Columbia Wastewater and Stormwater IMP

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Our Columbia Waters
Integrated Management Plan
Wastewater & Stormwater

Technical Memorandum 2 *Wastewater Collection System Assessment*

Columbia Wastewater and Stormwater Integrated Management Plan

Columbia, Missouri
February 2, 2017

HDR
Geosyntec consultants
Shockey Consulting Services, llc
RV
TREKK DESIGN GROUP, LLC

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Section 1. Introduction and Objectives

The City of Columbia, Missouri (City) is working to develop an Integrated Management Plan (IMP) for the City's wastewater and stormwater utilities. The goal of the IMP is to develop an adaptable and affordable long-term plan that addresses the City's wastewater and stormwater management needs and meets Clean Water Act requirements. The IMP will be developed based on guidance presented in US Environmental Protection Agency's (EPA) *Integrated Municipal Stormwater and Wastewater Planning Approach Framework* (Stoner 2012).

A critical step in the IMP includes evaluating the City's environmental resources and infrastructure assets to better define the existing condition, performance, and needs of its systems. This evaluation is important because it forms the basis for identifying priorities and developing alternatives in subsequent phases of the IMP. To develop a comprehensive understanding of existing conditions, the City and their project team compiled and evaluated existing surface water, wastewater, and stormwater data. These data, as well as current operation and maintenance practices and procedures, were then reviewed and discussed in a series of workshops. Results from these efforts are documented in the following technical memoranda:

- Technical Memorandum 1 – Surface Water Quality and Biological Conditions
- Technical Memorandum 2 – Wastewater Collection System Assessment
- Technical Memorandum 3 – Wastewater Treatment System Assessment
- Technical Memorandum 4 – Stormwater System Assessment

This purpose of this memorandum is to summarize findings from the wastewater collection system assessment. The wastewater collection system is a critical element of the infrastructure owned and operated by a City's wastewater utility. Effective management of the collection system is vital for meeting important goals like reducing sanitary sewer overflows (SSOs), achieving regulatory compliance, efficiently managing the utility, and ensuring customer satisfaction. On August 9 and 10, representatives from HDR Engineering, Inc. (HDR), met with City staff to discuss these goals and identify the City's priorities and level of service (LOS) expectations. Results from the collection system assessment are documented in the sections that follow.

Note that this review was not intended to serve as a regulatory compliance audit or detailed assessment of program health and safety practices. Rather, the scope of this assessment was to review and characterize the City's current collection system management strategies and practices in the context of good engineering practices and the core attributes important to managing and operating sanitary collection systems.

Section 2. Core Attribute Assessments

The American Public Works Association (APWA), American Society of Civil Engineers (ASCE), National Association of Clean Water Agencies (NACWA), and the Water Environment Federation (WEF) worked collaboratively to engage a broad group of industry stakeholders to identify and develop good engineering practices and core attributes essential to managing and operating sanitary collection systems. These organizations defined twelve fundamental principles that support effective collection system management.

These "Core Attributes of Effectively Managed Wastewater Collection Systems" are intended to provide guidance for wastewater collection system managers to evaluate their existing programs and confirm they are performing according to industry good engineering practices, and identify practices that are lacking or in need of enhancement. These attributes are not intended to be strict guidelines; the need for specific elements included in the attributes will vary between utilities based on size, organizational structure, performance history, and availability of resources.

This collection system assessment is organized around the following 12 core attributes:

- Core Attribute 1 – System Inventory and Information Management
- Core Attribute 2 – Maintenance Management System
- Core Attribute 3 – Safety and Training
- Core Attribute 4 – Overflow Emergency Response Plan
- Core Attribute 5 – Collection System Maintenance
- Core Attribute 6 – Source Control
- Core Attribute 7 – Structural Condition Assessment and Evaluation
- Core Attribute 8 – System Hydraulic Capacity Assessment, Evaluation, and Assurance
- Core Attribute 9 – Standard Design, Construction, and Inspection
- Core Attribute 10 – Communication and Outreach
- Core Attribute 11 – Monitoring, Measurement, and Modification
- Core Attribute 12 – Adequate Funding

These attributes were evaluated in the context of the priorities and level of service that the City wants to achieve, and regulators and the public expect. Level of service goals and priorities can vary significantly between utilities. During the IMP Visioning workshops, the City determined that the highest wastewater priorities that must be considered are maintaining public health protections, meeting level of service (LOS) goals, and providing justification for dedicated funding for certain activities. Specifically, the City would like to:

- Address wet-weather issues, including building backups, sanitary sewer overflows (SSOs), and areas with persistent inflow and infiltration (I/I) challenges;
- Eliminate hydraulic capacity limitations in the existing treatment and collection systems; and

- Develop and implement an asset management system to support system renewal and maintenance efforts and plan for future growth, including a mechanism to establish sufficient dedicated funding for these efforts.

Note that Core Attribute 10, Communication and Outreach, will not be addressed in this assessment of collection system activities, as the overall communication and outreach plan for the City will be addressed elsewhere in the Integrated Management Plan.

2.1 Core Attribute 1 – System Inventory & Information Management

Core Attribute 1 encompasses collection system inventory and information management. To efficiently manage the collection system, staff needs to be provided with sufficient resources to enable effective collection, storage, evaluation, and communication of data and information. Design, construction, and maintenance information needs to be readily available to meet a City's performance goals and system maintenance requirements. A comprehensive system inventory and information management system is an essential component to achieve efficient operations, and allows the City to plan and sequence future projects more efficiently.

Information management via geographic information system (GIS) software is a common platform used by many utilities. GIS can store, manage, analyze, and map spatially referenced system information. City maintenance management programs can also be integrated to GIS. An effective system inventory and information management system provides the following benefits to the City:

- Provides the necessary information to effectively respond to and prioritize service requests.
- Informs staff of existing system components and connectivity.
- Facilitates efficient system operation and maintenance.
- Builds confidence in analysis and decisions at the asset and system level.
- Minimizes risk of unforeseen service disruptions.
- Supports continuous system improvement.
- Generates consistent and reliable planning and forecasting information to improve management decisions.
- Supports system assessments and capital improvement planning.

The five main elements of system inventory and information management are:

- Asset identification and documentation;
- Data and process needs assessment;
- Information management plan development;
- Information management plan implementation; and
- Process monitoring adjustments.

Findings

The City has a dedicated GIS based information management system in place to handle its entire infrastructure. The collection system infrastructure is a component of the City-wide information system, but with its own unique data structure. A dedicated GIS team with a dedicated data administrator controls the GIS data, and coordinates additions and updates. In addition to its own staff, the City coordinates with Boone County, the Boone County Regional Sewer District, and the University of Missouri to update its database and keep it current.

The City has worked diligently to develop an extensive system inventory of the collection system. The spatial location and connectivity of all known pipes and structures are included in the Geographic Information System (GIS). Over 18,000 individual sanitary sewer pipes, with a total length of approximately 700 miles of gravity pipes and an additional 40 miles of forcemains for a total system length of 740 miles, are documented in the City's GIS (**Attachment A**).

Important asset attribute information such as pipe material, size, and installation date is available in GIS for much of the system. Invert information is also available for areas that have been surveyed, and areas where accurate as-built information is available. There are gaps present, particularly in invert elevation and pipe materials. The City should continue to work to fill in these data gaps. **Figure 1** and **Figure 2** present the collections system inventory by material for large diameter pipes, small diameter pipes, and all pipes, respectively.

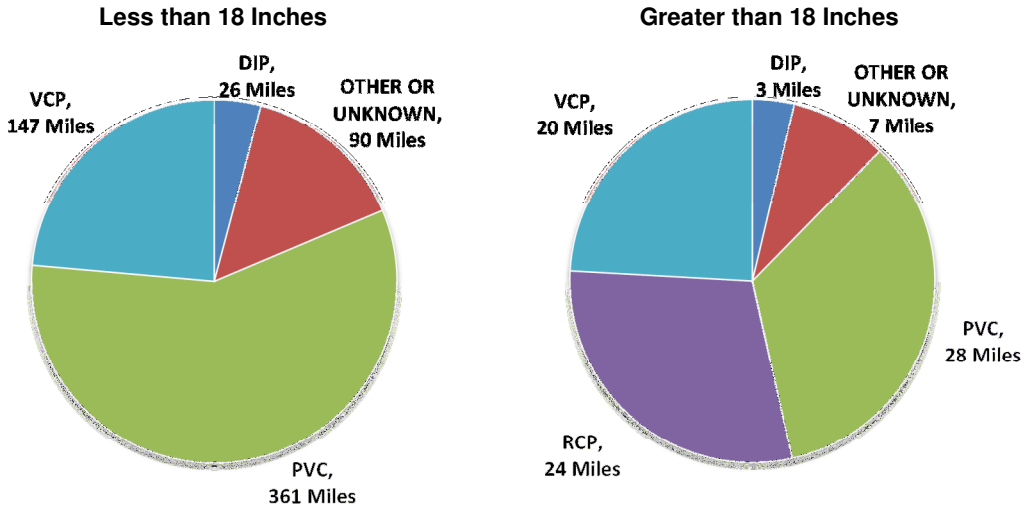

Figure 1. Inventory by Material for Gravity Pipes Less and Greater than 18 Inches in Diameter.

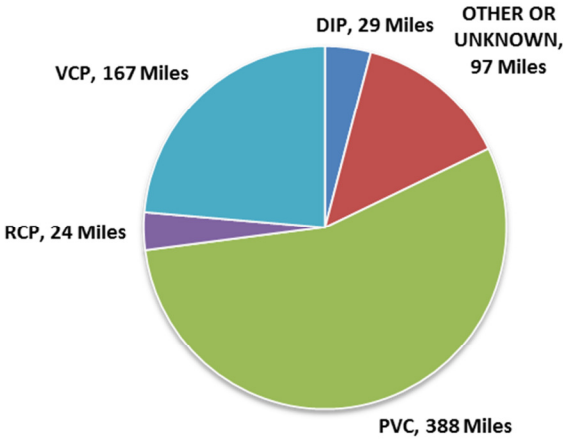

Figure 2. Inventory by Material for All Gravity Pipes.

