United States
Environmental Protection
Agency

FACT SHEET

Asset Management for Sewer Collection Systems

For wastewater management utilities, asset management can be defined as managing infrastructure capital assets to minimize the total cost of owning and operating them, while delivering the service levels customers desire. It is successfully practiced in urban centers and large regional sewer collection systems to improve operational, environmental, and financial performance. Many of these large organizations base asset management planning on sophisticated information systems and extensive personnel resources.

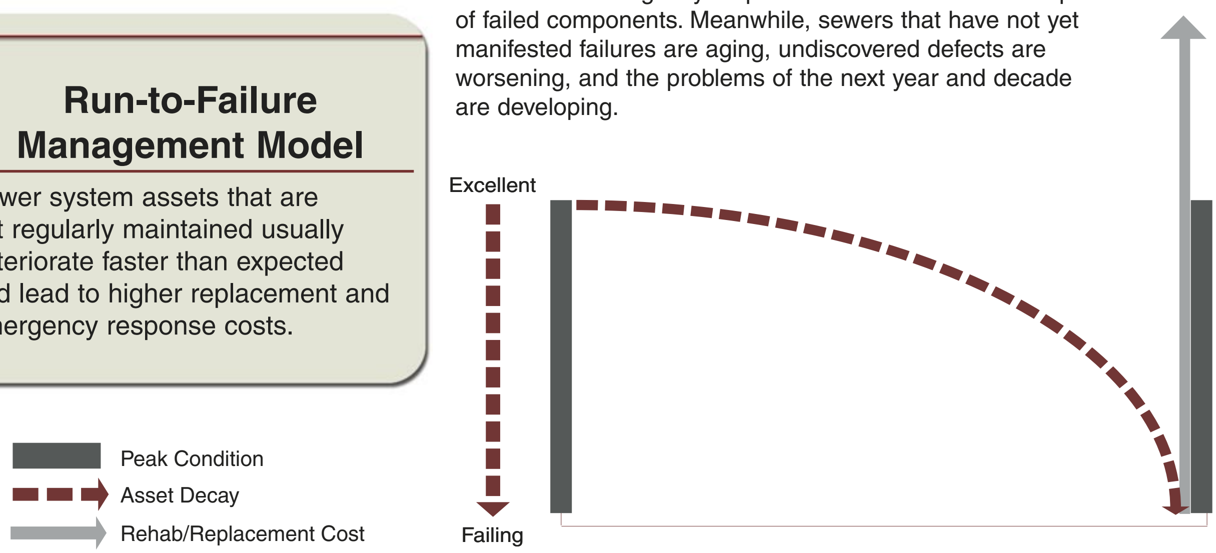
But a simpler form of asset management can be used by smaller collection system owners, starting with existing systems, staff and resources. Continuous improvement planning can then be used to provide program depth and coverage as implementation progresses. Developed to foster more efficient financial and physical resource investments and to prolong the life of infrastructure system components, asset management offers the potential to more than pay for itself over the long term. It can also serve as a logical, cost-effective framework for making organizational changes to meet new environmental regulations and financial reporting requirements.

Why Invest in Asset Management?

Many wastewater treatment utilities serving communities with individual or combined annual revenues of $100 million or less are located in areas that have grown dramatically over the past 30 years. Most have invested heavily in collection system expansions (to serve growing populations) and wastewater treatment plant upgrades (to handle the additional volumes and to meet tighter environmental requirements). Even with local rate and tax increases, a relatively small component of the wastewater utility budget goes toward improving the condition of the collection system. Lacking adequate focus on operations and maintenance, many collection system utilities have slipped into a reactive mode, with most of the operational resources allocated to emergency response and rehabilitation or replacement of failed components. Meanwhile, sewers that have not yet manifested failures are aging, undiscovered defects are worsening, and the problems of the next year and decade are developing.

Run-to-Failure Management Model

Sewer system assets that are not regularly maintained usually deteriorate faster than expected and lead to higher replacement and emergency response costs.



What is the national scope of the problem?

No one knows exactly, since there is no nationwide inventory of sewer pipe. One estimate is derived from data reported in Optimization of Collection System Maintenance Frequencies and System Performance, a 1999 study of sewer system maintenance practices prepared by the American Society of Civil Engineers (ASCE) under an EPA Cooperative Agreement (ASCE, 1999). In this study, ASCE surveyed wastewater utilities representing a good cross section of system sizes, populations served, and geographic regions. Of 42 utilities surveyed, an average of 21 feet of sewer was provided per person, which would equate to almost 1.2 million miles of sewer (owned by public and private entities) when extrapolated to the entire U.S. population served by sewers. Among these same agencies, an average of 57.5% of the system assets were reported to be between 21 and 100 years old, with 41.1% reported as between 21 and 50 years old and 16.8% greater than 51 years old. These data suggest that by 2020, up to half of the assets in these systems may be beyond the midpoint of their useful lives (which is generally assumed to be about 100 years). If these statistics hold true for the majority of utilities across the country, they represent an unprecedented need for capital replacement funding just beyond the fiscal horizon.

