CITY OF STILLWATER

WASTEWATER MASTER PLAN



PREPARED BY

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JUNE 2010

WASTEWATER MASTER PLAN

PREPARED FOR

THE CITY OF STILLWATER

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MASTER PLAN

Executive Summary

Introduction

Jacobs was selected by the City of Stillwater (COS) in December 2004 to prepare a Master Plan for their wastewater system.

The City of Stillwater (COS) is located in Payne County, in north-central Oklahoma, approximately 60 miles from the two metropolitan areas of Oklahoma City or Tulsa. The existing COS Wastewater Collection System consists of approximately 1,200,000 linear feet of sewer pipeline ranging in size from 4-inch to 42-inch. The system also includes approximately 4,500 manholes and 13 sanitary sewage lift stations.

The study included the following major sections, which are described in more detail in the following paragraphs:

- Nighttime manhole survey to determine infiltration/inflow (I/I) status
- Development of manhole numbering system for modeling
- Benchmarking of water and sewer rates
- Population projections
- Population distribution
- Lift station elimination feasibility
- Flow monitoring and manhole survey
- Operation and maintenance recommendations
- Sewer modeling
- Capital improvements plan
- Conclusions and recommendations

Nighttime Manhole Survey

The goal of this survey was to evaluate the potential impacts of I/I flow on the wastewater collection system, by visually inspect representative manholes during dry periods from midnight to 5:00 AM. This survey was conducted on May 11 and May 12, 2005. A total of 42 manholes were selected for accessibility and to be representative of drainage basins city-wide.

Significant observations from this program were: (1) manholes inspected were generally in good condition; (2) flow in 34 of the 42 manholes (81 percent) inspected indicated the likely presence of system infiltration; (3) the observed infiltration flows appear to occur city-wide, and are not concentrated in specific areas of the city.

The measure down data for each surveyed manhole was utilized, along with flow meter manhole survey data and as-built drawings of existing pipelines, for validation of the existing computer model data base.

Manhole Numbering System

An important element of this master plan was the development of a computer model of the wastewater collection system. The computer model would be used as a predictive tool to simulate various dynamic system flow conditions. Various manhole numbering methodologies were discussed. Option # 4 was the recommended MH numbering system for the COS sanitary sewer interceptor/collection system, as described below.

Consideration was given to link the model MH numbering system to the unique GIS ID for each manhole in the existing database. It was decided to add the unique GIS ID as the fourth set of numbers. The resulting numbering system is as follows:

04 – 01- 05 – 0XXXX

Manhole Number (based on 5 digit GIS ID)

Major Interceptor Drainage Basin Number

Sub-Basin Number (Branch Interceptor)

Branch Interceptor Number

Water and Sewer Rate Benchmarking

In preparing a Master Plan for the COS Wastewater System, it is important to evaluate the costs and performance of the existing COS wastewater collection and treatment systems. When beginning this evaluation, it was determined that it would be useful to benchmark the COS wastewater system performance with the performance of other wastewater systems in similar municipalities in Oklahoma, Texas, and nation-wide.

Based upon the information collected in 2004, COS wastewater rates were found to be somewhat above average for similar Oklahoma communities, with a rate of $23.50/10,000 gallons/month. The COS rate was right at the average for Texas, however. Water rates were found to be below average compared to both Oklahoma and Texas communities.

In terms of capital required per customer, COS was below the national average and slightly above the median level for wastewater services.

Population Projections

An important element of the Master Plan was the development of representative population projections for the 50-year planning horizon.

The Year 2000 population for the COS from the U.S. Census Bureau was approximately 39,000. An analysis of potential buildout population showed a range of 56,000 to 84,000 based upon the current incorporated land area of 28 square miles, and relative densities for Oklahoma and Texas communities.

The Oklahoma Department of Commerce uses a 1% annual growth rate assumption for COS, resulting in a 2030 population of approximately 51,000. However, in meetings with the City of Stillwater Community Development Division (CDD), it became apparent that a 1% annual growth rate may be too low for the Wastewater System Master Plan. CDD data indicates that commercial and residential development in the City of Stillwater is accelerating and annexation activities are up. In addition, projected increases in OSU enrollment alone accounted for almost 70% of the total Stillwater population increase forecasted for the year 2025 at the 1% growth rate. It was agreed that an annual growth rate of 2% for the City of Stillwater would be more consistent with actual development, would be consistent with OSU and Stillwater CDD projections, and would result in more representative population projections for the Wastewater System Master Plan.

The assumption of 2% annual average growth results in a 2055 population of approximately 116,000, which is therefore the population for the 50-year master plan.

Population Distribution

Population distribution was allocated based on existing sewers basins, topography and projected land use. Future COS land use and areas of projected development were obtained from the Comprehensive Plan.

The following assumptions were developed to facilitate the population distribution and projections at 10-year intervals:

- Existing sewer basins within the City of Stillwater will continue to develop based on current land use. Average 2055 population densities were established for North/East Peripheral (Basins A and B), Mid-Central (Basins C and D), Central (Basins E, F and G), and South/West Peripheral (Basins H/I, J, K and L)

- Population growth outside the existing COS limits will generally follow existing trends. First tier development will occur in the North, West and Southwest sectors, followed by second tier development in the Northeast and South sectors and third tier development in the Eastern sector.

- An average 2055 build-out population density of 3.2 people per acre was utilized for all areas of future new development outside the COS limits. Once initiated, annual population growth was assumed to be approximately linear to the projected 2055 build-out values.

Lift Station Elimination Feasibility

The 13 lift stations in the sewer system were considered for elimination. Of the 13, 5 were prioritized for feasibility evaluation. Those were Foxfire, Saddle Rock II, West Park, Washington/Airport, and Husband. Elimination of all of the 5 lift stations was considered feasible. A description of the improvements required and a cost estimate was included for each of these 5 lift stations.

Flow monitoring and manhole survey

In many existing sanitary sewer systems wet weather related Infiltration/Inflow (I/I) is a major cause of hydraulic overloading of both the collection system and the treatment plant. It is essential to measure and compare system flows during periods of dry weather (low flow) and wet weather (high flow). A standard method to develop this data is to install real-time flow meters in key system manholes to measure and record actual flow conditions. By correlating this flow data to corresponding area rainfall data for the same time periods, the I/I impacts on the wastewater collection system was estimated. The flow data was also utilized to calibrate the system computer model.

Jacobs, in conjunction with the COS, developed a flow monitoring program which included the installation of 18 flow meters, 4 tipping bucket rain gages and 6 volumetric rain gages. The COS began installing the 18 flow meters and rain gages in late April of 2005 and have been maintaining the equipment and collecting data from May 16 onwards. The location of the flow meter manholes and the rain gages is described in the report.

Also, a survey crew conducted a ground survey of the flow meter manholes during the last week in April. This survey included the location of each flow meter manhole based on the COS survey control monuments, as well as the rim and flow line elevations for each flow meter manhole. Flow line elevations for manholes directly upstream and downstream of the flow meter manholes were also surveyed.

Operation and maintenance

Recommendations included the following:

- Consider cleaning the entire system every four years
- Consider a goal of video inspecting 5% of the system every year, in coordination with cleaning activities
- Rehabilitation and/or replacement of piping should be considered on a 50-year rotation if possible, but this is usually not a fiscally achievable objective
- The system goal should be to have an I/I study performed every 20 years.

A section on estimated maintenance and replacement costs was also included.

Sewer modeling

The modeling process followed a series of interdependent tasks. The existing COS sanitary sewer geometry data furnished by the City was verified, supplemented using field survey data, and recorded in the model database. The sanitary flows derived from COS GIS dwelling maps and rooftop counts, were loaded into the model, and adjusted to reflect field monitoring data. Finally, model scenarios were created to analyze the sanitary sewer system for varying geometry and sanitary load conditions.

The model was created in XPSWMM and converted to SewerGEMS V8 XM software. SewerGEMS is a dynamic hydraulic modeling computer program from Bentley used to model gravity sewer systems. To facilitate model development, it was decided to divide the existing COS sanitary sewer system in four major sewersheds. Scenarios with varying sanitary load conditions and geometry combinations were created within each model for each of the sewersheds, representing the 2005 and 2055 conditions.

Northeast Model -- The northeast model collects flow from the north and east portions of Stillwater. This model includes two lift stations, one at Airport and Husband and the other at Washington and Airport. For the 2005 model, a good portion of the lines north of the City that flow to the Airport and Husband or Washington and Airport lift stations were either surcharging or overflowing. Additionally, several lines of a tributary east/southeast of the City were either surcharging or overflowing. The model also indicated that approximately 135,000 gpd are escaping this portion of the system and are not reaching the treatment plant. For the 2055 model, no additional pipes become surcharged or overflowing due to the change in population. The model does indicate an increase in the amount of flow escaping into the system equaling an additional 165,000 gpd (~300,000 gpd total). Some additional pipes were added to the model in order to serve future development in currently unserved areas

East Model -- The east model collects flow from the east and northeast of central Stillwater. This model does not include any lift stations. For the 2005 model, a little more than half of the conduits are either overflowing or surcharging. Additionally, the model indicates that approximately 265,000 gpd are escaping from this portion of the system and are not reaching the treatment plant. For the 2055 model, several additional segments become surcharged/overflowing due to the change in population. The model also indicates an increase in the amount of flow excaping into the system equaling an additional 35,000 gpd (~300,000 gpd total). No additional pipes have been added to the model for future development.

Downtown Model --The downtown model collects flow from the majority of central Stillwater. This model includes one lift station. For the 2005 model, only four locations show segments that overflow or are surcharged. The model does not indicate that flow is escaping the system. For the 2055 model, some additional pipes become surcharged/overflowing. As in 2005, the model does not indicate that flow is escaping the system in 2055. No additional pipes have been added to the model for future development.

Southwest Model -- The southwest model collects flow from the south and southwest portion of Stillwater. Additionally, the Downtown and East models flow directly into the Southwest trunk line and are conveyed to the wastewater treatment plant through this line. For the 2005 model, based on flow currently coming from the other two models, only two segments are overflowing/surcharging. However, when the Downtown and East models are upgraded to include the proposed pipes, a string of segments near the points of intersection of the models becomes overflowing/surcharged. The model does not indicate that flow is escaping the system, meaning that the overflowing/surcharged lines have hydraulic grades that are above the top of the pipe but never reach or exceed ground level. For the 2055 model, no additional pipes become overflowing/surcharged due to flow within the Southwest model. However, the additional flow coming from the Downtown and East models does create a longer string of lines that are overflowing/surcharging in the area of the points of intersection. Like in 2005, the model does not indicate that flow is escaping the system in 2055. Some additional pipes have been added to the model in order to serve future development in currently unserved areas. Several existing pipe segments need to be upgraded in order to provide a consistent increase in size of pipe in the areas of the future pipes.

Capital Improvements Plan (CIP)

The results of the modeling effort were utilized to develop a Capital Improvement Plan for the COS for the next 50 years. The Capital Improvement Program for the COS encompasses all aspects of the wastewater collections system, including pipe replacement and upsizing to transmit current and future flow, construction of new pipes to serve future areas, rehabilitation of existing lines that are deteriorating, and upgrades/elimination of the City’s existing Lift Stations.

The capacity criteria for improvements (no surcharged conditions) show that the majority of the improvements for certain sections will have to occur sooner than later in the planning period. The improvements in the earlier portion of the planning period should provide a more economical sewer replacement. A detailed list of improvements is included in the text for both the 2005 and 2055 conditions.

The East sewershed contains the vast majority of the undersized pipes. Additionally, following the pipe upgrades to address current capacity needs, very little will have to be done in 2055 to address future capacity needs.

The total sewer replacement projects total approximately $45 million at the 2005 condition and $3 million at the 2055 condition. New sanitary sewer line projects total approximately $37 million at the 2005 condition. The capital cost to replace all of the required pipes due to projected or current capacity issues is quite large and thus it is not feasible to replace these sections in one project. Therefore, the segments have been separated into proposed projects for replacement.

Based on a capital improvement cost of $45 million in 2005, assuming that the City of Stillwater has approximately 30,000 customers and can receive a 5% interest rate on a 50 year bond sale, the 2005 capital improvements will increase the monthly sewer rate by $6.50 per connection. Moreover, based on an additional cost of $49 million in 2055, the 2055 improvements will result in an increase of the monthly sewer rate by an additional $6.75 under the same assumptions.

Conclusions and Recommendations

Additional recommendations for the operation and maintenance of the wastewater collection system are presented in detail in the Master Plan and summarized as follows:

- Some permanent flow and precipitation monitoring stations should be installed to provide peak rainfall and flow information for future work
- A minimum of four permanent flow metering stations and four precipitation gauges should be installed, one per sewershed
- The master plan should be updated in approximately 2012, and every ten years thereafter
- More detailed information should be obtained on some of the sewersheds prior to the design of major facilities
- Conduct I/I or SSES studies for all sewersheds beginning with the East basin.
- Conduct an I/I study every twenty years.
- Create a program to routinely video and clean the sanitary sewer system.
- The entire system should be cleaned every 4 years.
- The entire system should be video inspected every 20 years
- A program of routine sanitary sewer replacements should be initiated with the goal of maintaining the system at an average life of 100 to 125 years
- Develop design, construction and inspection standards for the new sewer infrastructure.
- Continue to update the City design and construction standards to include appropriate materials
- Provide thorough construction inspection on all new sewer construction
- Provide City inspection of all service connections to the sanitary sewer

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 1
Nighttime Manhole Survey

Introduction

Jacobs was selected by the City of Stillwater (COS) in December 2004 to prepare a Master Plan for their wastewater system. To assist in the evaluation of the impact of Infiltration/Inflow (I/I) on the existing Stillwater wastewater collection system, Jacobs conducted a city-wide visual inspection of representative manholes during low flow (nighttime) conditions. This chapter summarizes the procedures utilized and the data collected for this nighttime manhole survey.

Background

The City of Stillwater (COS) is located in Payne County, in north-central Oklahoma, approximately 60 miles between the two metropolitan areas of Oklahoma City and Tulsa. The existing COS Wastewater Collection System consists of approximately 1,200,000 linear feet of sewer pipeline ranging in size from 4-inch to 42-inch. The system also includes approximately 4,500 manholes and 13 sanitary sewage lift stations.

In many existing sanitary sewer systems I/I is a major cause of hydraulic overloading of both the collection system and the treatment plant. I/I can enter the collection system through faulty pipe joints, cracked pipe and/or manholes. If I/I flows are excessive, it may become necessary to construct additional sewers and expand the treatment plant to handle the increased flows. In preparing a Master Plan for the COS Wastewater System, it is important to evaluate the impacts of I/I on the COS wastewater collection and treatment systems.

Nighttime Manhole Survey - Procedures

When beginning to evaluate the potential impacts of I/I flow on a wastewater collection system, it is often beneficial to observe system flows during periods of low flow. A convenient method to develop this data is to visually inspect representative manholes during dry periods, in the late evening/early morning hours, from midnight to 5:00 AM. It is anticipated that, since sanitary sewage flows during this period are minimal, a significant portion of the observed flows can be attributed to system infiltration.

Jacobs conducted a nighttime survey of COS sanitary sewer manholes, from Midnight-5:00 AM, on May 11 and May 12, 2005. Lin Lindsay of Jacobs, accompanied by Thomas Novotny of the COS, visually inspected 42 manholes during this period. They coordinated their field work with COS officials and Water Utilities staff to minimize public disruption. Manholes were selected for accessibility and to be representative of drainage basins city-wide.

Inspection procedures generally included removing the manhole cover and visually observing the manhole flow conditions. Flows were classified as either “Clear” (infiltration related) or “Dark” (sewage related) and the depth of flow was recorded. In addition, a measurement was made of the distance from the manhole rim to the manhole flow line. General notes related to manhole condition were also recorded as appropriate.

