonya Callahan, Will Cunningham, William Ford, William Marshall, Wolffie Miller, Brian Bingham, David Johnson, Daymond Talley, Greg Powell, James Skinner, John Kessel, Loren Levitz, Marc Thomas, Mike Griffith, Randal Clifton, Rhonda Crotzer, Ryan Fisher, Stephanie Laughlin, and William Wright
Change Management and Communication	Colette Easter, Geary Lasley, Heather Dodds, Loren Levitz, Sheryl Lauder, Will Cunningham, William Ford, and William Marshall
O&M Strategy	Andrew Foreman, Dwight Mitchell, Eric Hottel, Eric Toller, Gerald Dunlap, Heather Dodds, Ibn Green, Jeremy Goodwin, John Kozumplik, Jon Baldridge, Keith Gallai, Kevin Thompson, Leslie Brown, Lonnie Gaines, Loren Levitz, Mike Catalano, Mike Scott, Rick Jackson, Ryan Fisher, Staci Huber, Tamika Davis, Tony Morrison, Tony Woods, Tonya Callahan, and William Wright
Risk Management	Alex Novak, Dane Anderson, Darius Calloway, Dwight Mitchell, Ellis Anderson, Gerald Dunlap, Heather Dodds, James Skinner, Jermaine Murphy, Joe Exely, Joey Ashby, John (J.P.) Carsone, John Kozumplik, Josh Dickerson, Keith Gallai, Loren Levitz, Marc Thomas, Mike Moore, Randal Clifton, Rickie Bledsoe, Ryan Fisher, Simon Childress, Stephanie Laughlin, Tony Morrison, Tonya Callahan, William Marshall, Wolffie Miller, and William Wright

Program Charter

This Strategic Asset Management Plan (SAMP) is the primary document that guides the Louisville and Jefferson County Metropolitan Sewer District (MSD) efforts in the administration of asset management (AM) activities associated with facility and system assets: treatment plants, drainage, collections, and flood protection. It brings focus to the strategy for improved asset management, and provides the overarching framework for achieving the mission, goals, and critical success factors of the Asset Management Program, as described in the program charter (Figure 1). Rather than being an extensive manual of practice on asset management, the SAMP is a concise framework that creates a consistent approach for the divisions which operate and maintain the facilities and distributed systems. The SAMP framework provides the “rule book” for facility/system plans (Tactical Asset Management Plans – TAMPs) to help meet the established service level expectations and other operational objectives at the lowest life cycle cost.

Figure 1. Asset Management Program Charter.

Mission

Collaboratively develop and manage a risk-based approach to sustain quality wastewater, stormwater, and flood protection assets for our community.

Goals

- Provide strategic financial planning for the sustainability of our assets and the protection of our community
  - Prolong asset life and reduce costs through robust maintenance and planning strategies
    - Define renewal and replacement activities through data-driven risk analysis
    - Engage stakeholders in MSD’s risk-based decisions through strategic outreach
  - Invest in employees, practices, and technology for sustainable asset management
- Maintain a dynamic asset inventory that supports MSD’s Mission and Vision

Critical Success Factors

- Gain support for the asset management program through senior leadership and stakeholder engagement
  - Inclusion of the staff in program development
  - Creation of value throughout implementation
  - Employees are challenged to embrace new roles and responsibilities within the program
- Productive relationships between departments, divisions, and workgroups
- Clear understanding in the organization about asset management
- Priority driven implementation, innovation, and continuous improvement
- Sustained Resource allocation (funds, staff, technology, information)

Teams

Brian Bingham, Chief of Operations

Mike Brazel, Collections System & Emergency Response Manager

Will Cunningham, TVI Manager

Heather Dodds, Regulatory Compliance and Asset Management Administrator

Dan French, Regulatory Compliance, Records and GIS Services Manager

David Johnson, Chief of Engineering

Stephanie Laughlin, Infrastructure Planning Program Manager

Rene Lindsay, One Water Chief Procurement Officer

John Loechle, Engineering Technical Services Director

Alex Novak, Operations Director – Treatment Facilities

Daymond Talley, Assistant Director – Treatment Facilities

1. Overview

1.1 Organizational Overview

The Louisville and Jefferson County Metropolitan Sewer District (MSD) provides wastewater treatment, stormwater and drainage, and flood protection services in portions of Jefferson, Oldham, and Bullitt Counties. Jefferson County alone requires treatment of over 150 million gallons per day and consists of 5 water quality treatment centers: Cedar Creek, Derek R. Guthrie, Floyds Fork, Hite Creek, and Morris Forman. Additionally, MSD is responsible for over 3,300 miles of sewer pipes, 5,300 miles of drainage systems, 29 miles of floodwall and levees, and 16 flood pump stations. In pursuit of maintaining quality services, MSD is using asset management principles to manage linear and vertical assets efficiently to meet the needs of the stakeholders.

1.2 Strategic Asset Management Plan Overview

This Strategic Asset Management Plan (SAMP) is the primary document that guides MSD's efforts in the administration of asset management activities associated with its facility and treatment assets. It brings focus to the strategy for improved asset management, and provides the overarching framework for achieving the mission, strategic goals, and critical success factors of the Asset Management Program, as described in the Program Charter. Rather than being an extensive manual of practice on asset management, the SAMP is a concise framework that creates a consistent approach for the divisions which operate and maintain the facilities and distributed systems. The SAMP framework provides the "rule book" for how facility and system plans (Tactical Asset Management Plans – TAMPs) will be created and implemented to help meet the established service level expectations and other operational objectives at the lowest life cycle cost.

The SAMP serves several purposes:

1. Provides information about where the asset inventory data are located. Provides criticality criteria to determine individual asset inspection, replacement, and rehabilitation rankings.
2. Provides information on the established levels of service (LOS) and performance measures.
3. Identifies operations and maintenance, and renewal and replacement strategies and techniques. Identifies currently known data requirements and program enhancements.
4. Helps ensure that capital investments are proactive, flexible, and promote the most efficient use of available resources.

Asset Management Definitions

"Asset management is the set of coordinated activities that an organization uses to realize value from assets in the delivery of its outcomes or objectives. Realization of value requires the achievement of a balance of costs, risks and benefits, often over different timescales."

(ISO 55000)

- **Asset.** Something that has a value >=$10,000 with an expected life >=5 years either/or something that is managed, operated, or maintained by MSD to provide an expected LOS to our stakeholders.
- **Condition.** Measure of the physical state of an asset.
- **Consequence.** Impact on level of service, utility, customers, or public resulting from an asset failure.
- **Failure.** Inability of an asset to provide the function for which it was installed.
- **Likelihood.** Chance of an occurrence, such as an asset failure.
- **Level of Service.** Output or objectives one intends to deliver to its stakeholders (i.e., Public, Board, Regulators).
- **Lifecycle cost.** Total cost of an asset throughout its life (incl. planning, design, acquisition, O&M, rehabilitation & disposal costs).
- **Risk value.** The combination of consequence and likelihood of a failure.

5. In recognition of the fact that each facility and system owned and operated has specific assets, conditions, and requirements under which they are operated, the management of these facility and system assets are also governed by TAMPs. The TAMP structure is like that of the SAMP, but the SAMP provides a standardized approach for the overall asset management framework and business rules across facilities and systems. The TAMP describes the specifics for asset management at a particular location and identifies actions that are being implemented to achieve the standards and goals herein listed. The SAMP is intended as a guidance document to develop and implement the facility and system TAMPs. It provides the ground rules to help achieve the vision of the Asset Management Program. Figure 1-1 depicts the relationship between the SAMP and TAMPs.

Figure 1.1. SAMP and TAMPs relationship.

6. The fundamental components of the SAMP are shown in Figure 1-2, and include Operations and Maintenance, Organizational Framework, Decision Making and Capital Planning topics, and Information Systems and Data Management topics.

In addition to the SAMP and TAMPs, an Implementation Plan, or AM Roadmap, defines the sequencing, scheduling, and prioritization of asset management program activities. The AM Roadmap includes prioritized SAMP improvement strategies recommended for the ultimate fulfillment of a successful AM program.

Operations and Maintenance	Organizational Framework	Decision Making and Capital Planning	Information Systems & Data Management
• Inventory/Warehouse • Maintenance Strategy • Operations Strategy • Optimization	• Communications • Culture and Change Management • Document Management • Leadership and Commitment • Levels of Service and Performance Evaluation • Resource Management • Business Continuity	• CIP Development and Prioritization • Design & Construction • Funding • Risk Management	• Systems • Tools • Data

Figure 1.2. Asset management plan components

1.3 Asset Management Overview

For purposes of using this SAMP as a guide for managing MSD's facility and system assets, asset management is defined as the following:

> *Asset management is the set of coordinated activities that an organization uses to realize value from assets in the delivery of its outcomes or objectives. Realization of value requires the achievement of a balance of costs, risks and benefits, often over different timescales.*[1]

Asset management helps organizations answer and address the following questions:

What is the current state of my assets?	What is my required level of service?	Which assets are critical to sustained performance?	What are my best O&M and CIP strategies?	What is my long-term funding strategy?
• What do I own? • Where is it? • What condition is it in? • What is its performance? • What is its remaining useful life? • What is its remaining economic value?	• What is the demand for my services by my stakeholders? • What do regulators require? • What is my actual performance?	• How does it fail? How can it fail? • What is the likelihood of failure? • What does it cost to repair? • What are consequences of failure?	• What alternative management options exist? • Which are the most feasible for my organization?	• How will I pay for Renewal and Replacement? • Bond Funding? • Sinking Fund?

The sections of the SAMP align with asset management industry standards: International Infrastructure Management Manual (IIMM) provides insight and examples of asset management practices; and International Standards Organization (ISO), ISO 55000 provides a broad framework for topics that should be addressed as part of a sound AM program.

1.4 Asset Management Workflow

A typical path to achieve AM program excellence is shown in Figure 1-3. The key AM fundamentals are shown on the top row (i.e., operations and maintenance, organizational framework, decision making and capital planning, and information systems and data management). Without those overarching objectives and procedures in place, it is difficult to implement an effective AM program. As such, the first step in an AM program is to develop the organizational objectives. The AMSC collaboratively developed their organizational objectives: asset management program mission, goals, and critical success factors. Those elements are the guiding force behind the decisions that are made for the short- and long-term needs of the asset management program. The LOS, asset inventory and hierarchy, and risk assessment build on those foundational elements.

The remainder of the activities (condition assessment and monitoring, maintenance strategies, operations and maintenance, business case justification and project prioritization) are the bulk of the AM program. The workflow helps guide sequencing of the AM program execution.

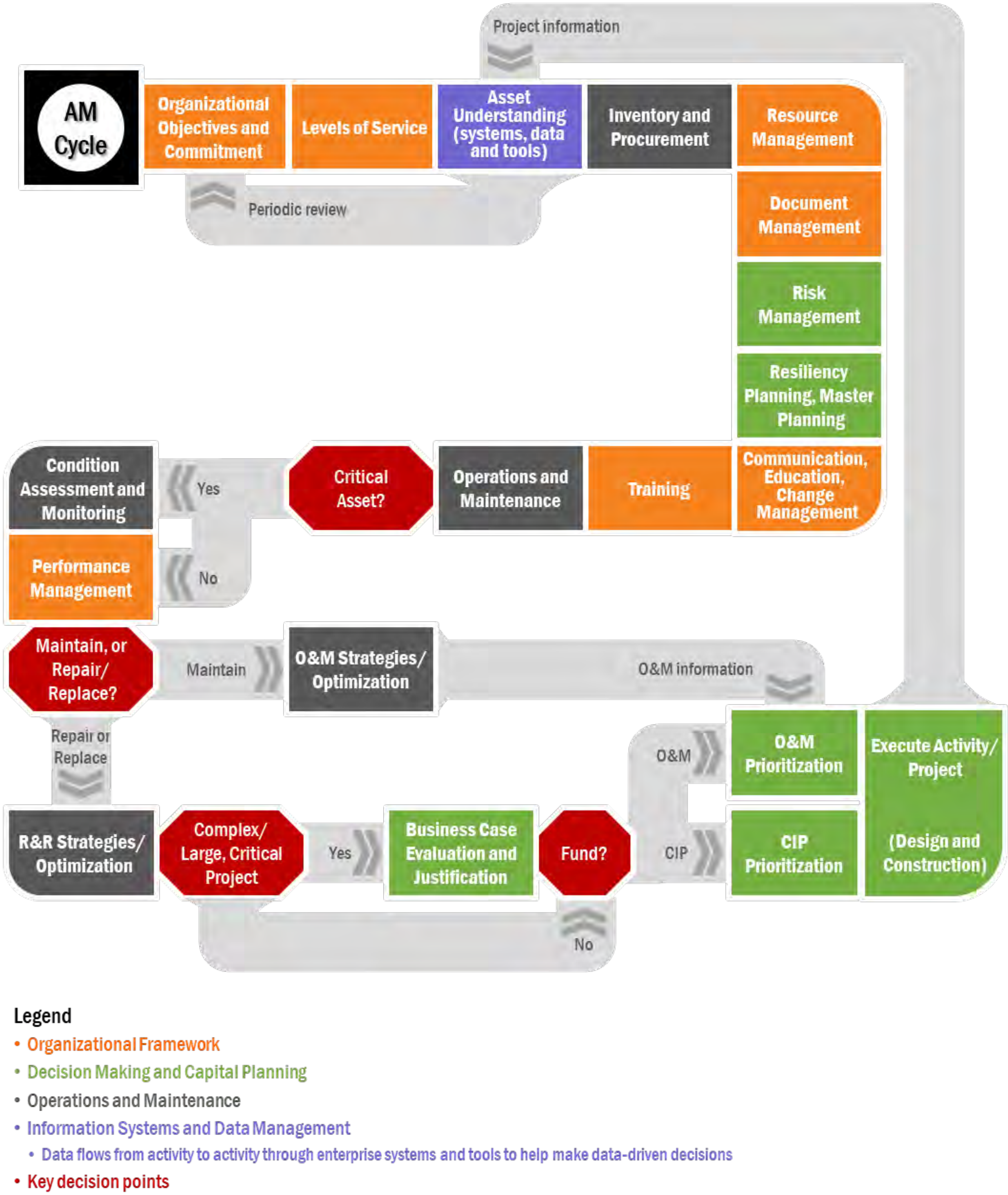


Figure 1.3. Asset Management framework.

1.5 SAMP Development and Maintenance

The approach used to advance the MSD's AM effort included establishing specific groups (Figure 1-4) that played a role in developing content for the AM program by: establishing a Chartering Team to define the AM program mission, goals and critical success factors; conducting interviews with a broad array of MSD management to assess the current state of MSD's asset management program; establishing an interdepartmental AM Steering Committee to determine desired state and priorities, and to develop the actions needed to address the gaps in asset management practices (AM Roadmap); and to develop SAMP content with the assistance of the Core Team and initiative specific Development Teams.

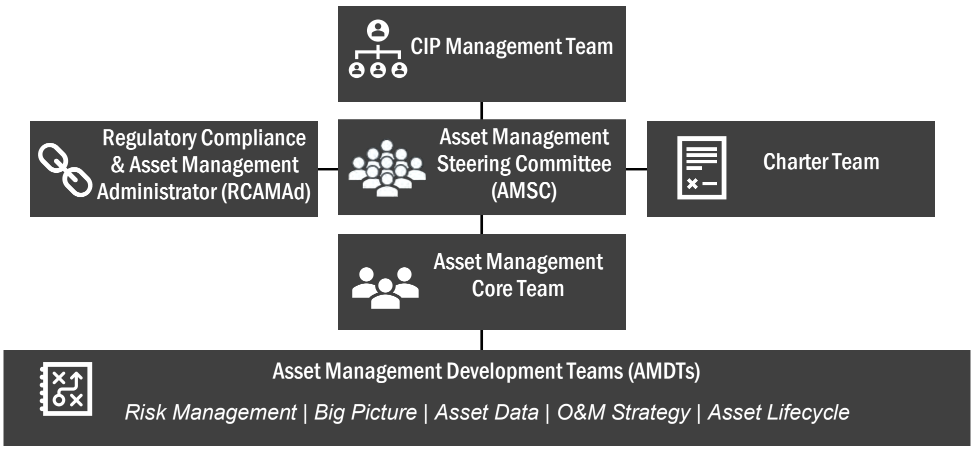


Figure 1.4. Asset Management development and implementation groups.

1.5.1 Development

The original contents of this SAMP were prepared by the AMSC and AMDT members in workshops facilitated by Brown and Caldwell (BC). The workshops were held from November 2020 to June 2021 to obtain input for the sections contained within this SAMP and included the establishment of a practical process to maintain and update the SAMP over time. The timeframe for AM program development and implementation is detailed in the AM Program Evaluation Technical Memorandum (BC, 2020) and the Asset Management Roadmap (BC, 2020) included in Appendices A and B, respectively.

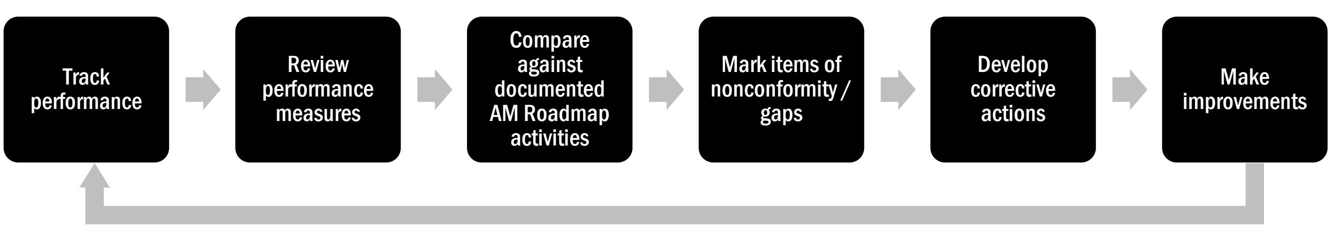
1.5.2 Administration

Managing the SAMP is a dynamic process of continuous planning, implementation, evaluation, and resultant adaptation to changing conditions and lessons learned. Through the active maintenance of this SAMP document, the Asset Management Program will continue to be refined and responsive to changing priorities. The AMSC will conduct annual SAMP update meetings for purposes of holistically reviewing and updating this SAMP, with specific actions listed in Table 1.1.

Table 1.1. SAMP Administration Duties		
Action	Activities	Responsible Person
Quarterly Status Sessions		
Review progress	Prepare change documentation for review and discussion at AMSC meetings	RCAMAd
Identify and document needs	Identify changes to SAMP defined process, section, workflow, or activity	AMDTs
	Record changes on change log and update approval status as appropriate to facilitate updates to the SAMP	RCAMAd
Annual Review Process		
Review SAMP and change log	Meet to review status of the SAMP	AMSC
	Identify successes in SAMP and AM Program implementation	AMSC
	Identify ways to address gaps in recommendations	AMSC
	Confirm roles and responsibilities are still appropriate	AMSC
	Compile logged updates/changes/edits to the SAMP	RCAMAd
Assess performance	Assess improvement activity performance (see performance measures)	AMSC
	Determine if the right information is being gathered to track performance and adjust as necessary	AMSC
Identify and document needs	Discuss newly needed improvement activities	AMSC
	Confirm priorities	AMSC
Update the SAMP	Review change documentation and submit to AMSC for review	RCAMAd
	Review recommended changes to the SAMP	AMSC
	Approve changes recommended to the SAMP	AMSC, CIP Management Team
	Incorporate approved changes into the SAMP on annual basis	RCAMAd

1.5.3 Continuous Improvement Process

Continuous improvement is a vital part of any AM program. It is a best practice that helps utilities focus on a systematic way of making necessary adjustments and improvements to AM activities. Typical steps in a continuous improvement process are shown below.



2. Organizational Framework

A successful, high-functioning asset management program depends on having a well thought out Organizational Framework. This includes having commitment from leadership; a solid understanding of organizational culture and an effective change management plan; comprehensive communications and document management procedures; levels of service and performance measures that allow the organization to track, understand and modify performance based on reliable data; and the right resources in place to make the AM program successful.

2.1 Leadership and Commitment

A vital step in building and maintaining a successful asset management program is getting support from leadership within the organization and from the governing body. To that end, it is important that the CIP Management Team understands and supports the objectives of AM and treats it as a policy priority. The AM Charter Team developed and defined the mission, goals, and critical success factors for achievement of the AM Program in the AM Charter. All levels of management have been trained on and understand the importance of AM and support activities to make improvements.

2.2 Culture and Change Management

Asset management is as much about culture as it is procedure. Uniformity, consistency, and repeatability, where needed, can be a challenge to achieve. As such, success relies on a greater involvement and participation of staff and the individuals serving as change agents more so than any other program. Culture change is therefore a critical element of success. Communication, training, education, and visibility by all personnel will be critical throughout implementation. Change management and communication methodologies are vital to a successful asset management program.

MSD has received select training on the Prosci-ADKAR© change management philosophy. It promotes a structured approach to understanding and managing change related issues and is a resource to the AM Program to help make changes successful and long lasting.

Communications for the AM program will be used to foster Awareness of asset management throughout the entire organization. The targeted messaging will include elements to foster a Desire for staff to engage in asset management and determine how they fit with the program and how the program fits with them. Training will be communicated in advance to help staff increase their Knowledge of asset management as well as develop additional skills needed to implement a long term, sustainable asset management program. Staff will shift that Knowledge to Ability and Reinforcement will be used throughout the program to continue the change management process.

A separate Asset Management Change Management Plan is included in the asset management supporting documents. It includes roles and responsibilities, impacts, risks and benefits of AM-related changes, and available resources to help execute the AM program.

2.3 Communications

A separate Asset Management Communication and Engagement Plan describes the ongoing activities designed to inform the internal stakeholders about the asset management program. The primary purpose for developing the plan is to report on program performance over time. This allows for staff and management to stay engaged in implementation of asset management activities, and to provide feedback and input for continuous improvement.

2.4 Document Management

Asset management relies on clear and effective documents that are used to convey AM principles and methodologies to the organization. The documents needed to support the AM program and to track performance through levels of service and metrics are identified, understood, evaluated, and documented. The AM program documents include:

Table 2.1. AM Program Documents

Document	Description
Asset Management	
SAMP	Strategic AM Plan: A concise framework that creates a consistent approach for the entire organization to operate and maintain the facilities and distributed systems.
TAMPs	Tactical AM Plans: Facility/system plans to help meet the established service level expectations and other operational objectives at the lowest life cycle cost as indicated in the SAMP.
Asset Management Program Evaluation (AMPE)	Assessment of current asset management practices, desired (target) levels for the practice areas; and observations for improvement in four key areas: Decision Making and Capital Planning; Information Systems and Data Management; Operations and Maintenance; and Organizational Framework. A technical memorandum summarizes the results of the AMPE including the methodology, best practices, observations, scores, and results. (Appendix A)
AM Roadmap	AM document that includes recommendations and all associated elements (resources, responsibilities, reporting, etc.) to close identified AM gaps from the AMPE. (Appendix B)
AM Charter	Sets the strategic goals and critical success factors of the Asset Management program
Capital Planning and Decision Making	
Risk Policy	Policy document based on ISO 31000 and IIMM guidelines to clearly state MSD's objectives for, and commitment to, risk management.
Records Policy	Policy document to ensure MSD follows KRS 171.410-171.748 public records management statutes and the rules and regulations of the Kentucky Department for Libraries and Archives (KDLA).
GASB 34	Governmental standards that define asset recognition and accounting requirements
Corps of Engineers – agreement	Defines level of service requirements for flood protection
CAFR/ Annual Operating Budget	A zero-based budgeting that defines expected expenditures for the fiscal year
Capital Improvement Plan	Summary of identified capital projects including general schedule, funding required, and scope of task
Business Case Evaluation Instructions and Template	Provides understanding and guidelines for preparing Business Case Evaluations (BCE's) for MSD. BCEs are necessary to make sure that all capital expenditures are in the best interest of its customers, the broader community, and the environment.
20-Year Comprehensive Facility Plan - Critical Repair and Reinvestment	Facility plan summary to prioritize rehabilitation, renewal, replacement, upgrade, and expansion across all its service areas.
Engineering Capital Project Management Handbook (ECPMH)	Working tool document to standardize project management practices within MSD.

Table 2.1. AM Program Documents	
Document	Description
Facility Design and Construction Conformance Standards and plan Approval Policy	All wastewater and stormwater facilities within Jefferson County, whether they are public or private, shall be designed, constructed, improved and/or altered to conform to all MSD design and construction regulations, standards, and specifications.
Amended Consent Decree	Federal mandate relating to collection systems activities
Continuous Sewer System Assessment Protocol (CSSA)	The primary objective of the CSSA is to develop and implement maintenance and rehabilitation recommendations that reduce sewer overflows and improve the capacity, structural integrity, and functionality of existing assets.
CMOM master plan	Planning document for addressing Capacity, Maintenance, Operating and Management (CMOM) concerns and system issues to ensure KPDES permit requirements are met and to prevent treatment center overflows, bypasses, or upsets.
Information Systems and Data Management	
IT Disaster Recovery Plan	Planning document to address key IT infrastructure and application systems that support or enable MSD's Mission Essential Functions (MEFs). The document includes strategy and procedures for recovering information systems in the event of a disaster that impacts MSD's primary data center.
Infor IPS 11.2 Guidance Documents	How to perform specific tasks within the Infor Public Sector (IPS) system.
Telog Enterprise Client Guidance Documents	How to perform tasks related to Telog meter usage and adjustments.
WQTC Asset Hierarchies	Hierarchies for assets as defined in IPS at each WQTC by location or equipment class category.
Facility Aerial View Maps	Aerial view maps for each WQTC and wet weather treatment facility with linear and vertical asset identification per LOJIC enterprise data.
O&M	
Air permits (Title V)	State legislation defining air quality standards
KPDES permits	MS4 permit authorizing discharges to waters of the US.
Clean Water Act	Federal legislation defining conveyance and treatment standards
Sewer Overflow Response Protocol (SORP)	Document to establish timely and effective methods and means of minimizing the impact of Sanitary Sewer Overflows (SSOs) and unauthorized discharges, reporting, and notifying the public.
Standard Operating Procedures (SOPs)	Operating procedures for each facility that includes process diagrams and SCADA overviews.
CMOM Task Procedures	SOPs for each WQTC to standardize and implement O&M activities to ensure operations meet KPDES permit requirements and prevent treatment center overflows, bypasses, or upsets.
Organizational Framework	
Organizational Chart	Chart depicting number of staff by job title or function.
Business Continuity Plan (BCP)	Critical component of the overall MSD risk management strategy. The BCP provides basic information, procedures, and guidance to enable MSD to continue Mission Essential Functions (MEFs) in the wake of an emergency.
Emergency Response Plan	Document outlining preparedness plans to assist MSD in responding to and recovering from diverse emergencies.
Blueprint 2025	Sets the strategic objectives for the next 5 years
FEMA – flood plain regulations	Defines requirements for areas within the 100-year flood plain
Training program	Development programs for apprentice and leadership personnel aimed at equipping staff with necessary skills to be successful
Health & Safety Manual	Defines safety, environment, and health standards for staff
Change Management	Prosci ADKAR-centered approach (proprietary materials)
Newsletter	Newsletter including recent plant happenings, staff highlights, upcoming events, and initiatives progress.
Communications Plan	Plan to raise awareness of vital services that MSD provides and improve public perception.
Brand Book and Graphics Standards	Document to define the MSD brand and graphics standards.

Table 2.1. AM Program Documents	
Document	Description
Operations Report	Report including charts and graphs related to MSD drainage, wastewater treatment, collection systems, flood protection, and support services.
Wet Weather Consent Decree Reports	Quarterly and annual reports to communicate program activities related to Nine Minimum Controls (NMC); Sewer Overflow Response Protocol (SORP); Discharge Abatement Plans (DAP); public outreach, education, notification, and participation; and CMOM.

2.5 Levels of Service and Performance Evaluation

A foundational part of asset management is the development of Levels of Service (LOS) and asset performance measures that document desired performance of AM programs and help inform decisions. LOS are any organizational services that a stakeholder perceives as valuable and that can be defined and measured. LOS usually relate to quality, quantity, reliability, responsiveness, environmental acceptability, and cost. LOS set expectations for managing assets and the outcomes that one strives to achieve. Asset performance measures help understand and improve the performance of the organization's assets and move the needle on meeting or exceeding the LOS.

Definitions

Level of Service:

The description of the service output for a particular activity or service area against which performance is measured. (NAMS, 2007 - Developing Levels of Service and Performance Measures)

Performance measure:

A qualitative or quantitative measure used to measure actual performance against a standard or other target.

Used to indicate how the organization is doing in relation to delivering levels of service.

Metric:

The numbers or values that can be summed and/or averaged, such as dollars, distances, durations, and temperatures, etc.

Performance Target:

A specific quantifiable target for performance, used about a performance measure.

Considerations

- Consistent with business goals and objectives
- Clear and understandable
- Rewards the right behaviors: efficiency and effectiveness
- Forward-looking
- Follows SMART:

Simple -- Measurable -- Accurate, Achievable -- Responsive, Realistic, Relevant -- Targeted, Timebound

2.5.1 Levels of Service

The LOS developed as part of this SAMP focus on standards for facilities and systems related to the asset management program. Each of the LOSs listed in Table 2.2 relate to at least one of MSD's critical success factor areas (bulleted below and refer to Blueprint 2025). This helps keep the AM program in full alignment with the overarching MSD vision.

- Quality/Compliant Core Services
- Earn Community Trust
- Employer of Purpose with Opportunities to Thrive
- Fiscal Responsibility and Resource Sustainability
- Operational Efficiencies and Revenue Generation

The LOS and corresponding measures were developed and agreed upon by a Development Team. They are listed below and are designed to be tracked and reported at an organizational level. Facility and system-specific LOS and the related performance measures, which are available in the TAMPs, roll up to the overall LOS.

Table 2.2 lists the LOS that will be tracked at the organizational level. Additional measures will be considered for future tracking and reporting toward the LOS and are included in the continuous improvement steps (see Section 2.8).

Table 2.2. Levels of Service and Related Performance Measures		
Level of Service Description	LOS Measure	Target*
Meet or exceed all environmental and public safety requirements in our wastewater, stormwater, and flood protection services	Number of individual flood pumps in service (available) / Total number of individual flood pumps (%)	≥ 90% pumps in service
	Total number of violations caused by asset failures	0-2 Total Permit Violation Months (confirm)
	Number of regulatory parameters within upper/lower warning limit of permit (numeric, procedural, etc.)	TBD
	Monitoring and reporting compliance • Sampling data missed • Sampling events missed • Number of reporting activities completed by due date / total reporting activities scheduled (%)	Trend down
	Number of discharges caused by asset failures / total discharges (%)	Refer to existing
Maintain the trust of the community through high quality and reliable services	(Hours a piece of equipment or unit process is available to be operated/Total hours in the reporting period)*100	TBD
	Total number service request complaints per 100 customers per year	TBD
	Average time to correct MSD-related issues {time to correct all work orders related to a service request}	TBD
Strive for constructive interactions with the community and stakeholders	A random sampling of calls is scored by a member of the Call Quality Department	95.0% or above
	Total number of service requests addressed within goal timeframe / Total number service requests	Varies: priority of SR, dept, type
	Total number of interactions with defined stakeholders / total number of planned interactions with defined stakeholders	TBD
Prioritize employee growth and development for sustainable asset management	Total number of employees that completed each required training by the deadline / total number of employees required to complete each training	≥ 98.0%
	Total number of employees that completed required AM training by the deadline / total number of employees required to complete AM training	≥ 98.0%
Provide a safe working environment for employees	• Incidents Per Days Worked • Worker Comp Claims per Days Worked • Days Off due to Work Related Issues Per Days Worked	Refer to existing safety metrics
	Total number of employees that completed required SAFETY training by the deadline / total number of employees required to complete SAFETY training	≥ 98.0%
Promote fiscal responsibility in utility operations and capital investments through risk-based decision making	CIP FY20 Schedule Milestones Achieved / Total CIP FY20 Baseline Milestones Planned (%)	≥ 95.0% milestones achieved
	Annualized capital spend/approved CIP budget (%)	≥ 98.1 – 100.0%
	Annualized operating spend / approved operating budget (%)	98.1 – 100.0%
	Total number of critical assets with high-risk score / total number of critical assets (%)	TBD

**Target reflects annual value*

2.5.2 Performance Measures

The measures listed in Table 2.3 were developed and agreed upon by the Development Team. They should be tracked and monitored by the division managers through the individual TAMPs and rolled up to the organizational level here in this SAMP. The performance measures listed below support the intent of the LOS described previously. They include measures related to improving asset performance, thereby helping to achieve the goals of the AM program.

Table 2.3. Performance Measures								
Asset performance measures to help achieve LOS	Organization-wide targets *	Reporting Frequency	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater, and flood protection services	Maintain the trust of the community through high quality and reliable services	Strive for constructive interactions with the community and stakeholders	Prioritize employee growth and development for sustainable AM	Provide a safe working environment for employees	Promote fiscal responsibility in utility operations and capital investments through risk-based decision making
Average age of WO backlog	TAMP level Set brackets in TAMP	Monthly		x				
Maximum age of WO	TAMP level	Monthly		x				
Aging WOs by age bracket, by priority	TAMP level	Monthly		x				
Overtime (hours) due to non-flood operations	TAMP level	Monthly		x				
Work order compliance	>70% completion rate	Monthly	x	x				
Inspection compliance	>70% completion rate	Monthly	x	x				
Schedule Compliance (percent)	TAMP level	Monthly	x	x			x	
Planned Maintenance Ratio (percent)	TAMP level	Monthly	x	x				
Emergency (*P1, P2 Priority*) Work (percent)	TAMP level	Monthly		x				
Worst 10 Performing Assets by Type and Criticality	Trend	Monthly		x			x	x
Worst 10 Performing Assets by Cost (maintenance costs)	Trend	Monthly		x				x
Vacant Positions	TAMP level	Monthly Annual	x	x			x	
Contractor maintenance cost	Trend	Monthly	x	x			x	
Fleet availability		Monthly		x				
Work Order Data Quality	TAMP level	Monthly	x	x	x	x	x	x

**Target reflects annual value. Specific TAMP targets may vary based on current resources and overall maturity of programs.*

2.5.3 Performance Evaluation

Performance measures are specific indicators used to demonstrate how an organization is doing. They are written in a clear, easy to understand language so that they may be shared with a wide audience – both internally and externally. Each division is responsible for accurately collecting, analyzing, and reporting the facility and system data required to properly calculate performance measures identified in this document and in the timeframe shown in the measure definition sheets, included in Appendix C. While some of these metrics are not currently being tracked, the information should be collected where possible in anticipation of greater measure reporting and communication.

The data associated with a performance measure are typically collected through various systems and groups and stored in an asset management system for trending and reporting. Appendix C includes the data requirements for tracking LOS and performance measures.

2.5.4 Regulatory Reporting

Methods (data collection, reporting) to comply with regulatory requirements are established and documented. Regulatory requirements and pending requirements are continuously monitored and communicated. Key performance measures related to regulatory compliance and monitoring are included in Appendix C.

2.6 Resource Management

Staff, equipment, and tools are available to develop and sustain an AM program (includes development, training, monitoring, controlling, reporting, auditing, updating, and improving the AM program). Details are included in the following sections.

2.6.1 Resources

The primary staff involved in asset management along with a brief description of their roles are shown in Figure 2-1, and in Table 2.4.

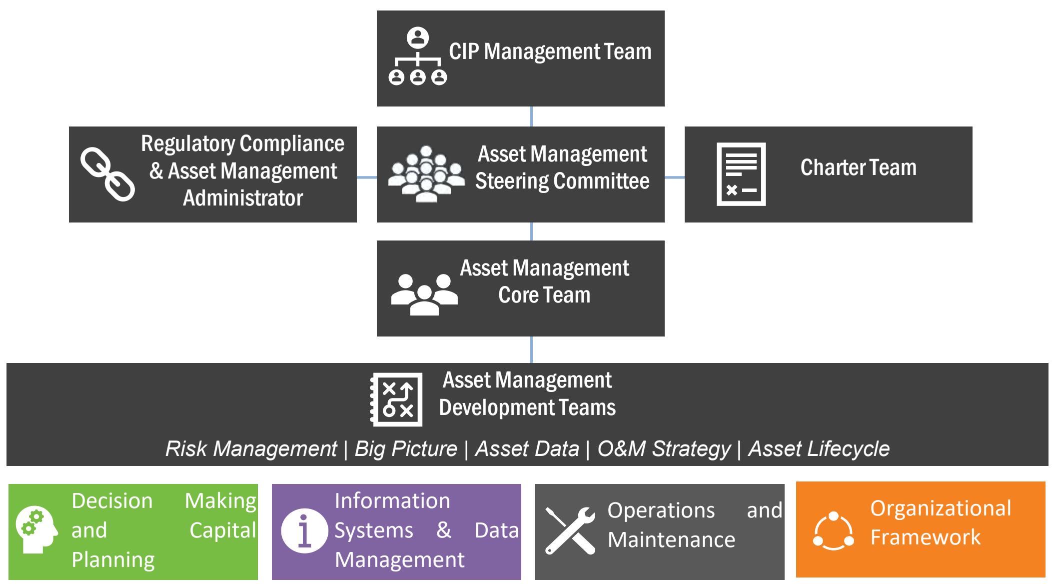


Figure 2.1. Asset Management organizational roles.

SAMP implementation responsibilities will fall to the staff referred to in Figure 2-1. Specific responsibilities and required actions are listed in Table 2.4 by group and are indicated as being performed on an ongoing, monthly, quarterly, or annual basis.

Table 2.4. SAMP Roles and Responsibilities

Role *	Description	Responsibility	Frequency
CIP Management Team	Final authority on the AM program direction, resources, and funding.	Support AM program	Ongoing
		Provide resources for AM program	Ongoing
		Communicate progress to Board	Annually - confirm
Asset Management Steering Committee (AMSC)	A cross-departmental steering team comprised of organizational leaders and key staff dedicated to execution of the AM program. The cross-functional skills represented on the team are important to successful implementation given the diversity of the areas under development. The AMSC is the senior sponsor of the AM program holding all staff accountable for its progress.	Champion Asset Management Program	Ongoing
		Make staff available to complete roles outlined in business process maps	Ongoing
		Review and provide input on the communication materials to staff related to the Asset Management Program	Quarterly
		Review LOS metrics	Quarterly
		• Review and approve AM products, including: • **SAMP, TAMP(s)** • **Communication Plan and Change Management Plan** • **AM policies, as needed** • **SOPs, Asset Class Plans, as needed**	As needed
		Participate in AMSC Quarterly Status Meetings to oversee implementation of the Roadmap	Quarterly
		Approve criteria that impacts AM Program at the strategic level (i.e., goals, risk, consequence, and likelihood of failure criteria, etc.)	Annually
Regulatory Compliance & Asset Management Administrator	The RCAMAd manages the AM program and guides the development of the initiatives from the AM Roadmap	• Guide the development of the AM program • Coordinate the activities of the AM Steering Committee • Monitor the progress of AM program development including schedules and resources • Coordinate the development of AM program with other initiatives • Serve as a liaison between the AM Steering Committee, AM Development Teams, stakeholders, and outside consultant services	Ongoing
		• Communicate progress to IC and CIP Management Team	Quarterly
Development Teams personnel	Staff tasked with AM responsibilities at the facilities and systems.	• Review and update business process maps	Annually
		• Provide input on specific content for SAMP topics	Annually
		• Refine performance measures	Annually
Operations Division Managers	Operations Division Managers for the facilities and systems.	Ensure that asset data has been collected/entered into IPS (CMMS) Management reports and analyzes data	Ongoing
		Ensure that baseline visual inspection and condition monitoring (as needed) of critical assets has been completed and recorded in the CMMS	Established in AM Program Roadmap
		Staff and management provide supporting data and other information for BCE justification documentation as requested	Ongoing
		Ensure standardized and complete use of IPS for asset data collection, work order tracking and closure and maintenance management	Ongoing
		Monthly reporting of LOS and performance measures data	Monthly
		Develop R/R plans for critical assets	Established in AM Program Roadmap

Table 2.4. SAMP Roles and Responsibilities

Role *	Description	Responsibility	Frequency
Senior Operations Management	Director and Assistant Directors of Operations.	Submit project justification documentation to Engineering and Finance for project funding consideration, as needed Review the project justification documentation	Ongoing
		Manage plant, equipment, or staff performance based upon metrics and identify improvement areas (applies to all levels of management)	Monthly
		Budget for necessary resources to implement and operate the program (all levels of management involved in process, and director approves)	Annually
Engineering	Staff working on the AM Program in the Engineering Department.	• Review and incorporate priority asset criteria into decision making on R/R project planning, budgeting, and rate development • Rely on R/R plans for budget projections • Developing the BCEs (approval depends on the specific BCE – see the BCE process)	Ongoing
Finance	Staff working on the AM Program in the Finance Department.	• Review and incorporate priority asset criteria into decision making on R/R project planning, budgeting, and rate development • Rely on R/R plans for budget projections	Ongoing
AM Team	Staff working on the AM Program in the Information Systems Department.	• Develop and maintain dashboards from defined key performance indicators • Maintain business process workflows	Established in AM Program Roadmap
Human Resources and Development Teams	Staff working on the AM Program in the Human Resources Department.	Support from training staff on AM training needs (upload content, notify staff of upcoming training, tracking)	Ongoing
Staff	All MSD staff	• Participate in training • Follow process workflows	Ongoing
IT	Staff working on the AM Program in the Information Technology Department.	• Support enterprise systems • Support process workflows	As needed
Communications Team	Staff working on the AM Program in the Communications Group	Support Communications and Management of Change efforts	As needed
Subject Matter Experts		• Staff well suited to provide communications and program support on as needed basis • SMEs are individuals that are well respected, knowledgeable and can assist with AM Program development, communication, and implementing new practices and processes. • SMEs will be identified throughout the AM Program by the Asset Management Steering Committee. It will be important that there are SMEs in all departments and that SMEs are engaged and knowledgeable about the direction and timing of AM Program.	Ongoing
AM Change Agents	Staff identified in Management of Change document.	• Management and staff well suited to lead communications and be ambassadors of the AM program. • These positions set the tone of AM and are key in distributing information, answering questions, and providing resources. Their organizational roles and their connections to the AM Steering Team make these positions the logical point of employee contact for information. Facilitating their knowledge of the overall program and providing tools for information sharing is a key support requirement for these positions.	Ongoing

2.6.2 Training

Staff require introductory and ongoing training so that they can be successful in their roles in executing their work. The training required by the staff that is needed to help advance the asset management program is summarized in Table 2.5.

Table 2.5. Summary of Training Needs

Training	Description	Recipients	Frequency
Asset Management			
AM awareness training (6 brief videos with PPTs)	A systematic approach for educating and motivating the work force to generate both direct and indirect value for the AM program has been established. The gap between needed AM competencies and staff capability are well understood at all levels of the organization and there is a plan to fill these gaps.	All	Initial
Capital Planning and Decision Making			
Business Case Justification and Evaluation	Introductory training Detailed training with case studies	As noted in the BCE guidance document	Annually
O&M			
O&M	Job Class specific	Job class specific	Per plan
Information Systems and Data Management			
Systems knowledge	Understand how the utility's major systems are used to support the asset management program and overall utility mission	All	Annually
Organizational Framework			
Performance measures	Understand how to view and analyze the available LOS and performance measures	All	Annually
Change management	Used to understand change management process and plan	Management	Annually
Communications	Use to understand communication plan	Management	Annually

2.7 Business Continuity

MSD has evaluated threats to its operations, the community and the environment that may impact the organization. MSD has a clear understanding of prevention activities and procedures to mitigate impacts to the organization and has documented them in the Business Continuity Plan (BCP) stating "the basic information, procedures, and guidance to enable MSD to continue or quickly resume MEFs in the wake of an emergency and to sustain continuous operations for up to 30 days after an incident."

- Delineates the Mission Essential Functions (MEFs) of MSD, its Divisions and Offices
- Prioritizes critical processes and services which support MEFs
- Establishes emergency lines of succession and associated delegations of authority
- Outlines responsibilities during BCP activation, implementation, and reconstitution
- Identifies vital records, critical applications, databases, systems, and equipment
- Identifies overall communication capabilities and requirements to ensure regulatory requirements are met
- Identifies alternate operating facilities where feasible
- Establishes BCP maintenance requirements and responsibilities

- Outlines tests, training, and exercise requirements for continuity planning
- Contains simple BCP activation checklists

2.8 Continuous Improvement

People	Process	Technology
• Since specific personnel associated with the responsible persons may change over the course of the AM Program, they should be revisited annually as part of the Asset Management Program review process. • The detailed personnel list should be updated as needed.	• Risk Monetization: MSD is refining its evaluation of projects and project alternatives in order to effectively compare potential solutions within, and across, each of MSD's three service areas (wastewater, stormwater, and flood protection). • Revisit ability to track additional performance measures (see table below)	• As part of the Information Systems and Data Management recommendations and activities, MSD will be developing a strategy for business systems to continually meet MSD objectives. This information will be added to the MSD Business Continuity Plan.

Table 2.6. Continuous Improvement: Potential Future Measures

Description	Measure
Maintain the trust of the community through high quality and reliable services	Total Amount of Time Equipment or Unit Process is Functional / In Service as a Percentage of Total Hours in Period)
Prioritize employee growth and development for sustainable asset management	AM Communications and AM Management of Change Plans compliance
Provide a safe working environment for employees	Safety related PMs completed by due date / total Safety related PMs scheduled (%)
Promote fiscal responsibility in utility operations and capital investments through risk-based decision making	Total dollar value of critical assets with high-risk score / total dollar value of critical assets (%)
AM Performance Measures	• Maintenance labor hour backlog (number) • Maintenance Labor Estimates • Mean Time Between Failure (elapsed time) • Asset class plan compliance for critical assets • Inventory requests on critical items that are stocked out • Number of positions /asset value • Fleet parts availability

3. Information Systems and Data Management

This section defines the high-level information associated with asset management-related data, tools, and systems. This includes the assets that comprise the facilities and systems, and the general hierarchy of managed assets that should be followed. Detailed asset inventories are managed and contained within the computerized maintenance management system (CMMS) and geographic information system (GIS).

3.1 Overview

MSD uses a combination of systems, tools, and data to support day-to-day operations and longer-term planning. The data collected are valuable repositories of information and used to support elements of the AM program. Table 3.1 shows the relationship of the AM categories with the enterprise systems, tools, in use at MSD. Specific products that MSD uses are listed in Sections 3.2, 3.3 and 3.4.

Table 3.1. Asset Management Systems, Tools and Data

AM Element	Systems	Tools	Data
Organizational Framework			
Communications	• Microsoft SharePoint	• Microsoft Teams • Electronic message boards • Social media (Facebook, Twitter, YouTube) • Monthly newsletters	• AM program status • AM metrics
Culture and Change Management	• N/A	• N/A	• AM Roadmap initiatives and schedule
Document Management	• Document Management System (DMS) • Microsoft SharePoint • File servers	• Reporting /Dashboards • eSignatures • Microsoft Teams	• IPS SOPs • Regulatory • Engineering manuals • Legal • As-Builts • Invoices • Permits • Photos from Service Requests
Leadership and Commitment	• N/A	• N/A	• AM Charter • Blueprint 2025
Levels of Service and Performance Evaluation	• CMMS • GIS • Customer Information System-CIS • Finance • Regulatory/Permitting	• CIP/Budgeting • Reporting /Dashboard • Power BI	• Asset attributes • Condition data • Maintenance history • Costs • Regulatory data • LOS
Resource Management	• HR • Timekeeping	• N/A	• Employee time • Employee training

Table 3.1. Asset Management Systems, Tools and Data

AM Element	Systems	Tools	Data
	• Learning Management System		
Information Systems and Data Management			
Inventory and Asset Profile	• CMMS • GIS • CIS • CCTV • Finance • DMS • Fleet Tracking (Faster/Asset Works)	• Data Collection Tools • Reporting /Dashboard	• Asset Attributes • Asset Classes • Asset Hierarchy • Asset Naming • Condition Data • As-builts
Decision Making and Capital Planning			
Risk Management	• CMMS • GIS • SCADA	• Overflow reporting • Real Time Controls (RTCs) • Replacement Planning	• Consequence of Failure (COF) • Likelihood of Failure (LOF) • Asset attributes • Condition data • Maintenance history
CIP Development and Prioritization	• Rate Models • Hydraulic Models • SCADA • CIS	• Business Case Project Justification • Prioritization • Replacement Planning • Demand Forecasting	• Condition data • Useful life • R&R schemes • Capacity info • Growth projections • LOS
Design and Construction	• CMMS • GIS • Finance • DMS	• CIP/Budgeting	• Install Date • Replacement cost • Asset Attributes • Maintenance History/costs • As-builts
Funding	• Finance	• Replacement Planning	• Budget • CIP
Operations and Maintenance			
Procurement / Warehouse	• Inventory/invoicing • Finance • CMMS	• Bar code / scanning	• Asset IDs
Operations and Maintenance Strategies	• CMMS • GIS • Finance • SCADA • Inventory • CCTV • DMS	• Condition assessment module/tools • CIP/Budgeting • Reporting /Dashboard • Bar code / scanning • Telog	• Asset Attributes • Condition Data • Maintenance History/costs • O&M Manuals • PM Schedules • Job Plans • Labor Rates • Failure Coding • LOS

Table 3.1. Asset Management Systems, Tools and Data

AM Element	Systems	Tools	Data
Optimization	• CMMS • GIS • SCADA	• Data Collection Tools	• Condition Data • Asset Attributes

3.2 Systems

MSD uses various information systems to gather, manage, and maintain asset management data. Each department is responsible for adhering to the use of these systems. IPS is the primary system used by MSD for work order management and for managing asset information. IPS is the system of record for vertical assets, while GIS (with synchronization to IPS) is the system of record for linear assets. All MSD staff will utilize IPS (vertical assets), GIS (linear assets), SAP, and other MSD information systems for their intended use in the management of MSD assets. The use of separate spreadsheets for data tracking, monitoring, and recording in lieu of the defined information management systems will not be permitted.

Table 3.2 summarizes the information systems currently used by MSD and the elements of the asset management program they support. Asset management requires all asset data to be easily stored, retrieved, and maintained. Only systems and tools shown in Table 3.2 should be used.

Table 3.2. Enterprise Information Systems

Type	Product	Integration with other systems	Description
Computerized Maintenance Management System (CMMS)	Infor Public Sector (IPS)	SAP/Workforce GIS Mobile IPS app CUES GraniteNet	Primary system used for work management and the system of record for all managed facility/vertical assets.
GIS	ESRI ArcGIS Platform (ArcGIS Enterprise and ArcGIS Online)	IPS eB Web SCADA Innovyze InfoAsset Planner	System of record for all managed distributed/linear system assets. Assets synced with IPS using GeoAdministrator tool Provides map-based applications as primary interface for viewing linear asset data Local GIS Consortium is LOJIC
Document Management System	eB Web SharePoint	GIS Constructor inspection app Grease hauler custom portal app	eB Web is the primary document management system. Documents include but are not limited to permits, as-builts, O&M manuals, photos, invoices. SharePoint serves as the MSD Intranet and stores IPS procedural documentation, work instructions, and engineering manuals
SCADA	GE Digital iFix / iHistorian IGS IDS	Telog OSI pi Oracle / SQL Server historian databases Aquasight	Real-time performance data sent from SCADA to PI, iFix Historian, and historian databases. Historian data is sent to Aquasight in near real-time for visualization and cost-savings analysis

Table 3.2. Enterprise Information Systems			
Type	Product	Integration with other systems	Description
		OneRain GIS	SCADA alarms are displayed on maps in the GIS
Pipe Inspections	CUES GraniteNet	IPS File Servers	PACP 7.0.4 pipe inspection data from CCTV trucks is synced daily to a central GraniteNet database. GraniteNet is synced to IPS daily. Video files aggregated to central file storage repository
Hydraulic Models	InfoWorks ICM 9.0	Telog InfoAsset Planner Optimatics TetraTech Csoft	Model is updated periodically from the GIS Model typically contains only pipes of diameter 18" and larger
Finance	SAP	IPS WorkForce (time and attendance) CC&B eB Web	SAP is the system of record for financial data and stores the fixed asset register SAP functions as the procurement system and is used to manage the parts inventory Money is collected through IPS to pay for applications, permits, and fines
Customer Information System	Oracle – CC&B IPS (Call Center)	SAP	CC&B used jointly by MSD and Louisville Water Oracle stores information for meters, flow monitors, billing, customer relations, stormwater service applications & information. IPS Call Center used by Customer Service to create service requests / inspections
Inventory/ invoicing	SAP	IPS	Parts inventory is tracked in SAP. Parts associated with work orders are tracked in IPS Cost for parts used is synced from SAP to IPS PCards are used
HR	SharePoint SAP	MS Teams linked to SharePoint	SAP is the HR System of record
Timekeeping	Workforce	SAP	Workforce and IPS are synced via SAP hourly
Learning Management	SharePoint Training Tracker database SAP – HR System of Record	MS Teams linked to SharePoint SAP linked to Training Tracker Database	SAP tracks employee training/qualifications There is a separate custom application that tracks training.
Regulatory/ Permitting	LinkoCTS Compliance library/ SharePoint eB Web IPS LabWorks		IPS used to track: • **EPSC permitting** • **Plan review and permitting** • **Industrial compliance tracking** • **Emergency response investigations** LinkCTS used for pretreatment management Received Permits stored on eB Web
Procurement/ Decommissioning	SAP	IPS	SAP is the system of record for procurement and parts inventory tracking.

Table 3.2. Enterprise Information Systems			
Type	Product	Integration with other systems	Description
			Assets are commissioned and decommissioned in IPS
Legal	eB Web	-	Contracts MOU/Legal Documents
Fleet Management	FleetFocus	Manual information transfer with IPS Napa parts management system	Used to track fleet assets and related maintenance

3.3 Tools

Table 3.3 lists the software tools to be used for the collection, management, analysis, reporting, and visualization of data related to the asset management program. Using the approved tools to manage data in the official MSD systems helps to eliminate redundant and potentially conflicting silos of information and standardizes information management through MSD's documented workflows.

Table 3.3. Enterprise Tools		
Type	Product	Description
Data Collection	Laptops iPads Inspections Custom App Construction Inspector App Grease Hauler's App CUES GraniteNet Esri ArcGIS Collector / Field Maps App IPS mobile app Trimble R2 GPS receivers Paper	Hardware lifecycle management plan covers all MSD IT hardware assets iPads are standard mobile hardware iPads have Verizon data plans
CIP/Budgeting	SAP Microsoft Project IPS	Costs tracked in SAP CIP projects aggregated from Microsoft Project IPS will be used to track projects from proposed through funded stages
Business Case Project Justification	Excel	
Prioritization	InfoAsset Planner	GIS-based prioritization model for linear assets that incorporates condition assessment information
Replacement Planning	GIS InfoAsset Planner IPS	Intend to use InfoAsset Planner for linear assets
Capacity Forecasting	InfoWorks ICM Optimatics Telog CSoft	Telog is used to represent flows for importing into the model Capacity information supplied to Innovyze planning tools Optimatics used to run non-real time What If? scenarios CSoft uses a pruned version of the model to make Real-Time Control (RTC) recommendations for reducing overflows

Table 3.3. Enterprise Tools		
Type	**Product**	**Description**
Condition Assessment	CUES GraniteNet IPS	Pipe condition assessment performed using CUES GraniteNet software in MSD CCTV trucks – PACP 7 standard used Historic manhole inspections captured on paper and entered IPS; new inspections use light version of MACP Other asset condition assessment logged in IPS via work orders Force main air release valve assessments logged in IPS
Reporting/ Dashboard	Crystal Reports Microsoft SQL Server Reporting Services (SSRS) Microsoft Power BI GL Wand Adaptive	All reporting tools are in use, with Crystal Reports being the legacy reporting platform replaced in part with SSRS. Power BI was more recently added to use for business intelligence dashboarding and visualization GL Wand and Adaptive are used to report/visualize financial data from SAP
Barcode/Scanning	SAP	Pilot program underway to scan barcodes on CMF inventory assets for integration with SAP.
Mobile Device Management	IBM MaaS360	New configuration consistent with security policy – standardization of iPads
Fleet Management	AssetWorks Fleet Focus	Migrated from FASTER in 2021
Project Management	Microsoft Project	Individual projects managed in Microsoft Project

3.4 Data

3.4.1 Asset Definition

A working definition of an asset was developed (Figure 3-1) as part of the AMDT workshops. It is intended to describe the criteria under which an item would be considered an asset (linear or vertical). If any of the criteria below is met, then the item is considered an asset. MSD defines an asset as:

Asset	Critical Asset
• Something with a value of greater than $10,000, with an expected life of 5 years or more. OR • Something that is managed, operated, or maintained by MSD to provide an expected level of service to our stakeholders.	• Assets that have either been identified as critical through the Risk Management process (described later in this document) and that affects health and safety or regulatory compliance.

Figure 3.1. Asset definitions.

3.4.2 Asset Inventory

The asset inventory for MSD is managed using the IPS system for vertical assets, and IPS in conjunction with the GIS for linear assets. Asset inventory information is comprised of different characteristics including the attributes describing the assets, the hierarchy in which assets are organized, and naming conventions used to identify and link data to assets. Figure 3-2 shows how the different asset characteristics relate to create a complete picture of the MSD asset inventory. Each of these components is described in the following sections.

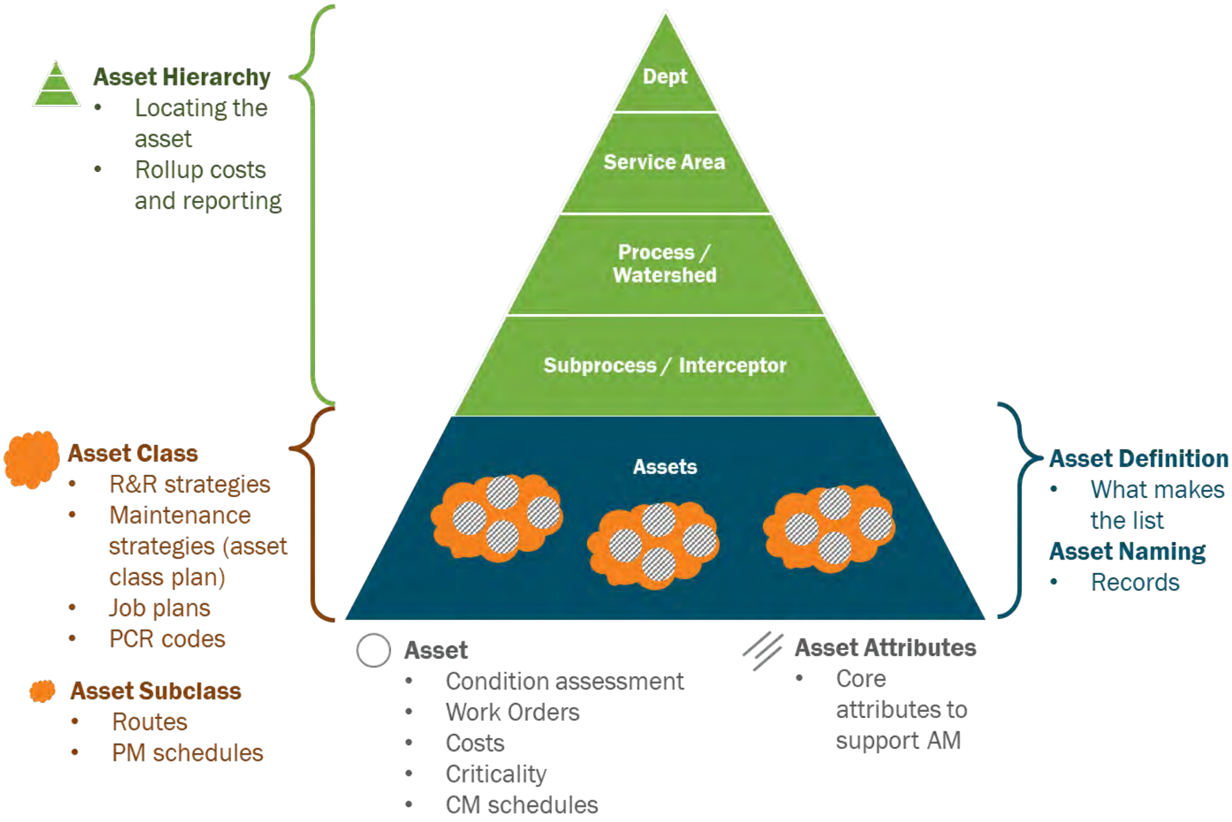


Figure 3.2 Asset Inventory Components

3.4.3 Asset Attribute Data

Assets are documented with a set of attributes that describe what is known about the asset. These attributes vary between asset classes as some attributes only apply to one asset type vs. another, but there is a set of "core attributes" that represent the essential details needed regardless of asset type to support the asset management program.

Table 3.4 and Table 3.5 list the core attributes for vertical and linear assets. In some cases, a core attribute does not apply to a particular asset class (e.g., some asset classes may not have risk scores calculated for them as that analysis is performed at the level of their parent asset). Attributes that have the "Required?" column set to "Yes" are required for all asset classes while those set to "No" are dependent upon the type of asset.

A placeholder for the full list of asset attributes per asset class (including the core attributes that apply to all assets presented in Table 3.4 and Table 3.5 plus additional attributes specific to each class) needed for commissioning new assets in IPS/GIS is included in Appendix D.

3.4.3.1 Core Attributes Vertical

Vertical asset information is managed in IPS. The core attributes for supporting the asset management program are listed in Table 3.4.

Table 3.4. Core Attributes – Vertical

Logical Attribute Name	Required?	Description	System	Field Type
Equipment ID	Yes	Unique identifier for the asset	IPS	Text
Equipment Type	Yes	Name or description commonly used to describe the asset in conversation	IPS	Text
Manufacturer	No	Manufacturer of asset/equipment	IPS	Text
Model #	No	Model number of asset/equipment	IPS	Text
Serial #	No	Serial number for asset/equipment	IPS	Text
Critical Asset	No	Is this a critical asset?	IPS	Bit
Condition	No	Most recent condition score for the asset	IPS	Number
Consequence of Failure	No	Consequence of Failure score (1-5)	IPS	Number
Risk Score	No	Risk calculated based on COF and Condition	IPS	Number
Installation Date	Yes	Date asset/equipment was installed	IPS	Date
Purchase Cost	Yes	Cost of asset/equipment as of date of installation	IPS	Number
Warranty Start Date	No	Warranty start date	IPS	Date
Warranty Expiration Date	No	Warranty end date	IPS	Date

3.4.3.2 Core Attributes Linear

Because linear asset information is managed in two systems (IPS and GIS), the core attributes are frequently duplicated in both systems. MSD's procedures initiate linear asset creation in GIS followed by synchronization of the asset information into IPS. Some attributes are only populated in IPS and not synchronized back to GIS. Whether an attribute is in both systems is indicated in the "System" column of Table 3.5.

Table 3.5. Core Attributes – Linear

Logical Attribute Name	Required?	Description	System	GIS Field Name	Field Type	GIS Domain
Asset ID	Yes	Unique identifier for the asset	IPS/GIS	COMPKEY	Text	-
Asset Name	No	Name commonly used to describe the asset in conversation	IPS/GIS	UNITID (point features)	Text	-
Asset Type	Yes	Type of asset	IPS/GIS	UNITTYPE	Text	-
Ownership / Responsibility	Yes	Agency with ownership and/or maintenance responsibility for an asset	IPS/GIS	AGENCY	Text	MSD_Owner
Location	Yes	Description of the general location of the asset	IPS/GIS	LOC	Text	MSD_Loc
Critical Asset	No	Is the asset is considered critical?	IPS/GIS	CRITICAL	Boolean	-
Condition	No	Most recent condition rating/score for the asset	IPS/GIS	CONDRATING	Number	-
Risk Rating	No	Risk calculated based on COF and LOF	IPS/GIS	RISKRATING	Number	-

Table 3.5. Core Attributes – Linear						
Logical Attribute Name	Required ?	Description	System	GIS Field Name	Field Type	GIS Domain
Installation Date	Yes	Date asset/equipment was installed	IPS/GIS	INST_DATE	Date	-
Status	Yes	The state of the asset in its lifecycle	IPS/GIS	SERV_STATUS	Text	MSD_ServStat

3.4.4 Asset Classes

The separation of assets into distinct asset classes is an essential component of managing the asset inventory as it defines the level of information detail to be collected for each type of asset and forms the basis for remaining useful life analysis and R&R planning. An asset class will be identified for all assets MSD maintains.

The asset classes for vertical and linear assets are discussed below.

3.4.4.1 Asset Classes – Vertical

Asset classes, or equipment types, have been identified for vertical assets and will continued to be developed and included in its entirety in the annual update to this document. The list of vertical asset classes is included in Appendix E.

3.4.4.2 Asset Classes – Linear

Linear asset classes are defined in IPS with corresponding feature classes in the enterprise GIS geodatabase. The GIS stores an attribute named “COMPTYPE” which specifies the corresponding IPS asset class type. For assets that have a GIS feature type of “Point”, the Asset Name is stored in an attribute called “UNITID”.

Table 3.6 lists the MSD linear asset classes as represented in the GIS.

Table 3.6. Asset Classes – Linear			
System	Asset Class Name	Feature Type	IPS COMPTYPE
Drainage	Catch Basins	Point	29
	Channel	Line	28
	Drainage Mains	Line	31
	Drainage Manhole	Point	Drainage Manhole, Sewer Crossover Manhole // 22
	Drainage Node	Point	Drainage Node, Sewer Crossover Node // 24
	Drainage Pump Station	Point	77
	Drainage Valve	Point	49
	Levee	Point	Close, Elev, Levee, Wall
	Storage Basin	Point	108
Sewer	Sewer Main	Line	21
	Sewer Manhole	Point	22
	Sewer Node	Point	Sewer Node, Drainage Crossover Storage Basin, Drainage Crossover Catch Basin // 24
	Sewer Pump Station	Point	Sewer Pump Station, Drainage Crossover Pump Station // 15

Table 3.6. Asset Classes – Linear

System	Asset Class Name	Feature Type	IPS COMPTYPE
	Sewer Treatment Plant	Point	98
	Sewer Valve	Point	35
	PSC	Point	Property Service Connection = 26

Note- stormwater system modifications will be coordinated with GIS and asset class for this system will be included in the annual update.

3.4.5 Hierarchy

Standardizing the asset hierarchy provides order to the asset registry, and a means by which metrics can be rolled up for reporting. Typically, there are two hierarchies housed in a CMMS: the location hierarchy and the equipment class hierarchy which are described below:

Location Hierarchy

- Defines where a piece of equipment lives within the organization's universe.
- An example is the "walk-to" location that is defined by where the asset is physically located, such as a water treatment plant, headworks building 1, floor 2, or room 1.
- Another way to create a location hierarchy is to use the processes to define the location, such as water treatment plant, raw water system, or influent pumps.

Equipment Class Hierarchy

- Defines where the asset lives within a class of assets.
- A well-defined equipment class hierarchy allows preventive maintenance (PM) work orders to be written at a higher hierarchy level, and corrective mainteance (CM) work orders to be written at lower level.
  - Assigning PM to a higher level allows planners to understand which components (i.e., assets) have upcoming PM tasks scheduled that the maintenance staff can perform during unscheduled down time—making the work more efficient.
  - Assigning CM to the lowest level allows failure modes can be identified and analyzed, which can help set the asset maintenance strategy.
- An example class hierarchy is: pumps → submersible pumps → influent pump 1.

3.4.5.1 Vertical Assets

For vertical assets, the location and equipment hierarchies are represented in IPS. MSD has established the following location hierarchy for vertical assets (Figure 3-3).

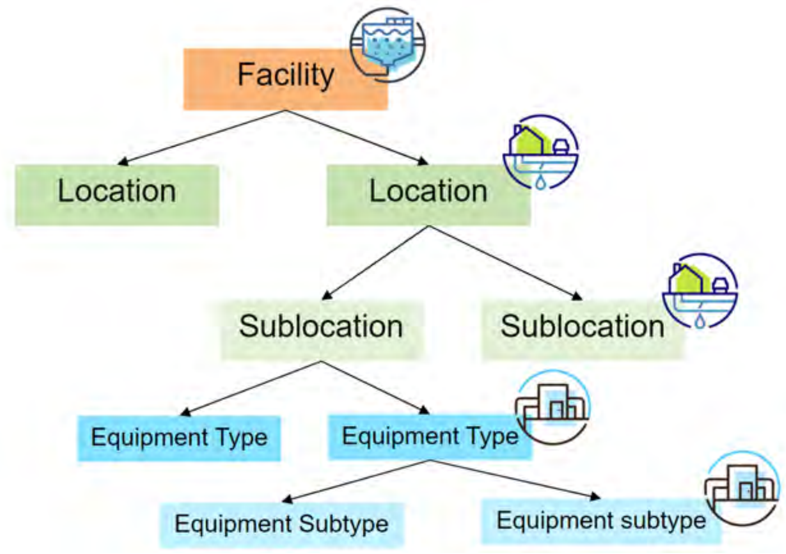


Figure 3.3. Facility hierarchy

The levels of the hierarchy are defined as follows:

- Facility: The facility where the equipment is located. Prefixes based on type of facility, basin, or service area.
- Location: Location/Process area within the Facility.
- Sublocation: Sublocation/Subprocess area within the Facility. This is done in some cases now like Floyds Fork Secondary/RAS PS.
- Equipment Type: IPS Equipment Type
- Equipment Subtype: IPS Sub equipment Type. For example, it would be beneficial to divide large pumps into components due to different maintenance strategies and better failure analysis.

Locations and Sublocations will be further defined in the TAMP and will be reviewed to assure compliance with this hierarchy so that costs and other data can be appropriately compiled. Inconsistencies found during this analysis will be resolved during TAMP implementation. Equipment types can be found in Section 3.4.4.1.

3.4.5.2 Linear Assets

The linear assets are not organized into a location hierarchy in the same way that vertical assets are, but have attributes indicating Area, Subarea, District, and other geographic groupings. The spatial representation of each asset in the GIS and its participation in the GIS geometric network provides locational context for the asset.

The linear assets are stored in a flat equipment class hierarchy for both Drainage and Sewer asset classes – each asset class exists at the same level. For pump stations and treatment plants, the top-level parent asset representing the station or plant is stored in GIS, but all associated child assets are managed only in IPS.

3.4.6 Asset Naming Convention

Having clear and consistent asset names and unique identifiers is a foundational component of managing asset information. Asset names typically provide staff with a mechanism to identify the type of asset and its location quickly, and in many cases provide a unique identifier by which to refer to that asset. Unique asset identifiers are essential to removing ambiguity between similar assets and provide a basis for linking together information about those assets stored in different information management systems. This section describes the naming conventions used by MSD for vertical and linear assets.