Each collection system utility is responsible for making sure that its system stays in good working order—regardless of the age of components or the availability of additional funds. Asset management programs with long-range planning, life-cycle costing, proactive operations and maintenance, and capital replacement plans based on cost-benefit analyses can be the most efficient method of meeting this challenge. Use of asset management will help protect sewers and extend financial resources by:

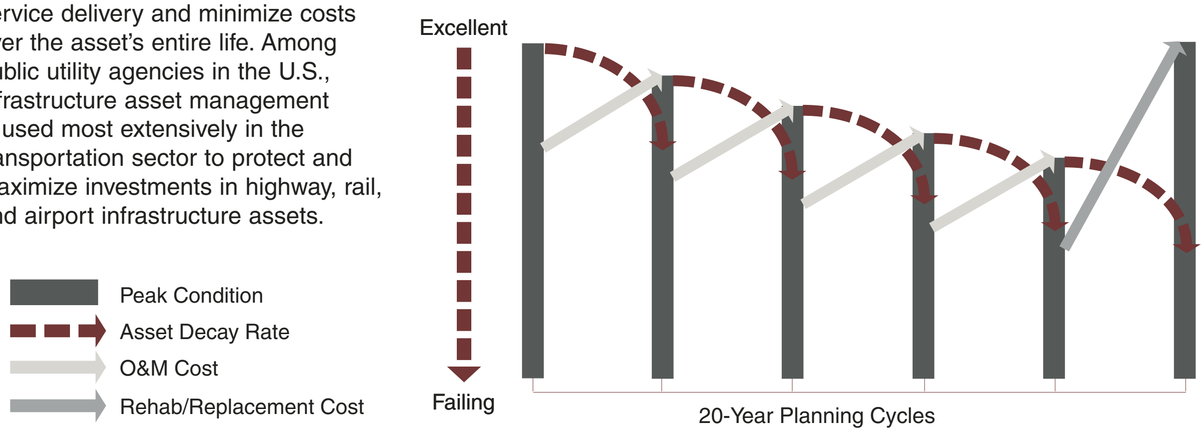
- Making sure components are protected from premature failure through proper operations and maintenance.
- Facilitating proactive capital improvement planning and implementation over longer cycles to reduce annual and overall costs.
- Reducing the need for expansions and additions through demand management (I/I reduction, flow balancing, etc.)
- Reducing the cost of new or planned investments through economic evaluation of options using life-cycle costing and value engineering.
- Focusing attention on results by clearly defining responsibility, accountability, and reporting requirements within the organization.

What is asset management?

Asset management is a continuous process that guides the acquisition, use, and disposal of infrastructure assets to optimize service delivery and minimize costs over the asset's entire life. Among public utility agencies in the U.S., infrastructure asset management is used most extensively in the transportation sector to protect and maximize investments in highway, rail, and airport infrastructure assets.

Asset Management Model

Components are regularly maintained over long planning cycles, and finally replaced when deterioration outweighs the benefit of further maintenance. Costs are well-distributed over the life of the asset.



An infrastructure asset is any long-lived capital asset that is operated as a system or network, such as a sewer collection system. The sewers, manholes, and pump stations are the primary asset components of the collection system. Buildings that are integral to the function of the network, such as pump station houses, are also considered part of the infrastructure asset.

The key elements of asset management are:

- Level of service definition
- Selection of performance goals
- Information system
- Asset identification and valuation
- Failure impact evaluation and risk management
- Condition assessment
- Rehabilitation and replacement planning
- Capacity assessment and assurance
- Maintenance analysis and planning
- Financial management
- Continuous improvement

These elements should be implemented by everyone in the organization, involving management, financial, engineering, administrative and field staff.

This sounds familiar. Isn't it the same as CMOM?

When utilities operate in a reactive mode, most of their resources go to emergency response and replacement or rehabilitation only after performance problems have surfaced. In recognition of the current and future problems associated with this approach, many people in technical leadership of the wastewater industry support the adoption of dynamic management, operation, and maintenance approaches for sanitary sewer collection systems. These dynamic approaches use information about system performance, changing conditions, and operation and maintenance practices to guide and modify responses, routine activities, procedures, and capital investments to try to prevent problems from occurring.

EPA, in conjunction with municipal and other industry representatives, has developed a framework for a dynamic management approach to collection systems called the capacity, management, operation, and maintenance (CMOM) approach. The CMOM approach is an information-based approach to setting priorities for activities and investments. CMOM embodies many asset management principles as they apply to collection systems such as defining goals, using an information-based approach to set priorities, evaluating capacity and taking steps to ensure it is adequate, developing a dynamic, strategic approach to preventive maintenance, and conducting periodic program audits to identify program deficiencies and ways to address those deficiencies.

Integrating asset management planning with a CMOM program can improve the effectiveness of the CMOM effort. An emphasis on asset management can better ensure that the key components of a strategic business plan, such as level of service definition, rate setting, budgeting, financing, and value-engineering are taken into consideration.

Sewer collection system utilities should begin implementing CMOM as soon as possible, especially if they are experiencing SSOs or contributing to peak flow violations at wastewater treatment plants. Following is a general discussion of ways to implement CMOM in an asset management framework.

What about GASB 34?

Carrot and Stick Approach to Encouraging Fiscal Responsibility

Government Accounting Standards Board Statement 34 (GASB 34) includes both requirements for reporting of public infrastructure assets in a government's financial statement and options for reporting additional information by governments that use asset management systems. The new rules are designed to establish a basic financial reporting model that will result in greater accountability by state and local governments by providing more useful information to a wider range of users than did the previous model. Communities that opt not to comply with the GASB 34 financial reporting requirements will not present financial statements in accordance with generally accepted accounting principles (GAAP).

The Stick: Full Accrual Accounting and Management Discussion and Analysis

GASB 34 requires full accrual accounting principles to be used in government-wide financial statements, reporting to readers of financial statements such as ratepayers and creditors, the historical cost of all the capital assets used in delivering services and the full cost of providing services to the public.