Nighttime Manhole Survey – Results

Forty-two (42) manholes were inspected during the COS Nighttime Manhole Inspection Program. The locations of the manholes inspected during this program are shown on Exhibit 1-1. The results of the Nighttime Manhole Inspection program are presented in Table 1-1. Significant observations from this program are summarized below:

1. The manholes inspected were generally in good condition.
2. The flow in 34 of the 42 manholes inspected was classified as “clear”. Thus, approximately 81% of the manholes inspected had “clear” flow, indicating the likely presence of system infiltration.
3. The observed infiltration flows appear to occur City-wide, and are not concentrated in specific areas of the City.
4. The measure down data for each manhole (rim to flow line) is utilized, along with flow meter manhole survey data and as-built drawings of existing pipelines, for validation of the existing computer model data base.

EXHIBIT 1-1

CITY OF STILLWATER
NIGHTTIME MANHOLE INSPECTION SURVEY

LOCATION MAP

TABLE 1-1

STILLWATER WASTEWATER SYSTEM MASTER PLAN
Nighttime Manhole Inspection Survey
May 11 - May 12, 2005
Sheet 1 of 3

Manhole No.	Cross Streets	Flow			Rim Measure Down	Condition Assessment/Comments
		Clear	Dark	Depth		
1	Airport Road @ Overland Color Press	X		0.2 ft.	14.5 ft.	
2	Airport Road @ Overland Color Press	X		0.6 ft.	6.6 ft.	
3	Perkins Road South of Richmond	X		min.	6.8 ft.	
4	Richmond East of Washington		X Cloudy	0.2 ft.	6.0 ft.	
5	Airport Road @ Washington	X		1.2 ft.	23.6 ft.	Brick Manhole
6	Monroe South of Brown	X		0.1 ft.	10.1 ft.	Brick Manhole
7	Monroe South of Preston	X		0.2 ft.	4.4 ft.	
8	Brookhollow @ Washington		X	0.6 ft.	9.9 ft.	
9	Ramsey @ Eskridge		X	0.6 ft.	7.5 ft.	
10	Tyler @ Boomer	X		0.2 ft.	6.5 ft.	
11	Wildwood @ Pecan	X		min.	5.1 ft.	
12	Lakeview East of Glenwood	X		1.8 ft.	18.8 ft.	
13	Lakewood East of North Star	X		0.3 ft.	6.8 ft.	
14	Benjamin South of Brook	X		min.	5.1 ft.	
15	Will Rogers North of Sunntbrook	X		0.2 ft.	7.0 ft.	

TABLE 1-1

STILLWATER WASTEWATER SYSTEM MASTER PLAN
Nighttime Manhole Inspection Survey
May 11 - May 12, 2005
Sheet 2 of 3

Manhole No.	Cross Streets	Flow			Rim Measure Down	Condition Assessment/Comments
		Clear	Dark	Depth		
16	Between Young and Denver		X	0.1 ft.	12.7 ft.	Static Flow Majority of Manholes Not Accessible
17	Connell @ Knoblock	X		Min.	5.0 ft.	
18	Scott West of Knoblock	X		0.4 ft.	9.3 ft.	
19	Grandview @ Virginia		X	0.2 ft.	7.1 ft.	
20	Arrington South of 6th	X		0.2 ft.	5.4 ft.	
21	Dryden South of 6th		X	2.8 ft.	20.8 ft.	
22	Trunkline North of Ransom	X		0.1 ft.	8.0 ft.	
23	14th West of Chester		X	1.1 ft.	13.0 ft.	
24	Old WWTP	X		1.2 ft.	15.0 ft.	
25	6th @ Kelly in Parking Lot	X		0.9 ft.	14.1 ft.	
26	Ramsey @ 9th	X		0.2 ft.	4.3 ft.	
27	6th @ Lincoln	X		0.2 ft.	4.6 ft.	
28	Meyers Park Lift Station	X		0.1 ft.	14.6 ft.	
29	4th @ Willis	X		0.1 ft.	7.3 ft.	
30	Elm @ Husband	X		0.1 ft.	4.3 ft.	

TABLE 1-1

STILLWATER WASTEWATER SYSTEM MASTER PLAN
Nighttime Manhole Inspection Survey
May 11 - May 12, 2005
Sheet 3 of 3

Manhole No.	Cross Streets	Flow			Rim Measure Down	Condition Assessment/Comments
		Clear	Dark	Depth		
31	Jardot South of Virginia	X		0.1 ft.	9.1 ft.	
32	Brush Creek South of 3rd	X		1.0 ft.	20.2 ft.	
33	19th West of Surry Drive	X		0.1 ft.	10.6 ft.	
34	19th East of Shalamar	X		0.2 ft.	13.6 ft.	
35	Country Club South of Loper	X		min.	5.7 ft.	
36	Country Club @ 6th	X		0.3 ft.	12.8 ft.	
37	5th @ Westpark	X		0.3 ft.	18.2 ft.	
38	Chester @ 17th		X	0.3 ft.	6.4 ft.	Static Flow
39	Western North of 19th	X		0.1 ft.	9.4 ft.	
40	Brush Creek @ Stone Gate	X		0.1 ft.	13.2 ft.	Majority of Manholes Not Accessible
41	Saddle Creek Lift Station Pioneer @ 33rd	X		min.	4.5 ft.	
42	Woodland Trails	X		min.	8.4 ft.	

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 2
Manhole Numbering System

Introduction

An important element of this Master Plan was the development of a computer model of the Wastewater Collection system. The computer model will be used as a predictive tool to simulate various dynamic system flow conditions. The computer model geometry consists of an interconnecting network of flow nodes, each node representing a flow junction/manhole. It is beneficial to assign manhole identification numbers based on a rational methodology that relates manhole numbers to actual locations of manholes within the system. Various manhole numbering methodologies are summarized in the following test. The recommended manhole numbering system is also presented to be utilized for the City of Stillwater Wastewater System Master Plan.

Background

As Stillwater becomes more proactive about managing their infrastructure investment and expands their use of GIS and other database/mapping software, it becomes necessary to be able to identify specific infrastructure components. To facilitate this identification, major elements of the Wastewater System must be uniquely numbered. The major component of the sanitary sewer collection system is the manhole.

The COS manhole numbering system must include the following:

1. Unique identifier for each manhole, to be compatible with COS GIS and other COS computer systems.
2. Identifier that relates each manhole location to the layout of the major drainage basins within the COS geographic boundaries.
3. Expandable identifier system, both in the addition of new manholes and the addition of new elements, such as mainline and lateral cleanouts.

Existing COS Manhole Numbering

The COS currently has no standard system to number their sanitary sewer manholes. The COS Water Utilities Department utilizes a standard section key map of the City, sub divided on a 4x4 grid, to provide general facility location references. The city staff has is very familiar with this key map location system and has used the system successfully for years. It may be desirable to retain the location references of this system for the new MH numbering system.

The existing COS GIS assigns a unique feature number to all manholes included in the GIS system. The GIS feature number is generated by the GIS software and is assigned sequentially to manholes city-wide, based on the order of entry into the data base. The GIS manhole numbering does not relate to geographic areas or sewersheds, however if linked with the MH numbering system, it will establish the geographical relationship.

The existing COS sanitary sewer computer model divides the City into four major sewersheds groups as follows:

1. Northeast
2. East
3. Downtown
4. Southwest

The existing sanitary sewer computer model also includes a manhole identification designation for manhole nodes included in the model. The model manhole designation includes a major trunk interceptor identification prefix and assigns manhole numbers sequentially along the interceptor. The model manhole designation, while unique, is provided only for manholes along major interceptor trunk lines that are included in the model data base.

Neither the GIS nor the computer model manhole numbering system relate manhole location to the layout of the major drainage basins within the COS geographic boundaries. In addition, neither existing manhole numbering systems provides adequate expandability for the addition of new manholes and the addition of new elements, such as mainline and lateral cleanouts.

Various additional Manhole Numbering Options were evaluated and are presented below.

Option Number 1

The approach of this manhole numbering system is to sequentially number the sub-basins city-wide. Within each sub-basin, the MH numbering was also done sequentially starting with Number 1. The format of this numbering system is a two digit number followed by a three digit number as follows:

05 – 025

Sub-Basin Number　　Manhole Number

This would be defined as MH #25 in sub-basin #5 and would produce a unique MH number. This system has the following disadvantages:

- The system does not allow for identification of the MH with any geographical area larger than the sub-basin.
- Interceptor MH's could not be identified or grouped by major sanitary sewer drainage basins.
- Sequential numbering of sub-basins is city wide and is generally arbitrary, with no distinction between major drainage basins.

Option Number 2

This option utilizes the MH numbering system identified in Option # 1, but adds a two digit field to identify the major interceptor drainage basin. The format for this MH numbering system would be as follows:

04 - 05 – 025

Major Interceptor Drainage Basin Number　　Manhole Number
Sub-Basin Number

This would be defined as MH #25 in sub-basin #5 in the Southwest Drainage Basin, assuming that the SW Drainage Basin trunk interceptor is assigned as interceptor number 4. This system would produce a unique MH number. This system has the following disadvantages:

- The combination of a geographically based number for the major drainage basin and a city-wide, sequentially assigned number for the sub-basin may be confusing to the user

Option Number 3

This option expands the MH numbering system identified in Option # 2 by adding a two digit field to identify the particular branch from the major trunk interceptor. The format for this MH numbering system would be as follows:

04 – 01- 05 – 025

Major Interceptor Drainage Basin Number
Manhole Number
Branch Interceptor Number
Sub-Basin Number (City-wide)

This would be defined as MH #25 in sub-basin #5 in the first branch of the trunk interceptor in the Southwest Drainage Basin, assuming that the SW Drainage Basin trunk interceptor is assigned as number 4. This system would produce a unique MH number. This system has the following disadvantages:

- The city-wide sequentially assigned number for the sub-basin may still be confusing to the user.

Option Number 4

This option is very similar to Option # 3, but differs in that the sub-basins are now sequentially assigned numbers throughout each branch interceptor instead of city-wide and the manhole number is basd on the 5 digit unique GIS ID. The format for this MH numbering system would be as follows:

04 – 01- 05 – 0XXXX (based on 5 digit GIS ID)

Manhole Number
Major Interceptor Drainage Basin Number
Sub-Basin Number (Branch Interceptor)
Branch Interceptor Number

This would be defined as MH #0XXXX located in the fifth sub-basin contained in the first branch of the trunk interceptor in the Southwest Drainage Basin, assuming that the SW Drainage Basin trunk interceptor is assigned as number 4. Cleanouts could be numbered by adding a “C” to the sequential MH number. This system has the following advantages:

- Each structure is numbered with a unique MH number.
- The system follows a logical progression based on the layout of the sanitary sewer/interceptor system.
- MH’s within each sub-basin are numbered sequentially.
- Each sub-basin contained in a branch interceptor drainage area is sequentially numbered, starting at the interceptor outfall and increasing in number going upstream.
- Each branch interceptor contained in the major drainage basin is sequentially numbered, starting at the major interceptor outfall and increasing in number going upstream.
- Any MH within the boundaries of the major drainage basins within the COS can be numbered. This numbering system can be expanded to capture additional detailed items.

Recommended Option

Option # 4 is the recommended MH numbering system for the COS sanitary sewer interceptor/collection system.

Consideration was given to link the model MH numbering system to the unique GIS ID for each manhole in the existing database. It was decided to add the unique GIS ID as the fourth set of numbers. The resulting numbering system is as follows:

04 – 01- 05 – 0XXXX

Manhole Number (based on 5 digit GIS ID)

Major Interceptor
Drainage Basin Number

Sub-Basin Number (Branch Interceptor)

Branch Interceptor Number

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 3
Water And Wastewater System Benchmarking

Introduction

Jacobs was selected by the City of Stillwater (COS) in December, 2004 to prepare a Master Plan for their wastewater system. To assist in the evaluation of the costs associated with the operation and maintenance of the existing Stillwater Wastewater System, Jacobs conducted a review of existing data related to costs and rates for water and wastewater systems for other municipalities in Oklahoma, Texas, and nation-wide. This chapter summarizes the data collected and evaluated for this benchmarking survey.

Background

The City of Stillwater is located in Payne County, in north-central Oklahoma, approximately 60 miles between the two metropolitan areas of Oklahoma City and Tulsa. The existing COS Wastewater Collection System consists of approximately 1,200,000 linear feet of sewer pipeline ranging in size from 4-inch to 42-inch. The system also includes approximately 4,500 manholes and 13 sanitary sewage lift stations. The COS has one Wastewater Treatment Plant with an average and peak capacity of 10 and 13 million gallons per day (MGD), respectively.

In preparing a Master Plan for the COS Wastewater System, it is important to evaluate the costs and performance of the existing COS wastewater collection and treatment systems. When beginning this evaluation, it is beneficial to benchmark the COS wastewater system performance with the performance of other wastewater systems in similar municipalities in Oklahoma and nation-wide.

Municipal Wastewater System Rates

Data for benchmarking utility rates for cities in Oklahoma was obtained from the Oklahoma Municipal Utility Costs in 2004 (2004 OML Rate Study), a report prepared by Oklahoma Conference of Mayors, Oklahoma Municipal League, Inc. and the Municipal Electric Systems of Oklahoma, Inc. This Report provides information on municipal utility charges for a wide range of Oklahoma cities. The survey was conducted in the fourth quarter of 2003 and the first quarter of 2004.

Water and Wastewater rates reported for representative Oklahoma cities in the survey, similar in size to Stillwater, are shown in Appendix A-1, and summarized in Table 3-1 below:

Table 3-1
Oklahoma Municipal Utility Costs in 2004
Water and Wastewater Rates

BENCHMARK	AVERAGE	MEDIAN	STILLWATER
Water Rate – 10,000 Gallons/month	$29.48	$27.25	$25.50
Wastewater Rate – 10,000 Gallons/month	$15.57	$14.10	$23.50

Data for the benchmarking the performance of water and wastewater systems in Texas was obtained from the 2004 Water and Wastewater Rate Study, prepared by the Texas Municipal League. This survey provides information on water and wastewater charges for a wide range of Texas cities. The survey was conducted in the fourth quarter of 2003 and the first quarter of 2004.

Water and Wastewater rates reported for representative Texas cities in the survey, similar in size to Stillwater, are shown in Appendix A-2, and summarized in Table 3-2 below:

Table 3-2
2004 Texas Municipal League Rate Study
Water and Wastewater Rates

BENCHMARK	AVERAGE	MEDIAN	STILLWATER
Water Rate – 10,000 Gallons/month	$34.66	$32.83	$25.50
Wastewater Rate – 10,000 Gallons/month	$23.63	$22.50	$23.50

2004 AWWA Water And Wastewater Rate Study

Data for benchmarking the performance of water and wastewater systems was obtained from the 2004 Water and Wastewater Rate Survey, prepared by American Water Works Association (AWWA) and Raftelis Financial Consulting (RFC). AWWA has been reporting on water/wastewater rates for decades. RFC has been conducting biennial water/wastewater rate surveys since 1996.

This survey provides information on the operation of water and wastewater systems for a wide range of US cities. The survey was conducted in the fourth quarter of 2003 and the first quarter of 2004. The data on rates is current as of the latter part of 2003. The data on water sold, wastewater treated and system revenues is for calendar year 2002 or the most recent fiscal year (2002-2003), if applicable.

For benchmarking purposes, the utilities were grouped according to common operating parameters. The water utilities were sorted by gallons of water sold, measured in MGD. The wastewater utilities were sorted by gallons of wastewater billed, measured in MGD. The utility grouping criteria used for this rate study are summarized in Table 3-3 below:

Table 3-3
2004 AWWA Rate Study - Group Criteria

GROUP DESIGNATION	WATER	WASTEWATER
A	>75 MGD sold	>60 MGD billed
B	20-75 MGD sold	15-60 MGD billed
C	<20 MGD sold	<15 MGD billed

Utilizing the 2004 AWWA Rate Study, Jacobs developed the following water and wastewater system performance benchmarking parameters for all cities in the survey and for the Group C cities:

1. Number of employees per 1000 customers
2. Number of employees per MGD capacity
3. Treatment capacity in use, expressed as a percentage of existing capacity.
4. Capital required per 100 customers.