3.4.6.1 Asset Naming Vertical

The vertical asset naming convention is based on the vertical asset hierarchy and is comprised of the following elements:

- Facility: The facility where the equipment is located. Prefixes based on type of facility, basin, or service area. (7 characters)
- Location: Location/Process area within the Facility. (4 characters)
- Sublocation: Sublocation/Subprocess area within the Facility. This is done in some cases now like Floyds Fork Secondary/RAS PS. (4 characters)
- Equipment Type: IPS Equipment Type(4 characters)
- Equipment Subtype: IPS Sub equipment Type. For example, it would be beneficial to divide large pumps into components due to different maintenance strategies and better failure analysis. (4 characters)
- Equipment Number: The equipment number within the Facility/Location pair, if needed. For example, multiple pumps would be numbered 1, 2, etc. (X numbers as required)
- Floor: The floor number/text where the equipment is located. (1 number)

This document defines the format for vertical assets including the facility IDs, equipment types, and subtypes. The location and sublocations are relevant to each facility and will be further defined in the TAMPs. The format for vertical asset naming is comprised of all the parts and is shown below:

TTTTPPP-LLLL-LLLL-EEEE-EEEE-NNN-F

Where:

- TTTT is the type of facility. Valid values are:
  - WQTC = Water Quality Treatment Center
  - SPS = Sewage Pumping Station
  - FPS = Flood Pumping Station
  - STPS = Stormwater Pumping Station
- PPP is the plant or pump station abbreviation. Valid values for the plants are:
  - HC = Hite Creek
  - FF = Floyd’s Fork
  - CC = Cedar Creek
  - DRG = Derek R Guthrie
  - MF = Morris Forman
- LLLL is the location and sublocation code. Location codes will be developed within the TAMPs.

- EEEE is the equipment and sub-equipment type. For a listing of valid equipment types, see Section 3.4.4.1.
- NNN is the equipment number as required. For example, multiple pumps would be numbered 1, 2, etc.
- F is the floor number, if appropriate.

Note that the asset name may not use all the elements in the naming convention. For example, if an asset is not associated with a sublocation, that element will be omitted from the name.

3.4.6.2 Asset Naming Linear

Linear assets have a different naming convention per asset class and rely on IPS-assigned internal asset numbers for unique IDs (stored in an attribute called COMPKEY) that are different from the asset names. For assets that represent “point” features (manholes, nodes, valves), the column that stores the asset name is the UNITID.

For some asset classes, several naming schemes have been applied to assets coming from different sources or representing different ownership. Rather than change existing asset names to match one standard and risk complicating the linking of existing data that references the current asset names, the asset naming standards listed below will only be applied to new assets moving forward (unless the asset class in question doesn’t currently have any assigned asset names at all).

Table 3.7 lists the primary linear asset classes as stored in the GIS along with their asset naming schemes.

Table 3.7. Linear Asset Naming Convention

Category	Asset Class	Asset Naming Convention
Drainage	Catch Basin	“XX####” using 2-digit code for the watershed
	Channel	<UNITTYPE>_<PIPE_DIA>_<PIPE_TYPE> Name stored in the Asset Name field in IPS
	Drainage Main	<UNITTYPE>_<PIPE_DIA>_<PIPE_TYPE> Name stored in the Asset Name field in IPS
	Drainage Manhole	“XX-####“ using 2-digit code for the watershed
	Drainage Node	“XX-####-“ using 2-digit code for the watershed
	Drainage Pump Station	MSD pump stations prefixed with “MSD” “####-XX” using 2-digit code to represent the station type
	Drainage Valve	“XX####” using 2-digit code for the watershed
	Storage Basin	“XX####” using 2-digit code for the watershed
Sewer	Sewer Main	<UNITTYPE>_<PIPE_DIA>_<PIPE_TYPE> Name stored in the UNITDESC field in IPS
	Sewer Manhole	5-digit integers using the next available # for new structures
	Sewer Node	“#####-XX” 5-digit integers using the next available # for new structures, appended with a 2-digit code for the node type
	Sewer Pump Station	“MSD####-XX” (PS or LS) for MSD facilities “#####-XX” (PS or LS) 5-digit integers for private facilities Pump stations names are managed in GIS, but equipment inside the pump station is managed as vertical assets in IPS

Table 3.7. Linear Asset Naming Convention		
Category	Asset Class	Asset Naming Convention
	Sewer Treatment Plant	“MSD####-TP” for MSD facilities “#####-TP” for private facilities
	Sewer Valve	“#####-V” 5-digit integers using the next available # for new structures, appended with a 1-digit code to indicate Valve
	Private Sewer Connection	Integers

3.4.7 Asset Commissioning and Decommissioning Process

The asset commissioning and decommissioning business process has been standardized to track the process through a work order in IPS to replace the disparate processes used in the past. Non-CIP (initiated by MSD staff) and CIP (initiated through delivery of assets by consultants and contractors) triggers will channel asset commissioning through similar workflows to provision MSD’s information systems that manage the asset information and documents with consistent input. This will help eliminate gaps or inconsistent asset information that hampers asset management activities such as maintenance and R&R planning.

Features of the asset commissioning and decommissioning processes are:

- The asset commissioning and decommissioning business processes include personnel from:
  - Consultants/Contractors (for CIP-related asset commissioning)
  - MSD
    - GIS
    - RCAM Team
    - Records
    - Planning/Scheduling
    - Inventory
    - SCADA
    - Engineering
    - Finance
    - Operations Performance Group
- The process is similar for commissioning and decommissioning, and centers around developing a work order to initiate the processes and trigger personnel to add or remove assets from the CMMS, SCADA, GIS, and inventory.
- To standardize and simplify incorporating new asset information into MSD information management systems, templates have been developed for importing equipment, spare parts, and job plan data into IPS and GIS. MSD will require contractors to deliver completed information related to assets in Excel format (for vertical assets) and Esri file geodatabase format (for linear assets) for direct upload into the systems prior to issuance of final payment using the templates. This will allow for all new equipment to be brought into the systems with the proper information.

Process flow diagrams describing the asset commissioning and decommissioning processes are shown in Appendix F. All facility/systems divisions will adopt these process steps as the procedure for asset commissioning and decommissioning.

3.5 Continuous Improvement

People

- Develop a better scanning system for tracking timesheets as they relate to the workorder.
- Train staff in the use of Power BI to explore/visualize data from core IT systems (CMMS, GIS, SAP) and implement report development support process

Process

- The asset hierarchy will be reviewed for each TAMP to assure compliance with this hierarchy so that costs and other data can appropriately be rolled up. Inconsistencies that are found in this analysis will be resolved during TAMP implementation to assure consistency.
- Develop a hierarchy for pump staions using the hierarchy outlined in this SAMP that better captures the assets in pump stations.
- Investigate part kitting for routine work where applicable.
- Develop a process for collecting operational data such as pump curves and storing it in IPS.
- Develop R/R schedule of values and incorporate into R/R planning tool (InfoAsset Planner / IPS)
- Implement policy to ensure contracts are entered into eB Web consistently
- Identify gaps in document metadata in eB Web and develop plan to close the gaps in order to improve search capabilities
- Implement process for updating linear asset inventory attributes in GIS from CCTV condition assessment data
- Improve the access to condition assessment data and reports through GIS
- Implement mobile force main assessment tools to push data (including photos) to IPS for easier analysis
- Improve vertical asset data quality in IPS through capturing and incorporating nameplate info from the field
- Identify and implement processes to improve "Year Installed" data for linear Drainage assets

Technology

- Continue developing transition to Power BI especially to allow self service reporting on hard to obtain data sets in addition to streamlining tools for consistent data.
- Continue to improve the integrations between SAP and IPS for parts materials and costs.
- Use IPS to track time and push that data back to Workforce.
- Investigate automating preventive maintenance scheduling by integrating IPS and SCADA for runtime data, etc.
- Investigate automating corrective maintenance creation for specific SCADA generated alarms.
- Develop predictive analytics analysis and reports for understanding when operations is outside of normal.
- Start planning for GIS Utility Network implementation to lay groundwork for improved network analysis and real-time modeling
- Expand the use of IPS Mobile tools to include initiating and documenting work orders, service requests, and inspections for major work types.
- Expand use of barcoding in O&M activities to streamline operational efficiency when interacting with IPS

4. Operations and Maintenance

A critical component of an asset management program is a standardized and repetitive maintenance program. Facilities and systems managers will implement best appropriate maintenance practices in the areas identified below across all assets to support achieving and possibly exceeding asset useful lifecycles.

4.1 Operations Strategy

Operational procedures are defined for the facilities and systems and are included in the appropriate O&M manuals which are developed in conjunction with the construction of a new facility or update as part of a rehabilitation project. The development of these documents is discussed in Section 5.4.3. The operational costs are tracked to the facility (or asset where appropriate and available) and analyzed using the IPS system.

Operational strategies and processes are reviewed periodically through a continual improvement process and appropriate updates are made to O&M manuals and procedures. Operational performance is assessed periodically to minimize maintenance expenses caused by operational factors.

4.2 Maintenance Strategy

Performing optimal maintenance for each asset is the goal of a maintenance strategy. Establishing Asset Class and Job Plans, performing preventive and corrective maintenance effectively, scheduling and tracking work in IPS, and understanding costs associated with the maintenance is part of that overall strategy. This information is discussed further in the following sections.

4.2.1 Asset Class Plans/Job Plans

Asset Class Plans are standardized strategy documents developed for each managed asset class. They include an overview of long and short-term activities and references. The short-term activities are further detailed into Job Plans which provide step by step information on how to complete maintenance activities. Accurately detailing the tasks to complete an activity ensures that each maintenance staff completes the task as intended. The details of the Asset Class Plans and Job Plans are contained in Table 4.1, a template for an Asset Class Plan is provided in Appendix G and a Job Plan Guideline is provided in Appendix H.

Table 4.1. Asset Class and Job Plan Components

Description	Item	Sources	Notes
Long-interval Activities (Asset Class Plan)			
Asset Class Plans include years and estimated costs of long-interval refurbishments and replacement (R&R schema). Costs include salvage values (if any) and disposal costs.	• Asset Class Overview • Useful Life (years) • Rehabilitation Interval (years) • Rehab Cost (or percent of replacement cost)	• R&R costs • Condition/age • LOF and COF • Risk policy	**Appendix G**
Short-interval Activities (Job Plans)			
Job Plans will be used to standardize how work is performed on each asset class, assist in planning and	Job Plans will be linked to the appropriate preventive maintenance work order in IPS and include the following information: • Personnel	• Manufacturer's recommended schedule • Institutional knowledge	**Appendix H**

Table 4.1. Asset Class and Job Plan Components			
Description	Item	Sources	Notes
scheduling work, and capture institutional knowledge. Job Plans should be created for all maintenance strategies based on the manufacturer's recommendations contained in the O&M manual along with institutional knowledge, especially where environmental conditions impact equipment performance.	• Duration • Tools/Equipment • Materials • Parts • Tolerances/Thresholds	• Regulatory requirements	

4.2.2 Work Order Priority Types

Work order priority codes are used to assist in prioritizing work schedules and resource assignments. All divisions will use the work order priority codes contained in IPS. Table 4.2 includes a description of the priority codes.

Table 4.2. CMMS Priority Codes				
Number	Description	Definition	Response Time	Schedule Responsibility
P1	Unplanned – Emergency	• Immediate safety risk or regulatory/environmental impact • Critical equipment/process down • Critical pipeline or manhole repair work, including cave-ins to secure area • Dry weather CSOs/SSOs • Structural/imminent/yard/street flooding or flood gate failure • Immediate/critical inspection work • Network/server issues (no remote operation or visual capability, data loss)	Immediate – Break Schedule	Supervisor
P2	Unplanned – High	• Manageable safety risk or regulatory/environmental impact • Critical equipment/process running at reduced efficiency or operated manually • Critical pipeline repairs (from P1) • Utility damages • Non-rain event obstructions • Pre-rain event drainage checks, discharges • Backup (Property service repair)	Within 1 week	Supervisor
P3	Structured	• Preventive and predictive maintenance • Non-critical inspection work	As scheduled	Maintenance Planner/Scheduler
P4	Planned – Medium Improvement	• Critical equipment/process running on spare equipment • Pipeline or manhole repair work, including cave-ins (street) • Moderate flooding risks, ditch cleanings and tree removals • Non-critical or spare/redundant equipment/process down • Neighborhood work/repair	Within 1 to 3 months	Maintenance Planner/Scheduler
P5	Planned – Low Improvement	• Non-critical or spare /redundant equipment/process running at reduced efficiency or operated manually • Non-critical pipeline or manhole repair work	Within 3 months	Maintenance Planner/Scheduler

Table 4.2. CMMS Priority Codes				
Number	Description	Definition	Response Time	Schedule Responsibility
		• Lower flooding risks drainage repairs		
P6	Planned – Discretionary Improvement	• Equipment running normally but work will protect, preserve, or restore • Non-priority work performed as time permits and resources are available	When resources available	Maintenance Planner/Scheduler

4.2.3 Maintenance Management Types

All divisions will adopt the use of the maintenance categories in Table 4.3 for MSD assets. Using the appropriate maintenance activity on each asset will increase the reliability of the system and can extend the useful life of an asset. Having a standardized set of maintenance criteria also provides the foundation for developing performance measures that can be used for analyzing maintenance performance. Workflows for the maintenance categories are included in Appendix F.

Table 4.3. Maintenance Management Types			
Maintenance Category	Description	Application	Examples
Corrective Maintenance (CM)	Used to repair assets and restore to its designed LOS. Corrective maintenance is an intrusive action used to correct an asset failure and is used to keep assets in a ready state to meet capacity and regulatory requirements.	With the exceptions of emergencies, corrective maintenance will be planned and scheduled in IPS to ensure all parts and materials are ready before work begins.	Treatment - CM initiated by a PM TVI - will have customer generated CMs for inspections. Drainage - Customer request. Majority of work is corrective Sanitary – Backups, Inspection for customer reported issues, cave-ins manhole raises, etc.
Preventive Maintenance (PM)	Asset maintenance strategy based on replacing or restoring an asset at a fixed interval (calendar or hours of operation) which will be planned and scheduled in IPS. To complete the PM activities with consistent quality, each PM activity will have a well-defined job plan including a bill of material, when appliable. Trends in asset condition, long-term cost estimates and corrective maintenance, along with cost and risk analyses, are used to update Asset Class Plans, intervals for PM and Job Plan details.	All PMs are planned and scheduled monthly and annual schedule exists to adjust workload and account for seasonal outages. Some PM activities may trigger a CM for follow up work such as changing drive belts.	TVI - routine sewer flushes and FOG, root control. Drainage – Ditch cleaning, contract mowing. DOW and COE required inspections CSO – weekly inspections, catch basin cleaning, pre-rain event inspection, viaduct pre-rain inspection Sanitary – No PMs
Predictive Maintenance (PdM)	Predictive maintenance (PdM) and condition monitoring are used interchangeably in the maintenance industry and provide valuable information in support of an asset management program. Typically. predictive technologies are non-intrusive and inform O&M staff how an asset is performing, predicts required maintenance activities, increases reliability, and avoids unanticipated failures.	All PdMs are planned and scheduled monthly and annual schedule exists to adjust workload and account for seasonal outages. PdM technologies can be used on critical or appropriate assets. To do this, critical assets must be identified in IPS. Some PdM is completed as part of a PM.	Treatment - Oil testing on large transformers. Generator oil and coolant analysis TVI - PACP and condition assessment.

Table 4.3. Maintenance Management Types			
Maintenance Category	Description	Application	Examples
Run to Failure (RTF)	No planned maintenance. Assets will be run to failure and immediately replaced with stocked spares. Run to Failure (RTF) is a maintenance strategy that is used on less critical equipment where the other maintenance activities are not cost effective. This strategy does require stocking or having access to replacement assets within a specified amount of time.	May use this strategy on non-critical assets.	

4.2.4 Work Scheduling

Work is scheduled by the Planner/Scheduler who generate the work orders from IPS on a weekly, monthly, quarterly, and annual basis. The work orders are assigned to staff by Supervisors. Each division is at a different level of maturity in completing planning and scheduling activities as well as using IPS to schedule and assign work orders. MSD's goal is to have all divisions perform formal planning/scheduling and assignment using the capabilities in the IPS system. The planning and scheduling workflow is outlined in Appendix F.

4.2.5 Maintenance Costs

All maintenance activities, including those completed by contractors, have an associated work order. Costs associated with the activity are collected via the work order and includes:

- Labor Classification
- Labor Hours
- Parts and Material cost
- Contract service costs
- Tool/Equipment rental costs

Accurately collecting costs associated with maintenance activities is an important piece of information that can be used to develop annual maintenance budgets and to determine if replacement vs. continuing to do extra maintenance is more cost effective.

4.3 Inventory/Warehouse

All parts and materials stored in inventory will be associated with a maintainable asset. Currently items received through a contract are kept in the SAP inventory system. Any parts or materials purchased by O&M are tracked outside of SAP inventory system by O&M staff. MSD is working towards an all-inclusive electronic inventory system that accounts for all parts, materials, and spare equipment, regardless of the origin, so that they can easily be associated with an asset during planning and scheduling activities. This will also provide for a more streamline approach to tracking costs on work orders associated with maintenance activities.

4.4 Optimization

4.4.1 Condition Assessment Methods

Monitoring and assessing asset condition provide essential information to decision-makers regarding when to repair, rehabilitate and replace assets. In addition to making rehabilitation and replacement decisions, condition assessment also informs asset managers on how best to operate and maintain an asset. For example, condition assessment results may indicate there is a need to adjust preventive maintenance schedules.

Monitoring and assessing the condition of critical assets at facilities and systems will be performed through two approaches: visual inspection and condition monitoring. The condition assessment approaches and how the standard ratings are to be used within each approach are summarized in Table 4.4 and explained in further detail in the Visual Inspection Guidelines document included as Appendix I.

Table 4.4. Condition Assessment Methods

Description	Use Application	Examples
Visual/Routine/Sensory Inspection		
A sensory evaluation of an asset to determine whether further action, including condition monitoring, is needed. Sensory inspection involves the use of visual, auditory, tactile, and olfactory senses to document the physical state of an asset (e.g., condition) and determine whether an asset is delivering its LOS requirements (e.g., performance).	Maintenance staff will conduct a baseline condition assessment on critical assets using the visual inspection approach. Assessment teams are to use the observations to support and justify the selection of condition, performance, and recommendation ratings. The sensory inspection approach is used to establish a baseline condition for critical assets and to assess the condition of assets over time where detailed condition monitoring is not warranted.	At a minimum, the following will be noted by staff if observed during an inspection. • Vibration • Abnormal temperature • Noise • Corrosion • Wear and material loss • Leaking • Belts loose • Cavitation
Condition Monitoring		
The collection and analysis of data to identify a change in the condition and/or performance of the asset over time with the goal of identifying changes that may indicate an impending failure.	Maintenance may perform ongoing condition monitoring to identify changes in condition and performance over time using the methods deemed appropriate for different asset types (see Section 4.2.3). Specifically, condition monitoring is used to: • Identify hidden failures • Predict maintenance activities • Avoid unanticipated failures • Inform maintenance and operations how equipment is running • Increase efficiency in performing work (planned vs. unplanned) • Increase reliability • Reduce lifecycle costs • Extend equipment life • Minimize environmental (regulatory) impact • Make sure equipment is installed to spec (acceptance testing) • Make knowledge-based decisions	Some of the parameters that may be monitored to predict asset failure include: • Vibration • Dimensions • Color (i.e., screw inspections) • Flow (running at full speed) • Meg motors • Voltage (motors) • Housekeeping • Bearing wear • Pass/fail • Pressure • Amperage (motors) • Run times (motors) • Temperature (bearings, housing)

Condition Assessment Ratings

Standardized condition, performance, and recommendation ratings have been established to ensure consistent documentation of asset condition. A standardized approach supports planning and prioritization of renewal and replacement decisions. When conducting visual inspection and condition monitoring, the assessment team at a particular location should document their findings using the standardized condition assessment format that includes the condition and performance ratings listed in Table 4.5 and the Visual Inspection Guidelines document (Appendix I). Condition assessment data is to be documented in the CMMS.

Table 4.5. Standard Ratings

Rating		Condition Rating Description	Performance Rating Description
1	Very Good	Like new with little signs of wear. Monitor asset condition and no further action required at present	Meets design capacity and regulatory requirements in all current and future anticipated demand conditions. State of the art technology with overall excellent performance.
2	Good	Minor defects evident. Monitor and trend asset condition for possible additional actions	Meets design capacity and regulatory requirements in current average conditions. May have minor risk under current peak conditions and/or will not meet anticipated future peak capacity conditions. Known future regulatory compliance may require some modifications. Overall performance excellent to very good with tried-and-true technology.
3	Fair	Normal signs of wear for age of asset. Continue to monitor asset condition and evaluate for rehabilitation	Current capacity is acceptable under average conditions but does not consistently meet current peak condition and would likely not meet known peak conditions. Current regulatory requirements are met, but known future requirements will likely not be met, even with modifications. Overall performance and efficiency are average.
4	Poor	Significant defects are evident. Continue to monitor asset condition, repair as needed and expedite plan for rehabilitation or replacement	Current performance is marginal under normal operating requirement and will not meet known additional requirements or increased demand (e.g., capacity, level of service goals).
5	Very Poor	Asset has failed or shows excessive wear and should be replaced as soon as possible	Current performance unacceptable and does not meet normal operating requirements or required performance criteria (e.g., capacity, level of service goals and/or regulatory requirements). If parts/or technology cannot be purchased anymore.

Based on the results of the visual inspection or condition monitoring, a recommendation should be made using the recommendation ratings in Table 4.6 for any needed further action (i.e., replacement).

Table 4.6. Standard Condition Recommendations

Rating	Description
1	No immediate action required
2	Consider if asset is a good candidate for condition monitoring*, set the visual inspection frequency to 2 years
3	Consider if asset is a good candidate for condition monitoring*, continue with 1-year visual inspection frequency
4	Develop estimate of remaining useful life, develop scope/plan for rehabilitation and replacement, develop costs to plan timing for budget/funding needs, continue 1-year visual inspection frequency until repairs can be made
5	Immediate corrective action required

Condition Assessment Data Collection Process

Data collection associated with visual inspection and condition monitoring activities will be documented in IPS. Visual inspection data will routinely be collected conducted in accordance with the Visual Inspection Guidance included in Appendix I.

4.4.2 Root Cause Failure Analysis

Failure Codes

Failure codes also known as Problem, Cause, and Remedy (PCR) codes are used to assist with trouble shooting failures and trending like failures across the MSD divisions. The key to successfully using PCR codes is having a set of standard codes for each asset class. A standardized set of PCR codes has been developed for both linear and vertical assets and are included in Appendix J. When MSD staff initiate a work order in IPS, they will be required to apply the appropriate problem code. Prior to the technician closing out a work order they will have to apply the appropriate cause and remedy code.

PCR codes assist in the following

- Track and trend asset failures
- Identify the causes of failure
- Change maintenance procedures to reduce failures
- Identify problem manufacturers and equipment

Root Cause Analysis

PCR codes will be used as part of completing root cause failure analysis (RCFA) on critical assets. Using failure codes and performing RCFA, MSD staff can make data-driven decisions related to adjustments to maintenance and operations procedures, engineering designs, and equipment selections to assist in reducing equipment failure.

All divisions will assign properly trained staff to complete this analysis on a periodic basis to support the AM program and continuous improvement of the operations and maintenance program.

4.5 Continuous Improvement

People	Process	Technology
• Ensure staff have the appropriate trainng to complete planning /scheduling and RCFA. • Ensure staff have the appropriate training to complete visual inspetion of critical assets.	• Based on trending and tracking of the applicable condition assessment parameters, staff will update the baseline condition, performance and recommendation ratings established for critical assets during inspections when there is an observed change in the parameter that warrants further action. • Based on PCR code information and RCFA, staff will update maintenance strategies to increase asset availabilty and decease asset down time. • Develop a formal process for inventory tracking of spare parts, equipment ad materials.	• Staff will evaluate the availablity of predictive technology and optomize mainteannce strategies by apply the approprate predictive maintnenace technologyto move towards condition based maintenance. • Ensure staff have access to tools as appropriate to asset type to conduct condition monitoring • Staff will use tablets or laptops to document all work in IPS.

5. Capital Planning and Decision Making

An asset management capital planning strategy includes both long-term and near-term components to address rehabilitation and replacement (R/R) needs. Long-term R/R plans involve identifying the aggregate R/R needs of each facility and system over the next fifty years, which helps establish needed funding levels. Near-term capital planning involves the identification and justification of specific R/R projects, prioritization of those projects using the risk-based prioritization criteria, and the development of a five-year capital program. Asset Commissioning and decommissioning reflects how new assets are delivered and old assets are retired as part of the engineering design and construction process.

5.1 Risk Management

This section describes the risk management strategies used to manage asset risk. This approach to risk management involves the development of a risk register and risk-based prioritization.

5.1.1 Asset Risk Policy

A separate Asset Risk Policy is included as a supporting document. The policy exists for the purpose of clearly outlining the principles the organization has adopted to manage risks of managing, operating, and maintaining MSD assets, facilities, and services to protect public health and safety. The policy supports financial stewardship and the ability to provide quality wastewater, stormwater, and flood protection services.

5.1.2 Risk Register

A risk register is used to document key organizational risk events that have the potential to impact business objectives and meeting levels of service. The register includes the following elements:

- **Risk Event.** The occurrence of a particular set of circumstances that influences objectives and meeting levels of service.
- **Effects/Impacts.** Describes the impact the event may have on the organization.
- **Consequence Score.** Value that quantifies the severity of the impact of the event as negligible (1), low (2), moderate (3), high (4), or very high (5).
- **Likelihood Score.** Value that quantifies the certainty that the event may occur as negligible (1), low (2), moderate (3), high (4), or very high (5).
- **Risk Score.** The result of multiplying the likelihood and consequence scores.
- **Risk Strategy.** Process to modify risk (includes mitigation, avoidance, transfer, or acceptance).

Table 5.1 provides an overview of the risk register format. It also includes example events to illustrate the use of the risk register. As part of the development of the TAMPs, each division will be responsible

Definitions

Risk:

- Relates to the consequence of an event happening and the certainty that it will happen.
- Within the context of asset management, risk is defined as the "likelihood" that an asset is unable to provide the function for which it was installed, combined with the "consequence" of the asset failure.
- Organizational Risk – Related to high-level risk events that impact the organization.
- Asset Risk – Related to critical assets including facilities, asset classes and/or individual assets.

Risk Register:

Documents the high-level risks to the organization, likelihood and consequence of occurrence, and any risk mitigation measures.

Risk-Based Prioritization:

Process for setting priorities and ranking assets using likelihood and consequence of failure (LOF and COF) criteria.

Critical Assets = High COF.

for developing an appropriate risk register and risk strategies (example shown in Table 5.2) for their assets in the timeframe determined by the AMSC.

Table 5.1. Risk Register (Example)

Risk ID	Risk Event	Effects/Impacts	Consequence Score (1 to 5)	Likelihood Score (1 to 5)	Risk Score	Risk Mitigation Strategies
1	Example 1: Large diameter structural failure (cave-ins, collapse) of gravity sewer	• Health and safety • Regulatory and environmental impacts • Economic impacts • Reputation and public relations impacts	5 – Very High	4 – High	20	• Routine inspections • Risk-based rehabilitation or replacement • Forensics on failures • Geotechnical assessments and modeling
2	Example 2: Insufficient design capacity in the collection system	• Health and safety • Regulatory and environmental impacts • Economic impacts • Reputation and public relations impacts • Community and stakeholder impacts	2 – Low	5 – Very High	10	• Facility planning • Capital improvements • Hydraulic modeling • Monitoring of future development • Determination of available capacity

A full draft risk register is in **Appendix K** and provides documentation of the latest identified key organizational risks for MSD. The risk register should be maintained in accordance with the continuous improvement items listed in Section 5.5.

Table 5.2. Risk Mitigation Strategies Example

Risk Mitigation Strategies	Description	Responsible Party	Status
Example 1: Routine inspections for gravity sewers	Develop and maintain schedules to perform gravity sewer line inspections (CCTV, laser profiling, sonar, etc.)	Engineering and Operations Divisions	In Progress
Example 2: Facility planning related to capacity of the collection system	Develop plans for facility improvements to increase capacity of the collection system, as needed.	Engineering and Operations Divisions	In Progress

5.1.3 Risk-Based Prioritization

Standardized risk criteria are used to identify critical assets and to prioritize maintenance programs. The consequence of failure (COF) criteria are defined in Table 5.3 and identify the impact on level of service, utility, stakeholders, or public resulting from an asset failure. Likelihood of failure (LOF) criteria are defined in Table 5.4 and inform the possibility of the asset failure happening.

Each facility or system should apply the COF and LOF criteria to individual assets to identify the highest priority assets based on risk score as shown in Figure 5-1. The assignment of COF and LOF criteria is a significant effort in the TAMP development. It is suggested that review of COF occur first for all assets. LOF criteria can then be assigned to assets with highest COF first. In this way the organization will identify high risk assets earliest as they complete the rest of the risk identification.

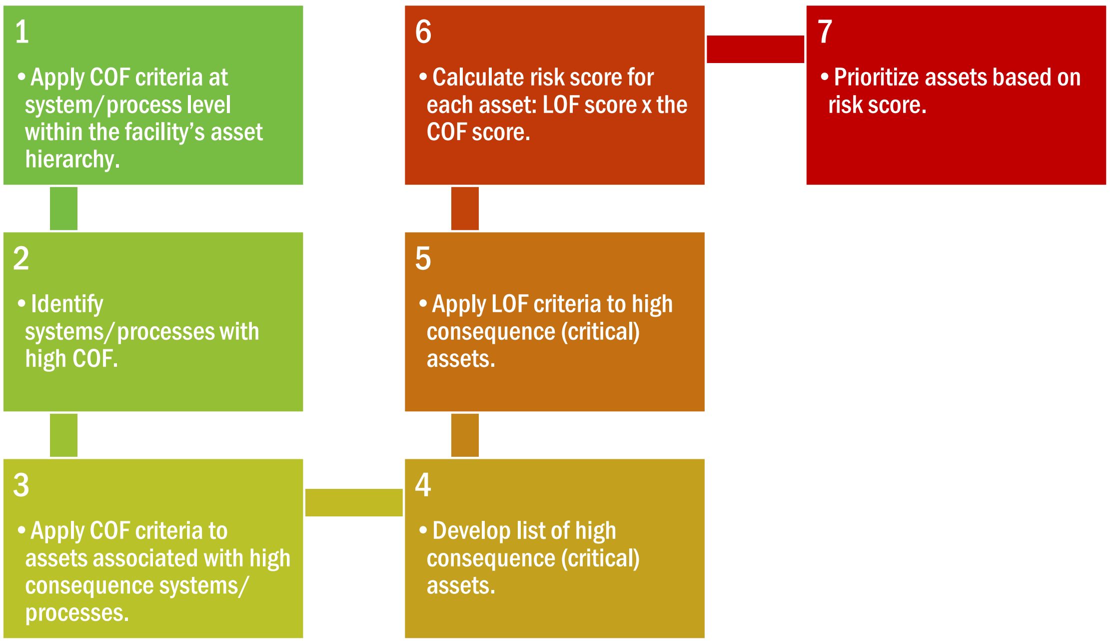


Figure 5.1. Risk-based prioritization steps.

Table 5.3. Consequence of Failure (COF) Criteria							
Criteria	Description	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Regulatory & Environmental Impacts	Overflows (discharge to waters of the US) Permit Violations at WWTP USACE Violations MS4 Violations Consent Decree Violation/Stipulated Penalties	Short duration Low quantity Contained within facility No violation	Minor disruption Few complaints Short process upset Minor SSO less than 1000 gals ($ based on local regulatory fines)	Substantial disruption Numerous complaints Prolonged process recovery Significant SSO Violation or fines.	Major disruption Complete loss of process Major SSO 0–6-month recovery time Violation, fines and/or prosecution.	Major disruption Complete loss of process Spill of >100,000 gallons > 6-month recovery time Inability to operate.	20

Table 5.3. Consequence of Failure (COF) Criteria							
Criteria	Description	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Community & Stakeholder Impacts	Number of customers, assets, and/or facilities impacted due to due to a failure.	Short duration disruption, less than 10 customers affected Localized impact	Up to 100 customers affected	Up to 1,000 customers affected Multiple systems/areas impacted	Up to 10,000 customers affected	More than 10,000 customers affected Facility-wide/system-wide disruption	16
Reputation & Public Relations Impacts	Media coverage based on number of people affected, environmental impacts, financial loss, lawsuits.	No Significant Impact	Public inquiry No media coverage	Local adverse media. Correspondence from State and/or local officials	Multi-agency interests and/or exposure across multiple social media platforms	Broad adverse media, (Service area and neighboring jurisdictions) Potential Legislative action	16
Health & Safety Impacts	Public health and safety impacts, employee safety, regulatory compliance.	First aid required (cut, bruise, topical rash)	Minor injury (Sprain, stitches)	Moderate injury (broken bone) or illness lasting several days	Severe injury or illness with permanent damage	Fatality (EPA death avoidance cost @ $9M), localized illness	20
Indirect Economic Impacts	Total repair, rehabilitation and/or replacement costs. Increased operational costs.	Less than $30K	$30K to $250K	$250 to $500K	$500K to $2M	$2M or greater	14
External Economic Impacts	Lost revenue, liability costs, fines, and property damage.	Less than $5K	$5K to $20K	$50K to $100K	$100K to $500K	$500K or greater	14

Table 5.4. Likelihood of Failure (LOF) Criteria							
Criteria	Description	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Proactive Maintenance and Inspection History	Proactive maintenance, testing, or inspections completed in accordance with plans	Consistent Preventive Maintenance and inspection scheduled and performed	--	Preventive Maintenance and inspection scheduled, but infrequently performed	--	No planned preventive maintenance or inspection	12
Usage/Run Times	Frequency of use as an indicator of operational and/or capacity issues	Low run times	--	Moderate run times	--	High run times	10

Table 5.4. Likelihood of Failure (LOF) Criteria

Criteria	Description	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Life Remaining	Remaining useful life based on the age of the asset	New or like new Greater than 80% useful life remaining	80% to 60% useful life remaining	60% to 40% useful life remaining	20% to 40% useful life remaining	At end of life or nearing end of life Less than 20% useful life remaining	9
Corrosion	Corrosion susceptibility	Not susceptible to corrosion	--	Moderately susceptible to corrosion and operating in moderately corrosive environment/ conditions	--	Highly susceptible to corrosion and/or operating in highly corrosive environment/ conditions	5
Difficult to maintain or limited/unsafe access	Assets that require specialized skills or equipment to operate and maintain Difficult to access	Able to access and maintain	Limited access and/or no specialized skills or equipment required	Limited access and/or requires specialized skills or equipment available in-house	Unable to access and/or requires specialized skills or equipment available in-house	Unable to access and/or requires specialty contractor(s) and equipment	12
Complexity	Number of points of failure within the asset/system	Simple asset/system with a single point of failure	Simple asset/system with a few points of failure	Moderately complex asset/system with few points of failure	Moderately complex asset/system with multiple points of failure	Highly complex, with multiple points of failure	5
Spare parts availability	Assets with parts that are difficult to find, no longer made, and/or with no vendor support	Parts readily available	Parts available within 24-hours	Parts available within a week	Parts available within a month	Parts available within multiple months or no parts available and/or no vendor support	10
Asset Failure	Frequency of asset failure under normal operating conditions based on historical asset operation and maintenance records	No known failures in the last 2 years	--	1 failure in the last 2 years	--	2 or more failures in the last 2 years	12
Backup Power Availability	Availability of backup power	Onsite generator installed	--	Offsite portable generator available and/or dual-feed available	--	No backup power	5

Table 5.4. Likelihood of Failure (LOF) Criteria							
Criteria	Description	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Pump Around Availability	Availability of pump around capabilities	Dedicated reserve pump in inventory	MSD owned standby pump available	Rented/contracted portable backup pump locally available	Rented/contracted portable backup pump available	No portable backup and/or no reserve pump in inventory	5
Reaction Time	Anticipated reaction time before failure occurs	More than 24 hours to respond before a failure occurs	12 to 24 hours	1 to 12 hours	30 minutes to 1 hour	Less than 30 minutes to respond before a failure occurs	5
Design or Material Defects or Known Issues	Defects and/or issues are known and have been identified	No known issues	--	Few defects/ known issues	--	Defects and known issues have previously resulted in asset failure	5
Capacity	Meets desired capacity requirements	Significant available capacity during peak conditions	Available capacity during peak conditions	At capacity during peak conditions	At capacity during average conditions	Exceeds capacity during average conditions	5

The COF/LOF guidance document is included in **Appendix L**. An example of asset COF/LOF scoring is included in Table 5.5 below for reference. It should be noted that COF scores will be static year to year and only significantly change when processes are modified, or assets are built/abandoned. Unlike COF scores, LOF scores are dynamic in nature and will move towards a higher score over time.

Table 5.5. Example Asset COF/LOF Scoring: "Gravity Main 1"				
COF Criteria	Score	Justification	Weight	COF Score
Regulatory & Environmental Impacts	4	Large diameter interceptor. Would result in a major SSO.	20	0.8
Community & Stakeholder Impacts	3	Anticipate up to 1,000 customers impacted, including traffic disruptions and potential for backups into homes.	16	0.48
Reputation & Public Relations Impacts	3	Expect some local media coverage due to the number of customers impacted and the high traffic areas affected.	16	0.48
Health & Safety Impacts	3	Potential public health impacts due to SSO and sewer backup.	20	0.6
Indirect Economic Impacts	4	Anticipate emergency repair to be at least $500K	14	0.56
External Economic Impacts	2	Would likely have some small claims due to impacts on customer's homes.	14	0.28
			COF TOTAL	3.2

Table 5.5. Example Asset COF/LOF Scoring: "Gravity Main 1"				
LOF Criteria	Score	Justification	Weight	LOF Score
Proactive Maintenance and Inspection History	1	CCTV inspections performed once every 2 years as scheduled	12	0.12
Usage/Run Times	-	Not Applicable	10	*
Life Remaining	3	Ductile iron pipe installed in 1955. Assuming a 100-year useful life, another 44 years remain. Main has approximately 44% of useful life remaining.	9	0.27
Corrosion	5	Ductile iron pipe installed in corrosive soils.	5	0.25
Difficult to maintain or limited/unsafe access	3	Located downtown on main thoroughfare. Maintenance activities require extensive traffic control.	12	0.36
Complexity	2	Civil asset with few points of failure.	5	0.10
Spare parts availability	3	Not a standard pipe size kept in inventory. Would take at least a week to get.	10	0.30
Asset Failure	3	Had a collapse in the pipe leading to an SSO 1 year ago. No other known failures.	12	0.36
Backup Power Availability	-	Not applicable.	5	*
Pump Around Availability	-	Not applicable.	5	*
Reaction Time	4	Very little storage in the system as this pipe already operates at near capacity during wet weather. Would expect less than an hour to respond if there was a major blockage.	5	0.20
Design or Material Defects or Known Issues	3	Few defects or known issues.	5	0.15
Capacity	3	Pipe already operates at near capacity during wet weather.	5	0.15
			LOF TOTAL	2.8

**Not all LOF criteria will be applicable for all assets. When deemed not applicable, exclude the LOF score for the criteria from the total LOF calculation as shown above.*

The outcome of this process is a risk-ranking of assets that can be used to prioritize condition assessment activities, operations and maintenance activities, spare parts inventories, and risk-mitigation projects such as replacement/rehabilitation. These rankings may also be used to determine the priority and timeframe for corrective actions as part of capital planning. Throughout development of the TAMPs, each division will be responsible for developing prioritized assets for their facilities in the timeframe determined by the AMSC.

5.1.4 Risk Results Analysis

The results of the Risk Register and Risk-based Prioritization may be placed on a risk matrix like Figure 5-2. Location of assets within the risk matrix corresponds to the appropriate risk strategy approach. For example, an asset or risk with low consequence and likelihood scores will fall into the low-risk zone which indicates managed strategies and, in some cases, requires accepting the risk (i.e., operating assets until failure). On the other hand, high consequence and likelihood risks will require risk strategies to manage and reduce the risk. For example, high risk assets may require planning for rehabilitation/replacement or enhanced condition assessment/monitoring and increased maintenance activities.

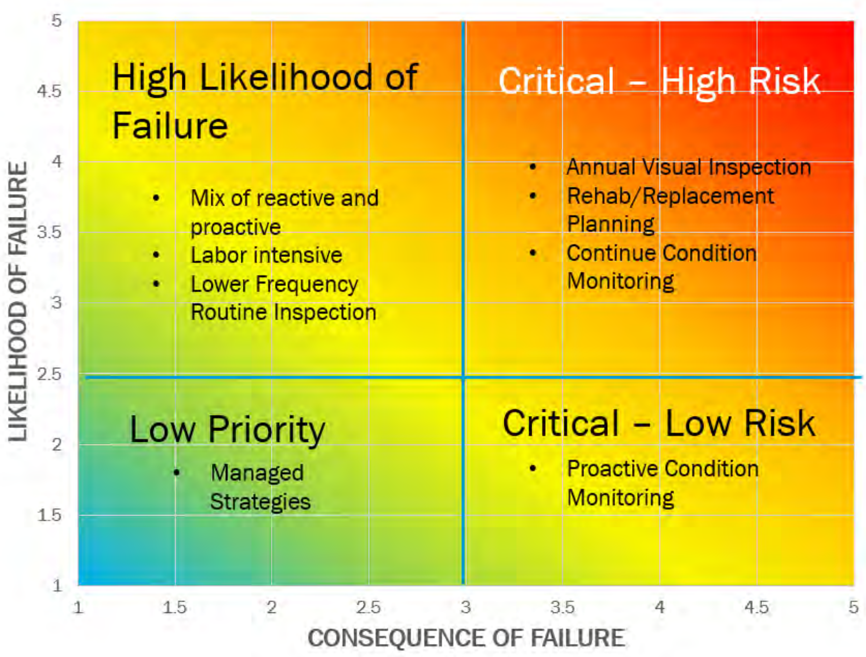


Figure 5.2. Asset risk matrix.

5.1.5 Risk Strategies

Risk strategies should be developed to lower the likelihood and/or consequence of a risk event. High-level organizational risks will typically be identified in the Risk Register, as outlined in Section 5.1.2, while critical asset risks will be identified through the risk-based prioritization process described in Section 5.1.3. Through the Risk Results Analysis, MSD staff will determine the most appropriate risk strategy based on where the risk is located within the risk matrix. Various options for risk mitigation exist, including:

- Avoiding the risk by deciding not to start or continue with the activity.
- Removing the source of the risk.
- Reducing or eliminating risks with capital projects, asset replacements, and/or changes in operating procedures or maintenance activities.
- Contingency planning.
- Transferring risk (through contracts, insurance).

Specific types of risk strategies identified for MSD are described below:

- **Studies**: Conduct studies to further quantify the actual level of risk to MSD. This may include studies to evaluate asset/facility condition, staffing, natural hazards, power reliability and/or capacity. These studies may result in capital projects or MSD actions to mitigate risk, if warranted. Studies are anticipated to result in reduction of the likelihood of a risk event occurring.
- **Capital Projects**: Implementation of planned projects or newly identified projects to help reduce risk. Projects may include increases in capacity, rehabilitation and/or replacement. Capital projects are anticipated to result in reduction of the likelihood of a risk event occurring.

- **Engineering Standards and Practices**: Update of engineering standards and practices to incorporate design requirements that may prevent or minimize risk in improvements to existing or future facilities. Engineering Standards and Practices are anticipated to result in reduction of the likelihood of a risk event occurring.
- **Contingency/Emergency Response Plans**: Development of plans that document the roles, responsibilities and procedures that would be needed if the potential risk were to occur. These plans will help MSD to minimize the impact of the consequences if the risk occurs. These plans are anticipated to result in reduction of the consequence of a risk event occurring.
- **Critical Assets and Spare Parts**: Development of a critical asset and spare parts management strategy to ensure reliability and availability of critical assets. This may include maintaining an inventory of critical spare parts and/or establishing robust service level agreements with key vendors and contractors to ensure timely response and availability. These strategies are anticipated to result in reduction of the consequence of a risk event occurring.
- **Operations and Maintenance**: Modification of strategies for operating and maintaining existing and future MSD assets to proactively minimize the likelihood of the risk occurring. They may include modification of staffing levels, SOP and/or maintenance planning and scheduling. These strategies are anticipated to result in reduction of the likelihood and/or consequence of a risk event occurring.

Risk events may have multiple risk strategies. This multi-pronged approach to some risks will help MSD to achieve the greatest level of risk reduction.

Potential risk strategies are included in the Risk Register in Appendix K and discussed in Sections 5.2 and 5.3. Examples of mitigation options identified for MSD are included in Table 5.2. The table also illustrates the minimum required information for risk strategies in the TAMPs.

5.2 CIP Development and Prioritization Process

All divisions will adopt these process steps and workflows as the guidelines for Capital Improvement Program (CIP) development and prioritization.

5.2.1 Growth and Forecasting

Analyses of growth and necessary capacity are performed on a scheduled basis and used to determine funding needs, as demonstrated in the 20-Year Comprehensive Facility Plan and Critical Repair and Reinvestment Plan (CRRP) developed in 2017 and revisited on a 5-year cycle. Forecasting is done using optimization tools (capacity planning, asset acquisition, maintenance analysis, R/R alternatives, etc.).

Periodic analyses are undertaken of the financial results and used to determine future costs of assets and asset operation and maintenance costs. Key assumptions for financial planning are included in the CRRP.

5.2.2 Rehabilitation and Renewal Process: Long-term Capital Project Planning

Long-term, or 20-year, R/R plans for critical assets should be developed for each facility and system and incorporated into the CIP. R/R plans should be comprised of estimated R/R costs for each critical asset over a designated period (i.e., 20-year period). The example shown in Figure 5-3, illustrates the various anticipated R/R costs over the lifecycle of a single asset.

The table included in Appendix M has been developed for use by facilities and systems managers to develop planning level estimates for use in R/R plan development and will be fully developed and included as part of a future SAMP update. It includes the following key pieces of information that each facility/system will need to establish an R/R plan for critical assets. The steps used by staff to populate required data fields in Appendix M and develop long-term R/R plans for critical assets are shown in Figure 5-4.

- **Asset Class Name.** Describes a group or type of assets with similar characteristics
- **Rehabilitation Interval.** Describes how frequently the rehabilitation will occur, in years.
- **Rehabilitation Cost OR Percent.** Provides the assumed cost or percent of the replacement cost that will be used to estimate the rehabilitation cost.
- **Asset Useful Life.** Typical life, in years, of an asset assuming that a reasonable and normal level of preventive maintenance is performed.
- **Replacement Cost.** Typical cost to purchase a new asset when the existing asset is decommissioned.

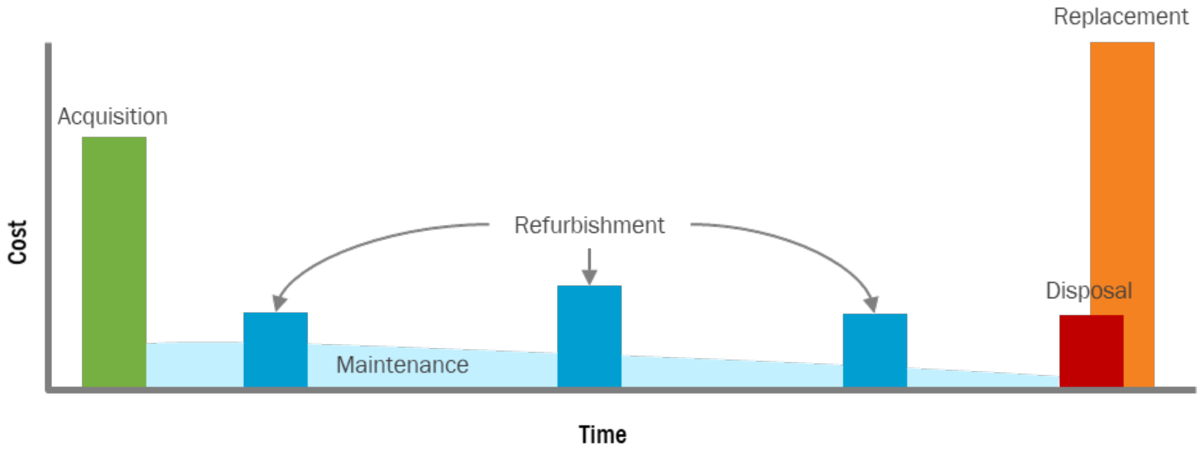


Figure 5.3. Typical costs incurred in an asset lifecycle.

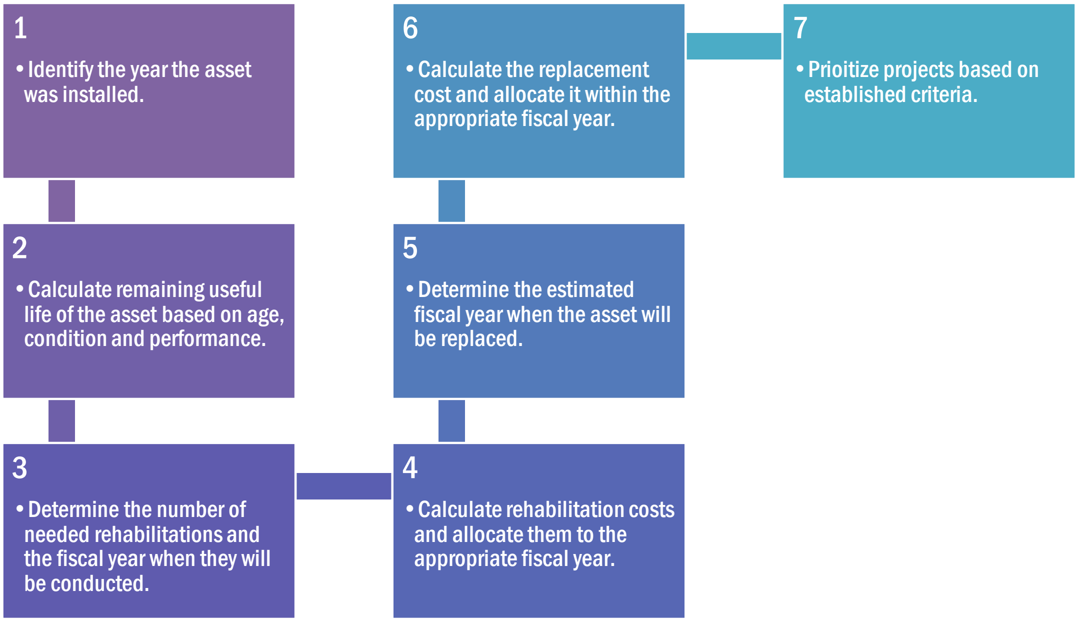


Figure 5.4. Long-term R/R planning process.

5.2.3 Rehabilitation and Renewal Process: Near-term Capital Project Planning

Near-term, or 5-year, capital project planning is to be conducted for critical assets that have received one of the following condition assessment ratings as tracked in the CMMS (see Table 4.6):

- (4) Replace/ Refurbish, or
- (5) Immediate corrective action required.

The development of a Business Case Evaluation (BCE) form is required for critical R/R capital projects, as instructed in Appendix N. Figure 5-5 shows the process for inclusion of identified R/R projects in the near-term CIP. MSD has developed a tentative list of AM projects for rehabilitation and replacement in Appendix O.

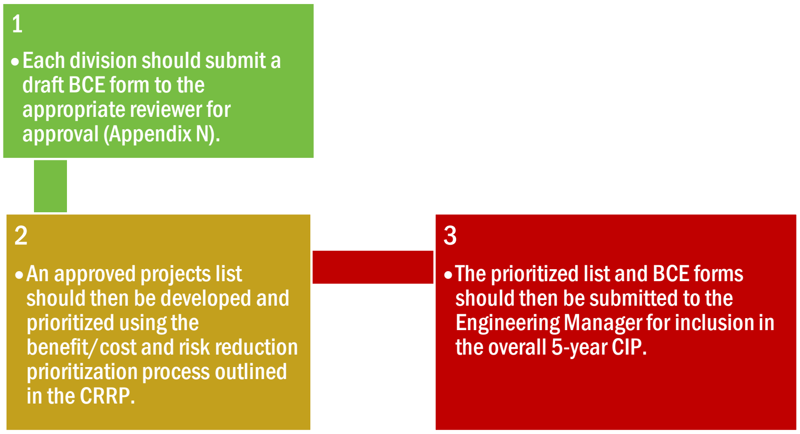


Figure 5.5. Near-term R/R planning process.

5.2.4 Business Case Justification and Evaluation

Providing a sound business case for projects is essential to developing and deliver a healthy, sustainable capital program. MSD has established a standardized approach to justifying needs/projects to allow staff to determine project priorities and make the case for funding projects. The intent is to develop project details, coordinate with interagency departments and outline a path forward during the planning phase. The BCE instructions for use by staff to facilitate this process is included in Appendix N.

- There is no cost threshold for conducting a BCE, the following options based on project background and complexity all for tailoring the appropriate level of detail:
  - Full Alternative Analysis – Used for initial strategy discussion and screening, as well as alternative development and analysis.
  - BCE Lite/Simplified Documentation – Used where there has been significant prior evaluation, or straightforward projects with limited alternatives.
- Staff will be trained on the business case justification process following the details noted in Table 2.5.

5.2.5 Project Prioritization Process

Developing and prioritizing capital projects involves many contributors across the organization including operations and maintenance, engineering, management, planning, and finance. The compiled CIP is based on BCEs and prioritization across all service areas (i.e., Wastewater, Stormwater, and Flood Protection).

The process flow diagram for prioritizing and scheduling projects is shown in Figure 5-6.

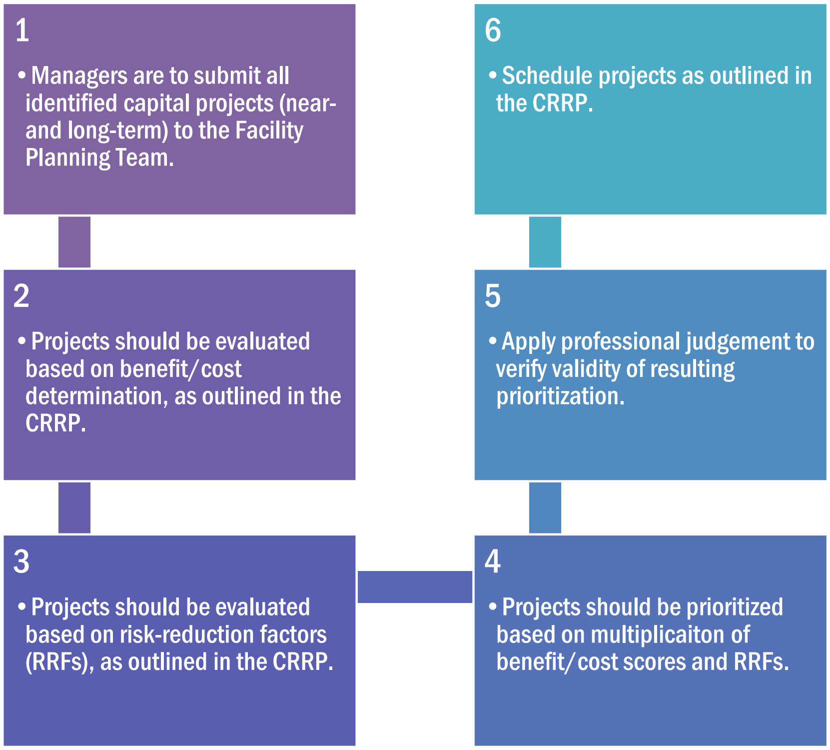


Figure 5.6. Project prioritization and planning process.

5.3 Funding

A Financial Plan for asset R/R and CIP projects is in place and maintained as outlined in the CRRP. The funding strategy and plans are developed by the District's Finance Department with input from the various departments and senior leadership.

5.3.1 Forecasting Long-term R/R Needs

MSD's performs long term financial planning supported by the 20-year Critical Repair and Reinvestment Program and a 20-year comprehensive financial model. Rate adjustments are considered in conjunction with bond issues. Key long-term considerations are debt service coverage, maintaining level debt service payments, and maintaining adequate cash reserves.

Periodic analyses are undertaken to determine future costs of asset renewal and replacement, including asset maintenance costs. This information is available to inform the development of the CRRP Financial Plan.

5.3.2 Funding Strategy

Once an asset R/R need has been justified, an integral part of the process is deciding how the project will be funded. All legally available delivery methods are considered, such as in-house, design and construct, design-build (DB), progressive design-build (PDB), design-build-own (DBO), design-build-own-operate (DBOO). The selection is made with due consideration of comparative lifecycle costs which includes leasing and buying of equipment.

There are several types of funding methods available to support the AM program. Table 5.6 provides details about potential funding options.

Table 5.6. Funding Methods

Funding Source	Description	Application
Operating Budget	Budget used for standard O&M of assets -rehabilitation and replacement	Smaller R/R improvements that can be self-performed or contracted within approved budget
Appropriations Budget	The broader Department budget that can be used to expedite asset R/R needs that exceed the division operating budget.	Expedited outsourced R/R improvements that are greater than can be accommodated by a divisional budget and/or cannot be delivered within the CIP timeframe
CIP	Budget process for specific asset R/R projects over a longer planning horizon. Engagement with Engineering is required for asset R/R sequencing within capital program.	Projects identified by the AMP or in master plans that are planned, prioritized, and can be delivered by the District's CIP
Emergency R/R	Emergency repairs that cannot be accommodated by other budgets and must be executed outside the CIP	Emergency as determined by Executive Director

5.4 Design and Construction

5.4.1 Design Requirements

The MSD Engineering Capital Project Management Handbook (ECPMH) provides guidance on design phase requirements and processes throughout the life cycle of a project development. Appendix F includes the design workflow based on the ECPMH and additional activities identified during development. Many of these additions were included to address operability and maintainability and other asset management considerations early in the design and are presented in Table 5.7.

The required elements contained in the design workflow are included in the ECPMH as specific sections to be included in the designer's scope of work (where appropriate). For design projects they may include operability and maintainability reviews at the 10%, 30%, 60% and 90% milestones of the design, naming conventions provided in Section 3 of this document for documentation and record drawings, and details to be incorporated into the construction contractors project specifications (see Section 5.4.3).

Table 5.7. Asset Management Activities During Design

Activity	Description	Location
O&M Engagement	Activities lead by the designer that engage operations and maintenance in the design process with the intent of creating meaningful O&M related improvements to the procurement documents	ECPMH
Operability/Maintainability	Specific reviews conducted periodically during the design that ensure that the finish product includes feature to enhance the future operations and maintenance for the delivered project	ECPMH
HAZOP Considerations	A review with O&M staff on hazardous processes or features that will be delivered as part of a project and the safety related aspects of the final design to mitigate hazards	ECPMH
Future Staffing Needs	Engagement of O&M management to assess the future knowledge, skills, and abilities required to successfully operate and maintain the completed project. May also include an assessment of staff additions or changes	ECPMH
MOO Planning	Maintenance of Operations Planning to ensure that existing facilities and infrastructure remain in operations during and following a construction project	ECPMH
AM Program Needs	The inclusion of asset management program required asset data, hierarchy, and naming conventions in the design documents for delivery to the asset management group for inclusion in the CMMS	ECPMH
Startup Criteria/Warranty	The inclusion of startup and warranty requirements, appropriate to the project, in the contract specifications for bidding by a contractor	ECPMH
O&M Specifications	The inclusion of O&M expectations with respect to training, O&M manuals, asset information, maintenance information and plans, spare parts, etc. in the contract specifications	ECPMH
Startup Leadership	The creation of a startup team made up of District staff to engage in testing, startup, and commissioning efforts during construction	ECPMH

5.4.2 Construction Requirements

The MSD Engineering Capital Project Management Handbook (ECPMH) provides guidance on construction phase requirements and processes throughout the life cycle of a project delivery. Appendix F includes the construction workflow based on the ECPMH and additional activities identified during development. Many of these activities were added to engage operations and maintenance staff during the construction period and to provide asset management information related to the new construction well ahead of anticipated startup. Processes are in place to ensure more efficient project walk-throughs, process start-ups and receipt of required documentation from the contractor. These processes are described in Table 5.8.

The required elements contained in the construction workflow are included in the ECPMH as specific sections to be included in the contractor's scope of work (where appropriate). For construction projects, they may include activities during construction required for successful training, startup and commissioning of new facilities, naming conventions provided in Section 3 of this document for documentation and record drawings, and specific protocols for transmitting required asset data prior to completion of the work.

Table 5.8. Asset Management Activities During Design

Activity	Description	Location
MOPO/Health and Safety	Collaboration between the contractor and O&M to establish protocols between contractor and operations teams related to temporary operating procedures, maintenance routines, emergency/contingency plans and health and safety during construction	ECPMH Contract Specifications
Testing	Engagement of O&M in plans and, where appropriate, execution of all form of testing required in the contract specifications	ECPMH
Staff Readiness	A planning activity that includes required contractor training on MSD protocols, MSD provided training to orient new staff, new facility tours for O&M; and contractor or designer provide training required as part of the project delivery	ECPMH Contract Specifications
Contractor Deliverables	Activities surrounding the construction delivered by the contractor including electronic O&M manual for new processes, SOPs for new processes, integration of record drawings into O&M manual review draft O&M manuals, required maintenance strategies asset data transfer to CMMS/GIS, spare parts turn over, Inventory records data	Contract Specifications
Startup	Development and review of the conceptual start-up plan, assessment of readiness to begin commissioning, confirm all relevant O&M information, data and punch list of issues are addressed, planning for the Initial operating period, actual start of improvements (wastewater/stormwater/sludge introduced, achievement of stable operations	Contract Specifications
Process Optimization	MSD led effort to review data and apply lessons learned to fine-tune process operations, includes updates to operations and maintenance procedures, SOPs, and O&M manuals	ECPMH Section 5.5

5.4.3 Operating Manuals, Procedures, and Warranties

Construction requirements include delivery of operating and maintenance manuals, SOPs, and warranty information. Asset data and spare parts recommendations are also required. These materials should be gathered as early as possible to allow for review by the designer or construction manager, input from operations, and incorporating comments prior to final acceptance (see Appendix F).

5.4.4 R/R Costs and Attributes

R/R costs, including indirect costs, and asset data attributes are transferred to the CMMS and become a record in the asset history for future use in asset management. If required in the contract specifications, data transfer should be by the specified protocol contained in the construction specifications. For new assets, the expected life will be included in the asset registry. For renewed assets, the expected life extension brought about by the R/R work (if any) is estimated and the remaining useful life of the asset is updated in the asset registry.

5.5 Continuous Improvement

People

- Evaluate future staffing needs during project design and construction phases. This may include consideration of apprenticeship program needs.
- Determine staff skills and training requirements prior to process start-up during late construction.
- Review data and apply lessons learned to fine-tune process operations, includes updates to operations and maintenance procedures, SOPs and O&M manuals
- As new assets are turned over the District assumes the responsibility of initiating the activities of the AM program as defined by this SAMP and the appropriate TAMP(s). Maintenance strategy, particularly that tied to warrantee requirements, condition assessment scheduling, and other activities discussed in this document are developed and/or initiated by the appropriate personnel.

Process

- The COF and LOF scores of individual facility/system assets need to be reviewed on a periodic basis to ensure that the critical assets are being evaluated appropriately. As the asset management program evolves, the number of critical assets may expand or contract based on priorities. Specific update and continuous improvement actions include.
  - Perform an annual review of LOF
  - Perform a review of COF when asset environment/criteria data change
  - Use COF and LOF scores to update facility critical asset list
- The Risk Register included in Appendix K should be re-evaluated on an annual basis and/or updated as appropriate.
- The table included in Appendix M should be re-evaluated on an annual basis and/or updated as appropriate when additional information regarding asset R/R cost is available.
- Conituously monitor and optimize processes based on data analysis and observations during the first year of asset operations.
- Develop a formalized Failure Mode, Effects, and Criticality Analysis (FMECA) process to include in early design.

Technology

- Update the CMMS with asset information gathered during design and construction phases of projects.
- As descrepencies are found in the data transferred to the IPS, corrections to the asset inventory, preventive maintenance plans, spare parts inventory, etc. are made.
- Implementation of condition monitoring, where appropriate, on critical assets

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Appendix A. Asset Management Program Evaluation Technical Memorandum

312 S. 4th Street, Suite 700
Louisville, KY 40202

T: 502.213.5938

Technical Memorandum

Prepared for: Louisville and Jefferson County Metropolitan Sewer District

Project Title: FY20 Asset Management Assistance

MSD Project No.: H20297

BC Project No.: 155134

Technical Memorandum

Subject: Asset Management Program Evaluation

Date: September 30, 2020

Issued Final: October 22, 2020

To: Heather Dodds

From: Jennifer Myers, PE

Copy to: David Hafner, PE

Prepared by: Jennifer Myers, PE

Reviewed by: Anne Kennedy

Limitations:

This document was prepared solely for the Louisville and Jefferson County Metropolitan Sewer District (MSD) in accordance with professional standards at the time the services were performed and in accordance with the contract between the MSD and Brown and Caldwell dated April 20. 2020. This document is governed by the specific scope of work authorized by the MSD it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the MSD and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 1: Overview

1.1 Project Understanding

As part of Louisville and Jefferson County Metropolitan Sewer District's (MSD) Asset Management (AM) program, Brown and Caldwell (BC) and MSD performed an Asset Management Program Evaluation (AMPE). The AMPE includes assessing current asset management practices, setting desired (target) levels for the practice areas; and providing observations for improvement in four key areas: Decision Making and Capital Planning; Information Systems and Data Management; Operations and Maintenance; and Organizational Framework.

This Technical Memorandum (TM) summarizes the results of the AMPE including the methodology, best practices, observations, scores, and results associated with MSD's assets. Recommended improvements are not included in this TM and will be presented in a separate report—the *Asset Management Roadmap*.

1.2 Scope

Prior to conducting the Gap Analysis, BC requested background materials and systems information to help understand the current state of MSD's AM practices and data. This information was used to help guide conversations with the staff and management during the Gap Analysis virtual workshops.

1.2.1 Current State Assessment

Prior to meeting with the MSD, BC administered an online survey for staff and management to solicit their views on the current state of their asset management program. BC then held a series of virtual workshops[1] with MSD attendees to discuss and validate their current practices associated with the AM categories. During those workshops, BC described the purpose of the AM program and the tasks in the scope to the attendees. They were then asked to describe their current practices related to the specific topics at hand (one or more of the gap analysis categories) for the assets/facilities where they work. Detailed observations were documented during the workshops.

1.2.2 Target State Assessment

BC held a working session with the Asset Management Steering Committee to establish target and importance levels for the AM practice areas. BC also compared the findings from the assessment with industry best practices, which are based on the International Infrastructure Management Manual and the ISO 55000 series of AM standards and include relevant institutional, cultural, programmatic, procedural, and technical elements.

1.2.3 Analysis

The gap analysis results provide an objective way of targeting improvement initiatives and investment areas. The analysis shows the current program maturity in various elements of asset management, the desired level of maturity (target score), and the identified "gap" based on the assessed gap and the importance placed on that particular asset management category. Based on the current and future state scores, and the importance scores, a gap is calculated. This points to the key gaps that need attention going forward and will be included in the AM Roadmap (next phase of the AM project).

[1] All workshops were held in a virtual Microsoft Teams environment due to the COVID-19 pandemic.

Section 2: Gap Analysis Approach

The Gap Analysis is a structured, repeatable process done through surveys, interviews and workshops that are designed to understand the desired (target) and current state of AM practice areas, to document observations about the practice areas, and to develop recommendations that bridge the gap between the target and current states. A general timeline of events held with MSD is shown in Figure 2-1, along with the event participants.

The Gap Analysis focused on understanding MSD's current and target state of performance and the relative importance of each category related to asset management for the purpose of:

- educating and communicating the components of asset management to the staff during the assessment interviews
- establishing baseline scores upon which to base future performance
- highlighting areas that are significant and in need of improvement so those areas can be prioritized for action.

The results of the Gap Analysis presented in this document include best practices, observations, and scores (both current and target states). The results are presented in Section 3.

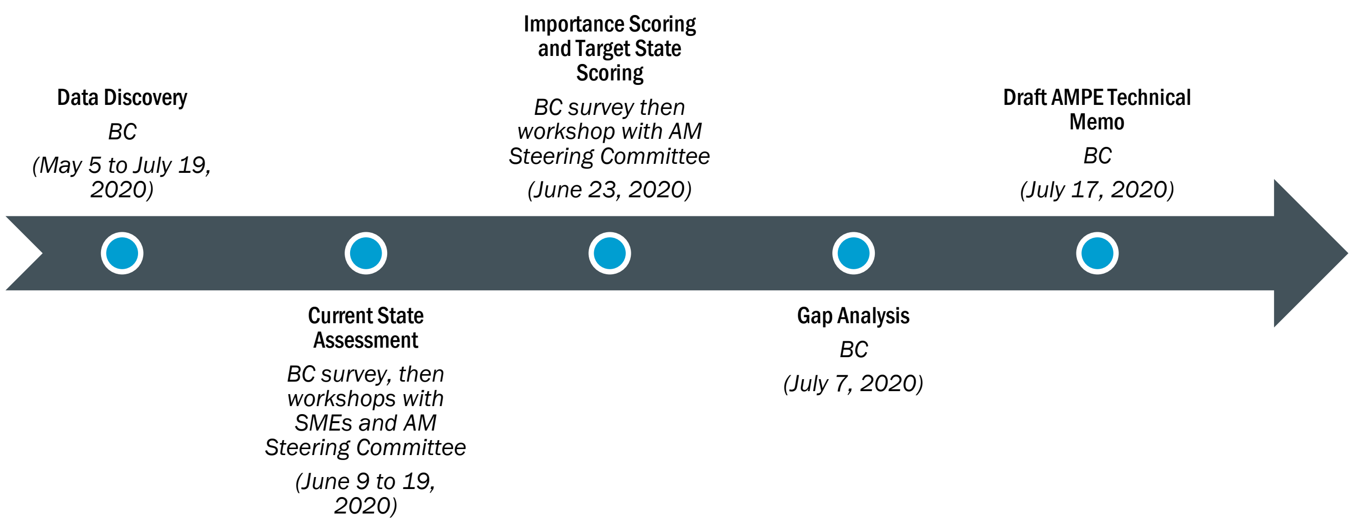


Figure 2-1. AMPE Timeline

Timeline shows the overall steps for the AMPE process along with the participants.

2.1 AMPE Categories

The asset management categories (Figure 2-2) are based on widely used and accepted AM methodology, which is the first step to define an integrated and in-depth approach to infrastructure management for the water/wastewater industry. It is a comprehensive model currently being widely implemented in the United States. The approach encompasses relevant institutional, cultural, programmatic, procedural, and technical elements.

AM Categories

Operations and Maintenance	Organizational Framework	Decision Making and Capital Planning	Information Systems & Data Management
AM Topics			
Inventory/Warehouse Maintenance Strategy Operations Strategy Optimization	Communications Culture and Change Management Document Management Leadership and Commitment Levels of Service and Performance Evaluation Resource Management Business Continuity	CIP Development and Prioritization Design & Construction Funding Risk Management	Systems Tools Data

Figure 2-2. AMPE Categories and Topics

2.2 Assessment

BC administered surveys and facilitated workshops to understand and validate the current state, target state, and importance scoring related to the AMPE categories. The specific steps are discussed below.

Current State

AM practice areas are given departmental-level scores by the AM Steering Committee and division subject matter experts.

Target State

Target scores are given for each AM topic by MSD. Importance scores are also documented for each of the AM topics.

Importance

Importance scores are given by MSD for each AM topic. They indicate relative importance to all other topics. Assigning an importance score is done in the same session as the target state scoring session.

Weighted Gap

Larger weighted gaps indicate areas that are both highly important to the organization and face larger gaps in AM practices.

2.2.1 Data Discovery

Prior to conducting the surveys and workshops, BC requested and reviewed background materials and systems information to help understand the current state of MSD's AM practices and data. This information was used to help guide the conversations with staff and management during the workshops.

2.2.2 Current State Scoring

Prior to meeting with the MSD, BC administered an online survey for staff and management to solicit their views on the current state of their asset management program. Four surveys were emailed to each of the workshop participants ahead of the virtual working sessions for each of the AMPE categories.