The modified accrual basis of accounting used by many collection systems in the past did not provide complete information about the system. This type of financial statement would show whether a given year's revenues were adequate to cover the cost of sewer system operations and debt service requirements for that same year. It would not show the capital assets used to provide service and whether the net assets of the system were increasing, decreasing, or remaining the same.

With full accrual accounting, collection system utilities must report the historical cost of the sewer system and its components. Revenues include all earnings of the system, even those that will be collected in cash in future years. Expenses of the system include annual depreciation (or preservation costs, if the modified approach is used), as well as all expenses incurred during the year, regardless of whether they were paid during the year or shortly after year end, or won't be paid until some time in the future.

Financial statements presented in the annual report must be accompanied by a management discussion and analysis (MD&A) that provides an analysis of the system's overall financial position and results of operations, to assist users in assessing whether the position has improved or deteriorated as a result of operations. The MD&A also provides information on known facts, decisions, or conditions that may have a significant effect on future financial results. It may also include information about the current condition of the system, how that condition compares with the condition level established by the government, and differences between the amount estimated to be needed to preserve and maintain the system, and the amount actually incurred.

GASB 34 offers a phased schedule for implementing the new reporting requirements. Communities with $100 million or more in annual revenues (government-wide, not just collection system revenues, for the year ending after June 15, 1999) were required to begin GASB 34 reporting in financial statements for fiscal years beginning after June 15, 2001. Communities with total annual revenue between $10 million and $100 million are required to meet the new standards in financial reporting periods beginning after June 15, 2002.

Government Total Annual Revenues in the Fiscal Year Ended After June 15, 1999	Date of GASB 34 Transition[1]	End of Grace Period for Retroactive Capitalization of Infrastructure Assets[2]
Over $100 million	June 15, 2001	June 15, 2005
$10 million— $100 million	June 15, 2002	June 15, 2006
Less than $10 million	June 15, 2003	Not required, but recommended

[1]GASB 34 compliant financial statements should be issued for the first fiscal year beginning after this date.
[2]Grace period is not available for infrastructure assets reported in enterprise fund.

Governments with less than $10 million in annual revenue should begin in financial reporting periods beginning after June 15, 2003.

Once a community has made the transition to GASB 34 reporting, any collection system components that are acquired, rehabilitated, or significantly improved should be recorded as new assets on the financial statement for the same fiscal year. Capital reporting of existing assets is also encouraged at the date of transition, but a four-year grace period is provided. Governments with less than $10 million annual revenues are not required to capitalize assets acquired before the date of transition.

Governments with less than $10 million total annual revenues are not required to retroactively capitalize system assets acquired before the date of transition. When system assets are retroactively reported, only those components that were acquired or received major renovations, restorations, or improvements in fiscal years ending after June 30, 1980, are required to be reported. It is encouraged, but not required, to report components acquired prior to that period.

Although the new infrastructure capitalization requirements will not take effect until 2005 or 2006, implementing asset management practices now would facilitate making the necessary data available when the reporting requirements take effect.

The Carrot: Modified Approach Accounting Can be Used to Avoid Depreciation

GASB 34 offers collection system owners the option of reporting the system at full historical cost, rather than reporting depreciation, as long as certain requirements are met. These requirements include maintaining the system at or above a condition level specified by the government, and managing the system using an asset management system that meets certain requirements. Under this option, known as the "modified approach," maintenance and preservation costs are expensed and only additions and improvements to the system are capitalized. The option is appropriate for utilities that use asset management activities to preserve the service life of the system over time. In contrast, depreciation accounting, a method of systematically writing off a portion of the historical cost over an estimated useful life, is more appropriate for assets that are used up over a finite life. To use the modified approach, the asset management system must inventory the system assets, perform condition assessments, and estimate the annual amount needed to maintain and preserve the system assets at the established condition level. The condition assessment must be performed at least every three years. As required supplementary information, the government must present a schedule of the assessed condition for the three most recent condition assessments, the estimated amounts needed to maintain and preserve the system, and the amounts actually expensed for the last five years.

> **Depreciation Doesn't Measure Condition**
>
> The value of a sewer system is its ability to provide service for the longest time possible for the least cost. Modified approach accounting offers a way to document in annual financial reports that the system can continue to provide service.

It may be more difficult for governments to meet the requirements to use the modified approach than it is to apply depreciation accounting, but most of these same activities are needed to meet similar CMOM requirements. The incremental effort may be modest, and the benefits of success are substantial. Sewer collection utilities that use modified approach accounting will be demonstrating to customers, lending institutions, and regulators a commitment to maintaining the assets for which they are responsible. This commitment may symbolize a government's dedication to delivery of excellent service, proper use of public funds, and compliance with environmental and health laws. In addition, the collection system will enjoy the benefit of asset management, including lower capital replacement costs, smoother system operations, less resistance to needed rate increases, and more advantageous commercial lending terms.

Where Do Environmental Management Systems Fit In?

Asset management and environmental management systems (EMSs) have valuable attributes and can complement each other, but they are not the same. The asset management approach helps utility owners optimize maintenance and replacement cycles to cost-effectively ensure that the sewer collection system runs smoothly and to accurately predict capital funding needs over a long planning horizon. It assumes that the utility owner has identified its environmental compliance goals and has incorporated them into the planning process. By contrast, EMSs are designed to help a facility identify and manage a full range of environmental, public health, and safety issues—both regulated and unregulated (i.e., surface water, groundwater, air quality, noise, etc.) EMSs are designed to help integrate these issues into an overall system that can help continually improve environmental performance and provide other important business benefits like reduced costs through energy and water conservation, reduced chemical usage, reduced risk of noncompliance, etc.

