Infrastructure Asset Management in Action at Onondaga County Department of Water Environment Protection (WEP)

Onondaga County Department of

Water Environment Protection

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Save the Rain

Onondaga County Department of WATER ENVIRONMENT PROTECTION

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Infrastructure Asset Management in Action Introduction

Onondaga County Department of Water Environment Protection (WEP) is a wastewater utility organization that serves a portion of central New York centered on Syracuse, New York. The County provides sanitary and storm sewer services through the Consolidated Sewer District and several drainage districts. The infrastructure managed by the Department is as diverse as the services provided by the staff. Staff includes administrative personnel, biologist, construction inspection, electricians, engineers, fiscal personnel, fleet maintenance, HVAC technicians, heavy machine operators, instrumentation technicians, inventory control personnel, IT, janitorial, laboratory technicians, managerial staff, mechanics, operations staff, permitting, personnel staff, sampling staff, sewer televising and inspection, and sewer and stream maintenance staff.

The magnitude and variety of the asset inventory for the Department requires organized practices to aid in the management of the infrastructure. WEP uses Asset Management (AM) as one method to organize, plan, make decisions, and keep staff informed regarding the relatively large collection of assets. This document summarizes the main goals and focus of WEP's AM program.

WEP's Asset Management Program Background

WEP provides services to Onondaga County residents in the Consolidated Sanitary District with an emphasis on being a respected leader in wastewater treatment, storm water management, and the protection of our environment using state-of-the-art, innovative technologies and sound scientific principles as a guide. Through this work WEP protects and improves the water environment of Onondaga County in a cost-effective manner ensuring the health and sustainability of our community and economy. One way WEP carries out its vision and mission is through the use of Infrastructure Asset Management (AM).

The United States Environmental Protection Agency (EPA) defines asset management as managing infrastructure capital assets to minimize the total cost of owning and operating them, while delivering the service levels desired by customers. As stated by the EPA "Sewer system assets that are not regularly maintained usual deteriorate faster than expected and lead to higher replacement and emergency cost." WEP's asset management program is designed to better deliver acceptable service and provide it on a sustainable cost basis to the ratepayer.

WEP's Asset Management Mission is to consistently deliver established levels of service and achieve sustainability using best-in-class Asset Management practices. What are best-in-class AM practices? At WEP, we have adopted many AM concepts developed by the EPA as our focus to be best-in-class. The EPA published its own Best Practices guide, which asserts that AM programs should focus on answering the following five (5) core questions of Asset Management.

1. What is the current state of our assets?
2. What is the desired level of service?
3. Which assets are critical to sustained performance?
4. How to achieve the minimum life cycle cost for an asset?
5. What is the long-term funding plan?

As stated in WEP's AM Mission, it strives to answer these questions. In addition to being best-in-class by answering these questions, WEP is also focused on being sustainable, and providing customers with the best service possible while minimizing the lifecycle cost of the assets or equipment owned, operated, and maintained by WEP's staff. WEP's AM program defines an asset as the following:

"A component of a facility with an independent physical and functional identity and age (e.g., pump, motor, sedimentation tank, main)."

This definition is taken from the EPA asset management guidance. WEP expanded the definition to better define the meaning as it applies to specific equipment and facilities being managed as part of WEP's AM program. An asset is the lowest level where a work task is generated and tracked. By definition, assets shall satisfy one or more of the following:

- A necessary component in the conveyance or treatment of wastewater, stormwater, and combined sewers (CSOs). Examples: Valves, Piping, Aeration Diffusers, Controls, Pumps, Tanks, and Aeration Blowers.
- A necessary component in the supply of electricity; Examples: Motors, Circuit Breakers, Transfer Switches, and Emergency Generators.
- A necessary component required to comply with local, state, or federal regulatory standard; Examples: Flow Meter, Chemical Containment, and Operational Monitoring Equipment.
- A component providing a safe and healthy work environment including ventilation of confined spaces; Examples: Exhaust Fans, Hazardous Gas Detector, and Boilers.
- Green infrastructure owned and maintained by WEP;
- Computers, laboratory equipment, or sampling equipment;
- Any piece of equipment with an estimated value greater than $5,000; or
- Any piece of equipment with an estimated useful life equal to or greater than three (3) years.