The GIS database also contained the installation date for approximately 60% of the pipes. Missing pipe ages were estimated by HDR based off the age of adjacent infrastructure and subdivision platting. **Figure 3** presents a summary of the estimated age of the collection system. A map of the collection system by age is presented in **Attachment B**.

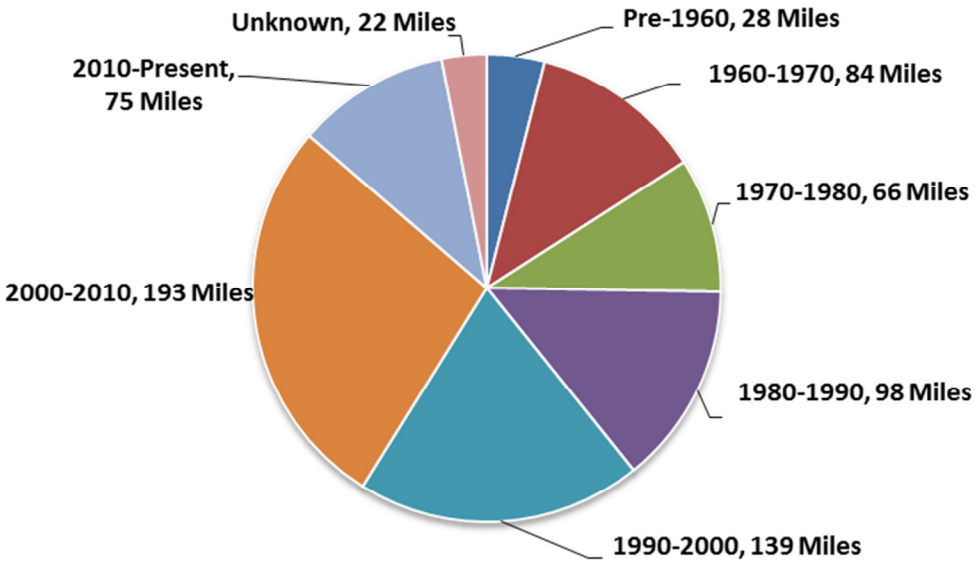

Figure 3. Estimated Collection System Age by Decade.

The City also uses their GIS system to document and track past and ongoing work activities, including the following:

- Work history from past and current sanitary sewer evaluation survey (SSES) projects - flow monitoring locations, public and private inflow and infiltration (I/I) source inspection results, and I/I source disconnection records.
- Capital project status tracking, including those projects which are planned, under construction, and complete.
- Maintenance records, which are updated nightly and include information such as date of pipe cleaning, cleaning findings identified by the field crew, and other observations like manhole conditions.
- Closed circuit television (CCTV) – indicator that identified which pipes have been inspected. Inspection findings and videos are not yet linked.

A thin client version of GIS on tablets is used by City staff to update data in the field. A backup and data synch takes place when the trucks return at the end of the day. Data is reviewed by the supervisor for anomalies and then backed up to the server. Asset data is also integrated on a nightly basis from the Boone County Assessor and cross checked for accuracy. New lines or infrastructure is updated by the inspectors handling inspections. This allows for efficient

updating of the GIS to reflect changes identified by field staff, and to consistently track the status of work activities such as pipe cleaning.

Data related to complaints such as sanitary sewer overflows (SSOs), building backups and other infrastructure damage is recorded by the complaint receiving official or the inspector on a local database. A GIS layer is maintained showing historical backup and overflow locations. Separate data layers of infrastructure are also maintained and updated by consultants who monitor the system for condition and I/I. Following any type of work on the system, the system is updated by the City staff.

Management of the information collected by CCTV inspection crews was a gap identified during the assessment. The inspection crews use Granite XP software to record observations made during CCTV inspections. This data is not currently linked to the City's GIS, and the inspection observation database is not readily available for use by engineering and operations staff.

Recommendations

The City is in the process of developing a system inventory and information management system that effectively supports collection system management. The City has a dedicated GIS team in place and an effective system for updating the information systems, and continues to proactively improve their system inventory as information becomes available. Recent improvements such as tracking cleaning status and findings by pipe will enable the City to more effectively use the data collected by field crews to drive management decisions. The City should continue their efforts to integrate the system inventory and work order information management system.

Opportunities for improvement exist in the management of CCTV inspection data, which the City is currently working to improve. Integrating the CCTV observations with the information management system will make the inspection observation database readily available for use by engineering and operations staff. At the pipe and manhole level, this will enable the City to more efficiently make renewal and repair decisions. From a collection system management perspective, it will facilitate the use of condition assessment information to better allow for data driven forecasting of short and long term renewal and maintenance needs, and inform overall management strategies.

2.2 Core Attribute 2 – Maintenance Management System (MMS)

Core Attribute 2 is the practice of keeping a continuous record of maintenance activities to track system performance, optimize maintenance, and identify areas requiring frequent attention. An integrated maintenance management system (i.e., a system that ties to GIS mapping and other programs used to manage the collection system) not only ensures records are current, but also increases the efficiency of work in the field by allowing collection system staff to view current mapping and system inventory, maintenance history, and work orders. An effective maintenance management system provides the following benefits to the City:

- Uses defined pathway(s) assigning customer comments and complaints to the appropriate staff for timely response.
- Issues maintenance, repair, and inspection work orders to appropriate staff.
- Compares maintenance performance against City targets for key measures.
- Tracks maintenance and repair costs by specific assets or asset groups.

The three main elements of a MMS are software, maps of the collection system, and maintenance records.

Findings

The City does not currently have an integrated MMS. The City uses their GIS system to document and track past and ongoing work activities. Since the MMS is not integrated with the GIS, it requires some manual processes to link information from the collection system program activities such as cleaning. An integrated MMS designed for the City's utility would reduce these manual processes and further improve data flow and sharing for other activities, such as CCTV inspections.

Although an integrated MMS would offer advantages to the City, it is not entirely necessary for effective collection system management, and the need for a MMS varies based on the size of the utility and the state of existing processes. The City has a sufficient GIS mapping system, and a process in place for documenting maintenance records. The City has also developed processes that use their current systems to achieve some similar outcomes that a MMS would provide, such as linking cleaning work order documentation and findings to individual GIS assets like pipes.

Recommendations

The results of the assessment indicate that an integrated MMS is not a high priority item at this time, and overall the City is currently managing their collection system maintenance, repair, and inspection activities effectively without an MMS. As the collection system continues to grow and management needs change, the City may want to further evaluate the benefits of implementing an MMS.

2.3 Core Attribute 3 – Safety and Training

Given the hazardous nature and location of work, safety of the crew is of prime importance in the drive to efficiently manage a collection system. Exposure to hazardous structures, materials, atmospheres, vehicular traffic and chemical and biological contaminants makes the collection system maintenance job site a high priority for implementing safety. Well drafted training programs combined with safety guidelines and procedures can thwart accidents and keep the crew and the collection system safe and running. Hazard communication for understanding hazards that may be encountered while on job is critical to the health and safety of the worker. The four main elements of safety and training are hazard communication, safety training, staff development needs and adequate workforce resources. Benefits of a safety and training program include, but are not limited to, the following:

- Reduced insurance premiums,
- Increased productivity,
- Reduced time lost in accidents,
- Better regulatory compliance, and
- More knowledgeable workforce.

This assessment evaluated whether the City has implemented a safety and training program for collection system personnel in the context of effective collection system management. Evaluation of the specific health and safety practices included in the City's program is outside the scope of this assessment.

Findings

The focus on safety by the sanitary sewer maintenance division of the City is apparent from their mission statement which reads,"Keep the wastewater confined to the system in a SAFE and efficient manner". The Sewer Maintenance Division has a well written operation manual guidance document (Sorrell 2015) in place which it is apparent the crews abide by and follow when responding to complaints, performing regular system maintenance, or regular inspections.

Clear guidance is in place even for simple procedures such as removing manhole covers on a routine monitoring outing. Detailed descriptions, along with informative pictures on safety procedures, on complex work such as trenching and excavating is clearly documented in the operations manual (Sorrell 2015). The Maintenance Division requires mandatory confined space entry training, heavy equipment operations training, and driver's certification by operators who perform the work. A hazard communication program is also in place and strictly adhered to by staff. All activities and outings are clearly recorded and the appropriate personnel are notified in the event of mishaps. The City has provided the necessary health and safety gear and personal protective equipment to the maintenance crews. The City requires regular training and updates and gear checkup for the crew and gear, respectively.

The effectiveness of the City's detailed safety and training program is evident in the numerous Safety Awards regularly received by the Collection System, which is given out by the Missouri Water and Environment Association. The division has won the safety award 9 times (1993, 1996, 1997, 2001, 2002, 2006, 2008, 2012 and 2013) for 'Large Facilities' in the past two decades, which indicates an exemplary safety record (**Figure 4**).

Figure 4. Recent Collection System Safety Award Received by the City of Columbia.

Recommendations

Given their record in receiving safety awards, the City appears to have well established procedures and guidance in place. Our evaluation of their health and safety guidelines only reiterates their commitment to ensure the safety of everyone involved. The City should continue these efforts, and regularly evaluate their resources and training needed to continue their strong track record in safety.