Like asset management, EMS was developed by the private sector to improve business planning, and it has a similar philosophy: the most cost-effective way to meet environmental goals is to specifically identify them, plan for them, and set performance benchmarks to ensure they are being met. A growing number of public sector organizations, including wastewater utilities in the United States and around the world, are adopting EMSs. Many are using independent third party certification, which involves an audit by a qualified, independent third party to ensure that the EMS conforms to the elements of ISO 14001 (or another established EMS standard), and that the organization is making progress toward meeting its own performance objectives and targets. An EMS audit does not specifically look at an organization's compliance, but does help determine if the organization has procedures in place to identify legal requirements, address noncompliance should it occur, and take steps to minimize the risk of a recurrence. Several wastewater utilities in the United States have achieved ISO 14001 certification and reported significant benefits from their efforts.

The CMOM approach can be seen as a type of EMS that focuses on sewer collection system utilities. It establishes an environmental goal (employing collection system management practices to minimize SSOs or peak flow violations at a treatment plant), provides specific operations and management guidelines to achieve the goal, and requires establishment of performance measures to make sure the goal is met. It is a logical starting point for a sewer collection system utility just embarking on comprehensive business planning. CMOM does not replace the need for true EMS planning and implementation, because it only addresses environmental concerns related to surface water quality protection.

CMOM is one of many environmental management approaches available to sewer collection system utilities, and more are being developed all the time. EPA and two industry trade groups are working on a project to examine the feasibility of creating a comprehensive structure for water and wastewater utilities that brings together the strengths of tools such as asset management, CMOM, QualServe, and performance benchmarking, to create a sustainable and effective utility-wide management system. EPA, the Association of Metropolitan Sewerage Agencies (AMSA) and the Water Environment Federation (WEF) hope to present preliminary recommendations for this comprehensive approach in summer, 2002.

Does asset management have to be complex?

An asset management program does not have to be complex to be effective. A basic program can be developed around existing systems, with new systems being added as the program progresses. For utilities with relatively small collection systems and pay-as-you-go financing, complex asset management systems may not be needed to meet organizational objectives. Other communities may benefit greatly from using the asset management approach to address serious current or impending infrastructure problems. More advanced asset management systems are justified for collection systems that have:

- High value, such that asset management decisions will have a large financial impact
- Components nearing or beyond the end of their service lives, components in poor condition, and/or a history of SSOs and peak flows that contribute to permit violations at a wastewater treatment plant
- System complexity in terms of the size, design, or location of components

Regardless of the level of sophistication of the asset management system, two primary performance goals chosen by the organization should be the fullest possible implementation of the CMOM approach and compliance with the financial statement reporting requirements of GASB 34. A third recommended goal is use of the modified approach for reporting sewer collection systems in financial statements.

Components of an Asset Management System for a Sewer Collection Network

Below is a general discussion of the components of an asset management system designed to meet the objectives of the CMOM approach, comply with GASB 34 reporting requirements, and take advantage of the modified approach option for infrastructure assets.

Level of service definition.

A basic level of service definition for most collection systems will be to deliver reliable sewer collection services at a minimum cost, consistent with applicable environmental and health regulations. Level of service criteria will be system-specific, but should address CMOM and GASB 34 requirements, particularly in areas where improvements are most needed and will yield the greatest benefits. Examples include:

- Ensuring adequate system capacity for all service areas
- Eliminating system bottlenecks due to pipe blockages
- Reducing peak flow volumes through inflow/infiltration (I/I) controls
- Providing rapid and effective emergency response service
- Minimizing cost and maximizing effectiveness of CMOM programs

Performance measurements.

Performance measurements are specific metrics designed to assess whether level of service objectives are being met. Some examples of performance measurements:

- Annual performance goals for sewer system inspection, cleaning, maintenance, rehabilitation, and capital improvement
- Correlating grease control education and enforcement measures with expected reductions in the number, distribution, and severity of grease blockages
- Establishing maximum hourly and monthly peak flow volumes
- Establishing maximum emergency response time to emergency calls, tracking customer complaints and claims for private property restoration
- Performing cost-benefit analysis of key completed activities, taking into account expected vs. actual outcome and budgeted vs. actual cost

Information system.

How much information is needed to create and implement an asset management system? There is no standard answer. Each utility must analyze its information needs, based on a variety of factors such as asset management goals, performance measures selected, regulatory requirements, and collection system size, complexity, and condition.

Snapshot in Time

Begin with an evaluation and documentation of existing information systems. For each data stream, questions to answer include:

- How much data is collected?
- How is it collected and managed?
- How frequently is the information collected?
- How thorough are the records?
- Is the data available to other information systems and/or other users?

For instance, field crews may track minor sewer repairs by recording the location of the defect, the type of repair, and the cost of labor and materials. This information could be logged into an asset management system by workers who have laptop computers in the field, or they may be handwritten on a work order that ends up in a file cabinet.

Gap Analysis

The next step is to perform a side-by-side comparison between identified information needs and existing systems to reveal gaps. A prioritized, phased plan is then developed to fill in the gaps.

