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JOHNSON COUNTY STORMWATER MANAGEMENT 2016 STRATEGIC PLAN IMPLEMENTATION

System Management White Paper

B&V PROJECT NO. 194641

PREPARED ON BEHALF OF

Johnson County Urban Services Division

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Introduction

In order to keep with national State of Practice to better address stormwater issues for stakeholders in Johnson County, the Board of County Commissioners (BOCC) adopted the Johnson County Stormwater Management 2016 Strategic Business Plan (2016 Plan), which states that the Stormwater Management Program (SMP) will develop the tools necessary for an asset management program as part of an overall system management initiative.

The Stormwater Management Program and its member municipalities are continually being asked to do more with less.

The term "asset management" can mean many different things to many different people based on their perspective and role within an organization. Some view asset management simply as a work order system; some as a means to prioritize capital project expenditures; and others as a program required by the federal government or Environmental Protection Agency (EPA). In actuality, asset management is focusing resources - human, financial, and technical - to maximize the value of assets. It's responsible stewardship that requires leadership, commitment to continual improvement, and a desire to capitalize on the hidden value in infrastructure.

Counties and municipalities nationwide are continuing to face the challenging obligations around the management of their aging stormwater systems, especially with the additional demands of urban population growth and more stringent water quality protection requirements. Meanwhile, the securing of new funding (or even maintaining current funding levels) for stormwater infrastructure rehabilitation and renewal has become increasingly more difficult. In short, programs such as the SMP, along with its member municipalities, are continually being asked to do more with less.

A system management approach that adopts asset management practices and tools makes sense. Asset management affects everything an organization does - from the asset lifecycle to managing organizational operations, staffing, finances, and risk. Using asset management as an overall system management strategy can help the SMP and member municipalities improve asset performance, and manage costs, while at the same time reduce the risks associated with asset failure.

Specific objectives around an asset management-based approach to system management were included in the 2016 Plan and provide direction for creating the desired program in the future. Those objectives are outlined in Table 1 below.

Table 1. System Management Strategic Objectives

IMPLEMENTATION PHASE	SYSTEM MANAGEMENT OBJECTIVE
PHASE I	• Develop comprehensive asset inventory within GIS of stormwater systems (both engineered and natural) • Define condition of stormwater assets to a uniform level county-wide • Develop criteria/prioritization for funding system replacement projects
PHASE II	• Develop comprehensive lists of prioritized projects for each watershed • Provide assistance to cities to achieve B+ Infrastructure Grade according to ASCE methodology or "Transformative Program" grading according to Modified WEF Utility Scorecard methodology

The transition to an asset management-based approach for system management requires consideration of several different factors. This White Paper seeks to help the assembled System Management Sub-committee to better understand how others have addressed these issues and to offer a suggested path forward. While this transition represents a significant change, it is important to remember the guidance that was put forward by the SMP on several occasions during the development of the 2016 Plan – **don't let good be the enemy of great.**

Elements of System Management Program

The elements of an asset management-based approach to system management are essentially the framework for which to build the program around. There are several well-defined asset management frameworks that have already been developed, tested, and put into practice specifically in the areas of public infrastructure management such as required for the Stormwater Management Program. These include WERF SIMPLE, the EPA's Effective Utility Management program, ISO 55000/55001, and the International Infrastructure Management Manual to name a few of the more prevalent reference frameworks.

Rather than "re-invent the wheel", it is recommended that the system management program be developed following the common major elements of these existing frameworks. These elements are typically documented within an overall asset or system management strategy document. Such a document would be used to provide alignment between the 2016 Plan and the asset management framework elements of the system management program. The framework elements are highlighted in Table 2.

