7 COLLECTION SYSTEM SUSTAINABILITY

7.1 COLLECTION SYSTEM IMPROVEMENTS

7.1.1 Estimated Reinvestment for Replacement of Aging Sewers

The City is responsible for maintaining its sanitary sewer system. Aging and deteriorating infrastructure is a challenge facing utilities throughout the United States; a plan for adequate system reinvestment and renewal is crucial for sustainability of the collection system. The intent of this section of the Master Plan is to provide the City with an initial budget estimate for renewal and replacement of the City’s collection system.

How long pipes last depend on many factors including pipe material, soil conditions, outside forces such as construction, and other environmental factors. The concept of useful life can be used to estimate needed annual infrastructure renewal budget requirements. The useful life of a pipe system can be expressed as a survival function where the probability of survival decreases over time. In other words, as pipe systems age, more and more of the system will require repair and/or replacement. Different survival functions can be used to estimate the survival of a particular group or class of pipe. Survival functions were defined for groups of pipe based on literature values and known pipe condition data collected in the City’s system. These survival functions used in concert with replacement costs were used to estimate annual reinvestment needs.

Pipeline reinvestment planning requires knowledge of the system inventory and condition. From this information, projections can be made for identified and unidentified reinvestment needs to maintain the system in good operating condition prior to failure. Specific tasks for pipeline planning include:

- Characterization of the system inventory.
- Collection and analysis of condition data.
- Definition of acceptable service level.
- Definition of pipe survival functions.
- Definition, costing, and prioritization of identified projects and unidentified projects.

Pipe Survival Functions

Pipes have a life-cycle with a beginning and an end. The beginning can be considered as the day the pipe is installed. Pipe degradation from this new condition to the end of its useful life can be estimated based on historical system information and information from ongoing research using survival functions. The life cycle analysis considers the structural life cycle only and does not consider functional obsolescence, which may come about due to increased hydraulic capacity needs due to growth. Aging and cohort survival models have been used to evaluate the probability of survival of infrastructure. The form of the survival function used for this analysis is known as a Herz survival function and is shown in Figure 7-1.
Figure 7-1 Survival Function of Pipes

Where:

\[ 1 - F(t \leq c) = 1 \]

\[ 1 - F(t > c) = \frac{(a+1)}{(a + \exp [b(t-c)])} \]

\[ 1 - F(t = \text{infinity}) = 0 \]

with \(a\), \(b\), and \(c\) being aging parameters and \(t\) being time in years.

The aging parameters define the shape of the survival function as follows:

- \(a\) is the aging factor and determines how slowly the aging process begins
- \(b\) is the aging factor and determines how quickly the aging process progresses
- \(c\) is the resistance time (or elapsed time from construction to first failure) up to which no reinvestment is needed.

For the example shown in Figure 7-1, \(a\) equals 10, \(b\) equals 0.06, and \(c\) equals 10.

The Herz survival curves are generally classified by the average or median age of failure that corresponds to the 50 percent survival level. In Figure 7-1, the median survival age is 50 years. There is an uncertainty in reported pipe life durations, however. The appropriateness of survival functions used for an analysis can be evaluated if a long and continuous record of pipe performance is maintained. In lieu of this detailed information, estimated survival functions may be used, which is the case for this analysis.

For purposes of the pipeline replacement and renewal analysis, three groups of pipes were defined as shown in Table 7-1. The groups were based on a qualitative assessment of pipes by basin based on
experience of City personnel. Group 1 includes pipes with the lowest rate of deterioration, and represents pipes that are in generally good condition with minimal cracks and breaks. Group 2 includes pipes with medium rates of deterioration and represents pipes that show some cracks and pipe deformations. Group 3 includes pipes with highest rates of deterioration and represents pipes that generally show multiple cracks and pipe deformations.

<table>
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<th>Group</th>
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There are no standards for associating pipe condition with corresponding life expectancy. By defining three groups, improved resolution relative to the overall system pipe life expectancy can be achieved. More or less groups can be defined based on judgment and available data; however, it is recommended at this time that three groups be used until additional data justifies a change.