Automated Information Management System

Collection system information should be managed by computer to ensure its availability for analysis and decision-making. Well-designed spreadsheet databases may be adequate for some very small or streamlined collection systems, but for most utilities, information is most efficiently managed by use of asset management software programs that help organize the data, perform many standard analyses, and facilitate planning, scheduling, and budgeting. These programs range in cost and complexity from affordable, simple applications to complex, expensive solutions. A number of commercial applications are modular, so that basic systems can be enhanced and expanded over time. It is best to start with the most basic system appropriate to the utility's information needs, and add complexity over time. This approach helps control up-front hardware and software costs and makes it easier for staff to master new systems, thereby reducing margin for error during transition.

GASB 34 and CMOM Requirements for Information Systems

GASB 34 establishes use of an asset management system as a condition of eligibility for modified approach accounting, but does not set forth detailed requirements for the information system component. The CMOM approach calls for information to be managed in a way that facilitates timely decision-making for planning, prioritization, and emergency response. It also establishes basic requirements for information system elements, including:

- Up-to-date system maps.
- Data related to capacity assessment studies, sewer inspections, and sewer modeling.
- Inventory of system assets, including age, capacity, major construction materials, historical cost, and condition.
- Information related to identified structural and nonstructural defects, including type of defect, severity, location, and date of discovery.
- Records of all SSOs, including location, date discovered, internal notification procedures, estimated volume of release, emergency response action taken, and notification of affected parties, including environmental and health agencies, water supply utilities, private property owners, and the public. If the SSO impacted a surface water or sensitive environmental resource, any required environmental monitoring results should be included.
- Records of routine preventive operation and maintenance activities, including type of activity, location, date, and labor, material, and equipment costs.
- Inventory of maintenance facilities and equipment, including replacement parts.
- Results of inspections and tests for new or rehabilitated system components, including sewers, pumps, manholes, and other appurtenances.
- Schedules and budgets for routine operations and maintenance activities and planned rehabilitation and replacement projects.

For most sewer networks, geographic information systems (GIS) offer advantages over plan drawings or CAD maps. A GIS links database information to points on the map, which are primarily defined by manhole locations and their connecting sewer segments. The GIS can then be linked to the asset management system, sewer system model applications, and even billing systems. Like the asset management system, the development of a GIS can be simplified and accomplished in phases to accommodate the utility's asset management goals and available resources.

Asset identification and capitalization.

GASB 34 requires that collection system assets be identified and that their historical cost be reported.

Asset Identification

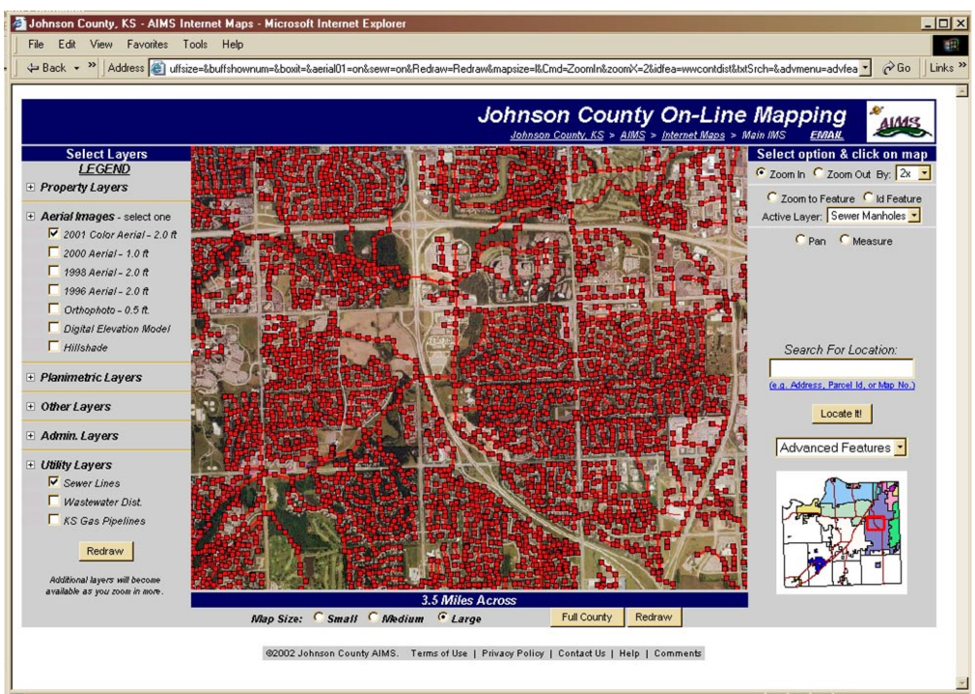
Asset identification is the process of identifying and numbering the primary components in the sewer system. Once the components are assigned unique identifiers, the utility can link information systems and aggregate data for financial, economic, technical and management use. Identification begins with architectural or engineering maps and as-built construction or repair records, which may exist in paper or electronic format. Information from these records should be transferred to a database, such as a spreadsheet, relational database, or asset management software program.

Each component record includes fields for relevant information. For instance, sewer main segments would be identified by location, length, material, size, slope, burial depth, beginning and ending manholes, and approximate or actual age. The component numbering system should be based on manholes, with the sewer segments labeled according to their relationship to the beginning and ending manholes.

Geographic Information Systems (GIS)

Johnson County, KS, uses GIS for planning, management, condition tracking, and public outreach, even providing an online mapping utility through its website.

Courtesy of Johnson County, KS



A utility with very little available information may limit the initial asset identification to major components, such as manholes and large-diameter gravity and force main sewers. This simple network can be expanded over time by adding smaller lines, additional manholes, pump stations, and other components.

Map data should be verified with physical system inspection methods such as closed-circuit TV (CCTV), sonar/CCTV, static camera, or person-entry. Latitude/longitude coordinates should be established or verified using global positioning surveying (GPS) techniques.