Table 2. Asset Management Framework Elements

FRAMEWORK ELEMENT	DESCRIPTION
COMMITMENTS & OBLIGATIONS	***"What do we have to do and why?"*** Identifies the goals and objectives of the asset management/system management program and explains how each objective ties back to or supports the objectives laid out in the 2016 Plan.
STAKEHOLDER REQUIREMENTS	***"What do stakeholders want us to do?"*** Identifies the stakeholders, both internal and external, that benefit from or participate in the program along with their expectations.
ASSET MANAGEMENT APPROACH	***"How will we manage our assets?"*** Lays out a series of ground rules for things such as service level expectations, what assets will be managed, a consistent approach for identifying high risk assets, tools that will be used, etc. Note that this is a major element of an asset management-based approach to system management and is discussed in further detail below.
ASSET MANAGEMENT MATURITY	***"What level of maturity do we want to be and when?"*** Identifies the end goal for the asset management/system management program – typically in terms of a "maturity score" from a level 1-5. Theoretically an organization could become "ISO 55000 Certified" with regards to its asset management program but to what end? At some point activities reach the point of diminishing returns and this helps identify "how far" the SMP and member communities wish to take the program.

FRAMEWORK ELEMENT	DESCRIPTION
ASSET MANAGEMENT OBJECTIVES	***"How do we monitor the effectiveness of the program?"*** Developing an asset management-based approach to system management is only worthwhile if it is having a positive impact on the SMP. This is typically done by identifying performance measures and/or key performance indicators (KPI's) that can be measured quantitatively to determine program effectiveness. Examples can be historical asset risk and/or condition scores, dollar value of risk mitigated via capital projects, etc.
IMPROVEMENT INITIATIVES	***"What do we need to do to get to our goal?"*** Once all of the program elements above are further defined, it is only natural that there will be "gaps" indicating opportunities for improvement from the current state to the end goal state. These improvement initiatives then become strategically defined efforts to be executed to implement the program.

In addition to the program elements identified above, a cultural/behavioral shift of seeking continual improvement as related to the asset management/system management program is also required. A common component of any of the aforementioned asset management frameworks is this adoption of continual improvement characterized by the Plan-Do-Check-Act approach as shown in Figure 1.

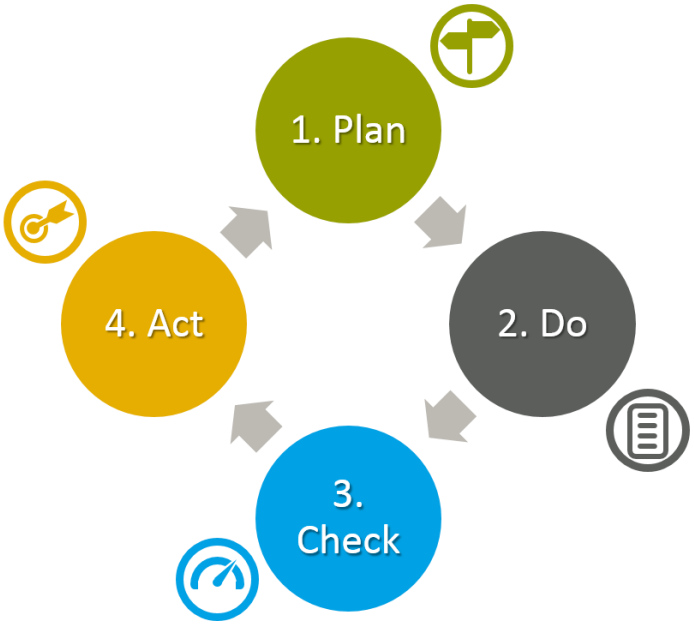


Figure 1. Plan-Do-Check-Act

Essentially, these elements define the following approach: objectives are defined as part of a holistic strategy or roadmap, actions and activities are executed to achieve those objectives, the impacts and effects of those actions are measured and evaluated, changes are adapted if the desired results are not being achieved, and the plan is refined for further improvement. An asset management-based approach to system management includes all of the elements described above but also accepts that the work is never "finished". It is an adopted approach that continually identifies best ways to target resources so as to maximize the value and performance of the stormwater system.