Assets DO NOT include miscellaneous fixtures such as light fixtures, light switches, toilets, sinks, and floor drains.

Infrastructure and Asset Management within the County's sewer system have a long history, taking on many forms and names. The Department began formalizing it's AM program in the late 1990's through early 2000's. Since that time the program has grown. It has consolidated simple computer and paper databases that staff utilized to manage work. The consolidation of these systems resulted in the implementation of a computerized maintenance management system (CMMS) referred to as Maximo. Maximo was and is still one of the leaders in the industry for CMMS. WEP has continued to implement Maximo and its continual upgrades to keep up with technology. Since the original implementation IBM bought Maximo and now maintains it as one of its product offerings. Maximo has continued to add features to allow users, including WEP, to utilize it as their Enterprise Asset Management System. This software continues to help WEP in accomplishing its AM mission.

What is the state of our assets?

WEP currently has over 12,000 operational assets being tracked in its Maximo system. These assets meet the conditions described above but do not include every component of every facility and that number does not include all "linear assets" such as sewer lines, manholes, and force mains: these linear assets include another 20,000 assets. As part of an ongoing effort, these linear assets are being organized and vetted for addition into WEP's Maximo system. In addition to tracking and performing over 46,000 maintenance work orders each year, a constant effort is being made to update and replace assets in our system to keep this list up-to-date.

Overview of WEP Asset Base		
Asset Class	**WEP Type**	**Characteristics**
Wastewater Treatment	The Plant Maintenance group maintains the assets that make up the six treatment plants. Typical asset types include: • Pumps • Screens • Blowers • Clarifiers • Standard wastewater process equipment	Process equipment assets are characterized as being complex systems of mechanical and electrical components. Failures are a mix of fatigue, age/ usage related and electrical components which are more prone to random failures.
Electrical Assets	WEP's electrical department is responsible for maintaining the electric asset at the treatment plants and pump stations. Typical assets include: • Motors • PLCs • VFDs • Panels • SCADA components including sensors and analyzers	These assets primarily consist of electric and electro-mechanical components. As such, failures are more complex and will include a mix of fatigue related, age/ usage related, and random.
Facilities (HVAC)	Facilities are part of the Plant Maintenance group and are responsible for maintaining the building infrastructure for the treatment plants and pump stations. Typical assets include: • Boilers • Unit Heaters • Exhaust and Ventilation Fans • Network assets – including drainage, plumbing (including the fire sprinkler systems), HVAC, boilers, chillers	HVAC assets are varied and consist of electrical and mechanical, long-life and moderate life structural assets, and electrical systems. Failures are a mix of all established failure patterns.
Flow Control	Flow Control maintains the conveyance systems, the regional CSO treatment and storage facilities, as well as green infrastructure assets. They are also responsible for maintaining drainage and storm management systems around the County. Typical assets include: • Pumps • Gravity Sewers • Manholes • Pressure mains • Landscaping	Gravity sewer assets are characterized as being long-life assets, with low probability and high consequence failures. They are generally a much simpler type of asset with failures typically related to age. The process equipment assets are characterized as being complex systems of mechanical and electrical components. Failures are a mix of fatigue, age/ usage related and electrical components which are more prone to random failures.

These assets are categorized into 33 "parent" classes and over 100 different "child" classifications. These asset classifications group equipment by similar characteristics and expected service life. Each classification has a set list of specifications. These classes provide multiple benefits such as allowing for the estimate of replacement values and reference materials for staff when doing maintenance. Above is a description of the different wastewater maintenance divisions within WEP and the typical types of assets that they maintain. In addition to these groups, WEP also maintains Laboratory Equipment which is also part of Maximo. Fleet maintenance is done in a similar way but the records and inventory are kept in a specialized fleet maintenance software program known as Faster.