Survival functions were based on literature values and a review of existing data. Estimates of mean pipe life reported in the literature have a wide variance but are generally expressed as a percent of pipe which “survives” up to a specified age. For this project, three life expectancy curves were selected that represent low, medium and high life expectancies. The three estimated life expectancy survival functions selected were defined as assigned to the three groups as follows:

- Group 1 is the lowest deterioration rate and is based on 50 percent of the pipe requiring replacement in 100 years
- Group 2 is the medium deterioration rate and is based on 50 percent of the pipe requiring replacement in 75 years
- Group 3 is the highest deterioration rate and is based on 50 percent of the pipe requiring replacement in 50 years

To estimate reinvestment needs, a uniform unit cost for replacement was used. Since the vast majority of the system is 8-inch diameter pipe, the construction cost of $125 per linear foot for replacement of pipe was used. Based on the survival functions and the average replacement construction cost, an estimated annual reinvestment need of about $2.75 million is determined in Table 7-2.
### Table 7-2
Estimated Annual Reinvestment Need

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<th>Pipe Group</th>
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Note: Total project cost includes a 40-percent factor for engineering, contingency, and legal.

The estimated reinvestment cost presented in Table 7-2 provides guidance for budgeting for reinvestment needs. Since removal of extraneous flows such as infiltration and inflow (I/I) is also a major need for the City’s collection system, and removal of I/I in the public sector is a reinvestment that may involve replacement of some aging and deteriorated infrastructure, it is important that the plan consider both reinvestment due to condition of the system and cost for removal of I/I. The costs for I/I removal are analyzed in the following section which is then followed by development of a plan for overall system rehabilitation considering both aging infrastructure and I/I removal.

#### 7.1.2 I/I Removal

Cost-effective removal of I/I is an important element of any collection system improvement program in areas that experience high groundwater and wet weather conditions. The City has conducted field inspection activities in the West Prairie Lee and South Prairie Lee basins including manhole inspections, line lamping, smoke testing, dyed water testing, and closed circuit television (CCTV) inspections which were summarized in previous reports by George Butler Associates (GBA).

In West Prairie Lee Basin 8, the GBA report projected that 71.8 percent of the inflow is originating from the private sector, 10 percent from the public sector, and the remaining inflow from unknown sources.

In the West Prairie Lee Basins 9 and 10, the GBA report projected that 62.4 percent of the inflow was from the private sector, 10 percent from the public sector, with the remaining inflow from unknown sources.

In the South Prairie Lee Basins 3 and 8, 99.1 percent of the inflow was unaccounted for.

An analysis was performed by Archer Engineers/CH2M Hill of each of the 69 basins for which flow data is available to identify areas that potentially should be considered for rehabilitation to remove I/I. The qualitative condition rating described in Section 7.1.1 and the inflow rate were used to prioritize basins. The resulting plot showing the cumulative inflow by cumulative area is shown in Figure 7-2.
The data show that inflow is not uniformly distributed throughout the system and much of the inflow can be accounted for by a smaller proportion of area. The “knee” of the curve in Figure 7-2 shows that 70 percent of the inflow is derived from about 30 percent of the area. By focusing rehabilitation within the 30 percent high inflow areas, overall costs will be reduced and benefits maximized. The basins representing the high I/I areas are shown in Figure 7-3. If 100 percent of the I/I could be completely removed in these basins, system-wide removals would be about 70 percent. Removal of 100 percent however, is not possible and should not be planned on.

A total of 21 basins with 516,253 feet of pipe (31 percent of the monitored system and 20 percent of total current system), comprise the high I/I areas. These areas are shown in Figure 7-3. Based on $2.50/ft for sewer system evaluation surveys (SSES) plus 25% contingency in these areas, a total condition assessment cost of $1.6 million is estimated. Rehabilitation of these basins, including private sector rehabilitation, was estimated using an overall construction cost factor of $30 per linear foot of total sewer in the basin, with a 40-percent factor for design and contingency. Estimated rehabilitation capital cost for these areas is $21.7 million. Total I/I rehabilitation, including SSES work, is estimated at $23.3 million.