ASSET MANAGEMENT APPROACH FURTHER DEFINED

As discussed in Table 2, a key element in the framework for the asset management-based approach to system management is the ***Asset Management Approach*** element. This element essentially defines the practices and tools that will be used to manage the program's assets and includes the following sub-elements.

Service Levels

Before determining optimal strategies for managing stormwater system assets, it is necessary to define the service levels that these assets will deliver against. The levels of service provided by the assets should address regulatory requirements, financial sustainability, and stakeholder (both internal and external) expectations.

The target levels of service determine the amount of funding that is required to operate, maintain, renew, and upgrade the stormwater infrastructure. Also determined is the relationship between differing levels of service and the associated cost of delivering the service. Understanding the levels of service is vital for the lifecycle management of assets. They will dictate what type of assets will be provided, how often they will be maintained, when assets will be rehabilitated or replaced, and how the assets will be disposed.

Asset Registries

Before any discussion can be had on ***how*** assets will be managed and maintained, it is first important to agree on ***what*** assets will be included in the system management program as well as the quantity and location of these assets. For example, will only man-made, engineered structures be considered as assets to be managed by the program or will it also include natural structures? Based on objectives outlined in the 2016 Plan, the system management plan should include both engineered and natural structures. The two components (man-made and natural) together represent a fully functioning system encompassing the entirety of a watershed.

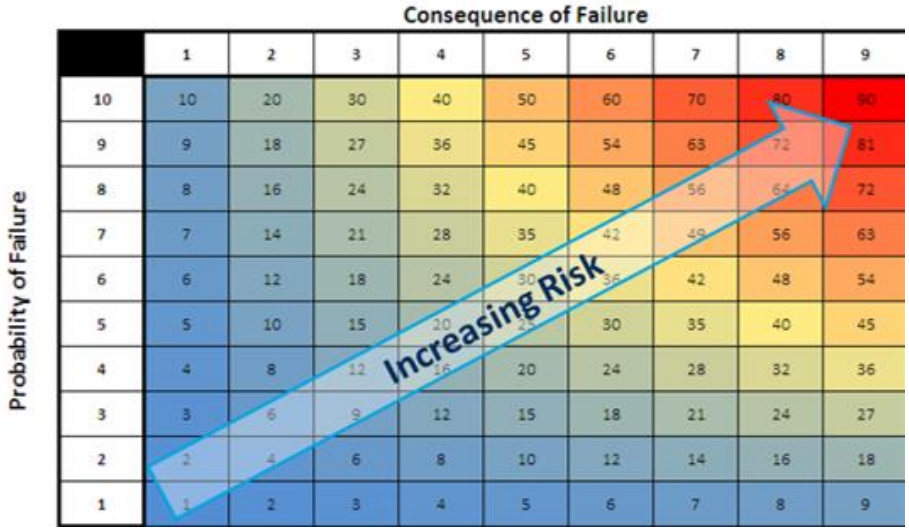
However, agencies differ on the level of detail they have collected and maintained over time with regards to both man-made and natural assets. Agreement is necessary on what assets will be covered under the program and then efforts will need to be completed for an accurate and consistent inventory of all these assets before a plan can be developed and implemented on their management.

Risk & Capital Prioritization Methodologies

> *"You can't manage what you can't measure."*
> *- Peter Drucker*

As previously discussed, the SMP and member municipalities are continually being asked to do more with less. Inevitably this means that there is competition as to which assets to focus on when it comes to repair, rehabilitation and replacement activities. Effective asset management-based system management programs have developed risk and capital prioritization methodologies to objectively target resources.

Risk prioritization involves developing an overall risk score for each asset that encompasses an asset's likelihood or probability of failure (PoF) combined with its consequence of failure (CoF). Combining these two scores represents the risk that an asset poses should it fail. The greater the risk of failure, the more important that asset is with regards to the targeting of resources.