2.4 Core Attribute 4 – Overflow Emergency Response Plan (OERP)

Core Attribute 4 is the development and implementation of an effective OERP. Implementing advanced response preparations for SSO events is crucial to managing the collection system to protect human and environmental health. An effective OERP provides several benefits to a wastewater utility, including:

- Enhancing the protection of public health and the environment;
- Providing compliance with regulations and permits;
- Maintaining trust with the public and regulatory agencies; and
- Minimizing the City's exposure and liability from claims, enforcement, or litigation.

The elements of an effective OERP are planning, notification procedures, documentation of the procedures for response planning and training purposes, and resource preparedness (e.g. ensuring essential parts, equipment, and contracting mechanisms are readily available).

Findings

The City has implemented an OERP. The OERP is updated by the City when needed; the most recent update to the plan was on November 30, 2015. The City OERP includes detailed procedures for responding to overflows. The OERP includes the following procedures:

- Notification procedures, with cell phone and home phone numbers for City staff who direct overflow responses.
- Notification of residents affected by the overflow, as warranted.
- Implementing a plan to effectively alleviate a dry weather overflow caused by a blockage or sewer failure.
- Securing the area to prevent unauthorized access to protect the public.
- Posting signs at any water body affected by the overflow, warning users of potential health risks.
- Procedures for containing the overflow, properly disposing of sewage when possible, disinfecting and deodorizing the area, and aeration of effected bodies of water if severe oxygen depletion is expected.
- Procedures for proper documentation of the overflow, including extent, location, cause, and discharge location.
- Proper notification of public agencies such as the Missouri Department of Natural Resources (MDNR) and Columbia/Boone County Public Health and Human Services.
- Proper materials on hand to complete repairs in pipes up to 30-inches in diameter and contract mechanisms in place to complete emergency repairs on larger diameter pipes.

Based on interviews with staff, the City has a record of successfully following the procedures laid out in the OERP.

Recommendations

The City's OERP appears to encompass the key elements of an effective plan, and has been successfully implemented. There are no recommended changes at this time.

2.5 Core Attribute 5 – Collection System Maintenance

Core Attribute 5 is focused on effective collection system maintenance, which is primarily achieved through the cleaning program. Proper system maintenance is vital to achieving safe conveyance of wastewater to the treatment plant, and avoiding backups or SSOs resulting from the accumulation of roots, grease, and debris in pipes. An effective collections system maintenance program provides many benefits to a City's wastewater utility:

- Averts or minimizes public health and environmental impacts.
- Reduces backups and sewer overflows.
- Reduces collection system odor.
- Minimizes backup claims from residents.
- Optimizes resources and reduces overall operation and maintenance costs.
- Increases the service life of the facilities.
- Minimizes potential of and exposure to enforcement and third-party litigation.
- Enhances the image of the wastewater agency.
- Maximizes available system hydraulic capacity.

A collection system maintenance program best practice is to implement an asset management approach for scheduling and executing cleaning of the system. Type and level of maintenance needs vary based on system size and characteristics such as age and materials. The frequency and schedule of maintenance activities is an important element in the development of an effective maintenance program. Managers should develop a schedule to perform maintenance in a timely manner based on history, collection system performance, and other risk based criteria, if available.

An effective cleaning program is typically comprised of the following activities:

- Proactive Preventive Maintenance Program – Scheduled cleaning, typically scheduled at the sub-basin or basin level
- "Hot Spot" Cleaning Program – Scheduled, accelerated cleaning of specific pipes or locations within the system where grease, debris, or root growth is known to quickly accumulate. These known trouble areas are typically cleaned on a much shorter schedule to mitigate the risk of overflow or backups.
- Reactive Cleaning – Unscheduled cleaning that occurs in reaction to a customer complaint, or to support the CCTV inspection program (e.g. the CCTV camera identified a major blockage that may result in an overflow that needs cleaned, or when the camera cannot make it through a pipe due to a blockage).

Findings

The City currently has 3 cleaning trucks and crews dedicated to executing the cleaning programs:

- Proactive Preventive Maintenance Program – This program is executed by proactively cleaning lines on a regularly scheduled basis. Lines are cleaned by sub-basin, generally

beginning at the upstream end which allows an individual cleaning crew to work in the same geographic area. This cleaning schedule reduces driving time and increases cleaning productivity. The routine cleaning or inspection frequency for lines in which an obstruction may result in a backup into a residence or business is intended to be a minimum of once every five years. The routine cleaning or inspection frequency for all other lines is intended to be a minimum of once every ten years. Lines that cannot be accessed, or are too large for the City to effectively clean are visually inspected within 5 years to verify there are no visual flow disruptions caused by blockages. The current cleaning schedule does not differentiate between material types.

- "Hot Spot" Program – The City keeps an updated list of more than 50 lines of concern that are cleaned on a 6-month basis to mitigate the risk of overflows and backups.
- Reactive Cleaning – The City regularly executes reactive cleaning in response to customer complaints, and to support the CCTV inspection crews. In recent years, the mileage of CCTV inspections has increased with the addition of another crew, which subsequently increased the volume of reactive cleaning needed to support the inspections. This reduces the resources of available for proactive cleaning.

The cleaning program has continually improved collection system performance since its implementation in the 1960's. The success of a cleaning program is primarily measured through the number of dry weather overflows and backups. According to the City's data, dry weather building backups and overflows caused by a blockage in the main line have decreased from an average of over 90 per 100 miles of pipe per year in the late 1960's to 2 per year per 100 miles of pipe in the last 10 years. These trends are shown below in **Figure 5**, expressed as overflows and backups per 100 miles of pipe.

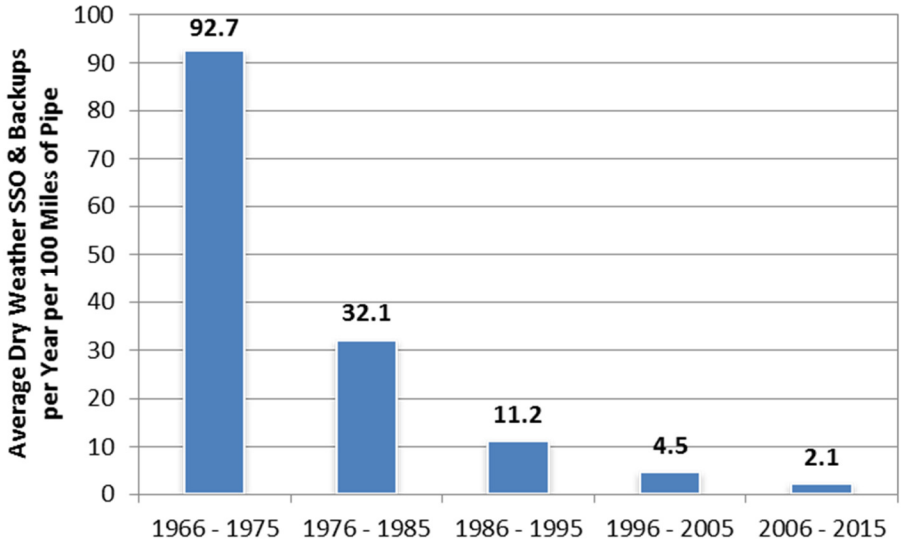

Figure 5. Historical Dry Weather Sewer Overflow and Backups in Columbia.

Performance has continued to improve in this area, and since 2010 the City has reduced this rate to an average of 10 per year, or less than 1.5 events per 100 miles of pipe (**Table 1 and Figure 6**). These results are in line with industry standards for an effective maintenance program.

Table 1. Recent Dry Weather Sewer Overflow and Backup Performance in Columbia.

Year	Dry Weather SSOs & Building Backups Per Year
2010	10
2011	10
2012	9
2013	6
2014	13
2015	12
Average	**10**

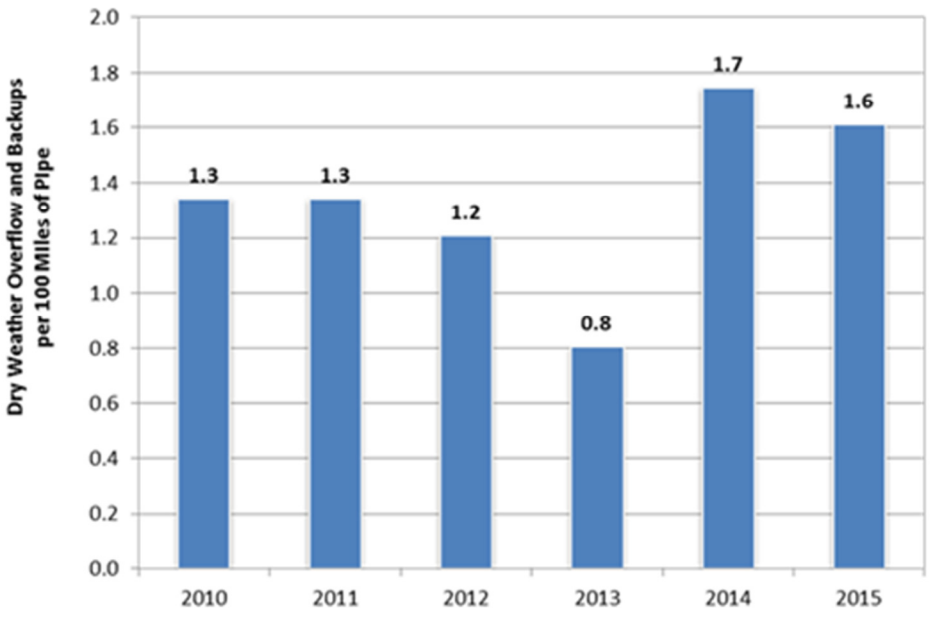

Figure 6. Dry Weather Sewer Overflow and Backups in Columbia between 2010 and 2015.