Some collection systems have never been completely inspected. Many industry experts believe that most sewer collection systems have components that are not fully identified (i.e., sewer lines that are shown on maps but have not been located in the field, or sewer lines that were added to the system, but not to the maps.) Complete sewer system inspection is an expensive and time-consuming undertaking that must be carefully planned and coordinated to support many aspects of the asset management program. Many communities will need to prioritize and plan inspection over a period of years. Highest priority for inspection should be given to sewers that have known defects, have caused or contributed to SSOs or treatment plant violations, or have the potential to impact sensitive environmental or drinking water sources.

Priorities can be further refined by performing system-wide failure impact analysis, as described below. Second-level priority should go to areas where upcoming construction projects are planned that may partially expose sewers, such as road replacement, water main construction, or other utility construction. Inspection should be coordinated so that, to the extent possible, sewer inspections are completed before the areas are disturbed. This will allow identification of sewer defects early enough to coordinate replacement or rehabilitation while the area is already being disturbed. Remaining areas of the collection system should be scheduled for inspection over a longer period of time.

Asset Capitalization

In general, the capitalized amount of an asset is defined as its acquisition cost (design, construction, land acquisition, etc.), plus capital improvements. Accumulated depreciation is also reported (except for systems accounted for using the modified approach). For collection system utilities, this capitalization amount could be established at the subsystem level—force mains, sewer mains, service laterals, manholes, catch basins, etc., or at the overall system level.

GASB 34 leaves the level of detail of asset capitalization to the discretion of the utility owner. For instance, some utilities choose to capitalize all sewer lines, manholes, and pump stations, while others capitalize only sewer mains above a certain size threshold. Either approach is considered valid.

To the extent possible, actual cost records should be used to determine the amount reported for sewer system assets. This applies unconditionally to components acquired, rehabilitated, or significantly improved after the community has made the transition to GASB 34 reporting. For these newly acquired assets, detailed acquisition records should be maintained for financial reporting purposes.

For pre-existing assets, use of actual historic cost records is encouraged, but if records are inadequate or nonexistent, GASB 34 provides several methods for estimating the historic cost. The community may decide to restrict its retroactive reporting of infrastructure to only those assets acquired, rehabilitated, and/or significantly improved after June 30, 1980. Phase 3 communities are not required to retroactively report assets, but are encouraged to do so.

Retroactive reporting of assets is not required until 2005 or 2006 for Phase 1 and 2 communities, respectively, but some communities may report those networks for which information is availabel at an earlier date. A description should be provided for those networks that are not yet reported, and whether they will be accounted for using the modified approach.

Failure impact evaluation and risk management.

The potential impacts from sewer line failures should be assessed on a system-wide basis. The goal is to identify those areas of the system that will have the most impact if a failure occurs, and focus asset management resources to minimize the risk. Failure impact severity factors to consider include location within the system, intended service function, burial depth and access barriers, proximity to public areas or environmental resources, hydrogeological features such as soil type, depth to groundwater, seismic activity, etc. Critical areas can be classified by zones, individual segments, or subnetworks within the sewer system.

As an example, a community may have established an association between a certain acidic soil type and a higher-than-average failure rate of ductile iron pipe. A high failure impact rating can then be applied to all areas where these soils occur and where ductile pipe is known to exist. Similarly, a high rating could be applied to sewer lines running under occupied structures in a commercial or residential district since any needed replacement would likely involve additional complexity, cost, and risk of private property damage.

Condition Assessment

Condition assessment is performed to identify assets that are underperforming, determine the reason for the deficiency, predict when failure is likely to occur, and determine what corrective action is needed and when.

The GASB 34 modified accounting option requires that condition assessment be based on an up-to-date inventory of assets, and that the methods used be documented in such a way that the same results could be obtained by someone else performing the same assessment. A condition level measurement scale should be used, and a minimum acceptable condition should be established and incorporated into the administrative rules governing the operation of the collection system (municipal ordinance, state or county statute, etc.)

The established condition level of the collection system is left to the discretion of the individual utility. Whatever benchmarks are chosen, they should refer primarily to the physical condition of the system and its components. For instance, an established condition level for a sewer collection system could include ensuring that no more than 10% of main sewer lines are allowed to degrade below fair condition during any 12-month period.

Condition Assessment Measurement Systems

There are many different measurement systems in use by sewer utilities. This is an example of a simple grading system found in *Managing Public Infrastructure Assets To Minimize Cost and Maximize Performance* (AMSA, 2002).

Grade	Condition	Description
0	Abandoned	No longer in service
1	Very Good	Operable and well-maintained
2	Good	Superficial wear and tear
3	Fair	Significant wear and tear; minor deficiencies
4	Poor	Major deficiencies
5	Very Poor	Obsolete, not serviceable

Condition assessment begins with the field inspector, who records defects found in sewer mains, service laterals, manholes, catch basins, and/or pump stations. These defects are characterized based on a standard notation system that is used by all field inspectors. The collection system utility establishes the appropriate level of detail. Some utilities focus on structural defects found in primary sewer lines, while others extend the inspection and rating systems to nonstructural defects and service laterals, access holes, and pump stations. The defect data gathered in the field are entered into the asset management system to allow analysis of the overall structural integrity and operating condition of each component. Some asset management software applications automatically evaluate the types and distribution of defects found in each component and assign a condition rating, while others allow the collection system manager to assign the rating manually. This analysis is then combined with the failure impact rating of the component to develop a prioritized condition rating.