Municipal Wastewater System Performance

Wastewater System Benchmarks developed for all cities in the 2004 AWWA Rate Study are shown in Appendix A-3 and summarized in Table 3-4 below:

Table 3-4
2004 AWWA Rate Study
Wastewater System Benchmarks - All Cities

BENCHMARK	AVERAGE	MEDIAN	STILLWATER
Employees/1000 Customers	0.52	0.47	0.48
Employees/MGD Treatment Capacity	2.81	2.27	2.0
% WW Treatment Capacity in Use	64.34	63.60	60.0
Capital Required/Customer	$75.15	$54.09	$63.81

Wastewater System Benchmarks developed for Group C cities in the survey are shown in Appendix A-4 and summarized in Table 3-5 below:

Table 3-5
2004 AWWA Rate Study
Wastewater System Benchmarks – Group C Cities

BENCHMARK	AVERAGE	MEDIAN	STILLWATER
Employees/1000 Customers	0.56	0.48	0.48
Employees/MGD Treatment Capacity	2.82	2.36	2.0
% WW Treatment Capacity in Use	62.38	60.00	60.0
Capital Required/Customer	$92.61	$57.61	$63.81

Municipal Water System Performance

Water System Benchmarks developed for all cities in the 2004 AWWA Rate Study are shown in Appendix A-5 and summarized in Table 3-6 below:

Table 3-6
2004 AWWA Rate Study
Water System Benchmarks - All Cities

BENCHMARK	AVERAGE	MEDIAN	STILLWATER
Employees/1000 Customers	0.59	0.56	0.79
Employees/MGD Treatment Capacity	2.24	1.71	1.83
% Water Treatment Capacity in Use	56.53	41.34	44.44
Capital Required/Customer	$67.55	$50.83	$38.46

Water System Benchmarks developed for Group C cities in the survey are shown in Appendix A-6 and summarized in Table 3-7 below:

Table 3-7
2004 AWWA Rate Study
Water System Benchmarks – Group C Cities

BENCHMARK	AVERAGE	MEDIAN	STILLWATER
Employees/1000 Customers	0.61	0.58	0.79
Employees/MGD Treatment Capacity	2.20	1.94	1.83
% Water Treatment Capacity in Use	47.24	39.20	44.44
Capital Required/Customer	$71.40	$50.20	$38.46

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 4
Population Projections

Introduction

An important element of this Master Plan is the development of representative population projections for the planning horizon. This chapter summarizes the data and methods utilized in developing population projections for the next 50 years for the City of Stillwater Wastewater System Master Plan.

Background

Founded as a starting point for the opening of the Oklahoma Territory in 1889, Stillwater has experienced steady growth in both land area and population. Home today for Oklahoma State University, as well as numerous industrial manufacturing and service companies, Stillwater has become a leading economic, educational and services hub for the region. Stillwater is positioned to further expand and diversify their economies, providing a foundation for continued growth.

Historic Population Data

Historic population data, as complied by the U.S Census Bureau and reported by the Oklahoma Department of Commerce, for the City of Stillwater from 1890 to 2000 is presented in Figure 4-1 and summarized in Table 4-1 below:

Figure 4-1
City of Stillwater - Historic Population Data

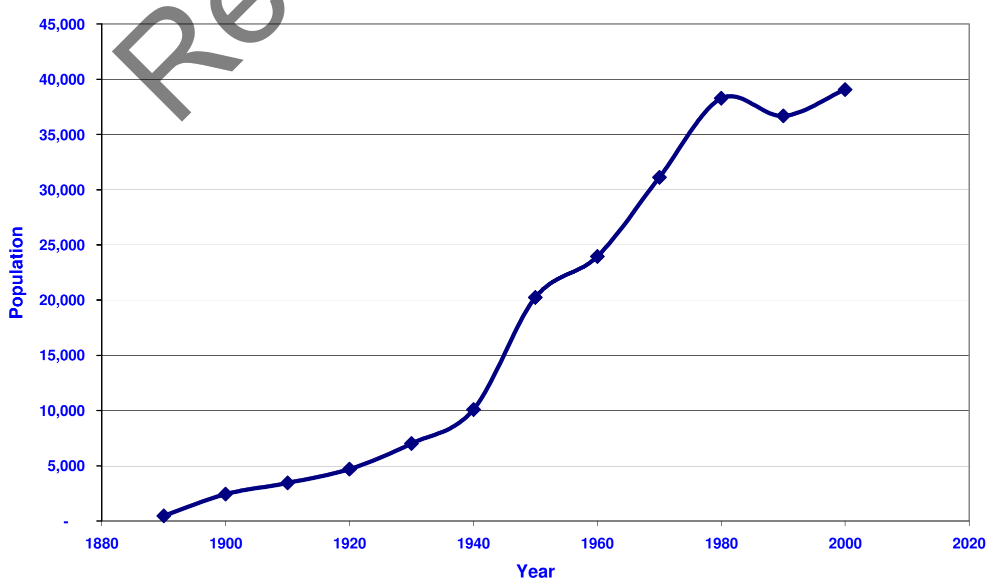


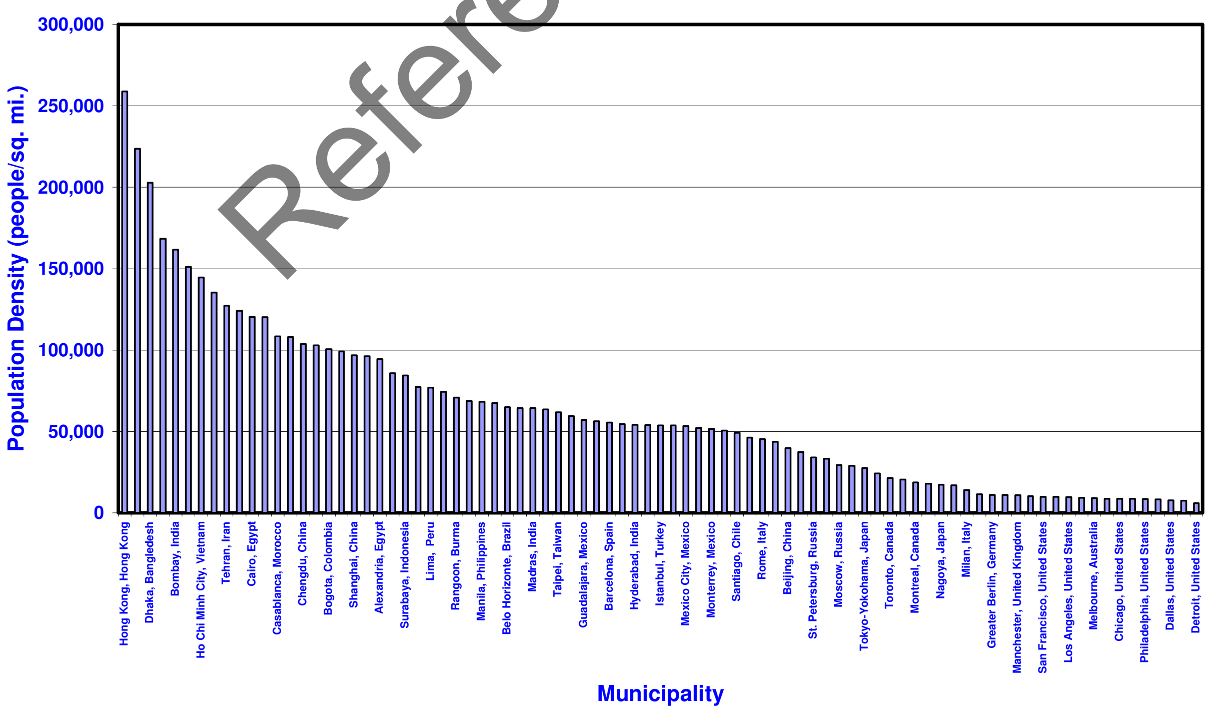
Table 4-1
City of Stillwater Population – 1890 –2000

YEAR	POPULATION
1890	480
1900	2,431
1910	3,444
1920	4,701
1930	7,016
1940	10,097
1950	20,238
1960	23,965
1970	31,126
1980	38,268
1990	36,676
2000	39,065

Build Out Population

When beginning to develop population projections for a geographic area, it is often enlightening to start with an estimate of total population at 100% build-out for the area. A convenient method to develop this "upper limit" benchmark population projection is to look at population densities for other municipalities. Typical population densities for the largest urban cities worldwide are presented in Figure 4-2.

Figure 4-2
Population Density of World's Largest Cities



It should be noted that, for large cities, population densities can vary from approximately 5,000-persons/sq. mile to over 250,000-persons/sq. mile. Population densities for cities similar to Stillwater in Oklahoma and Texas (Dallas/Fort Worth Metroplex) are shown in Figures 4-3 and 4-4, respectively.

Figure 4-3
Population Density In Oklahoma Cities

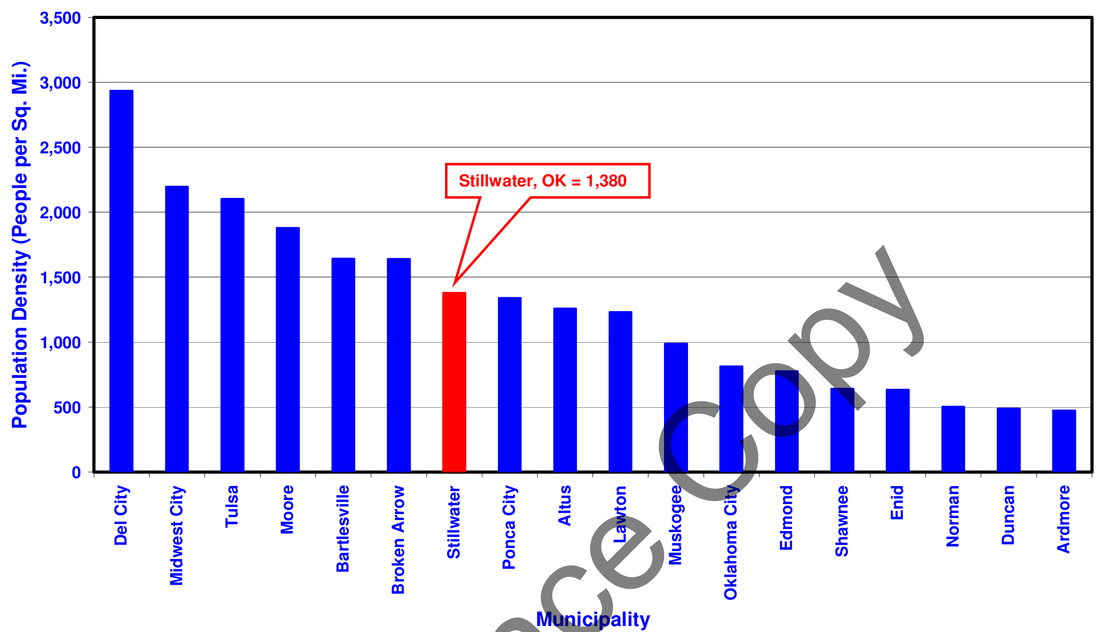
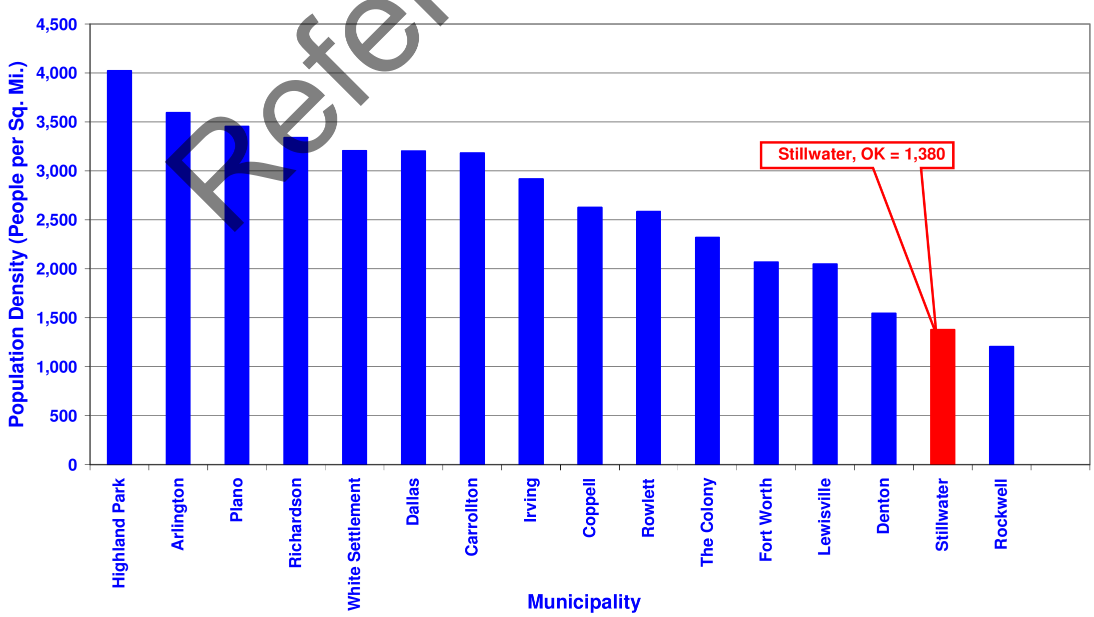


Figure 4-4
Population Densities of Texas Cities



Based on this data, a representative population density for Stillwater at build-out is 2,000 – 3,000 persons/sq. mile. Thus, based on Stillwater's current incorporated land area of approximately 28 sq. miles, the build-out population for Stillwater can be estimated to be between 56,000 and 84,000. Of course, as Stillwater annexes additional land in the future, the build-out population total will increase.

Population Projections

Projecting future population figures is a very subjective science. Many factors will influence the City of Stillwater's growth and development. Factors such as local and regional economic conditions, employment opportunities, transportation and utility infrastructure improvements, Oklahoma State University (OSU) enrollment, and private capital investments will all impact future growth. For instance, as the single largest employer in Stillwater, OSU enrollment will continue to have a significant impact (direct and indirect) on the stability and growth of Stillwater. OSU Institutional Research and Information Department maintains OSU enrollment records and has tabulated actual enrollment and future enrollment projections, as shown in Figure 4-5 and as summarized in Table 4-2 below:

Figure 4-5
OSU Enrollment Projections

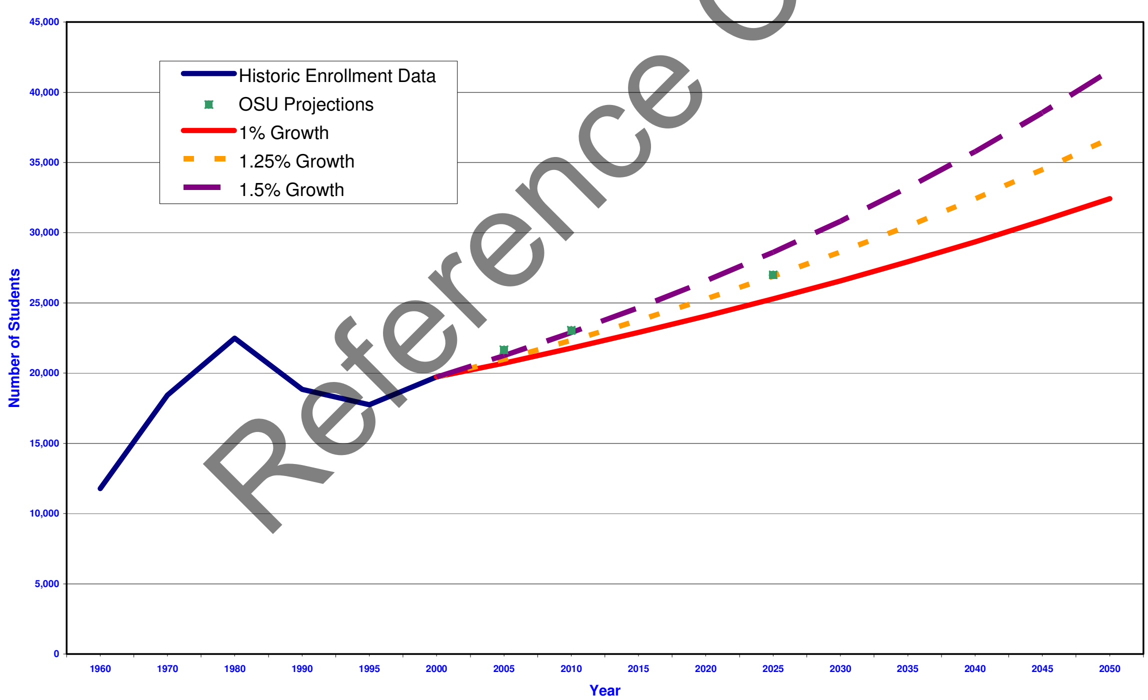


Table 4-2
OSU Enrollment – Stillwater Campus

Year	Enrollment
1995	17,759*
1996	18,364*
1997	18,466*
1998	18,527*
1999	19,518*
2000	19,722*
2001	19,857*
2002	20,275*
2003	21,604*
2004	21,576*
2005	21,659**
2006	21,886**
2007	22,086**
2008	22,268**
2009	22,344**
2025	27,000***

Notes:
* Actual Enrollment
** Enrollment Projection
*** Enrollment Estimate (2,000+or-)

It should be noted that the OSU enrollment projections represent an annualized growth rate of approximately 1.25%. This enrollment projection appears to be very conservative. OSU is preparing a Master Plan to guide future growth. It is anticipated that the OSU Master Plan will contain additional information related to enrollment projections and that the completed plan will be available by the end of this year.