In an effort to further its asset management, WEP began performing formal condition assessments in 2013. These condition assessments are being performed by WEP staff, consultants, vendors, and manufacturers. Condition scoring results are entered into Maximo with the date which they were conducted. We also consider other factors, the asset's condition score allows WEP to grade each piece of equipment based on a one (1) to ten (10) scale with ten being a piece of equipment which is currently failing. The table below shows the extremes of the condition score represented by very good or very poor. However, an asset may also be scored as good, fair, or poor which correspond to the scores of two (2), five (5), or seven (7) respectively.

Likelihood of Failure		
Likelihood Category	**1**	**10***
Physical Condition (60%)		
General Condition	Very good	Very poor
Grade - (Based on the Assessment Rubric)	Condition Grade 1	Condition Grade 5
Maintenance Requirements	No corrective maintenance required	Asset may be unserviceable, needs replacement or rehabilitation
Age (Remaining Useful Life)	Age ≤ 20% of its Service life	Age > 80% of its Service Life

Once the condition is assessed the staff then assigns a performance score to each asset, also on a scale of one (1) to ten (10). This performance score is an indicator of the asset's capacity to meet its required Level of Service (LOS), its efficiency, and availability of replacement parts. Similar to condition, performance has specific criteria to determine the score. Criteria for a performance score of one (1) and a ten (10) are shown below.

Likelihood of Failure		
Likelihood Category	**1**	**10***
Performance (30%)		
Capacity	Sufficient capacity to meet average and peak flow requirements	Unable to meet current average capacity requirements
Level of Service	Appropriate utilization and function for LOS	Cannot meet current or pending LOS
Financial Efficiency	Operationally efficient	Replacement with new equipment has ROI < 3 years
Inflow and Infiltration	I/I within allowable limit (< 100 GPD/IDM)	Significant I/I (>400 GPD/IDM)
Flooding	No history of flooding	
Obsolete Parts	Spare pares are listed in Maximo and available within 1 - 2 days, or no pare pares required	

Condition and performance are a good indication of the likelihood an asset will fail. As part of WEP's AM program the likelihood of failure (LOF) also considers the level of documentation of O&M protocols as well as the maintenance history. Thus for assets which have been reviewed, WEP can quantify the probability of an asset failing. The assets with the highest risk of failing need further investigate regarding their criticality. Often the most important assets cannot be allowed to approach failure because of their impact to the services we provide.

What are Levels of Service?

The International Infrastructure Management Manual defines "Level of Service" as "the defined service quality for a particular activity". WEP has established levels of service through work with consultants and internal staff. These levels of service support the overall goals of our utility and similar wastewater utilities. Maintenance, repairs, capital projects, and long-range planning are all aimed in an effort to have all County owned assets of the Consolidated Sanitary District meet these required levels of service.

Desired Levels of Service	
LOS Category	Target Levels of Service
System Reliability	
Capacity	Adequate capacity for all existing flows
SSO / Dry Weather CSO	No SSOs or Dry weather CSOs
Property Damage	No property damage
Odor	No odor complaints
Process/System Impact	No loss of treatment or system effectiveness
Regulatory Compliance	
Permit limits	No permit violations
Consent Decree	Meet all Consent Decree requirements (e.g., ACJ green & gray)
Water Body Use Attainability	Restore all impaired receiving waters to target classifications on set schedule
Public & Employee Health & Safety	
Injuries	No injuries or adverse health effects
Impact to Public Health	No infectious disease
Fiscal Impacts	
Capital & O&M budgets	Sufficient financial resources to meet capital and O&M budget
User rate stability	No unplanned need for borrowing
Public Confidence	
Construction Impact (e.g., traffic, noise, etc.)	No adverse impact on community
Business Impact	No adverse impact on businesses
Public perception	No adverse media attention
Development Impact	Support smart growth

WEP's levels of service identify are centered on the functions and goals of our department. These levels of service are the basis for a metric to measure each asset utility or importance to provide service to our customers. Using the established metric WEP can quantify each assets relative criticality.