- Decision Making and Capital Planning
- Information Systems and Data Management
- Operations and Maintenance
- Organizational Framework

BC and the AM Steering Committee set up a series of virtual workshops with SMEs and committee members to discuss the current state of each of the AM categories. The interviews were designed to solicit information about performance in each of the categories, to record relevant observations, and to understand performance in relation to each area.

Current state assessment interviews were held in June 2020, with subject matter experts (SMEs) from the following divisions/groups:

- Treatment Maintenance ➲ June 9 and 11, 2020
- Collections and Flood Protection ➲ June 11 and 12, 2020
- Engineering and Finance ➲ June 12 and 15, 2020
- Wastewater & Drainage ➲ June 15 and 16, 2020
- IT, Regulatory Compliance and GIS ➲ June 16 and 17, 2020
- Treatment Operations ➲ June 17 and 19, 2020
- Controls & Field Engineering ➲ June 18 and 19, 2020

After the sessions, BC reviewed the observations and scored the current performance in each area using the scoring criteria defined in Figure 2-3. As part of the workshops, BC requested additional information to clarify what was discussed. This additional information was used to revisit and modify the scores as needed.

Not Started (1)	Initial (3)	Defined Approach (6)	Managed (8)	Optimizing (10)
Not familiar with asset management principles or program not yet started.	Reactionary and without a systematic approach.	Defined repeatable approach that is documented and communicated within the organization.	Quantitative measurements are defined for processes and quality standards.	Continual improvement, refinement of processes, standards and procedures.

Figure 2-3. Gap Analysis Current and Target Scoring Criteria

2.2.3 Target State Scoring

The target scores were established by the AM Steering Committee in a facilitated workshop on June 23, 2020, based on the pre-workshop survey input and discussions on the scores as noted in Figure 2-3. The AM Steering Committee assigned a single target score to each of the AM topics. The target scores provide a clear indication of where the organization wants to go in the next 3-5 years in the AM program.

The AM Steering Committee also assigned an importance ranking to each of the AMPE topics. The areas were ranked high, moderate or low, based on what was relatively most important and least important to MSD. The importance scores provide an indication of what the organization's highest priorities are for the AM program.

2.2.4 Analysis

Using the current and target scores along with the importance ranking, a weighted gap score (Figure 2-4) was calculated. The weighted gap indicates those practice areas that are most important to the utility and require the most improvement.

$$\left(\underbrace{\text{Target Score} - \text{Current Score}}_{\text{Gap}}\right) \times \text{Importance} = \text{Weighted Gap}$$

Target Score	Current Score	Importance	Weighted Gap
Established by AM Steering Committee—at the AM topic level	*Established by BC based on data discovery, survey and SME input—at the AM practice level*	*Established by AM Steering Committee—at the AM topic level*	*Calculated by BC*

Figure 2-4. Weighted Gap Analysis Calculation

Section 3: Gap Analysis Scores

The summary scores for the gap analysis categories are included in Figure 3-1—these are averages of the individual AM practice areas scores (see Table 4.1 through Table 4.4). Also included is the weighted gap, which is calculated from the gap between the target and current scores, multiplied by the importance. Larger weighted gaps indicate areas that are both highly important to MSD and face larger gaps in AM practices.

Full gap analysis for each of the categories are included with the detailed observations about each of the categories in Section 4.

Scoring criteria for both the CURRENT score and TARGET score follow the methodology described earlier in Section 2.2.

Category	Topic	Current Score (average)	Target Score	Importance	Weighted Gap
Decision Making and Capital Planning	CIP Development and Prioritization	4.0	8	3	12.0
	Design & Construction	3.75	6	1	2.25
	Funding	4.5	8	3	10.5
	Risk Management	4.5	8	5	17.5
Information Systems and Data Management	Data	4.0	6	5	10.0
	Systems	4.5	6	3	4.5
	Tools	3.0	6	1	3.0
Operations and Maintenance	Inventory/Warehouse	3.0	6	1	3.0
	Maintenance Strategy	3.3	8	5	23.3
	Operations Strategy	4.5	8	5	17.5
	Optimization	2.6	8	3	16.2
Organizational Framework	Communications	4.5	6	5	7.5
	Culture and Change Management	3.0	6	3	9.0
	Document Management	4.0	8	3	12.0
	Leadership and Commitment	4.0	6	5	10.0
	Levels of Service and Performance Evaluation	5.3	10	5	23.3
	Resource Management	3.0	8	3	15.0
	Business Continuity	5.25	6	1	0.75

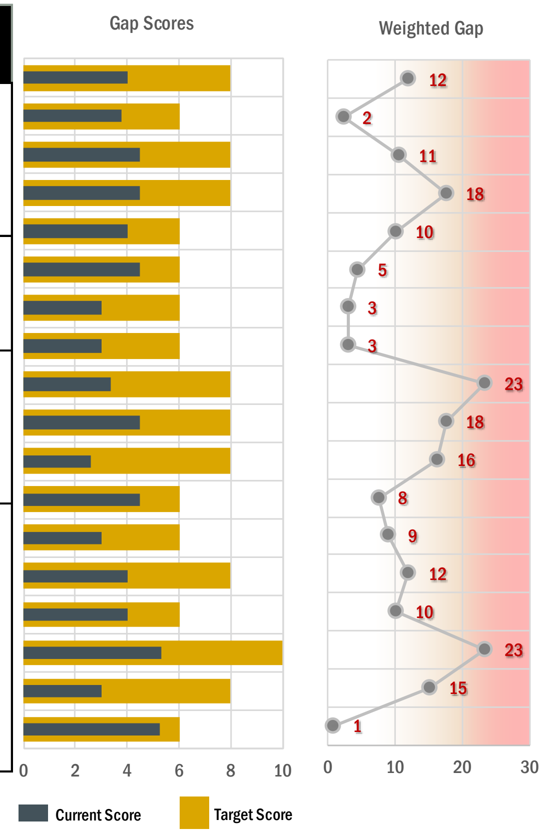


Figure 3-1. Gap Analysis Summary.

The scores shown are the averages for the AM elements included in the analysis—current score, target score, and weighted gap.

Current/Target Score	Current/Target Score Value
Not Started	*= 1*
Initial	*= 3*
Defined	*= 6*
Managed	*= 8*
Optimized	*= 10*

Importance Ranking	Importance Ranking Value
High	*= 5*
Moderate	*= 3*
Low	*= 1*

Section 4: Observations

This section includes detailed observations related to the AM practice areas. The current scores along with the target scores are shown for each practice area.

Note:

- *If the practice area had not been started at the time of the interviews, then "not initiated at this time" is shown in the observations.*
- *In some AM practice areas, the majority of MSD is at one stage of AM development, while select groups within the department are at more advanced level. In that scenario the listed current score reflects the majority but is noted with an asterisk (*). The AM Roadmap will include additional details about moving forward with implementation in a practical way that takes best advantage of specific groups' current state.*
- *Several of the areas included in the tables are directly linked to this project. Therefore, executing this project achieves either an initial or defined approach for the applicable areas.*

The mission and vision of MSD are central to the execution of asset management. The practice areas listed in Table 4.1 through Table 4.4 are strategic in nature and designed to align with the overall mission, vision, and goals of the AM program and charter.

Table 4.1. Decision Making and Capital Planning

	AM Topic and Practice	Best Practice	Observations	Current Score	Target Score	Importance
CIP Development and Prioritization	Business Case Evaluation/ Project Justification	BCEs are used to justify projects and prioritize operational and capital expenditures, using data from an AM system. These are done to provide the best cost and project outcome for the organization. A formal BCE process includes identifying alternatives, including new or reconfiguration of existing assets.	• MSD has well developed guidance document, template, and supporting manual for BCE process. • BCE process rolled out in June 2020. • No metrics to date for tracking BCEs. • Many have heard of the documents and process but have not seen the materials or been involved yet.	Defined	Managed	Moderate
CIP Development and Prioritization	Operability and Maintainability	Operations and Maintenance (O&M) personnel are involved in project planning from an early point with the objective of minimizing ongoing costs of asset ownership. A plan review process is in place that includes reviews and input by O&M personnel.	• Part of new BCE process includes involving O&M personnel early on. • Historically O&M staff are involved in design process (ad hoc), but not during planning. Exception is Treatment Operations is involved (ad hoc) during planning. • Managers are typically brought in, but front-line staff are not engaged, which can lead to disconnect in process.	Initial	Managed	Moderate

Table 4.1. Decision Making and Capital Planning					
AM Topic and Practice	**Best Practice**	**Observations**	**Current Score**	**Target Score**	**Importance**
Growth and Forecasting Needs	Systems/process to determine expected growth (population and system) and capacity needs are used on a scheduled basis to determine funding needs. Forecasting is done using optimization tools (capacity planning, asset acquisition, maintenance analysis, R&R alternatives, etc.).	• 20-yr Critical Repair and Replacement Plan (CRRP) (2017) for planning, but only looks at reinvestment in service area, not new growth. • Forecasting portion needs more work. Historically had forecasting tools, but those are no longer used. • Use hydraulic models with buildout for future conditions. • Long-term facility action plans need updating.	Initial	Managed	Moderate
Rehabilitation and Renewal Process	The need for new assets or R/R projects is anticipated well in advance based on risk and arises from a structured process, master plans or specific asset plans (not ad hoc, such as annual polling in engineering and operations, etc.). Budgets are developed in accordance with system needs and predefined levels of services. Budgets are measured against the goals and objectives.	• Stormwater is strictly reactive currently. • Written IT plan includes IT infrastructure needs. • CRRP has recommendations on R&R that could not be funded. Work that the AM group/pilot has completed on pump stations. • Some master plans exist but may be out of date. • Majority of R&R work not planned well in advance.	Initial	Managed	Moderate
Project Prioritization	The project prioritization process is structured and involves operations, engineering, finance and management. The impact of projects on delivering levels of service, including mitigating risk, is considered when prioritizing projects.	• Regular meetings occur throughout the year to discuss needs and priorities, but not sure of written criteria. • Risk monetization process does exist as part of the BCE process to inform prioritization. The process has not been implemented yet due to lack of projects that can be funded beyond CD or other regulatory projects. Use 1-2-3- ranking to fund projects as monies allow. • MSD is currently working on a tool for prioritizing stormwater projects. Currently health & safety (includes structural flooding), erosion, standing water determine priorities for DRI projects.	Defined	Managed	Moderate
Condition Assessment Evaluation	Condition and performance ratings support prioritization of renewal and replacement decisions of the assets.	• Very important, but not written down. Multiple staff are engaged to talk through the process. • Some staff are unaware of documentation and not done consistently across the organization or within facilities.	Initial	Managed	Moderate

Table 4.1. Decision Making and Capital Planning						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Design & Construction	Design Requirements	Record drawings identify assets using a standardized asset naming convention.	• Limited standard naming conventions for facilities and stormwater. • Do have standard method for collections handled by GIS. ID and numbering system are compatible between GIS and IPS. • Do have standard method for IT infrastructure assets (servers and workstations). • There is a standard naming process that was in development pre-COVID, but the effort was put on hold.	Initial	Defined	Low
	Construction Requirements	Projects/assets are delivered with asset listings in accord with the asset naming convention. Acquisition costs and asset lifecycle data are delivered along with the asset listings. A business process for adding new assets to the asset inventory has been developed.	• Partial list of materials is delivered- sometimes more defined than others, often just lump sums at project level. • Must sort through materials list for the parts and enter manually into system. • If it is a capital project, spare parts are not added to stockroom inventory since it was delivered as a part of the capital project. • Written process is not in place. • Acquisition costs and asset lifecycle data not delivered.	Initial	Defined	Low
	Manuals, Procedures, and Warranties	Design and construction requirements include delivery of operation and maintenance manuals, warranty information, and information needed for the Asset Class Plans.	• Receive O&M manuals, warranties as part of contractor deliverable. Inconsistent in where they are delivered/ stored. Exception—stormwater does not receive manuals. • Requirements in the contract documents, but nothing after contractor provides information. No workflow or chain of transmittal.	Defined	Defined	Low
	R&R Costs and Attributes	R&R costs, including indirect costs, are recorded in the asset history, and in the Asset Class Plans, where applicable. The remaining useful life of the underlying asset is estimated.	• No process exists. • Are not provided price of the assets at delivery. • Not a clear, reliable way to track costs of ownership for asset maintenance, R&R- including labor and materials. • Lifecycle costs and remaining useful life (RUL) information not available for assets.	Initial	Defined	Low

Table 4.1. Decision Making and Capital Planning						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Funding	Forecasting Long-term R/R Needs	Periodic analyses are undertaken to determine future costs of asset R&R needs, including operation and maintenance costs. Procedures to review the trend in funding needs and available funds are routinely used to update the funding policy/documentation.	• Not initiated at this time.	Initial	Managed	Moderate
Funding	Funding Strategy	A funding strategy for asset R&R/CIP exists and is maintained. The governing body has approved the formal long-term funding strategy for the utility.	• Funding strategy is same for last few years. Increase rates to cover debt. Consent Decree used to determine funds. • Board approves capital program • Goal to keep excellent bond rating and keep some monies in reserve. • Have a document and included in monthly report.	Defined	Managed	Moderate
Risk Management	Risk Policy	A risk policy has been established by the organization that establishes the level of risk the organization is willing to accept to meet its level of service.	• No formal risk policy.	Initial	Managed	High
Risk Management	Risk Register - Identification	Areas/activities that have the potential to impact service levels, regulatory compliance, financial objectives and other business objectives are understood in the organization.	• Risk identification and registers done at the project level and for cybersecurity. • Overall asset risk identification inherently known, but no documentation in place.	Defined	Managed	High
Risk Management	Risk Register - Mitigation	Risk mitigation plans have been established for equipment and processes determined to have a high-risk level.	• Have emergency response plans (ERPs) and mitigation strategies for some assets, but out of date.	Defined	Managed	High
Risk Management	Risk-Based Prioritization	The likelihood and consequence of failure have been established, quantified, and are used to prioritize maintenance and R/R activities. (The chance that a failure might occur has been established, documented and quantified at the asset level.) (The impact on level of service, utility, customers, or public resulting from an asset failure has been established, documented and quantified at the process/system and/or asset level.)	• Some COF and LOF criteria in new BCE process. • Sanitary uses PACP, SLR Dog and Rat scoring for LOF information. • Limited documentation of LOF or COF criteria and process.	Initial *	Managed	High

** The majority of MSD is at the listed current stage of AM development, while select groups within the organization are at more advanced level.*

Table 4.2. Information Systems and Data Management

AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Data	Asset Definition	A definition of an asset exists. It describes the criteria under which an item would be considered an asset.	• No clear written definition of an asset.	Initial	Defined	High
	Required Asset Attribute Data	Asset attribute data requirements exist for each asset class (maintenance requirements, date in service, acquisition cost, description, nameplate data, horsepower, length, diameter, etc.).	• For facilities, no complete list of asset attributes. • GIS assets do have attributes listed.	Defined	Defined	High
	Asset Classes	Assets are assigned to asset classes (a way of categorizing similar assets into groups, or a grouping of equipment that exhibit similar characteristics and function similarly), and general definitions of those classes have been documented.	• Asset classes are not consistently or clearly defined across MSD. • Asset inventory does not align with asset class/hierarchy.	Initial	Defined	High
	Asset Identification/ Hierarchy	Assets have been identified at the appropriate level of detail, assigned to asset classes, and placed in the asset hierarchy. Asset hierarchies are defined for all facilities/systems, and are used throughout the asset lifecycle, including design and construction.	• Asset hierarchies exist but are not documented or consistent across organization or facilities.	Initial	Defined	High

	Asset Inventory	An asset inventory has been documented in the applicable AM system(s). Examples include computerized maintenance management system (CMMS), and geographic information system (GIS).	• Vertical assets
			  • Listed in the CMMS and are partially complete.
			  • Changes to assets do not get reflected accurately in the system.
			  • SAP and IPS are not linked effectively, so is hard to get the data consistent and up to date.
			• Horizontal assets
			  • GIS maintains mostly complete asset inventory for sanitary. Stormwater less complete.
				Defined	Defined	High

	Asset commissioning and decommissioning	New assets are entered into the AM system(s). Assets removed from service are retired in the AM system(s). Asset changes are reflected in the AM system(s).	• There is a written material for Development and Planning group (PM handbook) portion of the process, and the Finance group. • Do not have consistent method to add or remove assets from systems. • Construction does not use IPS or other system to record drawing information.	Initial*	Defined	High

Table 4.2. Information Systems and Data Management						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Systems	Information Systems	The organization has IT systems to support AM. Example systems include CMMS, GIS, Customer Information System-CIS, Finance, Regulatory/Permitting, HR/timekeeping/Learning Management System	• CMMS, GIS, CIS, Finance, Timekeeping all available, but not integrated or working well together. • IT master plan does not exist- but CMMS upgrade last year. • Staff do not feel like there was enough or deep enough training for the CMMS upgrade. Supervisor had to train the others which was too difficult. • Tracking dollars across systems is difficult since they are not integrated. Extremely difficult to figure out what something costs. • Have asset information in several different systems.	Initial	Defined	Moderate
	Inventory/Stores/ Materials Management	Parts and materials are documented and tracked in the applicable AM system(s) and are associated with work orders.	• Inventory is managed in SAP, but parts are not always charged to a work order. • IPS does not communicate well with SAP, so data needs to be manually entered. • Parts and costs (accuracy and availability) may differ between systems.	Defined	Defined	Moderate
Tools	Data Access Methodology	User-friendly method(s) exists for entering and retrieving asset information for all users. Users have clear understanding of which systems to use for data management.	• Acceptable to enter information into the IPS and GIS. Sometimes difficult to apply to the correct level/asset in IPS/SAP. • Retrieving consistent, complete asset information is difficult. Crystal reports are challenging to use, and no set reports to get needed information. • Data entry is a cumbersome process and retrieval is difficult and time consuming. • Staff use spreadsheets to manage information.	Initial	Defined	Low
	Data Collection Tools	Data collection tools are readily available and used to streamline the process of data input and improve accuracy of information in the systems and databases.	• Some staff and supervisors have laptops. • Not all have enough training on using the tools/laptops. • Implementing mobile data collection currently. • CCTV records the inspection occurrence on paper, then information is entered into IPS. (Granite Net used to record the actual inspection data.)	Initial	Defined	Low

** The majority of MSD is at the listed current stage of AM development, while select groups within the department are at more advanced level.*

Table 4.3. Operations and Maintenance						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Inventory/ Warehouse	Purchasing/ Procurement	Purchasing parts and materials for use within maintenance activities is done efficiently and correctly in the applicable AM system(s).	• Stockrooms are organized consistently across organization. • Storeroom takes care of the parts and materials ordering and stocking. • Policy for procurement. • Not an easy, accessible consistent process to do the purchasing. • Started to add electronic docs (DocuSign) to make it easier. • In process of revising procurement documents.	Initial	Defined	Low
Maintenance Strategy	Asset Class Plans	Asset class plans are used to organize maintenance activities. Asset class plans include frequency and estimated costs of short-term work (job plans) and long-term O&M and R&R needs, along with parts and operational considerations. Costs include salvage values (if any) and disposal costs.	• Not initiated at this time.	Initial	Managed	High
	Job Plans/SOPs	Maintenance procedures are defined and connected to work orders. Step by step tasks, standard hours, parts lists, and required resources have been documented. Job plans include planned activities along with standard labor hours, materials, etc., for preventive and corrective maintenance, calibration, adjustment, cleaning, and condition assessment.	• No defined job plans with detailed work instructions per reliability standards. • Step by step instructions are available, but not in a job plan. • Not housed in CMMS and do not include the costs, tools, or spare parts.	Initial	Managed	High
	Maintenance Costs	Work orders are prepared on an asset-specific basis. Costs of fulfilling work orders are accumulated along with underlying details (hours used by craft, actual materials, time done, etc.).	• Cannot charge capital work to a WO. • Information is in different systems: SAP for inventory, labor rate in SAP (payroll goes thru SAP), WO in IPS (labor hours). • Not confident in the data.	Initial	Managed	High

Table 4.3. Operations and Maintenance					
AM Topic and Practice	Best Practice	Observations	Current Score	Target Score	Importance
CMMS WO Priority Types	WO prioritization criteria are well defined and inform the order in which work is performed.	• Treatment EM, Urgent, Preventive, UM (Unplanned) • Record the information but not used to prioritize activities, since the priorities are not well understood. • Collections does have WO Priority types (1-6) used to varying degrees of success. Defined and posted and criteria defined. • Wastewater and Drainage moving to a 1-5 system. • Sanitary using High, Medium, Low. • No unified approach.	Defined	Managed	High
Preventive Maintenance	Preventive maintenance (PM) activities are fully defined at the appropriate asset level, including frequencies. PM is scheduled and performed in accord with the specified frequencies.	• PM is defined by frequency and then supervisor distribute the work. • Typically, frequencies are set by manuals, US Army Corps of Engineers (USACE), CMOM or other available vendor recommendations. • Not available for all assets.	Initial*	Managed	High
Predictive Maintenance	Predictive maintenance is applied as a result of condition monitoring and is performed prior to failure and is tracked separately in the CMMS for analysis purposes.	• Flood protection (oil analysis, vibration testing, infrared scanning, temperature checks). Collections (drawdown testing, vibration, current, voltage, pressure testing). Data entered IPS. • Treatment do/contract infrared, megger test on motors, oil on transformers. Data is stored on the W-drive. Compare to historic data and make recommendations. Used to justify some R&R projects. • Not on stormwater or sanitary.	Initial	Managed	High
Corrective Maintenance	Corrective maintenance, based on equipment failure, is tracked separately in the CMMS for analysis purposes, including cost and time.	• Referred to as unplanned maintenance. • Tracked in IPS. • Costs not fully tracked (see Maintenance Costs). • Trying to shift to SMRP standard definitions for corrective maintenance.	Initial	Managed	High
Work Scheduling	All work is scheduled in the CMMS to allow for identification of resource issues (available labor, materials, parts, etc.).	• Schedule some work in CMMS (PMs), some is ad hoc (unplanned and emergency). • Planning done by supervisors (not the Planner/Scheduler role).	Initial	Managed	High
Updating Asset Class Plans	Trends in assessed condition, long-term cost estimates and near-term schedules for maintenance, along with cost and risk analyses, are used to update asset class plans.	• Using information for R&R, but typically not to adjust maintenance strategy. • Do discuss assets issues in daily briefings. • Process not documented.	Initial	Managed	High

Table 4.3. Operations and Maintenance						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Operations Strategy	Operational Procedures	Operational procedures are defined for asset classes and facilities/systems.	• Operations has SOP for all the treatment plants (electronic and paper). May vary in how they are executed between operators. • Collections have SOPs but may need updated. • OEMs are written down.	Defined	Managed	High
	Operations Costs	Operational costs (chemicals, power, etc.) are tracked by asset and analyzed using the applicable AM system(s).	• Track the costs for labor and energy, utilities, chemical costs to the facility level.	Initial	Managed	High
Optimization	Condition Assessment Data Collection Process	Standardized process (workflow/steps) has been developed for routine (sensory) inspection and condition monitoring data collection.	• FPS performs condition assessments for floodwalls, levees, and flood gates including visual inspections on a frequent basis. Written as WO in alignment with the USACE process. • Gravity – use PACP/MACP/LACP, data collected in Granite some stored in IPS. Retrievable, but not trended. • Facilities - Not a consistent process or clearly documented.	Initial	Managed	Moderate
	Condition Assessment Methods	Appropriate assessment procedures and intervals for assets are defined and allow for consistency in monitoring and assessing condition.	• FPS considers age in understanding frequencies for inspections and assessments. • Working on modifying/updating the inspection and assessment frequencies for asset classes. • Inspection frequencies are dictated in the CMOM program and LOF/COF criteria set points.	Initial*	Managed	Moderate
	Condition Assessment Ratings	Condition and performance ratings have been defined to ensure consistent documentation of asset condition.	• No standard or document for assessing the condition. • For gravity sewers use PACP. FPS - Corps has 1-3 rating.	Initial	Managed	Moderate
	Root Cause Failure Analysis (RCFA)	Asset failures are analyzed and used to update asset class plans as well as R&R schedules for similar assets.	• Do not do a RCFA, but they do try to figure out why an asset failed. Not documented. • CCTV staff will do field confirmation of the reason for failure case by case before lining.	Initial	Managed	Moderate
	Problem, Cause, Remedy Codes (Failure Codes)	Problem, Cause, Remedy Codes (failure codes) are tied to failure modes at the asset class level. Asset failures are recorded with appropriate codes and details in the CMMS.	• Activity code is the type of repair that needs made on WO. • Problem, Result codes stored, but not required fields. • P/C codes used on discharges and backups • Buildings must enter a problem code, and often add remedy.	Not Started	Managed	Moderate

** The majority of MSD is at the listed current stage of AM development, while select groups within the department are at more advanced level.*

Table 4.4. Organizational Framework						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
Communications	Communications Plan	Communications plan is established and used to communicate goals and objectives to all staff and stakeholders. Includes a mechanism to allow staff and stakeholders to provide feedback on program and procedural improvements in the AM program. Includes an understanding of level of service expectations and ongoing communication to manage those expectations.	• Not initiated at this time.	Initial	Defined	High
	AM Strategy Awareness	AM strategy has been communicated to guide all parts of the organization involved in gap closure and general strengthening of AM.	• AM charter developed as part of this project.	Defined	Defined	High
Culture and Change Management	Change Management Plan	A Change Management Plan is established, including an understanding of how stakeholders will be impacted and the organizational readiness for change associated with implementing AM improvements.	• Change Management Plan being developed for the organization as part of the Blueprint 2025 Leadership Committee.	Initial	Defined	Moderate
	Change Management Implementation	Risks associated with any significant change that can have an impact on achieving AM objectives are assessed and managed.	• Change Management Plan being developed for the organization as part of the Blueprint 2025 Leadership Committee.	Initial	Defined	Moderate
Document Management	AM Practices Assessment	Current AM-related business processes are identified, documented, understood, and evaluated. Comparisons have been made between the current status of business practices and the desired status, and "gaps" have been identified.	• Part of this project.	Initial	Managed	Moderate
	AM Plan	A document has been prepared to close the "gaps" within the associated time frames, and all associated elements (resources, responsibilities, reporting, etc.) have been specified.	• Part of this project.	Initial	Managed	Moderate

Table 4.4. Organizational Framework

AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
	General Document Management Practices	Document management is a structured process within the utility that ensures management, retention and retrieval of important documentation. A document management system or process is readily understood and available throughout the organization.	• EB system (O&M manuals) is part of the document management system. Not always easily accessible. Not sure of where the documents reside. • DMS is where documents can be stored but is not fully utilized. • Plan Review, Compliance Library have good document practices. • Document storage (electronic format) policy exists, but not overall awareness. • File structure varies from group to group. • New director over information. Part of her role will be to improve document management procedures and systems.	Defined	Managed	Moderate
Leadership and Commitment	Support from Policy Body	The governing body understands the objectives of AM and treats it as a priority.	• Unsure.	Initial	Defined	High
Leadership and Commitment	Organizational Commitment	All levels of management understand the importance of AM. They agree upon and support the implementation of identified improvements.	• Feels that senior management is supportive of and promoting AM. • Ongoing engagement from senior leadership noted as critical to program success.	Defined	Defined	High
Leadership and Commitment	AM Goals and Objectives	Vision has been defined for the AM program. The governing body has defined goals for achievement in each AM performance area.	• AM charter developed as part of this project.	Initial	Defined	High
Levels of Service and Performance Evaluation	AM Program Audit	The overall AM Program is reviewed periodically for adherence to the plan goals and for measurements of actual benefits arising from AM.	• Not initiated at this time.	Initial	Optimized	High
Levels of Service and Performance Evaluation	Balanced Levels of Service	A clear and complete (Simple, Measurable, Achievable, Realistic, Targeted: SMART) set of service levels (both internal and external) are documented that meet customer expectations and regulatory requirements and long-term interest of the organization. The relationships between service levels and costs are understood.	• Have corporate service goals as part of Blueprint 2025. • Each department has individual goals that are defined and measured. • No connection yet between service levels and cost.	Initial	Optimized	High

Table 4.4. Organizational Framework

AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
	Performance Measures (aka Key Performance Indicators)	Indicators of success are established to measure effectiveness of the AM program and used to develop corrective actions on a proactive basis. Includes measures for all aspects of the organization related to AM (O&M, information systems and data management, organizational framework, decision making and capital planning)	• Performance measures and goals at various levels in the organization. • Operational goals are on M-drive. • Blueprint 2025 document is on the MSD intranet.	Defined	Optimized	High
	Tracking and Reporting Performance Measures	Performance measures/KPIs are measured, tracked, analyzed and reported to the organization to ensure that the AM program is meeting the expectations of all stakeholders.	• Goals submitted in Performance Management system. • Measures are tracked and analyzed as part of Blueprint 2025.	Defined	Optimized	High
	Regulatory Reporting	Methods (data collection, reporting) to comply with regulatory requirements are established and documented in the organization.	• Well established process for document reporting. • Good process for making sure that reports are submitted on time. • Electronic DMRs with SOPs	Managed	Optimized	High
	Regulatory Compliance Strategy	Regulatory requirements and pending requirements are continuously monitored and communicated within the organization to the appropriate environmental compliance/regulatory personnel.	• Collaborative effort across ops, engineering and intergovernmental relations. They get together on a regular basis to discuss these issues. Still meet monthly. • Unsure if they are forward looking on potential regulatory impacts.	Defined	Optimized	High
Resource Management	Roles and Responsibilities	Roles and responsibilities have been defined for all personnel involved in the AM program.	• Some roles are shifting as getting more frontline staff involved in AM and asking for feedback from them. • Planner role shifting more to planning (instead of assistant supervisor). • IT, GIS aware of their internal roles. • In most of organization there is general awareness, but not clear understanding.	Initial	Managed	Moderate
Resource Management	Allocation of Resources	Adequate staff, equipment and tools are available to develop and sustain an AM program (includes development, training, monitoring, controlling, reporting, auditing, and updating and improving the AM program).	• Equipment and tools are enough. • Personnel are needed to build AM program. • Knowledge retention needed before those able to retire leave the organization.	Initial	Managed	Moderate

Table 4.4. Organizational Framework						
AM Topic and Practice		Best Practice	Observations	Current Score	Target Score	Importance
	Employee Development and Training	A training development plan exists for staff. Training includes courses for: asset management, organizational and leadership, and technical/job specific.	• Training program depth depends on individual department budgets. • Want to get everyone up to the same level of technical skills, but it is department specific and tied to budget. • Have a management academy—Aspire. • Training department is good, but formal training plans do not exist.	Initial	Managed	Moderate
Business Continuity	Staffing	Staff can change how/where they work based on external factors/threats that impact overall organizational operations.	• Overall MSD has done well in adapting to rapidly changing work environment due to Covid-19. • (Related to Covid-19: services levels compromised but functioning well). • Supplied more PPE and changed schedules for staff. Some working from home as possible. Operations staff are still working in the same areas and are wearing more PPE. • GIS/IT have been very nimble. Team has been teleworking the whole time without issues. • Natural disasters - do have EMP that are updated annually. Deploy staff and consultants during storms. Ohio River flooding event - pull people from throughout organization to man during all 3 shifts.	Defined	Defined	Low
Business Continuity	Technology and Systems	Systems and technology are resilient and support major shifts to overall organizational operations.	• Laptops have helped many (supervisors, managers, ops, engineering), but is harder for staff without mobile option. • Looking into additional mobile solutions. Want to meet people where they are at (skill and technology). • Would benefit from more staff input to help understand best technologies and platforms.	Initial	Defined	Low

Table 4.4. Organizational Framework					
AM Topic and Practice	Best Practice	Observations	Current Score	Target Score	Importance
Communication with stakeholders	Public Information Office ready to communicate major shifts to overall organizational operations and subsequent impacts to stakeholders.	• Public relations group has been able to share information readily using door hangers, social media (Facebook, Twitter) to make people aware of system shutdowns or upcoming events. • Internal communications have improved as well. Monitors with scrolling messages that share communication and knowledge. Monthly newsletter (current news and outreach) that includes MSD news for various stakeholders. • Upper management has been doing well and creating informational YouTube videos. Internal monitoring of videos has been good.	Defined	Defined	Low
Financial Procedures	Supply chain, procurement, capital decisions, and revenue and funding mechanism alternatives exist to support major shifts to overall organizational operations.	• Emergency procurement process is in place. FEMA also helps during flood emergencies if eligible (typically reimbursement). • Declared emergencies (with a certificate) allow the procurement process to go faster (with paperwork done at same time rather than ahead of time). Using DocuSign has also made big improvement in the speed of the process.	Defined	Defined	Low

** The majority of MSD is at the listed current stage of AM development, while select groups within the department are at more advanced level.*

Section 5: Summary

The summary scores for the overall evaluation were calculated from the gap between the target and current scores, multiplied by the importance score. Larger weighted gaps indicate areas that are both highly important to MSD and face larger gaps in AM practices. For each of the items in the evaluation, the larger the weighted gap, the higher the priority to make improvements in that area to close the gap. There are also foundational AM practices that are needed to support an overall robust AM program and help close the large weighted gap areas. The AMPE summary findings included in Table 5.1 highlight those larger gaps and foundational AM areas to focus MSD on how to best advance their AM program.

Recommendations for improvement based on these Gap Analysis findings will be included in the *Asset Management Roadmap*. The Roadmap will include prioritized recommendations, which will help organize them into a logical sequence of delivery that considers the large weighted gap areas, available resources, and precedencies (items that need addressed prior to others). The Roadmap will include a high-level scope of work required to deliver the recommendation, along with an approximate schedule, cost, level of effort, roles and responsibilities, and dependencies. The Roadmap will also identify quick wins that will assist MSD in gathering momentum for implementing the AM program.

Table 5.1. Summary Findings for AMPE

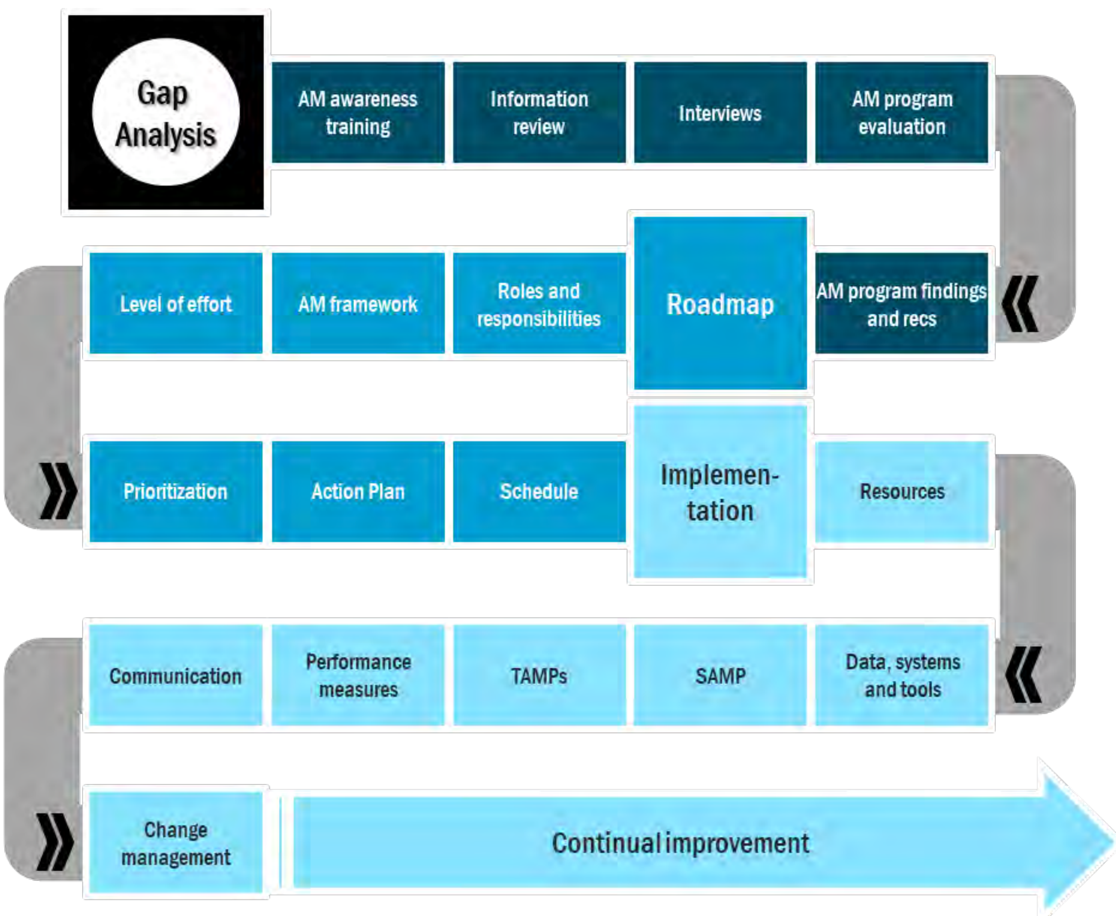
Large Weighted Gap AM Topics	Foundational AM Areas to Support Overall AM Program Development
Decision Making and Capital Planning • Risk Management • CIP Development and Prioritization Operations and Maintenance • Maintenance Strategy • Operations Strategy • Optimization Organizational Framework • Levels of Service and Performance Evaluation • Document Management • Resource Management	Information Systems and Data Management • Data • Systems Organizational Framework • Communications • Culture and Change Management • Leadership and Commitment

Appendix B. Asset Management Roadmap

Louisville and Jefferson County Metropolitan Sewer District

Asset Management Roadmap

October 2020



Asset Management Roadmap

Prepared for

Louisville and Jefferson County Metropolitan Sewer District

October 2020

155134

This document was prepared solely for the Louisville and Jefferson County Metropolitan Sewer District (MSD) in accordance with professional standards at the time the services were performed and in accordance with the agreement between MSD and Brown and Caldwell dated April 20, 2020. This document is governed by the specific scope of work authorized by MSD; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. BC has relied on information or instructions provided by MSD and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Brown AND Caldwell

312 S. 4th Street, Suite 700

Louisville, KY 40202

T: 502.213.5938

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Section 1

Background and Approach

1.1 Background

Louisville and Jefferson County Metropolitan Sewer District (MSD) is strengthening their asset management (AM) program in order to cost-efficiently maintain assets while managing their risk. This is done by balancing system cost, risk, and performance to services in their wastewater, stormwater, and flood protection systems.

How do we advance our Asset Management Program? This *Asset Management Roadmap* (Roadmap) is the primary document that will guide MSD's efforts in the execution of AM activities associated with their treatment plants, pump stations, and collection and stormwater assets. The Roadmap serves several purposes:

- Describes the overall approach for AM,
- Provides information about the current status of the AM program,
- Identifies priority and actionable plans for improvement, and
- Establishes the internal and external resources and the implementation team structure needed to grow and sustain the AM program.

Who does Asset Management? AM is not a standalone project. Rather, it requires the work of the entire organization to implement actions that will help MSD advance as an organization driven by service levels and asset lifecycles. The Regulatory Compliance & Asset Management Administrator, Asset Management Steering Committee, and multiple AM Development Teams with a cross-section of subject matter experts will support this effort.

Where do we document Asset Management? A **Strategic Asset Management Plan** (SAMP) and one or more **Tactical Asset Management Plans** (TAMPs) are the repository of the methodologies associated with the Asset Management Program.

- The SAMP provides the district-wide framework for achieving the mission and goals of the AM program.
- The TAMPs provide the details for the divisions, facilities, and/or service areas to execute the strategic framework.

Asset Management Definitions

"Asset management is the set of coordinated activities that an organization uses to realize value from assets in the delivery of its outcomes or objectives. Realization of value requires the achievement of a balance of costs, risks and benefits, often over different timescales."

(ISO 55000)

- **Asset.** Item that has potential value such as equipment, buildings, etc.
- **Condition.** Measure of the physical state of an asset.
- **Consequence.** Impact on level of service, utility, customers, or general public resulting from an asset failure.
- **Failure.** Inability of an asset to provide the function for which it was installed.
- **Likelihood.** Chance of an occurrence, such as an asset failure.
- **Level of Service.** Output or objectives one intends to deliver to its stakeholders (i.e. Public, Board, Regulators).
- **Lifecycle cost.** Total cost of an asset throughout its life (incl. planning, design, acquisition, O&M, rehabilitation & disposal costs).
- **Risk value.** The combination of consequence and likelihood of a failure.

1.2 Approach

The approach used by MSD and Brown and Caldwell (BC) to develop this Roadmap included working with the Executive Leadership Team (ELT)/Chartering Team and AM Core Team and Steering Committee; developing the mission and goals for the AM program; assessing the current state of the AM practices and its desired state and priorities; and developing the actions

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needed to address the gaps in practices. Each of these elements is summarized below in Table 1-1 and discussed in greater detail in Section 2 through Section 6. The general timeline of the AM project is shown in Figure 1-1, along with the event participants.

Table 1-1. AM Approach

Task	Description	Section
Asset Management Framework	The ELT/Charting Team collaboratively developed the mission and goals of their AM program through facilitated workshops and documented their directions in an AM Charter that was signed by all members.	2
Asset Management Roles and Responsibilities	The Asset Management Steering Committee and Core Team will participate in the AM project, develop the principles of the short- and long-term AM needs, and provide guidance during implementation. Additional AM teams will be responsible for developing AM elements and executing recommendations.	3
Gap Analysis	As part of the AM project, BC and MSD performed an AM gap analysis after the AM program kick-off workshop. The gap analysis included assessing current AM practices and setting desired (target) levels and priorities.	4
Asset Management Action Plan	This AM Roadmap establishes an implementation strategy for achieving improvements needed in the AM Program and provides direction for the coming years as MSD refines its AM practices. It recommends activities that the MSD should pursue based on identified gaps in the current program and the current priorities. At the core of the Roadmap are the implementation structure and action plan.	5
Next Steps and Continual Improvement	Developing and institutionalizing AM in the day-to-day business of MSD is not a "one-and-done" effort. Rather, it is a process that takes time and focused effort to accomplish. Next steps and continual improvement ideas are documented.	6

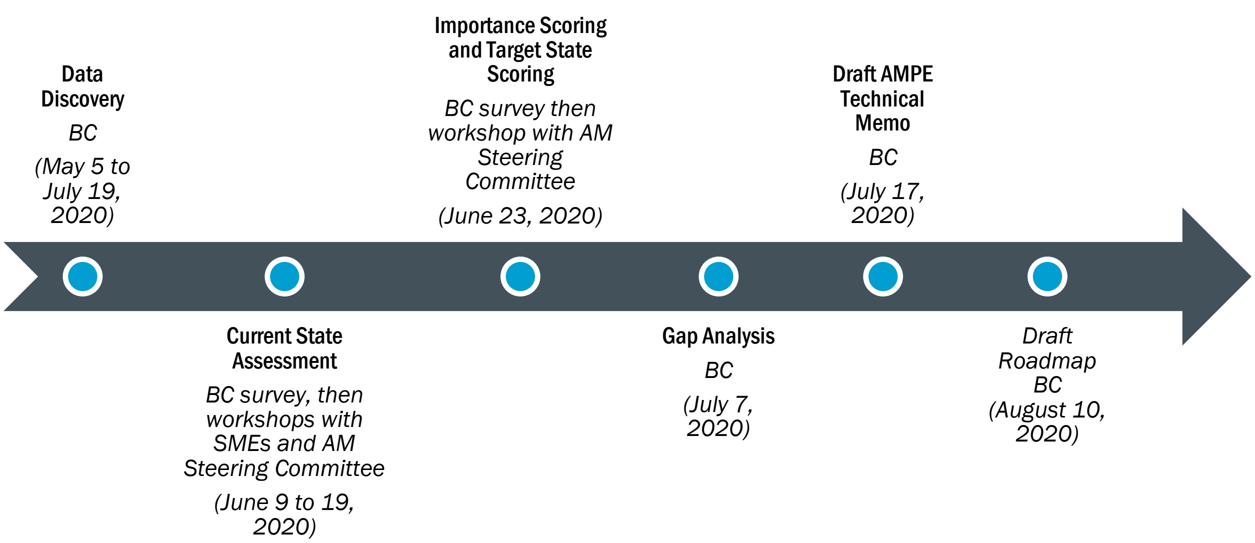

Figure 1-1. Project Timeline

Timeline shows the overall steps for the project along with the participants.

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Section 2

Asset Management Framework

The Environmental Protection Agency (EPA) defines an AM strategy with five questions designed to test an agency's readiness to maintain infrastructure at a specified level of service (LOS). Highly critical assets are expected to be maintained at a greater level of readiness than less critical assets. Knowing your assets, identifying their desired performance level, and providing a long-term maintenance and funding strategy are the backbone of any AM strategy. Benefits are realized in terms of sustained support for the agency's mission as well as lower operating costs.

What is the current state of my assets?	What is my required level of service?	Which assets are critical to sustained performance?	What are my best O&M and CIP strategies?	What is my long-term funding strategy?
• What do I own? • Where is it? • What condition is it in? • What is its performance? • What is its remaining useful life? • What is its remaining economic value?	• What is the demand for my services by my stakeholders? • What do regulators require? • What is my actual performance?	• How does it fail? How can it fail? • What is the likelihood of failure? • What does it cost to repair? • What are consequences of failure?	• What alternative management options exist? • Which are the most feasible for my organization?	• How will I pay for Renewal and Replacement? • Bond Funding? • Sinking Fund?

2.1 Culture

AM is as much about culture as it is procedure. With such a diverse enterprise as MSD, specific implementation will vary by division. Uniformity, where needed, can be a challenge to achieve. As such, success relies on a greater involvement and participation of staff and the individuals serving as change agents more so than any other program. Culture change is, therefore, a critical element of success. Communication, training, education, and visibility by all personnel will be critical throughout implementation. Change management and communication methodologies will be incorporated into the SAMP—discussed in Table 5-2 and Section 6.

2.2 Principles

As part of facilitated workshops, the AM Steering Committee used AM methodology to help guide selection of their AM mission and goals (Figure 2-1). That AM methodology promotes sound practices related to:

- People: Meeting customer service needs and promoting a highly trained and motivated staff.
- Process: Building effective and efficient processes, reducing asset lifecycle costs, and committing to continuous improvement.
- Technology: Thoughtful use of information management systems.

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Figure 2-1. MSD Asset Management Organizational Objectives: Mission and Goals and Critical Success Factors

2.3 Workflow

A typical path to achieve AM program execution is shown in Figure 2-2. The key AM fundamentals are shown on the top (i.e., organizational objectives, LOS, systems/tools/data, asset inventory and hierarchy, and risk assessment). Without those overarching objectives and procedures in place, it is difficult to implement an effective AM program. As such, the first step in the AM project was to develop the organizational objectives. The AM Steering Committee collaboratively developed their organizational objectives: AM program mission, goals, and critical success factors. Those elements will be the guiding force behind the decisions that are made for the short- and long-term needs of the AM program (Figure 2-1). The LOS and performance measures, resource management, risk assessment, and much of the Operation and Maintenance (O&M) category will be part of the priority recommendations in the AM action plan. The remainder of the activities are the remaining tasks of the AM program and are included in the AM action plan.

The SAMP and related TAMPs are the primary repositories for the AM program guidelines and contain the information and explanation for each of the elements in the AM cycle figure. They are the “go to” documents for understanding the framework of the AM program. The SAMP and TAMPs also follow the structure (categories and topics) found in this AM Roadmap and corresponding Action Item Table (Table 5-2) so that progress can be tracked and communicated easily and consistently.

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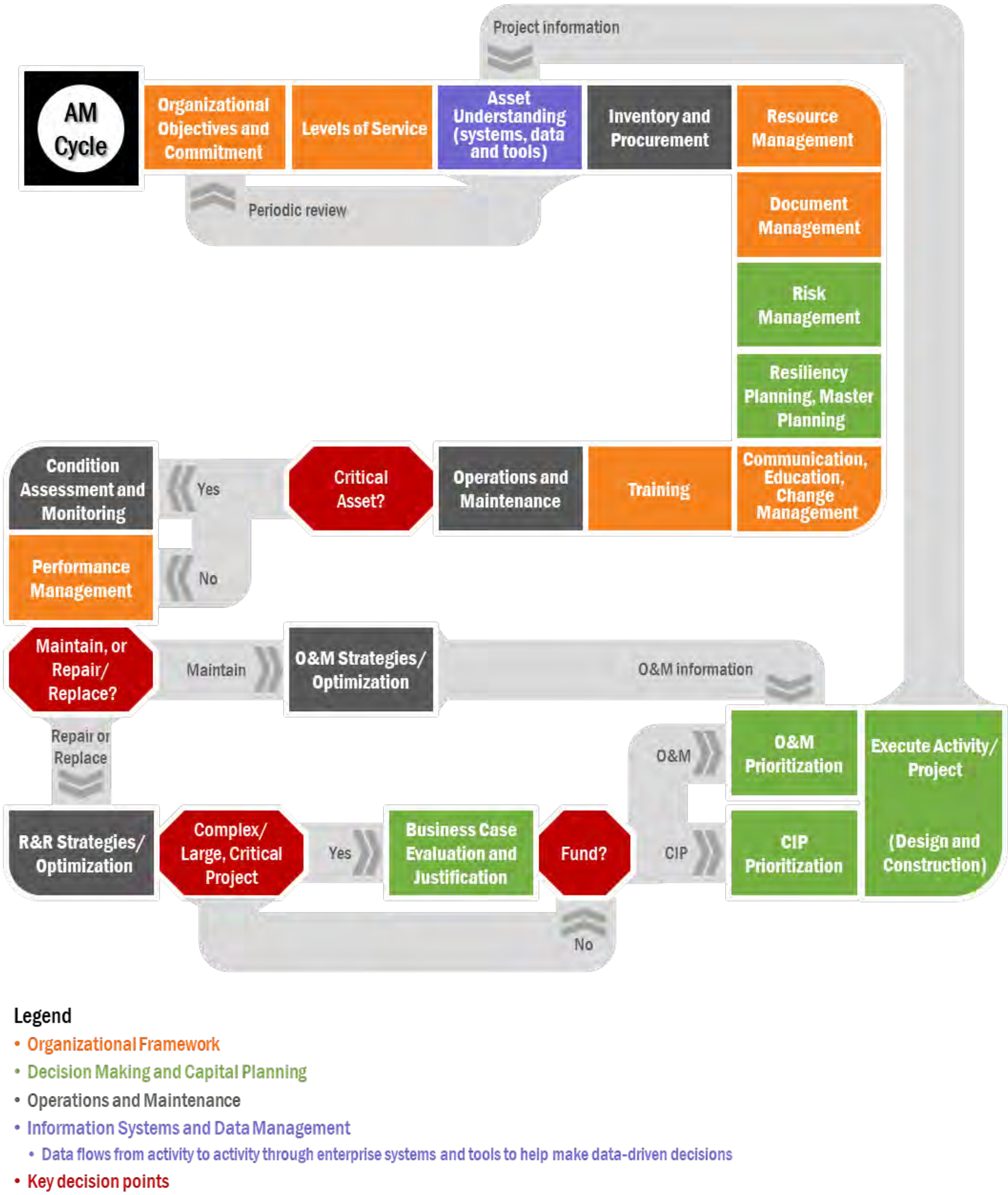

Figure 2-2. Asset Management Cycle

The AM cycle helps guide sequencing and dependencies of the AM program recommendations that came out of the gap analysis.

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2.4 Evaluation

An AM gap analysis (also known as the Asset Management Program Evaluation, or AMPE) is a structured, repeatable process designed to establish the desired future (target) and compare with current state of AM practices (shown in Figure 2-3 and detailed in *Appendix A*), to document observations about the practices, and to develop recommendations that bridge the gap between the target and current states. The gap analysis not only provides the baseline of AM understanding but also aids in educating and communicating the components of AM to the staff during the assessment interviews, and highlights areas that are of significant importance to MSD and in need of improvement so those areas can be prioritized for action.

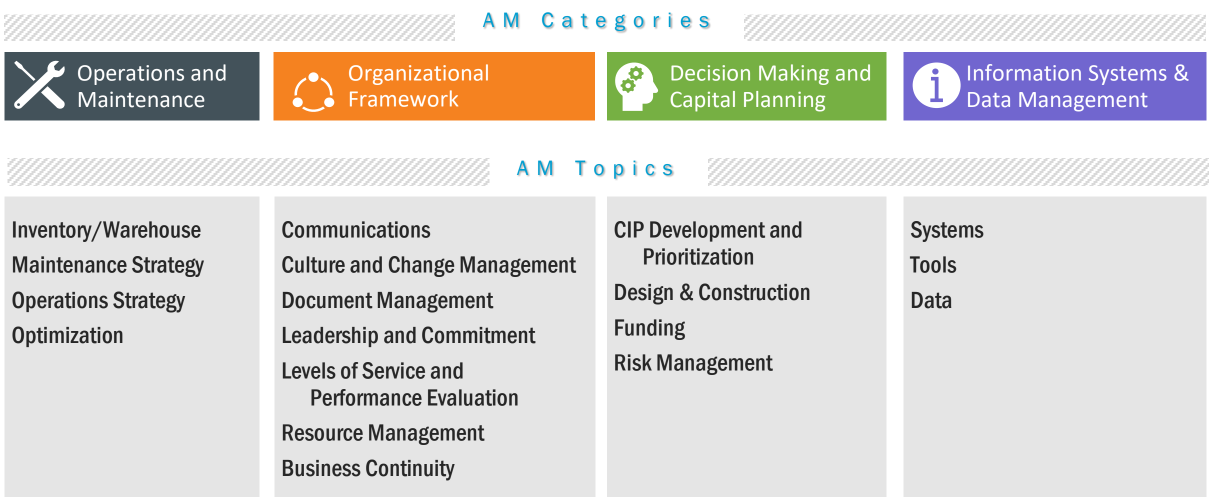

Figure 2-3. AM Gap Analysis Categories and Topics

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Section 3

AM Roles and Responsibilities

The personnel involved in developing and implementing the AM program are critical to the overall success of the work and utility. While the AM team is an important part of developing the AM program and providing support and resources for the overall program, it is the staff who will make the program succeed. During implementation, staff (and management) will be called upon to work together and carry out the recommendations and action items that are a part of this Roadmap. Staff will work together in teams for specific areas of interest. Additional duties of the teams are included in this section. Outside subject matter experts (SMEs) and facilitators can provide examples and input to the work products.

3.1 Regulatory Compliance & Asset Management Administrator

The Regulatory Compliance & Asset Management Administrator guides the development of the AM program. The primary functions of this position are as follows:

- Coordinate the activities of the AM Steering Committee and Core Team
- Provide leadership and program direction
- Implement the AM Roadmap
- Oversee development of the SAMP and TAMPs
- Monitor the progress of AM program development including schedules and resources
- Coordinate the development of AM program with other initiatives
- Serve as a liaison between the AM Steering Committee, AM Core Team, AM Development Teams, stakeholders, and outside consultant services

RCAM Administrator

- Coordinate teams, SMEs and activities
- Track performance
- Drive program
- Communicate status

3.2 Asset Management Steering Committee

MSD created an Asset Management Steering Committee, which includes representatives from:

- Treatment Maintenance
- Engineering
- Finance
- IT
- Regulatory Compliance and GIS
- Controls
- Field Engineering
- Collections and Flood Protection
- Wastewater & Drainage
- Treatment Operations
- TVI

The AM Steering Committee, as presently constituted, should be maintained through program development. The cross-functional skills represented on the teams are important to successful implementation given the diversity of the areas under development. The AM Steering Committee is the senior sponsor of the AM program holding all staff accountable for its progress. The primary functions of the AM Steering Committee are as follows:

- Secure adequate resources for program implementation

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- Charter the asset development teams, including purpose, objectives, leadership, and members
- Review and approve AM products, including:
  - SAMP
  - TAMP(s)
  - Communication Plan
  - Change Management Plan
  - AM policies, as needed
- Establish priorities for development of program elements
- Measure the performance of the program and make needed course corrections
- Provide input into the budgeting process
- Communicate with staff on the progress of program development
- Ensure continued change management efforts

AM Steering Committee

- Senior level position(s) from sponsored divisions
- Establish goals and objectives
- Approve AM documents
- Set strategy and vision
- Maintain relationship to other enterprise systems/groups
- Secure planning and funding

3.3 AM Core Team

A subset of the AM Steering Committee, the Core Team includes SMEs from around the district that can provide an initial layer of review for AM products prior to delivery to the AM Steering Committee in order to make the most efficient use of the Steering Committee's resources. The responsibilities of the AM Core Team include:

- Initial reviewers of AM products prior to delivery to Steering Committee
  - SAMP
  - TAMP(s)
  - AM Communication Plan
  - Change Management Plan
  - AM policies, as needed
  - AM process workflows
  - Standard Operating Procedures (SOPs), Asset Class Plans, as needed
- Monitor and be accountable for progress of AM Development Teams (AMDTs) in coordination with Regulatory Compliance & Asset Management (RCAM) Administrator
- Provide leadership and coordination of the AMDTs
- Manage backlog of program priorities established by the AM Steering Committee

AM Core Team

- Subset of Steering Committee
- Manage implementation and development
- Lead and coordinate development teams

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3.4 AM Development Teams

AM Development Teams will be composed of staff and management who have a direct interest and subject matter expertise in the specific area under program development. The teams should be of manageable size and should have representation at the front-line level with people involved in the execution of the work. This will help to create workable solutions and get buy-in from the people who will live with the outcome daily. Outside SMEs and facilitators will work closely with the teams to provide examples, input, and review of work products as appropriate.

The teams should provide regular progress updates to the AM Core Team to whom they report. They can also look to the RCAM Administrator to get assistance in planning and scheduling meetings and other AM activities and obtain resources that may be needed.

AM Development Teams

- 3 to 5 SMEs in each team
- Technology system SMEs (power users)
- Includes operating level staff, including but not limited to those listed in 3.4
- Act as change agents
- Implement Roadmap recommendations
- Develop SAMP and TAMPs
- Develop other AM documents

Each team (listed below and shown in Figure 3-1) will have a leader responsible for the direction of the teams and achieving the desired outcome—collectively the leaders are referred to as the Core teams. These AMDTs will be the active developers of the program and will, in turn, solicit feedback and communicate the program to the remainder of the staff. The responsibilities of each team include:

- Creating AM documents
  - SAMP
  - TAMP(s)
  - AM Communication Plan
  - Change Management Plan
  - AM policies, as needed
  - AM process workflows
  - SOPs, Asset Class Plans, as needed
- Reporting progress on elements to the AM Steering Committee and the AM Administrator

A proposed layout of AM organizational structure with proposed AMDTs is included in Figure 3-1.

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Figure 3-1. Asset Management Program Implementation Structure

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Section 4

Gap Analysis Summary

BC performed an AM gap analysis (AMPE) through online surveys and facilitated workshops to understand and validate the current state, target state, and importance rankings related to MSD's AM program. The steps including data discovery, current state and target state scoring, and analysis, are summarized below and detailed in the companion document: *Gap Analysis Tech Memo*.

1. Data Discovery

Prior to conducting the surveys and workshops, BC requested and reviewed background materials and systems information to help understand the current state of MSD's AM practices and data. This information was used to help guide the conversations with staff and management during the workshops.

2. Current State

BC administered an online survey for MSD staff and management to solicit their views on the current state of their AM program prior to meeting with them. Four surveys were emailed to each of the workshop participants ahead of the virtual working sessions—one for each of the AMPE categories.

BC and the AM Steering Committee set up a series of virtual workshops with SMEs and management to discuss the current state of each of the AM categories. The workshops were designed to solicit information about performance in each of the categories, to record relevant observations, and to understand performance in relation to each AM practice area. As part of the workshops, BC requested additional information to clarify what was discussed.

After the sessions, BC reviewed the workshop observations and scored the current performance in each area using the scoring criteria:

- Not Started (1) – Not familiar with AM principles or program not yet started
- Initial (3) – Reactionary and without a systematic approach
- Defined Approach (6) – Defined repeatable approach that is documented and communicated throughout organization
- Managed (8) – Quantitative measurements are defined for processes and quality standards
- Optimizing (10) – Continual improvement, refinement of processes, standards and procedures

3. Target State

The target scores (not started through optimizing) and importance scores (high=5, medium=3, low=1) were established by the AM Steering Committee in a facilitated workshop based on pre-workshop survey input and discussions. The AM Steering Committee assigned a single target score to each of the AM topics. The target scores provide a clear indication of where the organization wants to go in the next 3-5 years in the AM program. The AM Steering Committee also assigned an importance ranking to each of the AMPE topics, based on what was relatively most important and least important to MSD. The importance scores provide an indication of what the organization's highest priorities are for the AM program.

4. Analysis

Using the current and target scores along with the importance ranking, a weighted gap score was calculated {(Target Score – Current Score) x Importance = Weighted Gap}—see Figure 4-1. The weighted gap indicates those practice areas that are most important to the utility and require the most improvement. There are also foundational AM practices that are needed to support an overall robust AM program and help close the large weighted gap areas.

The AMPE summary findings shown in Table 4-1 highlight those larger gap areas and foundational AM topics to focus efforts on how to best advance MSD's AM program. The Action Plan Table (see Table 5-2) builds on the summary findings to create a prioritized list of recommendations that take into account available resources and precedencies (items that need addressing prior to others).

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A summary of the findings from the analysis are shown in Figure 4-1, which includes the current score, future score, importance ranking, and the overall weighted gap for each of the AM topics. Table 4-1 lists the AM topics that MSD scored highest, along with foundational AM topics that are needed to help successfully execute the AM program.

Louisville MSD

AMPE Summary Scores

Category	Topic	Current Score (average)	Target Score	Importance	Weighted Gap
Decision Making and Capital Planning	CIP Development and Prioritization	4.0	8	3	12.0
	Design & Construction	3.75	6	1	2.25
	Funding	4.5	8	3	10.5
	Risk Management	4.5	8	5	17.5
Information Systems and Data Management	Data	4.0	6	5	10.0
	Systems	4.5	6	3	4.5
	Tools	3.0	6	1	3.0
Operations and Maintenance	Inventory/Warehouse	3.0	6	1	3.0
	Maintenance Strategy	3.3	8	5	23.3
	Operations Strategy	4.5	8	5	17.5
	Optimization	2.6	8	3	16.2
Organizational Framework	Communications	4.5	6	5	7.5
	Culture and Change Management	3.0	6	3	9.0
	Document Management	4.0	8	3	12.0
	Leadership and Commitment	4.0	6	5	10.0
	Levels of Service and Performance Evaluation	5.3	10	5	23.3
	Resource Management	3.0	8	3	15.0
	Business Continuity	5.25	6	1	0.75

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AMPE Summary

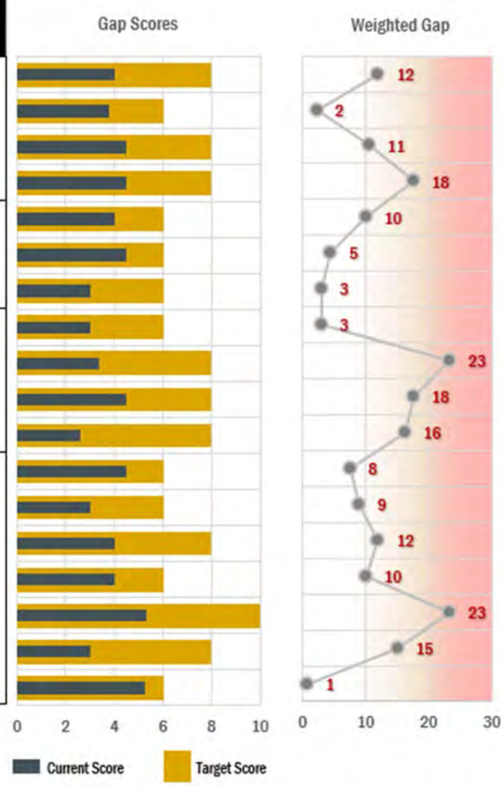

Figure 4-1. Gap Analysis Summary

Table 4-1. Summary Findings from AMPE	
Large Weighted Gap AM Topics	**Foundational AM Areas to Support Overall AM Program Development**
Decision Making and Capital Planning • Risk Management • CIP Development and Prioritization Operations and Maintenance • Maintenance Strategy • Operations Strategy • Optimization Organizational Framework • Levels of Service and Performance Evaluation • Document Management • Resource Management	Information Systems and Data Management • Data • Systems Organizational Framework • Communications • Culture and Change Management • Leadership and Commitment

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Section 5

Asset Management Action Plan

Implementing the AM program requires clear understanding of resources, actions, and timing. This section details the structure of the AM program work needed to implement this Roadmap and close the gaps identified during the AM program evaluation.

5.1 Internal Resources

The initial development of the AM program will be conducted using the roles identified in Section 2. This includes:

- MSD Program Champion (PC)
- Regulatory Compliance & Asset Management Administrator (RCAM Ad)
- ELT/Charter Team
- Asset Management Steering Committee (AMSC)
- AM Core Team (AMCT)
- AM Development Teams (AMDT)
- Subject matter experts (SMEs) including, but not limited to, those in Section 3.4.

The anticipated level of effort required of internal resources are noted in Table 5-2. It indicates the general level of effort from the PC, RCAM Ad, AMSC, AMCT, and AMDT to successfully implement the activities. This includes:

Limited	Moderate	Significant
• Participate in facilitated workshops. • Assume up to ~6 sessions.	• Participate in workshops. • Work in Development Teams outside of facilitated sessions. • Collect, analyze AM data and documents.	• Work extensively with consultant/project team to deliver an activity. • Develop materials and documentation for an AM activity.

Assumptions

- Effort needed for selection and/or modification and data cleanup of enterprise systems (IPS, GIS and SAP) will vary based on actual existing data reliability and desired data consistency. The magnitude of reconfiguration necessary in IPS/SAP will depend on the findings from several other activities.
- Another variable is the degree to which staff have availability to perform the work. If less work can be performed by staff, additional outside efforts or additional MSD staff may be needed to complete the activities.

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5.2 External Resources

The type of external resources that are anticipated to be needed are noted in Table 5-2. It indicates the type of involvement and general level of effort from outside vendors/consultants to successfully implement the activities. The type of outside consultant assistance is noted in the Action Plan table, and includes:

Consultation	Facilitation	Engagement	Augmentation
• Provide examples and samples of requested topics. • Review client-developed content.	• Consultation PLUS • Facilitate workshops • Prepare workshop materials and summarize content.	• Facilitation PLUS • Engage subject matter expertise on specific content. • Develop materials and documentation.	• Augment client staff and provide significant assistance to complete tasks associated with the activities.

Assumptions

- A significant number of activities noted in Phase 1 require external resources for facilitation and extensive subject matter expertise.
- Phase 1 activities involve external resources in key activities to help develop the SAMP and establish asset inventory and attributes that are foundational to other activities.
- Building on the asset-related activities addressed in Phase 1, Phase 2 activities include several TAMP activities and information management activities.
- Phase 3 activities requiring external resources are shown to reduce as MSD moves into more continuous improvement activities.

5.3 Quick Wins

The recommendations included as quick wins (QW) should be considered activities that should be focused on first. They help address the fundamentals of AM through commitment of needed AM resources; development, communication, and training of AM basics; and refining and improving information systems, tools, and data. The quick wins are informed by those AM topics that received high weighted gaps in the AMPE and foundational AM elements needed to implement the high-weighted gap areas.

The quick wins are identified in the Action Plan Table—Phase: QW.

5.4 AM Action Plan Table

The AM action plan establishes an implementation strategy for achieving improvements in the AM program. It provides a reference for the coming years as MSD enhances its AM practices. The action plan identifies recommended activities that MSD should pursue based on identified gaps in the current program and the current priorities. At the core of the action plans is the implementation structure (i.e. AM Development Teams). Also included are resource requirements and implementation schedule.

The action plan provides the path forward for the AM program. Table 5-2 contains the following information:

- Recommendation ID
- AM Category and Topic
  - Organizational Framework

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  - Decision Making and Capital Planning
  - Operations and Maintenance
  - Information Systems and Data Management
- AM Practice
- Best Practice
- Recommendation
- Activities
- Related activities/dependencies
- Resources
  - Internal: Low, Moderate, Significant
  - External: Consultation, Facilitation, Engagement, Augmentation
- Schedule phase
  - Quick win (QW): Start immediately
  - Phase 1: begin activity in Year 1 (November 1)
  - Phase 2: begin activity in Years 2 and 3 (November 1)
  - Phase 3: begin activity in Years 4 and 5 (November 1)
  - Continuous improvement activity ➲
- Roles
  - Lead: responsible for developing this recommendation
  - Support: identified as supporting development of this recommendation
  - Abbreviations for MSD internal groups by functional area are included in Table 5-1.