The City's productivity rates per crew have historically been strong. The City has historically been able to meet their preventive maintenance goals and have been able to clean lines approximately every four to five years. However, the City is facing challenges that are anticipated to make it harder to continue to meet proactive maintenance goals. These challenges include:

- According to the latest Census, Boone County is the fastest growing county in the state and Columbia is now the fourth largest city, which has resulted in continued growth of the collection system maintained by the City.
- In recent years, the City has increased the mileage of CCTV inspections in order to proactively assess the condition of the collection system and identify and mitigate structural issues and I/I sources. This increases the amount of reactive cleaning needed to support the CCTV crews, and decreases the resources available for proactive cleaning.
- The cleaning trucks have recently moved to a new dispatch facility at the WWTP, which has increased the driving time for the cleaning crews to much of the City.

Recommendations

In order to meet these challenges, optimize the use of resources, and continue the trend of improved performance, it is recommended the City build on the past successes and move towards implementing an asset management approach for scheduling and executing cleaning of the system. The program would focus on cleaning the right pipes at the right time, i.e. cleaning dirty pipes more often while cleaning clean pipes less often. Note that additional cleaning resources may also be required to meet these challenges.

To date, the City has been performing proactive cleaning of all accessible pipes (excluding those included in the “hot spot” program) on the same scheduled frequency. Typically, the level and frequency of maintenance needs within the collection system varies based on pipe characteristics such as age and material.

For example, Vitrified Clay Pipe (VCP), typically installed in most areas of the system prior to the 1980’s, is more prone to root growth through the joints. As a result, VCP pipe typically requires more frequent cleaning to address root growth. Many utilities set goals to clean the portions of the collection system made up primarily of VCP pipe every two to four years.

On the other hand, the Polyvinyl Chloride Pipe (PVC) typically installed in newer parts of town is not nearly as prone to root growth as VCP. It is also newer, and typically has less structural defects where debris may accumulate (e.g. offset joints). Many utilities clean this on a less frequent basis than VCP, often cleaning the newer areas of the system every six to eight years.

It is our experience that many cleaning frequencies that do not differentiate between materials often result in the City over-cleaning newer PVC pipes. The resources spent on cleaning this pipe would be more beneficially spent cleaning the older parts of town where root growth is a bigger issue.

Recent improvements to the City’s information system facilitate moving towards a data driven approach to cleaning scheduling. Mapping improvements provided by the GIS allow the City to identify the predominant age and materials of pipes in different areas of town, and facilitates the execution of cleaning work orders focused on cleaning specific areas of the system on different schedules. Additionally, the cleaning findings that have been recorded in GIS at the pipe level for the past two years will help to validate updated cleaning frequencies. An initial evaluation of

the cleaning findings recorded by the City's cleaning crews was completed on approximately 10,000 pipes. The cleaning findings indicated that 78% of the pipes were believed to be clean at the time of cleaning (**Figure 7**). The areas where pipes are predominantly clean are typically newer parts of town comprised of PVC.

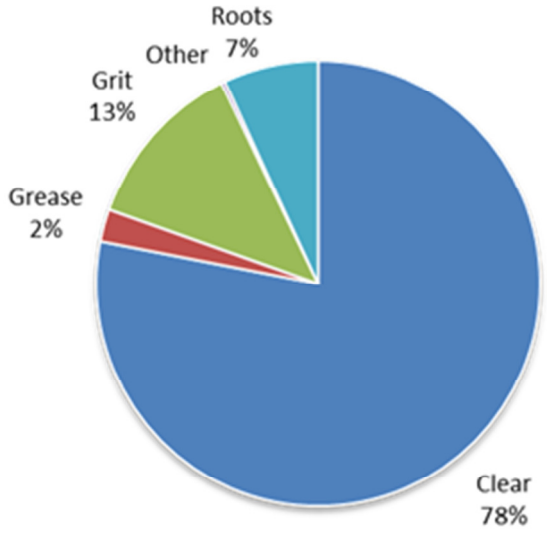

Figure 7. Summary of Cleaning Findings Documented through October 2016.

It is recommended that the City modify the cleaning findings recorded by their crews to better reflect the quantity of roots, grease, or debris present in the pipe at the time of the cleaning. The findings should differentiate between minor/moderate blockages and heavy blockages, because minor to moderate root growth typically means the pipe is being cleaned on the right schedule, while heavy root growth would indicate that the pipe may need to be cleaned more frequently. The findings recorded by crews should be simple and repeatable. In our experience, a 1 – 3 rating scale often works well and provides the actionable data needed to make decisions. An example scoring system for roots is shown below in **Table 2**.

Table 2. Example of a Scoring System that Could be Used to Establish Cleaning Findings.

	1 = Clean	2 = Moderate	3 = Heavy
Roots	***Visual:*** No evidence of roots, or small bits of hair/curtain roots without large clumps. **Passes:** 1 pass sufficient to clean. **Code: 1-Clean**	***Visual***: Moderate clumps of roots. Roots of 1/8" to 3/8" thickness. ***Feel***: Hose does not bind, or hydraulic pressure does not jump when roots encountered. **Passes:** Typically 1-2 passes sufficient to clean. **Code: R-2**	***Visual***: Large clumps of roots. Roots over 1/2" thickness. ***Feel***: Hose binds, jumps or slows down, hydraulic pressure can jump when using hydro cutter. **Passes:** Requires easing of saw into mass to remove roots. **Code: R-3**

This type of scoring system provides actionable data that can be used to inform management decisions. For example, if the findings for most pipes within a sub-basin were the following:

1 – Consider cleaning pipes less often

2 – Clean pipes on the same schedule

3 – Consider cleaning pipes more often

Note that CCTV data is another data source to use to aid in developing a data based refinement to cleaning frequencies. CCTV inspection findings can be evaluated in the context of the cleaning schedule to determine the rate of root growth, and the extent of other maintenance issues at both a pipe and sub-basin level. These findings can be used to inform cleaning schedule modifications.

All cleaning schedule modifications should be thoroughly reviewed with operations and engineering staff prior to implementation. The experience of cleaning crew leaders and other operations staff is an invaluable resource that should be fully used during schedule refinement. In order to maintain geographic centricity, in most cases cleaning schedules should be set so that all pipes within a sub-basin are cleaned on the same schedule (other than those pipes that are part of the “hot spot” program and thus cleaned on an accelerated schedule). This reduces driving time and increases productivity.

The City’s maintenance program has a demonstrated a strong trend of continuous improvement over the past several decades. The City has worked to reduce the rate of dry weather backups and overflows, and since 2010 the rate has averaged less than 1.5 events per year per 100 miles of pipe. Most similar regional utilities have goals ranging from less than 2 to less than 4 per 100 miles, with the stronger performing utilities typically maintaining average rates below 2 per 100 miles. The City’s results are in line with industry standards for an effective maintenance program.

In order to meet future challenges, optimize the use of resources, and to continue the trend of improved customer service, it is recommended the City build on these past successes and move towards implementing an asset management approach for scheduling and executing cleaning of the system. Additional cleaning resources may also be required to meet these challenges. This will be evaluated further during the Alternatives Analysis.

2.6 Core Attribute 6 – Source Control

Core Attribute 6 encompasses the preventative measures aimed at reducing potentially harmful discharges into the collections system that could cause blockages or overflows. Controlling these discharges improves collections system performance. An effective source control benefits the wastewater utilities by minimizing system overflows that result from blockage and minimizing system maintenance downstream of harmful discharge sources.

The five main elements of source control are:

- Fats, oils, and grease control (FOG program);
- Root control;
- Corrosion control;
- Vandalism prevention; and
- Odor prevention and control.

Findings

In the past, the City's collection system experienced many issues with grease blockages. To address this issue, the City implemented a dedicated FOG program approximately 15 years ago. The program employs a dedicated FOG inspector who regularly (six month schedule at the minimum) monitors grease traps and oil drains from known registered sources, such as restaurants and other commercial sources.

The FOG program has been successful and has helped lead to a considerable reduction in FOG related issues over the years. This success is reinforced by the fact the collection system has experienced an average of less than one overflow and backup per year caused by grease blockages.

The maintenance crew supervisors did note that they have observed a rise in residential sources for FOG in the recent years. A public education program will be discussed further and may be evaluated as part of the community outreach portion of the IMP. The City faces challenges in this area because a majority of its population is of a "rolling" type (e.g. college students). The City is considering a continuous education program focused on specific residential areas known to be sources of FOG.

The City addresses roots through the pipe cleaning program, as previously described in Core Attribute 5.

Corrosion is addressed on a case by case basis, when it occurs. It is recommended that the City pursue implementing additional measures on a case-by-case basis to protect infrastructure from corrosion due to hydrogen sulfide attacks, such as proactive epoxy lining of manholes that are located in the vicinity of forcemains or low pressure sewer discharges.

The City does not have any significant known problem locations for odor within the collection system. Odor control is typically addressed during the design of facilities that may cause odor issues.

Recommendations

The City has been successful in addressing source control to reduce unwanted discharges to the collection system. This is highlighted by the successful FOG program that has considerably reduced the quantity and extent of grease related blockages within the collection system. No changes are recommended to the FOG program at this time.

It is recommended that the City use engineering best practices to protect collection system facilities from corrosion, and provide odor control on a case-by-case basis, as warranted. The City should also consider efforts to educate the public on this issue through a continuous education program.

2.7 Core Attribute 7 – Structural Condition Assessment & Evaluation

Core attribute 7 is the structural condition assessment and evaluation of collection system pipes and manholes. Pipes and manholes deteriorate at different rates for many reasons. Condition assessment is a vital tool that allows utilities to identify and address deteriorated pipes before they collapse and cause a blockage that may result in an overflow or backup Proactive identification of structural deficiencies also allows utilities to address the infrastructure through cost-effective, trenchless rehabilitation techniques that minimize disruption to the public.