Which Assets are most critical?

Based on the above discussed levels of service, WEP assets are assigned a Consequence of Failure (COF) score. This score directly relates to the impact of an asset's failure on the Department and its mission. These assets are said to have a high consequence of failure if the results of a failed asset negatively impact the levels of service. We score COF based on a scale of one (1) to ten (10) with 10 being the most critical assets. The COF score is based on the five (5) LOS categories, system reliability, regulatory compliance, public and employee health and safety, fiscal impacts, and public confidence. A COF score of one (1) or a negligible consequence of failure equates to the asset's failure not affect the levels of service. For the asset's failure to be a severe or a score of ten (10), the failure must meet or exceed the follow criteria of each category.

Consequence Category	Severe = 10
System Reliability	
Capacity	Loss of hydraulic and / or treatment >30% existing capacity
SSO / Dry Weather CSO	SSO or DWCSO >100,000 gallons per event
Property damage	>25 property damage claims
Odor	Widespread (>25) odor complaints
Process/System Impact	Will immediately result in significant loss of treatment or system effectiveness if action is not taken promptly

Consequence Category	Severe = 10
Regulatory Compliance	
Permit limits	Potential for major enforcement action (including fines). Permit violation, SSO, DWCSO lasting longer than 7 days.
Consent Decree	Adverse impact on Consent Decree
Water Body Use Attainability	Receiving water bodies degradation

Consequence Category	Severe = 10
Public & Employee Health & Safety	
Injuries	Potential major injury due to extreme unsafe condition; >480V; loss of ventilation in classified areas
Impact to Public Health	Possible infectious disease, or release of contaminants without any containment (discharge of contaminants leaving site).

Consequence Category	Severe = 10
Fiscal Impacts	
Capital & O&M budgets (User rate stability)	Needs to go to full County Legislature (> 100K)

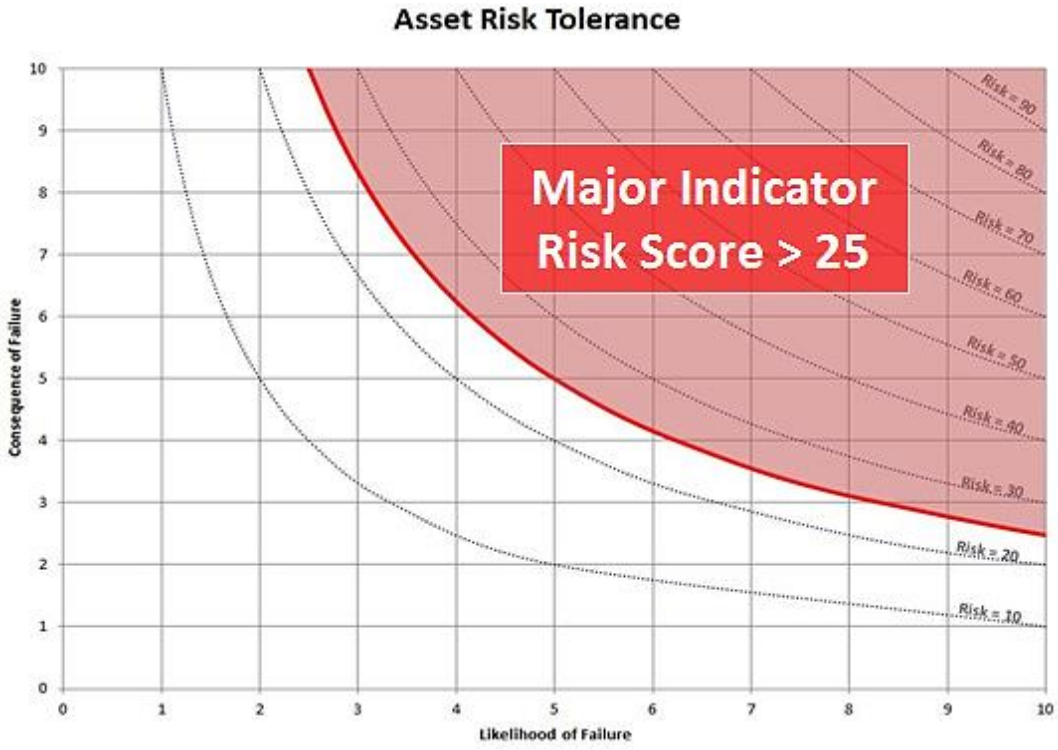
Consequence Category	Severe = 10
Public Confidence	
Construction Impact (e.g., traffic, noise, etc.)	Total closure or significant traffic disruption (e.g., congested area, major arterial, major connectors)
Business Impact	Disruption to customers providing critical services. Impacts >10 businesses with temporary closure lasting longer than one day.
Natural Resources	Discharge of contaminant to a impaired water body, tributary, or hydraulic connected storm sewer with impacts to local recreation.
Public perception	Widespread adverse impact on multiple businesses (National News Story)
Development Impact	No public confidence in the Utility (consistent negative media)