Table 5-1. Lead and Support Groups Functional Groups and Abbreviations

Accounting	ACC
Applications	APP
Budget & Financial Reporting	BFR
Community Benefits	CB
Chartering	CHA
Development and Stormwater Services- Construction Inspection	CI
CIP Management Team	CIP
Customer Relations & Communications	COM
Technical Services- Capital Program Controls	CPC
Customer Relations & Communications- Customer Relations	CR
Collections System, Flood Protection & Emergency Response	CS
AM Core Team	CT
Collections System, Flood Protection & Emergency Response- Controls	CTRL
Development and Stormwater Services- Development Review	DR
Wastewater & Drainage- Drainage	DRA
Technical Services- Project RI	DRI

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Table 5-1. Lead and Support Groups Functional Groups and Abbreviations	
Technical Services- Collection Systems & Construction management	ECS
Executive Leadership Team	ELT
Technical Services- Wastewater Treatment	EWW
Facilities, Safety, & Security	FAC
Support Services	FE
Fleet	FLT
Collections System, Flood Protection & Emergency Response	FP
Regulatory Compliance and GIS	GIS
Human Resources	HR
Facilities, Safety, & Security	HS
Technical Services- Infrastructure Planning	IP
Information Technology	IT
Treatment Facilities- Laboratory	LAB
Legal	LEG
LOJIC	LOJ
Development and Stormwater Services- MS4/Floodplain	MS4
Collections System, Flood Protection & Emergency Response—Operations Efficiency & Capital	OEC
Collections System, Flood Protection & Emergency Response- E-Prep and Operational Resiliency	OEP
Support Services- Operations Performance	OP
Wastewater & Drainage - Wastewater	OWW
Treatment Facilities-Performance Metrics	PM
Procurement	PRC
Treatment Facilities- Process Support	PS
Regulatory Compliance and GIS- Regulatory Compliance & Asset Management	RAM
Revenue & Collections	REV
Records & Information Governance	RIG
Steering Committee	SC
Supplier Diversity	SD
Facilities, Safety, & Security- Security	SEC
Storeroom	STR
Treatment Facilities- Treatment Maintenance	TM
Treatment Facilities- Treatment Operations	TO
Organizational Development & Training	TR
Wastewater & Drainage- TVI	TVI
Storeroom	STR

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
Decision Making and Capital Planning														
DM1	CIP Development and Prioritization	Business Case Evaluation (BCE)/Project Justification	BCEs are used to justify projects and prioritize operational and capital expenditures, using data from an AM system. These are done to provide the best cost and project outcome for the organization. A formal BCE process includes identifying alternatives, including new or reconfiguration of existing assets.	Communicate business case methodology and materials	• Communicate the BCE template that can be used to train personnel on the process and encourage a wide variety of involvement • Continuous improvement to refine BCE methodology to meet AM needs	DM4	L	C	■	➲	➲	➲	IP	CPC OEC
DM2	CIP Development and Prioritization	Operability and Maintainability	O&M personnel are involved in project planning, design, and construction from an early point with the objective of minimizing ongoing costs of asset ownership. A plan review process is in place that includes reviews and input by O&M personnel.	CIP business process and SOP	• Refine the design and construction process to engage O&M personnel at an earlier stage in the design to allow time for design adjustments based on their recommendations. • Create planning and design workflows		L	C		■			ECS	CPC EWW IP OEC CS TO TM FP
DM3	CIP Development and Prioritization	Growth and Forecasting Needs	Systems/process to determine expected growth (population and system) and capacity needs are used on a scheduled basis to determine funding needs. Forecasting is done using optimization tools (capacity planning, asset acquisition, maintenance analysis, Rehabilitation and Replacement [R&R] alternatives, etc.).	Capacity and growth analysis	• Create forecasting requirements list – investigate tools to perform • Develop workflow for annual review process for conducting/updating forecast • Align with master plans for systems (reference 20-yr Critical Repair and Replacement Plan [CRRP]) • Continue to incorporate hydraulic model information, expand to look at new growth (currently looks at existing capacity only) • Vet projects/outcomes through BCE/prioritization process		M	C				■	IP	DR RAM CPC
DM4	CIP Development and Prioritization	Rehabilitation and Renewal Process	The need for new assets or R&R projects is anticipated well in advance based on risk and arises from a structured process, master plans, or specific asset plans (not ad hoc, such as annual polling in engineering and operations, etc.). Budgets are developed in accordance with system needs and predefined levels of services. Budgets are measured against the goals and objectives.	R&R business model, and process or SOP	• Estimate R&R costs at the asset or asset class level • Create and populate a replacement planning model, include growth and forecasting identified needs • Document procedure to maintain the model annually • R&R planning output used in BCE process	IS2-4, DM3	M	F				■	RAM	IP CPC ACC
DM5	CIP Development and Prioritization	Project Prioritization	The project prioritization process is structured and involves operations, engineering, finance, and management. The impact of projects on delivering levels of service, including mitigating risk, is considered when prioritizing projects.	Project prioritization business process or SOP	• Develop CIP prioritization methodology and workflow • Needs are identified and fully considered including lifecycle needs of assets. R&R alternatives are evaluated considering economics and risk factors.	DM1, DM4	L	F				■	IP	RAM CPC
DM6	CIP Development and Prioritization	Condition Assessment Evaluation	Condition and performance ratings support prioritization of renewal and replacement decisions of the assets.	Condition and performance ratings included in R&R process	• Standardize condition and performance ratings • Ratings feed into likelihood of failure (LOF) criteria, which are used to understand risk and make R&R decisions	OM14, DM4, tie to data piece (IS-XX)	L	C		■			RAM	CS CTRL FP TM TO DRA TVI OWW IP

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
DM7	Design & Construction	Design Requirements	Record drawings identify assets using a standardized asset naming convention.	Develop design requirements for delivery of new asset information	• Define and document asset naming convention • Update/develop record drawing SOP to require use of asset naming convention • During design and early construction, asset information should be captured and recorded on record drawings and spreadsheets, for upload into IPS	IS1	L	C		■			RAM	ECS EWW DR TO CS FP TM
DM8	Design & Construction	Construction Requirements	Projects/assets are delivered with asset listings in accord with the asset naming convention. Acquisition costs and asset lifecycle data are delivered along with the asset listings. A business process for adding new assets to the asset inventory has been developed.	Develop construction requirements for delivery of new asset information	• Establish standard information that is required for delivery of new facilities and assets • Develop standard contract language so that asset information delivery is required in a format that can be incorporated into IPS • Communicate requirements and changes in construction standards/policies to development and engineering community	DM7, IS6	L	C		■			ECS	RAM EWW DR
DM9	Design & Construction	Manuals, Procedures, and Warranties	Design and construction requirements include delivery of operation and maintenance manuals, warranty information, and information needed for the Asset Class Plans.	Develop construction requirements for delivery of new asset information	• Require new assets be delivered with operating and maintenance manuals, guarantee/warranty information, and asset plan data (PMs, work instructions, etc.) • Revisit and update specifications and contract documents	DM8	L	C		■			TO	TM CS FP EWW ECS DR
DM10	Design & Construction	R&R Costs and Attributes	R&R costs are recorded in the asset history, and in the Asset Class Plans, where applicable. The remaining useful life of the underlying asset is estimated.	Develop R&R assumptions and information to be used in developing an R&R schedule for each facility/service	• For each asset class, document the following: • typical useful lives • rehabilitation schedule (i.e. rebuild pump every 5 years) • unit costs for R&R • Record labor, materials, contract costs, expected useful life in IPS to the asset	DM4, DM8, OM2	L	C				■	RAM	APP ACC
DM11	Funding	Forecasting Long-term R&R Needs	Periodic analyses are undertaken to determine future costs of asset R&R needs, including operation and maintenance costs. Procedures to review the trend in funding needs and available funds are routinely used to update the funding policy/documentation.	Develop R&R schedule for each facility/service	• Long-term R&R plans - identify the aggregate R&R needs of each facility/system over the next 25 to 50 years, which helps establish needed funding levels • Short-term capital plans - identify, justify, and prioritize specific R&R projects to develop a 5-year capital plan • Create R&R review procedure and workflow	DM10, OM2	L	C				■	IP	RAM
DM12	Funding	Funding Strategy	A funding strategy for asset R&R/CIP exists and is maintained. The governing body has approved the formal long-term funding strategy for the utility.	Document capital planning and financing strategy to address asset needs	• Develop methodology for use in developing long-term (i.e. next 50 years) and short-term (i.e. next 5 years) R&R needs as part of the SAMP, including updating project justification and prioritization protocols • Based on the identified needs, develop a strategy for providing needed funding to sustain the infrastructure	DM1, DM5	L	C		■			ACC	IP BFR CPC

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
DM13	Risk Management	Risk Policy	A risk policy has been established by the organization that establishes the level of risk the organization is willing to accept to meet its LOS.	Develop a policy for managing risk	• Develop a Risk Policy that defines the level of risk the organization is willing to accept to meet its LOS • Policy must be reviewed and approved by the policy review committee • Educate management staff on risk concepts • Revisit policy annually for changes in tolerance, assets, or LOS		L	F	■				RAM	IP LEG RIG CIP
DM14	Risk Management	Risk Register - Identification	Areas/activities that have the potential to impact service levels, regulatory compliance, financial objectives, and other business objectives are understood in the organization.	Develop a risk register	• Identify key organizational risk events of concern to inform future asset risk determination • Define LOF and consequence of failure (COF) criteria that will be used in the SAMP and TAMPs to assess asset risk, considering differences between how risk will be managed for vertical vs. linear assets • Develop a risk register that identifies the high-level risks to the organization, likelihood and consequence of occurrence and any risk mitigation measures (cite relevant documentation)	OF6, DM13, DM14	L	F	■				RAM with ECS (Rob)	IP ECS EWW DRI DR CS CTRL FP FE TM TO DRA TVI OWW CPC
DM15	Risk Management	Risk Register - Mitigation	Risk mitigation plans have been established for equipment and processes determined to have a high-risk level.	Develop/update risk mitigation plans	• For those risks that do not currently have plans/supporting material, create gap closure list, and create those risk mitigation documents		M	C		■			RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO DRA TVI OWW IWD OEP

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
DM16	Risk Management	Risk-Based Prioritization	The LOF and COF have been established, quantified, and are used to prioritize maintenance and R&R activities. (The chance that a failure might occur has been established, documented, and quantified at the asset level.) (The impact on LOS, utility, customers, or public resulting from an asset failure has been established, documented, and quantified at the process/system and/or asset level.)	Identify and document high-risk assets	• Identify LOF and COF criteria at overall department level – criteria that are broad enough to use across facilities and service lines (include in SAMP) • For each system, evaluate assets following LOF and COF criteria that have not been included in evaluation to date • Apply LOF criteria and combine with COF to calculate asset risk	OF6	M	F	■				RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO DRA TVI OWW OEP
Information Systems and Data Management														
IS1	Data	Asset Definition	A definition of an asset exists. It describes the criteria under which an item would be considered an asset.	Develop asset definition for use by O&M and Engineering	• Create asset definition • This definition may differ from the Finance definition of an asset for depreciation purposes		L	C	■				RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP

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Table 5-2. Asset Management Action Plan															
Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
IS2	Data	Required Asset Attribute Data	Asset attribute data requirements exist for each asset class (maintenance requirements, date in service, acquisition cost, description, nameplate data, horsepower, length, diameter, etc.).	Develop asset attribute list, by asset class	• From CMMS and GIS collect existing asset attribute information. • Starting with critical assets/classes, create asset attribute list – key attributes that should be populated for each asset class. • Create fields in IPS/GIS for the data attributes	IS3, IS1	L	C	■				RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP
IS3	Data	Asset Classes	Assets are assigned to asset classes (a way of categorizing similar assets into groups, or a grouping of equipment that exhibit similar characteristics and function similarly), and general definitions of those classes have been documented.	Document asset classes for each facility/service	• From CMMS and GIS collect existing asset class information. • Define each asset class and fill in gaps for additional asset classes.	IS1	L	C	■				RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP

Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
IS4	Data	Asset Identification/ Hierarchy	Assets have been identified at the appropriate level of detail, assigned to asset classes, and placed in the asset hierarchy. Asset hierarchies are defined for all facilities/systems, and are used throughout the asset lifecycle, including design and construction.	Refine asset inventory hierarchy to ensure readiness for support of other AM activities	• Review existing hierarchy • Reference ISO 14224 (Collection and Exchange of Reliability and Maintenance Data for Equipment) which discusses hierarchy best practice • Consider goals of hierarchy – maintaining assets throughout lifecycle, rolling up costs/information to make management decisions • Review existing hierarchy to make sure costs are rolling up properly • Phase 1 additional activity to perform the hierarchy update in IPS	IS3, IS2	M	F	■	■			RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP
IS5	Data	Asset Inventory	An asset inventory has been documented in the applicable AM system(s). Examples include computerized maintenance management system (CMMS), and geographic information system (GIS).	Refine and document asset inventories using the established hierarchies, enumeration, classes and attributes, to ensure readiness for support of other AM activities	FACILITIES • Compare the needed asset details to what is in IPS to identify gaps that need to be filled • Develop a process/tool for collecting attribute information for remaining assets • Collect and populate attribute information • Perform field verification for the facility assets • Update IPS with findings COLLECTIONS • Compare the needed asset details to what is in IPS and GIS to identify gaps that need to be filled STORMWATER • Compare the needed asset details to what is in IPS and GIS to identify gaps that need to be filled • Develop a process/tool for collecting attribute information for remaining assets • Perform field connectivity verification and obtain surveyed locations for the assets • Collect and populate attribute information • Update GIS with findings	IS1-3	H	C, A		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP DRI

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Table 5-2. Asset Management Action Plan															
Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
IS6	Data	Asset commissioning and decommissioning	New assets are entered into the AM system(s). Assets removed from service are retired in the AM system(s). Asset changes are reflected in the AM system(s).	Asset commissioning and decommissioning business process	• Develop workflow for bringing assets online (linear and facilities), modifying attributes of existing assets, retiring assets		L	C		■			RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP FAC ACC FLT
IS7	Systems	Information Systems	The organization has IT systems to support AM. Example systems include: CMMS, GIS, Customer Information System-CIS, Finance, Regulatory/Permitting, HR/timekeeping/Learning Management System	Optimize integrations and links between core enterprise systems	• Perform needs assessment to understand integration abilities of CMMS, CIS, GIS, Finance and Timekeeping functionality • Require training for each updated element of the systems		H	Software vendor to perform updates/ modifications		■			RAM	APP IT HR ACC BFR PRC STR GIS REV TR RIG LAB IWD
IS8	Systems	Inventory/Stores/Materials Management	Parts and materials are documented and tracked in the applicable AM system(s) and are associated with work orders.	Inventory documented	• Continuous improvement to keep warehouse inventory up to date • Create inventory/warehouse workflow	IS7	M	-		⟳	⟳	⟳	RAM	APP STR
IS9	Tools	Data Access Methodology	User-friendly method(s) exists for entering and retrieving asset information for all users. Users have clear understanding of which systems to use for data management.	Asset data collection business process/SOP	• Create list of potential/existing data entry and data retrieval scenarios/processes • Develop workflow for standard methods to enter and retrieve data	IS7	M	F				■	RAM	GIS APP PM OP

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
IS10	Tools	Data Collection Tools	Data collection tools are readily available and used to streamline the process of data input and improve accuracy of information in the systems and databases.	Asset data collection business process/SOP	• Continue with mobile development and data collection software • Require training for each element of the mobile data collection effort	IS7	M	C		■			RAM	GIS APP PM OP DRI CS FP
Operations and Maintenance														
OM1	Inventory/Warehouse	Purchasing/Procurement	Purchasing parts and materials for use within maintenance activities is done efficiently and correctly in the applicable AM system(s).	Inventory and warehousing business processes	• Continue to document the process for stocking, ordering, staffing, and using the warehouse • Create purchasing workflow	IS7, IS8	L	C			■		STR	PRC RAM
OM2	Maintenance Strategy	Asset Class Plans	Asset class plans are used to organize maintenance activities. Asset class plans include frequency and estimated costs of short-term work (job plans) and long-term O&M and R&R needs, along with parts and operational considerations. Costs include salvage values (if any) and disposal costs.	Document maintenance strategy for assets	• Create template for asset class plan including short- and long-term maintenance needs • Populate template for critical asset classes first, followed by additional classes later • Update annually based on collected and analyzed data	IS1-4, OM14, OM15, OF6	S	E		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP
OM3	Maintenance Strategy	Job Plans/SOPs	Maintenance procedures are defined and connected to work orders. Step by step tasks, standard hours, parts lists, and required resources have been documented. Job plans include planned activities along with standard labor hours, materials, etc., for preventive and corrective maintenance, calibration, adjustment, cleaning, and condition assessment.	Review and refine job plans	• Review existing job plans for completeness and verify schedule, labor hours, materials, tools and parts • Update/create job plans as necessary, begin with critical assets with PMs • Incorporate procedures into IPS to facilitate work order management	OM2	S	E, A		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP

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Table 5-2. Asset Management Action Plan

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							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
OM4	Maintenance Strategy	Maintenance Costs	Work orders are prepared on an asset-specific basis. Costs of fulfilling work orders are accumulated along with underlying details (hours used by craft, actual materials, time done, etc.).	Implement work order costs in CMMS	• Create work order workflow • Load/link labor rates, equipment rates, tool costs in CMMS • Investigate ability to charge capital work to an asset • Charge labor, equipment, and tools to all work orders • Track and analyze costs of fulfilling work orders, including labor and materials	IS7, DM9	L	C, Software vendor		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP APP
OM5	Maintenance Strategy	CMMS WO Priority Types	WO prioritization criteria are well defined and inform the order in which work is performed.	Work order priority types	• Review existing priority types • Document single, agreed upon approach to priority criteria	OF6, OM2	L	F	■				RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP
OM6	Maintenance Strategy	Preventive Maintenance	Preventive maintenance (PM) activities are fully defined at the appropriate asset level, including frequencies. PM is scheduled and performed in accord with the specified frequencies.	PM process/SOPs	• Develop workflow for preventive maintenance (include work order: creation, planning, scheduling, assignment, completion/execution, close, review and closing). • Inventory existing PM work orders • Determine gap of assets (starting with critical assets) that do not have existing/up-to-date PMs • Define and document PM activities, including intervals and resource information	OM2	M	E		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
OM7	Maintenance Strategy	Predictive Maintenance	Predictive maintenance is applied as a result of condition monitoring and is performed prior to failure and is tracked separately in the CMMS for analysis purposes.	PdM process/SOPs	• Develop workflow for predictive maintenance • Evaluate the use of predictive maintenance technologies to replace PM activities • Store PdM findings in CMMS to the asset	OM2	M	C				■	RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP
OM8	Maintenance Strategy	Corrective Maintenance	Corrective maintenance, based on equipment failure, is tracked separately in the CMMS for analysis purposes, including cost and time.	CM process/SOPs	• Document terminology for maintenance (reference - Society for Maintenance Reliability Professionals (SMRP)) • Develop workflow for corrective maintenance	OM2	L	C		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP
OM9	Maintenance Strategy	Work Scheduling	All work is scheduled in the CMMS to allow for identification of resource issues (available labor, materials, parts, etc.).	Plan and schedule work in CMMS	• Document work order workflow process (PM, PdM, CM, emergency, after-hours)	OM6-8 OF17	M	C			■		RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP APP

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Table 5-2. Asset Management Action Plan

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OM10	Maintenance Strategy	Updating Asset Class Plans	Trends in assessed condition, long-term cost estimates and near-term schedules for maintenance, along with cost and risk analyses, are used to update asset class plans.	Document maintenance strategy for assets	• Continuous improvement item • Analyze PM work order completion percentage, costs for the assets, trend condition for the assets • Modify PM frequency / steps if needed • Update asset class plan based on findings	OM2, IS9, OF14	M	F		➲	➲	➲	RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP
OM11	Operations Strategy	Operational Procedures	Operational procedures are defined for asset classes and facilities/systems.	Add operational information to Asset Class Plan	• Inventory existing operations SOPs • Determine gap of assets (starting with critical assets) that do not have existing/up-to-date operational SOPs • Include reference to operational procedures in the asset class plans	OM2	M	C		■			RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP RIG
OM12	Operations Strategy	Operations Costs	Operational costs (chemicals, power, etc.) are tracked by asset and analyzed using the applicable AM system(s).	Track operational-related work order costs in CMMS	• Load/link labor rates, equipment rates, tool costs in CMMS • Investigate ability to charge capital work to an asset • Charge labor, equipment, and tools to all work orders • Track and analyze costs of fulfilling work orders, including labor and materials • Phase 3 activity to track materials costs and energy costs to the asset/process • Investigate ability to track energy and material costs to assets/process	IS7, DM9	H	C, Software vendor			■	■	RAM	APP ACC BFR

Table 5-2. Asset Management Action Plan															
Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
OM13	Optimization	Condition Assessment Data Collection Process	Standardized process (workflow/steps) has been developed for routine (sensory) inspection and condition monitoring data collection.	Create assessment workflow	• Develop workflows for inspection/assessment types	OM2	L	C			■		RAM	CS CTRL FP FE TM TO DRA TVI OWW
OM14	Optimization	Condition Assessment Methods	Appropriate assessment procedures and intervals for assets are defined and allow for consistency in monitoring and assessing condition.	Document condition assessment protocols for all critical assets	• Develop workflow for performing condition assessment • Develop details for conducting condition assessment efforts which is asset class specific • Identify critical asset classes • Reference existing regulatory requirements/industry standard for type and interval of assessments	IS3, OM2	L	C		■			RAM	CS CTRL FP FE TM TO DRA TVI OWW
OM15	Optimization	Condition Assessment Ratings	Condition and performance ratings have been defined to ensure consistent documentation of asset condition.	Document condition rating methodology	• Develop condition rating methodology for including in SAMP • Phase 2 activity to develop condition assessment details, including rating scales, that will be used in development of the TAMPs	OM2	L	F	■		■		RAM	CS CTRL FP FE TM TO PM DRA TVI OWW OP

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Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
OM16	Optimization	Root Cause Failure Analysis (RCFA)	Asset failures are analyzed and used to update asset class plans as well as R&R schedules for similar assets.	Root cause analysis business process/SOP	• Create RCFA workflow • Identify personnel and train on RCFA • Perform analysis, starting with most critical assets	OM2	M	F				■	RAM	IP CS CTRL FP FE TM TO PM DRA TVI OWW OP EWW ECS DRI
OM17	Optimization	Problem, Cause, Remedy Codes (Failure Codes)	Problem, Cause, Remedy Codes (failure codes) are tied to failure modes at the asset class level. Asset failures are recorded with appropriate codes and details in the CMMS.	Review and implement failure hierarchy	• Review existing failure codes (activity, result codes, PACP) by asset classes • Update/remove/add failure codes as necessary • Determine if the codes should be required in the work orders	OM2	M	F		■			RAM	IP CS CTRL FP FE TM TO PM DRA TVI OWW OP ECS EWW DRI
Organizational Framework														
OF1	Communications	Communications Plan	Communications plan is established and used to communicate goals and objectives to all staff and stakeholders. Includes a mechanism to allow staff and stakeholders to provide feedback on program and procedural improvements in the AM program. Includes an understanding of LOS expectations and ongoing communication to manage those expectations.	Develop and institute AM communication plan.	• Develop *Communications Plan*, including elements of the Roadmap and the SAMP – goals, objectives, LOS, responsible persons • As part of the Communications Plan, provide mechanism for staff to provide input to AM program		L	F	■				RAM	COM CIP CT

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Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
OF2	Communications	AM Strategy Awareness	AM strategy has been communicated to guide all parts of the organization involved in gap closure and general strengthening of AM.	Communicate the status of the AM program	• Following the directives in the Communication Plan, communicate progress of this Roadmap to other senior management, staff and the Board. • In general, any of the action plan activities that result in changes in procedures or creation of documentation, should be communicated to all impacted staff after the procedure or document has been approved by the AM Steering Committee. • Communicate the AM roles and responsibilities as outlined in Section 2	OF1	L	C	➲	➲	➲	➲	RAM	CIP CHA SC
OF3	Culture and Change Management	Change Management Plan	A Change Management Plan is established, including an understanding of how stakeholders will be impacted and the organizational readiness for change associated with implementing AM improvements.	Develop and institute AM change management plan.	• Develop *Change Management Plan*, including an understanding of how stakeholders will be impacted and the organizational readiness for change associated with implementing AM		L	F	■				RAM	TR CIP CT
OF4	Culture and Change Management	Management of Risks Associated with Change	Risks associated with any significant change that can have an impact on achieving AM objectives are assessed and managed.	Execute AM change management plan.	• Follow guidance in Change Management Plan	OF3	L	-		➲	➲	➲	RAM	CIP CHA SC
OF5	Document Management	AM Practices Assessment	Current AM-related business processes are identified, documented, understood, and evaluated. Comparisons have been made between the current status of business practices and the desired status, and "gaps" have been identified.	Continuous Improvement	• Initial Gap Analysis/AMPE tech memo - COMPLETE • Revisit annually to track progress of AM understanding and program improvements		L	-		➲	➲	➲	RAM	CIP SC
OF6	Document Management	AM Plan	A document has been prepared to close the "gaps" within the associated time frames, and all associated elements (resources, responsibilities, reporting, etc.) have been specified.	Develop AM Roadmap for utility	• This Roadmap – COMPLETE • Revisit annually to track progress of AM program improvements		L	-		➲	➲	➲	RAM	CIP SC
				Develop Strategic Asset Management Plan	• Develop SAMP, which includes framework on the following sections: O&M, Decision Making and Capital Planning, Organizational Framework, Information Systems and Data Management	All	M	F	■				RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP

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Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
				Develop Tactical Asset Management Plans	• Determine number/specific facility and system TAMPs • Create Tactical Asset Management Plans (TAMPs) • Identify existing documentation and compare to guidelines established in the SAMP to identify gaps • Establish TAMP for each facility/system using existing documentation	All	M	F		■			RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP
OF7	Document Management	General Document Management Practices	Document management is a structured process within the utility that ensures management, retention and retrieval of important documentation. A document management system or process is readily understood and available throughout the organization.	Develop document management business process/SOP	• Continue to advance the document management procedures and systems • Develop workflow for adding and maintaining asset documentation to enterprise systems • Partner with Information Governance Steering Committee		L	C		■			RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP RIG
OF8	Leadership and Commitment	Support from Policy Body	The governing body understands the objectives of AM and treats it as a priority.	Update the Board on AM status	• Brief the Board on Asset Management Program status – date TBD • Develop a list of milestones (based on this Action Plan) at which additional communications will be held with the Board	OF1	L	-	■	↻	↻	↻	CIP	RAM
OF9	Leadership and Commitment	Organizational Commitment	All levels of management understand the importance of AM. They agree upon and support the implementation of identified improvements.	Continuous improvement of AM strategy/charter	• Authorize AM roles (Section 2) • Hold regular status (quarterly) meetings of AM Steering Committee • Use this roadmap to monitor progress	OF1, OF3	L	-	■	↻	↻	↻	CIP	RAM CHA SC

Table 5-2. Asset Management Action Plan

Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
OF10	Leadership and Commitment	AM Goals and Objectives	Vision has been defined for the AM program. The AM team has defined goals for achievement in each AM performance area.	Continuous improvement of AM strategy/charter	• Revisit AM Charter (vision, mission and goals) annually to confirm applicability, update as needed • Communicate AM vision, mission and goals to all MSD following Communication Plan	OF1	L	-		➲	➲	➲	CHA	CIP RAM SC
OF11	Levels of Service and Performance Evaluation	AM Program Audit	The overall AM Program is reviewed periodically for adherence to the plan goals and for measurements of actual benefits arising from AM.	Continuous improvement of AM program	• Continuous improvement item to annually revisit the AMPE and corresponding AM Roadmap progress		L	C		➲	➲	➲	RAM	CIP CHA SC
OF12	Levels of Service and Performance Evaluation	Balanced Levels of Service	A clear and complete set of service levels (both internal and external) are documented that meet customer expectations and regulatory requirements and long-term interest of the organization. The relationships between service levels and costs are understood.	Refine established LOS and performance measures	• Refine the established LOS measures and align with mission of AM program • Reference the Blueprint 2025 document • Develop and establish performance measures for use in the TAMPs		M	F	■				RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP TR
OF13	Levels of Service and Performance Evaluation	Performance Measures (aka Key Performance Indicators)	Indicators of success are established to measure effectiveness of the AM program and used to develop corrective actions on a proactive basis. Includes measures for all aspects of organization related to AM	Refine performance measures	• Document AM performance measures in the SAMP • Based on SAMP guidelines, establish division/facility/system performance measures and record them in the TAMPs	OF12	M	F		■			RAM	IP ECS EWW DRI DR CS CTRL FP FE TM TO PM DRA TVI OWW OP TR

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Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort: Internal (L, M, S)*	Level of Effort: External (C,F,E,A) **	Phase: QW	Phase: 1	Phase: 2	Phase: 3	Roles: Lead	Roles: Support
OF14	Levels of Service and Performance Evaluation	Tracking and Reporting Performance Measures	Performance measures/KPIs are measured, tracked, analyzed and reported to the organization to ensure that the AM program is meeting the expectations of all stakeholders.	Develop method to track and analyze for continuous improvement.	• Develop process and tools needed to periodically monitor and evaluate the measures • Develop enterprise reporting requirements • Develop process using PowerBI for reviewing monitoring results and making needed adjustments based on the results	OF12, OF13	M	F			■		RAM	APP TR OP
OF15	Levels of Service and Performance Evaluation	Regulatory Reporting	Methods (data collection, reporting) to comply with regulatory requirements are established and documented in the organization.	Develop workflow for regulatory reporting	• Develop SOP and workflow identifying regulations that need tracked and reported, personnel involved, and systems/data used		L	c		■			RAM	IP MS4 DR CS FP TO PS LAB OP APP
OF16	Levels of Service and Performance Evaluation	Regulatory Compliance Strategy	Regulatory requirements and pending requirements are continuously monitored and communicated within the organization to the appropriate environmental compliance/regulatory personnel.	Continuous improvement	• Continue to monitor regulatory requirements and pending requirements • Communicate changes to regulatory requirements to appropriate parties • Regulatory monitoring personnel are responsible for this activity	OF15	L	-		➲	➲	➲	RAM	IP MS4 DR CS FP TO PS
OF17	Resource Management	Roles and Responsibilities	Roles and responsibilities have been defined for all personnel involved in the AM program.	Adopt AM roles outlined in this AM Roadmap	• Identify specific personnel to participate in the Development Teams (DTs) for each phase of the AM program as identified in this Roadmap with updated staffing to support continuous improvement • Charter the Asset Management DTs, led by the established AM Core Team Members	OF1, OF2 Section 3 and 6	L	C	■				RAM	CT
OF18	Resource Management	Allocation of Resources	Adequate staff, equipment and tools are available to develop and sustain an AM program (includes: development, training, monitoring, controlling, reporting, auditing, and updating and improving the AM program).	Identify and allocate appropriate and adequate resources to support AM improvements.	• Identify and quantify resource needs for each phase of the AM program as identified in this Roadmap – internal and external resources • Define roles and responsibilities for all personnel that will be involved in the AM program (see Section 2) • Allocate internal and external resources in budget	OF17	M	C		■			CIP	RAM
OF19	Resource Management	Employee Development and Training	A training development plan exists for staff. Training includes courses for: asset management, organizational and leadership, and technical/job specific.	Training plan with business process/SOP	• AM Roadmap training: training for each recommendation in this Roadmap will be necessary once the new process is established, and documentation is completed/approved. • Develop the framework of comprehensive training plan, reference existing training and employee development resources that can be used in a gap analysis of training needs		M	F			■		TR	RAM

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Rec ID	AM Category / Topic	AM Practice	Best Practice	Recommendation	Activities	Related Activities	Level of Effort		Phase				Roles	
							Internal (L, M, S)*	External (C,F,E,A) **	QW	1	2	3	Lead	Support
OF20	Business Continuity	Staffing	Staff can change how/where they work based on external factors/threats that impact overall organizational operations.	Staffing Plan, Business Continuity Plan (BCP)	• Continuous improvement of staffing training and preparedness for emergencies (reference BCP)	OF19	L	-		➲	➲	➲	TR	HR OEP IT
OF21	Business Continuity	Technology and Systems	Systems and technology are resilient and support major shifts to overall organizational operations.	Technology Master Plan, Business Continuity Plan	• Continuous improvement of preparedness for emergencies (reference BCP) • Continue to develop mobile platforms for data collection and daily activities • Seek staff input during projects to update systems and tools.	IS9, IS10	L	-			■	➲	IT	APP LOJ GIS OEP RAM CTRL
OF22	Business Continuity	Communication with stakeholders	Public Information Office ready to communicate major shifts to overall organizational operations and subsequent impacts to stakeholders.	Communications Plan, Business Continuity Plan	• Continuous improvement of communications preparedness for emergencies (reference BCP)	OF1	L	-		➲	➲	➲	COM	RAM OEP
OF23	Business Continuity	Financial Procedures	Supply chain, procurement, capital decisions, and revenue and funding mechanism alternatives exist to support major shifts to overall organizational operations.	Financial procedures, Business Continuity Plan	• Continuous improvement of supply chain preparedness for emergencies (reference BCP)		L	-		➲	➲	➲	CIP	ACC APP PRC STR CPC IP OEC REV

**Internal level of effort: Limited, Moderate, Significant*

***External level of effort: Consultation, Facilitation, Engagement, Augmentation*

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Section 6

Continual Improvement

Managing the Roadmap is a dynamic process of continuous planning, implementation, evaluation, and resultant adaptation to changing conditions and lessons learned. Through the active maintenance of this document, the AM Program will continue to be refined and responsive to changing priorities.

6.1 Communications and Training

In general, any of the action plan activities that result in changes in procedures or creation of documents or methodology, should be communicated to all impacted staff after the procedure or document has been approved by the appropriate people (Executive Director to approve the initial AM Roadmap; AM Steering Committee to approve other documents and annual updates). Training should also be provided to impacted staff and added to their employee training plans.

6.2 Annual Update

The AM teams should conduct annual update meetings for purposes of holistically reviewing and updating this document, with specific actions and responsibilities listed below. Section 1.2 – Approach, should be used as the guidance for revisiting the asset management program work.

1. Review	Perform an annual AM Roadmap, Gap Analysis (AM Program Evaluation) review ➲ Meet to review status of the Roadmap and overall AM program ➲ Identify successes in Roadmap and AM Program implementation ➲ Determine if the AM activity is still applicable, requires adjustments to meet any changes to organizational drivers, or needs to be removed if it is no longer applicable ➲ Identify ways to address gaps in recommendations ➲ Confirm roles and responsibilities are still appropriate	AM Core Team
2. Assess	Assess whether improvement activities are performing as expected ➲ Assess improvement activity performance ➲ Determine if the right information is being gathered to track performance and adjust as necessary	AM Steering Committee
3. Update	Add or reprioritize Action Items ➲ Discuss newly needed improvement activities ➲ Modify Action Plan with findings and additions ➲ Any changes to the recommended Roadmap activities, procedures, resources or documents should be done with input from the AM Administrator, Development Teams, and SMEs, and approval by the AM Steering Committee, or other parties as appropriate	AM Steering Committee

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Appendix A: Asset Management Gap Analysis Categories, Topics and Practice Areas

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Category	Topic	Practice
Decision Making and Capital Planning	CIP Development and Prioritization	Business Case Evaluation/Project Justification
Decision Making and Capital Planning	CIP Development and Prioritization	Operability and Maintainability
Decision Making and Capital Planning	CIP Development and Prioritization	Growth and Forecasting Needs
Decision Making and Capital Planning	CIP Development and Prioritization	Rehabilitation and Renewal Process
Decision Making and Capital Planning	CIP Development and Prioritization	Project Prioritization
Decision Making and Capital Planning	CIP Development and Prioritization	Condition Assessment Evaluation
Decision Making and Capital Planning	Design & Construction	Design Requirements
Decision Making and Capital Planning	Design & Construction	Construction Requirements
Decision Making and Capital Planning	Design & Construction	Operating Manuals, Procedures, and Guarantees
Decision Making and Capital Planning	Design & Construction	R&R Costs and Attributes
Decision Making and Capital Planning	Funding	Forecasting Long-term R&R Needs
Decision Making and Capital Planning	Funding	Funding Strategy
Decision Making and Capital Planning	Risk Management	Risk Policy
Decision Making and Capital Planning	Risk Management	Risk Register - Identification
Decision Making and Capital Planning	Risk Management	Risk Register - Mitigation
Decision Making and Capital Planning	Risk Management	Risk-Based Prioritization
Information Systems and Data Management	Data	Asset Definition
Information Systems and Data Management	Data	Required Asset Attribute Data
Information Systems and Data Management	Data	Asset Classes
Information Systems and Data Management	Data	Asset Identification/ Hierarchy
Information Systems and Data Management	Data	Asset Inventory
Information Systems and Data Management	Data	Asset commissioning and decommissioning
Information Systems and Data Management	Systems	Information Systems
Information Systems and Data Management	Systems	Inventory/Stores/ Materials Management
Information Systems and Data Management	Tools	Data Access Methodology
Information Systems and Data Management	Tools	Data Collection Tools
Operations and Maintenance	Inventory/Warehouse	Purchasing/ Procurement
Operations and Maintenance	Maintenance Strategy	Asset Class Plans
Operations and Maintenance	Maintenance Strategy	Job Plans/SOPs
Operations and Maintenance	Maintenance Strategy	Maintenance Costs
Operations and Maintenance	Maintenance Strategy	CMMS WO Priority Types
Operations and Maintenance	Maintenance Strategy	Preventive Maintenance
Operations and Maintenance	Maintenance Strategy	Predictive Maintenance
Operations and Maintenance	Maintenance Strategy	Corrective Maintenance
Operations and Maintenance	Maintenance Strategy	Work Scheduling
Operations and Maintenance	Maintenance Strategy	Operational Supported Maintenance Scheduling
Operations and Maintenance	Operations Strategy	Operational Procedures
Operations and Maintenance	Operations Strategy	Operations Costs
Operations and Maintenance	Optimization	Condition Assessment Data Collection Process
Operations and Maintenance	Optimization	Condition Assessment Methods
Operations and Maintenance	Optimization	Condition Assessment Ratings
Operations and Maintenance	Optimization	Root Cause Failure Analysis (RCFA)
Operations and Maintenance	Optimization	Problem, Cause, Remedy Codes (Failure Codes)
Organizational Framework	Communications	Communications Plan

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Category	Topic	Practice
Organizational Framework	Communications	AM Strategy Awareness
Organizational Framework	Culture and Change Management	Change Management Plan
Organizational Framework	Culture and Change Management	Management of Risks Associated with Change
Organizational Framework	Document Management	AM Practices Assessment
Organizational Framework	Document Management	AM Plan
Organizational Framework	Document Management	General Document Management Practices
Organizational Framework	Leadership and Commitment	Support from Policy Body
Organizational Framework	Leadership and Commitment	Organizational Commitment
Organizational Framework	Leadership and Commitment	AM Goals and Objectives
Organizational Framework	Levels of Service and Performance Evaluation	Balanced Levels of Service
Organizational Framework	Levels of Service and Performance Evaluation	AM Program Audit
Organizational Framework	Levels of Service and Performance Evaluation	Performance Measures (aka Key Performance Indicators)
Organizational Framework	Levels of Service and Performance Evaluation	Tracking and Reporting Performance Measures
Organizational Framework	Levels of Service and Performance Evaluation	Regulatory Reporting
Organizational Framework	Levels of Service and Performance Evaluation	Regulatory Compliance Strategy
Organizational Framework	Resource Management	Roles and Responsibilities
Organizational Framework	Resource Management	Allocation of Resources
Organizational Framework	Resource Management	Employee Development and Training
Organizational Framework	Business Continuity	Staffing
Organizational Framework	Business Continuity	Technology and Systems
Organizational Framework	Business Continuity	Communication with stakeholders
Organizational Framework	Business Continuity	Financial Procedures

Use of contents on this sheet is subject to the limitations specified at the beginning of this document.

Appendix C. Performance Measure Definition Sheets

Level of Service	Measure
Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services	Flood pumps in service
	Violations caused by asset failures
	Number of near misses
	Monitoring and reporting compliance
	Monitoring and reporting compliance
	Reporting activities compliance
	Discharges caused by asset failures
Maintain the trust of the community through high quality and reliable services	Service request complaints rate
	Time to correct MSD-related issues
Strive for constructive interactions with the community and stakeholders	Call Quality Department call score
	Service requests compliance
	Stakeholder interactions
Prioritize employee growth and development for sustainable asset management	Training compliance
	AM training compliance
Provide a safe working environment for employees	Safety metrics
	Safety metrics
	Safety metrics
	Safety training compliance
Promote fiscal responsibility in utility operations and capital investments through risk-based decision making	CIP schedule milestones compliance
	Annualized capital spend
	Annualized operating spend
	Critical assets with high-risk score

Category	Performance Measure
Work Order (WO) Backlog	Average age of WO backlog
	Maximum age of WO
	Aging WOs by age bracket, by priority
Overtime (hours) due to non-flood operations	Overtime Hours Worked (excluding flood responses)
Work Order Maintenance Performance	WO compliance
	Inspection compliance
	Schedule Compliance (percent)
	Planned Maintenance Ratio (percent)
	Emergency (*P1, P2 Priority*) Work (percent)
	Worst 10 Performing Assets by Type and Criticality
	Worst 10 Performing Assets by Cost (maintenance costs)
Staffing levels	Vacant Positions
Contractor	Contractor maintenance cost
Fleet	Fleet vehicles availability
Data Quality	WO labor hours
	WO labor hour types (Future Measure
	WO attributes fields
	WO status
	WO type
	WO failure codes
	Condition assessment fields

Notes:

1. *Workflow Data Owner(s) (WDO) is the MSD position responsible for completing data inputs/updates for the activity being measured. The WDO must verify the accuracy of the data inputs/updates prior to forwarding to the data owner(s). The WDO is also responsible to ensure coverage by the backup WDO when unavailable to fulfill his/her reporting obligations within established timeframes. If the backup WDO is also unavailable, he/she must ensure activities/reporting occur within established timelines.*
2. *Reporting Owner(s) is the MSD position responsible for the following:*
   - *Verify the activity occurred as documented by the WDO.*
   - *Verify accuracy of data provided by the WDO.*
   - *Provide verified data to the PAA for reporting to the MSD Board.*
3. *Workflow data SOP should define how workflow data is compiled and verified by the WDO.*
4. *Reporting SOP should define how the data owner verifies activity occurred, verifies accuracy of data provided by the WDO and provides verified data to the PAA.*

Flood Pumps in Service	
Description	Number of individual flood pumps in service (available) during flood season relative to the total number of individual flood pumps
Purpose	During a flood event, flood pump availability is essential to effectively convey water throughout the collections system and prevent overflows.
Associated LOS	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.
Metric (formula)	In-service flood pumps (%) = (Number of in-service flood pumps during flood season / Total number of flood pumps) * 100
Performance Scale	Level 5 ≥ 90.0% Level 4 = 80.0 – 89.9% Level 3 = 75.0 – 79.9% Level 2 = 70.0 - 74.9% Level 1 ≤ 69.9%
Performance Assessment Type (frequency)	6-month rolling average (Flood season – December 1st to May 30th)
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	Excel spreadsheet
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Flood pumps in service = 66 Total flood pumps = 70 In-service flood pumps (%) = (66 / 70) * 100 = 94%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Violations Caused by Asset Failures			
Description	Total number of permit violations caused by asset failures.		
Purpose	Permit violations caused by asset failures should be tracked to effectively monitor regulatory compliance and prioritize asset maintenance or replacement.		
Associated LOS	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.		
Metric (formula)	Total number of permit violations caused by asset failures		
Performance Scale	Level 5 = 0 Level 4 = 1 Level 3 = 2 Level 2 = 3 – 4 Level 1 ≥ 5		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	LIMS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	1 permit violation		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Near Misses (Permit Limits)	
Description	Number of reported near misses related to exceeding KPDES permit limits.
Purpose	Near misses related to exceeding KPDES permit limits should be reported to avoid future permit violations or safety-related impacts.
Associated LOS	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.
Metric (formula)	Total number of regulatory parameters within KPDES permit upper/lower warning limits. Regulatory parameters should be identified at the TAMP level.
Performance Scale	Level 5 = 0 Level 4 = 1 Level 3 = 2 Level 2 = 3 – 4 Level 1 ≥ 5
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	LIMS Include reference to upper/lower warning limits
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Regulatory parameters A, B, and C exceed permit warning limits. Total number of regulatory parameters within permit upper/lower warning limits is 3.

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Monitoring and Reporting Compliance (Sampling Events)			
Description	Total number of missed sampling events.		
Purpose	It is important to obtain samples on a routine, scheduled basis to maintain records for regulatory compliance and reporting objectives.		
Associated LOS	Total number of missed sampling events.		
Metric (formula)	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.		
Performance Scale	Trend Down		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	MSD input required here		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	3 missed sampling events		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Monitoring and Reporting Compliance (Sampling Data)			
Description	Total number of missed sample data points.		
Purpose	It is important to obtain the correct number of sample data points during each sampling event to maintain complete and accurate records for regulatory compliance and reporting objectives.		
Associated LOS	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.		
Metric (formula)	Total number of missed sample data points.		
Performance Scale	Trend Down		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	MSD input required here		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	20 missed sample data points.		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Reporting Activities Compliance			
Description	Compliance for completing reporting activities relative to the scheduled reporting activities.		
Purpose	Completing all reporting activities within a scheduled time frame is necessary to maintain accurate records and meet reporting requirements established by environmental agencies.		
Associated LOS	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.		
Metric (formula)	Reporting activities compliance (%) = (Number of reporting activities completed by the due date / Total number of reporting activities scheduled) * 100		
Performance Scale	Monitor		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection		
Support Div(s)/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities		
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Reporting owner(s)[2] **(Primary/backup)**	Operations planners		
Source data format and storage location	RCAM		
Workflow data SOP[3]	LIMS		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	5 reporting activities completed by May 1st. 7 reporting activities scheduled for completion by May 1st. Reporting activities compliance (%) = (5 / 7) * 100 = 71%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Discharges Caused by Asset Failures	
Description	Total number of sanitary and combined sewer discharges caused by asset failures relative to the total number of discharges.
Purpose	Tracking the total number and causes of discharges is essential to effectively prevent future discharges and prioritize asset maintenance or replacement.
Associated LOS	Meet or exceed all environmental and public safety requirements in our wastewater, stormwater and flood protection services.
Metric (formula)	Discharges caused by asset failures (%) = (Number of discharges caused by asset failures / Total number of discharges) * 100
Performance Scale	Refer to existing
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	2 discharges caused by stormwater pipe collapses. 3 total discharges recorded for the reporting period. Discharges caused by asset failures (%) = (2 / 3) * 100 = 67%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Service Request Complaints	
Description	Total number of service request complaints per 100 customers per year.
Purpose	Monitoring total number of service request complaints is essential to determine ways in which the organization can improve service quality.
Associated LOS	Maintain the trust of the community through high quality and reliable services.
Metric (formula)	Service request complaints per 100 customers = (Total number of service request complaints / Total number of customers) * 100
Performance Scale	Monitor
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Customer Service Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	5000 service request complaints 230,000 total customers Service request complaints per 100 customers = (5000 / 230,000) * 100 = 2%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Service Request Completion (All Associated Work Orders)	
Description	Time to correct all MSD-related service issues, which includes completing all work orders related to a service request.
Purpose	Resolving service requests in a timely manner ensures efficient operations and positive customer experiences.
Associated LOS	Maintain the trust of the community through high quality and reliable services.
Metric (formula)	Average number of days to close out a service request or complete all associated work orders.
Performance Scale	Monitor
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Customer Service Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Service requests for the reporting period include: Service request A – 10 days to complete all associated work orders. Service request B – 20 days to complete all associated work orders. Service request C – 15 days to complete all associated work orders. Average number of days to closeout service requests for the reporting period = (10 + 20 + 15) / 3 = 15 days

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Call Quality Department Score	
Description	A random sampling of calls scored by a member of the Call Quality Department.
Purpose	Evaluating customer call quality is critical to ensure agent interactions with customers are polite, professional, and include accurate sharing of information.
Associated LOS	Strive for constructive interactions with the community and stakeholders.
Metric (formula)	A random sampling of calls is scored by a member of the Call Quality Department.
Performance Scale	Level 5 ≥ 95.0% Level 4 = 94.9 – 90% Level 3 = 89.9 – 85% Level 2 = 84.9 - 80% Level 1 ≤ 79.9%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Customer Service Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Call Quality Department
Support Div(s)/Dept(s)	Engineering – Regulatory Compliance
Workflow data owner(s) – WDO[1] (Primary/backup)	Call Quality Department
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	MSD input here
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Call Quality Department Scoring: Greeting/Verification (Out of 5) = 3.6 Communication Skills (Out of 45) = 32.8 First Call Resolution (Out of 45) = 39.7 Closing (Out of 5) = 4.7 Result = (3.6+32.8+39.7+4.7) / 100 = 80.8%

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Service Request Compliance	
Description	Total number of service requests completed within a set timeframe relative to the total number of service requests.
Purpose	Service request compliance is essential to ensure positive communications with customers.
Associated LOS	Strive for constructive interactions with the community and stakeholders.
Metric (formula)	Service request compliance (%) = (Total number of service requests addressed within a goal timeframe / Total number of service requests) * 100
Performance Scale	Monitor
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Customer Service Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	8 service requests addressed within 30 days. 12 total service requests. Service request compliance (%) = (8 / 12) * 100 = 67%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Stakeholder Interactions	
Description	Total number of interactions with defined stakeholders relative to the total number of planned interactions.
Purpose	Having frequent planned interactions with stakeholders enables MSD to raise awareness about organizational goals and develop positive relationships in the community.
Associated LOS	Strive for constructive interactions with the community and stakeholders.
Metric (formula)	Stakeholder interactions (%) = (Total number of completed stakeholder interactions / Total number of planned stakeholder interactions) * 100
Performance Scale	Monitor
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure/Customer Service Committees
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Customer Relations & Communications Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Customer Relations & Communications
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	Excel spreadsheet
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	6 completed stakeholder interactions for the month. 8 stakeholder interactions planned for the month. Stakeholder interactions (%) = (6 / 8) * 100 = 75%

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Training Compliance	
Description	Total number of employees that completed each required training by the deadline relative to the total number of employees required to complete the training.
Purpose	Training is essential to ensure all employees are prepared to efficiently perform job duties and grow in their career.
Associated LOS	Prioritize employee growth and development for sustainable asset management.
Metric (formula)	Training compliance (%) = (Total number of employees that completed training by the deadline / Total number of employees required to complete training) * 100 Weighted by training category: 16% annual ethics training 14% annual SORP training 14% Q1 SORP training 14% Q2 SORP training 14% Q3 SORP training 14% Q4 SORP training 14% annual Louisville Green training
Performance Scale	Level 5 ≥ 98.0% Level 4 = 95.0 – 97.9% Level 3 = 92.0 – 94.9% Level 2 = 90.0 – 91.9% Level 1 ≤ 89.9%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Personnel Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	All Departments
Support Div(s)/Dept(s)	Human Resources
Workflow data owner(s) – WDO[1] (Primary/backup)	MSD input here
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	Training Tracker
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly

Training Compliance			
Example	Ethics Training (500 employees completed training by the deadline / 600 employees required to complete training) * 100 = 83% Annual SORP Training (450 employees completed training by the deadline / 500 employees required to complete training) * 100 = 90% Q1 SORP Training (420 employees completed training by the deadline / 500 employees required to complete training) * 100 = 84% Q2 SORP Training (350 employees completed training by the deadline / 500 employees required to complete training) * 100 = 84% Q3 SORP Training (325 employees completed training by the deadline / 500 employees required to complete training) * 100 = 65% Q4 SORP Training (400 employees completed training by the deadline / 500 employees required to complete training) * 100 = 80% Annual Louisville Green Training (450 employees completed training by the deadline / 550 employees required to complete training) * 100 = 82% Weighted percentages: 16% annual ethics training = 0.16 * 83% = 13.3% 14% annual SORP training = 0.14 * 90% = 12.6% 14% Q1 SORP training = 0.14 * 84% = 11.8% 14% Q2 SORP training = 0.14 * 84% = 11.8% 14% Q3 SORP training = 0.14 * 65% = 9.1% 14% Q4 SORP training = 0.14 * 80% = 11.2% 14% annual Louisville Green training = 0.14 * 82% = 11.5% Training compliance (%) = 13.3 + 12.6 + 11.8 + 11.8 + 9.1 + 11.2 + 11.5 = 81.3%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Asset Management Training Compliance	
Description	Total number of employees that completed each required asset management (AM) training by the deadline relative to the total number of employees required to complete the training.
Purpose	AM training is essential to ensure employees are knowledgeable about asset management to support growth and sustainability of the program
Associated LOS	Prioritize employee growth and development for sustainable asset management.
Metric (formula)	AM training compliance (%) = (Total number of employees that completed AM training by the deadline / Total number of employees required to complete AM training) * 100
Performance Scale	Level 5 ≥ 98.0% Level 4 = 95.0 – 97.9% Level 3 = 92.0 – 94.9% Level 2 = 90.0 – 91.9% Level 1 ≤ 89.9%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Personnel Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	All Departments (Initial)
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance
Workflow data owner(s) – WDO[1] (Primary/backup)	MSD input here
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	Training Tracker
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	450 employees completed AM training by the deadline 500 employees required to complete AM training AM training compliance (%) = (450 / 500) * 100 = 90%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Safety Metrics	
Description	Safety metrics include incidents, worker comp claims, and days off due to work-related issues relative to days worked.
Purpose	Safety metric tracking is vital to establish a safety culture at MSD that strives to encourage safe work practices.
Associated LOS	Provide a safe working environment for employees.
Metric (formula)	Safety metrics include the following: Incidents (%) = (Incidents / Days worked) * 100 Worker Comp Claims (%) = (Worker Comp Claims / Days worked) * 100 Days off due to work-related issues (%) = (Days off due to work-related issues / Days worked) * 100
Performance Scale	Refer to existing
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Personnel Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	All Departments
Support Div(s)/Dept(s)	Human Resources
Workflow data owner(s) – WDO[1] (Primary/backup)	MSD input here
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	MSD input here
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Incidents = (2 incidents / 250 days worked) * 100 = 0.8% Worker comp claims = (2 worker comp claims / 250 days worked) * 100 = 0.8% Work-related issues = (5 days off due to work-related issues / 250 days worked) * 100 = 2%

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Safety Training Compliance			
Description	Total number of employees that completed required safety training by the deadline relative to the total number of employees required to complete safety training.		
Purpose	Safety training compliance is vital to establish a safety culture where employees are equipped with adequate training to conduct safe work practices.		
Associated LOS	Provide a safe working environment for employees.		
Metric (formula)	Safety training compliance (%) = (Total number of employees that completed required safety training by the deadline / total number of employees required to complete safety training) * 100		
Performance Scale	Level 5 ≥ 98.0% Level 4 = 95.0 – 97.9% Level 3 = 92.0 – 94.9% Level 2 = 90.0 – 91.9% Level 1 ≤ 89.9%		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Personnel Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	All Departments		
Support Div(s)/Dept(s)	Human Resources		
Workflow data owner(s) – WDO[1] **(Primary/backup)**	MSD input here		
Reporting owner(s)[2] **(Primary/backup)**	RCAM		
Source data format and storage location	Training Tracker		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	550 employees completed required safety training by the deadline 575 employees required to complete safety training Safety training compliance (%) = (550 / 575) * 100 = 96%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

CIP Schedule Milestones Compliance	
Description	Total number of capital improvement plan (CIP) schedule milestones achieved relative to the total CIP milestones planned.
Purpose	Compliance with CIP schedule milestones is essential to ensure progress within the organization related to investing in capital improvement projects.
Associated LOS	Promote fiscal responsibility in utility operations and capital investments through risk-based decision making.
Metric (formula)	CIP Schedule Milestones Compliance (%) = (CIP (fiscal year) schedule milestones achieved / total CIP (fiscal year) baseline milestones planned) * 100
Performance Scale	Level 5 ≥ 95.0% Level 4 = 90.0 – 94.9% Level 3 = 80.0 – 89.9% Level 2 = 70.0 – 79.9% Level 1 ≤ 69.9%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure/Finance Committees
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Finance Operations – Administration Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] (Primary/backup)	Finance
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	IPS SAP MS Project
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Quarterly
Example	30 CIP (fiscal year) schedule milestones achieved 32 CIP (fiscal year) baseline milestones planned CIP Schedule Milestones Compliance (%) = (30 / 32) * 100 = 94%

CIP Schedule Milestones Compliance			
Revision Log Date:	*Revision*	*Section Revised*	*Description*

CIP Spending	
Description	Total annualized capital spending relative to the approved CIP budget.
Purpose	Adherence with the CIP budget is essential to ensure progress within the organization related to investing in capital improvement projects.
Associated LOS	Promote fiscal responsibility in utility operations and capital investments through risk-based decision making.
Metric (formula)	CIP Spending (%) = (Annualized CIP (fiscal year) spending / Total CIP (fiscal year) budget) * 100
Performance Scale	Level 5 ≥ 98.1 – 100.0% Level 4 = 95.1 – 98.0% or 100.1 – 102.0% Level 3 = 90.1 – 95.0% or 102.1 – 104.0% Level 2 = 85.1 – 90.0% or 104.1 – 105.0% Level 1 ≤ 85.0% and ≥ 105.0%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure/Finance Committees
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Finance Operations – Administration Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Finance
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS SAP MS Project
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly

CIP Spending			
Example	Projected FY Total = $176,995,207 Approved yearly budget = $205,000,000 CIP Spending (%) = ($176,995,207/$205,000,000) * 100 = 86.3%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Operations Spending	
Description	Total annualized operations spending relative to the approved operations budget.
Purpose	Adherence with the operations budget is essential to ensure efficient and sustainable operations.
Associated LOS	Promote fiscal responsibility in utility operations and capital investments through risk-based decision making.
Metric (formula)	Operations Spending (%) = (Annualized operations (fiscal year) spending / Total operations (fiscal year) budget) * 100
Performance Scale	Level 5 = 98.1 – 100.0% Level 4 = 95.1 – 98.0% or 100.1 – 102.0% Level 3 = 90.1 – 95.0% or 102.1 – 104.0% Level 2 = < 90.0% or 104.1 – 105.0% Level 1 ≥ 105.1%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure/Finance Committees
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Finance Operations – Administration Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] (Primary/backup)	Finance
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Projected (cumulative) end of year operating spend = $145,042,000 Approved annual operating budget (cumulative) = $144,894,334 Operations Spending (%) = ($145,042,000/$144,894,334) * 100 = 100.1%

Operations Spending			
Revision Log Date:	*Revision*	*Section Revised*	*Description*

High-Risk Critical Assets	
Description	Total number of critical assets with a high-risk score relative to the total number of critical assets. (Refer to SAMP for definition of critical asset.)
Purpose	Identifying high-risk critical assets is essential for making educated financial decisions and risk mitigation.
Associated LOS	Promote fiscal responsibility in utility operations and capital investments through risk-based decision making.
Metric (formula)	High-Risk Critical Assets (%) = (Total number of critical assets with a high-risk score / Total number of critical assets) * 100
Performance Scale	Trend Down
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Engineering – Regulatory Compliance
Support Div(s)/Dept(s)	Engineering – Regulatory Compliance
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations – Administration Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities
Reporting owner(s)[2] **(Primary/backup)**	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Source data format and storage location	IPS Refer to SAMP Section 5.1 Risk Management for critical asset definition and criteria.
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	50 critical assets with a high-risk score 200 critical assets High-Risk Critical Assets (%) = (50 / 200) * 100 = 25%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Category	Measure
Work Order (WO) Backlog	Average age of WO backlog
	Maximum age of WO
	Aging WOs by age bracket, by priority
Overtime (hours) due to non-flood operations	Overtime Hours Worked (excluding flood responses)
Work Order Maintenance Performance	WO compliance
	Inspection compliance
	Schedule Compliance (percent)
	Planned Maintenance Ratio (percent)
	Emergency (P1, P2 Priority) Work (percent)
	Worst 10 Performing Assets by Type and Criticality
	Worst 10 Performing Assets by Cost (maintenance costs)
Staffing levels	Vacant positions
Contractor	Contractor maintenance cost
Fleet	Fleet parts availability
	Fleet vehicles availability
Data Quality	WO labor hours
	WO labor hour types
	WO attributes fields
	WO status
	WO type
	WO failure codes
	Condition assessment fields

Work Order Backlog (Average Age)			
Description	Average age, creation date through current, of backlog work orders.		
Purpose	Tracking average age of work order backlog ensures that MSD is keeping up with planned work orders which impact asset performance.		
Metric (formula)	Average age of accumulated work orders on backlog.		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Work orders A, B, and C have not been completed (backlog). Work order A = 5 days from creation of the work order to the current date. Work order B = 10 days from creation of the work order to the current date. Work order C = 25 days from creation of the work order to the current date. Average = (5+10+25) / 3 = 13 days		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Maximum Age			
Description	Maximum age, creation date through current, of a work order.		
Purpose	Tracking maximum work order age ensures that MSD is aware of lagging work orders and is striving to complete work orders in a timely manner to achieve optimal asset performance.		
Metric (formula)	Maximum age of a work order within the reporting period.		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Work order A, the oldest work order, is 50 days old.		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Aging Work Orders (By Priority)			
Description	Total number of work orders within age brackets, by priority (P1 to P6).		
Purpose	Tracking the amount of aging work orders by priority ensures that MSD is aware of lagging work orders and is striving to complete priority work orders in a timely manner to achieve optimal asset performance.		
Metric (formula)	Total number of work orders by age bracket and priority (P1 to P6).		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners		
Reporting owner(s)[2] **(Primary/backup)**	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	P1 work orders (0-10 days old) = 5 P1 work orders (10-15 days old) = 10 P1 work orders (15-20 days old) = 12 P1 work orders (> 20 days old) = 8 Provide this information for all priorities, P1 to P6. Age brackets should be developed at the TAMP level.		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Overtime Hours (Excluding Flood Response)			
Description	Total number of overtime hours due to non-flood operations.		
Purpose	Monitoring the amount of overtime hours by job title (excluding flood response) is essential for MSD to manage staffing required to sustain efficient operations and maintenance of assets.		
Metric (formula)	OT Hours (%) = (OT Hours Worked (excluding flood responses) by Job Title / Total hours worked by Job Title) * 100		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Personnel Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	All Departments		
Support Div(s)/Dept(s)	Human Resources		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations Supervisors		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	Workforce		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Treatment plant operators: OT hours worked = 40 Total hours worked = 200 OT Hours (%) = (40/200) * 100 = 20% Job title categories may be developed as applicable in the TAMPs.		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Compliance	
Description	Total number of structured maintenance work orders completed by a due date, relative to the total number of scheduled structured maintenance work orders
Purpose	Tracking structured maintenance work order completion by a target due date ensures that MSD is adhering to planned maintenance activities which impact asset performance.
Metric (formula)	Work order compliance (%) = (Structured maintenance work orders completed by due date / total structured maintenance work orders scheduled) * 100 25% Sanitary Pump Stations 25% WQTCs 25% Flood Protection System 25% Controls
Performance Scale	Level 5 ≥ 95% Level 4 = 94.9 – 90% Level 3 = 89.9 – 85% Level 2 = 84.9 – 80% Level 1 ≤ 79.9%
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Sanitary Pump Stations (30 structured maintenance work orders completed by May 1st / 33 structured maintenance work orders due for completion by May 1st) * 100 = 91%

Work Order Compliance			
	WQTCs (150 structured maintenance work orders completed by May 1st / 160 structured maintenance work orders due for completion by May 1st) * 100 = 94% Flood Protection System (50 structured maintenance work orders completed by May 1st / 52 structured maintenance work orders due for completion by May 1st) * 100 = 96% Controls (20 structured maintenance work orders completed by May 1st / 25 structured maintenance work orders due for completion by May 1st) * 100 = 80% Weighted percentages: 25% Sanitary Pump Stations = 0.25 * 91% = 23% 25% WQTCs = 0.25 * 94% = 23.5% 25% Flood Protection System = 0.25 * 96% = 24% 25% Controls = 0.25 * 80% = 20% Work order compliance (%) = 23 + 23.5 + 24 + 20 = 90.5%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Inspection Compliance	
Description	Total number of inspections completed by a due date relative to the total number of scheduled inspections.
Purpose	Tracking inspection completion by a target due date ensures that MSD is adhering to planned inspection activities which impact decisions related to asset maintenance and replacement.
Metric (formula)	Inspection compliance (%) = (Inspections completed by due date / total inspections scheduled) * 100 18% Sewers (Length of pipe inspected / length of pipe scheduled for inspection) 10% Air Relief Valves (Number of valves on sanitary FMs inspected / number of valves scheduled for inspection) 18% Force Mains (Length of force mains inspected / length of force mains scheduled for inspection) 18% Flood Levies/Wall (Length of levy/wall inspected / length of levy/wall scheduled for inspection) 18% CSO Assets (Assets inspected / number assets scheduled for inspection) 18% CSS Catch Basins (Catch basins inspected / number catch basins scheduled for inspection)
Performance Scale	Level 5 ≥ 70.0% completion rate Level 4 = 60.0 – 69.9% completion rate Level 3 = 50.0 – 59.9% completion rate Level 2 = 30.0 – 49.9% completion rate Level 1 ≤ 29.9% completion rate
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Sewers (10,000 linear feet of pipe inspected by May 1st / 12,000 linear feet of pipe length scheduled for inspection by May 1st) * 100 = 83%

Inspection Compliance	
	Air Relief Valves (30 valves on sanitary FMs inspected by May 1st / 33 valves scheduled for inspection by May 1st) * 100 = 91% Force Mains (9,000 linear feet of force mains inspected by May 1st / 8,300 linear feet of force mains scheduled for inspection by May 1st) * 100 = 92% Flood Levies/Wall (300 linear feet of levy/wall inspected by May 1st / 350 linear feet of levy/wall scheduled for inspection by May 1st) * 100 = 86% CSO Assets (30 assets inspected by May 1st / 35 assets scheduled for inspection by May 1st) * 100 = 86% CSS Catch Basins (200 catch basins inspected by May 1st / 220 catch basins scheduled for inspection by May 1st) * 100 = 91% Weighted percentages: 18% Sewers = 0.18 * 83% = 15% 10% Air Relief Valves = 0.10 * 91% = 9% 18% Force Mains = 0.18 * 92% = 17% 18% Flood Levies/Wall = 0.18 * 86% = 15% 18% CSO Assets = 0.18 * 86% = 15% 18% CSS Catch Basins = 0.18 * 91% = 16% Inspection compliance (%) = 15 + 9 + 17 + 15 + 15 + 16 = 87%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Schedule Compliance			
Description	Total number of work orders completed as scheduled relative to the total number of scheduled work orders.		
Purpose	Tracking scheduled work order completion ensures that MSD is adhering to planned work order activities which impact asset performance.		
Metric (formula)	Work order schedule compliance (%) = (Work orders completed as scheduled / total work orders scheduled) * 100		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Work orders completed as scheduled = 30 Total work orders scheduled = 37 Work order schedule compliance = (30/37) * 100 = 81%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Planned Maintenance Ratio			
Description	Total number of planned maintenance work orders relative to the total number of work orders.		
Purpose	Tracking the percentage of planned maintenance work orders ensures that MSD is aware of the efforts required for planned versus unplanned activities to better manage assets.		
Metric (formula)	Planned maintenance ratio (%) = (Planned maintenance work orders / Total work orders) * 100		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Planned maintenance work orders = 29 Total work orders = 33 Work order schedule compliance = (29/33) * 100 = 88%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Emergency (P1 or P2) Work	
Description	Total number of emergency (P1 and P2) work orders completed by a due date relative to the total number of emergency work orders scheduled by a due date.
Purpose	Tracking the percentage of emergency work orders completed by a due date ensures that MSD is addressing emergencies in a timely manner to regain or sustain asset performance.
Metric (formula)	Emergency Work (%) = (Emergency work orders completed by a due date / Total emergency work orders scheduled by a due date) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Emergency work orders completed by May 1st = 1 (P1) + 2 (P2) = 3 Total emergency work orders due by May 1st = 4 Work order schedule compliance = (3/4) * 100 = 75%
Revision Log Date:	*Revision* | *Section Revised* | *Description*

Worst 10 Performing Assets (Type and Criticality)			
Description	List of the worst 10 performing assets by type and criticality.		
Purpose	Identifying critical assets by type that demonstrate poor performance is essential to develop successful asset maintenance and replacement strategies.		
Metric (formula)	Lists of top 10 assets with highest criticality score, by asset type.		
Performance Scale	Trend		
Performance Assessment Type (frequency)	This is a management report		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners		
Reporting owner(s)[2] **(Primary/backup)**	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	List of worst 10 performing critical flood pumps – those with highest criticality score		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Worst 10 Performing Assets (Cost)			
Description	List of the worst 10 performing assets by total maintenance cost.		
Purpose	Identifying assets with poor performance and high maintenance costs is essential to develop successful asset maintenance and replacement strategies.		
Metric (formula)	Lists of top 10 worst performing assets by maintenance cost.		
Performance Scale	Trend		
Performance Assessment Type (frequency)	This is a management report		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners		
Reporting owner(s)[2] **(Primary/backup)**	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	List of worst 10 performing flood pumps, sorted high to low by totaled maintenance costs.		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Vacant Positions			
Description	Number of vacant positions, by job category, relative to the total number of positions.		
Purpose	Determining the number of vacant positions is essential to identify hiring needs and maintain efficient operations, employee satisfaction, and growth of the organization.		
Metric (formula)	Vacant Positions (%) = (Number of vacant positions by job category / Total number of positions) * 100		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	All Departments		
Support Div(s)/Dept(s)	Human Resources		
Workflow data owner(s) – WDO[1] (Primary/backup)	Human Resources Analyst		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Treatment plant operators: Number of vacant positions = 3 Total number of positions = 10 Vacant Positions (%) = (3/10) * 100 = 30% Develop job categories at the TAMP level.		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Contractor Maintenance Cost	
Description	Total cost of contractor maintenance relative to the total amount of maintenance costs.
Purpose	Tracking the percentage of contractor maintenance costs ensures that MSD is appropriately allocating funds to manage and sustain assets.
Metric (formula)	Contractor maintenance cost (%) = (Contractor maintenance cost / Total maintenance costs) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners
Reporting owner(s)[2] (Primary/backup)	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Contractor maintenance cost = $20,000 Total maintenance costs = $100,000 Work order schedule compliance = ($20,000/$100,000) * 100 = 20%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Fleet Vehicles Availability			
Description	Availability of fleet vehicles, or uptime, relative to the total number of working hours.		
Purpose	Availability of fleet vehicles is essential to ensure all fleet department activities can be conducted safely and efficiently.		
Metric (formula)	Fleet vehicles availability (%) = (Hours of fleet vehicle availability / Total number of working hours) * 100		
Performance Scale	Monitor		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Regulatory Compliance		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	256 vehicles per 31-day month (22, 8-hr working days) Working hours = 265 x 8 x 22 = 46,640 hrs. Scheduled downtime = 692 hrs. Unscheduled downtime = 232 hrs. Total downtime = 924 hrs. Therefore, total uptime = 46,640 – 924 = 45,716 hrs. Fleet vehicles availability (%) = (45,716 / 46,640) * 100 = 98%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Labor Hours			
Description	Total number of work orders with completed status but no labor charged relative to the total number of completed work orders.		
Purpose	Checking work order labor hours charged to completed work orders promotes quality of work order data and supports asset management improvements across the organization.		
Metric (formula)	Work order labor hours (%) = (Work orders with completed status (no labor charged) / Total number of work orders with completed status) * 100		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners		
Reporting owner(s)[2] **(Primary/backup)**	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Work orders with completed status (no labor charged) = 2 Work orders with completed status = 15 Work order labor hours = (2/15) * 100 = 13%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Labor Hours Types (FUTURE MEASURE)	
Description	Total number of work orders with labor hours charged to defined categories relative to the total number of work orders with labor hours charged.
Purpose	Tracking labor hours charged to defined categories for work orders promotes quality of work order data and supports asset management improvements across the organization.
Metric (formula)	Work order labor hours (%) = (Work orders with labor hours charged to defined categories / Total number of work orders with labor hours charged) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS Defined work order labor categories: *Additional changes to WF, SAP, IPS and all associated feeds- additional improvements required*
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Work orders with labor hours charged to defined categories = 5 Work orders with labor hours charged = 8 Work order labor hours = (5/8) * 100 = 63%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Attributes	
Description	Total number of work orders without minimum required asset specification fields completed relative to the total number of work orders.
Purpose	Tracking work orders without minimum required asset specification information promotes the quality of work order data and supports asset management improvements across the organization.
Metric (formula)	Work order attributes fields (%) = (Work orders without minimum required asset specification fields completed / Total number of work orders) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS Refer to SAMP for asset class attributes.
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Work orders without minimum required asset specification fields completed = 10 Total number of work orders = 30 Work order attributes fields = (10/30) * 100 = 33%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Status	
Description	Total number of work orders without work order status specified relative to the total number of work orders.
Purpose	Tracking work orders without work order status specified promotes the quality of work order data and supports asset management improvements across the organization.
Metric (formula)	Work order status (%) = (Work orders without work order status fields completed / Total number of work orders) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS List of approved work order statuses: LIST HERE. (example OPEN, DONE, CLOSED, WMATL, etc.)
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Work orders without status fields completed = 10 Total number of work orders = 30 Work order status = (10/30) * 100 = 33%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Type	
Description	Total number of work orders without work order type specified relative to the total number of work orders.
Purpose	Tracking work orders without work order type specified promotes the quality of work order data and supports asset management improvements across the organization.
Metric (formula)	Work order status (%) = (Work orders without work order type fields completed / Total number of work orders) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS List of approved work order types: CMO, CMP, EM, IMC, IMO, PMD, PMV
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Work orders without type fields completed = 10 Total number of work orders = 30 Work order type = (10/30) * 100 = 33%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Work Order Failure Codes	
Description	Total number of work orders without work order failure codes specified relative to the total number of work orders (for assets with failure hierarchy defined).
Purpose	Tracking work orders without work order failure codes specified promotes the quality of work order data and supports asset management improvements across the organization.
Metric (formula)	Work order status (%) = (Work orders without work order failure codes specified / Total number of work orders with failure hierarchy defined) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection
Support Div(s)/Dept(s)	Operations – Wastewater and Drainage
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations – Treatment Facilities
Reporting owner(s)[2] (Primary/backup)	Operations – Wastewater and Drainage
Source data format and storage location	Operations – Fleet Services
Workflow data SOP[3]	Engineering – Admin
Reporting SOP[4]	Engineering – Regulatory Compliance
Frequency of AM Steering Committee Performance Reporting	Engineering – Technical Services
Frequency of AM dashboard updating	Operations planners
Example	RCAM