	1	2	3	4	5	6	7	8	9
10	10	20	30	40	50	60	70	80	90
9	9	18	27	36	45	54	63	72	81
8	8	16	24	32	40	48	56	64	72
7	7	14	21	28	35	42	49	56	63
6	6	12	18	24	30	36	42	48	54
5	5	10	15	20	25	30	35	40	45
4	4	8	12	16	20	24	28	32	36
3	3	6	9	12	15	18	21	24	27
2	2	4	6	8	10	12	14	16	18
1	1	2	3	4	5	6	7	8	9

Figure 2. Example Risk Matrix Utilizing PoF and CoF

Capital prioritization involves the aggregation of at-risk assets into actionable projects. These projects are then analyzed to compare and prioritize them based on the collective risks they are mitigating, costs, project dependencies, and stakeholder benefits. Once balanced against budgetary and practical execution constraints, they represent an objective and actionable capital improvement program for the management and replacement of stormwater assets.

Maintenance Strategies

Not all assets need to be maintained the same way. Some assets might be allowed to strategically "run-to-failure" rather than invest in costly and ineffective maintenance activities. Other assets might be maintained to a higher level using regular condition monitoring activities and predictive maintenance (PdM) technologies or strategies such as reliability centered maintenance (RCM). How a streambed is maintained might differ from how a stormwater inlet is maintained which might differ from how green infrastructure or a BMP is maintained. An effective approach to managing assets as part of an asset management-based approach to system management will identify the right maintenance strategy for each asset so that maintenance resources can be more effectively deployed to achieve desired asset performance and longevity.

Information Management

Lastly, of particular importance to a multi-agency program such as the SMP is defining standards for both how information will be managed and shared with member agencies as well as a set of tools that will be used to support the program. For example, geographic information systems (GIS) are a natural fit in terms of a technical tool to utilize for the storage of the asset registry. An effective approach to managing assets will define how GIS data will be structured and shared with member organizations to support the program. This can also include common tools used to evaluate asset condition or measure risk.

Case Studies of Similar Programs

Although the SMP is very unique on a national scale, the application of asset management principles as part of an overall system management program has been implemented in other programs either holistically or in pieces and parts. The following case studies provide an overview of effective

implementation for similar programs. The case studies offer guidance related to potential challenges as well as how to potentially address issues as the SMP implements similar initiatives.

CITY OF MINNEAPOLIS STORMWATER ASSET MANAGEMENT SYSTEM

System Description

The City of Minneapolis, Minnesota, maintains approximately 600 miles of main line storm drain and 17 miles of storm tunnels that convey runoff from an approximately 50 square mile catchment area. Its system includes both engineered (man-made) and natural components including stormwater ponds and basins, outfalls, bio-infiltration areas, streams, main lines, tunnels, and treatment facilities.

Program Drivers

Beginning in March 2005, the City implemented a stormwater utility fee for residents. This fee is included in resident utility bills and provides overall funding for the stormwater management program. Over time, it became an increasing challenge to justify required funding levels for the program as well as to objectively prioritize capital funds for the rehabilitation and replacement of stormwater assets. An asset management-based approach was identified as a potential solution.

Development of the City's asset management program for its stormwater infrastructure began in 2012. Key objectives for the program included the following:

1. Improve overall system performance and reliability.
2. Identify the criticality of system components to best target resources for greatest impact.
3. Identify true, full lifecycle costs for the maintenance of stormwater assets.
4. Improve documentation and record keeping.
5. Improve future decision making by utilizing a fact-based, objective approach to targeting resources for the management of stormwater infrastructure.
6. Take a proactive versus reactive approach to maintaining stormwater infrastructure (both natural and engineered).