Cost-effective I/I removal requires that the cost for finding and fixing the system is less than the cost to transport and treat I/I flows. Hydraulic analyses were performed using the system computer model. The estimated additional conveyance capital cost to convey I/I without any removal is estimated to be $31.3 million. In addition to conveyance cost, additional storage, pumping and treatment capital costs of approximately $10.4 million would result. The total additional capital cost for conveying, storing, pumping and treating I/I without removal would be in the range of $41.7 million. Since the I/I removal costs are less than the costs to transport and treat the I/I flows, rehabilitation is recommended.
7.1.3 System Rehabilitation

Based on the I/I analysis, it is estimated that 30 percent of the inflow (43.6 percent in priority basins) can be effectively removed from the monitored system. Field investigations and system rehabilitation in both the public and private sectors for the basins shown in Figure 7-3 will be a cost-effective improvement to the system. In addition to the field investigations recommended to remove I/I, the City will identify other repairs necessary in other parts of the system through routine maintenance and unplanned improvements that can occur due to system failures. For budgeting purposes, it is recommended that the total estimated annual reinvestment of $2.8 million be targeted for both I/I removal and for other rehabilitation that is needed for replacement of aging infrastructure. The I/I program, if conducted over a 9-year period, will require an annual cost of $2.6 million leaving a balance for additional rehabilitation and replacement of $0.2 million. Planning level costs for sewer system evaluation surveys, design, and rehabilitation through 2015 are presented in Tables 7.3, 7.4, and 7.5.

7.1.4 Recommendations

Based on the reinvestment and I/I analysis, the following recommendations are made:

1. Review current condition assessment procedures and develop an approach to incorporate findings into the overall reinvestment needs.
2. Incorporate I/I removal into the overall system plan.
3. Investigate sources of I/I in the high priority basins and in newer areas.
4. Investigate private sector I/I and the potential impact of removal in existing areas and control in planned areas, (see section 7.3.2).
5. Set year 2015 plan in place to address I/I.
6. Maintain total annual budget of $2.8 million for I/I removal and replacement of aging infrastructure and review on an annual basis.
## Table 7-3

Sewer System Evaluation Survey – Projected Costs

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**NOTE:** Costs include condition assessment and rehabilitation costs in both the private and public sectors of the system.
### Table 7-4
Rehabilitation Plan – Projected Costs

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**NOTE:** Costs include condition assessment and rehabilitation costs in both the private and public sectors of the system.
Table 7-5
SSES and Rehabilitation – Estimated Costs

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NOTE: Costs include condition assessment and rehabilitation costs in both the private and public sectors of the system.
7.2 **CMOM - Capacity, Management, Operation and Maintenance**

The Environmental Protection Agency (EPA) Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Program at Sanitary Sewer Collection Systems describes a well run collection system as one that practices the following:

- Operation and Maintenance (O&M) considerations during design and construction
- Knowing what comprises the system (inventory and physical attributes)
- Knowing where the system is (maps and locations)
- Knowing the condition of the system (assessment)
- Planning and scheduling work based on condition and performance
- Effective maintenance activities
- Repairing, replacing, and rehabilitating system components based on condition and performance
- Managing timely, relevant information to establish and prioritize appropriate CMOM activities
- Training of personnel

Each CMOM program is individually tailored to the municipality that is operating the collection system, however, the practices listed above are included in the key elements of the CMOM program: Capacity Evaluation, Management, Operation and Maintenance of the collection system. Current City practices comply with EPA expectations.

7.2.1 **Capacity Assurance**

Capacity assurance refers to the ability of the sewer system to safely convey system design flows. The capacity of the system should be evaluated periodically to ensure that capacity is adequate considering changes in population and system deterioration, which can increase levels of I/I.

The basic information for capacity assessment is listed below:

- Existing and future population served
- Inventory of collection system
- Flow data and response of flow to rainfall and groundwater for systems with infiltration and inflow

SSO locations, basement backups, surcharged pipes or other capacity restrictions should be identified. The capacity evaluation should include peak (design) flow estimation and an estimate of the capacity of system components. The evaluation is best performed through the use of a hydraulic model to identify areas with hydraulic limitations. Improvements necessary to provide adequate capacity should be identified and implemented prior to the actual need of the improvements.