Condition assessment techniques vary based on material and accessibility. CCTV is the most popular and widely used industry method for pipe condition assessment. More specialized methods may be used when dictated by the situation, such as sonar scanning. An effective program uses inspection findings along with maintenance records, staff knowledge, and engineering judgment to prioritize and budget for short and long-term system renewal needs. This provides the following benefits to a wastewater utility:

- Reduces unexpected system failure, blockages, and overflows through preventation.
- Provides the information necessary to make informed decisions to plan and prioritize maintenance, rehabilitation and repair, and capital improvement projects.

Findings

The City's condition assessment activities consist primarily of the following:

- CCTV inspection of pipes to assess structural condition and potential for I/I.
- Manhole inspections to assess structural condition and potential for I/I.
- Exterior inspections of lines that may be at risk due to erosion, storm channels or other storm drainage paths, and exposed assets.

CCTV Inspection

The City has two CCTV trucks operating full time, primarily dedicated to condition assessment of the collection system. The trucks complete inspection of approximately 40 miles of sewer annually. Work performed by the crews on the CCTV trucks includes inspection of all new construction, including new or replaced service connections, prior to acceptance. Note that the City does not currently employ any contracted CCTV crews for proactive inspections but contractor crews do perform post-CCTV of Cured in Place Pipe (CIPP) lining. The primary inspection activities can be summarized as:

- Proactive inspections – proactive inspections, primarily in areas of the collection system with high I/I, or older areas of the system at higher risk of structural failure. These inspections are completed by sub-basin.
- Reactive inspections – inspections initiated to investigate a customer complaint, or in response to cleaning crews that are having issues cleaning lines.
- Repair acceptance – inspection of a recently completed pipe repair, completed to ensure the repair was completed successfully and in accordance with City standards.

The City has focused their inspection efforts on the highest risk areas of their system, and completed inspection of nearly all of the older VCP areas of the system that typically have higher rates of I/I and more prevalent structural issues. In HDR's experience, this puts the City ahead of the curve compared to many other peer utilities. Completing these proactive inspections of the older areas of the collection system is a collection system management best practice, and indicative of the focus that has been placed on maintaining and renewing aging collection system infrastructure. This proactive work will result in long-term savings for the City, and minimize disruption to the public by identifying structural issues that can be repaired though trenchless methods, before pipes fail, which often causes overflows/backups and requires expensive excavation to repair.

The inspection results have been evaluated and used as the basis for developing and executing the rehabilitation and repair (R&R) program. The City is currently CIPP lining approximately 30,000 feet of pipe each year, at about $2.7 Million annually, as well as completing point repairs with the in-house construction crew. This current system renewal rate equates to approximately 0.8% of the system renewed on an annual basis. The City's evaluation of the inspection data indicates a relatively high percentage of pipes inspected will require renewal to address structural or I/I defects.

The City has identified a backlog of over 700 pipes (approximately 31 miles of trenchless rehabilitation and over 150 pipes requiring various point repairs) that will be rehabilitated or repaired in the future, when the funding and/or staff resources are available. At the current renewal rate and funding levels, it will take the City several years to complete this backlog. This backlog estimate represents a snapshot in time of what the City has currently identified through its inspection program but does not reflect renewal needs for the entire collection system. As the City proactively inspects the collection system, additional needs will continue to be identified for the foreseeable future and a long-term, consistent funding source will be required to meet these needs. This is discussed further in this assessment in the context of Core Attribute 12, Adequate Funding.

Granite XP software is used for CCTV data collection. The City uses their own observation coding system, rather than using the more standard Pipeline Assessment and Certification Program (PACP) Coding. Although there are many advantages to using the standard PACP coding system, the end goal of any coding system is to provide the reviewer the information necessary to prioritize pipes for renewal and determine the optimum renewal method. Information includes:

- Type and severity of structural defects,
- Tap location and conditions,
- Infiltration and severity,
- Defect size and location,
- Maintenance defects (roots, grease, debris), and
- Percent blockage of the pipe.

A review of inspection records indicates the City's custom coding system meets the above requirements. As the current coding system is working effectively for the City, changing the current system at this time is not considered a high priority item. There are advantages to using the standard PACP coding system, and the City may consider transitioning at some point in the future when the timing makes sense. Note that most CCTV operators in the Midwest are trained to use the PACP coding system,

It was noted in Core Attribute 1 that management of the observation information collected by CCTV inspection crews was a gap identified during the assessment. The inspection results are not always readily available for use by engineering and operations staff for efficient analysis.

Manholes Inspection

The City completes proactive manhole inspections to identify structural issues and I/I sources. The primary internal inspection activities can be summarized as follows:

- Contracted manhole inspections in areas prone to high I/I.
- Yearly manhole inspections completed by in-house staff.
- Identification of major manhole issues observed by cleaning staff in the field.

The City has been aggressively assessing the condition of manholes through a combination of in-house and contracted inspections, and has also used their cleaning crews to document major manhole issues observed during cleaning activities. The City then completes rehabilitation and repair of defective manholes up to the available level of funding and in-house resources (funding levels will be addressed in the discussion of Core Attribute 12). These are all best practices, and another example of the City proactively assessing the condition of the collection system infrastructure.

Exterior Inspection of Assets at Risk due to Erosion

The City periodically inspects the following:

- Lines at risk to erosion that need to be checked periodically.
- Lines that need to be checked after heavy rains.
- Exposed lines that need to be checked annually.

These inspections, often called "stream crossing" inspections, are an industry best practice. Most inspection activities, such as CCTV inspection, are focused on the condition of the interior of the pipe, and do not address the effects of erosion and the forces caused by meandering stream channels and drainage ways. Regular inspection of these at risk lines to identify and mitigate these risks should be conducted. The City has an in-house program in place to assess these lines.

Recommendations

Opportunities for improvement exist in the management of CCTV inspection data, which the City is currently working to improve. Integrating the CCTV observations with the GIS system (and MMS system if the City implements one in the future) will enable the City to more efficiently

make decisions at the asset level, and better allow for data driven forecasting of short and long term renewal needs for collection system management.

Integrating observations will also aid the City in prioritizing future CCTV and system renewal efforts. Currently, the City has a significant backlog of structurally deficient and leaky pipes that require rehabilitation. As the City continues to move forward with the inspection and rehabilitation of the collection system, using the data to inform an asset management based process for prioritization of inspection and renewal activities will help ensure the City focuses their resources where they provide the most benefit.

To sustain the level of service expected by the public, a dedicated long term funding source for infrastructure renewal is needed. The City's current source of renewal funding was enacted for a 5-year period through a bond issue, by public vote in 2013. A long term, consistent source of system renewal funding to replace the current funding is needed. This is discussed further in Core Attribute 12, Adequate Funding.

2.8 Core Attribute 8 – System Hydraulic Capacity Assessment, Evaluation, and Assurance

Core Attribute 8 involves the assessment of hydraulic collection system capacity and projected design flows, identification of capacity restraints, and planning to mitigate the capacity restraints.

A combination of flow monitoring, hydraulic modeling, and field investigation/verification is typically used to complete capacity assessment activities. The package or suite of resources used depends on the site and can vary throughout a collection system. Proper application allows a utility to characterize status throughout the system, identify system bottlenecks, predict future bottlenecks, strategically plan to reduce infiltration and inflow, quantify capacity requirements, and plan design, and implement corrective or preemptive action to maintain system performance. The benefits of system hydraulic capacity assessment evaluation, and assurance include the following:

- Protect public health and the environment by minimizing sewer backups and overflows.
- Delegate resources effectively to reduce planning, engineering, and operation and maintenance costs.
- Supports sound wastewater system, land-use planning, and development practices.
- Minimizes exposure to enforcement actions and third-part litigation.
- Confirms available hydraulic capacity to accommodate future growth.
- Assists in the management of system infiltration/inflow.

The three main elements of system hydraulic capacity assessment, evaluation, and assurance are:

- Flow monitoring
- Hydraulic modeling
- Field verification

Findings

During the IMP Visioning workshops, the City determined that the highest wastewater priorities that must be considered are maintaining public health protections, meeting level of service (LOS) goals, and providing justification for dedicated funding for certain activities. The City needs to address system capacity limitations and continue to reduce I/I in order to meet the following goals:

- Address wet-weather issues, including building backups, sanitary sewer overflows (SSOs), and areas with persistent inflow and infiltration (I/I) challenges;and
- Eliminate capacity limitations in the existing treatment and collection systems.

The annual totals of wet weather SSOs and backups and the rate per 100 miles of pipe are presented in **Figure 8**, respectively.