Program Elements

To guide in meeting the six objectives outlined above, the City developed a program with five guiding principles:

- Protect people, property and the environment,
- Maintain and enhance infrastructure,
- Provide cost-effective level of services in a sustainable manner,
- Meet regulatory requirements, and
- Enhance livability and safety

These guiding principles serve as the **Commitments & Obligations** (or, "What do we have to do and why?") element of their asset management program. In addition, the City identified the following initiatives and/or practices necessary to implement their program:

- Inventory and identify the current state (age, condition, etc.) of stormwater assets;
- Develop a standardized data structure for inventorying assets and asset attributes;

- Identify and implement a standardized methodology for assessing condition of assets (for example the City elected to utilize National Association of Sewer Services Companies, or NASSCO, for assessing pipe condition);
- Implement a risk prioritization methodology to identify high risk areas and critical parts of the system;
- Implement a capital prioritization methodology to objectively identify, estimate, prioritize, and schedule capital projects;
- Improve documentation and record keeping related to the maintenance of the stormwater system by implementing a computerized maintenance management system (CMMS);
- Improve coordination and communication via public outreach; and
- Utilize the asset management program as a communication tool for coordination with elected officials and regulators to justify resource allocation and project planning and execution.

Issues and Challenges

As with any initiative of this nature the City had to address several challenges in the development and execution of its asset management program. In general, challenges coalesced around two main areas as follows:

Resource Constraints. This included human, technical and financial resource constraints. Examples include identifying and training the appropriate staff on asset management concepts and strategies and gaining support from the governing body for this initiative. Initial development of the program required allocating funds to develop the necessary data and tools to be able to achieve program objectives. Challenges were overcome through effective communication and coordination activities with upper management and the City Council.

System Complexity. The City initially focused on just the engineered (or man-made) components of the system. However, the City quickly realized that not addressing the natural components of the system provided an incomplete picture and hindered the ability of the City to holistically achieve its overall objectives. Including all aspects of the system – from raindrop to leaving the watershed – allowed for a more accurate means to manage the system.

CITY OF GRAND RAPIDS STORMWATER ASSET MANAGEMENT PROGRAM

System Description

The City of Grand Rapids, Michigan covers approximately 45 square miles and manages a stormwater system with a current valuation of $528 million and a replacement cost of $1.34 billion. The system encompasses both engineered and natural components such as catch basins, open channels, ditches, green infrastructure, manholes, and pipelines.

Program Drivers

Due to increasing pressures to meet water quality targets, address population growth, and maximize the effective useful life of stormwater assets, in 2008 the City of Grand Rapids developed a 20 year asset management program for its stormwater system. The main purpose of the program is to maintain a desired level of service at the lowest lifecycle cost to ensure quality community facilities, service, and amenities.

As part of the Green Grand Rapids planning process in 2008, the City committed to a number of outcomes for more sustainable management of the environment. These included initiatives such as energy reduction, improved environmental quality and use of natural systems, as well as smart and sustainable land use. Along with these initiatives, the City completed a Stormwater Asset Management and Capital Improvement Plan (2013) that serves as the foundation for the program.

Program Elements

In developing the Asset Management and Capital Improvement Plan, the City identified the following key program elements:

- Inventory and assessment of existing stormwater assets (both natural and engineered);
- Evaluation of each stormwater asset type levels of service;
- Summary of efforts necessary to meet the identified levels of service; and
- Development of a capital improvement plan to provide additional detail for projects and activities.

The plan also identified the use of several different data sets and tools to support development of the elements identified above. This included the extensive use of geographic information systems (GIS), development of estimated effective life (EEL) for each asset type to assess anticipated replacement dates, computerized maintenance management system (CMMS) to track the maintenance and condition assessment inspection activities associated with each asset, and specialized tools for conducting risk analysis (aka risk prioritization methodology) and rehab/replacement cost estimating.

In order to develop and communicate levels of service, the City developed three different scenarios showing the required funding levels and anticipated impacts and risks associated with system renewal rates of 100 years (scenario A), 125 years (scenario B), 150 years (scenario C), and existing "run to failure" approach (scenario D). This proved to be an effective means to communicate the linkage between funding levels, asset performance, maintenance efforts, and the resulting impacts on environment and related infrastructure (e.g. streets) to the governing body and to gain support for the program.