**MODELING**

The purpose of hydraulic modeling of the collection system is to determine the capacity requirements of the system with respect to sewer design and structural conditions.

7.2.2 **Management**

The proper management of the collection system enables the municipality to put the appropriate programs in place for the operation and maintenance of the system. The goals of the management program should include:

- Protection of public health and prevention of unnecessary property damage
• Minimization of infiltration, inflow and exfiltration, and maximum conveyance of wastewater to the wastewater treatment plant (WWTP).
• Provision of prompt response to service interruptions
• Efficient use of allocated funds
• Identification of and remedy solutions to design, construction and operational deficiencies
• Performance of all activities in a safe manner to avoid injuries

Organizational Structure
A well-developed CMOM Management program will include an effective organizational structure. This structure should include job descriptions for each position. The personnel in these positions should meet the position requirements. There should be a low turnover rate, and the current staffing levels should be adequate to ensure proper emergency response times. If work is contracted out, the contract should include the appropriate provisions for response times.

Operation and maintenance personnel should report to the same supervisor or director. This person should have overall responsibility for the collection system.

Budgeting
The budget is one of the most important variables in the operation of a utility. A key component of a good budget is the ability to track costs through the budget cycle so that the annual budget will reflect the actual needs of the organization.

The budget should be divided into the operating budget and the capital budget. Operating budget items are preventive and corrective maintenance and major collection system repairs. The capital budget will include projects with 1-5 year cycles for completion.

Training
The staff should be well trained, especially to include environmental awareness, specific equipment, policies and procedures and conducting maintenance activities. The effectiveness of this training should be demonstrated routinely through periodic testing, drills, demonstrations, or informal training, and the training should be improved routinely based upon this assessment.

Internal Communication
The form of communication in the municipality should be open, meaning top-down, bottom-up and laterally among the staff. Staff should receive information in timely manner, and procedures should be in place to facilitate this communication.

Customer Service
Another form of communication is customer service. The municipality should have a robust system in place to respond to customer complaints. This is the most visible segment of any sewer operation. The personnel taking the calls should be trained in what to expect from the customers and how to respond and direct the field crews on how to evaluate and resolve the complaint. Collection system field crews influence the public’s opinion and confidence in the City.

Management Information Systems
The management information system directly impacts the City’s ability to effectively manage its collection system. Access to the most current information is an effort that involves all members of the collection system staff.

SSO Notification Program
The City should maintain a written procedure for the notification of SSOs. This includes the entities that should be notified in the event of an SSO, such as drinking water suppliers, the public, health departments and the regulatory agency.
LEGAL AUTHORITY
The proper management of the utility should also include the selecting and enforcing of the legal authority necessary to regulate the flow into the collection system from its customers and unauthorized sources, such as I/I.

The City should prohibit materials that will cause harm to the collection system and treatment works through a robust pretreatment program. In addition, control over the connection of private laterals to the main sewer should be exercised to control I/I sources.

7.2.3 Operation and Maintenance
FLOW MONITORING
Flow and rainfall monitoring is important to establish system flows and system response to wet weather conditions. The monitoring program may include two types of monitoring;

- Permanent – these should be at key points in the system
- Temporary – these should be used for project level evaluations

Flow monitoring data should be processed to identify three components as follows:

- Base (wastewater production) flow
- Infiltration
- Inflow

SEWER SYSTEM INSPECTION AND TESTING
Smoke, dye, manhole, visual pipe, CCTV and building testing are techniques that are used to evaluate system condition and to identify I/I in the collection system.

SMOKE TESTING
Smoke testing consists of blowing smoke into the manholes and recording where the smoke leaves the sewer system. Smoke should come out of house vents and sanitary manholes. Smoke should not come out of downspouts, driveway drains, storm catch basins, area drains or the ground above the sanitary or storm lateral. The results of the smoke testing should be documented.