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Condition Assessment Fields	
Description	Total number of critical assets without condition assessment fields completed relative to the total number of critical assets.
Purpose	Obtaining and monitoring condition assessment data for critical assets is essential for maintaining efficient operations and asset performance.
Metric (formula)	Condition assessment fields (%) = (Critical assets without condition assessment fields specified / Total number of critical assets) * 100
Performance Scale	Develop targets at the TAMP level
Performance Assessment Type (frequency)	12-month rolling average
Board Committee	Infrastructure Committee
Start Date	July 1, 2021
End Date	June 30, 2022
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services
Workflow data owner(s) – WDO[1] **(Primary/backup)**	Operations planners
Reporting owner(s)[2] **(Primary/backup)**	RCAM
Source data format and storage location	IPS
Workflow data SOP[3]	RCAM
Reporting SOP[4]	RCAM
Frequency of AM Steering Committee Performance Reporting	Quarterly
Frequency of AM dashboard updating	Monthly
Example	Critical assets without condition assessment fields specified = 20 Total number of critical assets = 30 Condition assessment fields missing data (%) = (20/30) * 100 = 67%

Revision Log Date:	*Revision*	*Section Revised*	*Description*

Condition Assessment Fields			
Description	Total number of critical assets without condition assessment fields completed relative to the total number of critical assets.		
Purpose	Obtaining and monitoring condition assessment data for critical assets is essential for maintaining efficient operations and asset performance.		
Metric (formula)	Condition assessment fields (%) = (Critical assets without condition assessment fields specified / Total number of critical assets) * 100		
Performance Scale	Develop targets at the TAMP level		
Performance Assessment Type (frequency)	12-month rolling average		
Board Committee	Infrastructure Committee		
Start Date	July 1, 2021		
End Date	June 30, 2022		
Lead Div/Dept(s)	Operations – Collections System and Flood Protection Operations – Wastewater and Drainage Operations – Treatment Facilities Operations – Wastewater and Drainage Operations – Fleet Services		
Support Div(s)/Dept(s)	Engineering – Admin Engineering – Regulatory Compliance Engineering – Technical Services		
Workflow data owner(s) – WDO[1] (Primary/backup)	Operations planners		
Reporting owner(s)[2] (Primary/backup)	RCAM		
Source data format and storage location	IPS		
Workflow data SOP[3]	RCAM		
Reporting SOP[4]	RCAM		
Frequency of AM Steering Committee Performance Reporting	Quarterly		
Frequency of AM dashboard updating	Monthly		
Example	Critical assets without condition assessment fields specified = 20 Total number of critical assets = 30 Condition assessment fields missing data (%) = (20/30) * 100 = 67%		
Revision Log Date:	*Revision*	*Section Revised*	*Description*

Appendix D. Asset Attribute Data

Table D-1. Asset Attributes Where Applicable

Type	Data	Data Source	Notes
Core Attributes	Asset/Equipment ID	CMMS (vertical) GIS (linear)	
	Asset Name	CMMS (vertical) GIS (linear)	
	Asset/Equipment Type (and SubType)	CMMS (vertical) GIS (linear)	
	Manufacturer	CMMS	
	Model #	CMMS	
	Serial #	CMMS	
	Critical Asset	CMMS (vertical) GIS (linear)	
	Condition	CMMS (vertical) GIS (linear)	
	Consequence of Failure	CMMS (vertical) GIS (linear)	
	Risk Score	CMMS (vertical) GIS (linear)	
	Installation Date	CMMS (vertical) GIS (linear)	
	Purchase Cost	CMMS	
	Warranty Start Date	CMMS	
	Warranty Expiration Date	SMMS	
	Location: • Description • Watershed • Receiving Plant / Stream ID/Key/Name • Road Class	CMMS (vertical) GIS (linear)	
	Location/Facility Info: • District • Facility # • KPDES # • Date Acquired	GIS (linear)	Sewer Treatment Plant
	Status	CMMS (vertical) GIS (linear)	
Physical Attributes	Horsepower	CMMS	
	Voltage	CMMS	
	Amperage Rating	CMMS	
	Phase	CMMS	
	Hertz	CMMS	
	Speed	CMMS	
	Compressor Type	CMMS	Air Compressor
	Tank Volume	CMMS	Air Compressor, Tank
	Switch Rating	CMMS	Air Pack Switch, Switchgear

Table D-1. Asset Attributes Where Applicable			
Type	**Data**	**Data Source**	**Notes**
	Flow Rate	CMMS	Coolant System, Pump
	NEMA Rating	CMMS	Control Panel
	Dam Type	CMMS	Dam
	Dam Height	CMMS	Dam
	Lift Capacity	CMMS	Crane, Elevator
	Actuator Type	CMMS	Gate
	Generator Rating	CMMS	Generator
	Flow Rate	CMMS	
	Pump Type	CMMS	Pump
	Suction Diameter	CMMS	Pump
	Discharge Diameter	CMMS	Pump
	Door Type	CMMS	Overhead Door
	Roof Type	CMMS	Roof unit
	Transformer Rating	CMMS	Transformer
	Size/dimensions • Length • Diameter • Width • Height • Cover Diameter	CMMS (vertical) GIS (linear)	
	Material (including component materials, e.g., Wall Material for manholes)	CMMS (vertical) GIS (linear)	
	Lined / Liner Material	GIS (linear)	Sewer/Drainage Main, Manhole
	Elevation • Rim • Invert • Upstream/Downstream • Slope	GIS (linear)	
	Depth	GIS (linear)	
	Upstream/Downstream structure ID	GIS (linear)	Sewer/Drainage Main, Drainage Channel
	Receiving Treatment Plant Name/ID/Key	GIS (linear)	
	Asbuilt Drawing #	GIS (linear)	
	Address: • Number • Street • Direction • Street Name • Suffix • Zip Code	GIS (linear)	Pump Station, Treatment Plant, Service Line
Asset Management	Useful life	CMMS	

Table D-1. Asset Attributes Where Applicable			
Type	Data	Data Source	Notes
	Rehab Date	GIS (linear)	
	Operating performance	CMMS	
Financial	Cost	SAP	
	Labor	CMMS	

Table D-2. Required Spare Part Information	
Data	Data Source
Equipment Number	Equipment Number, If Applicable
Tag Name	SCADA tag name, If Applicable
Part Number	Manufacturer Part Number
Quantity	Quantity of spare parts required
Unit of Measure	PC., SET, FT., etc.
Spare Parts Bill of Material	Manufacturer's Description as it appears on the Bill of Materials (ex. Sprocket, 23T, 5.775B, keyed)

Table D-3. Required Job Plan Information	
Data	Data Source
Job Plan Number	Unique job plan number
Job Plan Description	
Job Plan Task Number	May be multiple tasks/descriptions per job plan
Job Plan Task Description	May be multiple tasks/descriptions per job plan
Job Plan Task Duration	Task Duration
Job Plan Task Tools/Materials	Task Tools/Materials required
Equipment Number	Equipment number that follows this job plan

Appendix E. Vertical Asset Classes

Vertical Asset Classes		
Asset Type	Equipment Type	Description
Plant Equipment	12VCHG	12V DC charger - computer
Plant Equipment	AAV	Air actuated valve
Plant Equipment	ACUNIT	AC unit
Plant Equipment	AER	Aerator
Plant Equipment	AGS	Automated grease system
Plant Equipment	AHU	Air handling unit
Plant Equipment	AID	First aid and safety
Plant Equipment	AIRCOM	Air compressor
Plant Equipment	AIRCRD	Aircard
Plant Equipment	AIRLP	Air lift pump
Plant Equipment	ALARML	Local alarm systems
Plant Equipment	ANALC	Analog card
Plant Equipment	APS	Air pack switch
Plant Equipment	ARREST	Flame arrester
Plant Equipment	BAGCAR	Carry-on bag - computer
Plant Equipment	BAR	Bar screen
Plant Equipment	BAT	Battery system
Plant Equipment	BATCHG	External battery charger
Plant Equipment	BFP	Backflow preventer
Plant Equipment	BGR	Building/grounds
Plant Equipment	BLOWER	Blowers
Plant Equipment	BNDSAW	Band saw
Plant Equipment	BOILER	Boiler
Plant Equipment	BOILFU	Boiler feed unit
Plant Equipment	BOILST	Boiler-steam
Plant Equipment	BOILWH	Boiler-hot water
Plant Equipment	BOMLIFT	Articulating boom lift
Plant Equipment	CART	Cart
Plant Equipment	CASEL	Leather case - computer
Plant Equipment	CDS	CDs unit
Plant Equipment	CENTRI	Centrifuge
Plant Equipment	CHEM	Chemical feed system
Plant Equipment	CHILL	Chiller
Plant Equipment	CLAR	Clarifier
Plant Equipment	CLASS	WQTC classifier
Plant Equipment	CLT	Coolant system
Plant Equipment	COLL	Collector assembly
Plant Equipment	COM	Computer
Plant Equipment	COMM	Comminutor
Plant Equipment	COMP	Compressor
Plant Equipment	COMPCT	Compactor
Plant Equipment	CONDRU	Condensate return unit
Plant Equipment	CONDUN	Condensing unit
Plant Equipment	CONVEY	Conveyor
Plant Equipment	COOLTW	Cooling tower

Vertical Asset Classes		
Asset Type	Equipment Type	Description
Plant Equipment	CP	Control panel
Plant Equipment	CPHONE	MSD cell phone
Plant Equipment	CPS	Cathodic protection system
Plant Equipment	CRANE	Crane or hoist
Plant Equipment	DAM	Dam
Plant Equipment	DEH	Dehumidifier
Plant Equipment	DIG	Digester
Plant Equipment	DIST	Distribution box
Plant Equipment	DLR	Data link radio
Plant Equipment	DRLPRSS	Drill press
Plant Equipment	DRYER	Dryer
Plant Equipment	EAV	Electrically actuated valve
Plant Equipment	ELECM	Electric meter
Plant Equipment	ELEV	Elevator
Plant Equipment	EMUNIT	Emissions unit (APCD)
Plant Equipment	ESCBOT	5/10 min escape bottle
Plant Equipment	ESV	Electrical service
Plant Equipment	FAN	Fans: heating/cooling
Plant Equipment	FCOIL	Fan coil unit
Plant Equipment	FENCE	Fence
Plant Equipment	FILTER	Filter
Plant Equipment	FIRE	Fire suppression equipment
Plant Equipment	FLARE	Gas flare
Plant Equipment	FLOW	Flow meter
Plant Equipment	FURN	Furnace
Plant Equipment	GATE	Gate
Plant Equipment	GATE E	Gate - electric
Plant Equipment	GATE H	Gate - hydraulic
Plant Equipment	GDS	Gas detection system
Plant Equipment	GEN	Generator
Plant Equipment	GENPOR	Generator - portable
Plant Equipment	GEO	Geothermal field
Plant Equipment	HEATP	Heat pump
Plant Equipment	HEX	Heat exchanger
Plant Equipment	HMI	Human machine interface
Plant Equipment	HPU	Hydraulic power unit
Plant Equipment	HRUNIT	Heat recovery unit
Plant Equipment	HTR	Heater
Plant Equipment	HUB	Hub - computer
Plant Equipment	HUM	Humidification chamber
Plant Equipment	HWWTR	Hot water heater
Plant Equipment	INPUT	Input
Plant Equipment	LAG	Lagoon
Plant Equipment	LATHE	Lathe
Plant Equipment	LDBANK	Load bank

Vertical Asset Classes		
Asset Type	Equipment Type	Description
Plant Equipment	LPTOPS	MSD laptop computers
Plant Equipment	LVL	Level controller/indicator
Plant Equipment	MCC	Motor control center
Plant Equipment	METER	LG&E meter
Plant Equipment	MILL	Mill
Plant Equipment	MIXER	Mixer
Plant Equipment	MODEM	Modem
Plant Equipment	MOISTURE	Moisture analyzer
Plant Equipment	MONITR	Computer monitor
Plant Equipment	MOTOR	Motor
Plant Equipment	OBA	Orbal drive assembly
Plant Equipment	OCS	Odor control system equipment
Plant Equipment	OHDOOR	Overhead door
Plant Equipment	OILINJ	Oil injection system
Plant Equipment	OILSEP	Oil/water separator
Plant Equipment	OMNIS	Integrated unit
Plant Equipment	OPHONE	Office phone
Plant Equipment	OUTPUT	Output
Plant Equipment	OXD	Oxidation ditch
Plant Equipment	PASYST	Pa system
Plant Equipment	PC	Desktop pc
Plant Equipment	PCC	Power correction capacitor
Plant Equipment	PCS	Pump coolant system
Plant Equipment	PLC	Programmable logical controller
Plant Equipment	PLOTR	Plotter
Plant Equipment	PMPCH	Pump-chilled water
Plant Equipment	PMPCW	Pump-cold water
Plant Equipment	PMPHW	Pump-hot water
Plant Equipment	PRESS	Press
Plant Equipment	PRO	Plc processor
Plant Equipment	PROBE	WQTC probe equipment
Plant Equipment	PROJTR	MSD projector
Plant Equipment	PTAC	Portable ac unit
Plant Equipment	PUMP	Pump
Plant Equipment	PW3702	Pickup truck
Plant Equipment	REACT	Reactor
Plant Equipment	REC	Rectifier
Plant Equipment	RECORDER	Recorder
Plant Equipment	REG	Regulator box
Plant Equipment	RGAUGE	Rain gauge
Plant Equipment	ROOFUN	Rooftop unit
Plant Equipment	ROUTER	Router - computer
Plant Equipment	SAMPLR	Sampler
Plant Equipment	SAPRTR	Standalone printer
Plant Equipment	SCALE	Scale

Vertical Asset Classes		
Asset Type	Equipment Type	Description
Plant Equipment	SCBA	SCBA
Plant Equipment	SCILIFT	Scissor lift
Plant Equipment	SCRN	Screen/splitter
Plant Equipment	SERVER	Server
Plant Equipment	SMTBRD	Smart board
Plant Equipment	SONDE	Sonde
Plant Equipment	SUB	Substation
Plant Equipment	SURVCAM	Surveillance camera
Plant Equipment	SWCHGR	Electrical switchgear
Plant Equipment	SWITCH	Switch - computer
Plant Equipment	SWT	Network switch
Plant Equipment	TANK	Tank
Plant Equipment	TB	Tipping bucket
Plant Equipment	TEMPSEN	Temperature sensor
Plant Equipment	TFM	Transformer
Plant Equipment	THOX	Thermal oxidizer
Plant Equipment	TRANSWT	Transfer switch
Plant Equipment	TRS	Trash rake system
Plant Equipment	UPS	Uninterrupted power supply
Plant Equipment	USBCD	USB CD/DVD ROM
Plant Equipment	USBFP	USB floppy
Plant Equipment	USBHD	USB hard drive
Plant Equipment	UVDIS	UV disinfection system
Plant Equipment	VALVE	Valve vault
Plant Equipment	VEN	Ventilation
Plant Equipment	WAT	Water system
Plant Equipment	WATSOF	Water softener
Plant Equipment	WELDER	Welder
Plant Equipment	WKEYBD	Wireless keyboard
Plant Equipment	WSHP	Watersource heat pump
Plant Equipment	WYSE	Wyse terminal
Plant Equipment	VFD	Variable frequency drive
Plant Equipment	GEARBOX	Gearbox
Plant Equipment	RAKE	Rack/rake
Plant Equipment	SWEEP	Sweep system
Plant Equipment	GRND	Grinder
Pump	18 MF	Mixed flow 18"
Pump	42 MF	Mixed flow 42"
Pump	48 MF	Mixed flow 48"
Pump	66 MF	Mixed flow 66"
Pump	72 MF	Mixed flow 72"
Pump	B53LNC	
Pump	BDRIVE	Belt drive pump
Pump	CENTRI	Centrifugal
Pump	DDRIVE	Direct drive pump

Vertical Asset Classes		
Asset Type	Equipment Type	Description
Pump	FEEDER	Feeder
Pump	MIX F	Mixed flow
Pump	PLUNG	Plunger/piston pump
Pump	PRIMER	Primer
Pump	PROP	Propeller pump
Pump	SAF	
Pump	SAFV	
Pump	SSV	
Pump	SUB	Submersible
Pump	SUMP	Sump pump
Pump	TRASH	Trash pump
Pump	UNK	Unknown pump type
Pump	US 32	
Pump	VSL	
Pump	WATER	Water
Sewer Pumps	18 MF	Mixed flow 18"
Sewer Pumps	42 MF	Mixed flow 42"
Sewer Pumps	48 MF	Mixed flow 48"
Sewer Pumps	66 MF	Mixed flow 66"
Sewer Pumps	72 MF	Mixed flow 72"
Sewer Pumps	B53LNC	
Sewer Pumps	BDRIVE	Belt drive pump
Sewer Pumps	CENTRI	Centrifugal
Sewer Pumps	DDRIVE	Direct drive pump
Sewer Pumps	FEEDER	Feeder
Sewer Pumps	MIX F	Mixed flow
Sewer Pumps	PLUNG	Plunger/piston pump
Sewer Pumps	PRIMER	Primer
Sewer Pumps	PROP	Propeller pump
Sewer Pumps	SAF	
Sewer Pumps	SAFV	
Sewer Pumps	SSV	
Sewer Pumps	SUB	Submersible
Sewer Pumps	SUMP	Sump pump
Sewer Pumps	TRASH	Trash pump
Sewer Pumps	UNK	Unknown pump type
Sewer Pumps	US 32	
Sewer Pumps	VSL	
Sewer Pumps	WATER	Water
Building	Amphitheater	Amphitheater
Building	Bath House	Bath house
Building	Cabin	Cabin
Building	Community	Community center
Building	Dining	Dining hall
Building	Education	Educational building

Vertical Asset Classes		
Asset Type	Equipment Type	Description
Building	General	General service building
Building	Golf Club	Golf club house
Building	Golf Rain	Golf rain shelter
Building	Lodge	Lodge
Building	Maintenance	Maintenance building
Building	Office	Office building
Building	Pool House	Pool house
Building	Residence	Residence
Building	Restroom	Restroom
Building	Shelter	Shelter
Building	Sports	Sports service building
Building	Stable	Stable
Building	Utility	Utility structure
Building	VAULT	MSD flood protection storage

Appendix F. Business Process Workflows

Asset Commissioning (non-CIP)

Asset Commissioning (CIP)

Asset Decommissioning

Corrective Maintenance

Preventive Maintenance

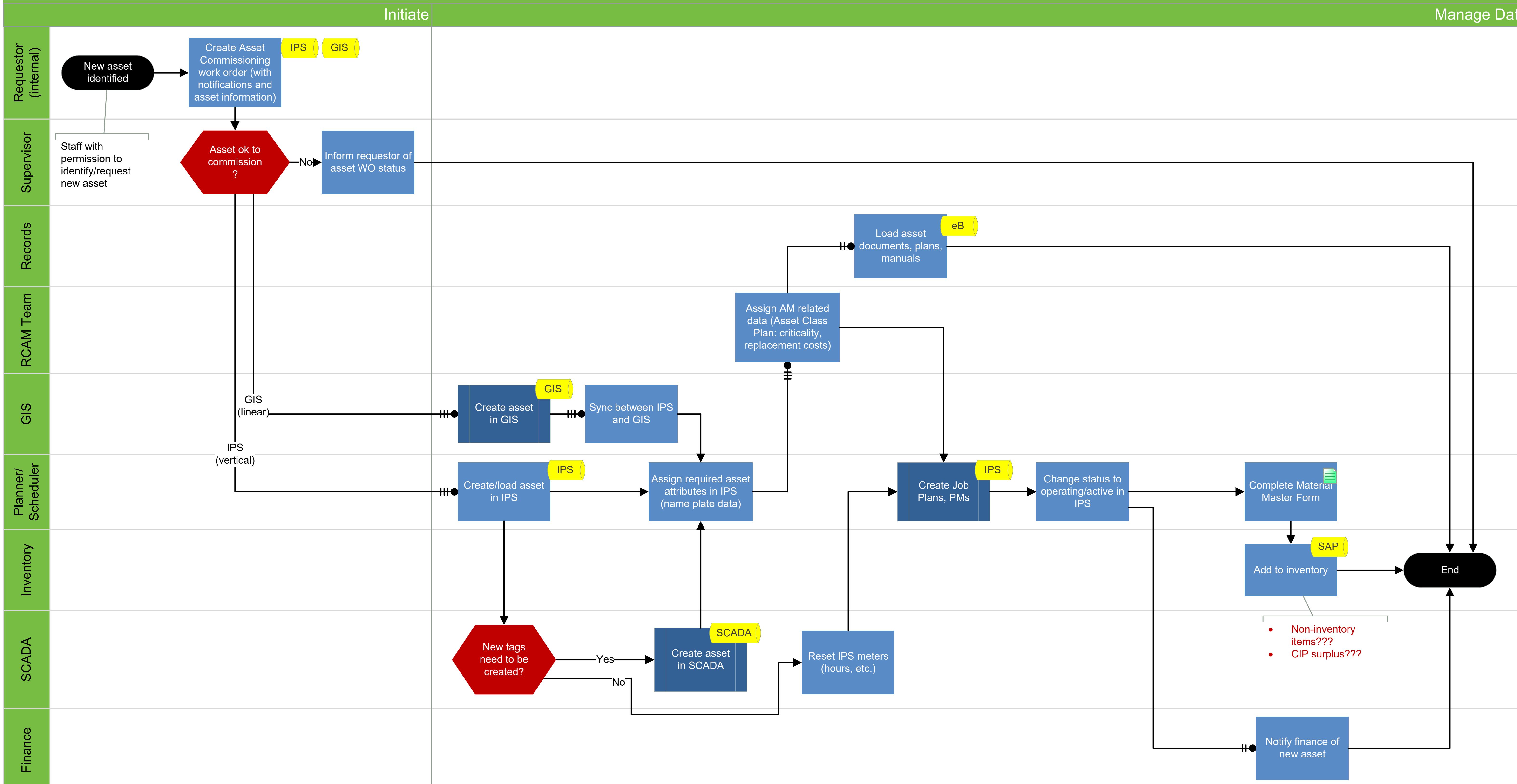
Predictive Maintenance

Construction workflow based on the ECPMH

Asset Management

Asset Commissioning: Non-CIP Assets

DRAFT



Revision Information

Revision Number: V2
Revision Date: 04/20/2021
Prepared: BC
Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

- PM: preventive Maintenance
- GIS: geographic information system
- SCADA: supervisory control and data acquisition
- IPS: infor public sector
- WO: work order

Description

This process map has been established to ensure that assets are commissioned and decommissioned in a consistent and timely manner across MSD.

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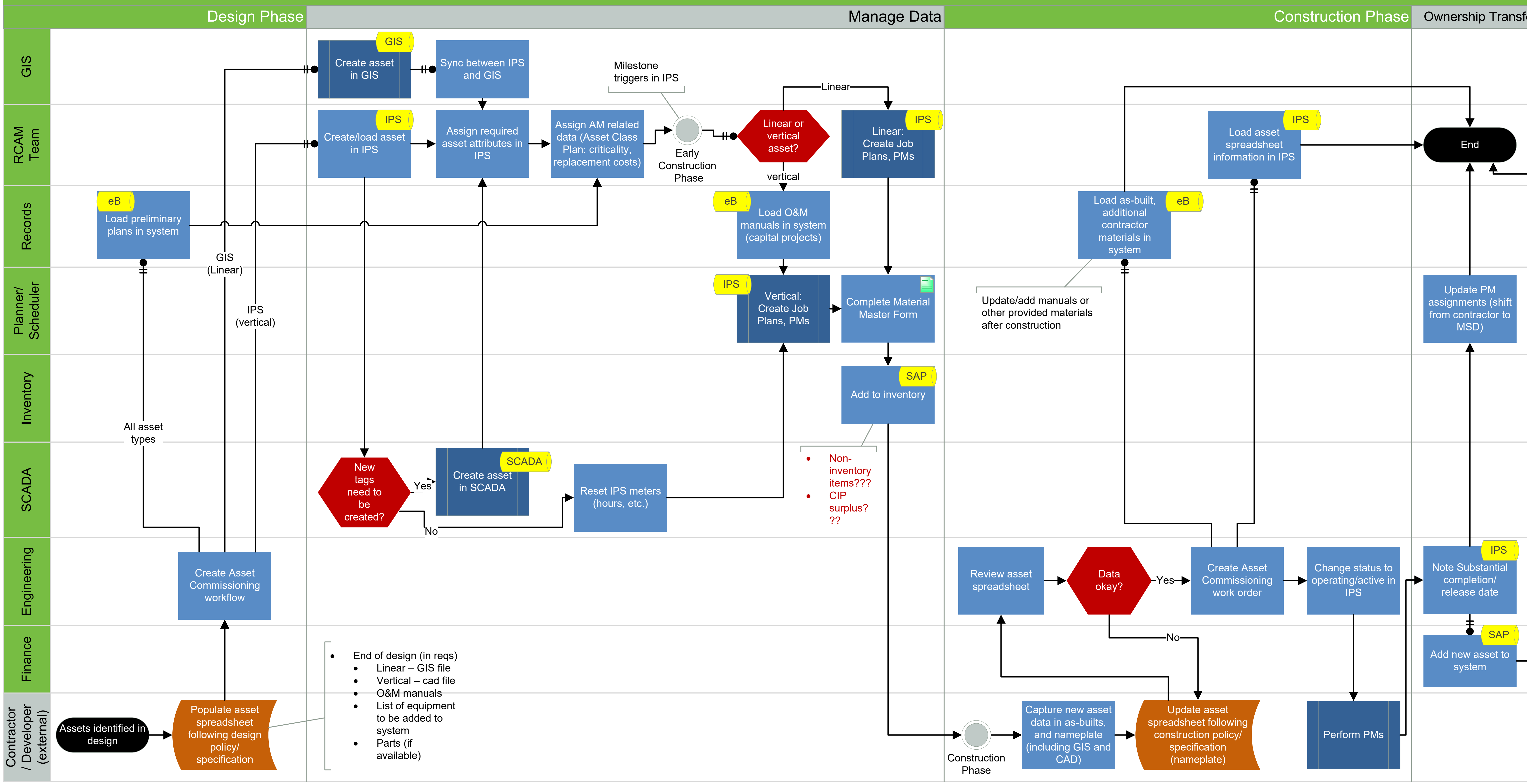
Asset Management

Asset Commissioning: CIP Assets

DRAFT



Revision Information

Revision Number: V2
Revision Date: 04/15/2021
Prepared: BC
Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Phase of work
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

- PM: preventive Maintenance
- GIS: geographic information system
- SCADA: supervisory control and data acquisition
- IPS: infor public sector
- WO: work order

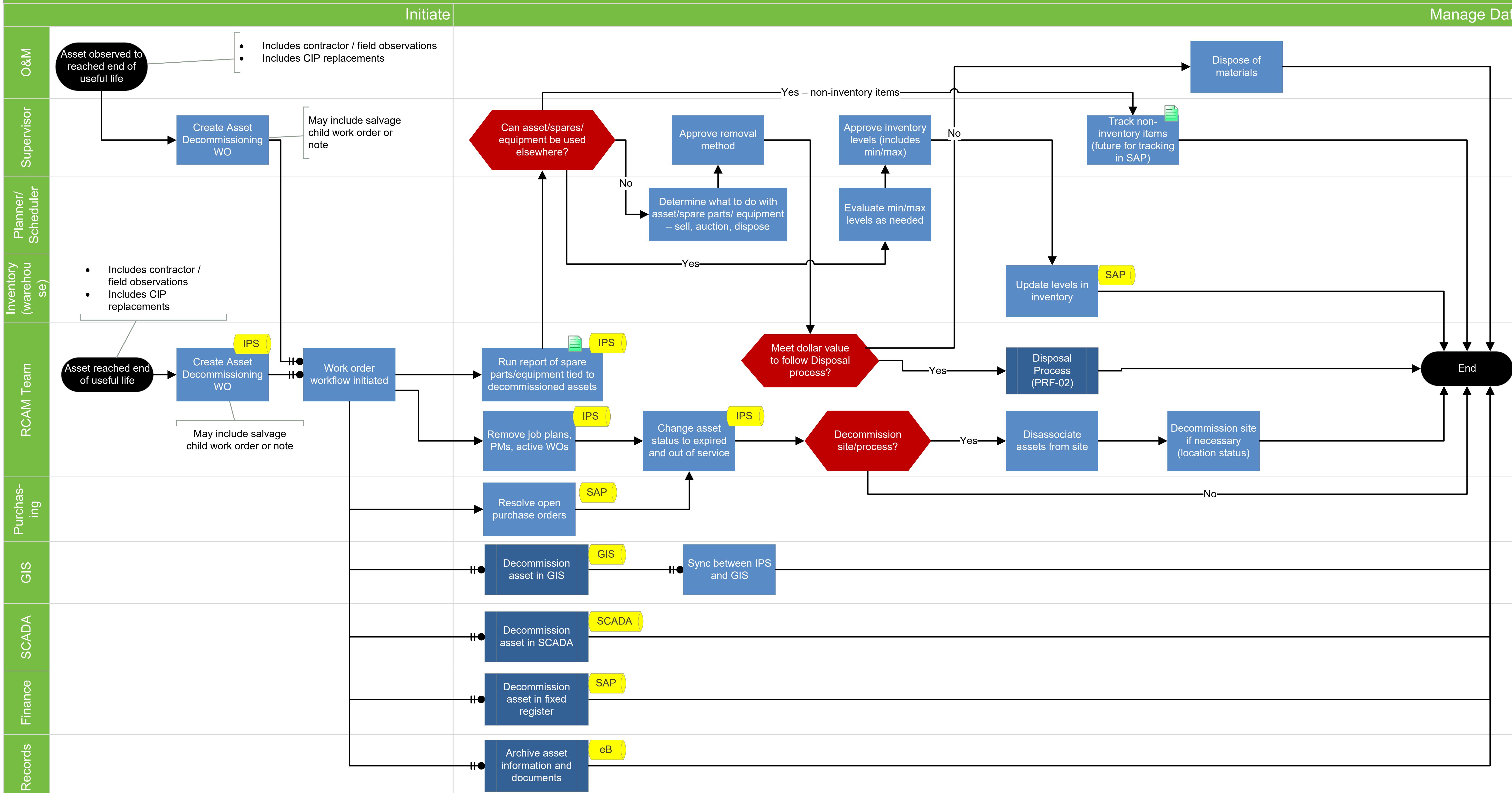
Description

This process map has been established to ensure that assets are commissioned and decommissioned in a consistent and timely manner across MSD.

Asset Management

Asset Decommissioning

DRAFT



Revision Information

Revision Number: V2
Revision Date: 04/15/2021
Prepared: BC
Issue Date: x/x/xx

Legend

Decision Point	Sub-process	Document	Workflow
Activity Box	Start / End	Email	Automated workflow/ notification
Off-page reference	Database / System	External data	Information exchange as needed

Acronyms

- PM: preventive Maintenance
- GIS: geographic information system
- SCADA: supervisory control and data acquisition
- IPS: infor public sector
- WO: work order

Description

This process map has been established to ensure that assets are commissioned and decommissioned in a consistent and timely manner across MSD.

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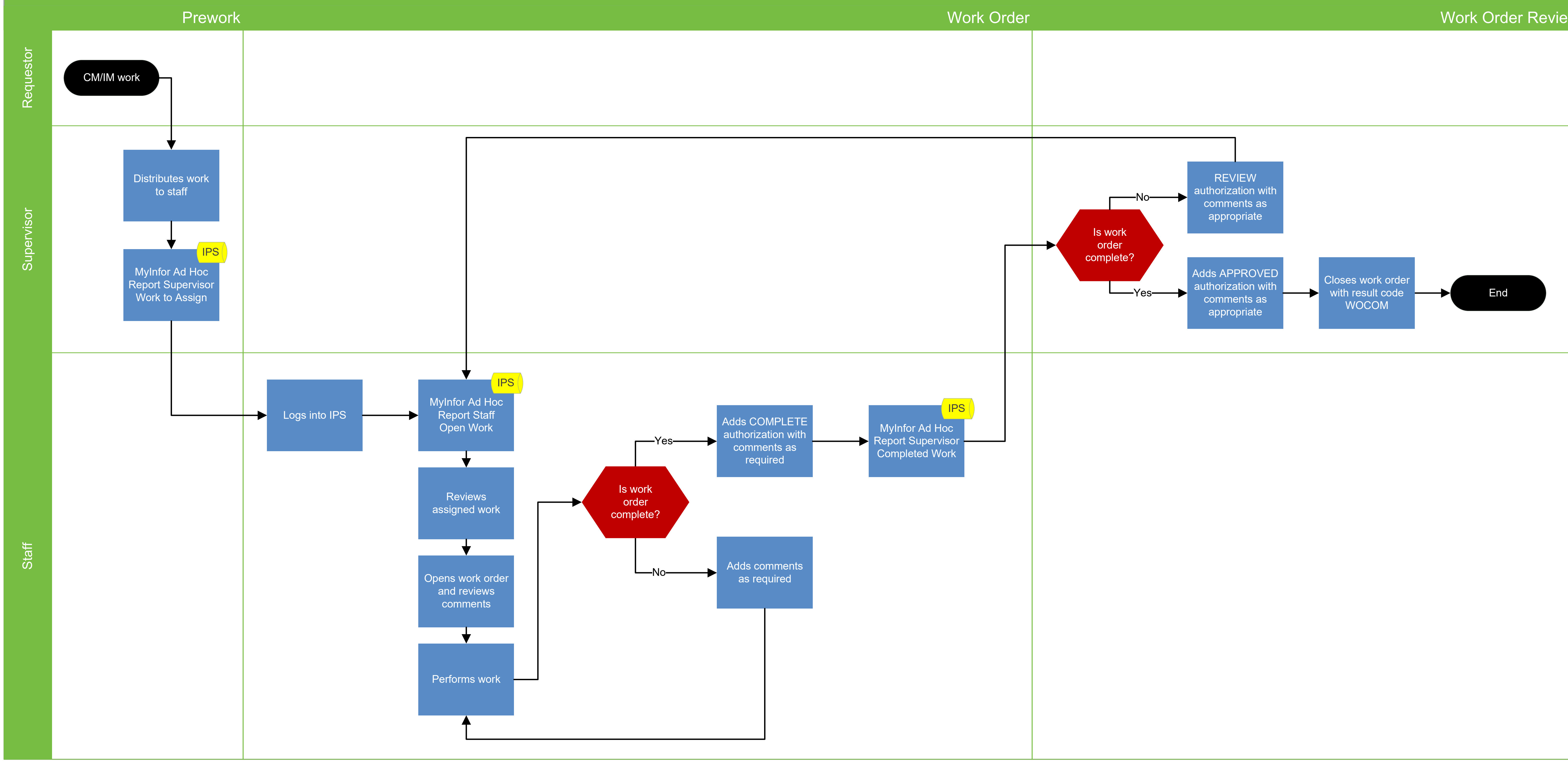
Treatment, Collections Systems & Flood Protection

Corrective Maintenance/Improvement Process

DRAFT



Revision Information

Revision Number: V3
Revision Date: 06/10/2021
Prepared: BC
Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

CM – corrective maintenance
IM – improvement maintenance
IPS – intrusive prevention system

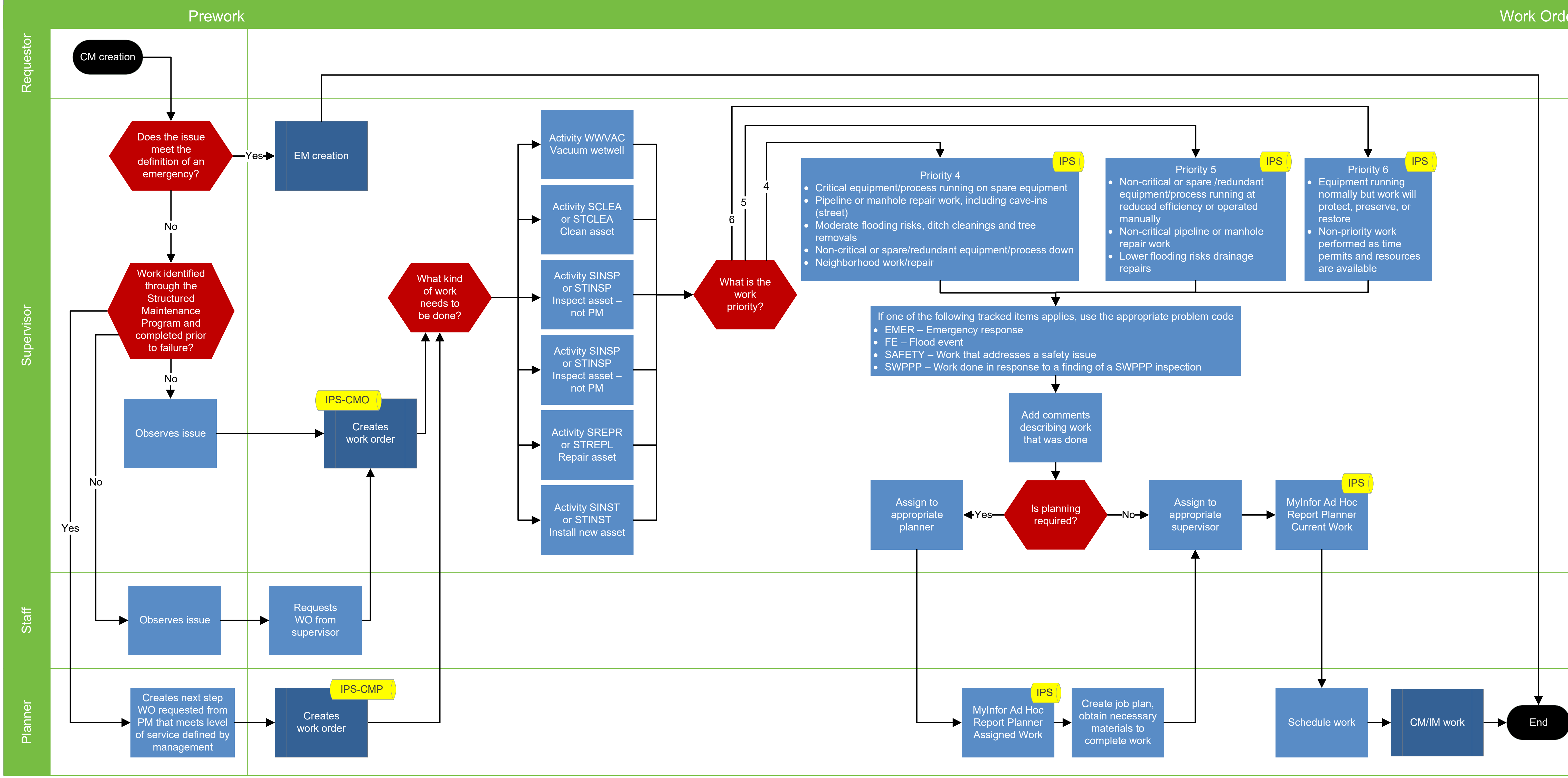
Description

This process map has been established to ensure that corrective maintenance improvement work orders are processed in a consistent and timely manner across MSD.

Treatment, Collections Systems & Flood Protection

Corrective Maintenance Creation Process

DRAFT



Revision Information

Revision Number: V3
Revision Date: 06/10/2021
Prepared: BC
Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

CM – Corrective Maintenance
CMO – Corrective Work not from Structured Work
CMP – Corrective Work from Structured Work
EM – Emergency Maintenance
PM – Preventative Maintenance
WO – Work Order

Description

This process map has been established to ensure that corrective maintenance creation process for work orders is in a consistent and timely manner across MSD.

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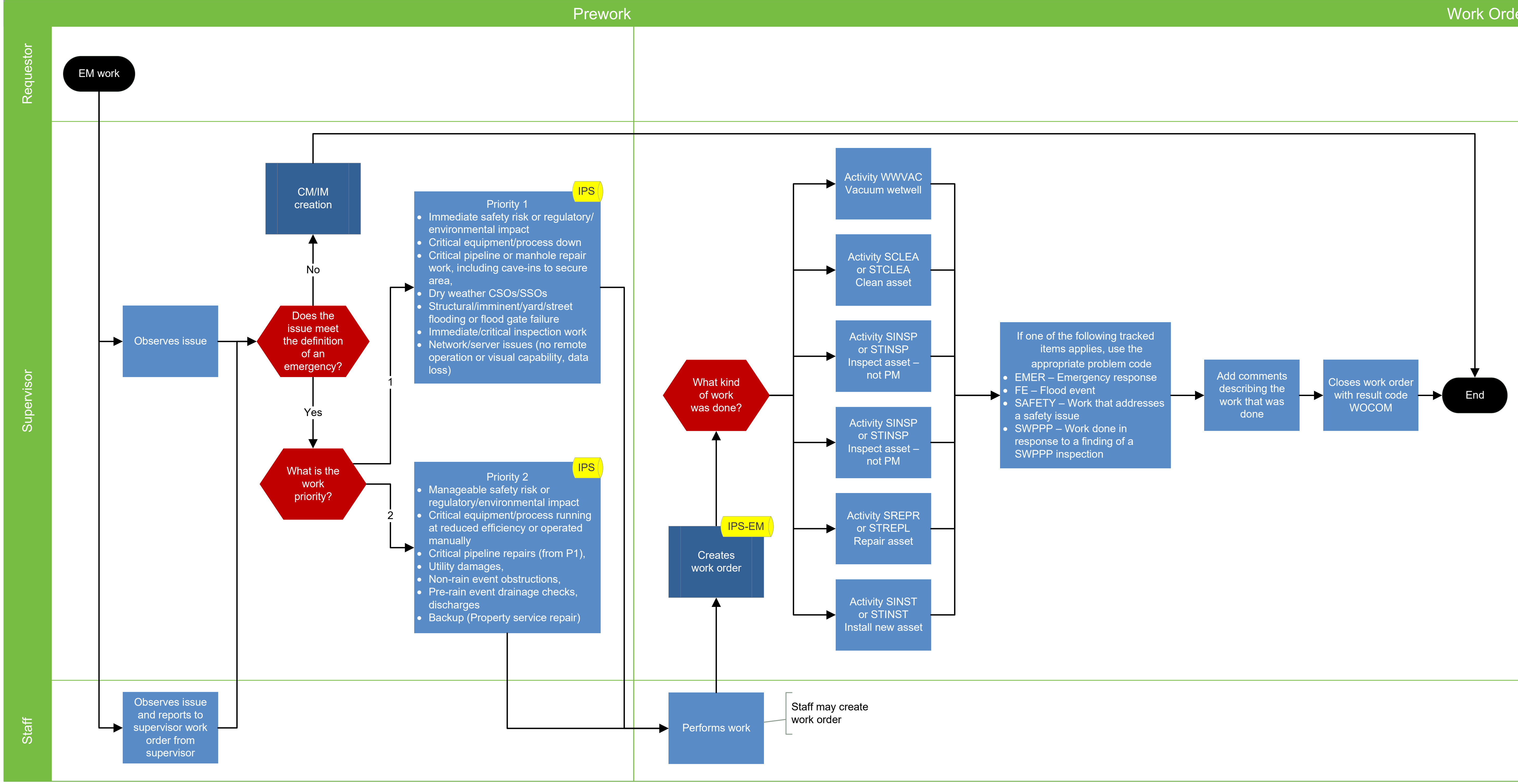
Treatment, Collections Systems & Flood Protection

Emergency Maintenance Process

DRAFT



Revision Information

Revision Number: V3
Revision Date: 06/10/2021
Prepared: BC
Issue Date: x/x/xx

Legend

Decision Point
Activity Box
Off-page reference
Sub-process
Start / End
Database / System
Document
Email
External data
Workflow
Automated workflow/ notification
Information exchange as needed

Acronyms

CM – corrective maintenance
EM – emergency maintenance
IM – improvement maintenance
PM – preventative maintenance

Description

This process map has been established to ensure that emergency maintenance work orders are processed in a consistent and timely manner across MSD.

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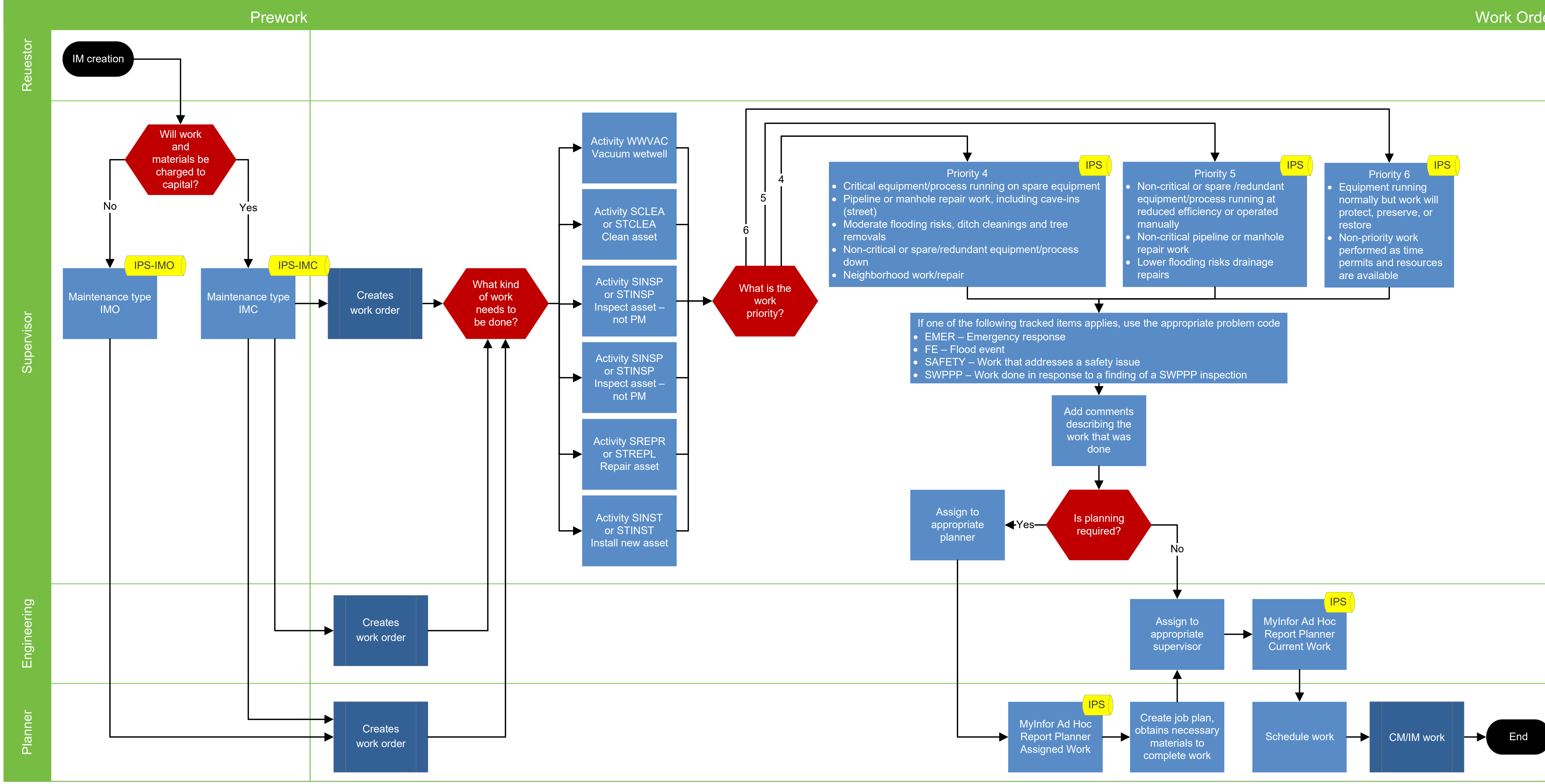
Improvement Creation Process

DRAFT



Revision Information

Revision Number: V3
Revision Date: 06/10/2021
Prepared: BC
Issue Date: x/x/xx

Legend

Decision Point
Activity Box
Off-page reference
Sub-process
Start / End
Database / System
Document
Email
External data
Workflow
Automated workflow/ notification
Information exchange as needed

Acronyms

CM – corrective maintenance
EM – emergency maintenance
IM – improvement maintenance
IMC – capital work
IMO – non-capital work
PM – preventative maintenance

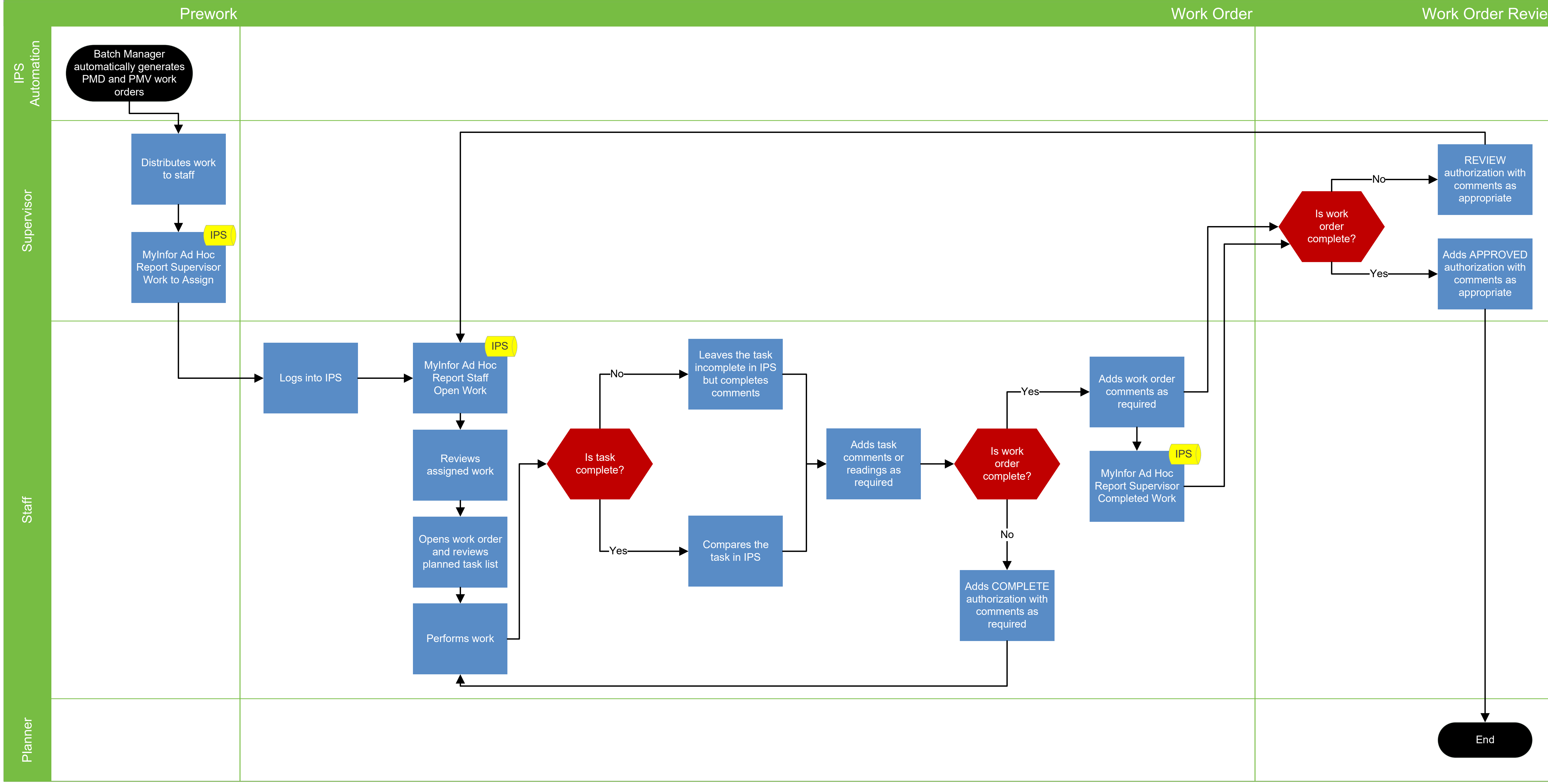
Description

This process map has been established to ensure that the improvement creation process for work orders is in a consistent and timely manner across MSD.

Treatment, Collections Systems & Flood Protection

Preventive/Predictive Maintenance Process

DRAFT



Revision Information	
	Revision Number: V3
	Revision Date: 06/10/2021
	Prepared: BC
	Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

IPS – intrusive prevention system
PMD – predictive maintenance
PMV – preventative maintenance

Description

This process map has been established to ensure that preventative and predictive maintenance work orders are processed in a consistent and timely manner across MSD.

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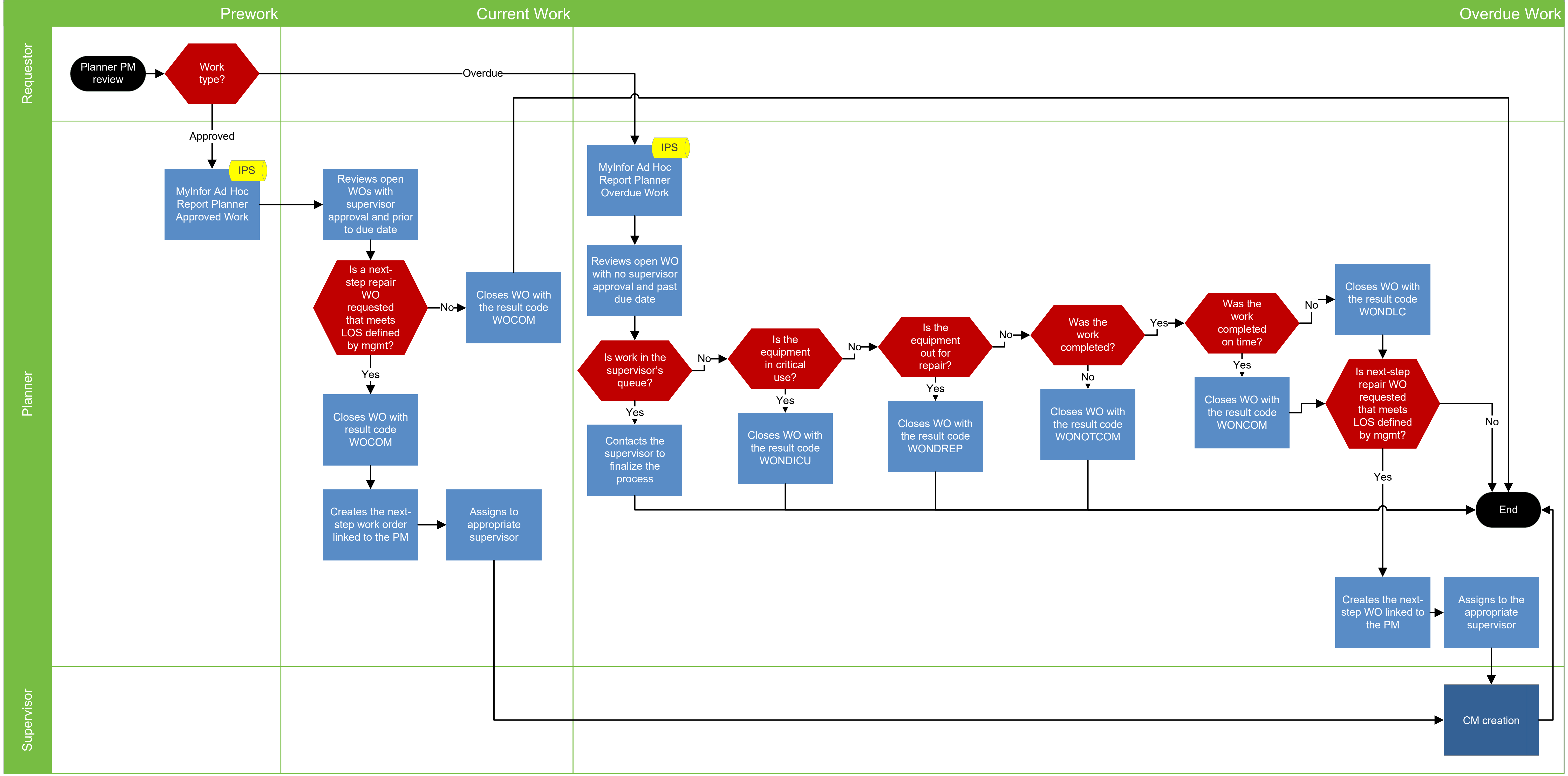
Treatment, Collections Systems & Flood Protection

Preventive/Predictive Maintenance Review Process

DRAFT



Revision Information

Revision Number: V3
Revision Date: 06/09/2021
Prepared: BC
Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

CM – corrective maintenance
LOS – level of service
Mgmt - management
PM – preventative maintenance
WO – work order

Description

This process map has been established to ensure that the preventative and predictive maintenance review process for work orders is in a consistent and timely manner across MSD.

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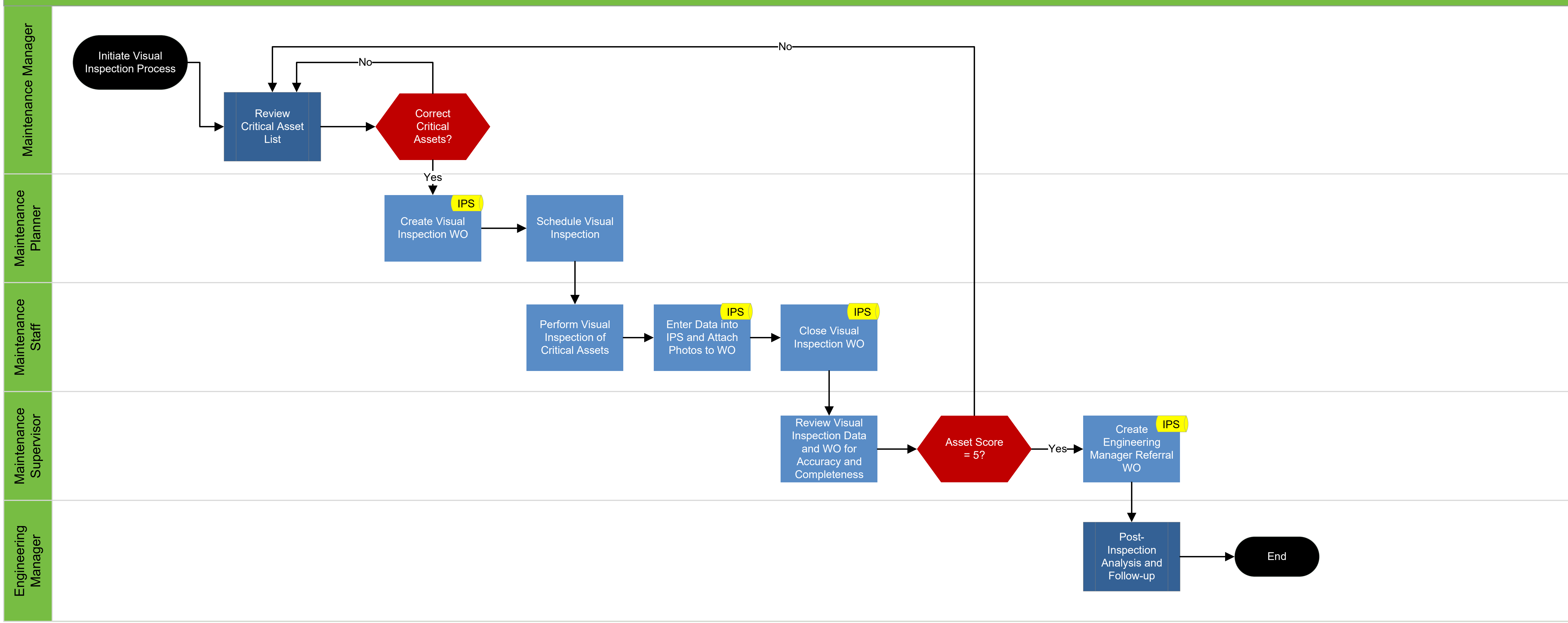
Asset Management

Visual Inspection

DRAFT



Revision Information

Revision Number: V2
Revision Date: 05/28/2021
Prepared: BC
Issue Date: x/x/xx

Legend

- Decision Point
- Activity Box
- Off-page reference
- Sub-process
- Start / End
- Database / System
- Document
- Email
- External data
- Workflow
- Automated workflow/ notification
- Information exchange as needed

Acronyms

- WO: Work Order

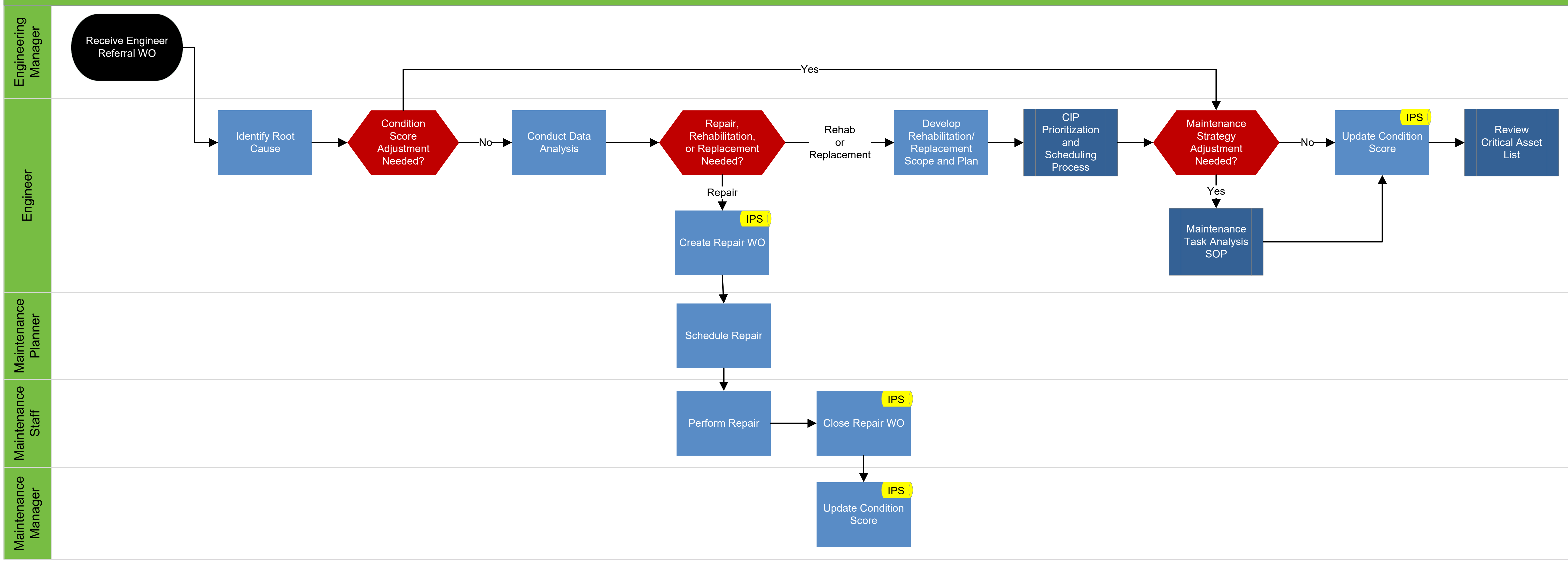
Description

This process map has been established to ensure a standardized design process is followed across the organization. Reference the ECPMH for more details.

Asset Management

Post-Inspection Analysis and Follow-up

DRAFT



Revision Information

Revision Number: V1
Revision Date: 05/13/2021
Prepared: BC
Issue Date: x/x/xx

Legend

Decision Point
Activity Box
Off-page reference
Sub-process
Start / End
Database / System
Document
Email
External data
Workflow
Automated workflow/ notification
Information exchange as needed

Acronyms

- WO: Work Order

Description

This process map has been established to ensure a standardized design process is followed across the organization. Reference the ECPMH for more details.

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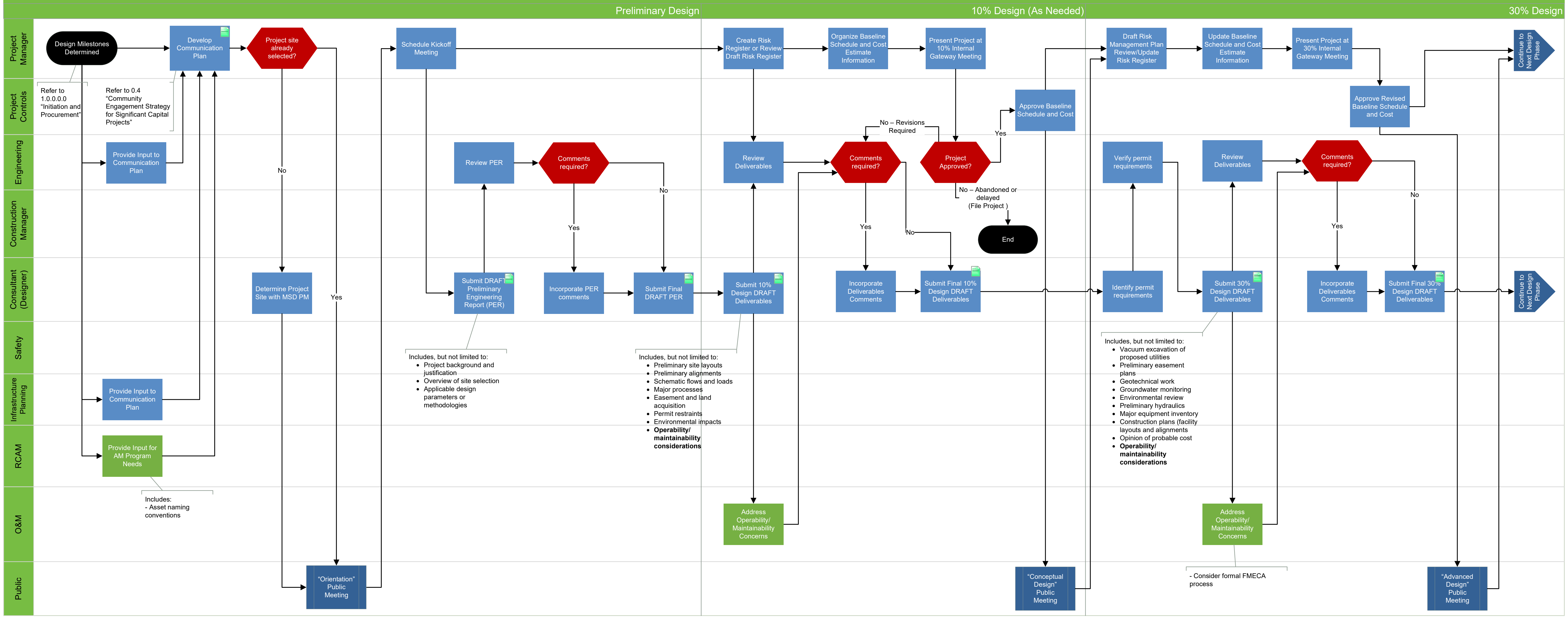
Asset Management

Design Requirements – Preliminary to 30% Design

DRAFT



Revision Information

Revision Number: V2
Revision Date: 05/28/2021
Prepared: BC
Issue Date: x/x/xx

Legend

Decision Point | Activity Box | Off-page reference | Sub-process | Start / End | Database / System | Document | Email | External data | Workflow | Automated workflow/ notification | Information exchange as needed

Acronyms

- MOO: Maintenance of Operations
- FMECA: Failure Mode Effects and Criticality Analysis

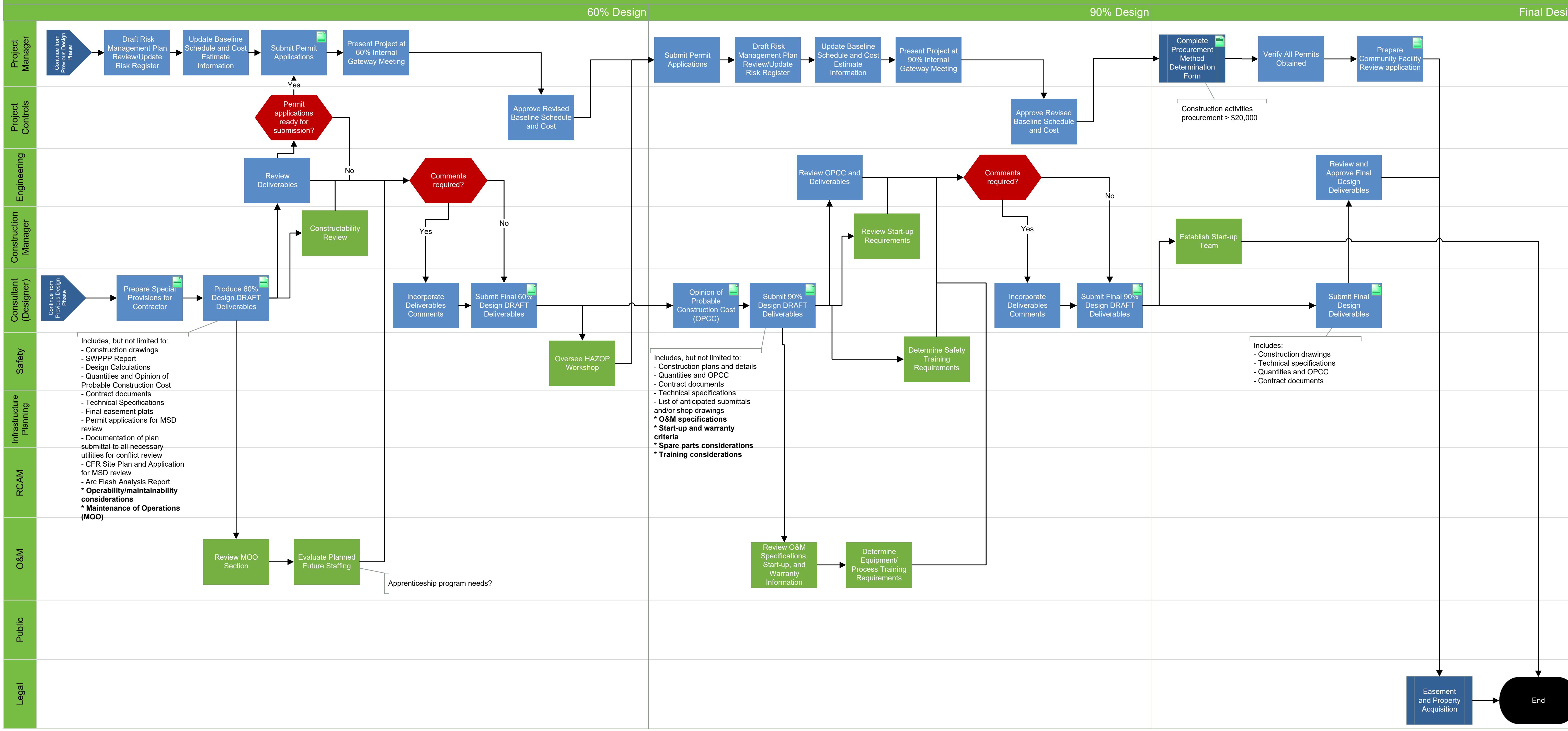
Description

This process map has been established to ensure a standardized design process is followed across the organization. Reference the ECPMH for more details.

Asset Management

Design Requirements – 60% to Final Design

DRAFT



Revision Information

Revision Number: V1
Revision Date: 04/29/2021
Prepared: BC
Issue Date: x/x/xx

Legend

Decision Point | Sub-process | Document | Workflow
Activity Box | Start / End | Email | Automated workflow/ notification
Off-page reference | Database / System | External data | Information exchange as needed

Acronyms

- MOO: Maintenance of Operations
- FMECA: Failure Mode Effects and Criticality Analysis

Description

This process map has been established to ensure a standardized design process is followed across the organization. Reference the ECPMH for more details.