Components found to be in poor condition, or with severe defects and high failure impact ratings, should be addressed as soon as possible after they are discovered. Less severe defects can be prioritized for more frequent inspection or cleaning, repair, rehabilitation, or replacement. The overall system condition is then assessed based on the aggregated condition ratings of the components to determine whether or not the system condition meets the minimum condition levels.

GASB 34 requires that the condition assessment be performed every three years:

> *Condition assessments may be performed using statistical samples that are representative of the eligible infrastructure assets being preserved. For example, one-third may be assessed each year. If a cyclical basis is used, a condition assessment is considered complete for a network or subsystem only when condition assessments have been performed for all (or statistical samples of) eligible infrastructure assets in that network or subsystem.* ***GASB 34, Paragraph 24(a), Note 19***

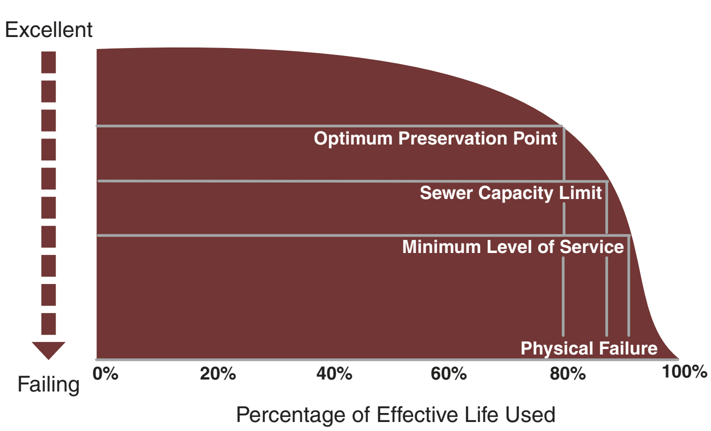
If statistical samples are employed as part of the complete condition assessment, the rationale and sampling methods must be documented. The methods must be applied consistently over time, and any changes should be documented in the MD&A.

Rehabilitation and Replacement Planning

Proactive rehabilitation and replacement planning provides the best opportunity for capital cost savings. By rehabilitating or replacing sewers and other components before they fail, the utility automatically avoids costs such as emergency contractor fees, staff overtime, unplanned repairs, and SSO cleanup costs. Additional savings can be achieved through coordination of sewer construction with other construction projects, replacing longer segments, and phasing construction over a period of years. Proactive planning also allows the utility to assess the relative economic costs and benefits of rehabilitation vs. replacement.

Replacement Planning

The goal of replacement planning is to find the point in the asset's life cycle where the cost of replacement is balanced against the accelerating cost to maintain it and declining level of service. It is much like deciding whether to repair or replace an old car.



Questions to explore for alternatives analysis include:

- When was the asset installed?
- What is the expected service life, and where is it in its life cycle?
- Can the anticipated deterioration rate and eventual failure be predicted?
- If so, what is the estimated residual life until rehabilitation or replacement is necessary?
- Could best management practices and maintenance prevent or extend the time to failure?
- Can the asset be rehabilitated? How much will rehabilitation cost?
- If so, would this extend the time to failure? By how much?
- What will be the incremental life-cycle cost of each alternative?
- Is the asset technically or commercially obsolete?

Once rehabilitation and replacement options are selected, value engineering can be performed to optimize the location, material, design, and timing of construction.

Capacity Assurance Planning

Capacity assurance planning is fundamental to the CMOM approach. EPA's draft proposed rule provides a detailed approach to sewer collection system evaluation and capacity planning (SECAP). In general, capacity planning should be based on:

- Review of operational, SSO, and peak flow data for evidence of existing capacity constraints.
- Analysis of predicted demand for sewer service, based on regional growth patterns. Where possible, sewer planning should be linked to regional land use and/or watershed management planning activities.
- Identification of current and future capacity shortfalls.
- Identification and evaluation of alternatives for correcting the deficiencies, focusing first on those that are contributing to SSOs or peak flow violations at the treatment plant.

If the utility believes that meeting the capacity demand will cause financial, operational, or physical design problems, it should explore demand management alternatives. The best way to begin is to complete a sewer system evaluation survey (SSES) to identify bottlenecks and evaluate the impact of inflow and infiltration (I/I) on system flows. If I/I is a significant component of flow, the utility should address I/I first, then evaluate capacity again. Some base flow demand management measures include flow balancing, price-based conservation incentives, and blockage elimination programs like sediment traps and grease control ordinances.

When additional capacity is required to accommodate new development, the utility can use "growth-pays-for-growth" strategies, such as requiring developers to install new service laterals as a condition of building permit issuance, requiring hook-up fees to cover costs of expanding sewer mains, additional pump stations, and treatment plant capacity. By minimizing its investment in additional capacity, the utility can focus more of its financial resources on other needed capital improvement projects.

Maintenance Analysis and Planning

An effective maintenance program keeps the sewer system running smoothly and helps prevent premature deterioration of components. Planning should be performed annually and updated throughout the year as needed to address changing conditions. Maintenance activities are either planned (i.e., inspecting all major lines in the system every 15 years, cleaning all major lines on a rotating basis every five years) or unplanned (i.e., defect repair, emergency blockage removal).