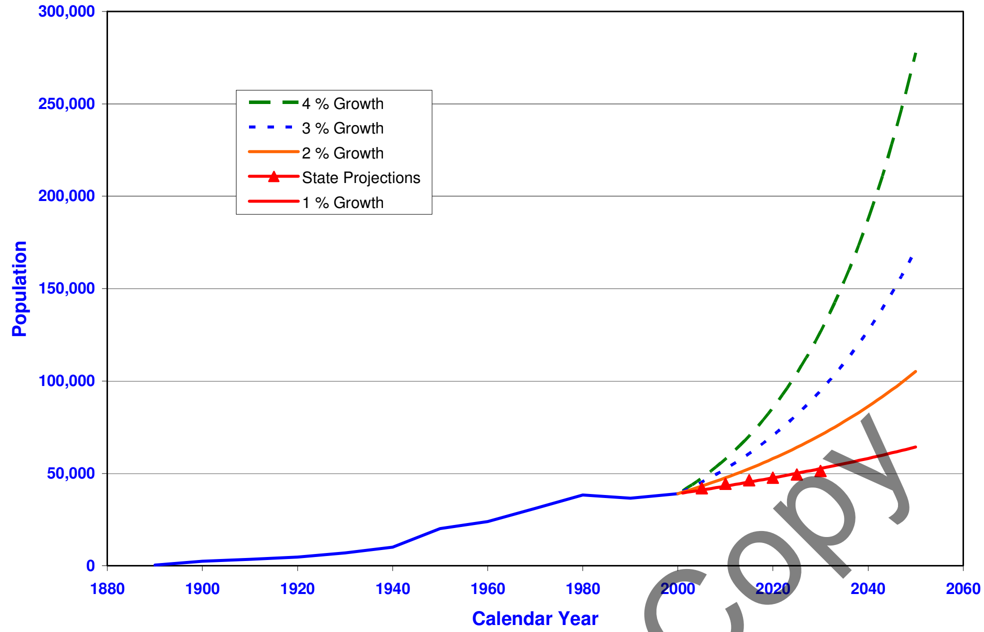
The Oklahoma Department of Commerce has developed population projections for the City of Stillwater through the year 2030. These projections are summarized in Table 4-3 below:

Table 4-3
City of Stillwater – Population Projections
Oklahoma Department of Commerce

Year	Population
2005	41,490
2010	44,400
2015	46,290
2020	47,780
2025	49,440
2030	51,330

It should be noted that these projections represent an annualized growth rate of approximately 1%. The impacts of various annual growth rates of 1%, 2%, 3%, and 4% are shown in Figure 4-6.

Figure 4-6
Various Population Projections For Stillwater



In subsequent meetings with City of Stillwater Community Development Division (CDD), it became apparent that a 1% annual growth rate may be too low for the Wastewater System Master Plan. CDD data indicates that commercial and residential development in the City of Stillwater is accelerating and annexation activities are up. In addition, projected increases in OSU enrollment alone accounted for almost 70% of the total Stillwater population increase forecasted for the year 2025 at the 1% growth rate.

It was agreed that an annual growth rate of 2% for the City of Stillwater would be more consistent with actual development, would be consistent with OSU and Stillwater CDD projections and would result in more representative population projections for the Wastewater System Master Plan. Based on the agreed upon annual growth rate of 2%, population projections for the Wastewater Master Plan horizon (2005-2055) were developed and are summarized in Table 4-4 below:

Table 4-4
City of Stillwater – Population Projections
Wastewater System Master Plan

Year	Population
2005	43,131
2010	47,620
2015	52,576
2020	58,049
2025	64,090
2030	70,761
2035	78,126
2040	86,257
2045	95,235
2050	105,147
2055	116,090

Recommendations

The current Oklahoma Department of Commerce (ODC) population projections for the COS indicate an annualized growth rate of approximately 1%. In meeting with the COS Community Development Division, it was apparent that an annualized growth rate of 1% is too low for the current and anticipated future development in the area. Lot platting activity indicates that residential development is very active in COS, especially in the southwestern portion of the City. Commercial development is also very strong, lead by large projects such as the new Wal-Mart facility and supplemented by numerous other smaller projects. The COS is also aggressively pursuing new industrial development. This strong development activity in all areas indicates that a growth rate of approximately 2% is more consistent with the actual development observed in the COS area. Also, it should be noted that the OSU enrollment projections, while generally thought to be conservative at an annual growth rate of 1.25%, account for almost 70% of the total ODC population increase forecasted for the COS for the year 2025. It is therefore recommended that an annualized growth rate of 2% be used for the development of the Stillwater Wastewater System Master Plan.

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 5
Population Distribution

Introduction

An important element of this Master Plan is the development of representative population projections for the planning horizon. Equally important for the planning process is the allocation of these population projections to the various sewer basins within the City. This chapter summarizes the data and methods utilized in developing population distributions for the next 50 years for the City of Stillwater Wastewater System Master Plan.

Background

Founded as a starting point for the opening of the Oklahoma Territory in 1889, Stillwater has experienced steady growth in both land area and population. Home today for Oklahoma State University, as well as numerous industrial manufacturing and service companies, Stillwater has become a leading economic, educational and service hub for the region. Stillwater is positioned to further expand and diversify their economies, thus providing a foundation for continued growth.

Population Projections

Population projections for the COS Wastewater System Master Plan were developed and presented previously in Chapter 4. Based on the agreed upon annual growth rate of 2%, population projections for the COS Wastewater Master Plan horizon (2005-2055) are summarized in Table 5-1 below:

Table 5-1
City of Stillwater
Population Projections

YEAR	POPULATION
2005	43,131
2010	47,620
2015	52,576
2020	58,049
2025	64,090
2030	70,761
2035	78,126
2040	86,257
2045	95,235
2050	105,147
2055	116,091

Population Distribution

For the COS Wastewater System Master Plan, population distribution was allocated based on geographical drainage basins and projected land use. Existing wastewater sewer basin boundaries for the area within the current City limits was obtained from the COS and is summarized on Exhibit 5-1.

Utilizing the existing COS GIS dwelling mapping, a roof top count was performed. Based on population densities of 3.2 people/dwelling for single family residences and 1 person per 500 SF for apartment dwellings, existing sewer basin populations were estimated and are presented in Table 5-2 below:

Table 5-2
City of Stillwater
Existing Population Distribution

BASIN DESIGNATION	NO. DWELLINGS	DENSITY PEOPLE/UNIT	2005 POPULATION
A	598	3.2	1,914
B	752	3.2	2,406
C	1334	3.2	4,269
C-Apartments	1360	2	2,720
D	1555	3.2	4,976
D-Apartments	115	2	230
E	1475	3.2	4,720
F	1523	3.2	4,874
G	1421	3.2	4,547
G-OSU Housing	EST	NA	4,261
H + I (South I)	201	3.2	643
J	431	3.2	1,379
K	1104	3.2	3,533
L	831	3.2	2,659
TOTAL			43131

Future population distribution has been developed based on projected land areas to be developed and projected land use (population densities). Future COS land use and areas of projected development were obtained from the Comprehensive Plan and are summarized in Exhibit 5-2.

The following assumptions have been developed to facilitate the population distribution for the COS Wastewater System Master Plan:

1. Existing sewer basins within the City of Stillwater will continue to develop based on current land use. Average 2055 population densities are summarized below:
   a. North/East Peripheral (Basins A and B)
   Generally located on the periphery of the existing COS core development, these areas have significant existing development and will continue to grow. An average population density of 4.8 people/acre was utilized for basins A and B.
   b. Mid-Central (Basins C and D)
   Generally located between existing COS core development and COS perimeter development, these areas will grow at a moderate rate. A density of 6.4 people/Acre was utilized for basins C.and D.
   c. Central (Basins E, F and G)
   Generally comprising the COS core development, these areas will have the highest population densities in the study area. It has been assumed that the highest population density will occur in the OSU campus area, with densities decreasing as you move away from the central campus. Average population densities of 9.6, 9.6 and 16 people/acre were projected for Basins E, F and G, respectively.
   d. South/West Peripheral (Basins H/I, J, K and L)
   Generally low density type areas with large residential lots, these areas will continue this pattern of development. An average population density of 4.8 people/acre was utilized for all of these basins.

2. Population growth outside the existing COS limits will generally follow existing trends. First tier development will occur in the North, West and Southwest sectors, followed by second tier development in the Northeast and South sectors and third tier development in the Eastern sector.
3. An average 2055 build-out population density of 3.2 people per acre (1 dwelling/Acre x 3.2 people/dwelling) was utilized for all areas of future new development outside the COS limits. Once initiated, annual population growth was assumed to be approximately linear to the projected 2055 build-out values.

Based on the data and assumptions presented above, COS basin population projections have been developed at 10 year intervals for the COS Wastewater Master Plan horizon and are summarized in Table 5-3 on the following page.

Table 5-3
City of Stillwater
Future Population Distribution

BASIN	ACRES		DENSITY	YEAR					
DESIGNATION	TOTAL	DEVELOPED	People/Acre	2005	2015	2025	2035	2045	2055
A	2560	1024	4.8	1,914	2,514	3,114	3,715	4,315	4,915
B	960	768	4.8	2,406	2,662	2,918	3,174	3,430	3,686
C	2720	1920	6.4	6,989	8,049	9,109	10,168	11,228	12,288
D	1920	1536	6.4	5,206	6,131	7,056	7,981	8,906	9,830
E	960	768	9.6	4,720	5,251	5,781	6,312	6,842	7,373
F	800	640	9.6	4,874	5,128	5,382	5,636	5,890	6,144
G	960	768	16.0	8,808	9,504	10,200	10,896	11,592	12,288
H + I (South I)	1600	800	4.8	643	1,282	1,922	2,561	3,201	3,840
J	640	512	4.8	1,379	1,595	1,810	2,026	2,242	2,458
K	1600	1280	4.8	3,533	4,055	4,577	5,100	5,622	6,144
L	960	768	4.8	2,659	2,864	3,070	3,275	3,481	3,686
NORTH	1920	1536	3.2	-	750	1,733	2,716	3,699	4,915
NORTHEAST	3200	2560	3.2	-		1,000	2,638	5,096	8,192
EAST	2560	2048	3.2	-			755	2,721	6,554
SOUTH	1920	1536	3.2	-		754	1,737	3,212	4,915
SOUTHWEST	2560	2048	3.2	-	1,311	2,621	3,932	5,243	6,554
WEST	4480	3584	3.2	-	1,480	3,042	5,504	8,516	12,309
TOTAL	32320	24096	NA	43,131	52,576	64,090	78,126	95,235	116,091

EXHIBIT 5-1

CITY OF STILLWATER
POPULATION DISTRIBUTION

EXISTING SEWER BASIN MAP

EXHIBIT 5-2

CITY OF STILLWATER
POPULATION DISTRIBUTION

FUTURE SEWER BASIN MAP

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 6
Lift Station Elimination Feasibility
Foxfire, Saddle Rock II, West Park, Washington & Husband Airport

Introduction

Jacobs was selected in December, 2004 by the City of Stillwater to prepare a Master Plan for their wastewater system. Jacobs analyzed the feasibility of eliminating lift stations located throughout the City. These lift stations includes the following:

1. 44th and Husband
2. Fountain Square
3. Foxfire
4. Saddle Rock II
5. Squires Landing
6. Woodlake
7. Woodland Trails
8. Washington/Boomer
9. Myers Park
10. Quailridge
11. Washington/Airport
12. Husband/Airport
13. West Park

Out of the 13 lift stations listed, 5 are discussed in this chapter: Foxfire, Saddle Rock II, West Park, Washington/Airport, and Husband.

Background

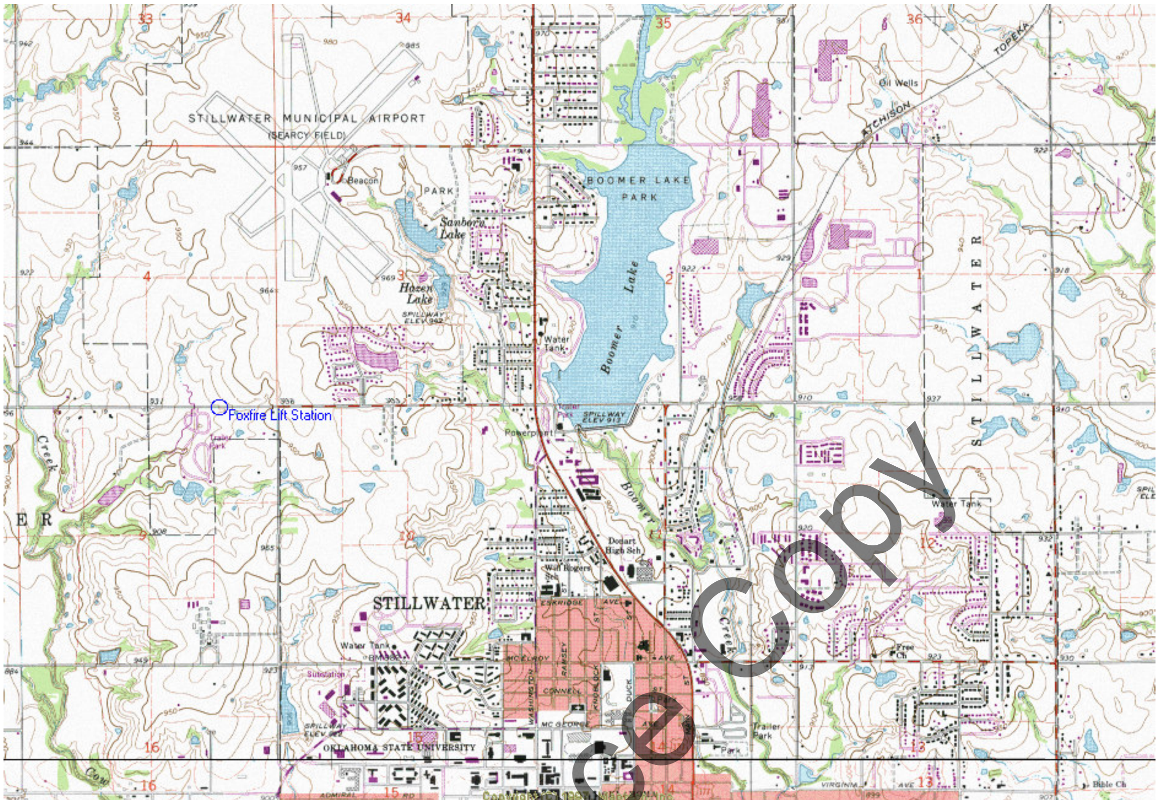
The City of Stillwater (COS) is located in Payne County, in north-central Oklahoma, approximately 60 miles between the two metropolitan areas of Oklahoma City and Tulsa. The existing COS Wastewater Collection System consists of approximately 1,200,000 linear feet of sewer pipeline ranging in size from 4-inch to 42-inch. The system also includes over 4,500 manholes and 13 sanitary sewage lift stations.