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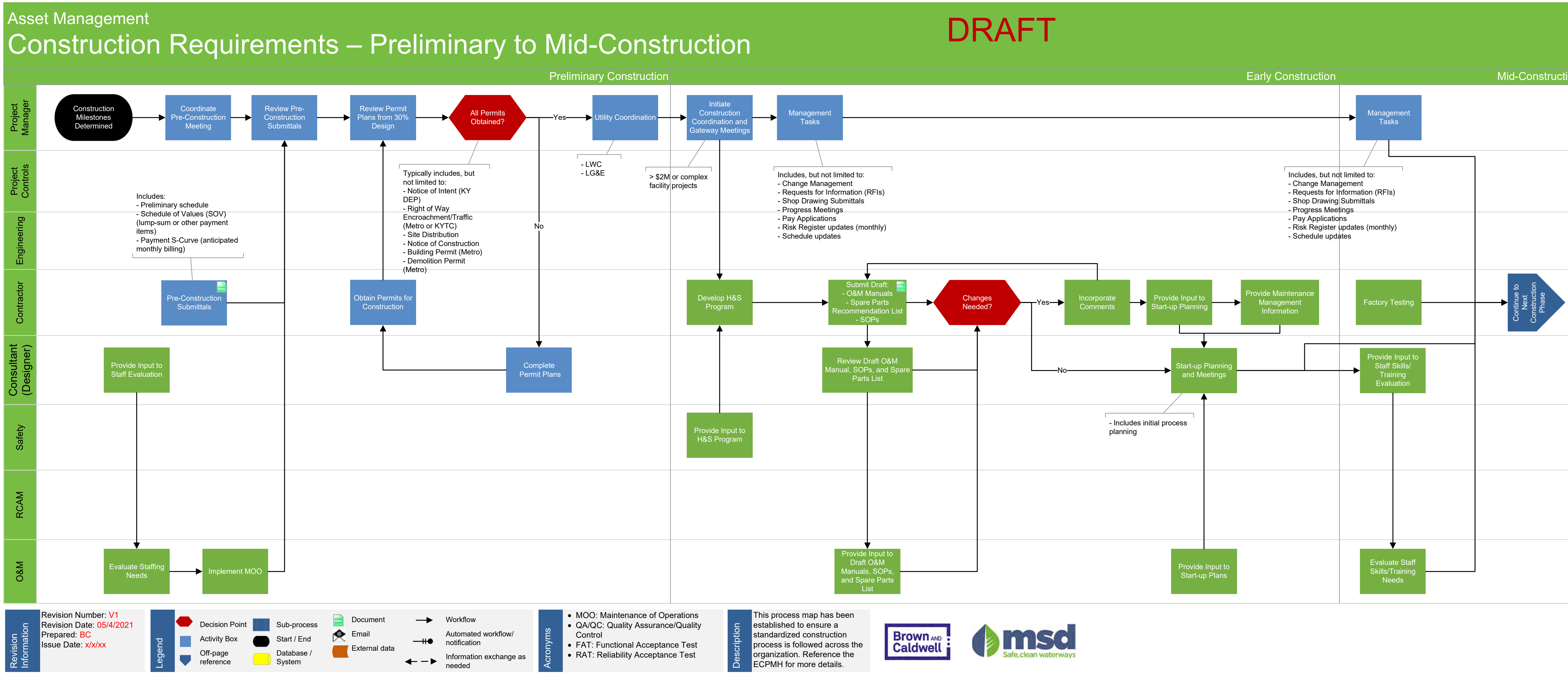
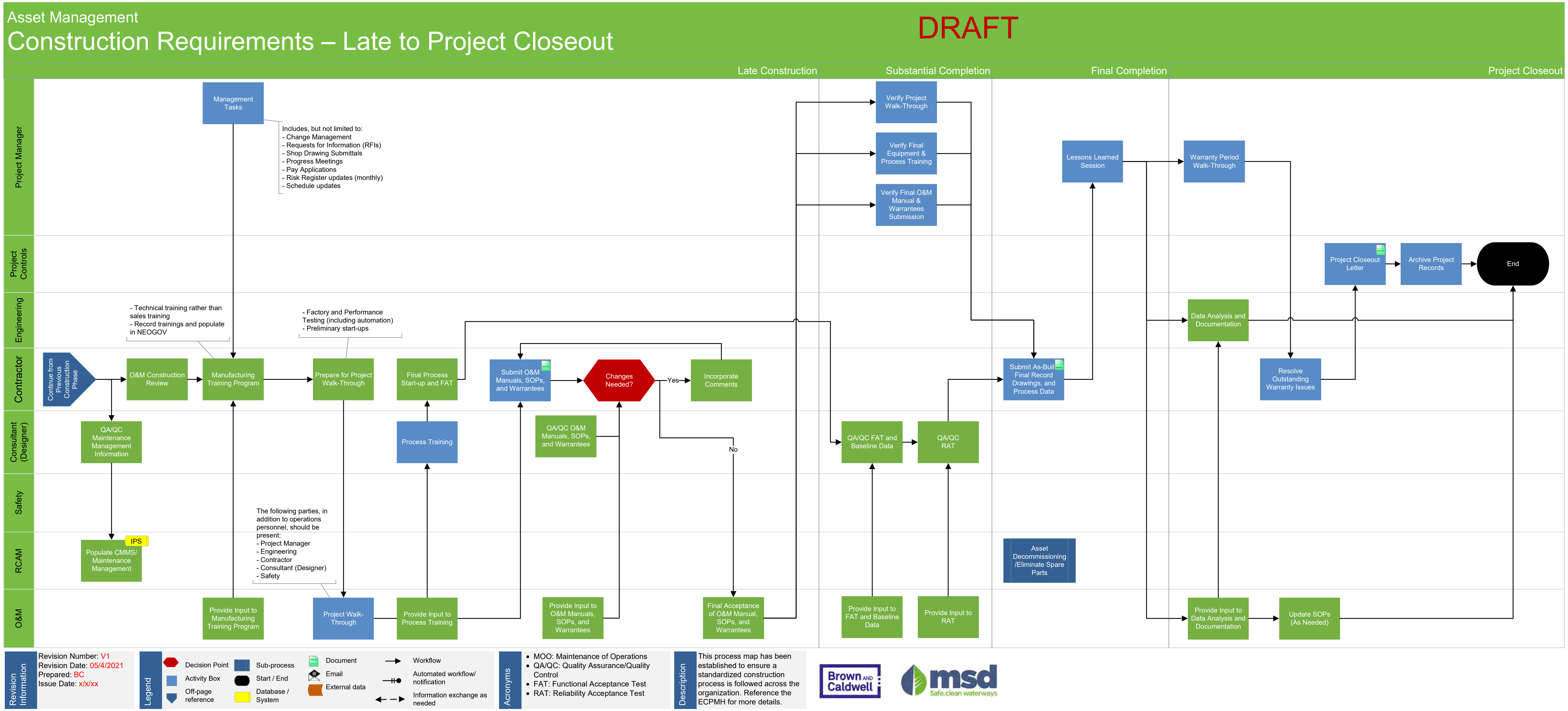


Asset Management
Construction Requirements – Preliminary to Mid-Construction
DRAFT
Preliminary Construction
Early Construction
Mid-Construction
Project Manager
Project Controls
Engineering
Contractor
Consultant (Designer)
Safety
RCAM
O&M
Construction Milestones Determined
Coordinate Pre-Construction Meeting
Review Pre-Construction Submittals
Review Permit Plans from 30% Design
All Permits Obtained?
Yes
No
Utility Coordination
- LWC
- LG&E
Initiate Construction Coordination and Gateway Meetings
> $2M or complex facility projects
Management Tasks
Typically includes, but not limited to:
- Notice of Intent (KY DEP)
- Right of Way Encroachment/Traffic (Metro or KYTC)
- Site Distribution
- Notice of Construction
- Building Permit (Metro)
- Demolition Permit (Metro)
Includes:
- Preliminary schedule
- Schedule of Values (SOV) (lump-sum or other payment items)
- Payment S-Curve (anticipated monthly billing)
Includes, but not limited to:
- Change Management
- Requests for Information (RFIs)
- Shop Drawing Submittals
- Progress Meetings
- Pay Applications
- Risk Register updates (monthly)
- Schedule updates
Pre-Construction Submittals
Obtain Permits for Construction
Complete Permit Plans
Develop H&S Program
Provide Input to H&S Program
Submit Draft:
- O&M Manuals
- Spare Parts Recommendation List
- SOPs
Review Draft O&M Manual, SOPs, and Spare Parts List
Provide Input to Draft O&M Manuals, SOPs, and Spare Parts List
Changes Needed?
Yes
No
Incorporate Comments
Provide Input to Start-up Planning
Provide Maintenance Management Information
Start-up Planning and Meetings
- Includes initial process planning
Provide Input to Start-up Plans
Management Tasks
Factory Testing
Continue to Next Construction Phase
Provide Input to Staff Skills/ Training Evaluation
Evaluate Staff Skills/Training Needs
Provide Input to Staff Evaluation
Evaluate Staffing Needs
Implement MOO
Revision Information
Revision Number: V1
Revision Date: 05/4/2021
Prepared: BC
Issue Date: x/x/xx
Legend
Decision Point
Activity Box
Off-page reference
Sub-process
Start / End
Database / System
Document
Email
External data
Workflow
Automated workflow/ notification
Information exchange as needed
Acronyms
• MOO: Maintenance of Operations
• QA/QC: Quality Assurance/Quality Control
• FAT: Functional Acceptance Test
• RAT: Reliability Acceptance Test
Description
This process map has been established to ensure a standardized construction process is followed across the organization. Reference the ECPMH for more details.
Brown AND Caldwell
msd
Safe, clean waterways


Asset Management
Construction Requirements – Late to Project Closeout
DRAFT
Late Construction
Substantial Completion
Final Completion
Project Closeout
Project Manager
Project Controls
Engineering
Contractor
Consultant (Designer)
Safety
RCAM
O&M
Management Tasks
Includes, but not limited to:
- Change Management
- Requests for Information (RFIs)
- Shop Drawing Submittals
- Progress Meetings
- Pay Applications
- Risk Register updates (monthly)
- Schedule updates
Verify Project Walk-Through
Verify Final Equipment & Process Training
Verify Final O&M Manual & Warrantees Submission
Lessons Learned Session
Warranty Period Walk-Through
Project Closeout Letter
Archive Project Records
End
- Technical training rather than sales training
- Record trainings and populate in NEOGOV
- Factory and Performance Testing (including automation)
- Preliminary start-ups
Data Analysis and Documentation
Continue from Previous Construction Phase
O&M Construction Review
Manufacturing Training Program
Prepare for Project Walk-Through
Final Process Start-up and FAT
Submit O&M Manuals, SOPs, and Warrantees
Changes Needed?
Yes
No
Incorporate Comments
Submit As-Built Final Record Drawings, and Process Data
Resolve Outstanding Warranty Issues
QA/QC Maintenance Management Information
Process Training
QA/QC O&M Manuals, SOPs, and Warrantees
QA/QC FAT and Baseline Data
QA/QC RAT
The following parties, in addition to operations personnel, should be present:
- Project Manager
- Engineering
- Contractor
- Consultant (Designer)
- Safety
IPS
Populate CMMS/ Maintenance Management
Asset Decommissioning /Eliminate Spare Parts
Provide Input to Manufacturing Training Program
Project Walk-Through
Provide Input to Process Training
Provide Input to O&M Manuals, SOPs, and Warrantees
Final Acceptance of O&M Manual, SOPs, and Warrantees
Provide Input to FAT and Baseline Data
Provide Input to RAT
Provide Input to Data Analysis and Documentation
Update SOPs (As Needed)
Revision Information
Revision Number: V1
Revision Date: 05/4/2021
Prepared: BC
Issue Date: x/x/xx
Legend
Decision Point
Activity Box
Off-page reference
Sub-process
Start / End
Database / System
Document
Email
External data
Workflow
Automated workflow/ notification
Information exchange as needed
Acronyms
• MOO: Maintenance of Operations
• QA/QC: Quality Assurance/Quality Control
• FAT: Functional Acceptance Test
• RAT: Reliability Acceptance Test
Description
This process map has been established to ensure a standardized construction process is followed across the organization. Reference the ECPMH for more details.
Brown AND Caldwell
msd
Safe, clean waterways

Appendix G. Asset Class Plans Template

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3. **Routine Maintenance** ... 2
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5. **Periodic Replacements** ... 3
6. **Operational Test** ... 3
7. **Rehabilitation and Replacement** ... 3
8. **References** ... 4

1. Overview

Provide an overview of the Asset Class Plan, including what the overall asset class plan or equipment provides, quantity of equipment (if applicable), when and how it is used, etc. If applicable, attach any schematics to illustrate any equipment details.

2. Maintenance

Provide a write-up on the regular maintenance to ensure that it continues to be reliable after surpassing the anticipated XX-year useful life. A consistent approach to executing maintenance activities will not only assist in extending the useful life but will also minimize the risk of failure and increase safety for MSD employees.

3. Routine Maintenance

Routine maintenance should be completed on the following pieces of equipment according to the manufactures recommendations while considering the environmental and operational conditions that can either shorten or lengthen the period between services. The frequency and details of the services outlined below are contained in Job Plans which will be part of the Preventive Maintenance tasks stored in IPS.

Routine Maintenance Tasks		
Equipment	Maintenance Task	Frequency

4. Periodic Inspection

are required to assess how equipment is performing relative to the estimated useful life and to condition information in order to plan for capital projects and to replace equipment or perform non-routine maintenance before it fails.

Inspection Task	Frequency

5. Periodic Replacements

will be required to keep the system in operational condition. These replacements include the following items. The replacement cycle can be extended or shortened based on the condition information gathered during the periodic inspections. Insert all periodic replacement parts, some examples are shown below.

- Valve wear such as seats and packing
- Rehabilitate the pump when capacity or condition of the pump has significantly declined

6. Operational Test

In addition to the maintenance activities outlined above, insert any operational tests here. The test should be conducted through the full operating range under actual operating conditions to determine that the equipment performs satisfactorily. These tests will also provide the opportunity to address any deficiencies.

Operational Test	Frequency

7. Rehabilitation and Replacement

(Fill-out table below, some examples are shown below.)

Schedules for rehabilitation and replacement of XXXX system assets will be determined by MSD staff based on observed condition and work order history. The types of expected rehabilitation activity and normal replacement intervals are listed below.

Renewal Activity	Asset Type	Frequency (Years)
Replacement	Piping	100
Replacement	Pumps	40
Bearings/Seals/Major Maintenance	Pump Compressors Oil Accumulator System Other Mechanical Equipment	10

8. References

(Include all referenced documents here, some examples are shown below.)

1. Vender manuals
2. Regulatory Requirements

Notes (Include all notes here, some examples are shown below.)

* Future inspections intervals may increase depending on the findings during the inspection.

** This type of inspection would typically be conducted every 3 months on a piece of equipment that is operated on a regular basis throughout the year. This pump only operates 3-4 months a year. Should the operational parameters change, the frequency should be revisited.

Appendix H. Job Plan Guidance

Job Plan Guidance

Jefferson and Louisville County Metropolitan Sewer District
Brown and Caldwell
June 30, 2021

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2. **Safety** 3
3. **Maintenance Task Details** 3
4. **In-Service Testing/Acceptance** 3
5. **Task Completion** 4
6. **Labor Information – Craft** 4
7. **Labor Information – Materials** 4
8. **Labor Information – Tools** 4

The purpose of this guideline is to provide a constant approach in developing Job Plans for maintenance activities. Th content of the Job Plan will ultimately reside in the IPS under the appropriate tabs.

1. Preparation Work

- Verify correct parts and tools are ready
- Coordinate equipment isolation with operations
- Confirm equipment is isolated and drained by operations
- Determine, if entering a piece of process equipment (such as a clarifier, wet well or tank) if it has it been cleaned out
- Verify positive response from Before You Dig (BUD)
- Spill kit available
- Traffic permits

2. Safety

- Follow all safety practices before starting work on the equipment
    - Confirm LOTO procedure
    - Follow Safety Plan and fill out form, where required
    - Hot work permit
    - Confined Space procedure
    - Traffic control plan
- Apply all required isolation devices
- Before starting the task, verify all energy sources (i.e., electrical, hydraulic, mechanical, etc.) have been isolated.

3. Maintenance Task Details

(Use ID numbers for each task.)

- Include sequential step by step process for completing the maintenance task
    - Include a level of detail that is appropriate to the complexity of the task
    - Reference attachments when in-depth information is needed including specific manual and page numbers
- Include measurements
- Reference torque specifications in SOP or manual

4. In-Service Testing/Acceptance

- Conduct activity that needs to be performed to verify equipment is fully operational. Examples are provided below:
    - Bleed air from pump
    - Run pump for 30 minutes and adjust packing

- Operator verifies equipment is ready for service
- Restoration activities

5. Task Completion

- Verify Area is clean, tools and debris are all picked up
- Record all measurement points
  - i.e., Pump station drawdown information
- Return unused materials to warehouse
- Note needed in the comments section for any changes to the task and notify supervisor.

6. Labor Information – Craft

- Identify required craft Collection Systems/Treatment Plant Operator, Mech, Ins/Elec
- Identify Level of skill required (Level 1, Level 2, Level 3, HVAC, Welder)
- Identify number of craft needed
- Estimate total hours for each craft
  - For complex jobs, hours should be broken out for each task (ex. operations wash down, electrical motor maintenance, equipment operator).

7. Labor Information – Materials

- Provide item number Add quantity for materials such as oil, bar stock
- Identify stock/non-stock (stores/direct issue)

8. Labor Information – Tools

- Identify specialty tools and the Task ID it is associated with the following:
  - A-Frame
  - Lifting devices
  - Parts kits such as shims (stored and managed by the warehouse)
  - Spill kits
- Identify Inside Services (MSD equipment) - Specific equipment such as a crane or a vactor truck
  - Include operator hours in the labor tab
- Identify Outside Services (cranes, scaffold) required to complete task

Appendix I. Condition Assessment Guidance

Condition Assessment Guidance

Jefferson and Louisville County Metropolitan Sewer District

Brown and Caldwell

June 30, 2021

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Document Revision History				
Version	Summary	Editor	Date	Description of Changes
1	Initial Draft	BC	May 28, 2021	

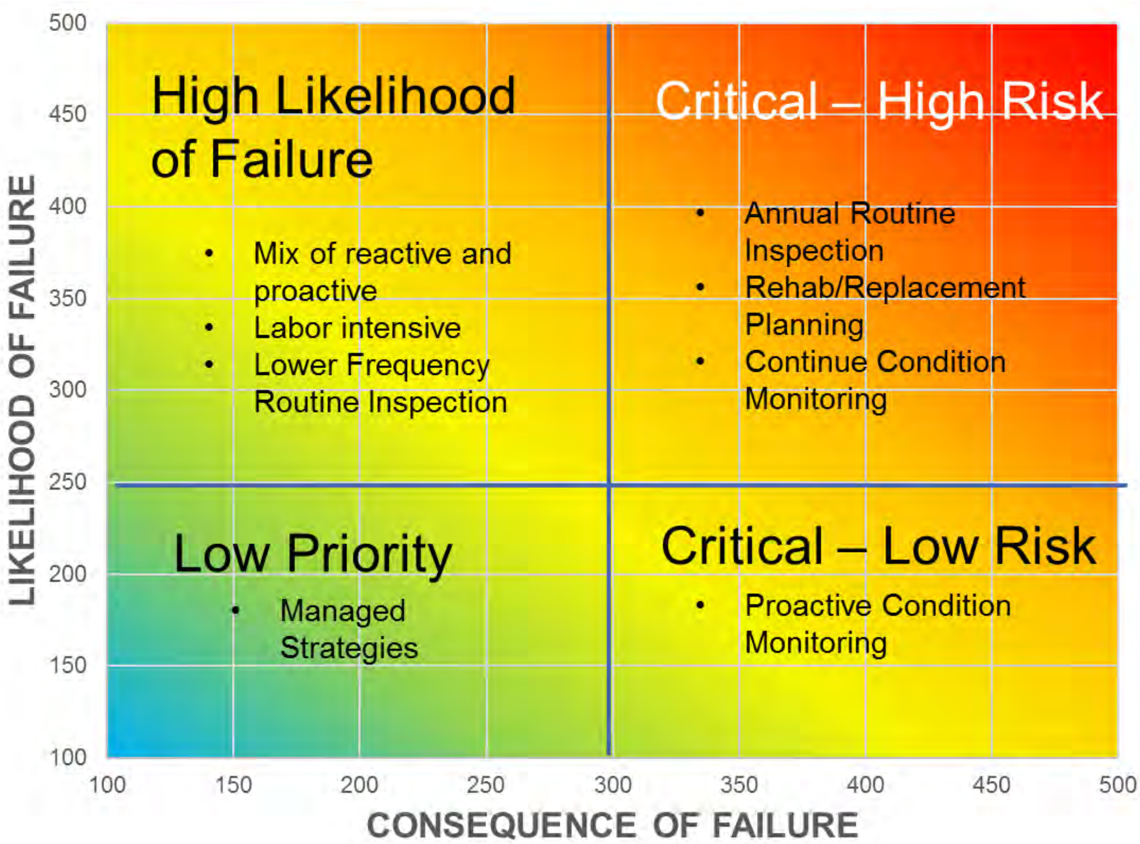
1. Purpose

The purpose of this document is to provide a reference guide for Louisville and Jefferson County Metropolitan Sewer District (MSD) staff scoring the physical condition of critical assets through the Visual Inspection process in vertical and linear assets. This guidance works in conjunction with several other documents developed as part of the Asset Management program including the Strategic Asset Management Plan (SAMP), facility or system specific Tactical Asset Management plans (TAMP), and the Consequence of Failure (CoF) and Likelihood of Failure (LoF) Guidance document.

MSD has identified critical assets for each facility based upon assigned CoF and LoF scores based on the following formula:

Risk = CoF x LoF

Assets with a certain risk threshold have been identified as 'critical-high risk' assets identified for visual inspection. These critical-high risk assets will be inspected as established in the facility specific TAMP. A list of critical high-risk assets is available in each facility specific TAMP and constitute the list of assets that will be assessed as part of the Visual Inspection.



Visual Inspection will also be performed on the high likelihood of failure assets, however at a lower frequency of inspection that will be based on the previous condition rating. To initiate the process all high likelihood of failure assets will be inspected as established in Appendix B. Those assets with a poor condition rating will have their cycles shortened; those assets with good condition ratings will have their cycles lengthened.

Critical – low risk assets will implement a proactive condition monitoring program, while managed strategies will be used for low priority assets.

1.1 Visual Inspection Benefits

Visual inspection is a sensory level inspection of the assets to document the baseline condition of the assets. Table 1.1 provides a summary of the reasons and details for visual inspection.

Table 1-1. Visual Inspection Benefit

Reason	Details
Ensure Consistency	• Standardized assessment methodology across all facilities • “Poor Condition” at Plant A should mean the same thing as “Poor Condition” at Plant B
Document Asset History	• Physical state and performance of our assets not “in someone’s head”
Inform Key Programs	• Maintenance – adjust frequency and priority of PMs • Capital – adjust priority of capital improvements
Avoid Surprises	• Verify results of desktop likelihood of failure scoring • Minimize costly catastrophic failures and emergency repairs • Predict resource needs (maintenance, rehab, renewal)
Cost-Effective “Triage”	• Trigger more detailed assessment and/or follow-up • Understand urgency/timing of corrective actions

1.2 Visual Inspection Roles and Responsibilities

The primary staff responsible for conducting visual inspection of critical assets at MSD and a brief description are depicted in Figure 1-1.

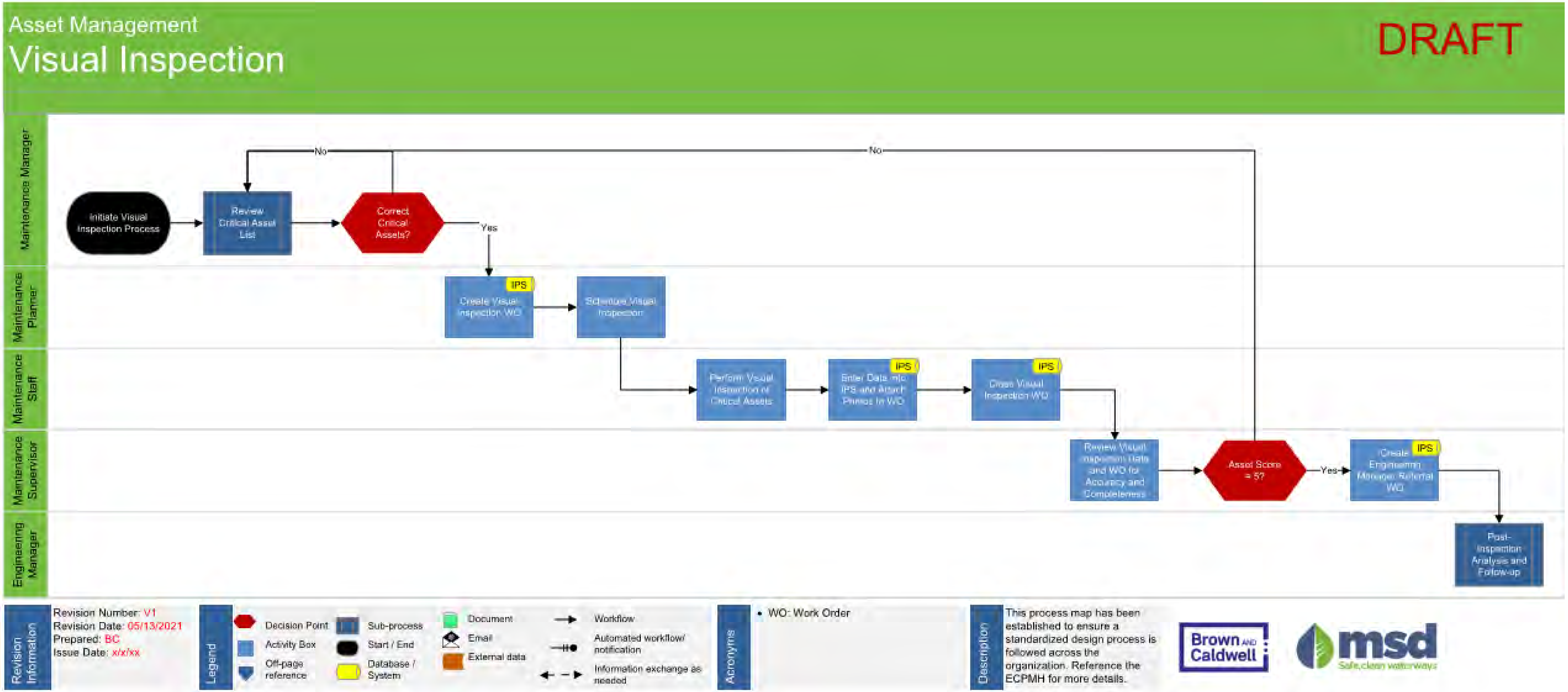


Figure 1-1. Staff Roles and Responsibilities for Visual Inspections of Critical Assets

2. Visual Inspection Scoring and Criteria

The purpose of this section is to summarize the guidelines for conducting a Visual Inspection for mechanical, electrical, structural, instrumentation and controls (I&C), and earthen feature assets.

2.1 Visual Inspection Process

The physical condition of the asset is the current state of repair and operation of the asset as influenced by age, operating environment, and historical maintenance. A Visual Inspection will be the first step in the evaluation of the physical condition of an asset and a baseline inspection will occur initially and then at a frequency as set forth in the facility specific TAMP. In practice, the assessor must initially determine if the asset is operational and functioning as intended. A flow chart depicting the Visual Inspection process is included as Figure 1-1.

2.2 Scoring Descriptions and Characteristics

All visual inspections are evaluated on a 1 to 5 scale. Assets receiving a condition score of 1 are in good condition and assets receiving a condition score of a 5 are in very poor condition. An asset with a score of 2 to 4 is intended to represent the observed condition between those good and very poor condition ratings. The following scoring descriptions and characteristics apply to all asset types for Visual Inspection of MSD assets:

2.2.1 Asset Score = 1; Very Good Condition

"Like new with little signs of wear. Monitor asset condition and no further action required at present."

2.2.1.1 Primary Equipment Characteristics

- Equipment with less than 10% of surface corroded or degraded by UV exposure.
- Equipment is not leaking or only showing evidence of historic leaks.
- Equipment does not exhibit any vibration or noise outside of normal operating levels.
- Equipment pedestals and mounting equipment less than 10% damage.
- Equipment appears to be well maintained. Note whether grease fittings appear used, filters are replaced regularly, etc.
- Equipment is in good condition and no rehabilitation or renewal actions are required.
- Earthen features less than 10% damage
- Piping and valves are well supported and maintained with no evidence of leakage or corrosion.
- Instrumentation and Local Control Panels are well maintained and functioning properly.
- Electrical connections are sound with no evidence of damage to junction boxes or conduits. All components are well supported.

2.2.2 Asset Score = 2; Good Condition

"Minor defects evident. Monitor and trend asset condition for possible additional actions."

2.2.2.1 Primary Equipment Characteristics

- Equipment could be older, but physical appearance is very good, may have been repainted since installation.
- Operating environment is generally clean and dry without the potential for excessive heat/cold (temperature changes), humidity or potential for corrosion (exposure to corrosive chemicals, H2S gas, etc.).
- Equipment may have some minor surface corrosion or UV degradation (10-25% of surfaces).
- Equipment is not leaking but may have evidence of historic leaks or may be damp.
- Equipment may exhibit very little vibration or noise outside of normal operating levels.
- Equipment pedestals and supports are not damaged and have little to no surface corrosion (10-25% of surface).
- Equipment appears to be well maintained. Equipment may have recently undergone rehabilitation/overhaul. Note whether grease fittings appear used, filters are replaced regularly, etc.
- Equipment will need only minor renewal or rehabilitation in near term.
- Piping and valves are well supported and maintained with minor surface corrosion (10-25%). There should be no visible leakage. There may be evidence of maintenance / replacement.
- Local Control Panels may have some minor maintenance issues (dents, surface corrosion 10-25%). No evidence of leakage or internal corrosion. All panel mounted instruments and devices should be functional.
- Field Instruments - All field instruments should be functional. There should be no visible leakage – could be evidence of historic leakage.
- Electrical connections are sound with no evidence of damage to junction boxes or conduits. All components are well supported. There may be evidence of maintenance/replacement.
- Earthen features have 10-25% damage with evidence of pests or vandalism.

2.2.3 Asset Score = 3; Fair Condition

“Normal signs of wear for age of asset. Continue to monitor asset condition and evaluate for rehabilitation.”

2.2.3.1 Primary Equipment Characteristics

- Equipment is generally older, with physical appearance of good to fair.
- Operating environment could be subject to periodic wet conditions or the potential for excessive heat/cold (temperature changes), humidity or potential for corrosion (exposure to corrosive chemicals, H2S gas, etc.).
- Equipment may have surface corrosion or UV degradation (>50-75% of surface) and needs painting/coating. May have significant structural corrosion affecting the structure.
- Equipment may have significant leaks but is still operating.
- Equipment may exhibit moderate vibration or noise but is still inside of normal operating levels (equipment feels and sounds rough – need to discuss with O&M staff).
- Equipment pedestals and supports may have surface cracking, grout loosening, etc. (>50-75%) and/or surface corrosion (>50-75% of surface).
- Equipment appears to require visual or preventive maintenance of normal wear items (e.g., lubrication, belts, gaskets, seals, etc.).
- Equipment will need moderate renewal or rehabilitation in near term.

- Piping and valve supports may have surface corrosion (>50-75% of surface), minor damage or require minor maintenance. There may be evidence of minor leaks (dripping or seeps).
- Local Control Panels may have some maintenance issues (dents, surface corrosion >50-75%). May have significant corrosion affecting structure. All panel mounted instruments and devices should be functional.
- Field Instruments - All field instruments should be functional. Minor leaks could be present at connections only.
- Electrical connections appear sound but conduit and/or junction boxes show damage (surface cracking, gaps – missing gaskets/seals, surface corrosion >50-75%), but are functional. Wiring is not exposed.
- Earthen features show 25-50% damage with current pests or vandalism, but the asset is still functional.

2.2.4 Asset Score = 4; Poor Condition

"Significant defects are evident. Continue to monitor asset condition, repair as needed and expediate plan for rehabilitation or replacement."

2.2.4.1 Primary Equipment Characteristics

- Equipment is generally older, with physical appearance of poor.
- Operating environment could be subject to frequent wet conditions or the potential for excessive heat/cold (temperature changes), humidity or potential for corrosion (exposure to corrosive chemicals, H_2S gas, etc.).
- Equipment has extensive surface corrosion or UV degradation (>75% of surface area) and/or evidence of structural corrosion (multiple locations).
- Equipment has heavy leakage at gaskets/connections (steady stream) and/or there is evidence of current or previous leakage from holes or other failure (>1 location).
- Equipment exhibits excessive vibration or noise but still within normal operating levels with evidence of nonstructural damage resulting from excessive vibration (loose guards, connections, etc.) - need to discuss with O&M staff.
- Equipment concrete pedestals have >75% surface cracking and/or are cracked through (<25% of pedestal) and/or steel supports are damaged (<25% of steel supports with structural corrosion, missing/broken anchors, or other similar damage).
- Equipment appears to require corrective action beyond visual or preventive maintenance of normal wear items. Action involves extended down time to implement (e.g., alignment, leveling, etc.).
- Equipment will need to be replaced or rehabilitated in near term.
- Piping and valve supports exhibit heavy surface corrosion (>75%) and/or structural corrosion (flaking, section loss). Connections are damaged with missing and/or broken anchors. There are heavy leaks on piping or valves (steady stream) and/or evidence of current or previous leakage from holes or other failure.
- Local Control Panels show heavy surface rust (>75%) and/or structural damage. Evidence of leakage and/or internal corrosion. Some panel mounted instruments/indicators with scratches and cracks, but still functional.
- Field Instruments exhibit damage, corrosion but are functional. Electrical connections appear unsound. Conduits and/or junction boxes heavily corroded or damaged (>75%) and/or wiring is not exposed.

- Earthen features show 50-75% damage with current pests or vandalism. Corrective action needed but the asset is still functional.

2.2.5 Asset Score = 5; Very Poor Condition

“Asset has failed or shows excessive wear and should be replaced as soon as possible.”

2.2.5.1 Primary Equipment Characteristics

- Equipment is generally older, with physical appearance of very poor.
- Operating environment could be subject to frequent wet conditions or the potential for excessive heat/cold (temperature changes), humidity or potential for corrosion (exposure to corrosive chemicals, H_2S gas, etc.).
- Equipment has extensive and heavy surface corrosion or UV degradation (>95% of surface area) and/or evidence of structural corrosion (2 or more locations).
- Equipment has heavy leakage at gaskets/connections (steady stream) and/or there is evidence of current or previous leakage from holes or other failure (2 or more locations).
- Equipment exhibits excessive vibration or noise outside of normal operating levels (evidence of structural damage resulting from excessive vibration – need to discuss with O&M staff).
- Equipment pedestals and/or supports are heavily damaged (cracks > ½-inch), (>3 locations with structural corrosion, missing/broken anchors, or other similar damage).
- Equipment appears inoperable in current state – need to discuss with O&M staff.
- Piping and valve supports exhibit heavy surface corrosion (>95%) and/or structural corrosion (flaking, section loss). Connections are damaged with missing and/or broken anchors. There are heavy leaks on piping or valves (steady stream > 3 locations) and/or evidence of current or previous leakage from holes or other failure – multiple locations.
- Local Control Panels show heavy surface rust (>95%) and/or structural damage (2 or more locations). Evidence of leakage and/internal corrosion. Some panel mounted instruments/indicators non-functional).
- Field Instruments show >95% surface damage or corrosion and/or are non-functional.
- Electrical connections appear unsound. Conduits and/or junction boxes heavily corroded or damaged and/or wiring is exposed.
- Earthen features show >75% damage with current pests or vandalism. Asset is not functional.

2.3 Mechanical Assets

The following table summarizes the criteria and scoring approach for a Visual Inspection of mechanical assets which include pumps, motors, HVAC, grinders, etc.:

Table 2.1 Visual Inspection Criteria for Mechanical Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Corrosion	10	Surface only	<10%	10%-50%	>50% - 75%	>75%	>95%
		Structural (loss of metal)	None or minor surface only	Multiple minor Surface	Significant corrosion affecting structure	Multiple Significant corrosion affecting structure	Major Corrosion compromising structure
Leakage	25	Gaskets / Connections	None or historic	_	Significant leakage to equipment still operating	-	Leakage level will impact equipment operation imminently
		Holes / Failures	-	-	1 location	>1 location	>3 locations
		Packing Gland/mechanical seal	Normal leakage	-	Excessive leakage with adjustment available	-	Excessive leakage with no adjustment available
Vibration	25	Noise	Within what is considered normal	-	Higher than what is expected during normal operations	-	Abnormal noise not associated with normal operation
		Vibration (measured using installed sensors)	Within Normal Operating Range	-	-	-	Above normal operating range
		Vibration Apparent with Noise	None or normal vibration	-	Moderate (vibration level sensed but within operating standards)	-	Severe vibration (level measured beyond acceptable limits)
		Non-Structural Damage	-	-	Yes	-	-
		Structural Damage	-	-	-	-	Yes
Heat	15	Measured using installed temperature gauges or heat gun (if available) with equipment operating at least 1 hour	Within Normal Operating Range (Typical 140-180)	-	10-20 degrees above normal operating range	-	>20 degrees above normal

Table 2.1 Visual Inspection Criteria for Mechanical Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Concrete Support	10	Surface Cracking / Loose Grout	Presence of surface cracks or loose grout	Multiple surface cracks	Potential loss of asset anchor point	Asset stability compromise d due to surface cracks	Asset stability failed due to surface cracks
		Spalling	<10%	10%-50%	>50% - 75%	>75%; stability compromise d	>95%; Asset stability failed
		Through Cracks	Presence of through cracks	Multiple through cracks	Foundation settling	Equipment stability compromise d	Equipment stability failed
		Missing Pieces (within 6 inches of equipment mounts)	-	-	-	1 or more	3 or more
Metal Supports	10	Surface Corrosion	<10%	10%-50%	50%-75%	>75%	>95%
		Structural Corrosion	-	-	<25%	>=25%	>=50%
		Missing/Broken Anchors	-	-	<25%	>=25%	>=50%
Painting/ coating	5	Surface only	<10%	10%-50%	>50% - 75%	>75%	>95%

Photographs depicting mechanical assets with scores corresponding to 1 (good) to 5 (very poor) are included in Appendix A.

2.4 Electrical Assets

The following table summarizes the criteria and scoring approach for a Visual Inspection for an electrical asset:

Table 2.2 Visual Inspection Criteria for Electrical Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Corrosion	10	Surface only (enclosure)	<10%	10%-50%	>50% - 75%	>75%	>95%
		Structural	None or minor surface only	Multiple minor Surface	Significant corrosion affecting structure	Multiple Significant corrosion affecting structure	Major Corrosion

Table 2.2 Visual Inspection Criteria for Electrical Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
		Connections	<10%	10%-50%	>50% - 75%	>75%	>95%
Leakage	15	Transformer/Connection Leaks	None or historic	-	Significant leakage to equipment operating	-	Leakage level will impact equipment operation imminently
Vibration/ Noise	5	Vibration (use handheld monitor)	None or normal vibration	-	Moderate (vibration level sensed but within operating standards	-	Severe vibration level measured beyond acceptable limits
		Motors noise level while operating	Normal	-	Moderate (Indicating equipment condition issue)	-	Severe noise level (indicating imminent issue)
Electrical Damage	25	Evidence of Overheating/Arcing	Within spec limits	-	Abnormal heat, but asset is still operating and possible cause for concern	-	Exceeding spec limits
		Grounding Missing/Damaged	Minor ground connection damage, No loss of ground connection	-	Corrosion evident, but can be grounding can be cleaned	-	Total loss of equipment grounding
		Cooling System	Ambient temperature is appropriate for asset operations	-	Operating temperature is above normal for asset operations	-	Ambient temperature significantly above asset operating condition and/or loss of cooling system
		Connections Loose/Broken	Cover off or missing	-	Connection loose or exposed or not properly dressed	-	Connections broken
Concrete Supports	5	Surface Cracking / Loose Grout	Presence of surface cracks or loose grout	Multiple surface cracks	Potential loss of equipment anchor point	Equipment stability compromised	Equipment stability failed

Table 2.2 Visual Inspection Criteria for Electrical Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
						due to surface cracks	due to surface cracks
		Through Cracks	Presence of through cracks	Multiple through cracks	Foundation settling	Equipment stability compromised	Equipment stability failed
Metal Supports	5	Surface Corrosion	<10%	10%-50%	>50%-75%	>75%	>95%
		Structural Corrosion	Presence of corrosion	>10%	<25%	>=25%	>=50%
		Supports/Unistrut/ channel	Support moving or vibrating	support anchor loose or severely corroded	Single Support not performing function	Supporting system compromised	Supporting system failed
Housekeeping (Cleanliness)	5	Evidence of dust	None	-	Minimal	Minor	Severe
		Evidence of pests	None	Evidence of pests, but no current activity	Present- no damage to asset	Present- minor damage. Corrective action required but asset still operating	Present- significant damage and asset not operating
		Evidence of water damage	None	-	Evidence of moisture	-	Standing water
Smell	10	Chemical, burning, etc.	Normal	-	-	-	Abnormal
Loose/Unsupported Conduit	5	Conduit damaged or not properly secured	None	-	Signs of damage, but asset functional	-	Holes in conduit or broken conduit, asset not functional
Exposed Wiring	15	Signs of exposure, cut, frayed, cracked, split, uncovered, etc.	None	-	Good	-	Insulation is significantly damaged or bare wire

Photographs depicting electrical assets with scores corresponding to 1 (good) to 5 (very poor) are included in Appendix A.

2.5 Structural Assets

The following table summarizes the criteria and scoring approach for a Visual Inspection for structural assets:

Table 2.3 Visual Inspection Criteria for Structural Assets							
Criteria	Weight	Evaluation	1= Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Paint/ Coating	5	Missing paint or coating	<10%	10%-50%	>50% - 75%	>75%	>95%
Leakage	15	Cracks/Joints /Penetrations/Failures	None or Historic only	Damp	Drip or seep	Stream >1 loc	Stream >3 loc
Concrete/ Masonry Surface Damage/Joint Damage	15	Cracking (Width of crack)	< 1/16 inches	1/16-1/8 inches	1/8-1/4 inches	>1/4 inches	>1/2 inches
		Exposed Reinforcement	-	-	1 location	>1 location	>3 locations
		Spalling, Exposed Aggregate., Pitting, Delamination, Freeze/Thaw Damage	<10%	10%-50%	>50% - 75%	>75%	>95%
		Settling/Heaving	-	-	1 location	>1 location	>3 locations
Metal Damage	15	Cracking	-	-	1 location	>1 location	>3 locations
		Fatigue/Connection Failure	-	-	1 location	>1 location	>3 locations
		Seating (gate and valves)	Fully seated	minor wear	wear with minor leakage	significant leakage, but manageable	complete bypass of gate or valve
		Deformation	<10%	10-50%	>50% - 75%	>75%	>95%
		Corrosion/Metal Loss	<10%	10-50%	>50% - 75%	>75%	>95%
Wood Damage	5	Dry Rot	-	-	1 location	>1 location	>3 locations
		Warping/Splitting	-	-	1 location	>1 location	>3 locations
		Biological Growth (algae)	<10%	10-50%	>50% - 75%	>75%	>95%
		Connection Failure (nail pops)	-	-	1 location	>1 location	>3 locations
		Loss of Section	<10%	10-50%	>50% - 75%	>75%	>95%

Table 2.3 Visual Inspection Criteria for Structural Assets							
Criteria	Weight	Evaluation	1= Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Water/ Drainage	5	Evidence of Standing Water along Foundation, walkways, driveways (soil settling)	Inadequate grass cover	-	Swale; <1-foot wide and 1-inch deep	-	Ponded; >2-foot wide and 3-inches deep
Asphalt Surfaces	5	Sealer Missing	<10%	10-50%	>50% - 75%	>75%	>95%
		Roadbed Failure	<10%	10-50%	>50% - 75%	>75%	>95%
		Cracking	<10%	10-50%	>50% - 75%	>75%	>95%
		Heaving/potholes	None or <2 inches deep	-	>2 inches deep and less than 12-inch diameter	-	>6 inches deep and >12-inches in diameter
		Aggregate Exposure	<10%	10-50%	>50% - 75%	>75%	>95%
Roof Condition	10	Ponding	<10%	10-50%	>50% - 75%	>75%	>95%
		Shingle Grit Loss/cracking	<10%	10-50%	>50% - 75%	>75%	>95%
		Missing Shingles	-	-	<10	>10	>20
		Dry Rot of Rubber Membrane	-	-	1 location	>1 location	>3 locations
		Metal roofing damage	-	-	1 location	>1 location	>3 locations
		Torn/split Membrane	-	-	1 location	>1 location	>3 locations
		Flashing Issues	-	-	1 location	>1 location	>3 locations
		Attic space Issues/leaks	-	-	1 location	>1 location	>3 locations
Windows/ doors	10	Broken Glass	None	-	Cracked	-	Broken or Missing
		Caulking	None or minor issues	-	Noticeable/ loose caulking	-	>50% caulk loose or missing
		Leakage	None	-	Moisture present between windowpanes	-	Leaking
		Warpage/alignment/rot	None or minor issues	-	Issue noted, but still functional	-	Not functional

Table 2.3 Visual Inspection Criteria for Structural Assets							
Criteria	Weight	Evaluation	1= Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
		Hardware Issues	None or minor issues	-	Issue noted, but still functional	-	Not functional
Security and Fencing	15	Fence Damage	None or minor issues	-	Issue noted, but still functional	-	Asset not functional and security risk
		Gate	None or minor issues	-	Issue noted, but still functional	-	Asset not functional and security risk
		Access issues (lock, actuator, scanner)	None or minor issues	Asset functional	Asset functional, but signs of wear	Significant condition issues noted, but asset functional	Missing, damaged, or cut and asset not functional

Photographs depicting structural assets with scores corresponding to 1 (good) to 5 (very poor) are included in Appendix A.

2.6 Instrumentation and Control Assets

The following table summarizes the criteria and scoring approach for a Visual Inspection of instrument and control assets which include meters, PLCs, control centers, etc.:

Table 2.4 Visual Inspection Criteria for Instrument and Control Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Corrosion	10	Surface only (enclosure)	<10%	10%-50%	>50% - 75%	>75%	>95%
		Structural	None or minor surface only	Multiple minor Surface	Significant corrosion affecting structure	Multiple Significant corrosion affecting structure	Major Corrosion
		Connections	<10%	10%-50%	>50% - 75%	>75%	>95%
Mounted Instruments	20	Damaged/non-functional devices	No Damage	-	Environmental interference present (dirt, grease, etc.) and can be	-	Not functioning

Table 2.4 Visual Inspection Criteria for Instrument and Control Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
					restored with cleaning		
Concrete Supports	5	Presence of surface cracks or loose grout	Multiple surface cracks	Potential loss of equipment anchor point	Equipment stability compromised due to surface cracks	Equipment stability failed due to surface cracks	Equipment stability failed due to surface cracks
		Presence of through cracks	Multiple through cracks	Foundation settling	Equipment stability compromised	Equipment stability failed	Equipment stability failed
Metal Supports	5	Surface Corrosion	<10%	10%-50%	>50%-75%	>75%	>95%
		Structural Corrosion	Presence of corrosion	>10%	<25%	>=25%	>=50%
		Supports/Unistrut/ channel	Support moving or vibrating	support anchor loose or severely corroded	Single Support not performing function	Supporting system compromised	Supporting system failed
Housekeeping (Cleanliness)	5	Evidence of dust	None	-	Minimal	Minor	Severe
		Evidence of pests	None	Evidence of pests, but no current activity	Present- no damage to asset	Present- minor damage. Corrective action required by asset still functional	Present- significant damage and asset not functional
		Evidence of water damage	None	-	Evidence of moisture	-	Standing water
Loose/Unsupported Conduit	5	Conduit damaged or not properly secured	None	-	Signs of damage, but asset functional	-	Holes in conduit or broken conduit, asset not functional
Human Machine Interface (HMI)	25	Display	No Damage	Dirt/sludge on display screen or touchpad	Pixilation or touch screen/keypad not operating as designed, but unit has limited functionality	Sun fade or scratches/cracks on the screen	Not functioning
Battery Life	5	Status	Charged	-	Low Battery Alarm	-	Drained
Communications (modem, ethernet, etc.)	20	Signal	No damage, operational	-	Damaged equipment/loose connections	-	Not functioning

Photographs depicting process mechanical assets with scores corresponding to 1 (good) to 5 (very poor) are included in Appendix A.

2.7 Earthen Feature Assets

The following table summarizes the criteria and scoring approach for a Visual Inspection of earthen feature assets which include levees, channels, basins, etc.:

Table 2.5 Visual Inspection Criteria for Earthen Feature Assets

Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Erosion	20	Bank caving	<10%	10-25%	25-50%	>50% - 75%	>75%
		Washout	Inadequate grass cover	-	Swale; <1-foot wide and 1-inch deep	-	Ponded; >2-foot wide and 3-inches deep
		Siltation	None	-	10-25%	-	>25%
		Seepage	None or Historic only	Damp	Drip or seep	Stream >1 loc	Stream >3 loc
Obstructions	20	Percentage obstructed	<10% obstructed	-	25-50% obstructed	-	>50% obstructed
Vegetation	5	Grass/sod missing	<10%	10-25%	25-50%	>50% - 75%	>75%
		Weeds, undesirable vegetation present (Johnson grass and woody vegetation)	None	-	10-25%	-	>25%
Trash/debris	5	Number of trash/debris (MSD responsibility and/or ability to block flow)	None	-	Present- asset functional	-	Present- asset not functional
Access roads/road ramps	5	Damage and accessibility (roadbed failure/ obstruction)	<10%	10-25%	25-50%	>50% - 75%	>75%
Damage	10	Pest Damage	None	Evidence of pests, but no current activity	Present- no damage to asset	Present- minor damage. Corrective action required but asset still functional	Present- significant damage and asset not functional
		Vandalism	None	Evidence of vandalism, but no current activity	Present- no damage to asset	Present- minor damage. Corrective action required but asset still functional	Present- significant damage and asset not functional
Concrete/	5	Cracking (Width of crack)	< 1/16 inches	1/16-1/8 inches	1/8-1/4 inches	>1/4 inches	>1/2 inches

Table 2.5 Visual Inspection Criteria for Earthen Feature Assets							
Criteria	Weight	Evaluation	1 = Very Good	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Joint Damage		Exposed Reinforcement	-	-	1 location	>1 location	>3 locations
		Missing Pieces (within 6 inches of equipment mounts)	-	-	-	>1 location	>3 locations
		Spalling, Exposed Aggregate., Pitting, Delamination, Freeze/Thaw Damage	<10%	10%-50%	>50% - 75%	>75%	v
		Settling/Heaving	-	-	1 location	>1 location	>3 locations
Encroach-ments	10	Objects in Right of Way	None	Vegetative	Woody Vegetation	Gates/Fences	Structures
Security and Fencing	20	Fence Damage	None or minor issues	-	Issue noted, but still functional	-	Asset not functional and security risk
		Gate	None or minor issues	-	Issue noted, but still functional	-	Asset not functional and security risk
		Access issues (lock, actuator, scanner)	None or minor issues	Asset functional	Asset functional, but signs of wear	Significant condition issues noted, but asset functional	Missing, damaged, or cut and asset not functional

Photographs depicting process mechanical assets with scores corresponding to 1 (good) to 5 (very poor) are included in Appendix A.

3. Visual Inspection Documentation

3.1 Visual Inspection Form

The following form was developed for the visual inspection of the critical assets at each plant and the pump stations. A consolidated assessment form was created to capture process mechanical, structural, and electrical condition of an asset, as applicable. Inspection efforts will utilize a mobile inspection form with the same criteria and entry fields. An example Visual Inspection Form is shown below:

MECHANICAL - VISUAL INSPECTION ASSESSMENT FORM

Asset ID		Asset Description:	
Assessor's Name:		Date of Assessment:	___/___/_____

Photos *(keep photo size low (~2 mb) - turn time/date stamp on)*

Did you take a photo? yes no (if yes, attach to work order)

Extra photos for major damage (all 5's) or project specific purposes? yes no

(Circle one score in every row. If not applicable, circle the choice in column 1.)

Criteria	Evaluation	1	2	3	4	5
Corrosion	Surface only	<10%	10%-50%	>50% - 75%	>75%	>95%
	Structural (loss of metal)	None or minor surface only	Multiple minor Surface	Significant corrosion affecting structure	Multiple Significant corrosion affecting structure	Major Corrosion compromising structure
Leakage	Gaskets / Connections	None or historic	-	Significant leakage to eqmt still operating	-	Leakage level will impact equipment operation imminently
	Holes / Failures	-	-	1 location	>1 location	>3 locations
	Packing Gland / mechanical seal	Normal leakage	-	Excessive leakage with adjustment available	-	Excessive leakage with no adjustment available
Vibration/Noise	Noise	Within what is considered normal	-	Higher than what is expected during normal operations	-	Abnormal noise not associated with normal operation
	Vibration (measured using installed sensors)	Within Normal Operating Range	-		-	Above normal operating range
	Vibration Apparent with Noise	None or normal vibration	-	Moderate (vibration level sensed but within operating standards)	-	Severe vibration (level measured beyond acceptable limits)
	Non-Structural Damage	-	-	Yes	-	-
	Structural Damage	-	-	-	-	Yes
Heat	Measured using installed temperature gauges or heat gun (if available) with equipment operating at least 1 hour	Within Normal Operating Range (Typical 140-180)	-	10-20 degrees above normal operating range	-	>20 degrees above normal
Concrete Support	Surface Cracking / Loose Grout	Presence of surface cracks or loose grout	Multiple surface cracks	Potential loss of asset anchor point	Asset stability compromised due to surface cracks	Asset stability failed due to surface cracks
	Spalling	<10%	10%-50%	>50% - 75%	>75%; stability compromised	>95%; Asset stability failed
	Through Cracks	Presence of through cracks	Multiple through cracks	Foundation settling	Equipment stability compromised	Equipment stability failed
	Missing Pieces (within 6 inches of equipment mounts)	-	-	-	1 or more	3 or more
Metal Supports	Surface Corrosion	<10%	10%-50%	50%-75%	>75%	>95%
	Structural Corrosion	-	-	<25%	>=25%	>=50%
	Missing/Broken Anchors	-	-	<25%	>=25%	>=50%
Painting/coating	Surface only	<10%	10%-50%	>50% - 75%	>75%	>95%

ADDITIONAL COMMENTS:

Figure 3.1 Visual Inspection Form

3.2 Visual Inspection Equipment

Following completion of the Visual Inspection activities, data and photos should be available for review in Infor Public Sector. Note- assets that are rated a ‘5’ for one or more criteria will require a work order for additional evaluation. Although Visual Inspection is a sensory level assessment, some equipment may be useful to document the asset condition. At a minimum, the assessor should have the following equipment available for use during a Visual Inspection:

- Digital Camera to photo document observed asset condition
- Tape Measure to evaluate structural cracking.
- Flashlight to provide additional lighting as necessary
- Temperature gun to assess temperature of equipment
- Rag or cloth to wipe away debris or material from an asset tag
- Small Wire Brush to assess presence of historic leakage

3.3 Photo Documentation

It is important to document the asset condition during a Visual Inspection and digital cameras will be provided to document observed conditions for possible review during follow-up. Photos will also be loaded into Infor Public Sector on the work order to document asset condition over time. The following guidelines should be followed regarding photo documentation:

- Set camera at lowest megapixel setting (1-2 MB).
- Set-up date stamping
- Record photo number on assessment sheet
- Rename photo to Asset ID after downloading
- Take photos sparingly:
  - One photo minimum per group and one per structure.

Additional photo of individual assets in very poor condition- all assets scoring a 5 require additional photos for engineering referral.

3.4 Program Execution

Condition assessment approaches and intervals will be established based on the Condition Assessment Methods in Appendix B. Assets will be scheduled in Infor Public Sector as a recurring work order for planning and tracking.

Asset CoF and LoF will be re-evaluated on an annual basis to group assets accordingly on the matrix. Visual Inspections will be performed on critical – high risk and high likelihood of failure asset categories.

4. Post-Visual Inspection Analysis

The purpose of this section is to summarize the guidelines for conducting analysis and follow-up after the Visual Inspections have been completed and the results have been compiled.

4.1 Overall Condition Score

An overall condition score will be calculated in IPS for each asset that was inspected as follows:

- The highest score for each criterion is the score for that criteria.
- The criteria score is multiplied by the weight of that criteria.
- The weighted criteria score is totaled for the asset and is used as the overall condition score.
- If multiple asset inspection types apply to the asset being assessed, then both are performed, and the higher score is used for the asset.

4.2 Scoring Analysis

Analysis of the scores will include not only high scores (i.e., ‘5’s) but also looking at score trends over time. Once the overall condition score has been calculated, it can be compared to the historical scores to identify changes in condition over time to predict asset failure before it happens and to determine the best timing for mitigation activities such as repair, rehabilitation, replacement, and modification of the maintenance strategy for that asset.

4.2.1 Physical Condition Scores

As the physical condition scores of critical high-risk and high likelihood of failure assets are monitored and trended over time, the following recommended actions may be taken for the given scoring ranges:

- 1: No immediate action required
- 2: Consider if asset is a good candidate for condition monitoring*, set the visual inspection frequency to 2 years
- 3: Consider if asset is a good candidate for condition monitoring*, continue with 1-year visual inspection frequency
- 4: Develop estimate of remaining useful life, develop scope/plan for rehabilitation and replacement, develop costs to plan timing for budget/funding needs, continue 1-year visual inspection frequency until repairs can be made
- 5: Immediate corrective action required

*Note: Condition monitoring readings of concern should trigger a work order for conducting a visual inspection as part of troubleshooting the issue.

4.3 Engineering Follow-up and Troubleshooting

As shown in the Visual Inspection process (Figure 1-1), the Engineering Manager will receive an Engineering Referral Work Order in instances where the asset receives an individual observation score of five (5) for any criteria category. The Post-Visual Inspection Analysis and Follow-up process shown in Figure 4-1 includes the steps to be taken by engineering. The outcome of the follow-up activities conducted by engineering may include:

- Verification of score
- Referral for repair by MSD maintenance staff

- Scoping and planning for rehabilitation and replacement by MSD staff or outside contractor within the plant budget
- Scoping and planning for rehabilitation and replacement for referral to CIP
- Referral for adjustment of maintenance strategy
- Rescoring of asset upon maintenance, rehabilitation, or replacement

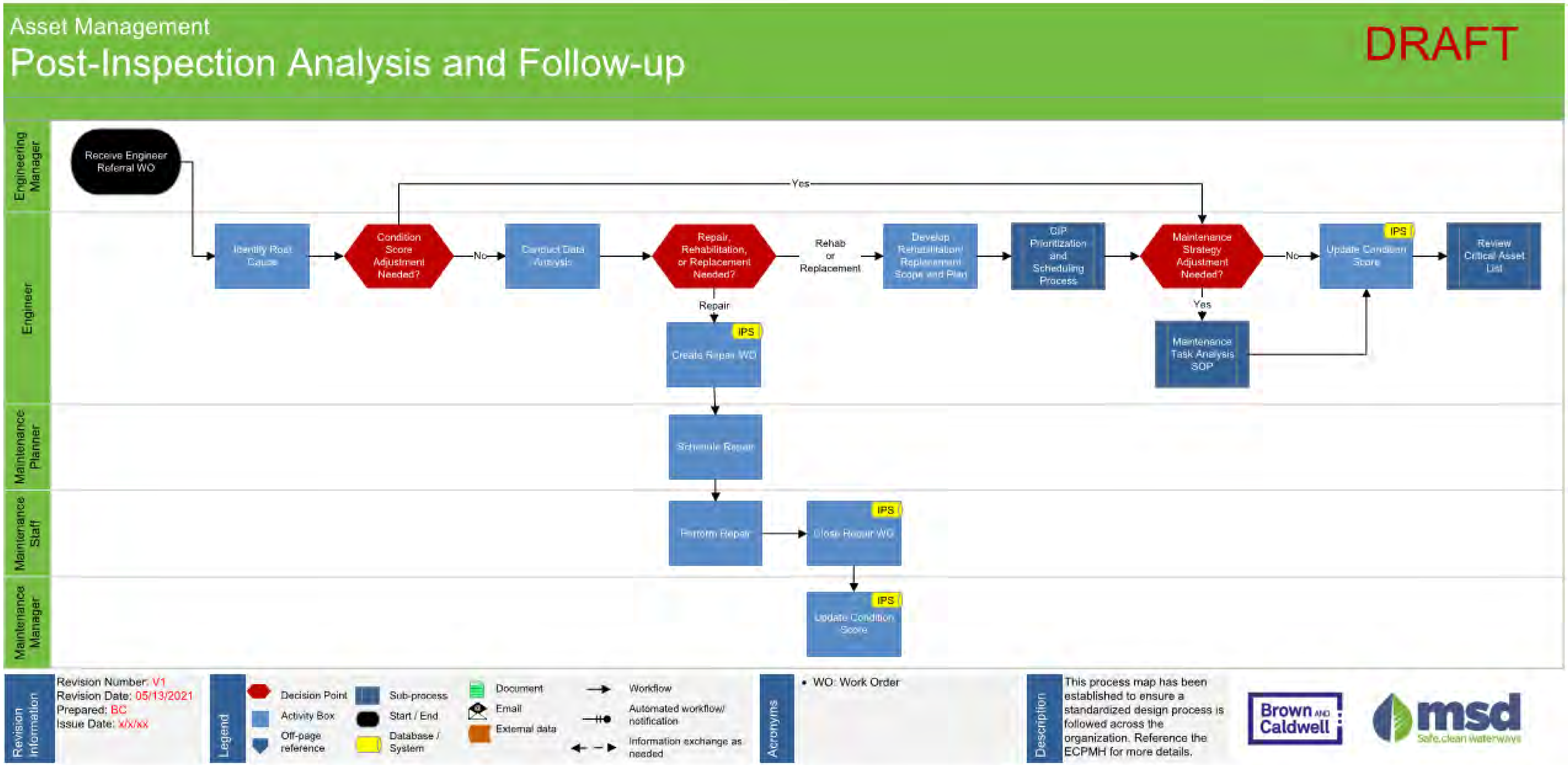


Figure 4-1. Post-Visual Inspection Analysis and Follow-up Process

Appendix A. Inspection Photographs

Mechanical Assets in Very Good Condition

Table A.1 Mechanical Asset in Very Good Condition: Score = 1	
	<10% Surface corrosion and historic leakage only noted.
	No corrosion or leakage noted.

Table A.1 Mechanical Asset in Very Good Condition: Score = 1	
	No corrosion; new asset.
	<10% corrosion and evidence of historic leakage.

Table A.1 Mechanical Asset in Very Good Condition: Score = 1	
	No signs for vibration. Corrosion <10% and historic only leakage noted.

Mechanical Equipment in Good Condition

Table A.2: Mechanical Equipment in Good Condition: Score = 2	
	Surface corrosion 10-50%, evaluate for recoating.

Mechanical Equipment in Fair Condition

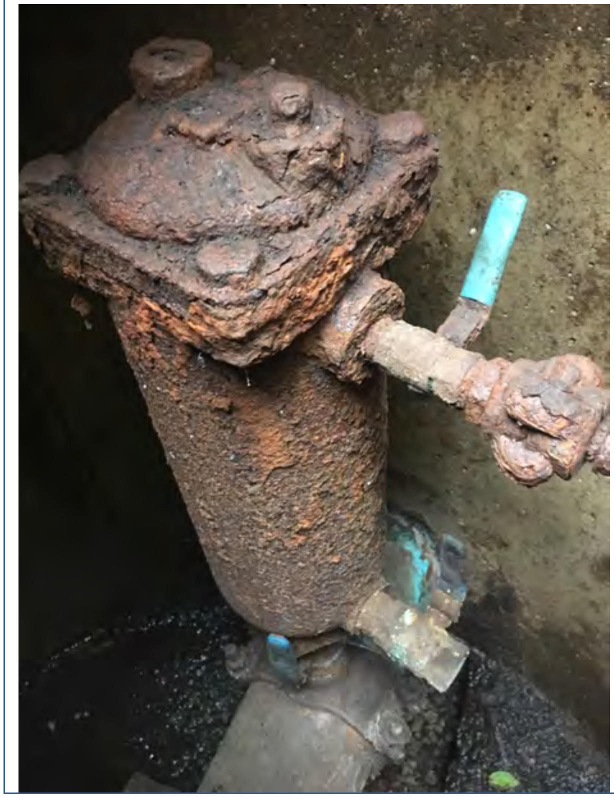
Table A.3: Mechanical Equipment in Fair Condition: Score = 3	
	Leakage noted (drip only).

Mechanical Equipment in Poor Condition

Table A.4: Mechanical Equipment in Poor Condition: Score = 4	
	Leakage and metal support structural corrosion >=25% noted.
	Surface corrosion noted, but not compromising the asset. Evaluate for recoating.

Mechanical Equipment in Very Poor Condition

Table A.5: Mechanical Equipment in Very Poor Condition: Score = 5	
	Major corrosion compromising structure, structural corrosion >50%
	Stream leakage noted.
	Major corrosion compromising structure, structural corrosion >50%

Table A.5: Mechanical Equipment in Very Poor Condition: Score = 5	
	Major structural corrosion compromising structure, Coating missing >95%
	Major structural corrosion compromising structure, Coating missing >95%

Electrical Equipment in Very Good Condition

Table A.6: Electrical Equipment in Very Good Condition: Score = 1	
	Local control panel with no corrosion. Like new condition.

Table A.6: Electrical Equipment in Very Good Condition: Score = 1	
	No evidence of corrosion; covers and panels in good condition. No evidence of leakage or visible damage.

Table A.6: Electrical Equipment in Very Good Condition: Score = 1	
	Minor surface only corrosion and panels in good condition. No visible damage or loose conduit.

Electrical Equipment in Good Condition

Table A.7: Electrical Equipment in Good Condition: Score = 2	
	Surface corrosion (<50%), no leakage or visible damage noted.

Electrical Equipment in Fair Condition

Table A.8: Electrical Equipment in Fair Condition: Score = 3	
	Evident signs of corrosion.

Electrical Equipment in Poor Condition

Table A.9: Electrical Equipment in Poor Condition: Score = 4	
	Multiple significant structural corrosion affecting structure. Metal supports structural corrosion >25%

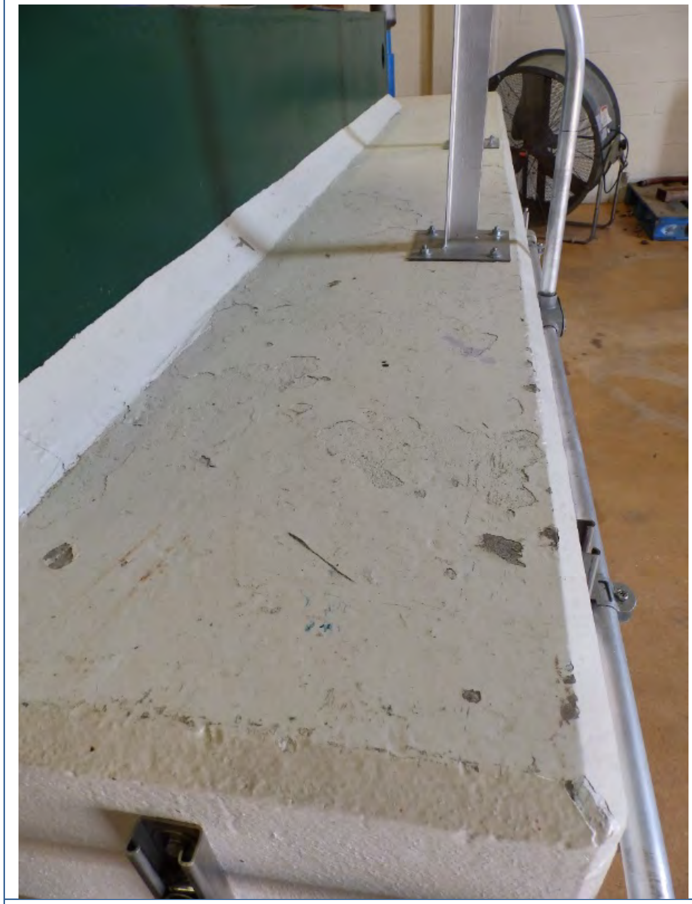
Electrical Equipment in Very Poor Condition

Table A.10: Electrical Equipment in Very Poor Condition: Score = 5	
	Corrosion on inside of panel that compromises asset. Corrosion has completed eroded metal.
	Evidence of pests that compromise asset performance

Table A.10: Electrical Equipment in Very Poor Condition: Score = 5	
	Visible Damage on exterior of panel, Evidence of overheating/arcing exceeding spec limits.

Structural Assets in Very Good Condition

Table A.11: Structural Asset in Very Good Condition: Score = 1	
	Concrete shows no signs of spalling, cracking, leakage, or exposed rebar.
	Concrete pedestal showing no signs of cracking, leakage, or spalling.

Table A.11: Structural Asset in Very Good Condition: Score = 1	
	<10% spalling of concrete, no cracks observed, no exposed rebar. No structural corrosion observed.
	Concrete cracking <1/16 inches, spalling <10%, metal loss <10%

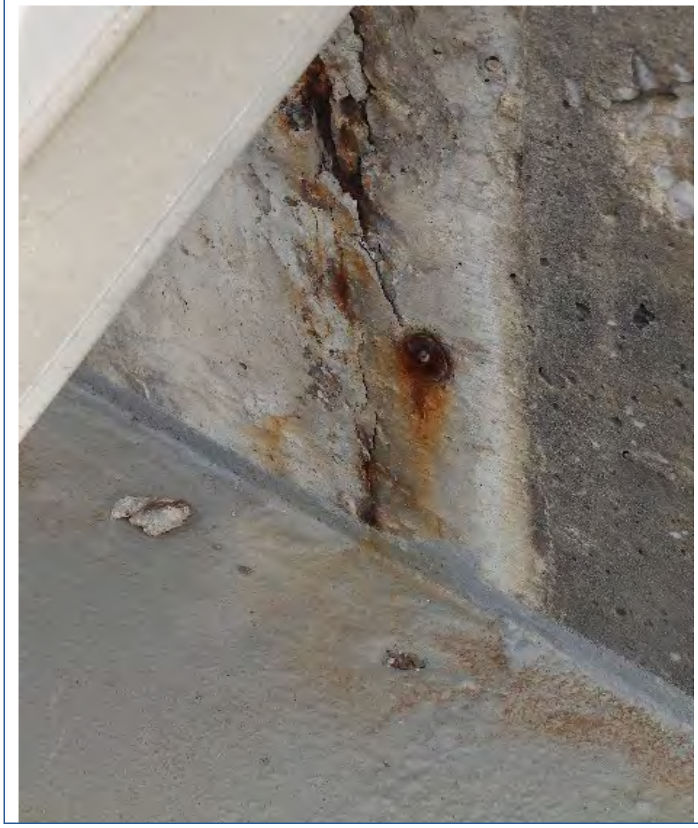
Structural Assets in Good Condition

Table A.12: Structural Assets in Good Condition: Score = 2	
	Security access issues, asset functional
	Cracks >1/16-inch and >10% spalling.