DYE TESTING
The appurtenances that smoked during the smoke test such as the downspouts, catch basins, driveway drains and area drains should all be verified with a dyed water test. This will show how the storm water is actually entering into the sanitary system.

MANHOLE INSPECTIONS
Manhole inspections should be undertaken on a regular basis. Manhole inspections include observing surface conditions around the manhole and the top and bottom condition of the manhole.

VISUAL PIPE INSPECTIONS
Visual pipe inspections can be conducted during internal manhole inspections. Visual pipe inspections involve looking down each pipe entering a manhole and observing the condition of observable pipe sections. Typically, about 20 – 30 feet of pipe can be observed which provide a good indication of the general condition of the pipe segment and provide justification for more intensive CCTV inspection.

CCTV INSPECTIONS
CCTV inspections (closed circuit television inspections) are performed by a remote television camera that provides a view of the entire pipe circumference above the water line and service lateral connections. Some CCTV cameras have a lens that can be controlled to provide a lateral view of the pipe and into the service lines. Pipe conditions are recorded by footage.
BUILDING INSPECTIONS
Building inspections are performed to locate illegal I/I connections from buildings. These illicit connections can include area drains, storm sump pumps, uncapped cleanouts, and foundation drains.

SEWER SYSTEM REHABILITATION
A rehabilitation program should be implemented. This program should be built using the evaluated pipe and manhole data.

SAMPLING AND MONITORING
The sampling and monitoring program in a collection system should encompass the industrial users, SSOs, and permit monitoring such as that required to comply with an NPDES permit, a 308 letter, administrative order, or a consent decree.

The sampling and monitoring program should include written procedures that should specify:

- Sampling location(s)
- Sample volumes, preservatives, and holding times
- Instructions for operating monitoring equipment
- Sampling frequency
- Sampling and analytical methodologies
- Laboratory Quality Assurance/Quality Control (QA/QC)

H2S CONTROL
Hydrogen sulfide (H2S) control is a not-so-subtle indicator of a poorly maintained and operated system. H2S generation is the result of sewers with low velocities and/or long detention times, sewers subject to solids deposition, pump stations, turbulent areas such as drop manholes or force main discharges, or inverted siphon discharges.

The methods for prevention and control of H2S include proper design, use of chemicals to reduce the dissolved sulfide levels in the waste stream, sewer cleaning to remove deposited solids, installation and proper operation and maintenance of air relief valves in force mains.

The key is to understand the collection system so that vulnerable points can be inspected and the corrosion recognized and addressed quickly.

SAFETY
Safety program should be in place for the following areas:

- Confined spaces
- Chemical handling
- Trenching and excavations
- Material Safety Data Sheets
- Biological hazards in wastewater
- Traffic control and work site safety
- Lockout/Tag out
- Electrical and mechanical safety
- Pneumatic or hydraulic systems safety

The utility should have written procedures in place to handle the above issues, the staff should be trained, and procedures should be in place to enforce the programs.
**Emergency Preparedness and Response**

Procedures should be in place to handle both routine and catastrophic emergencies. Routine emergencies are manholes overflowing or sewers collapsing. A catastrophic emergency would be a tornado, flood, earthquake, widespread chemical spill or electrical outage. Staff should be trained on these procedures, and the procedures reviewed and updated at periodic intervals.

**Mapping**

This aspect of maintaining and operating a collection system is one of the most important. Accurate and up to date maps are essential elements of the tool box. The maps should include the following:

- Main, trunk and interceptor sewers
- Building/house laterals
- Manholes
- Cleanouts
- Force mains
- Pump stations
- Service area boundaries
- Other landmarks (roads, water bodies, etc.)

An important issue here is that each manhole, cleanout, or junction must have a unique identifier.

**New Construction**

The utility should maintain strict control over new flows that come into the collection system. Newly constructed sewers and pump stations should be easy to maintain and operate.

**Pump Stations**

Pump station operation and maintenance requires special electrical, hydraulic and mechanical expertise. The procedures for operating and maintaining pump stations should be in writing.