As Stillwater development continued to grow, lift stations were used by developers to connect to the City's sewer interceptors. Jacobs staff met with the COS to prioritize the 5 most critical lift stations and analyzed feasibility for their elimination.

1. FOXFIRE LIFT STATION

The Foxfire Lift Station is located in northwest Stillwater area approximately 1,000 LF west of Lakeview and Western. The lift station consists of two above ground pumps 50hp pumps. The lift station provides service to approx. 175 single family residential units. The lift station was constructed and placed in service in 1985. A vicinity map of the Foxfire Lift Station is shown as follows in Figure 6-1:

Figure 6-1
Foxfire Lift Station Location Map



ELIMINATION FEASIBLITY

The elimination of the Foxfire Lift Station may be done by converting the lift station into a junction structure and gravity boring approximately 6,000 lf to an existing connection near Monroe Street. This connection would allow the City to abandon pumping operations at the Foxfire Lift Station.

PLANNING LEVEL COST ESTIMATE

The costs associated with the elimination of the Foxfire Lift Station are for planning purposes only. Items such as contractor's profit, mobilization, and escalation are not included in the planning estimate. A more detailed estimate may be developed at a future date.

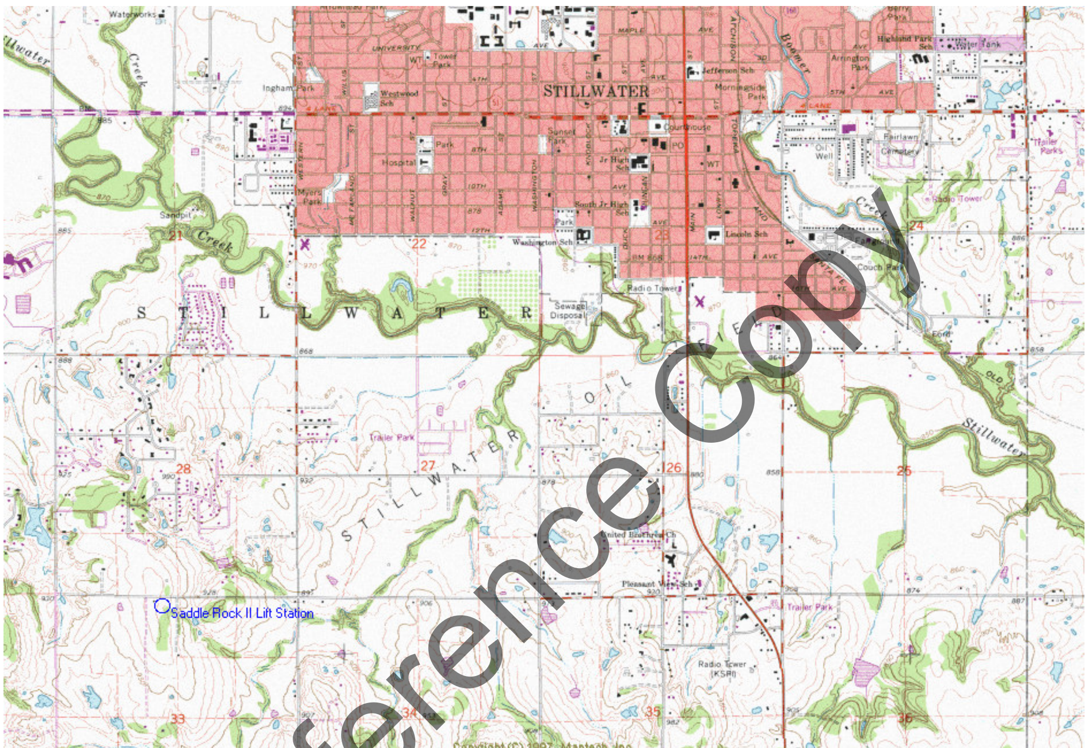
Table 6-1
Foxfire Lift Station Elimination Cost Estimate

Description	Qty	Unit	Cost	Total Cost
16-inch DIP	6,000	LF	$150	$900,000
48-inch Manhole	12	EA	$1,500	$18,000
Pavement Restoration	1	LS	$10,000	$10,000
Convert LS into Junction Structure	1	LS	$50,000	$50,000
Restablish existing connections	1	LS	$15,000	$15,000
Total				$993,000
Contingency	25%			$248,250
Overall Total				**$1,241,250**

2. SADDLE ROCK II LIFT STATION

The Saddle Rock II Lift Station is a small lift station located in southwest Stillwater area approximately 2,800 LF west of Western and West 32nd Avenue. The lift station provides service to approx 25 single family residential units. The lift station was constructed and placed in service in 1999. A vicinity map of the Saddle Rock II Lift Station is shown as follows in Figure 6-2:

Figure 6-2
Saddle Rock II Lift Station Location Map



ELIMINATION FEASIBLITY AND COST ESTIMATE

The elimination of the Saddle Rock II Lift Station may be accomplished by constructing a lift station bypass gravity line in the south interceptor near West 22nd Avenue and South Washington Street. The new connection would follow along the creek heading southwest ending near the Woodland Trails Lift Station. Saddle Rock II Lift Station may be converted into a junction structure, thus eliminating the need for a lift station.

The costs associated with the elimination of the Saddle Rock II Lift Station are for planning purposes only. Items such as contractor's profit, mobilization, and escalation are not included in the planning estimate. A more detailed estimate may be developed at a future date.

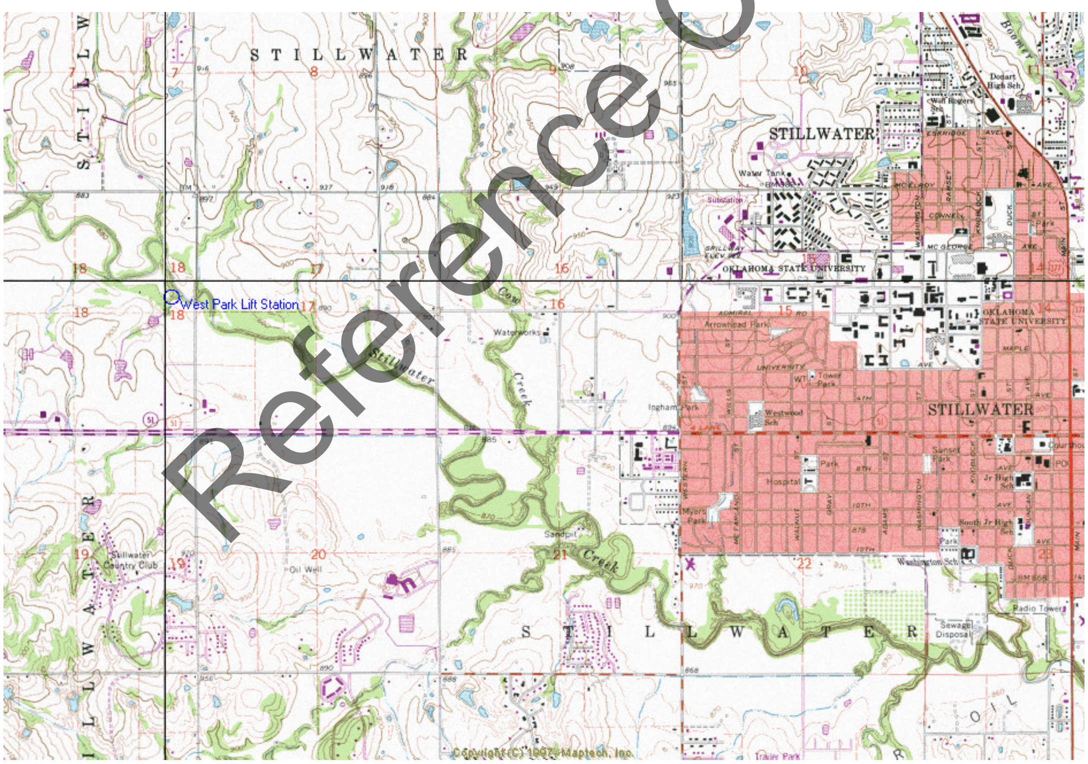
Table 6-2
Saddle Rock II Lift Station Elimination Cost Estimate

Description	Qty	Unit	Cost	Total Cost
16-inch DIP	14,000	LF	$120	$1,680,000
48-inch Manhole	40	EA	$1,500	$60,000
Pavement Restoration	1	LS	$50,000	$50,000
Convert LS into Junction Structure	1	LS	$50,000	$50,000
Total				$1,840,000
Contingency	25%			$460,000
Overall Total				**$2,300,000**

3. WEST PARK LIFT STATION

The West Park Lift Station is located in southwest Stillwater area approximately 2,500 LF northwest of State Hwy 51 and Country Club. The lift station provides service to approx 230 single family residential units. The lift station was constructed and placed in service in 1981. A vicinity map of the West Part Lift Station is shown as follows in Figure 6-3:

Figure 6-3
West Park Lift Station Location Map



ELIMINATION FEASIBLITY AND COST ESTIMATE

The draft report assessed the feasibility of eliminating the West Park Lift Station was based on the recommendations proposed in “South Sanitary Sewer Interceptor” planning report prepared by Dewberry Design Group in May 2001.The report proposed to install a new sewer main parallel to the existing sewer main. It was assumed that the construction of this new sewer main would allow a gravity connection to the residential subdivision and abandon pumping operations at West Park lift station.

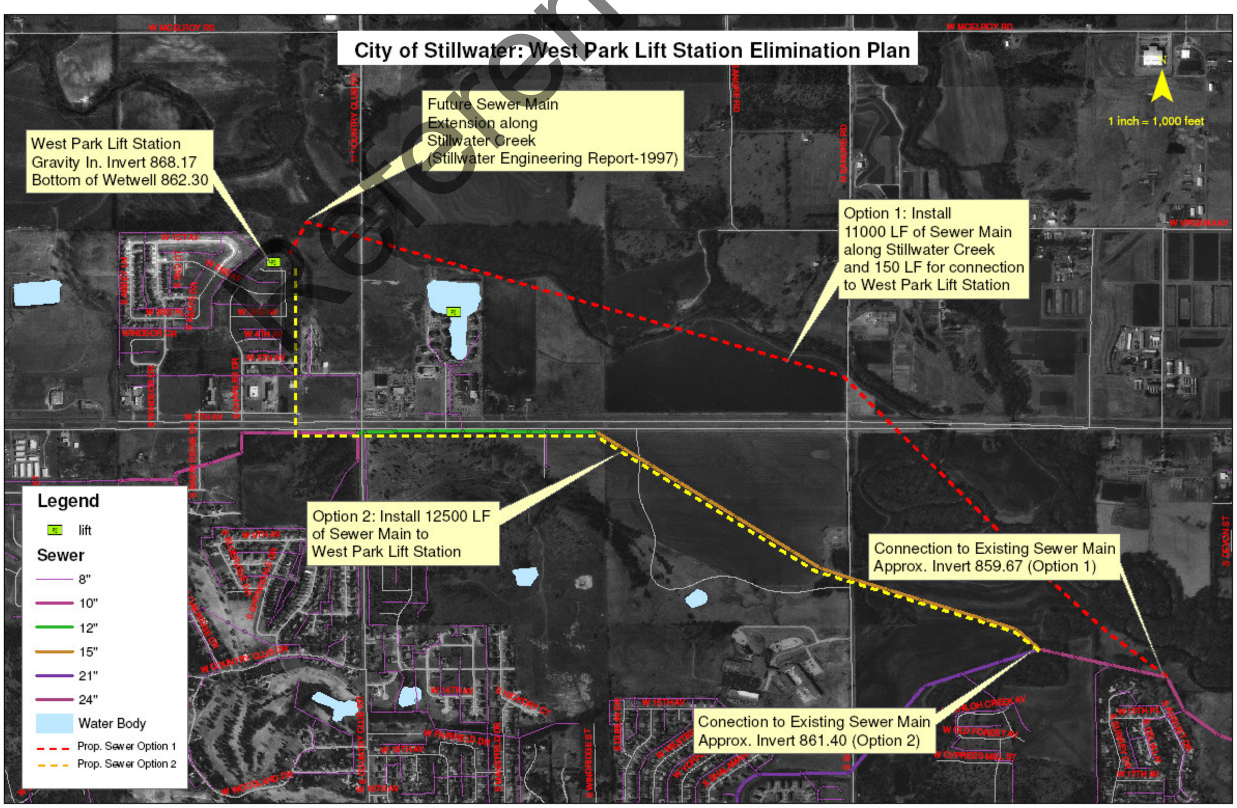
It is to be noted that the recommended improvements have not been constructed and based on the current status of the elimination feasibility; three options in the order of preference are proposed. These options are also shown as Figure 6-4.

Option 1: This option proposes to construct a sewer main segment along Stillwater creek following the alignment proposed in a conceptual planning report issued in March 1997 by Stillwater Engineer titled “Sanitary Sewer Extension – Harrington Creek Drainage Basin”. This option also follows the alignment proposed for the future sewer mains in the Master Plan. The proposed sewer main will be 24” in diameter and approximately 11,000 LF in length. This line will connect into the existing 24” sewer main along Stillwater creek just north of Babcock Park and continue northwest, terminating in the vicinity of West Park lift station. The size of this new sewer main is based on the minimum slope criteria defined by ODEQ and future growth of the area of service. The low invert of this new sewer main will allow an 8” gravity connection from the subdivision served by West Park lift station.

Option 2: This option proposes to construct a dedicated sewer segment parallel to the existing 15” and 12” sewer mains along Hwy 51 and Stillwater creek and connect to the existing 24” sewer main just north of Babcock Park. The proposed dedicated sewer line will be 24” in diameter and approximately 12,500LF in length. The line size is based on minimum slope criteria defined by ODEQ. This option will require the line to be a very deep to allow a gravity connection to the residential subdivision served by West Park lift station. The depth and proximity of this sewer line with another sewer main and adjoining road infrastructure could present significant construction challenges.

Option 3: Leave the West park lift station in operation.

Figure 6-4
West Park Lift Station Elimination Plan



The cost associated with each option for the elimination of the West Park Lift Station is for planning purposes only. Items such as contractor's profit, mobilization, and escalation are not included in the planning estimate. A more detailed estimate may be developed at a future date.