Issues and Challenges

Through development and implementation of the program, the City has seen both social and economic barriers that are typical in municipal programs of this nature. Although the asset management and capital improvement plan served as an effective communication tool for the linkage between funding and expected service levels and risk, the realities of the economic recession of 2008-2012 resulted in the lack of availability of required funds to execute all of the projects and initiatives in the plan. This in turn required overall plan adjustment. In addition, from a cultural perspective, collaboration across City departments (e.g. coordination with Streets to execute projects in tandem to achieve economies of scale) proved to be more difficult than anticipated until those departments also implemented a similar methodology for identifying high risk assets.

ASSET MANAGEMENT & INTEGRATED PLANNING FOR ST. PETERS

System Description

St. Peters, Missouri has a population of approximately 57,000 and encompasses an area of about 22 square miles. The City owns, operates, and maintains over

165 miles of storm sewer pipe and associated structures as well as 3 pump stations. The system also includes natural systems including over 47 miles of streams.

Program Drivers

The City identified the need for an innovative and interdisciplinary approach to develop a stormwater master plan that encompassed many elements of an asset management program. In 2011, the City had a requirement to assess and classify the relative value of land for capturing, storing, and infiltrating stormwater runoff. They also had the requirement to identify vacant land that could be used to construct new water quality BMP's to meet the City's stormwater objectives.

Program Elements

To complete the master plan, the City identified a series of criteria to prioritize high risk assets (a risk prioritization methodology) and to aggregate those assets into executable projects based on desirable site criteria, spatial adjacency, construction methods, and budgetary constraints. Projects were rated with priority scores and evaluated against cost benefit ratios to determine a prioritization (capital prioritization). Several different tools were used in the development of these elements including P8 and HEC-HMS models as well as extensive use of GIS. The result was over 100 prioritized and scheduled projects. Prioritization of projects included an objective and quantifiable measure of mitigated risk, assets addressed, and project cost-benefit for execution as a comprehensive CIP.

Issues and Challenges

As with many municipalities in Missouri, St. Peters was struggling to pay for stormwater improvements without the benefit of a Stormwater Utility. Past efforts to persuade the voters to approve bonds to pay for stormwater had failed. The reason for this failure was perceived to be that the City had not adequately characterized the stormwater needs to be addressed. Completion of this project allowed the City to sufficiently communicate the needs of the system, and a bond measure passed on the first ballot following completion of the Masterplan. The City is now 'working the plan,' and has used the approved bond money to complete many stream stability, basin improvement, and flood control projects.

Potential Barriers to Implementation

As with any program of this nature that involves multiple organizations and both internal and external stakeholders, there exist barriers for implementing an asset management-based approach for stormwater system management. These may include:

Lack of Uniform Asset Data. There are likely differences in the nature, complexity and structure of asset data for stormwater assets between the County and member municipalities. Some may have focused only on engineered (or man-made) infrastructure whereas others may also include the natural elements of the system. Even if all of the same asset types are considered to be "in the system", there will also likely be differences in the information about those assets from one agency to the next. A coordination effort and willingness to participate would be required to determine a common intermediary data structure to facilitate information sharing across all entities.

Coordinated Risk and Capital Prioritization Methodologies. In order to conduct an objective "apples to apples" comparison of assets for the targeting of SMP resources, member entities would need to develop and agree upon common risk and capital prioritization methodologies (at least for SMP asset and project comparison purposes). This would include a consistent means for defining both

the probability (PoF) and consequence of failure (CoF) of assets along with their respective contributions to an overall risk score. This would also involve estimating, prioritizing, and scheduling SM capital projects across political boundaries. Although a municipality might use one risk or capital prioritization method within its borders, a common method would need to be used across all municipalities and unincorporated areas of the County for equitable comparison of risk and capital projects for all stormwater assets.

Perception of Equity. Depending on the risk and capital prioritization methodologies developed for the program, some municipalities may feel that certain criteria or weights within the methodologies favor certain asset types or conditions more prevalent in other municipalities. This might also be impacted by municipalities that are "further ahead" in developing a more detailed inventory of stormwater assets that include both man-made and natural elements.