**Planned and Unplanned Maintenance**

The goal of a good maintenance program is to:

- Prevent overflows and backups
- Maximum service and reliability of the collection system
- Collection system sustainability

Detailed maintenance procedures should be in place. These procedures should include the maintenance and repair approach for the various systems and facilities.

The types of maintenance include planned and unplanned. Planned maintenance can be predictive or preventive. Predictive maintenance looks for signs of failure and makes timely repairs so that emergency maintenance is not needed. Preventive maintenance schedules the repairs on a regular basis.

Unplanned maintenance consists of two types, corrective and emergency. Corrective maintenance consists of scheduled repairs to problems found under planned or predictive maintenance. Emergency maintenance repairs are those that are necessary due to a serious failure where immediate action is necessary. The goal is to reduce corrective and emergency maintenance through planned and predictive maintenance.

**Maintenance Budgeting**

The maintenance budget is a large part of the operating budget. All maintenance costs, both internal and external, should be tracked throughout the year so that these costs can be adequately budgeted.
The goal for the maintenance budget is to adequately cover the costs associated with the age of the system. Emergency repairs should be a small (five to ten percent) of the budget. The backlog of work should also be considered in developing this type of budget.

**SEWER CLEANING AND FATS, OILS, AND GREASE CONTROL**

The causes of blockages in sewer pipes can be attributed to the following:

- Structural defects
- Poor design
- Poor construction
- Grease buildup
- Root intrusion
- Protruding laterals

There are three types of sewer cleaning; hydraulic, mechanical, and chemical. Hydraulic cleaning uses water, such as from a jet truck. Mechanical cleaning using physical devices to scrape or cut the material, such as a root cutter or a cleaning machine. Chemical cleaning refers to the use of chemical, such as for root intrusion or grease buildup.

An integral part of sewer cleaning is accurate record keeping. This will enable the evaluation of the results and planning for future cleaning.

The scheduling of sewer cleaning should take into account the type of system, the problem areas and the pipe material. For example PVC pipe needs to be cleaned less than vitrified clay pipe. An area with many restaurants may need to be cleaned for grease more often. The area with PVC pipe may be on a once every-five-years schedule, where the grease prone area may need to be cleaned every six months.

In addition to sewer cleaning, control of fats, oils, and greases (FOG) is an important part of collection system maintenance. FOG control can be achieved through education of restaurant owners regarding proper disposal of grease and grease trap use and cleaning.

**PARTS AND EQUIPMENT INVENTORY**

An inventory of spare parts, equipment, and supplies should be kept. The basis of the inventory should be the equipment manufacturer’s recommendation and historical knowledge of the equipment.

A yard should be maintained to house equipment, supplies, pipes, spare parts. Equipment and personnel should be dispatched from the centrally located yard.

**7.2.4 CMOM Audit**

An EPA CMOM Self Audit form was completed by the City in an effort to identify CMOM gaps and make recommendations for improvement in system operations. The audit is a screening tool and identifies areas of strengths and weaknesses and addresses practices that EPA believes should be considered by most utilities. The CMOM self audit form is in the appendix to this document. The CMOM audit was completed by the City and reviewed by the Consultant team. The CMOM audit indicated that the City is implementing all the major elements of CMOM and is continuously looking for ways to improve system performance in a cost-effective manner. The CMOM audit for each major collection activity and the evaluation is presented in Table 7.6.

A review of the City’s reinvestment history indicates that the annual reinvestment is slightly greater than the median reinvestment reported in the Water Environment Research Foundation’s (WERF) study entitled, “Effective Practices for Sanitary Sewer and Collection System Operations and Maintenance” published in 2003. The median reinvestment of 29 utilities reported in this study was about $12,500/mile/year while the City’s reinvestment during 2005 was about $13,200/mile/year.
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**Performance and Maintenance Measures**

Some additional considerations for an effective CMOM program for the City is to measure and annually track performance and maintenance measures. Performance measures which would be useful for the City to track as reported in the Effective Practices WERF reported cited above, include:

- Pipe failure rate
- Sanitary sewer overflows frequency
- Customer complaints (related to collection system performance) frequency
- Pump station failure frequency
- Peak hourly to average annual flow