Table 6-3
West Park Lift Station Elimination Cost Estimate

Option 1				
Description	**Quantity**	**Unit**	**Cost**	**Total Cost**
24" PVC Sewer Pipe	11000	LF	$110.00	$1,210,000.00
8" PVC Sewer Pipe	150	LF	$45.00	$6,750.00
4' Diameter Manholes	24	EA	$3,000.00	$72,000.00
Pavement Restoration	50	SY	$60.00	$3,000.00
Boring/Tunneling	150	LF	$250.00	$37,500.00
Convert Existing Lift Station (Remove Equipment)	1	LS	$50,000.00	$50,000.00
Traffic Control and Barricading	1	LS	$10,000.00	$10,000.00
Broadcast Seeding	500	SY	$2.00	$1,000.00
Trench Safety And Support	11150	LF	$10.00	$111,500.00
Erosion Control	1	LS	$15,000.00	$15,000.00
SUB TOTAL				**$1,516,750.00**
Contingency (20%)				$379,187.50
TOTAL				**$1,895,937.50**

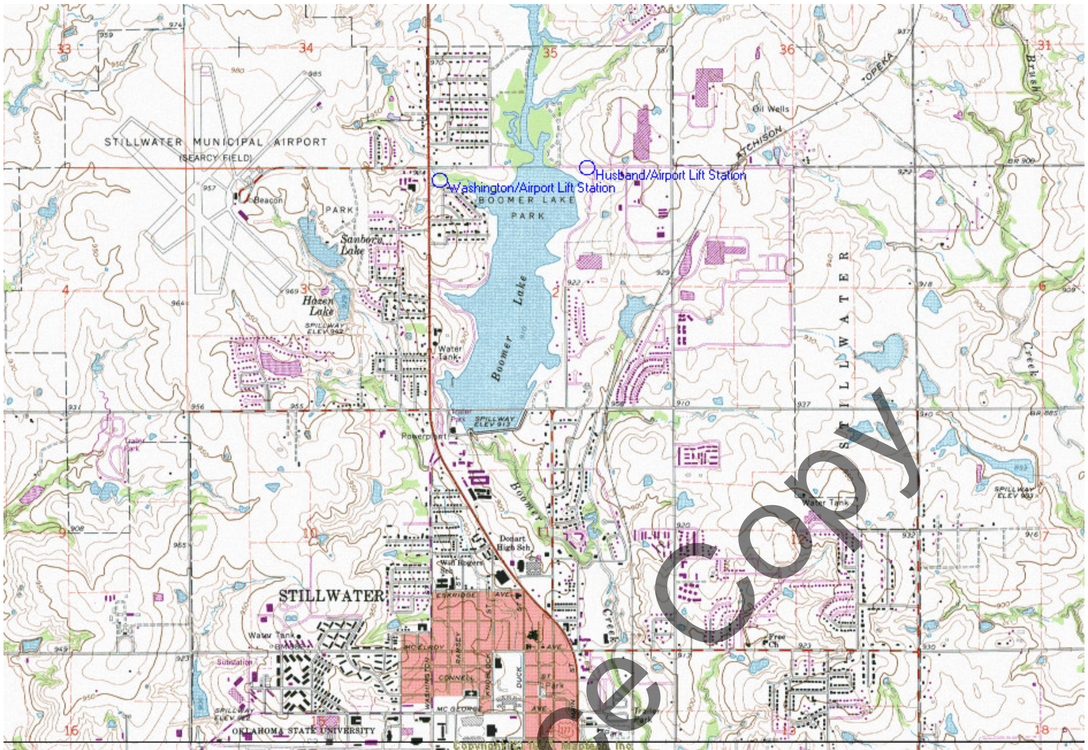
Option 2				
Description	**Quantity**	**Unit**	**Cost**	**Total Cost**
24" PVC Sewer Pipe	12500	LF	$120.00	$1,500,000.00
4' Diameter Manholes	25	EA	$3,000.00	$75,000.00
Pavement Restoration	400	SY	$60.00	$24,000.00
Boring/Tunneling	150	LF	$250.00	$37,500.00
Convert Existing Lift Station (Remove Equipment)	1	LS	$50,000.00	$50,000.00
Connection to existing services	1	LS	$100,000.00	$100,000.00
Traffic Control and Barricading	1	LS	$25,000.00	$25,000.00
Broadcast Seeding	4500	SY	$2.00	$9,000.00
Trench Safety And Support	12500	LF	$10.00	$125,000.00
Erosion Control	1	LS	$15,000.00	$15,000.00
			SUB TOTAL	**$1,960,500.00**
Contingency (20%)				$490,125.00
			TOTAL	**$2,450,625.00**

4. WASHINGTON/AIRPORT & HUSBAND/AIRPORT LIFT STATIONS

The Washington and Husband lift stations are located in the northern Stillwater area. The Washington Lift Station is located near the intersection of Washington and Airport. The Husband Lift Station is located approximately 2,000 LF west of Perkins and Airport. Both lift stations consist of two below ground pumps.

A vicinity map of both Lift Stations is shown as follows:

Figure 6-5
Washington/Airport & Husband/Airport Lift Station Location Map



ELIMINATION FEASIBLITY

The elimination of the Washington and Husband Station may be accomplished by converting the Washington Station into a junction structure and installing a gravity sanitary sewer line under Airport Street. The new gravity line would extend approximately 4,000 lf from the junction structure to a new lift station that would replace the Husband Lift Station. This scenario would allow for the elimination two older lift stations in lieu of one new lift station and a gravity sewer line. The City of Stillwater currently is entering into a service agreement for improvements to the Airport and Husband Lift Station. The required upgrades and modifications should be completed at this time including any change in depth or pumping required to serve this area.

PLANNING LEVEL COST ESTIMATE

The costs associated with the elimination of the Washington and Husband lift stations are for planning purposes only. Items such as contractor's profit, mobilization, and escalation are not included in the planning estimate. A more detailed estimate may be developed at a future date. Additionally, the City is already reconstructing the Airport and Husband Lift Station. If all necessary upgrades are completed as part of the current project, the "construct new lift station" line item should be disregarded.

Table 6-4
Washington/Airport & Husband/Airport Lift Station Elimination Cost Estimate

Description	Qty	Unit	Cost	Total Cost
16-inch DIP	4,000	LF	$150	$600,000
48-inch Manhole	8	EA	$1,500	$12,000
Pavement Restoration	1	LS	$15,000	$15,000
Convert LS into Junction Structure	1	LS	$50,000	$50,000
Remove LS from Service	1	LS	$15,000	$15,000
Construct New Lift Station*	1	LS	$300,000	$300,000
Total				$992,000
Contingency	25%			$248,000
Overall Total				**$1,240,000**

* Currently under construction

STILLWATER WASTEWATER SYSTEM
MASTER PLAN

Chapter 7
Flow Meter Installation and Manhole Survey

Introduction

Jacobs was selected by the City of Stillwater (COS) in December, 2004 to prepare a Master Plan for their wastewater system. An important element in preparing this Master Plan is the development of a computer model for the COS wastewater collection system. To assist in the calibration of this model, the COS installed 18 flow meters in key manholes within the system to gather representative flow data for dry and wet weather conditions. Jacobs then conducted a ground survey of the flow meter manholes to establish manhole locations, rim elevations and flow line elevations. This chapter summarizes the procedures utilized and the data collected for this flow meter manhole survey.

Background

The City of Stillwater is located in Payne County, in north-central Oklahoma, approximately 60 miles between the two metropolitan areas of Oklahoma City and Tulsa. The existing COS Wastewater Collection System consists of approximately 1,200,000 linear feet of sewer pipeline ranging in size from 4-inch to 42-inch. The system also includes approximately 4,500 manholes and 13 sanitary sewage lift stations.

Flow Monitoring Program

In many existing sanitary sewer systems wet weather related Infiltration/Inflow (I/I) is a major cause of hydraulic overloading of both the collection system and the treatment plant. I/I can enter the collection system through faulty pipe joints, cracked pipe and/or manholes. If I/I flows are excessive, it may become necessary to construct additional sewers and expand the treatment plant to handle the increased flows. In preparing a Master Plan for the COS Wastewater System, it is important to evaluate the impacts of I/I on the COS wastewater collection and treatment systems.

When beginning to evaluate the potential impacts of I/I flow on a wastewater collection system, it is essential to measure and compare system flows during periods of dry weather (low flow) and wet weather (high flow). A standard method to develop this data is to install real-time flow meters in key system manholes to measure and record actual flow conditions. By correlating this flow data to corresponding area rainfall data for the same time periods, Jacobs can estimate the I/I impacts on the wastewater collection system. This flow data will also be utilized to calibrate the system computer model.

Jacobs, in conjunction with the COS, developed a flow monitoring program which included the installation of 18 flow meters, 4 tipping bucket rain gages and 6 volumetric rain gages. The COS began installing the 18 ISCO flow meters and rain gages in late April of 2005 and have been maintaining the equipment and collecting data from May 16 onwards. The location of the flow meter manholes and the rain gages is described in Table 7-1 and shown in Exhibit 7-1.

Table 7-1
Flow Meter Manhole Locations

Flow Meter Manhole Number	Stillwater Site No.	Location
1	16	Chiquita
2	1	WWTP
3	10	19th & Boyscout
4	2	2010 South Main
5	9	19th & Lewis
6	3	Western South of Bridge
7	4	Sangre North of 19th
8	5	Owens
9	11	Brushcreek North of 6th
10	14	Strickland Park
11	13	Scholarship Park
12	17	Washington North
13	18	Airport & Quebecor
14	15	Elm & Main
15	12	Virginia & Walmart
16	6	9th & Adams
17	7	12th & Washington
18	8	13th & Knoblock

Flow Meter Installation and Manhole Survey Program

A Jacobs survey crew, lead by Troy Cobb, RPLS and accompanied by COS staff, conducted a ground survey of the flow meter manholes during the last week in April. This survey included the location of each flow meter manhole based on the COS survey control monuments, as well as the rim and flow line elevations for each flow meter manhole. In addition, flow line elevations for manholes directly upstream and downstream of the flow meter manholes were also surveyed.

The results of the flow meter manhole survey are shown on Exhibit 7-2 and summarized in Table 7-2 below. This data will be used to confirm and calibrate the COS wastewater collection System Computer model.

Table 7-2
Flow Meter Manhole Survey Results

Survey Pt.	Manhole	Coordinates		Elevation	
Designation	Designation	Northing	Easting	Rim	Flow Line
100	SSMH 2	398874.89	2256715.1	854.321	
101	FL 2	398874.98	2256715.1		834.02
102	FL 2U	398931.37	2256238.7		834.963
103	FL 2D	398883.82	2257085.8		833.954
104	SSMH 9	408474.48	2259211.4	865.2	
105	FL 9	408473.61	2259212.2		845.004

Survey Pt. Designation	Manhole Designation	Coordinates		Elevation	
		Northing	Easting	Rim	Flow Line
108	SSMH 3	402298.21	2252040.2	855.901	
107	FL 3	402297.37	2252040.7		842.552
106	FL 3U	402568.49	2251825.7		842.773
109	FL 3D	402036.79	2252248.5		842.127
111	SSMH 18	404624.74	2244558.9	860.486	
110	FL 18	404624.63	2244557.8		851.182
112	FL 18D	404262.82	2244561.6		851.001
113	FL 18U	404620.38	2244166.1		851.596
114	SSMH 17	404853.32	2243391.1	862.019	
115	FL 17	404853.36	2243391.1		854.393
116	17D TOP CL	404582.18	2243396.2		862.115
118	SSMH 16	406207.53	2242289.5	879.065	
119	FL 16	406207.49	2242290.6		864.145
117	FL 16D	406198.88	2242458.1		863.89
120	FL 16U	406201.85	2241951.7		864.928
122	SSMH 8	407255.81	2229521	877.606	
121	FL 8	407255.71	2229522.2		870.109
123	FL 8U	407254.31	2229300.6		870.767
124	FL 8D	407257.34	2229665.2		869.815
126	SSMH 7	402803.36	2232850.8	879.136	
127	FL 7	402803.36	2232850.8		864.888
125	FL 7D	403581.77	2233450.5		863.427
128	FL 7U	402793.23	2232354.5		865.481
130	SSMH 14	410034.06	2246513.9	882.037	
131	FL 14	410032.99	2246514.1		873.767
132	FL 14D	409850.2	2246517.9		873.321
129	FL 14U	410216.66	2246509.7		874.128
133	SSMH 11	410921.05	2248241.1	877.529	
134	FL 11	410920.06	2248241.2		863.095
135	FL 11U	411239.48	2248066.3		863.862
136	FL 11D	410620.14	2248408.3		862.597
140	SSMH 15	410312.4	2249376.8	880.122	
137	FL 15U	410608.88	2249373.5		867.793
138	FL 15 IN	410313.31	2249377.3		866.767
139	FL 15 OUT	410312.22	2249375.8		866.899
141	FL 15D	410312.08	2249003.2		865.427

Survey Pt. Designation	Manhole Designation	Coordinates		Elevation	
		Northing	Easting	Rim	Flow Line
142	SSMH 10	410611.44	2247322.9	874.971	
143	FL 10	410611.39	2247323.8		864.419
144	FL 10D	410614.93	2247798.7		864.231
145	FL 10U	410609.24	2246839.1		864.992
146	SSMH 13	424712.66	2246048.5	916.287	
147	FL 13	424711.58	2246048.6		906.508
148	SSMH 6	402789.22	2238201.6	870.282	
149	FL 6	402788.69	2238202.5		857.07
150	SSMH 4	401588.1	2246724.7	860.571	
151	FL 4	401588.99	2246724		847.97
152	SSMH 5	402251.28	2247064.5	861.147	
153	FL 5	402250.56	2247065.2		847.464
154	SSMH 1	416145.61	2246920.3	891.222	
155	FL 1	416145.16	2246921.2		878.062
156	FL 1 U	416319.57	2246727.1		878.993
157	SSMH 12	416813.27	2243200.6	907.102	
158	FL 12	416813.27	2243199.6		895.6
159	FL 12 D	416505.31	2243205.8		894.361
160	SSMH 20 ABANDONED	406113.11	2239179.4	870.87	
161	FL 20	406113.12	2239180.4		855.691
162	SSMH 21	406105.38	2239174.4	870.69	
163	FL 21	406105.71	2239175.3		856.121
170	SSMH 22	406103.04	2239009.8	871.437	
171	FL IN 22	406104.07	2239009.6		856.671
172	SSMH 23	404848.93	2242947.8	862.328	
173	FL OUT 23	404849.04	2242949		855.254
174	CTR HDWL	404838.87	2242935.9	859.218	
175	FL 10X4 RCB N	404838.31	2242935.6		853.129

EXHIBIT 7-1

CITY OF STILLWATER
FLOW METER MANHOLE SURVEY

FLOW METER MANHOLE AND RAIN GAUGE LOCATIONS

EXHIBIT 7-2

CITY OF STILLWATER
FLOW METER MANHOLE SURVEY

FLOW METER MANHOLE SURVEY RESULTS

STILLWATER WASTEWATER COLLECTION SYSTEM
MASTER PLAN

Chapter 8
Collection System Operation and Maintenance

Introduction

Jacobs was selected by the City of Stillwater (COS) in December, 2004 to prepare a Master Plan for their wastewater system. An important element of this Master Plan is the development of representative operation and maintenance costs for the collection system. This chapter summarizes the data and methods utilized in developing operation and maintenance costs for the collection system for the next 50 years for the City of Stillwater Wastewater Collection System Master Plan.

Background

The City of Stillwater is located in Payne County, in north-central Oklahoma, approximately 60 miles between the two metropolitan areas of Oklahoma City and Tulsa. The existing COS Wastewater Collection System consists of approximately 1,200,000 linear feet of sewer pipeline ranging in size from 4-inch to 42-inch. The system also includes approximately 4,500 manholes and 13 sanitary sewage lift stations.

Collection System Maintenance

Routine maintenance activities for the wastewater collection system are essential for maintaining the long-term integrity of the wastewater collection system. Most cities design collection systems for a design life of 50 years. However, those cities expect the lines to last longer than 50 years, and an expectation of a service life of 75 to 100 years is common in the industry. It will become apparent that having a service life that is considerably longer than the design life is necessary for proper utility financing; reinforcing the need for good maintenance practices. Several videos of the City of Stillwater sewer system were provided for review by Jacobs. A summary report of the condition of these lines is included as Appendix B.

The major routine maintenance activities associated with collection system operation include the following:

- System cleaning
- Video inspection
- Rehabilitation and replacement of mains
- Performing infiltration and inflow (I/I) studies

System Cleaning

The more frequently a system is cleaned the better it works. This old adage is still true, and system cleaning is one of the most important things a utility can do to maximize the performance of the system. The frequency with which utilities clean their systems varies considerably, but a target of cleaning the entire system every four years should be considered desirable. Certain portions of the system may require more frequent cleaning, and some portions may require cleaning less frequently, but a four year average cycle is a good goal.