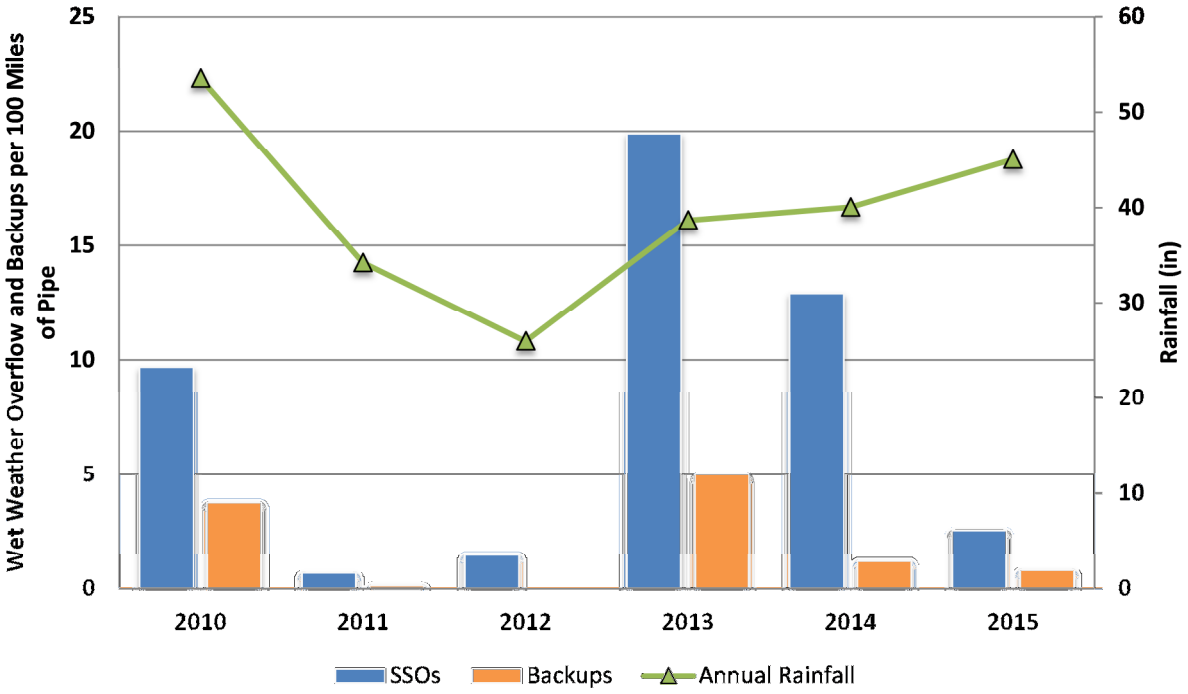

Figure 8. Total Number of Wet Weather Sanitary Sewer Overflows and Backups per 100 Miles of Pipes (2010 – 2015). Note that backup numbers are based on building backups that are reported to the City.

Addressing the performance of the collection system during major wet weather events was a primary objective identified during the IMP Visioning Workshops. Following ongoing issues with overflows and backups, the City has recently begun efforts to reduce overflows and basement backups through a combination of I/I reduction efforts and capacity improvement projects.

The City has identified the influent pump station to the wastewater treatment plant (WWTP) as a major capacity bottleneck that results in surcharging upstream through the collection system and can result in SSOs. The City completed operational improvements to the influent pump station near the end of 2014. These improvements increased pump station capacity and dramatically reduced surcharging and SSOs in the collection system upstream of the WWTP in 2015 (**Figure 8**). However, the influent pump station remains a bottleneck during major wet weather flow events. Alleviating this bottleneck should improve collection system performance and further reduce SSOs; however, additional improvements to the influent pump station would exceed the limits of the hydraulic capacity of the plant.

The City last conducted extensive flow monitoring and hydraulic modeling during development of the 2004 wastewater systems facilities planning efforts (B&V 2004). Flow monitoring and hydraulic modeling of specific areas has been completed in recent years; however, it has been primarily focused on those basins specifically targeted for I/I removal or specific capacity improvement projects. The flow monitoring data collected in 2003 is now considered to be out of date. The original hydraulic model was calibrated based off the 2003 flow monitoring results. At

this point, City staff does not believe the hydraulic model is still an accurate representation of current collection system performance.

The City has an existing hydraulic model for portions of the collection system; however, it is primarily calibrated to the outdated flow monitoring, and its extent is limited to the primary interceptors within the collection system (**Figure 9**).

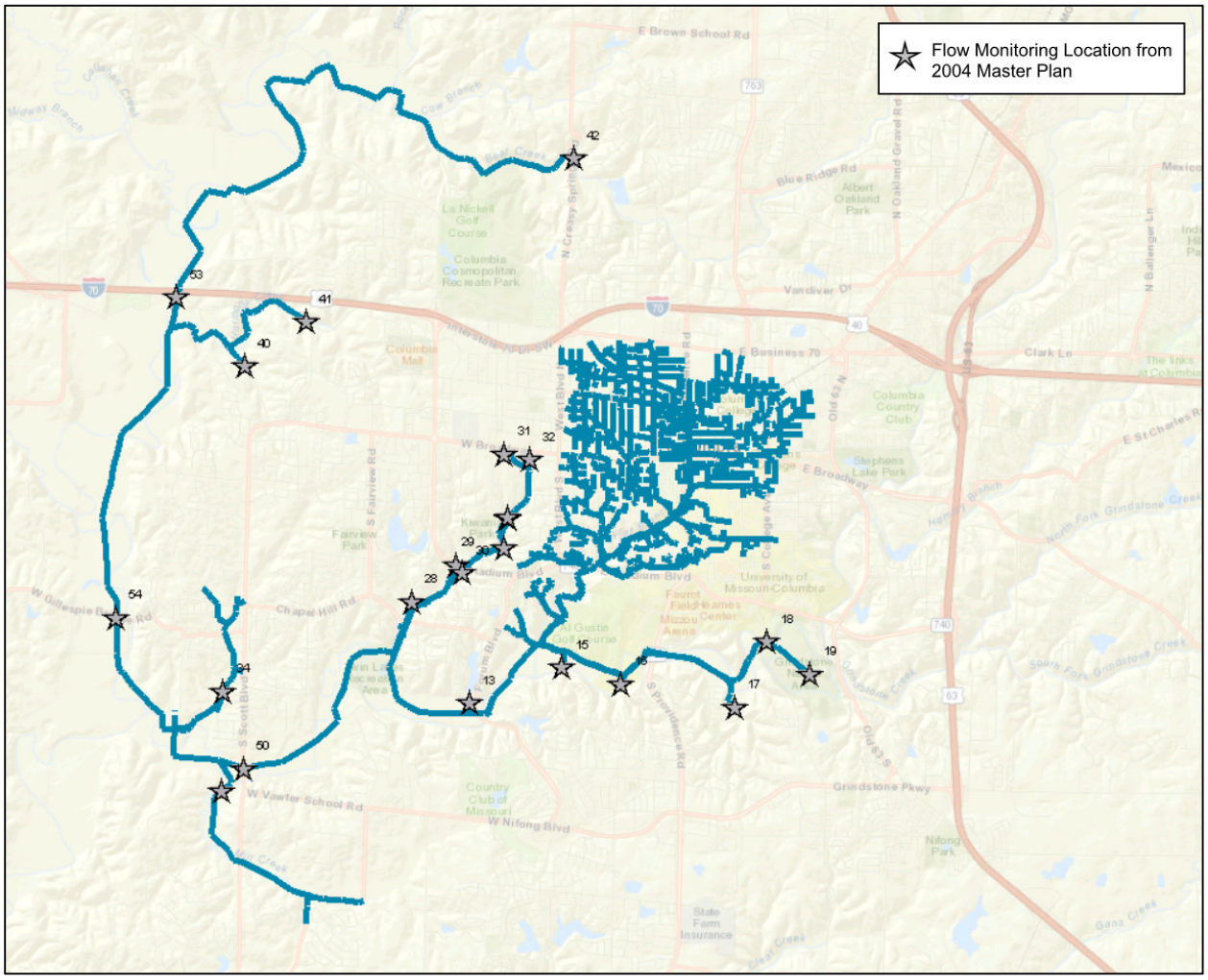

Figure 9. Extent of Existing Hydraulic Model.

Accurately identifying the current capacity constraints within the collection system is a primary concern for the City. There are capacity improvement projects identified in the 2004 wastewater systems facilities planning efforts (B&V 2004) and currently listed in the draft fiscal year (FY) 2017 capital improvements plan (CIP, Columbia 2016) that based on current conditions, may not be necessary. It is also believed that there are capacity bottlenecks within the system that are not identified 2004 wastewater systems facilities planning efforts (B&V 2004). An accurate hydraulic model, calibrated to current conditions through updated flow monitoring is necessary to identify the improvements needed and develop the plan for executing the improvements.

Note that the improvements will likely be a combination of I/I reduction and collection system capacity improvements.

Recommendations

In order to address the capacity issues present within the collection system, it is recommended that the City pursue the following activities over the next five years:

- Conduct flow monitoring to gather the data necessary to calibrate a hydraulic model of the collection system trunk lines (10-inch and larger).
- Collect survey data needed for key hydraulic model inputs.
- Develop and calibrate a hydraulic model of the collection system trunk lines using the City's current hydraulic modeling program, InfoSWMM.
- Develop simplified hydraulic modeling of small diameter lines within the collection system where the city believes capacity issues may be present (a spreadsheet model or simple hydraulic modeling program).
- Use hydraulic modeling to develop an improvements plan to identify and address capacity issues. Note that the improvements will likely be a combination of I/I reduction and collection system capacity improvements.
- Continue the City's current efforts to identify and address public sector I/I sources. Evaluate if private sector I/I reduction efforts should be expanded.
- Concurrently with these activities, evaluate alternatives to eliminate hydraulic capacity issues within the collection system, including improvements at the WWTP to alleviate the known bottleneck at the influent pump station. It is likely that peak flow storage facilities could be constructed to help alleviate this bottleneck.

2.9 Core Attribute 9 – Standard Design, Construction, & Inspection

Core Attribute 9 is a utility's best cost approach to provide reliable wastewater service through proper design, construction, and inspection procedures that meets the needs of the community and regulatory standards. Planning and design decisions are interwoven with short and long term strategies in order to bring a concept into reality. Facilities are built in the construction phases in accordance with current methods and materials. Inspection is integral to the construction phases in order to ensure facilities are properly built in accordance with plan and design. The benefits of standard design, construction, and inspection include the following:

- Supports public health and the environment through proper wastewater collection system and facilities.
- Supports the goals of the utility's management.
- Supports the ability of the utility to meet regulatory standards, and minimizes system infiltration and exfiltration.
- Maximizes the use of public money by providing the best facilities at the least cost.
- Reduces operations and maintenance costs over the service life of facilities.
- Maximizes service life of facilities.

The four main elements of standard design, construction, and inspection are planning, design, construction, and inspection. The City's current practices in these four areas are summarized below.