	(Metal Housing) Metal corrosion 10-50%

Structural Assets in Fair Condition

Table A.13: Structural Assets in Fair Condition: Score = 3	
	Concrete showing some (<25%) spalling and evidence of cracking.
	Moderate surface corrosion 10-50%, Missing paint >50%-75%

Table A.13: Structural Assets in Fair Condition: Score = 3	
	Exposed rebar at one location with >50-75% concrete spalling.

Structural Assets in Poor Condition

Table A.14: Structural Assets in Poor Condition: Score = 4	
	Cracking > ¼ inch
	(concrete basin) Concrete cracking >1/4-inch, spalling >75%

Table A.14: Structural Assets in Poor Condition: Score = 4


Structural Asset in Very Poor Condition

Table A.15: Structural Asset in Very Poor Condition: Score = 5	
	Exposed reinforcement >3 locations, cracking > ½ inch
	(metal platform) Metal corrosion >95%, missing coating >95%, metal fatigue >3 locations

Table A.15: Structural Asset in Very Poor Condition: Score = 5	
	
	Connection failure >3 locations, corrosion/metal lost >95%
	Concrete cracking > ½ inch, freeze/thaw damage >95%, metal loss >95%, water damage >2-foot wide and 3-inches deep

Table A.15: Structural Asset in Very Poor Condition: Score = 5	
	Connection failure >3 locations,
	Concrete cracking >1/2inch, damage >95%
	Concrete crack >1/2 inch

Instrument and Control Assets in Very Good Condition

Table A.16: Instrumentation and Control Assets in Very Good Condition: Score = 1	
	Corrosion none or minor surface only, no damage,
	Corrosion none or minor surface only, no damage,

Instrumentation and Controls Assets in Good Condition

Table A.17: Instrumentation and Control Assets in Good Condition: Score = 2	
	Good housekeeping, no evident damage. PLC cabinet has minor external corrosion.

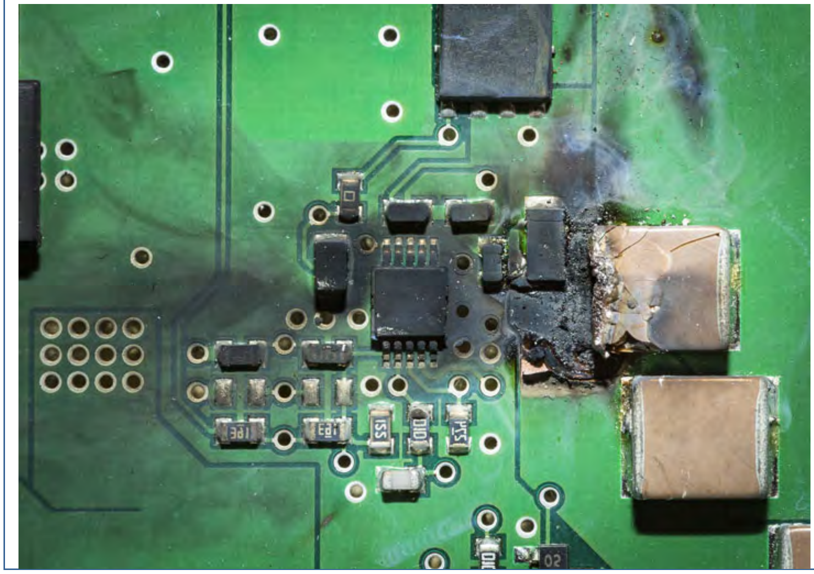
Instrumentation and Controls Assets in Fair Condition

Table A.18: Instrumentation and Control Assets in Fair Condition: Score = 3	
	Slow response and outdated screen, but unit functional

Instrumentation and Controls Assets in Poor Condition

Table A.19: Instrumentation and Control Assets in Poor Condition: Score = 4	
	Damaged HMI screen with scratches evident.

Instrumentation and Controls Assets in Very Poor Condition

Table A.20: Instrumentation and Control Assets in Very Poor Condition: Score = 5	
	Surge damaged PLC board.

Earthen Feature Assets in Very Good Condition

Table A.21: Earthen Feature Assets in Very Good Condition: Score = 1	
	New completion-
	New drainage feature

Earthen Feature Assets in Good Condition

Table A.22: Earthen Feature Assets in Good Condition: Score = 2	
	Debris noted, ditch in good condition
	Vegetation noted, good condition

Earthen Feature Assets in Fair Condition

Table A.23: Earthen Feature Assets in Fair Condition: Score = 3	
	Vegetation 10-25%
	Debris present – asset functional,
	Access road damage 25-50%

Earthen Feature Assets in Poor Condition

Table A.24: Earthen Feature Assets in Poor Condition: Score = 4	
	Vandalism present – minor damage but asset still functional
	Vandalism present – minor damage but asset still functional, vegetation missing >50-75%

Earthen Feature Assets in Very Poor Condition

Table A.25 Earthen Feature Assets in Very Poor Condition: Score = 5	
	Erosion bank caving >75%, vegetation missing >75%
	Bank caving >75%, washout >2-foot wide and 3-inches deep, grass/sod missing >75%

Table A.25 Earthen Feature Assets in Very Poor Condition: Score = 5	
	Bank caving >75%, washout >2-foot wide and 3-inches deep, grass/sod missing >75%
	Erosion washout >2-foot wide and 3-inches deep, grass missing

Appendix B. Condition Assessment Methods

Table B.1: Condition Assessment Techniques (Vertical Assets)					
Analysis	Asset Type	Data Source	MSD or Contractor?	Data Collection Frequency	Data Usage
Visual Inspection- AHU Filters	HVAC- AHUs	Visual condition	MSD	• Bi-weekly and monthly (MFWQTC)	Maintenance Strategy
Visual Inspection- Critical Assets	Critical Assets, All Equipment	Visual condition	MSD	• As determined in TAMPs	Maintenance Strategy, Project Initiation, and Project Prioritization
Visual Inspection/Performance Testing- Flood Pumps	Flood Pumps	Visual/Performance Data	MSD	• Monthly test run, amp, DC volts, • 3-month visual on pipes etc. • 6-month (Starkey pumps pull and inspect plus change wear rings), • Annual electrical inspection and amp on panels (test run and quarterly regulatory)	Maintenance Strategy, Project Initiation, and Project Prioritization
Visual- Pump Station	Pump Station	Visual and Signal Testing	MSD	• Monthly (Generally, 3 or more pumps, CSO or Flood)or bi-monthly inspection for smaller stations	Maintenance Strategy
Visual Inspection- Screens	Bar racks and screens, grinders (FP)	Visual condition	MSD	• 2 weeks (stations/FPS) • Monthly and Quarterly (PS) • 1 week (WQTCs by operators) • Monthly, Annual (WQTCs by maintenance) • Manual screen after each rain event (Collections)	Maintenance Strategy, Project Initiation, and Project Prioritization
Battery Check	UPS (small)	Instrument measured	MSD	• Quarterly battery status ()	Maintenance Strategy, Project Initiation, and Project Prioritization
Boiler Water/Cooling Water Loops	Boilers	Analytical results	Contractor	• Monthly (MFWQTC)	Maintenance Strategy
Performance Testing	Pumps	Performance Data	MSD	• 6-month (Collections) • Annual (Future State in WQTCs)	Maintenance Strategy, Project Initiation, and Project Prioritization
Laser Alignment Check	Pumps/motors	Instrument measured	MSD	• Future State • Critical assets first	Maintenance Strategy

Table B.1: Condition Assessment Techniques (Vertical Assets)					
Analysis	Asset Type	Data Source	MSD or Contractor?	Data Collection Frequency	Data Usage
Load Testing	Generators	Instrument measured	MSD	• Weekly station load, annual electrical PM (Collections) • Monthly plant load, no load bank testing (WQTCs)	Maintenance Strategy
Meg and Current Testing	Motors	Instrument measured	MSD	• Annual (PS and FPS) • Future state (WQTCs)	Maintenance Strategy, Initiate project, Troubleshooting for runtime
Oil Analysis and separate line for coolant	Engine/ generators, final clarifiers, transformers, blowers	Analytical results	Contractor	• Annual for Transformers (MFWQTC and DRGWQTC) • Annual Generators over 65KW (Collections) (MFWQTC and DRGWQTC) all regionals • Large Motor every 5 years (FPS)	Maintenance Strategy
Physical Dimension Measurement	Pump wear rings, Clarifier wear strips and shoes, and large number of devices	Direct Measure	MSD	• Future State (WQTCs) • Pump Annual wear rings (Collections)	Maintenance Strategy, Project Initiation, and Project Prioritization
Relay Tests	Switchgear	Instrument measured	Contractor	• Annual (FPS) • Annual Future State (WQTCs)	Maintenance Strategy
Thermography/Infrared	Electrical systems (substations, MCCs, switchgear)	Instrument measured	Contractor/MSD	• As needed, expanded future state (Collections) • Future state program in place • Annual electrical PM (FPS) • Future State (WQTCs)	Maintenance Strategy
Vibration (external and on-line)	Rotating equipment (fans, pumps, blowers)	Instrument measured	Contractor and MSD	• Annual PM on motor and pumps (Collections) • Future state (WQTCs) • Future state for data analysis (Collections)	Maintenance Strategy

Appendix J. PCR Codes

Linear PCR Codes			
Asset	**Problem**	**Cause**	**Remedy**
Service Line/Cleanout	Adjustment Needed	Contractor/Third Party Caused Problem	Adjust
	Broken / Damaged	Corrosion	CCTV
	Cave-In	Crack(s)	Clean
	Erosion	Debris (Trash/Sticks)	Dye Test
	Flood	Flood	Flush
	Leaking/Seepage	FOG	Inspect (Site)
	Missing parts	Hardware (Stem/Rounded Nut)	Install/commission
	Odor	Hole	Locate
	Overflowing/Surcharge	Improper Installation/Construction	No Action
	Settlement	Inflow/Infiltration	Rehab
	Stoppage	Joint Failure	Relocate (Clean out)
	Unable to Locate/Missing	Other Structural Failure	Remove Obstruction
	Vandalism	Paper/Rags/Other Obstructions	Remove/Decommission
		Rocks	Repair
		Roots	Replace
Manhole (CSO)	Adjustment Needed	Animals	Adjust
	Broken / Damaged	Contractor/Third Party Caused Problem	Clean
	Cave-In	Corrosion	Dye Test
	Erosion	Crack(s)	Flush
	Flood	Debris (Trash/Sticks)	Inspect (Site)
	Leaking/Seepage	Flood	Install/commission
	Missing parts	FOG	Locate
	Odor	Hardware (Stem/Rounded Nut)	Mow
	Overflowing/Surcharge	Hole	No Action
	Settlement	Improper Installation/Construction	No Problem Found
	Stoppage	Inflow/Infiltration	Rehab
	Unable to Locate/Missing	Joint Failure	Relocate
	Vandalism	Mechanical Failure	Remove Obstruction
	Weeds/Vegetation	Missing Material (Brick etc)	Remove/Decommission
		Other Structural Failure	Repair
		Paper/Rags/Other Obstructions	Replace
		Rocks	
Valve		Roots	
	Adjustment Needed	Contractor/Third Party Caused Problem	Adjust
	Alarm	Corrosion	CCTV
	Broken / Damaged	Crack(s)	Clean
	Cave-In	Flood	Flush
	Erosion	FOG	Inspect (Site)
	Flood	Hardware (Stem/Rounded Nut)	Install/commission
	Hard to Operate	Hole	Lubricate
	Leaking/Seepage	Improper Installation/Construction	No Action
	Missing parts	Inflow/Infiltration	No Problem Found
	Odor	Joint Failure	Operate

Linear PCR Codes			
Asset	Problem	Cause	Remedy
	Overflowing/Surcharge	Lack of Lubrication	Rehab
	Settlement	Mechanical Failure	Relocate
	Stoppage	Mud/Silt/Sludge	Remove Obstruction
	Unable to Locate/Missing	Operator Error	Remove/Decommission
	Vandalism	Other Structural Failure	Repair
	Weeds/Vegetation	Packing	Replace
		Paper/Rags/Other Obstructions	
		Roots	
Gate	Adjustment Needed	Contractor/Third Party Caused Problem	Adjust
	Alarm	Corrosion	CCTV
	Broken / Damaged	Crack(s)	Clean
	Hard to Operate	Erosion	Flush
	Leaking/Seepage	Flood	Inspect (Site)
	Missing parts	Hardware (Stem/Rounded Nut)	Install/commission
	Settlement	Hole	Lubricate
	Stoppage	Improper Installation/Construction	No Action
	Unable to Locate/Missing	Inflow/Infiltration	No Problem Found
	Vandalism	Joint Failure	Operate
		Lack of Lubrication	Rehab
		Mechanical Failure	Remove Obstruction
		Mud/Silt/Sludge	Remove/Decommission
		Operator Error	Repair
		Other Structural Failure	Replace
		Rocks	
Forcemain	Broken / Damaged	Contractor/Third Party Caused Problem	Adjust
	Cave-In	Corrosion	CCTV
	Leaking/Seepage	Crack(s)	Check Pressure
	Overflowing/Surcharge	Debris (Trash/Sticks)	Clean
	Settlement	Flood	Dye Test
	Stoppage	FOG	Flush
	Unable to Locate/Missing	Hardware (Stem/Rounded Nut)	Inspect (Site)
	Vandalism	Hole	Install/commission
		Improper Installation/Construction	Locate
		Joint Failure	No Action
		Other Structural Failure	No Problem Found
		Paper/Rags/Other Obstructions	Rehab
			Relocate
			Remove Obstruction
			Remove/Decommission
			Repair
			Replace
Gravity/Drainage Main	Broken / Damaged	Contractor/Third Party Caused Problem	Adjust

Linear PCR Codes			
Asset	Problem	Cause	Remedy
	Cave-In	Corrosion	CCTV
	Leaking/Seepage	Crack(s)	Clean
	Odor	Debris (Trash/Sticks)	Dye Test
	Overflowing/Surcharge	Flood	Flush
	Settlement	FOG	Inspect (Site)
	Stoppage	Hole	Install/commission
	Vandalism	Improper Installation/Construction	Locate
		Inflow/Infiltration	No Action
		Joint Failure	No Problem Found
		Missing Material (Brick etc.)	Rehab
		Mud/Silt/Sludge	Remove Obstruction
		Other Structural Failure	Remove/Decommission
		Paper/Rags/Other Obstructions	Repair
		Rocks	Replace
		Roots	
Catch Basin	Adjustment Needed	Contractor/Third Party Caused Problem	Adjust
	Broken / Damaged	Corrosion	CCTV
	Cave-In	Crack(s)	Clean
	Leaking/Seepage	Debris (Trash/Sticks)	Dye Test
	Missing parts	Flood	Flush
	Odor	FOG	Inspect (Site)
	Overflowing/Surcharge	Hardware (Stem/Rounded Nut)	Install/commission
	Settlement	Hole	Locate
	Stoppage	Improper Installation/Construction	No Action
	Unable to Locate/Missing	Inflow/Infiltration	No Problem Found
	Vandalism	Joint Failure	Rehab
	Weeds/Vegetation	Missing Material (Brick etc.)	Relocate
		Mud/Silt/Sludge	Remove Obstruction
		Other Structural Failure	Remove/Decommission
		Paper/Rags/Other Obstructions	Repair
		Rocks	Replace
		Roots	
Levee/Earthen Basin	Alarm	Animals	CCTV
	Broken / Damaged	Contractor/Third Party Caused Problem	Check Pressure
	Erosion	Crack(s)	Clean
	Leaking/Seepage	Encroachment	Inspect (Site)
	Overflowing/Surcharge	Erosion	Install/commission
	Settlement	Flood	Mow
	Vandalism	Hole	No Action
	Weeds/Vegetation	Improper Installation/Construction	No Problem Found
		Inflow/Infiltration	Rehab
		Mud/Silt/Sludge	Remove Obstruction
		Operator Error	Remove/Decommission
		Other Structural Failure	Repair

Linear PCR Codes			
Asset	Problem	Cause	Remedy
		Roots	
Dam	Alarm	Animals	CCTV
	Broken / Damaged	Contractor/Third Party Caused Problem	Clean
	Erosion	Crack(s)	Inspect (Site)
	Leaking/Seepage	Encroachment	Install/commission
	Overflowing/Surcharge	Erosion	Mow
	Settlement	Flood	No Action
	Vandalism	Hole	No Problem Found
	Weeds/Vegetation	Improper Installation/Construction	Rehab
		Inflow/Infiltration	Remove Obstruction
		Joint Failure	Remove/Decommission
		Other Structural Failure	Repair
		Roots	
Channel	Broken / Damaged	Animals	CCTV
	Erosion	Contractor/Third Party Caused Problem	Clean
	Odor	Corrosion	Inspect (Site)
	Overflowing/Surcharge	Crack(s)	Install/commission
	Settlement	Encroachment	Mow
	Stoppage	Erosion	No Action
	Vandalism	Flood	No Problem Found
	Weeds/Vegetation	Hole	Rehab
		Improper Installation/Construction	Remove Obstruction
		Inflow/Infiltration	Remove/Decommission
		Joint Failure	Repair
		Mud/Silt/Sludge	
		Other Structural Failure	
		Rocks	
Flood Wall	Alarm	Animals	CCTV
	Broken / Damaged	Contractor/Third Party Caused Problem	Clean
	Erosion	Corrosion	Inspect (Site)
	Leaking/Seepage	Crack(s)	Install/commission
	Settlement	Encroachment	No Action
	Vandalism	Erosion	No Problem Found
	Weeds/Vegetation	Flood	Rehab
		Hardware (Stem/Rounded Nut)	Remove Obstruction
		Improper Installation/Construction	Remove/Decommission
		Inflow/Infiltration	Repair
		Joint Failure	
		Missing Material (Brick etc)	
		Operator Error	
		Other Structural Failure	
Head Walls	Broken / Damaged	Animals	Clean
	Cave-In	Contractor/Third Party Caused Problem	Inspect (Site)
	Erosion	Corrosion	Install/commission
	Leaking/Seepage	Crack(s)	Locate

Linear PCR Codes			
Asset	Problem	Cause	Remedy
	Missing parts	Erosion	Mow
	Overflowing/Surcharge	Flood	No Action
	Settlement	Improper Installation/Construction	No Problem Found
	Stoppage	Inflow/Infiltration	Rehab
	Unable to Locate/Missing	Joint Failure	Remove Obstruction
	Vandalism	Missing Material (Brick etc.)	Remove/Decommission
	Weeds/Vegetation	Mud/Silt/Sludge	Repair
		Other Structural Failure	Replace

Vertical PCR Codes			
Asset	**Problem**	**Cause**	**Remedy**
Grounds	Alarm (Process/Security)	Animals	Clean
	Broken/Damaged	Contractor/Third Party Damage	Flush
	Communication Fail	Debris (Trash/Sticks)	Inspect (Site)
	Erosion/Settlement	Encroachment	Install/Commission
	Flood	Erosion	Mow
	Overflow/Surcharge	Missing Material (Brick etc.)	No Action
	Trash Debris	Overgrowth	No Problem Found
	Vandalism	Paint	Refer to Contractor
	Weeds/Vegetation	Theft/Vandalism	Rehab
		Weather	Remove/Decommission
			Repair
			Spray (Grounds)
Structure	Alarm (Process/Security)	Animals	CCTV
	Broken/Damaged	Broken Pipe	Clean
	Communication Fail	Contractor/Third Party Damage	Flush
	Corrosion	Corrosion	Inspect (Site)
	Flood	Cracks	Install/Commission
	Leak/Seepage	Debris (Trash/Sticks)	No Action
	Odor	Encroachment	No Problem Found
	Overflow/Surcharge	Erosion	Paint
	Trash Debris	Hardware (Stem/Rounded Nut)	Refer to Contractor
	Vandalism	High Level Drywell	Rehab
	Weeds/Vegetation	Hole	Remove/Decommission
		Joint Failure	Repair
		Low Level Drywell	
		Missing Material (Brick etc)	
		Paint	
		Power Outage	
		Rocks	
		Theft/Vandalism	
		Vault Damage	
		Weather	
Valve	Alarm (Process/Security)	Bearing Bad	Adjust
	Broken/Damaged	Contractor/Third Party Damage	CCTV
	Communication Fail	Corrosion	Clean
	Corrosion	Debris (Trash/Sticks)	Dye Test
	Hard to Operate	Hardware (Stem/Rounded Nut)	Flush
	Leak/Seepage	Improper Installation/Construction	Install/Commission
	Vandalism	Joint Failure	Lubricate
		Lack of Lubrication	No Action
		Mechanical Failure	No Problem Found
		Mud/Silt/Sludge	Operate

Vertical PCR Codes			
Asset	**Problem**	**Cause**	**Remedy**
		Operator Error	Paint
		Other Structural Failure	Refer to Contractor
		Out of Tolerance	Rehab
		Packing	Remove Obstruction
		Paint	Remove/Decommission
		Paper/Rags/Other Obstructions	Repair
		Rocks	Replace
		Roots	
		Theft/Vandalism	
		Vault Damage	
Gate	Alarm (Process/Security)	Bearing Bad	Adjust
	Broken/Damaged	Contractor/Third Party Damage	CCTV
	Communication Fail	Corrosion	Clean
	Corrosion	Debris (Trash/Sticks)	Dye Test
	Hard to Operate	Hardware (Stem/Rounded Nut)	Install/Commission
	Leak/Seepage	Improper Installation/Construction	Lubricate
	Vandalism	Joint Failure	No Action
	Vibration	Lack of Lubrication	No Problem Found
		Mechanical Failure	Operate
		Mud/Silt/Sludge	Paint
		Other Structural Failure	Refer to Contractor
		Out of Tolerance	Rehab
		Paint	Remove Obstruction
		Paper/Rags/Other Obstructions	Remove/Decommission
		Rocks	Repair
		Roots	Replace
		Theft/Vandalism	
		Vault Damage	
Pump	Alarm (Process/Security)	Bearing Bad	Adjust
	Broken/Damaged	Cavitation	Check Pressure
	Communication Fail	Contractor/Third Party Damage	Clean
	Corrosion	Control Failure	Flush
	Flood	Corrosion	Install/Commission
	Leak/Seepage	Debris (Trash/Sticks)	Lubricate
	Vandalism	FOG	No Action
	Vibration	Hardware (Stem/Rounded Nut)	No Problem Found
		Improper Installation/Construction	Operate
		Lack of Lubrication	Paint
		Mechanical Failure	Refer to Contractor
		Motor Fail	Rehab
		Operator Error	Remove Obstruction
		Packing	Remove/Decommission
		Paint	Repair

Vertical PCR Codes			
Asset	Problem	Cause	Remedy
		Paper/Rags/Other Obstructions	Replace
		Power Outage	
		Rocks	
		Roots	
		Theft/Vandalism	
Motor	Alarm (Process/Security)	Bearing Bad	Install/Commission
	Broken/Damaged	Contractor/Third Party Damage	Lubricate
	Communication Fail	Corrosion	No Action
	Corrosion	Hardware (Stem/Rounded Nut)	No Problem Found
	Leak/Seepage	Improper Installation/Construction	Operate
	Vandalism	Lack of Lubrication	Paint
	Vibration	Motor Fail	Refer to Contractor
		Paint	Rehab
		Roots	Remove/Decommission
		Theft/Vandalism	Repair
			Replace
Bar Screen	Alarm (Process/Security)	Bearing Bad	Adjust
	Blockage	Contractor/Third Party Damage	Clean
	Broken/Damaged	Corrosion	Install/Commission
	Communication Fail	Debris (Trash/Sticks)	Lubricate
	Corrosion	FOG	No Action
	Vandalism	Hardware (Stem/Rounded Nut)	No Problem Found
	Vibration	Improper Installation/Construction	Operate
		Lack of Lubrication	Refer to Contractor
		Mechanical Failure	Rehab
		Mud/Silt/Sludge	Remove Obstruction
		Operator Error	Remove/Decommission
		Out of Tolerance	Repair
		Paint	Replace
		Paper/Rags/Other Obstructions	
		Power Outage	
		Rocks	
		Roots	
		Theft/Vandalism	
Grinder	Alarm (Process/Security)	Bearing Bad	Adjust
	Blockage	Contractor/Third Party Damage	Check Pressure
	Broken/Damaged	Control Failure	Clean
	Communication Fail	Corrosion	Flush
	Corrosion	Debris (Trash/Sticks)	Install/Commission
	Leak/Seepage	FOG	Lubricate
	Vandalism	Hardware (Stem/Rounded Nut)	No Action
	Vibration	Improper Installation/Construction	No Problem Found

Vertical PCR Codes			
Asset	Problem	Cause	Remedy
		Lack of Lubrication	Operate
		Low Level Drywell	Paint
		Mechanical Failure	Refer to Contractor
		Mud/Silt/Sludge	Rehab
		Operator Error	Remove Obstruction
		Out of Tolerance	Remove/Decommission
		Paint	Repair
		Paper/Rags/Other Obstructions	Replace
		Power Outage	
		Rocks	
		Roots	
		Theft/Vandalism	
Hoist	Alarm (Process/Security)	Bearing Bad	Adjust
	Broken/Damaged	Contractor/Third Party Damage	Clean
	Communication Fail	Corrosion	Flush
	Corrosion	Hardware (Stem/Rounded Nut)	Install/Commission
	Hard to Operate	Improper Installation/Construction	Lubricate
	Vandalism	Lack of Lubrication	No Action
	Vibration	Mechanical Failure	No Problem Found
		Missing Material (Brick etc)	Operate
		Operator Error	Refer to Contractor
		Paint	Rehab
		Power Outage	Remove/Decommission
		Theft/Vandalism	Repair
			Replace
Electrical	Alarm (Process/Security)	Animals	Adjust
	Broken/Damaged	Contractor/Third Party Damage	Clean
	Communication Fail	Control Failure	Flush
	Corrosion	Corrosion	Install/Commission
	Flood	Hardware (Stem/Rounded Nut)	No Action
	Vandalism	Improper Installation/Construction	No Problem Found
		Motor Fail	Refer to Contractor
		Operator Error	Rehab
		Paint	Remove/Decommission
		Power Outage	Repair
		Theft/Vandalism	Replace
I&C	Alarm (Process/Security)	Animals	Adjust
	Broken/Damaged	Contractor/Third Party Damage	Check Pressure
	Communication Fail	Corrosion	Clean
	Corrosion	Hardware (Stem/Rounded Nut)	Install/Commission
	Flood	Improper Installation/Construction	No Action
	Vandalism	Operator Error	No Problem Found

Vertical PCR Codes			
Asset	**Problem**	**Cause**	**Remedy**
		Paint	Refer to Contractor
		Power Outage	Rehab
		Theft/Vandalism	Remove/Decommission
			Repair
			Replace
Generator	Alarm (Process/Security)	Bearing Bad	Clean
	Broken/Damaged	Contractor/Third Party Damage	Flush
	Communication Fail	Corrosion	Install/Commission
	Corrosion	Hardware (Stem/Rounded Nut)	Lubricate
	Flood	Improper Installation/Construction	No Action
	Leak/Seepage	Lack of Lubrication	No Problem Found
	Vandalism	Mechanical Failure	Operate
		Motor Fail	Paint
		Operator Error	Refer to Contractor
		Paint	Rehab
		Power Outage	Relocate
		Theft/Vandalism	Remove/Decommission
			Repair
			Replace
Odor Control	Alarm (Process/Security)	Bearing Bad	Adjust
	Broken/Damaged	Broken Pipe	Check Pressure
	Communication Fail	Cavitation	Clean
	Corrosion	Control Failure	Flush
	Leak/Seepage	Corrosion	Install/Commission
	Odor	Cracks	Lubricate
	Vandalism	Hardware (Stem/Rounded Nut)	No Action
	Vibration	Hole	No Problem Found
		Improper Installation/Construction	Operate
		Joint Failure	Paint
		Lack of Lubrication	Refer to Contractor
		Mechanical Failure	Rehab
		Operator Error	Remove/Decommission
		Out of Tolerance	Repair
			Replace
Safety Equipment	Alarm (Process/Security)	Broken Pipe	Adjust
	Broken/Damaged	Contractor/Third Party Damage	Clean
	Corrosion	Corrosion	Flush
	Flood	Cracks	Install/Commission
	Hard to Operate	Flood	Lubricate
	Leak/Seepage	Hardware (Stem/Rounded Nut)	No Action
	Vandalism	Improper Installation/Construction	No Problem Found
		Mechanical Failure	Operate

Vertical PCR Codes			
Asset	**Problem**	**Cause**	**Remedy**
		Coatings	Apply Coating
		Theft/Vandalism	Repair
		Weather	Replace
Tanks	Alarm (Process/Security)	Contractor/Third Party Damage	Clean
	Blockage	Control Failure	Flush
	Broken/Damaged	Corrosion	Inspect (Site)
	Communication Fail	Cracks	Install/Commission
	Corrosion	Debris (Trash/Sticks)	No Action
	Leak/Seepage	FOG	No Problem Found
	Odor	Hardware (Stem/Rounded Nut)	Refer to Contractor
	Overflow/Surcharge	High Level Drywell	Rehab
	Trash Debris	Hole	Remove Obstruction
	Vandalism	Improper Installation/Construction	Remove/Decommission
		Joint Failure	Repair
		Low Level Drywell	Replace
		Missing Material (Brick etc.)	
		Mud/Silt/Sludge	
		Operator Error	
		Other Structural Failure	
		Paint	
		Paper/Rags/Other Obstructions	
		Theft/Vandalism	
Other Mech	Alarm (Process/Security)	Bearing Bad	Adjust
	Broken/Damaged	Cavitation	Clean
	Communication Fail	Contractor/Third Party Damage	Install/Commission
	Corrosion	Control Failure	Lubricate
	Hard to Operate	Corrosion	No Action
	Vandalism	Debris (Trash/Sticks)	No Problem Found
	Vibration	FOG	Operate
		Hardware (Stem/Rounded Nut)	Paint
		Improper Installation/Construction	Refer to Contractor
		Lack of Lubrication	Rehab
		Mechanical Failure	Remove/Decommission
		Motor Fail	Repair
		Operator Error	Replace
		Out of Tolerance	
		Packing	
		Paint	
		Paper/Rags/Other Obstructions	
		Power Outage	
		Theft/Vandalism	
Elevators	Alarm (Process/Security)	Contractor/Third Party Damage	Adjust

Vertical PCR Codes			
Asset	Problem	Cause	Remedy
	Blockage	Control Failure	Clean
	Broken/Damaged	Corrosion	Install/Commission
	Communication Fail	Hardware (Stem/Rounded Nut)	Lubricate
	Corrosion	Improper Installation/Construction	No Action
	Hard to Operate	Lack of Lubrication	No Problem Found
	Vandalism	Mechanical Failure	Operate
	Vibration	Motor Fail	Paint
		Operator Error	Refer to Contractor
		Other Structural Failure	Rehab
		Out of Tolerance	Relocate
		Paint	Remove Obstruction
		Power Outage	Remove/Decommission
		Theft/Vandalism	Repair
			Replace

Appendix K. Draft Risk Register

Draft Risk Register

Risk ID	Risk Event	Risk Description	Effects/ Impacts	LIKELIHOOD		CONSEQUENCE		Risk	Risk Strategy	Risk Strategy Priorities
				Likelihood Score	Likelihood Justification	Consequence Score	Consequence Justification			
1	Regional Force Main Break	Regional (large diameter) force main breaks reaching waters of the US	- Environmental impacts. Potential discharge to creeks, rivers and streams - Economic impacts - Community/neighborhood impacts - Reputation/public relations impact - Public health and safety	3		4	Spill. Location specific (near bodies of water or not). Potential for fish kill	12	- Contingency/Emergency Response Plans - Force main walks (visual assessment) and ARV inspections performed annually - Forensics on failures after they happen for lessons learned - Engineering standard changes for ARV material and replacement of stainless steel ARVs to prevent corrosion - Testing and assessment - Soil testing and/or geotech assessment/modeling	**- Develop Contingency/Emergency Response Plans for regional force mains.** Have sewer overflow response protocol, but not targeted to large diameter force mains. - Force main walks (visual assessment) and ARV inspections performed annually **- Forensics on failures after they happen for lessons learned** **- Engineering standard changes for pipe/ARV material and replacement of stainless steel ARVs to prevent corrosion** **- Testing and assessment** **- Engineering standard changes to require pig port (access point) for new force mains to allow for future testing and assessment** **- Soil testing and/or geotech assessment/modeling**
2	Regional WW Pump Station Failure	Regional wastewater pump station failure reaching waters of the US	- Environmental impacts. Potential discharge to creeks, rivers and streams - Economic impacts - Community/neighborhood impacts - Reputation/public relations impact - Public health and safety	2		4	Spill + could back up into homes. Higher economic impact than a force main failure.	8	- Preventive maintenance - Contingency/Emergency Response Plans - Critical pare parts - Capacity assessments, including drawdown tests - Condition assessment - Standby generators/ backup power	
3	Large Diameter Gravity Sewer Structural Failure	Large diameter structural failure (cave-ins, collapse) of gravity sewer	- Public health and safety - Regulatory impacts - Economic impacts - Public relations impacts	4		5	Potential for loss of life, longer outage/disruption	20	- Proactive inspection - Risk-based rehabilitation or replacement - Soil testing and/or geotech assessment/modeling - Forensics on failures after they happen for lessons learned (i.e. like materials failing)	- Large diameter sewers are on an inspection schedule (CCTV, laser profiling, sonar) - Identify through inspection the high risks for rehabilitation and replacement - Have a risk register for large diameter sewers, includes pipe material **- No geotech assessments or soil testing** **- No forensics** - Doing some hydraulic modeling to look at where failures would have the biggest impact
4	Insufficient Collection System Capacity	Insufficient design capacity in the collection system	- Public health and safety - Regulatory impacts - Economic impacts, including development - Public relations impacts - Basement backups	5		2	Economic/development impacts	10	- Facility planning and hydraulic modeling - Capital improvements - Monitoring of future development and determination of available capacity	
5	Dry-weather CSO	Dry-weather CSO discharges to waters of the US	- Public health and safety - Regulatory impacts - Economic impacts - Environmental impacts	5		4	Potential for fish kill due to higher concentration entering bodies of water	20	- Preventive maintenance - Visual inspection - Flow meters in manholes - Visual inspection and calibration of flow meters - Level sensors upstream of the dam to identify CSO before it occurs	- Currently do weekly visual inspections of CSOs - Have flow meters on the outfalls - Have SOPs for how flows are calculated at each outfall - Have visual inspection and calibration of flow meters **- Do not havel level sensors upstream of the dam to identify CSO before it occurs (notifications not set up)**
6	Insufficient WWTP Capacity	Insufficient design capacity at a wastewater treatment plant	- Economic impacts, including development - Regulatory impacts - Odor issues - Public health and safety - Capital impacts - Health and safety	3	Existing facilities. Could change with future acquisitions.	5	Major system impacts, high cost, next to waters of the US	15	- Facility planning and hydraulic modeling - Capital improvements - Monitoring of future development and determination of available capacity - Monitor regulatory changes that could impact capacity	- Ongoing Facility planning and hydraulic modeling - Ongoing Capital improvements - Ongoing Monitoring of future development and determination of available capacity - Ongoing Monitor regulatory changes that could impact capacity
7	Lack of Available Land for Expansion	Lack of available land for expansion and/or new facilities	- Economic impacts - Reputation impacts - Delay to project schedules - Regulatory impacts	4		3		12	- Proactively search for available land adjacent to facilities - Negotiate/buy options with adjacent landowners - Monitor and prevent encroachment on existing facilities - Identify areas where expansion might be needed as part of Facility Planning	**- Implement proactively searching for available land adjacent to facilities** **- Pursue Negotiate/buy options with adjacent landowners** - Monitor and prevent encroachment on existing facilities - Identify areas where expansion might be needed as part of Facility Planning
8	Unauthorized Discharge to WWTP	Unauthorized discharge to a wastewater treatment plant (industrial, chemical, solids)	- Pass-through at the plant - Health and safety - Regulatory compliance	2	Has only happened once in last 15 years	4	Short-term impact. Potential for fish kill due to higher concentration entering bodies of water. Could shut down the plant.	8	- Industrial Waste Department implements Pretreatment program - Monitor what is discharged and who discharges it (flow and pollutants of concern) - Conduct more inspections of dischargers	

Draft Risk Register

Risk ID	Risk Event	Risk Description	Effects/ Impacts	LIKELIHOOD Likelihood Score	Likelihood Justification	CONSEQUENCE Consequence Score	Consequence Justification	Risk	Risk Strategy	Risk Strategy Priorities
9	Sabotage & Vandalism	Sabotage and/or vandalism at a facility	- Public health and safety - Economic impacts - Public relations	3	Numerous examples of injuries from stealing copper wires	5		15	- Security monitoring - Identify key locations where stolen equipment is sold - Analyze existing reports on vandalism and theft to identify key locations - Fences, locks, etc. to secure facilities	- Security monitoring currently done. Evaluating other facilities that need it and adding monitoring at those sites. - Identified key locations where stolen equipment is sold **- Analyze existing reports on vandalism and theft to identify key locations** - Evaluate security needs for new facilities as part of design process. - Fences, locks, etc. are put in place to secure facilities
10	Widespread Power Outage	Widespread power outages with generator failure or lack of standby power	- Structural or road flooding - Property damage - Public health and safety - Economic impacts - Environmental impacts	3		5	Potential to impact multiple facilities. Loss of life potential.	15	- Capital projects to add more generators and standby power capabilities (portable and onsite) - Contingency and emergency response plans - Preventive maintenance and testing/inspections of generators - Prioritize critical sites where standby power would be needed - Solar power	- Previously identified flood-prone areas ("flooders") based on historical flooding and installed backup generators at sanitary sewer pump stations - Capital projects to add more generators and standby power capabilities (portable and onsite) at new sanitary sewer pump stations and/or at stations that are being upgraded - Have PMs and testing on onsite generators **- Consider documenting site-specific contingency and emergency response plans at sites that don't have generators (i.e. Flood Pump Stations where back up power is not feasible)** **- Update prioritization of critical sites where standby power would be needed basend on Regionalization and as part of the TAMP development** - Opportunities for use of solar power. - Currently have battery backup power on instrumentation and communications at stations. Alarms set up to notify when power has been lost.
11	Odor Issues	Odor issues	- Customer complaints - Regulatory impacts	5	Receive multiple calls a day in dry-weather.	2		10	- Chemical treatment - Source determination - FOG Program - Address untrapped catch basins - Proactive watering down in dry times - Public education - Odor eliminators	
12	Pressure to Reprioritize Projects	Stakeholder pressure to change / reprioritize projects	- Economic impacts - Customer impacts - Reprioritization of projects - Reputation impacts	3	Changes in requirements and stakeholders are fairly common. Current service levels may not allow for all requests to be addressed.	3	Economic impacts	9	- Strong justification for priority and the design - Education of the public and other stakeholders	
13	Regulatory Changes	Regulatory changes	- EPA/DOW/USACE/APCD changes impacts and can restrict or expand current processes - Economic impacts - Customer impacts - Reprioritization of projects	3		3	Have time to prepare for changes.	9	- Participation in industry organizations to monitor and provide input to potential changes - Maintaining relationships with Regulators - Facility planning	
14	Third-party Collection System Damage	Third-party damages critical MSD collection system infrastructure	- Public health and safety - Environmental impacts - Economic impacts - Public relations impacts - Regulatory impacts	3	Assumes critical infrastructure is less common.	4		12	- Contingency and emergency response plans - Put a deterrent in place, including legal/enforcement actions - Full and accurate asset inventory - Processes associated with utility locates	- Contingency and emergency response plans. Have an overflow response plan protocol. **- Develop a cost recovery process** - Put a deterrent in place, including legal/enforcement actions - Full and accurate asset inventory. **Asset inventory gaps identified within the SAMP and will be closed as part of the TAMP development** **- Evaluate processes associated with utility locates. Force main locates need to be looked at, including confirmation of location (excavation).**
15	Natural Disasters	Natural disasters at large that interfere with mission critical equipment and processes	- Health and safety impacts - Regulatory impacts - Environmental impacts - Economic impacts	2		5	Potential to impact multiple facilities. Loss of life potential.	10	- Contingency and emergency response plans - Resiliency and redundancy planning - Facility planning, including adjusting level of service	

Draft Risk Register

Risk ID	Risk Event	Risk Description	Effects/ Impacts	LIKELIHOOD Likelihood Score	Likelihood Justification	CONSEQUENCE Consequence Score	Consequence Justification	Risk	Risk Strategy	Risk Strategy Priorities
16	Insufficient Staffing	Insufficient staff and/or insufficient qualified and trained staff for mission critical duties	- Increased overtime - Equipment/assets degrade due to deferred maintenance - Increased costs for contractors/outsourced resources - Loss of system knowledge - Increased costs for repairs and running assets to failure - Opportunity and innovation costs	5	Have some functions currently contracted out. Undergoing expansion.	4	Potential for injury and/or asset failure due improper operation and/or maintenance practices	20	- Staffing and skills studies - Update engineering standards to include FTE estimate and required skills and training with new facilities and/or equipment - Documented Standard operating procedures and training on those SOPs - Testing and recertification as appropriate - Relationships with community partners for skill development - Outsource staffing, if needed	- Staffing study started for Operations Division but not completed. Based on new infrastructure that was added. **Restart and complete the staffing study to consider reorganization and include staffing, regionalization, and skills. May consider also adding engineering staff to the study.** - Starting an apprenticeship program for maintenance mechanics **- Update engineering standards to include Full Time Equivalent (FTE) estimate and required skills and training with new facilities and/or equipment** **- Document Standard operating procedures and training on those SOPs. Some already in place. Will be developing these as part of the TAMP development.** - Testing and recertification as appropriate. Guidelines are in place. Continuing education requirements in place. HR is developing a notification system for tracking and maintaining compliance with requirements. **- Oppurtunity to enhance relationships with community partners for skill development. Community Benefits Program in place working with non-profits that could be leveraged.** - Outsource staffing in use, if needed
17	Lack of System Knowledge	Lack of documented and accessible system knowledge (asset inventory, operational)	- Health and safety impacts - Regulatory impacts - Environmental impacts - Economic impacts	4	Some information is currently unavailable or out of date.	4	Potential for injury and/or asset failure due to improper operation and/or maintenance practices	16	- Succession planning - Complete asset inventory - Knowledge retention strategy - Documented Standard operating procedures and training on those SOPs - Leverage new technologies to capture and access data, documents, and processes more readily	**- Develop a Succession Planning and Knowledge Retention strategy** **- Document Standard operating procedures and training on those SOPs. Some already in place. Will be developing these as part of the TAMP development.** - Starting an apprenticeship program for maintenance mechanics **- Asset inventory gaps identified within the SAMP and will be closed as part of the TAMP development** **- Continue to leverage new technologies to capture and access data, documents, and processes more readily**
18	Data Breach	Data breach/compromise	- Economic impacts - Reputation impacts	2	Currently have security measures in place.	3	Moderate impact. Financial, customer, and/or employee HR information could be compromised. Facility/asset information could be compromised.	6	- System backups - Security - More frequent and robust cybersecurity training	

Draft Risk Register

Risk ID	Risk Event	Risk Description	Effects/ Impacts	LIKELIHOOD Likelihood Score	Likelihood Justification	CONSEQUENCE Consequence Score	Consequence Justification	Risk	Risk Strategy	Risk Strategy Priorities
19	Unauthorized System Access	Unauthorized access to information systems	- Economic impacts - Reputation impacts - Public health and safety - Regulatory impacts	2	Currently have security measures in place.	5	Potential for injury and/or asset failure due to intentional improper operation and/or sabotage	10	- System backups - Security - More frequent and robust cybersecurity training - Review of appropriate staff responsibilities, access and clearances - Business Continuity Plan	
20	Information System Outage	Information systems going down for extended period during high priority event	- Economic impacts - Reputation impacts - Public health and safety - Regulatory impacts	3	Has happened before.	4	MSD has the ability to manually operate some equipment, but may not have time to react. Missed work requests and no operational monitoring (stations, etc.).	12	- Emergency and contingency plans - Redundancy - Documented manual processes - Business Continuity Plan	- Emergency response plan and a Business Continuity Plan in place - Redundancy is being built into the IT infrastructure
21	Operational & Adminstrative Facility Damage	Damage to operational and/or administrative facilities	- Disrupts operation - Public health and safety - Regulatory impacts - Economic impacts	3		4	MSD has the ability to manually operate some equipment. Requires relocation of staff and equipment.	12	- Emergency Response Plan - Business Continuity Plan - Redundancy - Emergency Action Plans (Facility and/or asset specific)	- Emergency response plan and a Business Continuity Plan in place **- Emergency Action Plans for some facilities, but not all. May need them for those missing them currently.**
22	Flood Protection System Failure	Failure of flood protection system (condition, capacity, sabotage/vandalism, 3rd party, etc.)	- Property damage - Injury - Environmental impacts - Reputation impacts - Economic impact	1	Assume failure of complete/majority of flood protection system is unlikely.	5	Potential loss of lives (100+).	5	- Emergency Action Plans (Facility and/or asset specific) - Capital improvements - Critical assets and spare parts availability - Preventive maintenance, including routine inspections - Facility planning - Predictive maintenance	
23	Stormwater Pipe Structural Failure	Structural failure (cave-ins/collapse) of stormwater pipes	- Structural or road flooding - Property damage - Public health and safety - Economic impacts	5		5	Potential loss of life.	25	- Condition assessment - Facility planning - Capital improvements - Critical assets and spare parts availability	**-No formal ongoing condition assessment program** - Currently collecting asset information on stormwater pipes **- Capital improvements being implemented, but not enough funding to do everything that needs to be done** **- Master Plan/Facility Plan has not been completed** **- Have not identified critical assets** **- Currently reactive, but would like to become more proactive**

Draft Risk Register

Risk ID	Risk Event	Risk Description	Effects/ Impacts	LIKELIHOOD Likelihood Score	Likelihood Justification	CONSEQUENCE Consequence Score	Consequence Justification	Risk	Risk Strategy	Risk Strategy Priorities
24	Structural Flooding due to Major Obstructions	Major obstructions that block major channels that can increase structural flooding	- Structural or road flooding - Property damage - Public health and safety - Economic impacts	4		5	Potential loss of life.	20	- Inspections before rain events (including drones) - Public education - Identification of hot spots and develop mitigation plans for those that don't have them - Preventive maintenance (debris/vegetation management) - On-call contracts for debris/vegetation management	- Inspections before rain events currently done on historical problem areas (pre and post rain event checks). - Have a list where pre/post rain event checks are done. **Not a comprehensive list, could identify more.** - Have a tree/vegetation management on-call contract in place to cut back trees/vegetation as needed. - Work with USGS to remove blockages associated with monitoring sites. **- Public education related to identifying and notifying MSD of tree/vegetation management issues.** - Identify beaver dams that may lead flooding issues.
25	Exceed Stormwater System Capacity	Exceeding capacity of the existing stormwater system beyond the flood protection system.	- Structural or road flooding - Property damage - Public health and safety - Economic impacts	5	Happens during wet weather	5	Potential loss of life.	25	- Capital improvements (i.e. Drainage/stormwater pump station) - Facility planning/ Master Plan for flood protection - Public education on safety measures - Early warning system	**- Capital improvements being implemented, but not enough funding to do everything that needs to be done** **- Master Plan/Facility Plan has not been completed** **- Current public education effort is after rain events, not before. Some social media efforts.** - Project for installing level indicators at Viaducts is currently planned. **- Quick-buy Workgroup to buy-out properties in flood prone areas. Workgroup exists but not sure about current level of activity.** - Have some drainage/stormwater pump stations currently in place
26	Insufficient Capital Funding	Insufficient capital funding	- Regulatory impacts - Health and safety impacts - Public relation impacts	5	Funding may not be accessible or may not receive approval to use existing funding.	3	May delay some critical projects. However, assume will have time to make alternative plans and adjust operations to accommodate delays.	15	- Public education - Potential for use of grant funding or low interest loans - Look for efficiency gains, including controlling the scope and schedule - Potential innovative approaches that are more efficient - Planning, prioritization, and justification of projects	- Ongoing public education meetings around capital project efforts, including press releases - Currently evaluate potential for use of grant funding or low interest loans **- Look for efficiency gains, including controlling the scope and schedule** **- Evaluate potential innovative approaches that are more efficient, including cost-sharing arrangements** - Planning, prioritization, and justification of projects. Business case evaluations are in place. SAMP and TAMPs are being developed as part of Asset Management - Currently updating service levels for stormwater to aid in justifying projects
27	Capital Project Delays and/or Overruns	Capital delays and/or overruns of construction projects	- Regulatory impacts - Economic impacts - Public relations impact - Public health and safety - Operational impacts	4		3	Assume will have time to make alternative plans and adjust operations to accommodate delays.	12	- Implement Construction Project Risk Registers - Involve O&M in the design process - Project planning - Follow PM procedures	
28	Capital Project Operational Impacts	Capital project impacts operations of existing facilities and infrastructure	- Regulatory impacts - Economic impacts - Public relations impact - Public health and safety - Operational impacts	2		4	Potential for injury and/or asset failure due to improper operation and/or maintenance practices	8	- Project planning - Constructability review - Involve O&M in the design and construction process	
29	Major Vehicle Accident	Vehicle accident with serious injury and/or property damage	- Public health and safety - Public relations impact - Economic impact - Operational impacts	3		5	Potential for injury and/or loss of life	15	- Employee training - Routing to minimize travel times - Safety reminders - Fleet maintenance - Follow existing policies and procedures - Walk-arounds and inspections prior to using vehicles	- Employee training **- Evaluate opportunities to optimize routing to minimize travel times. Leverage IPS capabilities for routing.** - Have GPS tracking tools on vehicles - Safety reminders - Fleet maintenance - Follow existing policies and procedures - Walk-arounds and inspections prior to using vehicles - Communication in place by the City to notify about road closures related to City projects. MSD also puts out notification about ongoing project work impacting transportation. - Attend Local Emergency Planning Committee meetings.

Appendix L. COF/LOF Guidance

COF/LOF Guidance

Jefferson and Louisville County Metropolitan Sewer District

Brown and Caldwell

June 30, 2021

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Document Revision History				
Version	Summary	Editor	Date	Description of Changes
1	Initial Draft	BC	May 28, 2021	

List of Abbreviations/ Definitions	
ACD	Amended Consent Decree
Asset	An item that has potential value to the organization such as equipment, buildings, etc.
Condition	Measure of the physical state of an asset.
COF / Consequence	Consequence of Failure: The impact on level of service, utility, customers, or general public resulting from an asset failure.
Failure	The inability of an asset to provide the function for which it was installed.
LOF / Likelihood	Likelihood of Failure: The chance of an occurrence, such as an asset failure.
Risk	Value represented by multiplying the consequence and likelihood of a failure scores.
Risk Register	Documents the high-level risks to the organization, likelihood and consequence of occurrence, and any risk mitigation measures
Risk-Based Prioritization	Process for setting priorities and ranking assets using likelihood and consequence of failure criteria
Strategic Asset Management Plan	Guides overall asset management processes to ensure consistency. Includes organizational elements such as: charter vision & goals, training, communications, engineering design & construction, capital planning & financing, project justification, and key processes and templates.
Tactical Asset Management Plans	Guide asset management processes at each facility or system. Each facility or system has its own TAMP, which includes technical elements such as: level of service measures, asset inventory, risk & criticality, O&M strategies, condition assessment, capital/engineering/rehab & replacement strategies, and information management.

1. Introduction

This Consequence of Failure (COF) and Likelihood of Failure (LOF) guidance document has been prepared to aid the Louisville Metropolitan Sewer District (MSD) staff in the identification of critical assets at MSD's vertical and linear assets. The intent of this document is to provide guidance on the application of COF and LOF criteria, scores, and weights to prioritize assets for further evaluation including visual inspection, condition monitoring, and maintenance activities.

1.1 Staff Responsible for Assessing COF and LOF of Assets

The Asset Management Steering Committee (AMSC) will be responsible for the process of reviewing the SAMP annually, including criteria for COF and LOF. MSD staff at each facility will be tasked with the updating of critical assets using the criteria, scores, and weights as outlined in this guidance document. Additional staff may be involved, as directed by the Asset Management Steering Committee.

1.2 COF and LOF Development and Maintenance

1.2.1 COF and LOF Development

The initial COF and LOF scores for assets were developed for each facility as part of the development of facility specific TAMPs. Initial scores were developed during workshops and will be summarized and included in each facility specific TAMP.

Table 1-1. Staff Responsible for Assessing COF and LOF of Assets

Staff Group	Description
Operations Division Managers	The designated Operations Division Manager will be responsible for ensuring that their assigned facilities have developed a critical asset list.
Regulatory Compliance & Asset Management	This group will provide as needed assistance with assigning COF and LOF criteria at each facility as well as being tasked with reviewing the critical asset list.
Subject Matter Experts	Staff designated to assign COF and LOF to assets at each facility include operators, maintenance supervisors, and plant engineers.

1.2.2 COF and LOF Maintenance

The COF and LOF scores of individual facility assets need to be reviewed on a periodic basis to ensure that the critical assets at each facility are being evaluated appropriately. As the asset management program evolves at MSD, the number of critical assets may expand, or contract based on MSD priorities. Additionally, as processes are modified at each facility, it will be appropriate to re-evaluate the COF and LOF of facility assets to ensure that assets are designated appropriately. At a minimum, each facility will conduct annual COF and LOF review meeting for purposes of reviewing and updating the COF and LOF scores, with specific actions listed in Table 1-2.

Table 1-2. Annual COF and LOF Review

#	Action	Meeting Activities
1	Perform an annual COF and LOF review	• Meet to review the COF scores for facility assets • Meet to review the LOF scores for facility assets • Re-score assets as appropriate based on new assets or processes
2	Use COF and LOF scores to update facility critical asset list	• Revise critical asset list as appropriate with COF and LOF review scores. • Evaluate critical asset list for completeness

2. Consequence of Failure

2.1 COF Criteria, Scores, and Weights

MSD uses standardized criteria to identify critical equipment at each facility and prioritize identified projects and maintenance programs. The "consequence of failure" criteria used by MSD facilities are defined in Table 2-1 and identify the impact a failure may have on level of service. Each facility should apply the "consequence of failure" criteria to identify the highest priority assets as follows:

- Using the COF spreadsheet (see Appendix A), list the location hierarchy for each facility.
- Apply the consequence of failure criteria, scores, and weights identified in Table 2-1 for all locations within the facility's hierarchy.
- Scores of 1 to 5 will be used.

Table 2-1. Consequence of Failure (COF) Criteria

Criteria	Definition	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Regulatory & Environmental Impacts	Overflows (discharge to waters of the US) Permit Violations at WWTP USACE Violations MS4 Violations Consent Decree Violation/Stipulated Penalties	Short duration, low quantity, contained within facility. No violation.	Minor disruption, few complaints, short process upset, minor SSO less than 1000 gals. ($ based on local regulatory fines)	Substantial disruption, numerous complaints, prolonged process recovery, significant SSO. Violation or fines.	Major disruption, complete loss of process, major SSO, 0–6-month recovery time. Violation, fines and/or prosecution.	Major disruption, complete loss of process, spill of >100,000 gallons, > 6-month recovery time. Inability to operate.	20
Community & Stakeholder Impacts	Number of customers, assets, and/or facilities impacted due to due to a failure.	Short duration disruption, less than 10 customers affected. Localized impact.	Up to 100 customers affected.	Up to 1,000 customers affected. Multiple systems/areas impacted.	Up to 10,000 customers affected.	More than 10,000 customers affected. Facility-wide/system-wide disruption.	16
Reputation & Public Relations Impacts	Media coverage based on number of people affected, environmental impacts, financial loss, lawsuits	No Significant Impact	Public inquiry. No media coverage.	Local adverse media. Correspondence from State and/or local officials.	Multi-agency interests and/or exposure across multiple social media platforms.	Broad adverse media, (Service area and neighboring jurisdictions). Potential Legislative action.	16
Health & Safety Impacts	Public health and safety impacts, employee safety, regulatory compliance.	First aid required (cut, bruise, topical rash)	Minor injury (Sprain, stitches)	Moderate injury (broken bone) or illness lasting several days	Severe injury or illness with permanent damage	Fatality (EPA death avoidance cost @ $9M), localized illness	20

Table 2-1. Consequence of Failure (COF) Criteria							
Criteria	Definition	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 - Very High	Weight
Indirect Economic Impacts	Total repair, rehabilitation and/or replacement costs. Increased operational costs.	Less than $30K	$30K to $250K	$250 to $500K	$500K to $2M	$2M or greater	14
External Economic Impacts	Lost revenue, liability costs, fines, property damage	Less than $5K	$5K to $20K	$50K to $100K	$100K to $500K	$500K or greater	14

2.2 COF Criteria Application

The “consequence of failure” criteria used by MSD facilities identify the impact a failure may have on level of service. Each facility should apply the “consequence of failure” criteria to identify the highest priority assets as follows:

- Using the risk spreadsheet (see Appendix A for screen shot), list the assets for each facility.
- Apply the consequence of failure criteria, scores, and weights identified in Table 2-1 to the locations within the facility’s hierarchy.
- Review the applied COF scores and verify that the score is appropriate for the asset.
- COF scores are divided by 100 and rounded to the nearest whole number.

2.3 COF Scoring Example

The following example shows how COF criteria, scores, and weights were applied to an asset at a treatment Plant.

1. Identify the Process/System in the plant.
2. Review each scoring criteria and review the criteria description.
3. Assign a score (1 - 5 with 1= best or least, and 5= worst or most) to each criterion.
4. Weights for each criterion are already established and will be automatically applied.
5. A COF score will be calculated for each asset at the facility.
6. For this example, a grit removal process at a treatment plant was evaluated as follows:

Table 2-2. Grit Removal COF Scoring Example			
COF Criteria	Score	Weight	COF Score
Regulatory & Environmental Impacts	2	20	0.40
Community & Stakeholder Impacts	1	16	0.16
Reputation & Public Relations Impacts	1	16	0.16
Health & Safety Impacts	1	20	0.20
Indirect Economic Impacts	2	14	0.28
External Economic Impacts	1	14	0.14
		COF Score	1.3

3. Likelihood of Failure

3.1 LOF Criteria, Scores, and Weights

MSD uses standardized criteria to determine criticality of assets at each facility and prioritize identified projects and maintenance programs. “Likelihood of failure” criteria, scores, and weights are defined in Table 3-1.

- Using the LOF spreadsheet (see Appendix B), list the assets for each facility.
- Apply the likelihood of failure criteria, scores, and weights identified in Table 3-1 for all assets within the facility.
- Scores of 1 to 5 will be used.

Table 3-1. Likelihood of Failure (LOF) Criteria

Criteria	Definition	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 – Very High	Weight
Proactive Maintenance and Inspection History	Proactive maintenance, testing or inspections completed in accordance with plans.	Consistent Preventive Maintenance and inspection scheduled and performed	--	Preventive Maintenance and inspection scheduled, but infrequently performed	--	No planned preventive maintenance or inspection	12
Usage/Run Times	Frequency of use as an indicator of operational and/or capacity issues.	Low run times	--	Moderate run times	--	High run times	10
Life Remaining	Remaining useful life based on the age of the asset.	New or like new. Greater than 80% useful life remaining	80% to 60% useful life remaining	60% to 40% useful life remaining	20% to 40% useful life remaining	At end of life or nearing end of life. Less than 20% useful life remaining	9
Corrosion	Corrosion susceptibility.	Not susceptible to corrosion	--	Moderately susceptible to corrosion and operating in moderately corrosive environment/ conditions	--	Highly susceptible to corrosion and/or operating in highly corrosive environment/ conditions	5

Criteria	Definition	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 – Very High	Weight
Table 3-1. Likelihood of Failure (LOF) Criteria							
Difficult to maintain or limited/unsafe access	Assets that require specialized skills or equipment to operate and maintain. Difficult to access.	Able to access and maintain	Limited access and/or no specialized skills or equipment required	Limited access and/or requires specialized skills or equipment available in-house	Unable to access and/or requires specialized skills or equipment available in-house	Unable to access and/or requires specialty contractor(s) and equipment	12
Complexity	Number of points of failure within the asset/system.	Simple asset/system with a single point of failure	Simple asset/system with a few points of failure	Moderately complex asset/system with few points of failure	Moderately complex asset/system with multiple points of failure	Highly complex, with multiple points of failure	5
Spare parts availability	Assets with parts that are difficult to find, no longer made, and/or with no vendor support.	Parts readily available	Parts available within 24-hours	Parts available within a week	Parts available within a month	Parts available within multiple months or no parts available and/or no vendor support	10
Asset Failure	Frequency of asset failure under normal operating conditions based on historical asset operation and maintenance records.	No known failures in the last 2 years	--	1 failure in the last 2 years	--	2 or more failures in the last 2 years	12
Backup Power Availability	Availability of backup power.	Onsite generator installed	--	Offsite portable generator available and/or dual-feed available	--	No backup power	5
Pump Around Availability	Availability of pump around capabilities.	Dedicated reserve pump in inventory	MSD owned standby pump available	Rented/contracted portable backup pump locally available	Rented/contracted portable backup pump available	No portable backup and/or no reserve pump in inventory	5
Reaction Time	Anticipated reaction time before failure occurs	More than 24 hours to respond before a failure occurs	12 to 24 hours	1 to 12 hours	30 minutes to 1 hour	Less than 30 minutes to respond before a failure occurs	5

Table 3-1. Likelihood of Failure (LOF) Criteria							
Criteria	Definition	1 - Negligible	2 - Low	3 - Moderate	4 - High	5 – Very High	Weight
Design or Material Defects or Known Issues	Defects and/or issues are known and have been identified.	No known issues	--	Few defects/ known issues	--	Defects and known issues have previously resulted in asset failure	5
Capacity	Meets desired capacity requirements.	Significant available capacity during peak conditions	Available capacity during peak conditions	At capacity during peak conditions	At capacity during average conditions	Exceeds capacity during average conditions	5

3.2 LOF Criteria Application

Each facility station should apply the "likelihood of failure" criteria to identify the highest priority assets as follows:

- Using the LOF spreadsheet (Appendix B), apply the likelihood of failure criteria to assets Review the applied LOF score for assets and verify that the score is appropriate for the individual asset.
- LOF will be calculated by dividing the score by 100 and truncated to the nearest whole number.

3.3 LOF Scoring Example

The following example shows how LOF criteria, scores, and weights were applied to an asset at a treatment plant.

1. Identify the assets in the plant.
2. Review the LOF as determined in Section 2.
3. Review each LOF scoring criteria and review the criteria description.
4. Assign a score (1 to 5 with 1= best or least, and 5= worst or most) to each criterion.
5. Weights for each criterion are already established and will be automatically applied.
6. A LOF score will be calculated for each asset at the facility.
7. For this example, a grit tank was evaluated as follows:

Table 3-2. Grit Tank LOF Scoring Example			
Location Priority	1	(from section 2)	
LOF Criteria	Score	Weight	LOF Score
Proactive Maintenance and Inspection History	3	12	0.36
Usage/Run Times	3	10	0.3
Life Remaining	4	9	0.36
Corrosion	5	5	0.25
Difficult to maintain or limited/unsafe access	3	12	0.36
Complexity	4	5	0.09

Table 3-2. Grit Tank LOF Scoring Example			
Location Priority	1	(from section 2)	
LOF Criteria	Score	Weight	LOF Score
Spare parts availability	3	10	0.30
Asset Failure	5	12	0.6
Backup Power Availability	3	5	0.15
Pump Around Availability	1	5	0.05
Reaction Time	3	5	0.15
Design or Material Defects or Known Issues	3	5	0.15
Capacity	3	5	0.15
		LOF Score	3.3

4. Critical Assets

4.1 Risk Score and Asset List

Once the COF and LOF criteria have been applied to locations and assets at each facility and the associated scores (COF and LOF) have been determined; the facility will be able to place assets on the risk matrix as shown in Figure 4-1.

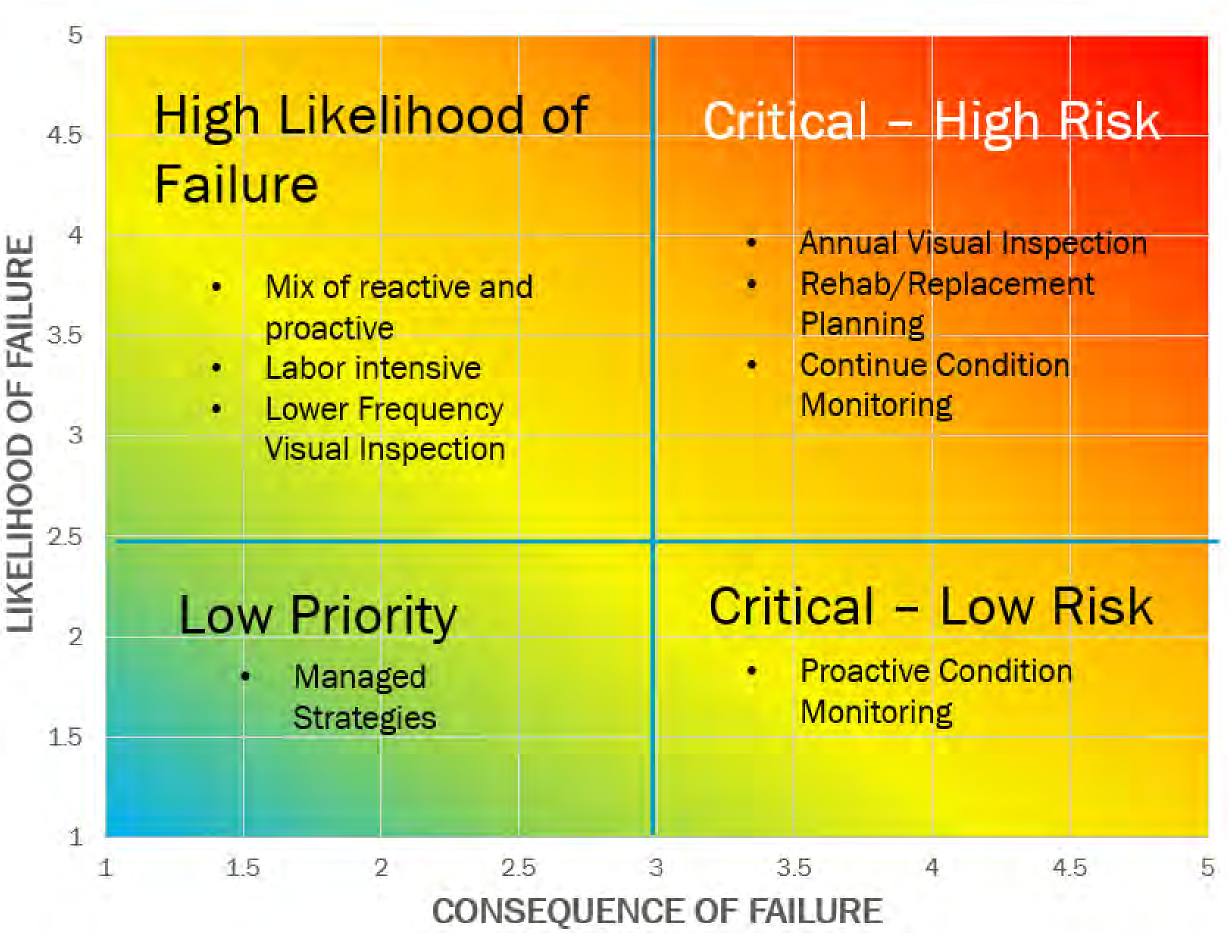


Figure 4-1. Asset risk matrix.

It should be noted that COF scores will be static year to year and only significantly change when processes are modified, or facilities built/abandoned. LOF scores, on the other hand, are more dynamic in nature and over time will move towards a higher score. The LOF scores should be influenced by the asset condition rating.

4.1.1 Critical – High Risk Assets

Critical assets have a COF greater than or equal to 3 and a LOF greater than 2. Assets within this area of the Risk Matrix are vital to the operation and take priority over other assets. Assets within this group need to be very reliable and maintenance activities focused on eliminating the potential for failures. As the asset condition rating becomes worse, rehab/replacement plans need to be put in place to sustain operations.

4.1.2 Critical – Low Risk Assets

These assets have a COF greater than or equal to 3 and a LOF less than or equal to 2. These assets are important to the operation; however, the likelihood of failure is lower than critical high-risk assets. Assets within this group are good candidates for condition monitoring. This monitoring is the trigger for maintenance activities or rehab/replacement plans.

4.1.3 High Likelihood of Failure Assets

These assets have a COF less than 3 and a LOF of greater than 2. These assets are less vital to the operation; however, can become a focal point due to the frequency (i.e., likelihood) of failure and require significant resources (time and materials) to sustain.

4.1.4 Low Priority Assets

These assets have a COF less than 3 and a LOF less than or equal to 2. Assets in this group are less vital to the operation and are unlikely to fail.

4.2 System Entry

After all the Risk Matrix has been evaluated for accuracy of COF and LOF scores, this data will be populated within Infor Public Sector.

The outcome of this process is a risk-ranking of assets that can be used to prioritize condition assessment activities, operations and maintenance activities, spare parts inventories, and risk-mitigation projects (such as replacement/rehabilitation). Criticality ratings are also to be used to determine the priority and timeframe for corrective actions as part of capital planning.