Maintenance measures that would be useful for the City to track as reported in the Effective Practices WERF reported cited above, include:

- System cleaning frequency
- Pump station service frequency
- CCTV frequency
- Root removal frequency
- Flow monitoring
- Manhole inspections
- Smoke testing
- Dye water testing
- Private sector inspections
- System rehabilitation
- System capacity enhancements

7.2.5 **Recommendations**

Based on the CMOM self audit and sewer workshops with the City, the following recommendations are made:

- Assemble supporting data and documents referenced in the CMOM self audit.
- Refine and set maintenance, performance and reinvestment measures. Definitions should be developed that are easily understood by the City for clarity of reporting.
- Improve reporting and data collection for SSOs. This includes improved estimates of SSO volumes and actions to determine SSO causes.
- Continue ongoing collection system analysis and rehabilitation, and evaluate the impact of these activities on system flows and performance.
- Based on new flow data collected in rehabilitated and in newer construction, continue to review the appropriateness of the existing design flow curve.
- Regularly (annually) review and analyze performance and maintenance measures.
- Make CMOM program adjustments as appropriate to optimize the overall program effort and costs.

7.3 **PRIVATE SEWER POLICIES**

7.3.1 **Private Sector I/I Magnitude**

The City has conducted detailed flow monitoring and public sector inspections in West Prairie Lee Basins 8, 9, and 10. The magnitude of I/I in these basins indicates that there are likely many sources of I/I that can be cost-effectively removed from the system. Field inspections performed during the study of these basins include manhole inspections, visual pipe (line lamping), smoke testing, dyed water testing, and CCTV inspection. Of the tests performed, only smoke testing and dyed water testing identify I/I sources from the private sector. Furthermore, the flow that was monitored indicates that inflow is by far the more significant flow contributor during wet weather events. Inflow is a result of rainfall entering the system through system defects or illicit direct connections and lateral defects from the private sector.
Estimates of the distribution of inflow sources from the West Prairie Lee and South Prairie Lee studies projected that inflow originating from the private sector accounts for about 60 to 70 percent of the total inflow. However, only 3 to 15 percent (depending on the basin) of the inflow could be specifically located from the inspection activities. Based on these analyses and the experience of other communities around the country and locally, especially in Johnson County, Kansas, private sector inflow is likely a major contributor to the overall system inflow during wet weather events. Furthermore, it is unlikely that I/I can be reduced to acceptable standards without addressing the private sector I/I in a comprehensive manner.

### 7.3.2 Private Property Issues

Inspection, maintenance, and/or construction on private property will require both the authority to access private property and the responsibility to issue work orders for private property improvements.

**ACCESSING PRIVATE PROPERTY**

The City appears to have the authority under the City’s Municipal Code to access private property for observation or inspection. See Section 32-248 Accessibility of Facilities for Inspection, which states:

> The service pipes, building sewers, and fixtures on the customer's premises shall be accessible to the Department for observation or inspection at reasonable hours.

(Code 1988, § 32-248)

The City attorney should be consulted in order to develop a private sector program.

**DAMAGES**

If any damage is done to the property during the inspection, identification process or construction of improvements, most agencies accept the liability and either reimburse the property owner or repair the damage. Some cities have insurance that covers these costs.

Some cities have avoided legal responsibility by including a disclaimer on the right of entry form or by having third party contractors perform the work.

**INSPECTION AND MAINTENANCE OF LATERALS**

For municipalities, where the definition of private lateral includes the entire lateral all the way to the saddle on the main, which is the case in Lee’s Summit, the property owner is normally responsible for any inspection and maintenance of the service lateral.

**REHABILITATION**

Responsibility for the rehabilitation of the lateral usually is the same as the responsibility for the maintenance and inspection.

**IDENTIFICATION OF INFLOW SOURCES**

The identification of inflow sources such as downspouts, driveway drains, area drains, stairwell drains and foundation drains is often the responsibility of the municipality. This is often accomplished as part of a larger identification and removal program and requires that the policy and legal aspects of a private sector I/I removal program be clearly defined.