Findings

Planning

A systematic planning process is in place for capital improvement projects. Design flow criteria for new collection system facilities and upgrades to existing facilities are detailed in the 2004 wastewater systems facilities planning efforts (B&V 2004). The flow metering data collected during the planning efforts was used as the basis for this design flow criteria (note that the design flows produced using this criteria exceed MDNR minimum design criteria). New facilities are designed to carry peak flows for the 10-year storm event. The planning process takes into account future development as well as potential changes to land use within the service area.

Alternatives are thoroughly evaluated during the planning process. The cost-effectiveness analysis takes into account constructability, geotechnical conditions, easement acquisitions, and future conditions. Non-economic factors including environmental impacts and community disruptions are evaluated and factored into the alternatives analysis.

Design & Construction

The City has standard design criteria in place for typical collection system projects. The criteria include many industry best practices to ensure new facilities are constructed to acceptable standards. The criteria also include specific industry standard testing procedures to be followed during construction.

Capital improvements projects are typically administered through the standard Design-Bid-Build process. The bulk of construction administration activities for typical collection system projects are performed in-house. A term and supply contract is in place with a vendor for sewer rehabilitation work. This provides advantages to the City, as it saves time and money on engineering and administration time that would be required if the bidding process was followed for each rehabilitation authorization.

Inspection

All construction work is inspected. The majority of the inspection work for collection system projects is completed in-house. Additionally, the CCTV crews complete post-rehab acceptance CCTV of both in-house and contracted repair/rehabilitation work and new sewer extensions, to ensure repairs are acceptable.

Recommendations

The City's design, construction, and inspection programs are thorough and incorporate many industry best practices. The current processes have been effective for the City, and no modifications are recommended at this time.

2.10 Core Attribute 10 – Communication Outreach

The communication and outreach plan for the City will be addressed later during the integrated planning process. Therefore, Core Attribute 10 is not addressed in this assessment of collection system activities.

2.11 Core Attribute 11 – Monitoring, Measurement, and Modification

Core Attribute 11 involves the monitoring, measurement, and modification of collection system programs. Collection system managers should routinely track and evaluate system and program performance, and make necessary modifications and adjustments based on these results. These Key Performance Indicators (KPIs) are used to evaluate the utility's success in meeting strategic goals, quantify the benefits of continuous improvement initiatives, and measure performance in managing gravity sewer infrastructure.

The benefits of these practices include the following:

- Optimizes use of utility resources.
- Realizes performance gains with reasonable effort.
- Allows staff to report progress of system performance.
- Provides validation when an assessment plan is successful.
- Builds support and trust between staff and stakeholders.

The two main elements evaluated for the attribute are:

- Monitoring, measurement and modifications
- Performance measures – i.e. KPI's

Findings

Keeping the goals and objectives of the assessment plan current with community priorities and regulatory standards is essential. The City does not currently have a formal KPI plan. However, the City regularly tracks several important KPIs, including the following:

- Wet weather backups and SSOs (note: goals for this KPI are often tracked relative to the City's collection system design storm event criteria, e.g. no SSOs per year unless greater than a 10-year storm event occurs)
- Dry weather backups and SSOs
- Total service requests, and responsibility (public or private)
- Cleaning mileage (jetted and root-sawed)
- CCTV inspection mileage
- Customer service response time
- Monitoring effectiveness of I/I reduction efforts, where appropriate
- Sewer rehabilitation and repair
    - Trenchless (CIPP)
    - Replacement footage
    - Manhole repairs
    - Lateral connection repairs

When identifying key performance indicators to track, a particular emphasis should be placed on developing "actionable" KPIs that support the City in making business decisions, allocating

resources, and identifying potential challenges that if unmitigated could negatively impact performance and service levels. It is typically most effective for a utility to track a relatively small number of actionable KPIs with meaningful goals that support decision making, rather than tracking a larger number of statistical KPIs that do not inform management decisions.

The City has made significant progress towards developing an actionable KPI plan, and is already collecting the key data needed to monitor collection system program progress. However, the City has not yet developed the goals needed to fully use this information and translate it to actionable KPIs that drive decisions. System performance goals should be developed and aligned with industry standards for effective collection system management. Maintenance and inspection productivity goals should be data-based and align with the practices needed to optimize maintenance activities. For example, system cleaning goals should be determined based off the cleaning mileage necessary to effectively clean the collection system (i.e. focusing cleaning activities on cleaning pipes at the right time), which may include cleaning older, VCP pipes that are prone to roots on a more frequent basis than newer PVC pipes that present less risk of backup due to blockages.

Recommendations

The City tracks several important KPIs that form a foundation for developing an actionable KPI plan that will support continuous improvement. It is recommended that the City take the next step and update the collection system goals to ensure they are in line with the City's short and long term collection system management goals. Achieving these goals should be measured through actionable KPI's that support the City in making business decisions, allocating resources, and identifying potential challenges that if unmitigated could negatively impact performance and service levels. Alternatives for these goals will be further analyzed and reviewed as part of the Alternatives Analysis.

2.12 Core Attribute 12 – Adequate Funding

Core Attribute 12 is focused on ensuring that adequate funding exists to provide the consistent revenue stream needed to support the effective management of the collection system. The benefits of a sustainable revenue stream and adequate funding include the following:

- Ensures adequate funding is available to provide the utility the necessary resources to achieve level of service goals.
- Increases system performance and achieves positive results.

The five main elements of adequate funding are rate structure characteristics, revenue requirements, cost of service, rate structure, and additional funding sources. The City recently conducted cost of service studies for the wastewater and stormwater utilities to set rates and a structure to adequately fund current programs. The IMP is being developed to help determine long term utility funding needs and establish the right prioritization of funds between the collection system, treatment facilities, and stormwater infrastructure. Therefore, the overall utility rate structure and revenue requirements were not evaluated specifically in the context of the collection system program needs. However, over the course of the assessment, potential future funding gaps have been identified that could negatively impact the City's ability to effectively manage the collection system.

Findings

The City owns and operates approximately 700 miles of gravity sewer lines. The replacement costs for these pipes and manholes were estimated to be approximately $700 Million. This high level estimate was based on the system inventory in the City's GIS and typical replacement costs from the Midwestern region.

The City's current source of renewal funding was enacted through a publicly-approved bond issue. The bond issue established funding for a five year period. This funding is primarily focused on rehabilitation of public infrastructure in areas that experience high I/I. This annual budget of $2.7 Million is available through 2019, at which point a new funding source will need to be secured.

It was noted in Core Attribute 7 that the City has already identified a backlog of over 700 pipes that will require trenchless rehabilitation or other repairs to address I/I or structural deficiencies. At the current funding level, this represents an existing backlog of more than three years of system renewal work on pipes alone (this figure does not included manholes or forcemains). This backlog estimate represents a snapshot in time of what the City has currently identified through its inspection program. However, this backlog does not reflect renewal needs for the entire collection system. As the City proactively inspects the collection system, additional needs will continue to be identified for the foreseeable future and a long-term, consistent funding source will be required to meet these needs.

If not addressed, as this infrastructure continues to age and deteriorate, failure rates could increase resulting in overflows and building backups. Expensive emergency repairs that are disruptive to the community could also increase. To sustain the level of service expected by the public, a consistent long term funding source for infrastructure renewal is needed.

Recommendations

To sustain the level of service expected by the public, a consistent long term funding source for infrastructure renewal is needed. As the City continues to work towards implementing an asset management approach to support system renewal and maintenance efforts, the magnitude of these needs will be defined more clearly. Implementing a mechanism to establish sufficient dedicated funding for the City's future needs is one of the primary goals. Alternatives to achieve these goals will be further analyzed and reviewed as part of the Alternatives Analysis.

There are capacity improvement projects included in the future Capital Improvements Plan CIP, identified through the 2004 Wastewater Facilities Planning Report that staff believe may not be necessary. As detailed in Core Attribute 8, it is recommended that the City develop an updated hydraulic model, in order to increase the level of confidence in the capital improvement projects and I/I reduction efforts needed to address SSOs and building backups within the collection system.

Section 3 - Summary of Recommendations

This section presents a summary of the recommendations detailed in Section 2. Refer to Section 2 for a detailed description of each attribute, the assessment findings, and recommendations.

Core Attribute 1 – System Inventory & Information Management: The City should continue their efforts to integrate the system inventory and work order information management system. Opportunities for improvement exist in the management of CCTV inspection data. Integrating the CCTV observations with the information management system will make the inspection observation database readily available for use by engineering and operations staff.

Core Attribute 2 – Maintenance Management System: Although an integrated MMS would offer advantages to the City, it is not necessary for effective collection system management, and the need for a MMS varies based on the size of the utility and the state of existing processes. An integrated MMS is not a high priority item at this time, and overall the City is currently managing their collection system maintenance, repair, and inspection activities effectively without an MMS.

Core Attribute 3 – Safety and Training: The City has a detailed safety and training program, and has received the Collection System safety award from the State Water and Environment Association nine times in the past two decades. The City should continue these efforts, and regularly evaluate their resources and training needed to continue their strong track record in safety.

Core Attribute 4 – Overflow Emergency Response Plan: The City's Overflow Emergency Response Plan appears to encompass the key elements of an effective plan, and has been successfully implemented. There are no recommended changes at this time.

Core Attribute 5 – Collection System Maintenance: The cleaning program has continually improved collection system performance since its implementation in the 1960's. The success of a cleaning program is primarily measured through the number of dry weather overflows and backups. These results are in line with industry standards for an effective maintenance program. The City's productivity rates per crew have also been strong, and the City has historically been able to meet their preventive maintenance goals and clean lines approximately every four years. However, the City is facing challenges that are anticipated to make it harder to continue to meet proactive maintenance goals and provide the LOS the City hopes to achieve.