Video Inspection

Video inspection provides an excellent tool for evaluating the condition of the system. A goal of completely inspecting 5% of the system per year should be considered reasonable. Obviously, the system needs to be cleaned prior to inspection; therefore, these two tasks need to be coordinated.

Rehabilitation and Replacement

The pipe in the system will not last forever; therefore, it is critical that the utility have a program of routine rehabilitation and replacement of the piping. The most desirable goal is to operate the system with an average life of 50 years; however, this is usually not a fiscally achievable objective.

Infiltration and Inflow Studies

Infiltration and inflow studies should be conducted on a sewershed by sewershed basis. The data obtained will help focus the replacement program on those lines that will provide the maximum benefit to the utility. It is important to conduct and I/I study before and after rehabilitation work has been preformed. When performed in this manner it is possible to evaluate the actual amount if I/I reduction achieved. The system goal should be to have an I/I study performed every 20 years.

Projected System Maintenance Costs

The preliminary estimate for replacing the entire wastewater collection system is presented in Table 8-1. The estimate is approximately $119 million. When an average replacement cost of $100 per linear foot is used, a replacement cost of approximately $115 million is obtained. For planning purposes using a replacement cost of $120 million is recommended.

Table 8-1
Estimated Collection System Replacement Costs

SIZE	LENGTH	UNIT COST	TOTAL COST
Inch	***Feet***	**$/LF**	**$**
<4	8,081	$40.00	$323,240.00
4	12,853	$40.00	$514,120.00
6	69,440	$40.00	$2,777,600.00
8	734,168	$50.00	$36,708,400.00
Subtotal	***824,542***		***$40,323,360.00***
10	63,468	$55.00	$3,490,740.00
12	70,745	$60.00	$4,244,700.00
14	79	$65.00	$5,135.00
15	48,729	$70.00	$3,411,030.00
16	795	$75.00	$59,625.00
18	27,991	$85.00	$2,379,235.00
20	20	$95.00	$1,900.00
21	12,553	$105.00	$1,318,065.00
24	12,396	$130.00	$1,611,480.00
27	22,992	$160.00	$3,678,720.00
30	9,400	$190.00	$1,786,000.00
33	9,030	$205.00	$1,851,150.00
36	12,992	$215.00	$2,793,280.00
42	3,765	$285.00	$1,073,025.00
Subtotal	***294,955***		***$27,704,085.00***
Total Pipe	***1,119,497***		***$68,027,445.00***
Manholes	**4500**	$1,500.00	$6,750,000.00
Misc. Paving/Service Connection/etc.	NA	30% Pipe Cost	$20,408,233.50
Total Miscellaneous Items			***$27,158,233.50***
Sub Total			***$95,185,678.50***
Administration, Engineering and Inspection @ 25%			***$23,796,419.63***
Grand Total			***$118,982,098.13***

If the system is to have an average life of 50 years, two percent of the system must be replaced every year; this corresponds to an annual replacement program of $2.4 million. Additionally, it is important to note that approximately 10% of the total linear footage of pipe in the system will be upsized over the next 50 years in order to provide additional capacity for the current and projected flow. It is recommended that when and if a pipe that is projected for upsizing at a later date develops a condition problem, that pipe should be upsized at that time in order to prevent a scenario where a newly rehabilitated pipe is then replaced due to capacity issues.

System cleaning requirements on a 4 year cycle are 279,875 LF per year. Assuming the crews can work 200 days out of the year, a production rate of 1,400 LF per day is required. Most operators estimate sustained production at about 1,000 LF per day; therefore, approximately two cleaning crews will be required.

The cost associated with a single crew is presented in Table 8-2 below. Based on this information, an annual budget of $320,000 for cleaning should be established.

Table 8-2
Single Cleaning Crew Costs

Item	Annual Cost
Personnel (4peoplex$20Kx1.5)	$120,000
Equipment	$25,000
Administration	$15,000
Total	**$160,000**

Video inspection of 5% of the system annually results in a twenty-year cycle for the entire system. This rate will require 55,975 LF/year of pipe to be inspected each year. Assuming 200 production days per year, a production rate of 280 LF/day is required. This is reasonable rate for one crew. The costs associated with a video inspection crew are presented in Table 8-3 below. Based on this information, the annual budget for video inspection should be established at $185,000.

Table 8-3
Single Video Inspection Crew Costs

Item	Annual Cost
Personnel (4peoplex$20Kx1.5)	$120,000
Equipment	$35,000
Administration	$15,000
Engineering Support	$15,000
Total	**$185,000**

The costs for I/I studies vary, but a good planning number is to assume about $2.50 per LF of pipe. Therefore, if the goal is to perform I/I studies at 20 year intervals, approximately 55,975 LF of line would have to be evaluated each year. This represents an annual cost of $140,000.

Summary

The costs associated with a comprehensive maintenance program with a 50-year replacement cycle are summarized in the Table 8-4 below.

Table 8-4
Maintenance Program Costs with 50-Year Replacement Cycle

Program Component	Annual Cost in 2008 Dollars
Rehabilitation and Replacements	$2,400,000
System Cleaning	$320,000
Video Inspection	$185,000
I/I Studies	$140,000
Total Annual Cost	**$3,045,000**

Based on an average water production rate of 10 MGD, at total of 3,650,000 thousand gallons (T-gal) are produced during a calendar year. Therefore, the proposed 50-Year program would represent an increase of $0.834 per T-gal.Assuming a 10,000-gallon per month customer with a monthly bill of $23.50, the impact of the 50-Year program is to require an increase in the monthly bill of $8.34, or 35.5 percent.

The costs for a maintenance program with a 75-year replacement cycle are summarized in Table 8-5 below. The annual costs will be $2,231,000, which is an increase in cost of $0.611 per T-gal. This translates into a monthly increase in the sewer bill of $6.11 or a 26.0 percent increase.

Table 8-5
Maintenance Program Costs with 75-Year Replacement Cycle

Program Component	Annual Cost in 2008 Dollars
Rehabilitation and Replacements	$1,586,000
System Cleaning	$320,000
Video Inspection	$185,000
I/I Studies	$140,000
Total Annual Cost	**$2,231,000**

If the service life of the pipes can be extended to 100 years, then costs presented in Table 8-6 can be anticipated. These costs are $1,835,000 per year, or an increase of $0.503 per T-gal. This would result in an increase in the monthly sewer bill of $5.03, or a 21.4 percent increase.

Table 8-6
Maintenance Program Costs with 100-Year Replacement Cycle

Program Component	Annual Cost in 2008 Dollars
Rehabilitation and Replacements	$1,190,000
System Cleaning	$320,000
Video Inspection	$185,000
I/I Studies	$140,000
Total Annual Cost	**$1,835,000**

The impact of actual service life on the annual costs to the rate payer is summarized in Table 8-7. Although a 50-year replacement cycle is desirable very few utility operators are able to afford the costs associated with that program. Therefore, to develop a program the citizens are willing to finance, extended service life is essential. For this reason having a good maintenance program is vital – you have to keep what you own working. The corollary to this is to build it right the first time so you do not have to replace it too soon!

Table 8-7
Summary of Annual Maintenance Program Costs for Various Collection System Replacement Options

Program	Annual Cost ($)	Increase In Average Sewer Bill ($)	Increase In Average Sewer Bill (percent)
50-Yr Replacement	$3,045,000	$8.34	35.5
75-Year Replacement	$2,231,000	$6.11	26.0
100-Year Replacement	$1,835,000	$5.03	21.4

STILLWATER WASTEWATER COLLECTION SYSTEM MASTER PLAN

Chapter 9
Sanitary Sewer Modeling

Introduction

One of the most important components of this Master Plan report is the creation of a sanitary sewer model for the entire City of Stillwater (COS). Data acquisition at various stages in the development of this model along with the methodology used is summarized in this chapter.

The Hydraulic Model

The modeling process follows a series of interdependent tasks. The existing COS sanitary sewer geometry data furnished by the City was verified and supplemented using field survey data and recorded in the model database. The sanitary flows derived from COS GIS dwelling maps and rooftop counts, were loaded into the model, and adjusted to reflect field monitoring data. Finally, model scenarios were created to analyze the sanitary sewer system for varying geometry and sanitary load conditions.

The Software

The model of the sanitary sewer provided by the City of Stillwater was created in XPSWMM and converted to SewerGEMS V8 XM software. SewerGEMS is a dynamic hydraulic modeling computer program from Bentley used to model gravity sewer systems. The software uses the commonly accepted Saint-Venant's equation for gradually varied unsteady flow. The advantage of this software is that it is platform independent. This allows the software to work seamlessly with both CAD and GIS software, as well as in stand alone version. The software's graphical user interface is quite simple to use, which makes it very easy to enter and modify data relating to the components of the sewer model. There are several tools which can help populate the raw data in the model's database. "Model Builder" tool, for example, uses CAD/GIS line or point data and converts it to sewer pipes and manholes. Similarly, "Load Builder" tool can be used to process land use or population data to apply sanitary or combined loads the model. Once the model data is loaded the software easily allows setting up "what-if" scenarios. The final results are very clear and presentable in a number of output formats.

Model Geometry

To facilitate model development, it was decided to divide the existing COS sanitary sewer system in four major sewersheds. Scenarios with varying sanitary load conditions and geometry combinations were created within each model for each of the sewersheds.

The geometry of the model was created using an existing XPSWMM model and survey data collected by Jacobs and COS staff. The model files were converted to more robust software SewerGEMS. Upon inspection of the existing data in the model provided it was determined that additional field surveying was required to verify and supplement the sewer system geometry.

In April 2005, a Jacobs crew accompanied by COS staff conducted ground survey of manholes fitted with flow meters. Additional upstream and downstream manhole data was also obtained in the vicinity of the manholes with flow meters. The details of the survey can be found in Chapter 7 of this report.

Dry Weather Loading and Calibration

The existing dry weather flows were developed using exiting wastewater basins boundary data and dwelling mapping provided by COS. The data provided by COS in GIS format was used to perform a roof top count. Smaller sanitary loading areas contributing to the loading node of the model were identified. Based on the criteria detailed in depth is chapter 5 "Population Distribution", an assumed value of 120 gallons per capita per day was used to calculate the average flow for that particular sanitary loading area.

The future flows were developed based on potential land areas for development and their projected land use. This data was taken from the Comprehensive Plan provided by COS. Based on the criteria detailed in depth is chapter 5 "Population Distribution", an assumed value of 120 gallons per capita per day was used to calculate the average flow for that particular sanitary loading area.

For the Master Plan, the model was analyzed for the 2005 and 2055 planning periods. For each period, Jacobs coordinated with the City of Stillwater planning department to develop agreed upon population projection and distribution. More detail about the population projection and distribution can be found in Chapters 4 and 5.

Flow meter data was taken from a study performed previously in which 18 flow meters were used to measure the flow in the City of Stillwater system. For the dry weather scenario, three "no rain" days from the data collection period (5/24/05, 5/25/05, and 5/26/05) were averaged to determine the average daily dry weather flow curve at each flow meter. The curves were made unit less by dividing by a common factor. This helped develop a flow curve specifically for that flow meter.

Model Calibration was performed by first adding the derived daily dry weather flow curve to more accurately reflect actual flow in the model. All loading points were assigned the pattern associated with the closest downstream flow meter. Once the flow volume projections and predicted flow patterns were entered into the model, the values of the pattern were iteratively compared with actual flow data values and modified until the flow pattern and magnitude for each loading point matched the data found by the flow meters. The dry weather model was set up to serve as a base for the other models. The final calibration curves are shown in Appendix C. The dry weather flow hydrographs for each sewershed are shown in Appendix D.

Wet Weather Loading and Calibration

The limited availability of wet weather flow data made the inflow estimation quite challenging. Many of the flow meters either were not functioning or provided errant data during significant storm events and thus a uniform rain event could not be determined for the entire city. For purpose of simplicity, the COS was divided up in four quadrants each corresponding to a specific rain gauge. Table 9-1 shows a collection precipitation data for significant events in each of the four quadrants of the city. A rain gauge location map is shown as Exhibit 7-1.

Table 9-1
Major Events Depth at Rain Gages

Event Date	Quadrant			
	NE	**NW**	**SW**	**SE**
13-May	1.37	1.48	3.07	0.77
31-May	0.79	0.56	0.15	1.09
12-Aug	0.68	ND	1.52	ND
13-Aug	0.41	ND	0.50	ND
14-Aug	0.51	ND	0.94	ND
20-Aug	0.85	0.49	1.13	2.44
22-Aug	2.08	2.28	3.17	2.31
13-Sept	0.96	0.44	0.00	0.19
14-Sept	1.47	0.00	1.92	1.67
15-Sept	1.14	0.00	0.99	1.10
30-Sept	0.35	0.56	0.60	0.51
1-Oct	1.08	1.46	1.02	0.73
11-Oct	0.25	0.24	0.30	0.20
31-Oct	0.49	0.39	0.50	0.59

As a result of precipitation, the response of the manhole flow meter downstream of that gauge was also recorded. Table 9-2 shows the date of significant precipitation events on which flow mater data was measured and used. The flow meter data was processed to remove the "dry weather flow" from the combined "wet and dry weather flow" hydrograph. It was assumed that the resulting inflow hydrograph is a direct result of the precipitation occurrence on the rain gauge in that quadrant. Since a uniform precipitation depth criterion is required for true wet weather modeling, the individual recorded depths in each quadrant at various occurrences were modified to match a 3.6" (i.e. 5yr 24 Hr) hypothetical storm depth. This resulting hydrograph showed a linear relation the inflow hydrograph from the actual storm event. The wet weather flow hydrographs for each sewershed are shown in Appendix D.

Table 9-2
Flow Meter Precipitation Events

Stillwater Site No.	Stillwater Site Location	Data			
		Round 1	Round 2	Round 3	Round 4
1	WWTP	5/16-6/20	ND	9/20-10/10	10/10-11/17
2	2010 South Main	5/6-6/20	ND	ND	ND
3	Western South of Bridge	5/6-6/20	6/23-8/25	ND	10/10-11/17
4	Sangre North of 19th	5/6-6/20	ND	9/20-10/10	10/10-11/17
5	Owens	5/17-6/20	6/18-8/25	9/20-10/10	10/10-11/17
6	9th & Adams	5/2-6/1	7/27-8/26	ND	ND
7	12th & Washington	5/6-6/20	7/1-8/25	9/20-10/10	10/10-11/17
8	13th & Knoblock	5/17-6/20	ND	9/20-10/10	10/10-11/17
9	19th & Lewis	5/17-6/20	6/19-8/25	9/22-10/10	ND
10	19th & Boyscout	5/17-6/20	ND	9/19-10/10	10/10-11/17
11	Brushcreek North of 6th	5/16-6/20	6/19-8/25	9/19-10/10	10/10-11/17
12	Viriginia & Walmart	4/7-6/20	ND	ND	ND
13	Scholarship Place	5/6-6/20	ND	9/20-10/10	10/10-11/17
14	Strickland Park	5/11-6/20	6/18-8/25	9/20-10/10	10/10-11/17
15	Elm & Main	5/11-6/20	6/20-8/25	ND	ND
16	Chiquita	4/7-6/20	ND	9/20-10/10	10/10-11/17
17	Washington North	4/7-6/20	ND	9/20-10/10	10/10-11/17
18	Airport & Quebecor	5/6-6/20	6/20-8/25	9/20-10/10	10/10-11/17

Hydraulic Analysis: Existing Sanitary Sewer System

The hydraulic model analyzed the capacity of the existing (10” and above with exception of some 8”) Sewer Mains and lift stations in the COS sanitary sewer system. As mentioned earlier, four separate models were created and named as follows:

- SW Sewershed
- E Sewershed
- DT Sewershed
- NE Sewershed

Two lift stations within the system were analyzed to determine if any upgrading would be needed to accommodate the future flow. The lift stations analyzed are as follows:

- Husband/Airport Liftstation
- Washington/ Airport Liftstation

By running the model and simulating the flow in the system, it was possible to determine the capacity needs of the system for both current and future scenarios. SewerGEMS software’s graphical representation tools were utilized to help identify the problem areas in both plan view and profile view. The sewer system in plan view was set up to display sewers in specific colors for surcharged/ non-surcharged conditions. The analysis showed that there were numerous lines and manholes which surcharged at varying sanitary load and combined conditions. Lift stations were also evaluated for their performance under these sanitary loads and the needs for upgrades were evident in most scenarios.