**REMOVAL OF INFLOW SOURCES**

Municipalities that have established I/I identification and removal programs have several different methods for payment of this work. These options include:

- Municipality performing the work with private contractors and paying for the improvement
- Municipality performing the work with private contractors and billing the property owner
• Property owner performing the work with inspection by the municipality
• Property owner hiring private contractors to perform the work with inspection by the municipality

**ENFORCEMENT**

Enforcement measures are often necessary for successful removal of inflow and infiltration sources. Enforcement measures include:

• Disconnection of water service
• Fines
• Property liens
• Perform the work and bill the property owner using these mechanisms:
  • Monthly surcharge on utility bill
  • Adding the amount to the property tax
  • Summoning the property owner to court

**PUBLIC FUNDS SPENT ON PRIVATE PROPERTY IMPROVEMENTS**

Many municipalities do not have the authorization to spend public funds on private property; many of those that do have this authority have passed legislation for this approval. Some municipalities that have paid for the improvement are then faced with the responsibility of ongoing maintenance and replacement of the improvement. This issue should be addressed prior to the start of a removal program.

### 7.3.3 Johnson County, Kansas, Wastewater Experience

Johnson County Unified Wastewater District (JCUWWD) implemented a comprehensive private sector I/I removal program in the mid-1980s and continues this program today. The initial cost of this program was $11.2 million to remove about 15,600 private sector sources of I/I served by 742.6 miles of main sewer lines. JCUWWD has estimated that the private sector program has removed over 60 million gallons per day (mgd) of I/I under design conditions. I/I removal (both public and private) in JCUWWD’s three largest service areas averages 57.3 percent. There has been a significant reduction in sewer backups. The focus of the program today is the backup prevention program and is referred to as BUPP (Back-up Prevention Program). JCUWWD has developed a private sector procedures manual, which they have made available to other utilities as requested. The manual covers all aspects of a private sector program including inspections, removal of sources, legal and follow-up.

JCUWWD has achieved 100 percent compliance with their private sector program. The JCUWWD private sector program is highlighted on EPA’s web site location dealing with SSOs. JCUWWD reports that their private sector program has been significant in terms of achieving flow reduction. Through field work and responses to the BUPP questionnaires, JCUWWD has identified “cluster” areas of homes known to have problems with sewer backups. In some cases, JCUWWD installs backflow valves until a final, long-term solution can be found. The valve cost, including installation, is about $2,200 each.

As part of the ongoing private sector I/I program, JCUWWD set a goal of re-inspection after 7 years from completion of the initial program. All new construction requires inspection to ensure that there are not illicit connections or other ways I/I can enter the collection system. New services are not allowed to connect to the main sewer until there is a roof on the structure or there is a plug in the service line. Each service line constructed is also inspected.

### 7.3.4 Recommendations

JCUWWD offers an excellent local resource of materials related to implementing a private sector I/I removal program. In addition, a recently-published research project by the Water Environment Research Foundation (WERF) entitled, “Methods for Cost-Effective Rehabilitation of Private Lateral Sewers,”
provides up-to-date information on financial, legal, and implementation aspects of a private sector I/I removal program. Based on the findings of this report and the experiences of other utilities, it is recommended that the City:

- Implement a private sector I/I removal program and regularly evaluate the effectiveness of this program.
- Develop a plan to address the legal and financial aspects of the program. Items that need to be considered are the legal and enforcement authority to require corrections on private property and the approach for paying for these improvements.
- Develop and implement a public awareness campaign relative to private sector I/I removal.
- Review construction standards and inspection procedures for new building laterals and for buildings being sold. Consider the following for all new construction:
  - Improved foundation drains that direct groundwater and inflow away from the building, avoiding the illegal use of sanitary sewers for drains,
  - Trench-checks outside the building excavation on the lateral line to avoid inflow from traveling along the lateral bedding material to the public sewers,
  - Inspection of basement floor drains and sump pumps prior to occupancy to eliminate illegal connections.
CITY OF LEE'S SUMMIT WASTEWATER MASTER PLAN
HIGH INFLOW AREAS IN EXISTING SYSTEM
FIGURE 7-3