Appendix A. COF Scoring Spreadsheet

ASSET LIKELIHOOD AND CONSEQUENCE OF FAILURE: SCORING EXAMPLE				CONSEQUENCE OF FAILURE													
				Regulatory & Environmental Impacts		Community & Stakeholder Impacts		Reputation & Public Relations Impacts		Health & Safety Impacts		Indirect Economic Impacts		External Economic Impacts			
			Criteria Weight	20		16		16		20		14		14			
ID	Facility	Asset	Asset Type	Overflows (discharge to waters of the US), Permit Violations at WWTP, USACE Violations, MS4 Violations, Consent Decree Violation/Stipulated Penalties		Number of customers, assets, and/or facilities impacted due to due to a failure.		Media coverage based on number of people affected, environmental impacts, financial loss, lawsuits		Public health and safety impacts, employee safety, regulatory compliance.		Total repair, rehabilitation and/or replacement costs. Increased operational costs.		Lost revenue, liability costs, fines, property damage		Total Weighted Likelihood of Failure Score	Total Weighted Consequence of Failure Score
Example	*Example Gravity Main 1*	*Gravity Main 1*	*Gravity Main*	*4*	*Large diameter interceptor. Would result in a major SSO.*	*3*	*Anticipate up to 1,000 customers impacted, including traffic disruptions and potential for backups into homes.*	*3*	*Expect some local media coverage due to the number of customers impacted and the high traffic areas affected.*	*3*	*Potential public health impacts due to SSO and sewer backup.*	*4*	*Anticipate emergency repair to be at least $500K*	*2*	*Would likely have some small claims due to impacts on customer's homes.*	*2.8*	*3.2*
1	Beargrass Creek Flood Pumping Station	Pump 1	Pump														
2	Flood Control Gate 25	Gate 1	Gate														
3	Derek R. Guthrie WQTC	Transformer 1	Transformer														
4	Morris Forman WQTC - Final Effluent PS	Pump 1	Pump														
5	Southwestern Parkway Pump Station	SCADA/Telemetry	SCADA/Telemetry														
6	Eastwood-Fisherville Rd. Force Main	Force Main	Force Main														
7	Viaduct 23 - Dixie Hwy. and Standard Ave.	Sump Pump 1	Sump Pump														
8	Mill Creek Drainage Channel	Drainage Channel	Drainage Channel														
9	Sneads Branch Real Time Control Site	Real Time Controls	Real Time Controls														

Appendix B. LOF Scoring Spreadsheet

ASSET LIKELIHOOD AND CONSEQUENCE OF FAILURE: SCORING EXAMPLE

				LIKELIHOOD											
				Proactive Maintenance and Inspection History		Usage/Run Times		Life Remaining		Corrosion		Difficult to maintain or limited/unsafe access		Complexity	
			Criteria Weight	12		10		9		5		12		5	
ID	Facility	Asset	Asset Type	Proactive maintenance, testing or inspections completed in accordance with plans.		Frequency of use as an indicator of operational and/or capacity issues.		Remaining useful life based on the age of the asset.		Corrosion susceptibility.		Assets that require specialized skills or equipment to operate and maintain. Difficult to access.		Number of points of failure within the asset/system.	
Example	*Example Gravity Main 1*	*Gravity Main 1*	*Gravity Main*	*1*	*CCTV inspection performed once every 2 years as scheduled*		*Not Applicable*	*3*	*Ductile iron pipe installed in 1955. Assuming a 100 year useful life, another 44 years remain. Main has approximately 44% of useful life remaining.*	*5*	*Ductile iron pipe installed in corrosive soils.*	*3*	*Located downtown on main thoroughfare. Maintenance activities require extensive traffic control.*	*2*	*Civil asset with few points of failure.*
1	Beargrass Creek Flood Pumping Station	Pump 1	Pump												
2	Flood Control Gate 25	Gate 1	Gate												
3	Derek R. Guthrie WQTC	Transformer 1	Transformer												
4	Morris Forman WQTC - Final Effluent PS	Pump 1	Pump												
5	Southwestern Parkway Pump Station	SCADA/Telemetry	SCADA/Telemetry												
6	Eastwood-Fisherville Rd. Force Main	Force Main	Force Main												
7	Viaduct 23 - Dixie Hwy. and Standard Ave.	Sump Pump 1	Sump Pump												
8	Mill Creek Drainage Channel	Drainage Channel	Drainage Channel												
9	Sneads Branch Real Time Control Site	Real Time Controls	Real Time Controls												

Appendix M. Asset Class Rehabilitation and Renewal Schedule

Asset Classes with R/R Schema							
Asset Type		Useful Life (Years)	Replacement Cost	Replacement Cost Unit	Rehabilitation Interval (Years)	Rehab Cost (Or Percent of Replacement Cost)	Notes
Vertical							
Drainage							
Sewer							

TO BE DEVELOPED

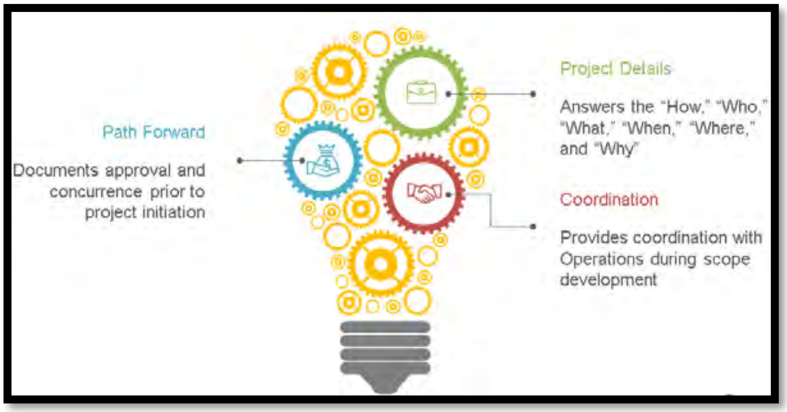
Appendix N. Project/Business Case Justification Materials

LOUISVILLE MSD, INFRASTRUCTURE PLANNING – BUSINESS CASE EVALUATION (BCE)

This manual provide an understanding and guidelines for preparing Business Case Evaluations (BCE's) for Louisville MSD. BCEs are required for [Enter Text Here]. BCEs are necessary to make sure that all capital expenditures are in the best interest of its customers, the broader community, and the environment.

Intent of the BCE

The BCE process is a robust planning analysis that assesses project alternatives. Developing **Project Details**, **Coordination** with interagency departments, and outlining a **Path Forward** during the Planning Phase will help to better inform the Capital Improvement Planning (CIP) planning and prioritization process.



Types of BCEs

The type of BCE depends on the level of planning effort needed. Some projects may only on one true alternates, while others have a number of different scenarios and alternatives that should be considered. #Fact_Sheet

Full Alternative Analysis
- Initial Strategy discussion and screening
- Alternative development and analysis

BCE Lite/Simplifed Documentation
- Significant prior evaluation
- Straightforward projects
- Limited alternatives/opportunities

Fact Sheet
- [Enter Text Here]

Content of the BCE

Section 1.0 Executive Summary

The Executive Summary is a quick, informative section that outlines the **Why** (purpose and justification for project), **What** (the recommended alternative and brief summary of scope), **Where** (location of the project), **How** (the total project cos and construction cost of the project and funding sources), and **When** (the schedule of the project from design through construction) or the project. *This section should generally not exceed one page in length*.

Section 2.0 Problem Statement

Reviewer shall write a brief narrative of how the problem began, precise description of how the asset/process works or operates, indicate failure, and state any ties with Integrated Overflow Abatement Plane or regulatory document. Review shall then assess any available Condition Assessment data or reporting.

Section 3.0 Project Objectives

This section outlines the project objectives and any unique project constraints, includes or issues affecting the project. Reviewer shall state the boundary/boundaries of the analysis for the project and note any project coordination (internally and/or within the community) requirements.

Section 4.0 Strategies

Review shall briefly summarize all strategies developed throughout the project and whether or not the strategy was screened out prior to detailed analysis. This is a high level ("gut check") analysis or a "first cut", the goal is to not to present hard numbers. This section stays in the "big picture" realm.

It is important to note that strategies may include more than new construction. Additional strategies include changes in operation, maintenance, equipment, training, etc.

In order to provide a baseline for the project, Strategy 0 shall always be "Do Nothing".

Section 5.0 Alternatives

This section summaries the method(s) of analysis used to select recommended alternatives. Key point so cover include: Regulatory requirements, key internal stakeholders, Triple Bottom Line (TBL) analysis, impact on other work in the sewershed, capacity analysis, and staffing/skill set issues.

A tabular summary comparing alternatives will be presented (outlining EAC, Risk, Benefits, and schedule), followed by a final project alterative recommendation.

Components of BCE

Project Categorization

Project Categories were developed by MSD's Engineering team during the 2016 Capital Improvement Plan development, as well as in correlations with the 20-year Facility Plan/Critical Repair & Reinvestment Plan (CRRP).

Service Area

- Stormwater, Support Systems, Wastewater

Program

- Capital Equipment, CMOM, Consent Decree (IOAP), Development, Drainage, Facilities, Floodplain Management, IT, LOJIC, NMC, Ohio River Flood Protection, Stormwater Quality (MS4)

Driver

- Asset Management/Deferred Maintenance, Consent Decree, Customer Service, Emergency, Growth, Property Protection, Regulatory, Safety, Utility Relocation

Project Type

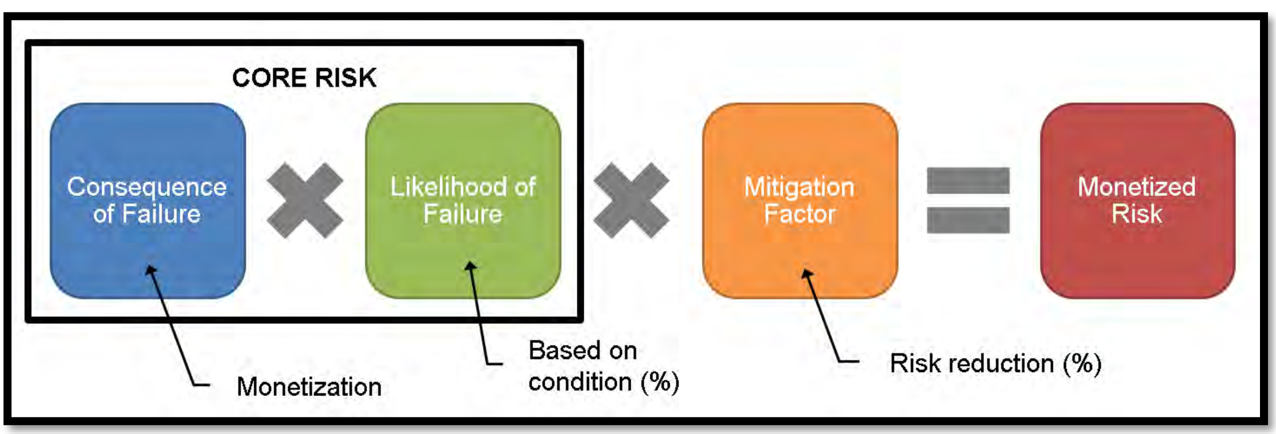
- Assessment, Buy-Outs and Grants, Drainage Response Initiative (DRI), Flood Proofing, Flood Pump Station, Green Infrastructure, In-Line Storage, Mapping and Surveying, Other Services, Planning Study, Plumbing Modification Program, Property, Pump Station/Force Main, Renewal/Replacement, Sewer, Storage Basin, Viaduct Flood Relief, Water Quality, WQTC

Monetized Risk

MSD's Monetized Risk approach is based loosely on the EPA SIMPLE approach, adapted to evaluate the project as a whole instead of individual assets. The monetization is a component of the core risk of the project, and therefore the project must be scored under two scenarios: before the project is initiated (current conditions/ "Do Nothing" alternative) and after the project is complete.

The core risk of the project is effectively a product of Consequence of Failure (CoF) and the Likelihood of Failure (LoF) scores. Additionally, a Mitigation Factor is applied to account for redundancy elements that can be realized within the project.

Figure 1 - Monetized Risk



Consequence of Failure (CoF)

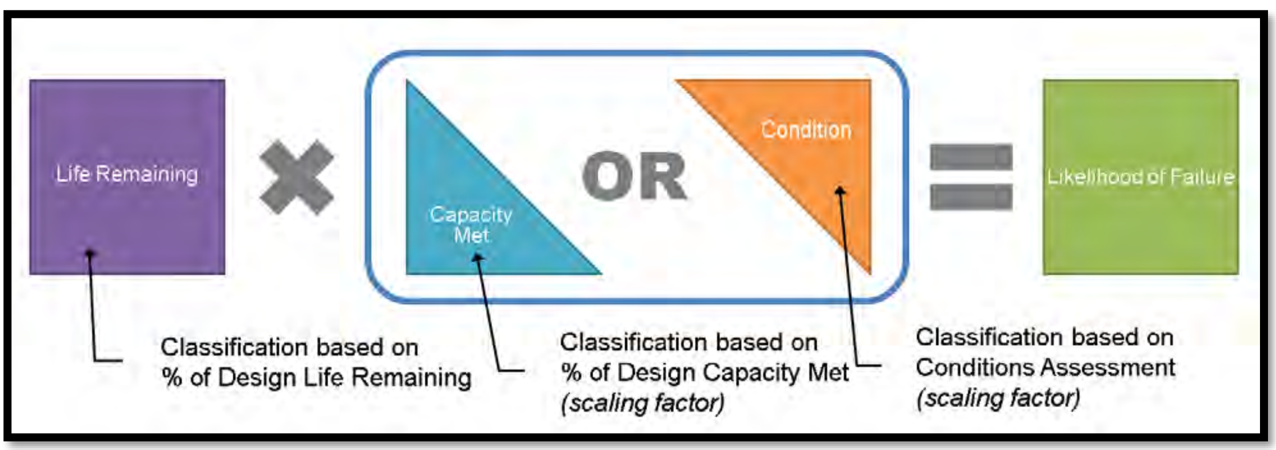
The proposed Consequence of Failure (CoF) for a given project is developed as a framework of realistic impacts. The risk “universe” has been limited to events what could occur within the community, with the components of the CoF being representative values that do not reflect the precise cost of a particular event. The three main categories evaluated in the CoF are **Environmental**, **Social**, and **Economic** *(Triple Bottom Line (TBL) categories)*, and each is represented by several risks and impacts specific to that category. When scored, the CoF represents an estimate based on available industry standard and actuarial data that adds a meaningful metric to relative risks. In this type of evaluation, consistency is more important than accuracy when comparing large numbers of disparate projects.

Attachment 1 – Consequence of Failure (CoF) Table summarizes **CoF Categories**, **Impacts**, **Impact Description**, and **Scoring**.

Likelihood of Failure (LoF)

The proposed LoF for a given project is primarily associated to the **age** of the asset/facility when compared it’s **expected design life**. Scaling factors are then applied based on either the **capacity met** or the **condition** of the asset/facility, depending on the type of project. This approach is intended to accommodate a wide range of scenarios, including assets that are old(er) but in good condition and assets/facilities that are relatively new but subject to, perhaps, unexpected conditions. It is predictable that this component of the core risk will provide the most significant difference between the two Monetized Risk values (before and after the project is complete).

Figure 2 - Likelihood of Failure (LoF)

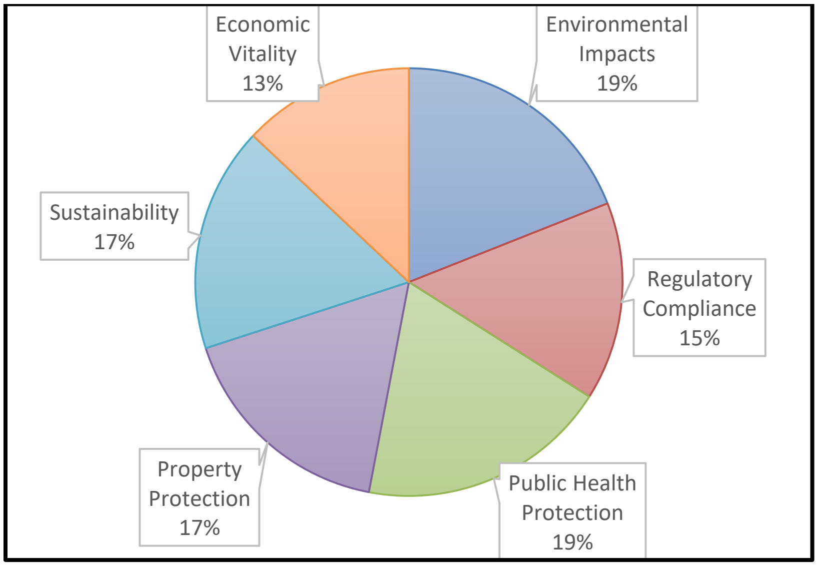


Mitigation Factor

The final component to the Monetized Risk approach is the Mitigation Factor. Similar in concept to a safety factor, this can provide a reduction to either the CoF or LoF by providing **redundancy** and **response plans** or **backup** and **alternative operational schemes**, respectively. It also can becomes phased alternative to consider besides replacing expensive critical assets.

Benefits

MSD has expanded the Triple Bottom Line (TBL) approach to include **Environmental Impacts**, **Regulatory Compliance**, **Public Health Protection**, **Property Protection**, **Sustainability**, and **Economic Vitality**.



These values are weighted according to what benefit program is selected: Wastewater, Stormwater, Flood Protection, and General. **Attachment 2 – Benefit Scoring Table** includes a full summary of benefits aspect, rationale, measurement method, and scoring.

Estimate at Completion (EAC)

A planning-level cost estimate must be completed for the project alternatives, with line items for: **Planning**, **Design**, **Easement & Land Acquisition**, **Miscellaneous Design**, **Construction** (plus contingency), **RPR/DCDC/Inspection**, and **Miscellaneous Construction**.

*For more information on developing detailed cost estimates, please see Section **PACC Cost Estimating** (Page 12).*

Schedule

A planning-level schedule must be completed for the project alternatives, with milestones for: **Design** (preliminary, 30%, 60%, Final), **Easement & Land Acquisition**, **Construction** (bidding, construction, regulatory deadline) and **Closeout** (final payment, warranty).

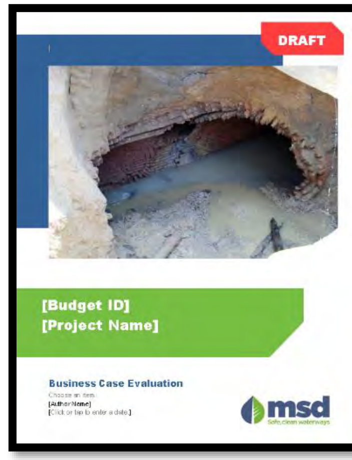
BCE Report Instructions

When completing a BCE, you must get the latest version of the template from the Infrastructure Planning Program Administrator or Manager. *Please do not re-use a template from a previous project*. All BCEs are required to use this template.

Reminder: The BCE should answer the "**How**," "**Who**," "**What**," "**When**," "**Where**," and "**Why**," for drafting project plan.

Cover Sheet

Insert text, then delete the brackets, for the Budget ID, Project Name, and Author Name. Use the dropdown to select a Document Version, and the date picker to select the report date.

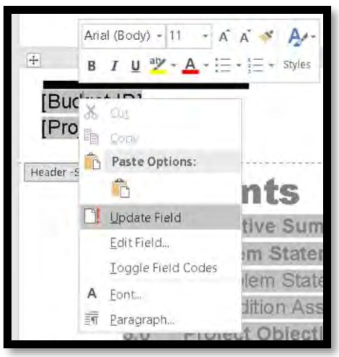


Document version options should reflect the current stage of the BCE development and/or the goal of the document (e.g. "Draft 3 | Gateway Review" should be used for the document leading up to, and presented at, the Gateway meeting).

To easily replace the picture, right-click the picture and select "Change the Picture", then follow the prompts to upload a project-specific photo.

Once the Document Version has moved from Draft to Final, delete the "Draft" from the Cover Sheet: right-click the red text box shape, select "Cut".

Header and Footer Information

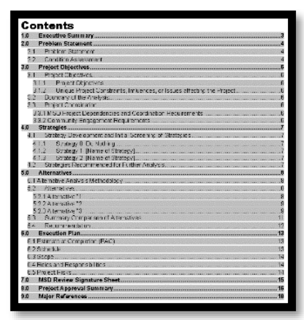


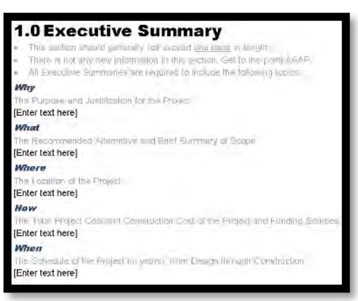
The Header and Footer information will be used to help easily identify the Project being evaluated. Double click inside the Header, right-click the greyed out Budget ID field, and select "Update the Field". Repeat for the Project Name in the Header, and Document File Name in the Footer.

There are three header and footer sections: Section 1 *at the* Table of Contents Page, *Section 2 on* 5.3 Summary Comparison of Alternatives *page, and* Section 3 *on* 5.4 Recommendation.

Body of Document

For consistency between BCEs, all sections and sub-sections (e.g., 3.0, 3.1, 3.1.1, etc.) are required and should not be omitted unless the instructions state otherwise. If a particular section or sub-section does not apply to a particular project, state the reasoning in the particular section or sub-section that does not apply.





Greyed out text has been placed throughout the template to assist the author with understanding the purpose of each section and sub-section. Additional "[Enter text here]" has been added to assist author the placement of needed text (which has been pre-formatted).

Once the Document Version has moved from "Draft 1" to "Draft 2", the author is to delete the instructive grey text before saving.

Document Version and Review/Approval Process

A BCE is considered to be in draft form until it is approved. Use the following options within the drop down on the title sheet:

Document Version	Description	Review/Approval
Draft 1 | Planning Development	This is the initial, working, draft	Infrastructure Planning Program Manager
Draft 2 | Planning Review	This is the draft submitted for Planning approval	Engineering and Operations Management, Engineering Director
Draft 3 | Gateway Review	This is the draft submitted for Gateway approval	Chief Engineer, Chief of Operations, and applicable Operations Director
Final 1 | Planning Approval	For construction projects <$1M, this is the final copy	Includes signatures from Planning Review
Final 2 | Gateway Approval	For construction projects >$1M, this is the final copy	Includes signatures and comments from Gateway Review

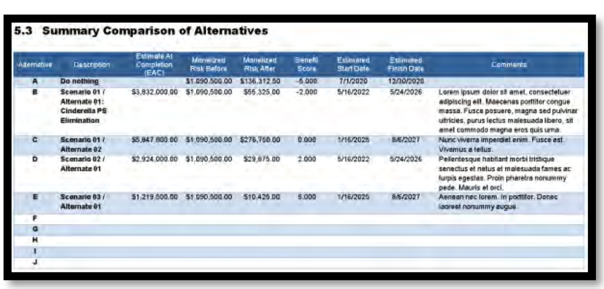
It is important to note that many of the staff listed on the signature sheets are only concurring with the BCE recommendations. Final approval is the decision of the Engineering Director or Gateway, depending on construction cost. If any of the reviewers listed do not concur with recommendations presented in the BCE (and the issues cannot be reconciled), the staff member should submit the reasons why he or she does not concur to the planning team in lieu of signing Section 7 of the BCE. These should be included in the final BCE document.

Summaries from BCE Worksheet

The BCE Worksheet was development to assist the planner in developing, reviewing, and comparing Alternate Project Risks, Benefits, Estimate at Completion (EAC), and Schedule. Cells highlighted in grey are available for user to enter or select data. Please refrain from adjusting formulas/calculations.

Data from a number of tables in the worksheet are to be copied and pasted into the BCE Documents:

Data for Section *5.3 Summary of Comparison of Alternatives* can be found on tab "Alternative Summary"



5.3 Summary Comparison of Alternatives

Alternative	Description	Estimate At Completion (EAC)	Monetized Risk Before	Monetized Risk After	Benefit Score	Estimated Start Date	Estimated Finish Date	Comments
A	Do nothing		$1,090,500.00	$136,312.50	-6.000	7/1/2020	12/30/2020	
B	Scenario 01 / Alternate 01: Cinderella PS Elimination	$3,832,000.00	$1,090,500.00	$55,325.00	-2.000	5/16/2022	5/24/2026	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Maecenas porttitor congue massa. Fusce posuere, magna sed pulvinar ultricies, purus lectus malesuada libero, sit amet commodo magna eros quis urna.
C	Scenario 01 / Alternate 02	$5,847,800.00	$1,090,500.00	$276,750.00	0.000	1/16/2025	8/6/2027	Nunc viverra imperdiet enim. Fusce est. Vivamus a tellus.
D	Scenario 02 / Alternate 01	$2,924,000.00	$1,090,500.00	$29,875.00	2.000	5/16/2022	5/24/2026	Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Proin pharetra nonummy pede. Mauris et orci.
E	Scenario 03 / Alternate 01	$1,219,500.00	$1,090,500.00	$10,425.00	5.000	1/16/2025	8/6/2027	Aenean nec lorem. In porttitor. Donec laoreet nonummy augue.
F								
G								
H								
I								
J								

Data for Section 6.1 Estimate at Completion (EAC) and 6.2 Schedule can be found on tab "Alternative Summary"

6.1 Estimate at Completion (EAC)

- A planning-level cost estimate must be completed for the recommended alternative
- Costs should be rounded to the nearest $100
- Use the following format

A planning-level estimate was completed for the recommended alternative:

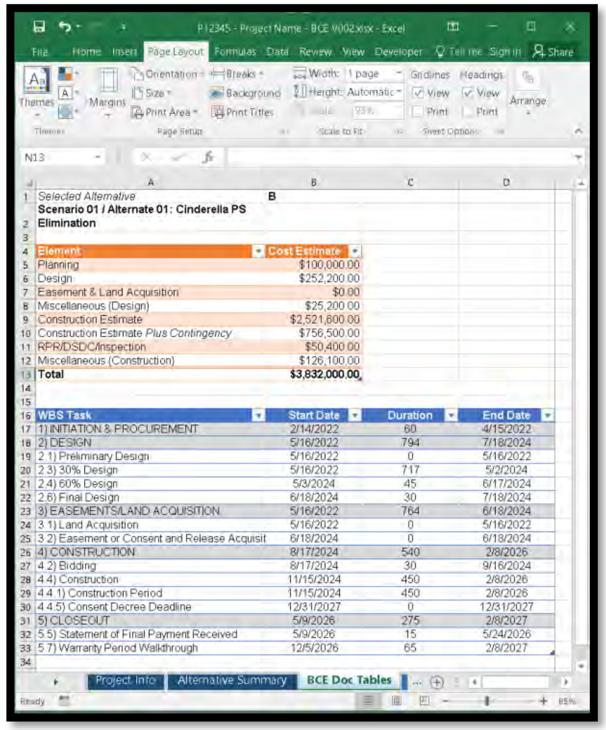
Element	Cost Estimate
Planning	$100,000.00
Design	$252,200.00
Easement & Land Acquisition	$0.00
Miscellaneous (Design)	$25,200.00
Construction Estimate	$2,521,600.00
Construction Estimate *Plus Contingency*	$756,500.00
RPR/DSDC/Inspection	$50,400.00
Miscellaneous (Construction)	$126,100.00
Total	**$3,832,000.00**

6.2 Schedule

- Present a proposed schedule of the project using major milestones
- Use the following format

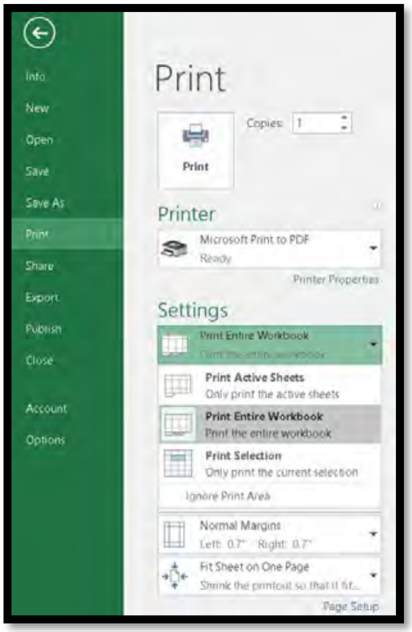
A planning-level schedule was prepared for the recommended alternative:

WBS Task	Start Date	Duration	End Date
2) DESIGN	5/16/2022	794	7/18/2024
2.1) Preliminary Design	5/16/2022	0	5/16/2022
2.3) 30% Design	5/16/2022	717	5/2/2024
2.4) 60% Design	5/3/2024	45	6/17/2024
2.6) Final Design	6/18/2024	30	7/18/2024
3) EASEMENTS/LAND ACQUISITION	5/16/2022	764	6/18/2024
3.1) Land Acquisition	5/16/2022	0	5/16/2022
3.2) Easement or Consent and Release Acquisition	6/18/2024	0	6/18/2024
4) CONSTRUCTION	8/17/2024	540	2/8/2026
4.2) Bidding	8/17/2024	30	9/16/2024
4.4) Construction	11/15/2024	450	2/8/2026
4.4.1) Construction Period	11/15/2024	450	2/8/2026
4.4.5) Consent Decree Deadline	12/31/2027	0	12/31/2027
5) CLOSEOUT	5/9/2026	275	2/8/2027
5.5) Statement of Final Payment Received	5/9/2026	15	5/24/2026
5.7) Warranty Period Walkthrough	12/5/2026	65	2/8/2027



	A	B	C	D
1	*Selected Alternative*	**B**		
2	**Scenario 01 / Alternate 01: Cinderella PS Elimination**			
3				
4	Element	Cost Estimate		
5	Planning	$100,000.00		
6	Design	$252,200.00		
7	Easement & Land Acquisition	$0.00		
8	Miscellaneous (Design)	$25,200.00		
9	Construction Estimate	$2,521,600.00		
10	Construction Estimate *Plus Contingency*	$756,500.00		
11	RPR/DSDC/Inspection	$50,400.00		
12	Miscellaneous (Construction)	$126,100.00		
13	**Total**	**$3,832,000.00**		
14				
15				
16	WBS Task	Start Date	Duration	End Date
17	1) INITIATION & PROCUREMENT	2/14/2022	60	4/15/2022
18	2) DESIGN	5/16/2022	794	7/18/2024
19	2.1) Preliminary Design	5/16/2022	0	5/16/2022
20	2.3) 30% Design	5/16/2022	717	5/2/2024
21	2.4) 60% Design	5/3/2024	45	6/17/2024
22	2.6) Final Design	6/18/2024	30	7/18/2024
23	3) EASEMENTS/LAND ACQUISITION	5/16/2022	764	6/18/2024
24	3.1) Land Acquisition	5/16/2022	0	5/16/2022
25	3.2) Easement or Consent and Release Acquisit	6/18/2024	0	6/18/2024
26	4) CONSTRUCTION	8/17/2024	540	2/8/2026
27	4.2) Bidding	8/17/2024	30	9/16/2024
28	4.4) Construction	11/15/2024	450	2/8/2026
29	4.4.1) Construction Period	11/15/2024	450	2/8/2026
30	4.4.5) Consent Decree Deadline	12/31/2027	0	12/31/2027
31	5) CLOSEOUT	5/9/2026	275	2/8/2027
32	5.5) Statement of Final Payment Received	5/9/2026	15	5/24/2026
33	5.7) Warranty Period Walkthrough	12/5/2026	65	2/8/2027
34				

Export Workbook



User shall export the entire workbook to pdf and attach to the BCE Document. To do this, select "File", "Print", Printer = "Microsoft Print to PDF" (or any available PDF Printer), and Setting = "Print Entire Workbook". Store export in the appropriate project file location.

BCE Worksheet

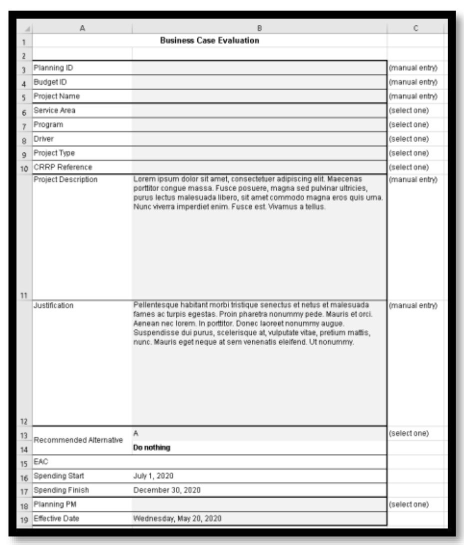
Project Summary Tabs

Project Information

Use the "Project Info" tab to populate high-level project information. A number of fields are free-form/manual entries, while others have drop-down menus.

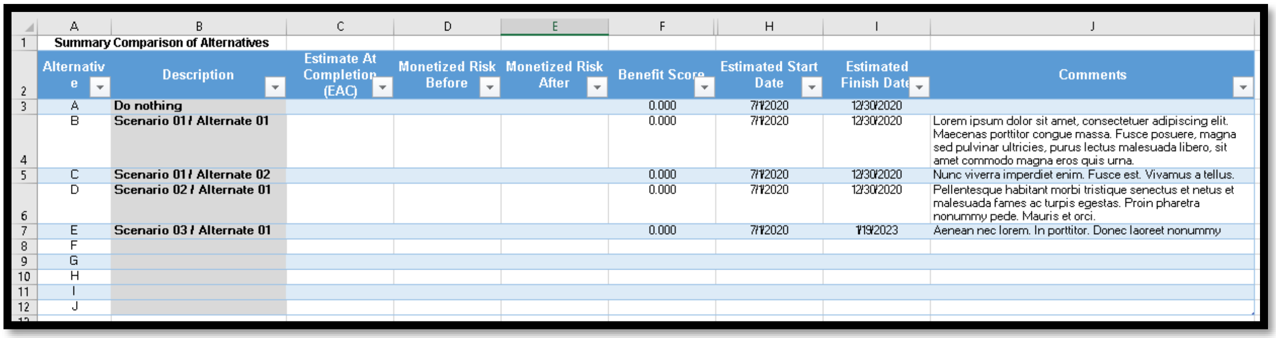
The bottom of the form allows user to select the final recommended alternative.

**For clarification, the "Planning PM" is the person in charge of the BCE effort.*



	A	B	C
1	**Business Case Evaluation**		
2			
3	Planning ID		(manual entry)
4	Budget ID		(manual entry)
5	Project Name		(manual entry)
6	Service Area		(select one)
7	Program		(select one)
8	Driver		(select one)
9	Project Type		(select one)
10	CRRP Reference		(select one)
11	Project Description	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Maecenas porttitor congue massa. Fusce posuere, magna sed pulvinar ultricies, purus lectus malesuada libero, sit amet commodo magna eros quis urna. Nunc viverra imperdiet enim. Fusce est. Vivamus a tellus.	(manual entry)
12	Justification	Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Proin pharetra nonummy pede. Mauris et orci. Aenean nec lorem. In porttitor. Donec laoreet nonummy augue. Suspendisse dui purus, scelerisque at, vulputate vitae, pretium mattis, nunc. Mauris eget neque at sem venenatis eleifend. Ut nonummy.	(manual entry)
13	Recommended Alternative	A	(select one)
14		**Do nothing**	
15	EAC		
16	Spending Start	July 1, 2020	
17	Spending Finish	December 30, 2020	
18	Planning PM		(select one)
19	Effective Date	Wednesday, May 20, 2020	

Alternative Summary



Summary Comparison of Alternatives

Alternative	Description	Estimate At Completion (EAC)	Monetized Risk Before	Monetized Risk After	Benefit Score	Estimated Start Date	Estimated Finish Date	Comments
A	Do nothing				0.000	7/1/2020	12/30/2020	
B	Scenario 01 / Alternate 01				0.000	7/1/2020	12/30/2020	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Maecenas porttitor congue massa. Fusce posuere, magna sed pulvinar ultricies, purus lectus malesuada libero, sit amet commodo magna eros quis urna.
C	Scenario 01 / Alternate 02				0.000	7/1/2020	12/30/2020	Nunc viverra imperdiet enim. Fusce est. Vivamus a tellus.
D	Scenario 02 / Alternate 01				0.000	7/1/2020	12/30/2020	Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Proin pharetra nonummy pede. Mauris et orci.
E	Scenario 03 / Alternate 01				0.000	7/1/2020	1/19/2023	Aenean nec lorem. In porttitor. Donec laoreet nonummy
F								
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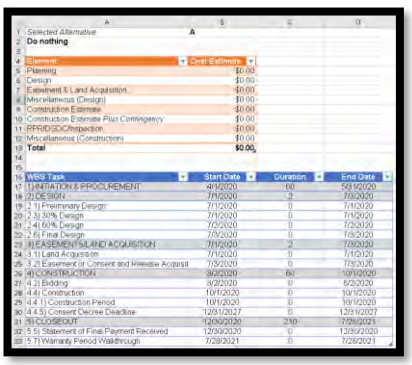
H								
I								
J								

The main item to populate in the “Alternative Summary” tab is the Alterative “Descriptions”. These Descriptions will show up in other tabs.

Please see the Summaries from BCE Worksheet *section (Page 7) under* BCE Report Instructions *for additional information on how to incorporate these tables into the BCE Report*.

BCE Doc Tables

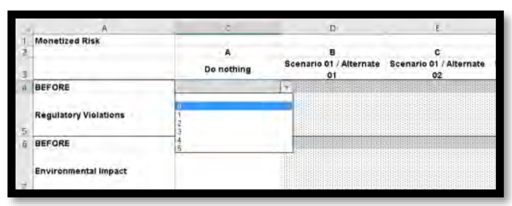


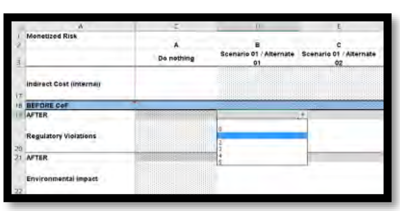
There is not anything to populate on the “BCE Doc Tables” tab. Once a project is selected in the “Project Info” tab, the Cost and Schedule will update automatically.

Please see the Summaries from BCE Worksheet *section (Page 7) under* BCE Report Instructions *for additional information on how to incorporate these tables into the BCE Report*.

Monetized Risk Scoring

First, use the dropdowns to score the “Before CoF” fields for the “Do Nothing” alternative. This will act as the existing conditions of the project and will provide a baseline for the other alternatives. All Before Risk scores will be the same as the “Do Nothing” alternative.

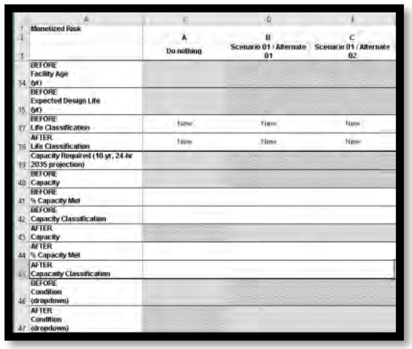


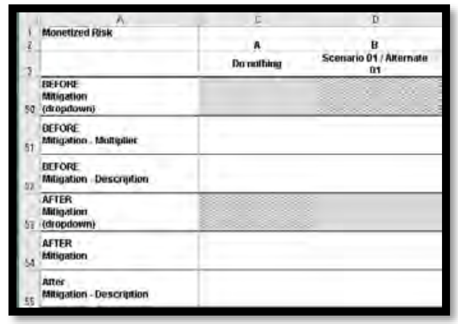


Next, use the dropdowns to score the “After CoF” fields for the remaining alternatives. The before and after CoF scores will be the same for the “Do Nothing” alternative.

Attachment 1 – Consequence of Failure (CoF) Table summarizes **CoF Categories**, **Impacts**, **Impact Description**, and **Scoring**.

Following the CoF section is LoF and Mitigation Factors. Similar to CoF, Before fields are available for the "Do Nothing" alternative and After fields are available for the other alternatives.

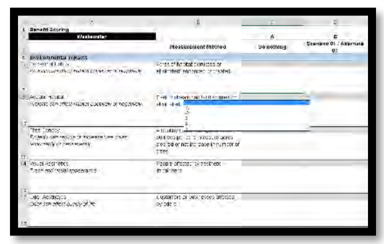




Please see the Monetized Risk *section (Page 3) under* Content of the BCE *for additional information*.

Benefits Risk Scoring

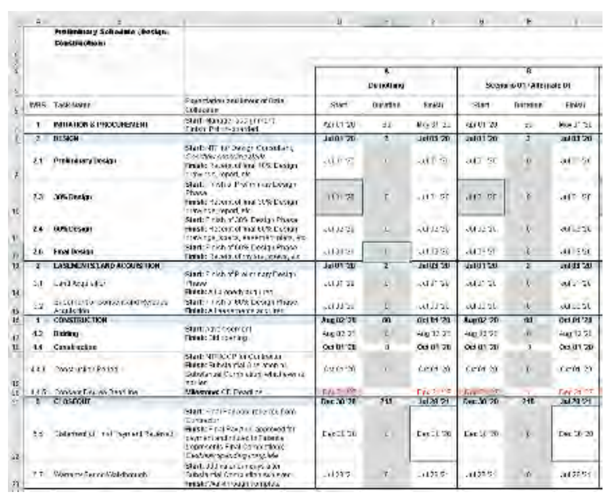
First, use the dropdown in cell A2 so select the type benefit program being evaluation: Wastewater, Stormwater, Flood Protection, and General. Then use the dropdowns and score each alternative.



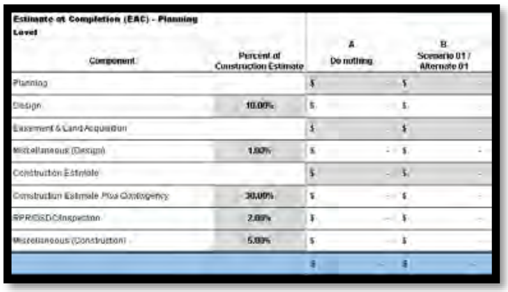
Attachment 2 – Benefit Scoring Table includes a full summary of benefits aspect, rationale, measurement method, and scoring.

Preliminary Schedule

A planning level preliminary schedule is needed to further compare alternates. Start by populating dates for WBS level 2.3 "30% Design" and 4.4.5 "Consent Decree Deadline" (if applicable, the estimating durations for each task.



EAC_Planning



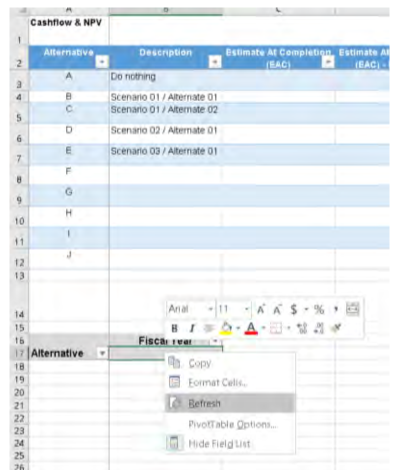
Estimate at Completion (EAC) - Planning Level Component	Percent of Construction Estimate	A Do nothing	B Scenario 01 / Alternate 01
Planning		$ -	$ -
Design	10.00%	$ -	$ -
Easement & Land Acquisition		$ -	$ -
Miscellaneous (Design)	1.00%	$ -	$ -
Construction Estimate		$ -	$ -
Construction Estimate Plus Contingency	30.00%	$ -	$ -
RPR/CSDC/Inspection	2.00%	$ -	$ -
Miscellaneous (Construction)	5.00%	$ -	$ -
		$ -	$ -

In order to prepare a planning level EAC, start by estimating "Perent of Construction Estimate", which will calculate those fields. Then estimate costs for Planning, Design, and Construction.

Cashflow & NPV

The Cashflow table will be populated with data from the "EAC_Planning" tab. Use the dropdown and select the appropriate Distribution Geometry. Then right-click inside the pivot table (cell B17 is a good place) and select "Refresh". The results from the pivot table will be auto-populated in the "Estimate At Completion (EAC) – Modeled" field.

A graphic showing available Cashflow Geometries is available in Attachment 4 – Cashflow Distribution Geometry.



PACC Cost Estimating

[Enter Text Here]

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POWER BI [TBD]

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ATTACHMENTS

Attachment 1 – Consequence of Failure (CoF) Table

Consequence of Failure Table							
Environmental							
Impact	**Description**	**0**	**1**	**2**	**3**	**4**	**5**
Regulatory Violations	Overflows (discharge to waters of the US) Permit Violations at WWTP USACE Violations MS4 Violations	N/A - Not Applicable	Short duration, low quantity, contained within facility	Minor disruption, few complaints, short process upset, minor SSO less than 1000 gals. ($ based on local regulatory fines)	Substantial disruption, numerous complaints, prolonged process recovery, significant SSO	Major disruption, complete loss of process, major SSO, 0-6 month recovery time.	Major disruption, complete loss of process, spill of >100,000 gallons, > 6 month recovery time.
	Monetized Value	**$0**	**$1,000**	**$25,000**	**$250,000**	**$500,000**	**$1,000,000**
Environmental Impact	Fauna, flora, water quality, odor, other miscellaneous factors	N/A - Not Applicable	Short duration, low quantity, contained within facility	few complaints,	Substantial disruption, numerous complaints, prolonged enviromental recovery,	Major disruption, widespread ratepayer complaints, complete loss of process, major SSO, 0-6 month recovery time.	Major disruption, widespread regional complaints, complete loss of process, spill of >100,000 gallons, > 6 month recovery time.
	Monetized Value	**$0**	**$1,000**	**$25,000**	**$250,000**	**$500,000**	**$1,000,000**
Social							
Impact	**Description**	**0**	**1**	**2**	**3**	**4**	**5**
Health & Safety	Public health and safety impacts, employee safety, regulatory compliance.	N/A - Not Applicable	First aid required (cut, bruise, topical rash)	Minor injury (Sprain, stitches)	Moderate injury (broken bone) or illness lasting several days	Severe injury or illness with permanent damage	Single fatality (EPA death avoidance cost @ $9M), localized illness
	Monetized Value	**$0**	**$500**	**$5,000**	**$50,000**	**$1,000,000**	**$9,000,000**
Level of Service	Reduced fire flow, poor water quality, impaired treatment ability, dimished system capacity	N/A - Not Applicable	Short duration disruption, less than 100 customers affected	Up to 1,000 customers affected.	Up to 10,000 customers affected.	Up to 100,000 customers affected.	More than 100,000 customers affected.
	Monetized Value	**$0**	**$500**	**$5,000**	**$50,000**	**$500,000**	**$5,000,000**
Public Image	Media coverage based on number of people affected, environmental impacts, financial loss, lawsuits	N/A - Not Applicable	Limited complaints (neighborhood level)	Local adverse media (County level)	Broad adverse media, (Service area and neighboring jurisdictions)	Regional adverse media, (State level), political consequences	National adverse media, political and regulatory consequences
	Monetized Value	**$0**	**$500**	**$10,000**	**$50,000**	**$500,000**	**$5,000,000**

Consequence of Failure Table							
Economic							
Impact	**Description**	**0**	**1**	**2**	**3**	**4**	**5**
Direct Cost (External)	Lost revenue, total repair costs, liability costs, fines, property damage	N/A - Not Applicable	<-$100K	$100K-$1M	$1M-$5M	$5-$15M	>$15M
	Monetized Value	**$0**	**$100,000**	**$1,000,000**	**$5,000,000**	**$15,000,000**	**$25,000,000**
Indirect Cost (Internal)	Organizational operating costs including additional personnel cost, insurance rate increases, reduced operational efficiency (increased chemical cost/containment requirments/ regulatory costs)	N/A - Not Applicable	Moderate operational changes, 2% - 3% increase in operating costs	Moderate operational changes and process costs, 3% - 5% increase in operating costs	Significant operational costs, 5% - 10%, increase in operating costs. Impacts other activities.	Major operational costs, 10% - 25%, increase in operating costs. Impacts other activities.	Major operational costs, >25% increase in operating costs. Rate and organizational change impacts.
	Monetized Value	**$0**	**$25,000**	**$125,000**	**$500,000**	**$1,500,000**	**$5,000,000**
						Maximum Consequence of Failure Score	**$51,000,000**

Business Risk Exposure (BRE) = Probability of Failure (PoF %) x Consequence of Failure (CoF $) x Mitigation Factor (Backup 0.02 - 1)

Attachment 2 – Benefit Scoring Table

Value:	Environmental Impacts	19.00%									
					Scoring						
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
Terrestrial Habitat	Projects can affect habitat positively or negatively	Acres of habitat disrupted or eliminated; enhanced or created	Substantial decrease (>5) in acreage	Slight decease in acreage	No acres of habit affected, neither positively or negatively	Slight Increase in acreage created	Substantial Increase (>5) in acreage created	10.2%	10.2%	14.9%	11.1%
Aquatic Habitat	Projects can affect habitat positively or negatively	Feet of stream habitat disrupted or eliminated; enhanced or created	Substantial amount of stream impacted >500LF	Minimal amount of stream impacted	No feet of stream habitat affected, neither positively or negatively	Minimal amount of stream enhanced	Substantial amount of stream enhanced >500LF	11.4%	11.4%	16.7%	11.1%
Tree Canopy	Projects can reduce or increase tree cover, temporarily or permanently	A healthy forest has approximately 50 trees per acre, measure acres cleared or net increase in number of trees	Substantial Amount (>1 acre) of Canopy Removed	Minimal amount of canopy removed	No square feet of tree canopy affected, neither positively or negatively	Minimal amount of canopy added	Substantial Amount (>50 trees) of canopy added	12.0%	12.0%	17.6%	11.1%
Visual Aesthetics	Trash and visual appearance	People affected by aesthetic impairment	Create substantial visual disturbance affecting large number of customers	Create slight visual disturbance affecting large number of customers or create substantial visual disturbance to small number of customers	No impact on visual aesthetics	Eliminate slight visual disturbance affecting large number of customers or eliminate substantial visual disturbance to small number of customers	Eliminate substantial visual disturbance affecting large number of customers	10.4%	10.4%	15.3%	11.1%
Odor Aesthetics	Odor can affect quality of life	Customers or businesses affected by odors	Create frequent annoying odor for 20 or more homes or businesses	Create frequent detectable odor or occasional identifiable odor	No impact on odors	Eliminate frequent detectable odor or occasional identifiable	Eliminate frequent annoying odor for 20 or more homes or businesses	11.6%	11.6%	17.1%	11.1%
Stream Base Flow	Changes in base flow (up or down) can be positive or negative	Amount of flow changed, can increase or decrease	25%+ decrease in flow during critical conditions.	Frequent decrease in flow during critical conditions	No impact on average or base stream flow	Intermittent increase in stream flow - often improves critical conditions	25%+ permanent increase in stream flow during critical conditions.	10.3%	10.3%	*0.0%*	11.1%
Stream Peak Flow	Changes in peak flow (up or down) can be positive or negative	Amount of flow changed, can increase or decrease	Substantial increase (>25%) in peak flow	Slight increase in flows - no significant peak increases	No impacts on scouring and erosion due to peak flow events, neither positive or negative	Slight reduction in flows - no significant peak reduction	Substantial reduction (>25%) in peak flows	12.6%	12.6%	18.4%	11.1%
Nutrient Loadings	Even if not in permits nutrient loadings have impacts	Changes in loading of nutrients \	Substantial increase (>25%) in nutrient loadings	Slight increase in nutrient loadings	No change in nutrient loading, neither positive or negative	Slight decrease in nutrient loadings	Substantial decrease (>25%) in nutrient loadings	11.2%	11.2%	*0.0%*	11.1%
Impaired Use Impacts	For impaired stream segments, changes to pollutant of concern can have impacts	For impaired streams, changes in POC per WAT model	Substantial increase (>24%) in pollutants of concern	Slight increase in pollutants of concern	No ecological impacts, neither positive or negative	Slight decrease in pollutants of concern	Substantial decrease (>25%) in pollutants of concern	10.3%	10.3%	*0.0%*	11.1%

Instructions: (1.) Score each alternative for each of the nine aspects of the value. Scores can be positive or negative, depending on the impact of the alternative on the value. (2.) Total the scores for each aspect to get the total score for this alternative in this value. (3.) Shaded area represents "fatal flaw". Alternatives that score in this area should not be proposed.

Value:	**Regulatory Compliance**	***15.00%***									
			Scoring								
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
KPDES	Permit limits and requirements are specific	Best professional judgment on impact to KPDES permit compliance	Jeopardizes meeting permit requirements	Moderately reduces the factor of safety for meeting permit requirements	No change in reliability of performance for meeting permit requirements	Moderately improves performance for meeting permit requirements	Significantly improves performance for meeting permit requirements	27.5%	*0.0%*	*0.0%*	16.7%
MS4	Permit requirements are specific	Best professional judgment on impact to MS4 Permit compliance	Jeopardizes meeting permit requirements	Moderately reduces the factor of safety for meeting permit requirements	No change in reliability of performance for meeting permit requirements	Moderately improves performance for meeting permit requirements	Significantly improves performance for meeting permit requirements	*0.0%*	32.2%	*0.0%*	16.7%
Amended Consent Decree	Projects can have unintended impacts on consent decree requirements	Best professional judgment on impact to Amended Consent Decree	Substantial detrimental effects to consent decree obligations	Creates potential for non-compliance with consent degree obligations	No detrimental effect to consent decree obligations	Achieves greater than required consent degree obligations	Substantially achieves greater than required consent degree obligations	30.2%	34.1%	37.2%	16.7%
Flood Plain Management	FEMA program, USACE operating requirements and local regulations	Positive or negative risk factors relative to regulations	Substantially increases risk of flooding for people in mapped floodplains	Slightly increases risk of flooding for people in mapped floodplains	No change in current floodplain	Slightly reduces risk of flooding for people in mapped floodplains	Substantially reduces risk of flooding for people in mapped floodplains	*0.0%*	33.7%	36.7%	16.7%
Air Permits	Permit limits and requirements are specific	Best professional judgment on impact to air permit compliance	Jeopardizes meeting permit requirements	Moderately reduces the factor of safety for meeting permit requirements	No change in reliability of performance for meeting permit requirements	Moderately improves performance for meeting permit requirements	Significantly improves performance for meeting permit requirements	21.1%	*0.0%*	26.1%	16.7%
Biosolids	Permit limits and requirements are specific	Best professional judgment on impact to biosolids permit compliance	Jeopardizes meeting permit requirements	Moderately reduces the factor of safety for meeting permit requirements	No change in reliability of performance for meeting permit requirements	Moderately improves performance for meeting permit requirements	Significantly improves performance for meeting permit requirements	21.2%	*0.0%*	*0.0%*	16.7%

Instructions: (1.) Score each alternative for each of the six aspects of the value. Scores can be positive or negative, depending on the impact of the alternative on the value. (2.) Total the scores for each aspect to get the total score for this alternative in this value. (3.) Shaded area represents "fatal flaw". Alternatives that score in this area should not be proposed.

Value:	**Public Health Protection**	***19.00%***									
			Scoring								
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
Pathogen Exposure	Primary direct impact of MSD's operations	Best professional judgment on change in pathogen discharge, public accessibility	Broad public exposure to 25% higher pathogen contamination	Limited public exposure to higher pathogen contamination	No change in public's exposure to pathogens	Reduction in pathogens in a location with limited public exposure	25% reduction in pathogens in a location with broad public exposure	58.0%	40.7%	*0.0%*	33.3%
Drowning Risk	Rushing water or deep pools are risky to pedestrians and autos	Water Surface elevations; velocities over roadways where models exist. If no model exist, best professional judgment	Substantial increase in drowning risk	Slight increase in drowning risk	No change in drowning risk	Slight decrease in drowning risk	Substantial decrease in drowning risk	*0.0%*	29.8%	50.3%	33.3%
Mold Exposure	Mold can grow in buildings after exposure to water	Increase/decrease in likelihood of chronic exposure to water	Extreme increase (more than 20 homes) in the likelihood of mold exposure	Possibility of an increase in the likelihood of mold exposure	No change in likelihood of chronic exposure to water, neither positively or negatively	Possibility of an decrease in the number of homes removed from repeated flood risk	More than 20 homes removed from repeated flood risk	42.0%	29.5%	49.7%	33.3%
~~**Public Utility Delivery**~~	~~Lou Water Co's, LG&E's, etc. ability to deliver their services/products~~	~~Inability of other agencies to deliver their services as~~	~~Completely prevents other agencies from delivering services~~	~~Possibly prevents other agencies from delivering services~~	~~No change in ability of other agencies to deliver services~~	~~Possibly improves other agencies in delivering services~~	~~Guaranteed to improve other~~	-	-	-	-

Value:	Public Health Protection		*19.00%*								
					Scoring						
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
		~~a result of MSD operations or lack thereof~~					~~agencies in delivering services~~				

Instructions: (1.) Score each alternative for each of the four aspects of the value. Scores can be positive or negative, depending on the impact of the alternative on the value. (2.) Total the scores for each aspect to get the total score for this alternative in this value. (3.) Shaded area represents "fatal flaw". Alternatives that score in this area should not be proposed.

Value:	Property Protection		*17.00%*								
					Scoring						
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
Basement Backup	Basement back-ups not regulated by permit, but property and health issue	Sewer surcharging or blockage potential	Causes 20 or more backups per year per 100 miles of sewer	Slight increase in backups	No change	Slight decrease in backups	Prevents 20 or more backups per year per 100 miles of sewer	26.5%	21.7%	28.1%	20.0%
Surface Flooding - Traffic Disruption	Surface flooding can be caused by sewer backups or surface drainage	Sewer overflows, drainage modeling, FPS capacity, surface flooding versus transportation disruption	Prevents 5% or more surface streets from being driven on	Possibly prevents vehicles from driving on surface streets	No change in ability of vehicles from driving on surface streets	Possibly improves vehicles driving on surface streets	Reduces surface flooding on surface streets by 5% or more	20.5%	16.9%	21.9%	20.0%
Surface Flooding - Structural Damage	Surface flooding can be caused by sewer backups or surface drainage	Sewer overflows, drainage modeling, FPS capacity, surface flooding versus structural damage	Increase in the structural damage to 20 or more structures	Possibility of an increase in the likelihood of structural damage	No change in likelihood of structural damage, neither positively or negatively	Possibility of an decrease in the likelihood of structural damage	Decrease in the likelihood of structural damage to 20 or more structures	25.3%	20.8%	26.9%	20.0%
Flood Insurance Rating (CRS Rating)	Ratings affect the cost of insurance to residents	Increase or decrease in CRS rating per FEMA scoring system	Substantial decrease in CRS ratings	Slight decrease in CRS ratings	No change in current floodplain programs	Slight increase in CRS ratings	Substantial increase in CRS ratings	0.0%	17.9%	23.1%	20.0%
Utility Service Delivery	N/A	N/A	Completely prevents other agencies from delivering services	Possibly prevents other agencies from delivering services	No change in ability of other agencies to deliver services	Possibly improves other agencies in delivering services	Substantially improves other agencies in delivering services	27.7%	22.7%	0.0%	20.0%

Instructions: (1.) Score each alternative for each of the four aspects of the value. Scores can be positive or negative, depending on the impact of the alternative on the value. (2.) Total the scores for each aspect to get the total score for this alternative in this value. (3.) Shaded area represents "fatal flaw". Alternatives that score in this area should not be proposed.

Value:	Sustainability		*17.00%*								
					Scoring						
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
Non-Renewable Resource Consumption	Electric, fuel, and chemical addition all use non-renewable resources	Power, fuel and chemical use at normal operations	Substantial increase (>25%) in use of non-renewable resources	Slight increase in use of non-renewable resources	No change in use of non-renewable resources, neither positive or negative	Slight decrease in use of non-renewable resources	Substantial decrease (>25%) in use of non-renewable resources	12.4%	12.4%	14.4%	12.5%

Value:	Sustainability	17.00%										
				Scoring								
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
Mechanical v. natural systems	Mechanical systems more prone to catastrophic failure than natural systems	Extent of requirement on mechanical maintenance	Entirely mechanical with no redundancy and no backup power	Mechanical with redundancy or backup power	No change	Mix of mechanical and natural (gravity)	All natural - gravity solutions	14.0%	14.0%	*0.0%*	12.5%
Multi-purpose community asset	Facility viewed as community asset more likely to be preserved	Extent to which facility can provide neighborhood amenity (environmental, recreational, or other)	Removes a community asset	Removes a portion of a community asset	No Impact	Increases an existing community asset	Provides a new community asset	12.1%	12.1%	14.0%	12.5%
Public access	Projects can impact public access to greenspace and open lands (current or proposed)	Creates or removes access to green space and open lands		Removes access	No acres of green space affected, neither positively or negatively	Adds access		11.4%	11.4%	13.2%	12.5%
Public information/ education enabler	Projects can illustrate key environmental principles	Level of active or passive information/education opportunities directly related to project	Eliminates the opportunity for active public education	Eliminates passive public education	No Impact	Provides passive signs for public education	Provides educational facility with a substantial opportunity for public education.	11.2%	11.2%	13.1%	12.5%
Reclaim abandoned or under-utilized land	Abandoned or under utilized lands may be repurposed as project sites	Acres of abandoned or under-utilized property used in project siting.	Creates substantial amount of abandoned land (>5 acres)	Creates slight amount of abandoned land	0 acres used	Provides for slight amount of repurposed land	Provides for substantial amount of repurposed land (>5 acres)	13.4%	13.4%	15.5%	12.5%
Impact on Impervious surface	Projects can add or remove impervious area	Pervious area created or removed	Decreases pervious surfaces by more than 1 acre	Decreases slight amount of pervious surfaces	No impervious area created or removed	Increases slight amount of pervious surfaces	Creates impervious surfaces of more than 1 acre	13.0%	13.0%	15.2%	12.5%
Land Use compatibility or improvement	Projects can be evaluated for compatibility of land use & opportunities for improvement	Qualitative judgement on how project fits neighborhood, potential for green space or other improvement.	Completely incompatible with the project neighborhood	Possibly incompatible with the project neighborhood	No impact to the project neighborhood	Compatible with the current project neighborhood	Compatible with the future or improves project neighborhood	12.5%	12.5%	14.6%	12.5%

Instructions: (1.) Score each alternative for each of the eight aspects of the value. Scores can be positive or negative, depending on the impact of the alternative on the value. (2.) Total the scores for each aspect to get the total score for this alternative in this value. (3.) Shaded area represents "fatal flaw". Alternatives that score in this area should not be proposed.

Value:	Economic Vitality	13.00%										
				Scoring								
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**
Potential number of new customers served by project	Wastewater Service is enabler for customer growth	Potential number of customers served or removed from service by project	Removes 100 or more residential customers	Moderately decreases the number of customers	No new customers	Moderately increases the number of customers	Creates 100 or greater new residential customers	46.2%	46.2%	46.2%	50.0%
Potential for new commercial/industrial flows or loads served by project	Wastewater Service is essential to attract commercial/industrial customers	Potential for commercial/industrial flows served or removed from service by project	Removes 10 commercial customers, or > 40,000 gpd in commercial and/or industrial flow	Moderately decreases the flow from commercial/industrial customers	No new flow from commercial/industrial customers	Moderately increases the flow from commercial/industrial customers	Creates 10 new commercial customers, or >40,000 gpd in commercial and/or industrial flow	53.8%	53.8%	53.8%	50.0%

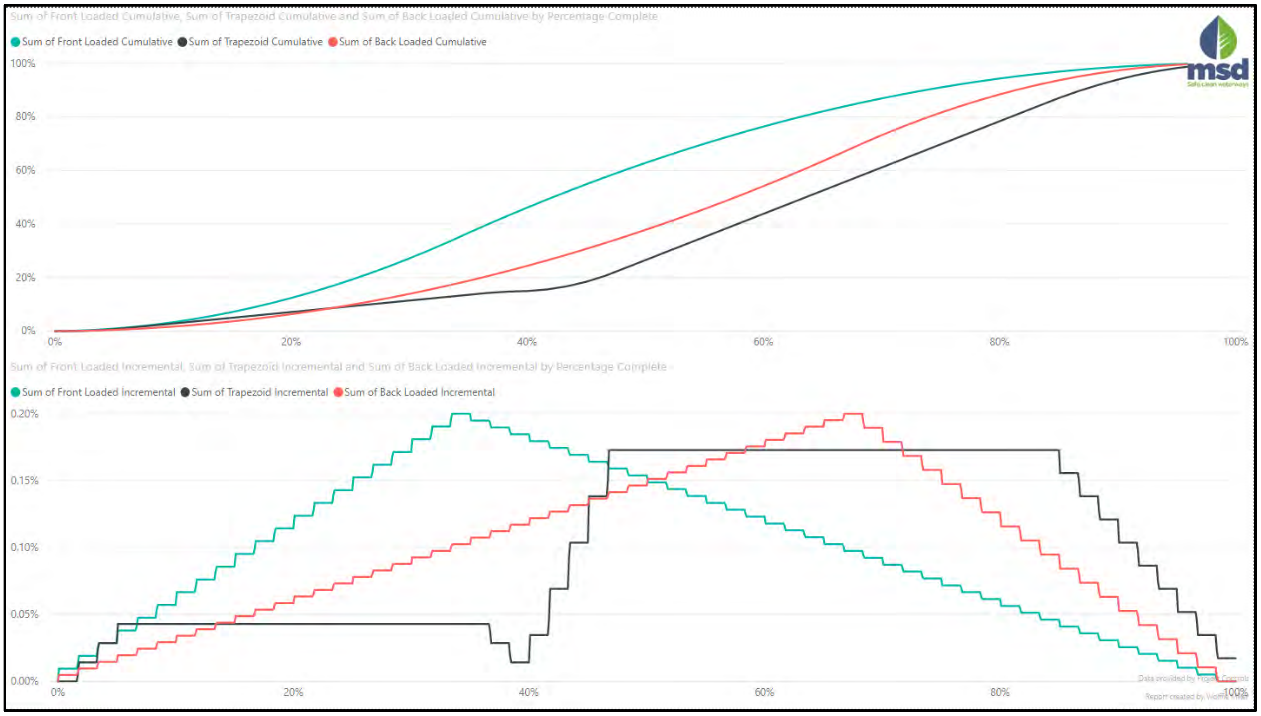
Value:	Economic Vitality		*13.00%*								
					Scoring						
Aspect	**Rationale**	**Measurement Method**	**-5**	**-2**	**0**	**2**	**5**	**Wastewater**	**Stormwater**	**Flood Protection**	**General**

Instructions: (1.) Score each alternative for both of the aspects of the value. Scores can be positive or negative, depending on the impact of the alternative on the value. (2.) Total the scores for each aspect to get the total score for this alternative in this value. (3.) Shaded area represents "fatal flaw". Alternatives that score in this area should not be proposed.

Attachment 3 – Expected Design Life – Suggested

	Secondary Project Category				
Primary Project Category	**Structural**	**Mechanical**	**Pumped**	**Not Pumped**	**NA**
WQTC	50	15			20
Flood PS	50	50			50
PS	50	15			15
Viaduct			20	50	20
Sewer					90
NPS/WQ					40

Attachment 4 – Cashflow Distribution Geometry



Appendix O. Tentative Candidate AM Project List

Tentative Potential AM Projects		
MSD Budget ID	Project Name	Estimated Cost
C20332	Admiral Pump Station Foundation Repairs	$ 263,500
D20222	Bells Lane Grit Classifier Drain Line	$ 113,100
D20224	Bells Lane PAA System	$ 602,100
D20223	Bells Lane WWTF Polymer Feed System Improvements	$ 332,000
F20321	Bluegrass Fields PS Renovation	$ 511,000
E15036	Broad Fern Pump Station Elimination	$ 287,000
D20149	Cedar Creek WQTC Admin Building Expansion.	$ 1,067,000
D19039	Cedar Creek WQTC Effluent Parshall Flume Upgrade	$ 1,786,000
D16272	Cedar Creek WQTC Influent PS MCC Upgrades	$ 757,000
D16274	Cedar Creek WQTC Oxidation Ditch Mods	$ 375,000
D16273	Cedar Creek WQTC Power Reduction Mods	$ 124,000
A18069	Cedar Creek WQTC Service Area Back-Up Power For Critical Pump Stations	$ 895,000
E21118	Cedar Creek WQTC Service Area Inventory For Critical Pump Stations	$ 708,000
D20017	Cedar Creek WQTC Sodium Aluminate Building	$ 814,000
D18090	Cedar Creek WQTC Solids Dewatering Handling Facility (& Dig. Decant Enhance)	$ 5,020,000
D17032	Cedar Creek WQTC Tertiary Filtration	$ 5,812,000
D16275	Cedar Creek WQTC WAS Cycle Automation	$ 187,000
D20016	Derek R. Guthrie WQTC Admin and RAS Buildings HVAC	$ 678,000
New_BD163	Derek R. Guthrie WQTC Replace Clarifiers 4, 5, & 6	$ 1,374,000
D18093	Derek R. Guthrie WQTC Alternative Outfall	$ 3,590,000
D18292	Derek R. Guthrie WQTC Clarifier Grout Repair and RAS Gate Replacement	$ 2,551,000
D21129	Derek R. Guthrie WQTC Elevator Repairs	$ 1,123,000
D20278	Derek R. Guthrie WQTC RAS Building Electrical Modifications	$ 235,000
A18073	Derek R. Guthrie WQTC Service Area Back-Up Power For Critical Pump Stations	$ 1,119,000
E21116	Derek R. Guthrie WQTC Service Area Inventory For Critical Pump Stations	$ 631,000
E18065	Derek R. Guthrie WQTC Service Area Upgrade Critical PSs With Inadequate Capacity	$ 730,000
D20286	Derek R. Guthrie WQTC Substation U-13 Modifications	$ 150,000
D18132	Derek R. Guthrie WQTC WWPS WW Screen Bldg HVAC	$ 1,030,000
A18068	Floyds Fork WQTC Service Area Back-Up Power For Critical Pump Stations	$ 672,000
X_0166	Floyds Fork WQTC Service Area Inventory For Critical Pump Stations	$ 682,000
D18092	Floyds Fork WQTC Solids Dewatering Handling Facility RR	$ 5,195,000
Annual	CMOM Collection System PS RR	$ 2,500,000
Annual	CMOM Gravity Line Cleaning & Inspection	$ 6,675,000
Annual	Morris Forman WQTC Equipment RR	$ 13,100,000
Annual	Miscellaneous Facility Repairs	$ 1,090,000
Annual	MSD Owned Building Roof Replacements	$ 2,025,000
Annual	Operations Renewal & Replacement	$ 10,300,000
Annual	Regional WQTC RR	$ 7,500,000
A14129	Gorham Way Pump Station Elimination	$ 286,000
A18077	Hite Creek WQTC Service Area Back-Up Power for Critical Pump Stations	$ 1,900,000
K18067	Hite Creek WQTC Service Area Inventory for Critical Pump Stations	$ 1,178,000
D21057	Hite Creek WQTC Sodium Aluminate Feed Automation	$ 129,000

Tentative Potential AM Projects		
MSD Budget ID	Project Name	Estimated Cost
D20008	Kirby Lane Pump Station Elimination	$ 860,000
E15035	Lake Forest Pump Station Eliminations	$ 893,000
A20006	Lea Ann Way Pump Station Elimination	$ 13,587,000
G18417	Morris Forman WQTC Admin. Building Roof Replacement	$ 356,000
D15024	Morris Forman WQTC Chiller Replacement	$ 477,000
D18161	Morris Forman WQTC Chlorine Contact Tanks Structural Repairs	$ 308,000
D17039	Morris Forman WQTC DAFT Rehab and TWAS Piping Replacement	$ 3,680,000
G20028	Morris Forman WQTC Elevator Repairs	$ 1,895,000
D18121	Morris Forman WQTC Heat Polymer Water	$ 356,000
D20304	Morris Forman WQTC Headworks and Blower Building Repairs	$ 307,000
D18159	Morris Forman WQTC HPO Tanks (Battery A, B, and C) Structural Repairs	$ 2,607,000
D18162	Morris Forman WQTC Final Effluent Pump Station (FEPS) Structural Repairs	$ 66,000
D18157	Morris Forman WQTC North and South Primary Sludge PS Structural Repairs	$ 142,000
F14181	Morris Forman WQTC Process Water Pump & VFD	$ 100,000
D19048	Morris Forman WQTC Radio Repeater	$ 528,000
D18160	Morris Forman WQTC Secondary Clarifiers Structural Repairs	$ 186,000
D18156	Morris Forman WQTC Service and Blower Building Structural Repairs	$ 124,000
A18088	Morris Forman WQTC Service Area - Enhanced Odor Control for Two Pump Stations	$ 2,518,000
A18082	Morris Forman WQTC Service Area Back-Up Power for Critical Pump Stations	$ 2,844,000
E21120	Morris Forman WQTC Service Area Inventory for Critical Pump Stations	$ 1,886,000
E18084	Morris Forman WQTC Service Area Upgrade Critical PSs With Inadequate Capacity	$ 2,543,000
D21104	Morris Forman WQTC Sewer and Manhole Rehab	$ 469,000
D18118	Morris Forman WQTC Truck Unloading Station Pavement Repair	$ 59,000
E21062	Modesto Pump Station Elimination	$ 320,000
D20010	Northern Ditch Pump Station Odor Control	$ 715,000
D20011	Northern Ditch Pump Station Replacement	$ 20,947,000
D18285	ORFM Odor and Corrosion Control	$ 2,325,000
E21066	Pirogue Pump Station Elimination	$ 720,000
E21070	Rosa Terrace PS Elimination	$ 4,405,300
E21091	Sanders Lane PS Rehabilitation	$ 690,000
A18485	Shady Villa Pump Station Elimination	$ 1,356,000
H16076	Sneads Branch Pump Replacement	$ 726,000
E21090	Sonne Avenue PS Elimination	$ 2,298,000
D19286	SWPS Gas Monitoring	$ 569,000
E21071	Wathen Lane PS Rehabilitation	$ 1,559,000
	Total	**$ 159,518,000**

Note: This list of projects excludes MFWQTC Corrective Action Plan, Critical Interceptors, MFWQTC New Biosolids Facility.

Asset Management Program

Strategic Asset Management Plan

msd

Safe, clean waterways