Although there will likely be other barriers to implementing an asset management-based approach to system management, the above issues are the most pressing and expected during initial phases of program development.

Suggestions for Implementation

Similar to the movement to a Watershed-Based Organization, the adoption of an asset management-based approach to System Management is not optional. It was recommended by the Steering Committee, the Stormwater Management Advisory Council (SMAC) voted to recommend adoption of the plan, and the Board of County Commissioners approved adoption of the 2016 Plan to move the SMP forward accordingly. The SMP is a county program, and county leaders have decided this is the best path forward.

That said, the goal of the county is to develop a program approach and structure that encourages participation by member municipalities and also seeks to assist municipalities in the development of a holistic asset management program for stormwater assets. The following are ***suggested*** initiatives to begin development of this program.

Establish an Asset Management Advisory Council

In order to provide a voice and contribute to the development of the system management program, an advisory council should be established consisting of county staff, representatives from member municipalities, and local industry experts. The purpose of the council would be to focus on program development and coordination activities as well as serve as an outreach arm to member agencies and municipalities for education on the purpose and impacts of the program.

Develop Stormwater Asset Management Strategy Document

An overall asset management program strategy document should be developed that identifies the key elements of the program as laid out in this White Paper. Objectives should be tied to the 2016 Plan and the elements, as defined in strategy, should drive and define future initiatives as part of the program. At minimum, the strategy document should include the elements identified in Table 2.

Develop a Common Asset Registry & Structure

One of the first tangible activities following development of the strategy should be to define the assets that comprise the stormwater system (both natural and man-made) and to develop a common data structure for the sharing of asset data between entities. This should include asset type naming conventions, standardized asset attributes, asset identification standards (e.g. standard

county-wide ID's for individual stormwater assets), etc. This will facilitate both the sharing of data between entities but will also serve as a foundation from which to build future program elements such as the risk and capital prioritization methodologies.

Establish Service Levels & Performance Measures

The program strategy document will assist in defining service levels for each asset type tied to stakeholder expectations. This information should then be used to define performance measures (SMART – Specific, Measurable, Agreed-upon, Reasonable, Time-based) to quantify program effectiveness. This should be done early in the development of the program so involved parties can begin to track current state asset performance and program effectiveness. In turn, this will allow for quick identification of initiative effectiveness (or ineffectiveness) and program adjustments.

Develop Risk & Capital Prioritization Methodologies

Development of the risk and capital prioritization methodologies will be challenging, but will also result in some of the most impactful and effective decision making tools for the program. This will require development of comprehensive probability (PoF) and consequence of failure (CoF) criteria along with weighting for each asset type so as to produce an overall risk score. Additionally, consistent and comprehensive means to assess condition of assets both man-made and natural will be required.

Once asset risk is defined, assets will need to be aggregated into executable projects based on construction or rehabilitation method, priority watersheds, spatial adjacency, and budgetary constraints. Each project will need to be analyzed based on a set of defined criteria for its impact (typically expressed as amount of risk mitigated) and schedule. Projects will then be prioritized into an overall capital improvement program.

Identify Supporting Tools & Technologies

Many of the above efforts will require identification of specific technologies or tools necessary to support either the storage or sharing of data. Specific tools will also be necessary to calculate risk scores or analyze and optimize a capital improvement program. An initiative should be undertaken to identify a common set of tools that the county and member municipalities can utilize for executing these initiatives both internally (e.g. within a municipality) and holistically as part of the asset management program.

Program Metrics & Success Measures

Metrics for the development and implementation of an asset management-based approach for system management will, at least initially and similar to the Watershed Based Organization element, be driven by binary measures. This includes development of an asset management strategy document identifying the program elements (or not), identification of asset types to be included in the system (or not), development of risk and capital prioritization methodologies (or not), etc. Once the asset management strategy document is developed, quantitative performance measures and key performance indicators (KPI's) will be created to track the effectiveness of the program over time.