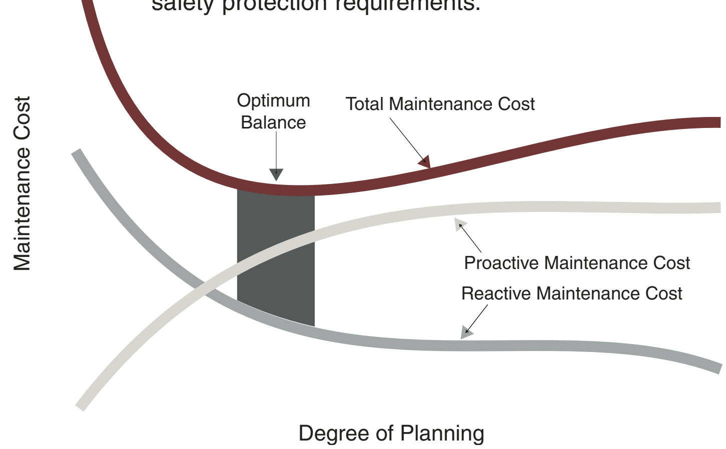
The asset management goal is to maximize planned maintenance and minimize unplanned maintenance. Planned maintenance is more cost-effective because it is performed on a non-emergency basis, is coordinated with other system operation activities, and provides more opportunity to value engineer activities during the planning process. In general, chronic unplanned maintenance conditions indicate that:

- Planned maintenance is too infrequent
- Planned maintenance is inadequate (activities are ineffective at preventing defects, or needed activities are not being performed)
- The failing component may be too deteriorated to preserve through maintenance, or it is improperly designed, and should be rehabilitated or replaced

Maintenance planning is improved by evaluating the patterns of failures leading to unplanned maintenance to see if they were related to timing (the line failed before the next cleaning was scheduled); ineffective maintenance methods (repeatedly clearing sediment blockages in a sagging line, rather than correcting the sag); or to advanced deterioration or improper design. It is important to document the assumptions, methods, and information used to support maintenance planning analysis.

Field crews should be integrally involved with maintenance planning. This gives management the benefit of field crews' on-the-ground expertise and achieves buy-in from the staff. As the maintenance program proceeds, field staff should be encouraged to provide feedback on which strategies are working and which are not, to allow mid-course corrections if necessary.

Training is also essential. Informal on-the-job training for new employees often allows improper procedures and mistaken assumptions to be passed on. This type of initiation also places too much emphasis on "what we do" and not enough on "why we do what we do," so that employees do not have enough information to respond to problems they encounter as they are performing their tasks. Maintenance activities should be documented in standard operating procedures that are reviewed for accuracy, efficiency, and effectiveness every two to three years, or as often as necessary to remain up to date. New employees should be trained on how to perform standard procedures, coordinate with other public works and private utility crews, operate equipment, and observe health and safety protection requirements.



Maintenance Planning

The goal of system maintenance is to improve system performance and preserve asset condition as long as possible. Effective planning is used to target maintenance activities to meet these goals and minimize costly emergencies.

Financial Management

The goal of sewer system financial management is to identify how much money will be needed to meet level of service goals and maintain the system at or above the identified minimum condition, forecast when the money will be needed, and use the information to set user fees, other revenues, and debt financing.

Financial forecasting should be performed over a period of five to 10 years and should be updated annually. The annual estimate of the cost to maintain the system is included in the utility's annual financial report, along with a full accounting of cash flows, debt financing, and financial reserve activity.

The better the support data, the more reliable the financial forecast. Support data include:

- Asset identification and valuation
- Condition assessment
- Performance monitoring
- Current and future capacity assessments

Where gaps in the data exist, reasonable assumptions must be used as a basis for financial forecasting.

The high up-front costs of capital acquisition often dominate the capital improvement planning process. It is important, however, to evaluate capital improvement alternatives relative to the blend of capital and lifecycle costs and the expected useful life of the asset. For instance, it may cost $1 million to construct a 36" HDPE sewer using a four-inch compacted gravel bed, and $5 million to build the same line using an eight-inch gravel bed. Over time, however, the probable higher maintenance costs and shorter useful life related to the first design would more than make up for the difference in up-front cost. Other life cycle costs that may affect the cost of ownership include the risk of harm to human health or the environment, or the risk of private or public property damage in the event of failure.

Continuous Improvement

Continuous improvement processes are based on periodic review of systems against performance measures to identify any shortfalls. Performance measures can be related to level of service goals, condition maintenance goals, or asset management system goals.

For instance, if one of the level of service goals is to shift maintenance resources from excessive emergency response to more proactive rehabilitation/replacement, then the performance measure may be a reduction in the number of sewer emergencies during the planning year, supported by corresponding increases in miles of sewer line replaced. If improvement was not achieved, the performance data would be studied to determine what barriers prevented achievement of the goal. For instance, the utility may have identified sewer lines with significant structural deterioration that required replacement, but was not able to obtain debt financing. The improvement plan would address this barrier through identification of additional sources of funding, identification of more cost-effective alternatives, or a phased replacement program to reduce the initial required investment.

Alternatively, if an operational or capital improvement program is completed and the expected performance improvement is not realized, further analysis may needed to identify the most effective next actions. Frequently, performance shortfalls occur because planning assumptions were based on incomplete information. The continuous improvement plan should include elements to improve the collection, management and use of data, including:

- More aerial coverage of asset inspection and condition assessment.
- Identification, inspection, and condition assessment of additional asset classes, such as smaller service mains and laterals.
- More sophisticated information management tools.
- Better data quality assurance.
- More data correlating types of defects and time-to-failure to improve predictive planning capability.
- More integration between operational, financial, and planning systems.
- Improved organizational efficiency through better systematization of asset management programs.

Resources

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