In order to meet current and future challenges, optimize the use of resources, and to continue the City's trend of improved customer service, it is recommended the City build on the past successes and move towards implementing an asset management approach for scheduling and executing cleaning of the system. The program would focus on cleaning the right pipes at the right time (i.e. cleaning dirty pipes more often while cleaning clean pipes less often) in order to most effectively use the City's resources.

Core Attribute 6 – Source Control: In the past, the City's collection system experienced many issues with grease blockages. To address this issue, the City implemented a dedicated Fats, Oils, and Grease (FOG) program approximately 15 years ago to address grease blockages within the collection system. The FOG program has helped considerably reduce the quantity and extent of these blockages. No changes are recommended to the FOG program at this time.

It is recommended that the City use engineering best practices to protect collection system facilities from corrosion, and provide odor control on a case by case basis, as warranted.

Core Attribute 7 – Structural Condition Assessment and Evaluation: Opportunities for improvement exist in the management of CCTV inspection data. Integrating the CCTV observations with the information management system will enable the City to more efficiently make decisions at the asset level, and better allow for data driven forecasting of short and long term renewal needs for collection system management. This will also aid the City in prioritizing future CCTV and system renewal efforts. Currently, the City has a significant backlog of structurally deficient and leaky pipes that require rehabilitation. As the City continues to move forward with the inspection and rehabilitation of the collection system, using the data to inform an asset management based process for prioritization of inspection and renewal activities will help ensure the City focuses their resources where they provide the most benefit.

This current system renewal rate equates to approximately 0.8% of the system renewed on an annual basis. The City has identified a backlog of over 700 pipes that will be rehabilitated or repaired in the future, when the funding and/or staff resources are available. At the current renewal rate and funding levels, it will take the City several years to complete this backlog. As the City proactively inspects the collection system, additional needs will continue to be identified for the foreseeable future. The City's current source of renewal funding was enacted for a 5-year period through a bond issue. A long term, consistent source of system renewal funding to replace the current funding source is needed.

Core Attribute 8 – System Hydraulic Capacity Assessment, Evaluation, and Assurance: The City needs to address system capacity limitations and continue to reduce I/I in order to meet the goals identified in the IMP Visioning workshops. In order to meet these goals, it is recommended that the City pursue the following activities over the next five years:

- Conduct flow monitoring to gather the data necessary to calibrate a hydraulic model of the collection system trunk lines (10-inch and larger).
- Collect survey data needed for hydraulic modeling.
- Develop and calibrate a hydraulic model of the collection system trunk lines using InfoSWMM or another high quality hydraulic modeling program.
- Develop simplified hydraulic modeling of small diameter lines within the collection system where the city believes capacity issues may be present (a spreadsheet model or simple hydraulic modeling program).
- Use hydraulic modeling to develop an improvements plan to address the capacity issues. Note that the improvements will likely be a combination of I/I reduction and collection system capacity improvements.

- Concurrently with these activities, evaluate alternatives to eliminate hydraulic capacity issues within the collection system, including improvements at the WWTP to alleviate the known bottleneck at the influent pump station. It is likely that peak flow storage facilities could be constructed to help alleviate this bottleneck.

Core Attribute 9 – Standard Design, Construction, and Inspection: The City's design, construction, and inspection programs are thorough and incorporate many industry best practices. The current processes have been effective for the City, and no modifications are recommended at this time.

Core Attribute 11 – Monitoring, Measurement, and Modification: The City tracks several important Key Performance Indicators (KPIs) that form a foundation for developing a KPI plan that will support continuous improvement. It is recommended that the City take the next step and update the collection system goals to ensure they are in line with the City's short and long term collection system management goals. Achieving these goals should be measured through actionable KPI's that support the City in making business decisions, allocating resources, and identifying potential challenges that if unmitigated could negatively impact performance and service levels. Alternatives for these goals will be further analyzed and reviewed as part of the Alternatives Analysis.

Core Attribute 12 – Adequate Funding: The City's current source of renewal funding was enacted through a publicly-approved bond issue. The bond issue established funding for a five year period. This funding is primarily focused on rehabilitation of public infrastructure in areas that experience high I/I. This annual budget of $2.7 Million is available through 2019, at which point a new funding source will need to be secured.

The City has already identified a backlog of over 700 pipes that will require trenchless rehabilitation or other repairs to address I/I or structural deficiencies. At the current funding level, this represents an existing backlog of more than three years of system renewal work on pipes alone (this figure does not included manholes or forcemains). This backlog estimate represents a snapshot in time of what the City has currently identified through its inspection program. However, this backlog does not reflect renewal needs for the entire collection system. As the City proactively inspects the collection system, additional needs will continue to be identified for the foreseeable future and a long-term, consistent funding source will be required to meet these needs. To sustain the level of service expected by the public, a consistent long term funding source for infrastructure renewal is needed.

There are capacity improvement projects included in the future Capital Improvements Plan CIP, identified through the 2004 Wastewater Facilities Planning Report that staff believe may not be necessary. As detailed above, it is recommended that the City develop an updated hydraulic model, in order to increase the level of confidence in the capital improvement projects and I/I reduction efforts needed to address SSOs and building backups within the collection system.

Section 4 - References

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Technical Memorandum 2

Attachments

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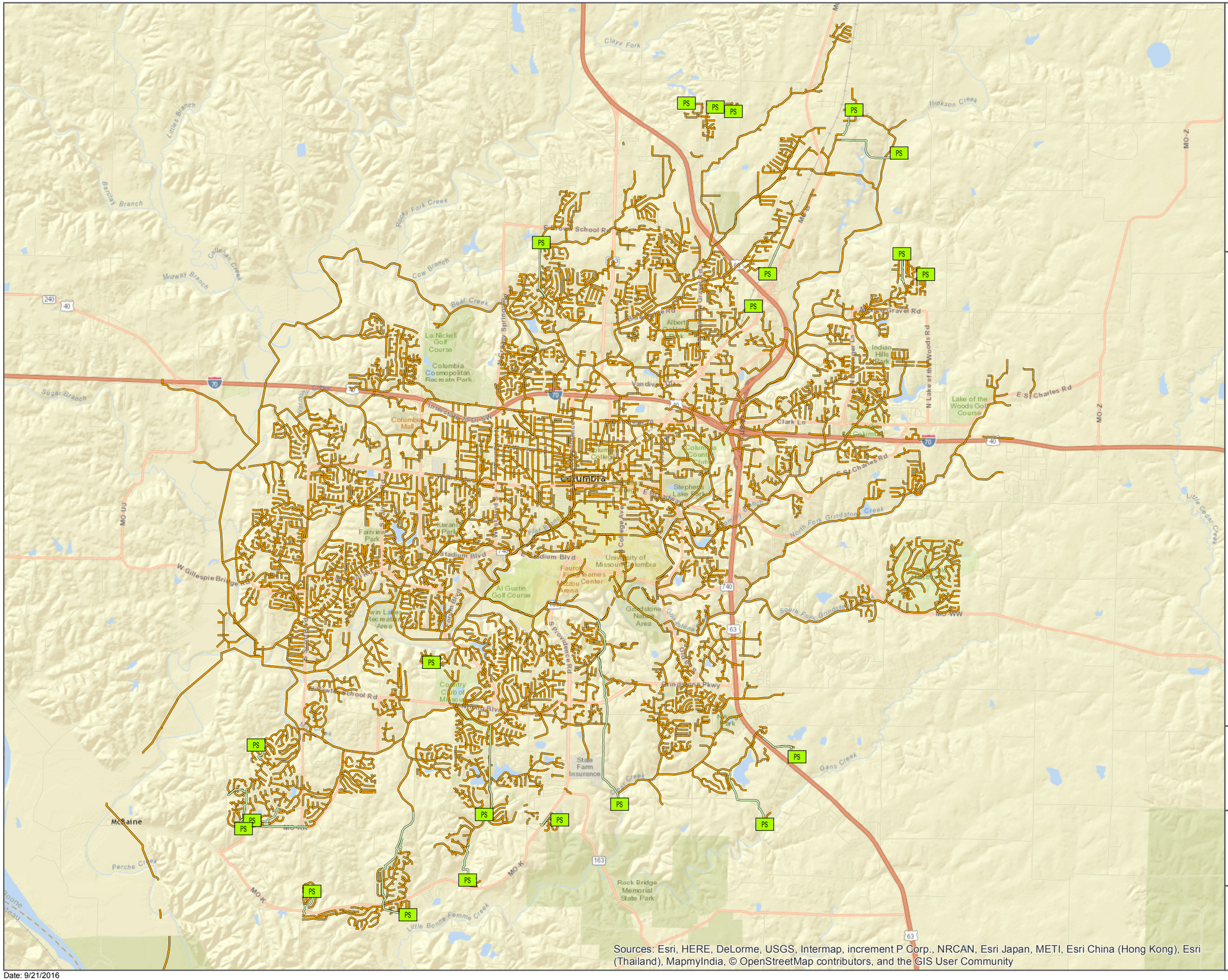

Legend

- PS — City Pump Stations
- City Forcemain
- City Gravity Sewer Lines

ATTACHMENT A

WASTEWATER COLLECTION SYSTEM

CITY OF COLUMBIA, MISSOURI

WASTEWATER & STORMWATER INTEGRATED MANAGEMENT PLAN

N

0 1.25

MILES

Our Columbia Waters Integrated Management Plan Wastewater & Stormwater

HDR

Date: 9/21/2016

Legend

Pipe Without Age Data

DECADE

Pre-1960

1960-1969

1970-1979

1980-1989

1990-1999

2000-2009

2010-Present

ATTACHMENT B
PIPE AGE BY DECADE

CITY OF COLUMBIA, MISSOURI

WASTEWATER & STORMWATER
INTEGRATED MANAGEMENT PLAN

N

0 1.25

MILES

Our Columbia Waters
Integrated Management Plan
Wastewater & Stormwater

HDR

Date: 9/21/2016