This COF score can be reduced by process changes or adding redundancy to a particular system. For example if a process requires two (2) pumps to function properly and it is critical to maintaining permit compliance, these assets would have a high COF. If we added a third (3) pump that would reduce the impact or consequence of one (1) pump failing. The rubric for which assets are scored on consequence of failure is included below and is based on the above described levels of service.

How to get Risk from Likelihood of Failure and the Consequence of Failure?

The Likelihood of Failure (LOF) and Consequence of Failure (COF) already discussed give WEP the understanding of potential future failures and what the impacts might be of those failures. Once both of these have been quantified then an overall risk score can be assigned. This risk score is the product of the likelihood of failure multiplied by the consequence of failure.

This score is a numerical value between one (1) and 100. An asset with a score of above 25, is considered to be a major indicator for further investigation. However, it is not necessary to replace all assets above a risk score of 25. Instead it has been WEP's experiences that understanding the circumstances which make that asset's score a 25 or higher is the most important task. In the case of assets with a risk score greater than 50, the asset should be included in a current project or reviewed for potential replacement or rehabilitation, as these assets are susceptible to a pending failure and will impact system operations. Below is a risk matrix with the likelihood of failure on the "x" axis and the consequence of failure on the "y" axis. These two as shown above give you the risk score. Risk scores from 10-90 are shown as dotted lines on the graph as examples of where asset would be on the graph. Ultimaltely the red shaded area shows on the graph where asset with a score of 25 or higher would be located. As you move to the top right of the graph the risk score increases.

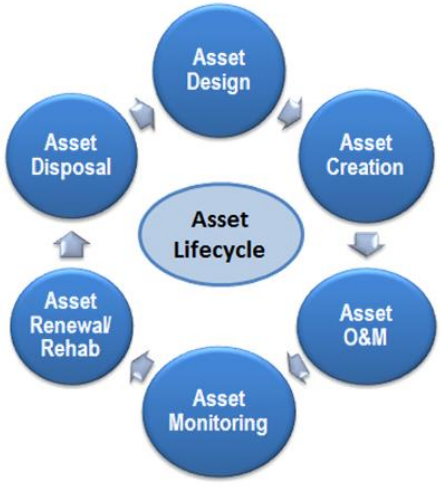


In addition there are some cases in which an asset has failed but because the consequence of that failure is so small that the asset never reaches a risk score of 25. These assets require planned replacement or rehabilitation as is the case with assets with a risk score greater than 50. The majority of assets are in a range between a risk score of 10 and 50. This large group of assets is where good planning and forecasting will lead to savings. Within this range, good Asset Management practices are able to help predict failures and reduce the impacts and costs of unexpected failures. As stated by the EPA, lack of maintenance will lead to greater replacement and failure cost, thus this level of maintenance can lead to saving.

"We can impact the overall cost of maintaining our infrastructure by replacing the right asset, at the right time, for the right reasons."

How to minimize the lifecycle cost of an asset?

Using the adage of replacing the right asset, at the right time, for the right reasons we can improve our management of an asset's lifecycle. Unfortunately once we replace an asset the process is not complete. To the contrary, the process begins again. We initiate monitoring the new asset's condition, performance, and work order history. With the information obtained from the previous asset and the new asset's information we are able to make more informed decisions and react more efficiently to failures. These efforts lead to minimizing the lifecycle costs of an asset. As a part of the asset management program, WEP is currently working to optimize the preventative maintenance schedules for its assets. These efforts utilize staff experience, historical maintenance records, and recommended best practices to define the right intervals for preventative maintenance. This is becoming a living process with the intent to continual improve the efficient use of scarce resources.



Asset lifecycle diagram: Adapted from the IIMM.

Planning for the Future (long-term) funding plan

WEP has extended its application of Asset Management through the use of consultants. As an example, consultants were tasked to work with WEP staff at two treatment facilities - Brewerton and Baldwinsville Seneca Knolls treatment plants. These projects assessed the overall condition of the facilities and forecasted infrastructure rehabilitation and replacement over the next twenty (20) years.

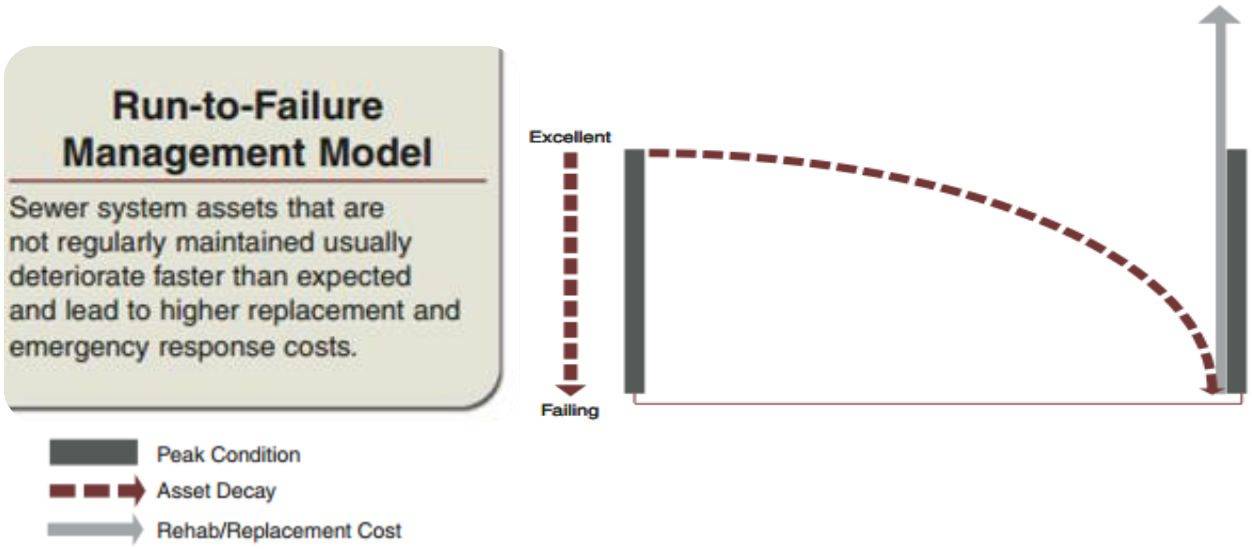
This same approach is being is expected to be implemented for other facilities within WEP. A 20 year forecast allows WEP is to better prepare for design and construction of facility capital rehabilitation improvements. This approach is proactive in nature and allows monitoring of assets to ensure if an asset begins to deteriorate more rapidly that it will be included in the next project cycle. Resources are scarce and WEP striving to invest resources to replace the right asset, at the right time, for the right reasons using AM. An example of a 20-year planning level projection for the Baldwinsville Seneca Knolls (vintage 1982) treatment facility is shown below.

Cost Component	Immediate Capital Cost	5-Year Capital Cost	10-Year Capital Cost	20-Year Capital Cost
Site		$500,000	$820,000	--
Architectural	$6,000	$700,000	$2,100,000	--
Structural	$95,000	$2,9000,000	$9,080,000	--
Mechanical	$746,000	$4,900,000	$7,900,000	$300,000
Electrical	$145,000	$700,000	$1,340,000	$1,900,000
HVAC		$300,000	$730,000	
Subtotal General Conditions, Overhead & Profit (28%)	**$990,000** $300,000	**$10,000000** $2,800,000	**$22,000,000** $6,200,000	**$2,200,000** $600,000
Subtotal Construction Costs Combined Contingency (25%)	**$1,300,000** $100,000	**$12,800,000** $3,200,000	**$28,200,000** $7,100,000	**$2,800,000** $700,000
Total Construction Costs Administrative, Legal & Engineering (15%)	**$1,400,000** $210,000	**$16,000,000** $2,400,000	**$35,3000,000** $5,300,000	**$3,500,000** $500,000
TOTAL PROJECT COSTS (2013) (ENR Cost Index = 9552)[1]	**$1,610,000**	**$18,400,000**	**$40,600,000**	**$4,000,000**
Total Project Costs to Midpoint of Construction (2014) (Projected ENR Cost Index = 9839)[2]	**$1,700,000**	--	--	--
Total Project Costs to Midpoint of Construction (2018) (Projected ENR Cost Index = 10985)[2]	--	$21,200,000	--	--
Total Project Costs to Midpoint of Construction (2023) (Projected ENR Cost Index = 12418)[2]	--	--	$53,000,000	--
Total Project Costs to Midpoint of Construction (2033) (Projected ENR Cost Index = 15283)[2]	--	--	--	$6,000,000

Conclusion: The importance of AM for Sustainability of WEP

Answering the five core questions is crucial for WEP because of its significant responsibility to maintain a vast number of aging assets. WEP is making progress each year in furthering its effort to know the condition of all assets. Those assets are being maintained to ensure the required levels of service will be provided to the residents being served by the Consolidated Sanitary District. The levels of service allow WEP to plan more efficiently, and invest more cost effectively based on the criticality of each asset. These planning efforts are leading WEP in its efforts to minimize the overall lifecycle cost of each asset and properly manage the cost of service to every ratepayer in the Consolidated Sanitary District. Based on information collected, efforts are made to insure the right assets are being replaced, at the right time, for the right reasons.

This replacement or rehabilitation of assets is fundamentally necessary in an asset rich industry such as a wastewater utility. As stated by the US EPA "Sewer System assets that are not regularly maintained usual deteriorate faster than expected and lead to higher replacement and emergency response costs." The diagram below shows a simplistic visualization of asset decay as published by the EPA.



As WEP continues in its asset management journey, it strives to make the benefits of its asset management program more measurable and even more effective over time. These efforts include moving away from a reactive or run-to-failure management as well as making sure all investments in asset renewal are done in a responsible and defensible manner. In addition to the day to day benefits that can be attributed to AM, the department anticipates that AM can provide the best use of scare resources. Ultimately, all of the work done by WEP to promote Asset Management will lead to the sustainability of the wastewater infrastructure, our community, and the economy WEP serves.

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