The color designation created in SewerGEMS to identify surcharged/non-surcharged pipes was mapped using GIS mapping tools. The resulting graphical representation for the problematic areas is shown in Exhibits 9-1 through 9-2. Detailed sewer profiles for the existing sewer system are shown in Appendix E.

Hydraulic Analysis: Proposed Sanitary Sewer Improvements

Once the capacity limitations were identified for the current (2005) and the future (2055) conditions for wet weather scenarios, the models were run for the same scenarios with upsized (proposed) pipes to identify any remaining capacity related issues. Since the planning periods are 50 years apart it was determined that pipes would only be upgraded to the required size for the current planning period. If necessary, the pipe will be upsized again in 2055. Cost details for the proposed improvements are shown in Chapter 10 of this text. A Capital Improvements map is shown as Exhibit 10-1.

Summary of Results
Northeast Model

The northeast model collects flow from the north and east portions of Stillwater. This model includes two lift stations, one at Airport and Husband and the other at Washington and Airport. For the 2005 model, a good portion of the lines north of the City that flow to the Airport and Husband or Washington and Airport lift stations are either surcharging or overflowing. Additionally, several lines of a tributary east/southeast of the City are either surcharging or overflowing. The model also indicates that approximately 135,000 gpd are escaping this portion of the system and are not reaching the treatment plant. A map showing the location of these surcharged/overflowing lines is included in Exhibit 9-1. For the 2055 model, no additional pipes become surcharged or overflowing due to the change in population. The model does indicate an increase in the amount of flow escaping into the system equaling an additional 165,000 gpd (~300,000 gpd total). Some additional pipes have been added to the model in order to serve future development in currently unserved areas. These lines appear in black in Exhibit 9-2.

East Model

The east model collects flow from the east and northeast of central Stillwater. This model does not include any lift stations. For the 2005 model, a little more than half of the conduits are either overflowing or surcharging. Additionally, the model indicates that approximately 265,000 gpd are escaping from this portion of the system and are not reaching the treatment plant. A map showing the location of the surcharged/overflowing lines for the 2005 East model is included in Exhibit 9-1. For the 2055 model, several additional segments become surcharged/overflowing due to the change in population. The model also indicates an increase in the amount of flow excaping into the system equaling an additional 35,000 gpd (~300,000 gpd total). No additional pipes have been added to the model for future development. A map showing the location of the surcharged/overflowing lines for the 2055 East model is included in Exhibit 9-2.

Downtown Model

The downtown model collects flow from the majority of central Stillwater. This model includes one lift station, Myer's Park, near McFarland and 6th Ave. For the 2005 model, only four locations show segments at that overflowing/surcharged. This includes more than half of the line running along 6th Ave along with several tributaries. The model does not indicate that flow is escaping the system, meaning that the overflowing/surcharged lines have hydraulic grades that are above the top of the pipe but never reach or exceed ground level. A map showing the location of surcharged/overflowing lines for the 2005 Downtown model is included in Exhibit 9-1. For the 2055 model, some additional pipes become surcharged/overflowing. The additional pipes occur along the same lines mentioned above including the line along 6th Ave which is shown as completely surcharged/overflowing. Like in 2005, the model does not indicate that flow is escaping the system in 2055. No additional pipes have been added to the model for future development. A map showing the location of the surcharged/overflowing lines for the 2055 Downtown model is included in Exhibit 9-2.

Southwest Model

The southwest model collects flow from the south and southwest portion of Stillwater. Additionally, the Downtown and East models flow directly into the Southwest trunk line and are conveyed to the wastewater treatment plant through this line. For the 2005 model, based on flow currently coming from the other two models, only two segments are overflowing/surcharging. However, when the Downtown and East models are upgraded to include the proposed pipes, a string of segments near the points of intersection of the models becomes overflowing/surcharged. The model does not indicate that flow is escaping the system, meaning that the overflowing/surcharged lines have hydraulic grades that are above the top of the pipe but never reach or exceed ground level. A map showing the location of surcharged/overflowing lines for the 2005 Southwest model is included in Exhibit 9-1. For the 2055 model, no additional pipes become overflowing/surcharged due to flow within the Southwest model. However, the additional flow coming from the Downtown and East models does create a longer string of lines that are overflowing/surcharging in the area of the points of intersection. Like in 2005, the model does not indicate that flow is escaping the system in 2055. Some additional pipes have been added to the model in order to serve future development in currently unserved areas. Several existing pipe segments need to be upgraded in order to provide a consistent increase in size of pipe in the areas of the future pipes. These lines appear in black in Exhibit 9-2.

EXHIBIT 9-1

UNDERSIZED SANITARY SEWERS 2005

EXHIBIT 9-2

UNDERSIZED SANITARY SEWERS 2055

STILLWATER WASTEWATER COLLECTION SYSTEM
MASTER PLAN

Chapter 10
Capital Improvement Program Recommendations

Introduction

The results of the modeling identify the proposed improvements to the existing sanitary sewer system for City of Stillwater for the next 50 years (i.e. planning period of 2005 and 2055). This Capital Improvements Plan (CIP) includes detailed information for existing sewer replacement, new wastewater lines for service to areas of growth and other infrastructure upgrades. The plan also presents estimated Capital Cost associated with these improvements.

Existing Sanitary Sewer System Improvements

Improvements to existing sanitary sewer system of the City of Stillwater is required due to inadequate conveyance capacity and/or sewer condition. The modeling results can only identify capacity inadequacies, however, pipe replacement/rehabilitation due to sewer condition and the cost associated for maintenance is discussed in more detail Chapter 8 “Collection System Operation and Maintenance” of this Master Plan.

The capacity constraints highlighted by modeling show that the majority of the improvements are required in the 2005 planning period. These improvements if addressed in time will also provide a relatively economical solution in the long term. A detailed list of sewer segments recommended for replacement, as well as required to meet future needs for planning periods of 2005 and 2055 are shown in Tables 10-1 through 10-4 at the end of this chapter. A brief summary of the number of segments and linear footage of existing sewer lines requiring improvements for the 2005 and 2055 planning periods is shown in the Tables 10-5 and 10-6 below.

Table 10-5
Number of Line Segments to be Replaced

Sewershed	2005	2055
Downtown	32	0
East	352	17
Northeast	16	0
Southwest	19	20
Total	**419**	**37**

Table 10-6
Linear Footage of Pipe to be Replaced

Sewershed	2005	2055
Downtown	7928	0
East	96232	3636
Northeast	5285	0
Southwest	8101	6029
Total	**117546**	**9665**

As evident from these tables, the East sewershed contains the vast majority of the undersized pipes. Additionally, following the pipe upgrades to address 2005 capacity needs, very little will have to be done in 2055 to address future capacity needs in this sewershed. The pipes identified for replacement for both planning periods are shown as Exhibit 9-1 and 9-2. Exhibit 10-1 shows a map of the capital improvements for each planning period.

The modeling also identified improvements to the existing lift stations. These improvements, recommendations and their costs are addressed Chapter 6 “Lift Station Feasibility”. It is recommended that the Washington and Airport lift station will be eliminated and the Husband and Airport lift station will be rebuilt and upgraded as part of a project outside of this Master Plan. The model suggests that the Husband and Airport lift station will see a substantial increase in flow and thus, the current lift station improvement project should consider these increases during their design.

Capital Costs for Existing Sanitary Sewer System Improvements

The calculations for the total cost of the sewer improvements per sewershed, especially for sewer mains, are based on the unit cost for the replacement pipe size and its associated length. Lift station improvement cost is based on equipment replacement, wet well reconstruction or rehabilitation and improvements to force main. The unit costs for these sanitary sewer system improvements are based on current construction costs. Additionally, costs have been added to include construction contingency, engineering, survey, construction administration, inspection, and materials testing. The calculation detail is shown in the following table.

Table 10-7
Calculation of Total Cost

Subtotal (material and placement)
Contingency (30%)
Subtotal
Engineering (7.5%)
Survey (2.5%)
Project Administration (10%)
Inspection (2.5%)
Material Testing (2%)
Total Cost (2009 Dollars)

Tables 10-8 and 10-9, at the end of this chapter, show the cost detail for each sewershed. A summary of the capital cost per sewershed for each planning year is given in Table 10-10.

Table 10-10
Summary of Costs for Sanitary Sewer Lines

Sewershed	2005	2055
Downtown	$ 2,524,000	-
East	$ 35,848,000	$ 1,319,000
Northeast	$ 1,607,000	-
Southwest	$ 5,161,000	$ 1,987,000
Total per Year	**$ 45,140,000**	**$ 3,306,000**

* All costs are given in 2009 dollars.

New Sanitary Sewer Lines

The planning department of the City of Stillwater projects that significant growth will occur on almost all sides of the current Stillwater city limits. For details about the Population Distribution refer to Chapter 5 “Population Distribution” of this report. In order to accommodate this future growth, it is recommended that new wastewater interceptors be constructed to serve these areas. It is recommended that these line be constructed at the time of the development and be sized for the 2055 projected flows. A layout of these proposed lines is also shown in Exhibit 10-1. A detailed cost estimate for the proposed sanitary sewer lines is included as Table 10-11.

Table 10-12
Linear Footage of New Pipe

Sewershed	2055
Southwest	101259
Northeast	34141
Total	**135400**

Table 10-13
Summary of Costs for New Sanitary Sewer Lines

Sewershed	2055
Southwest	$ 34,195,000
Northeast	$ 11,520,000
Total per Year	**$ 45,715,000**

* All costs are given in 2009 dollars.

Capital Improvement Program - Summary

The Capital Improvement Program for the City of Stillwater encompasses all aspects of the wastewater collections system, including existing pipe replacement to meet future demands and construction of new Sewer Mains to serve future development needs, however the rehabilitation/replacement of existing infrastructure components due to deteriorating condition are discussed separately as part of the Operations and Maintenance budget.

The Capital Cost to replace all of the required pipes due to current or projected capacity limitations is quite large and it is not feasible to make these improvements as one large project. Therefore, smaller projects have been created for the COS to plan the improvements. The following tables summarize the projects, their total linear footage and projected costs for improvements. Appendix F can be referred to for detailed information about these projects.

Table 10-14 Replaced Pipes 2005		
Project Name	Total LF of Pipe	Total Cost
DT1	2566	$ 872,000.00
DT2	2704.7	$ 854,000.00
DT3	2656.9	$ 798,000.00
NE1	3415	$ 1,018,000.00
NE2	1869.8	$ 589,000.00
SW1	2535.6	$ 1,675,000.00
SW2	2615	$ 1,678,000.00
SW3	4979.1	$ 1,693,000.00
SW4	385	$ 115,000.00
E1	2045.6	$ 643,000.00
E2	2459	$ 1,634,000.00
E3	2414.1	$ 1,597,000.00
E4	5519.8	$ 1,793,000.00
E5	3170	$ 988,000.00
E6	3600.7	$ 1,842,000.00
E7	2755	$ 934,000.00
E8	2759.6	$ 1,427,000.00
E9	3853.9	$ 1,238,000.00
E10	4053	$ 1,313,000.00
E11	3470.2	$ 1,131,000.00
E12	3465.6	$ 1,885,000.00
E13	4500.7	$ 1,478,000.00
E14	2969	$ 946,000.00
E15	2481.6	$ 820,000.00
E16	2515	$ 1,161,000.00
E17	3067.5	$ 1,296,000.00
E18	3992.9	$ 1,324,000.00
E19	2883.8	$ 946,000.00
E20	3581.5	$ 1,150,000.00
E21	3992	$ 1,451,000.00
E22	5372.7	$ 1,695,000.00
E23	2797.9	$ 985,000.00
E24	2995.4	$ 1,043,000.00
E25	2886	$ 999,000.00
E26	5159.5	$ 1,705,000.00
E27	5009.3	$ 1,626,000.00
E28	2460.4	$ 798,000.00
Totals	**119958.8**	**$ 45,140,000.00**

Table 10-15 Replaced Pipes 2055		
Project Name	Total LF of Pipe	Total Cost
SW5a	2214.9	$ 778,000.00
SW11a	3813.9	$ 1,209,000.00
E1	3636.1	$ 1,319,000.00
Totals	**9664.9**	**$ 3,306,000.00**

Table 10-16 Proposed Pipes 2055		
Project Name	Total LF of Pipe	Total Cost
NE1	3171.8	$ 1,029,000.00
NE2	2910.1	$ 947,000.00
NE3	3412.7	$ 1,354,000.00
NE4	3905.6	$ 1,498,000.00
NE5	4127.3	$ 1,465,000.00
NE6	4183.2	$ 1,349,000.00
NE7	4776.2	$ 1,486,000.00
NE8	2979.7	$ 978,000.00
NE9	4674.1	$ 1,414,000.00
SW1	4665.2	$ 1,554,000.00
SW2	4416.9	$ 1,401,000.00
SW3	4182.6	$ 1,274,000.00
SW4	4379.4	$ 1,322,000.00
SW5b	5725.6	$ 1,852,000.00
SW6	3347.4	$ 1,038,000.00
SW7	3609.7	$ 1,193,000.00
SW8	4144.6	$ 1,314,000.00
SW9	4007	$ 1,248,000.00
SW10	4173.5	$ 1,297,000.00
SW11b	5801.5	$ 1,755,000.00
SW11c	4949	$ 1,974,000.00
SW11d	4734.7	$ 1,871,000.00
SW11e	6822.1	$ 2,695,000.00
SW11f	4527.6	$ 1,359,000.00
SW12	4990.5	$ 1,579,000.00
SW13	3207.7	$ 1,300,000.00
SW14	3698	$ 1,491,000.00
SW15	3572.2	$ 1,374,000.00
SW16	3508.7	$ 1,258,000.00
SW17	3380.5	$ 1,145,000.00
SW18	4036.5	$ 1,314,000.00
SW19	4282.2	$ 1,312,000.00
Totals	**135400**	**$45,715,000.00**

In the tables above, the project's name represent the basin in which the project is located (DT=downtown, E=east, etc) and they are number sequentially within each basin as to the preferred order of the projects. Depending on the available funds in the City of Stillwater, these projects can be completed at a rate of one (1) per year, but preferably, several projects would be completed each year so that all of the projects can be completed more quickly and capacity issues in the system can be resolved.

Capital Improvement Program - Economic analysis

Based on a capital improvement cost of $45 million in 2005, assuming that the City of Stillwater has approximately 30,000 customers and can receive a 5% interest rate on a 50 year bond sale, the 2005 capital improvements will increase the monthly sewer rate by $6.50 per connection. Moreover, based on an additional cost of $49 million in 2055, the 2055 improvements will result in an increase of the monthly sewer rate by an additional $6.75 under the same assumptions.

Table 10-2:Downtown

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Cost Per Segme	Cost per Segment
298	g24m13	g24m12	257	8	10	$ 55.00	$ 14,135.00								
299	g24m12	g24m11	252	8	10	$ 55.00	$ 13,860.00								
300	g24m11	g24m10	345	8	10	$ 55.00	$ 18,975.00								
301	g24m10	g24m09	248	8	10	$ 55.00	$ 13,640.00								
302	g24m09	g24m08	317.9	8	10	$ 55.00	$ 17,484.50								
303	g24m08	g24m07	340	8	10	$ 55.00	$ 18,700.00								
304	g24m07	g24m06	340	8	10	$ 55.00	$ 18,700.00								
305	g24m06	g24m05	161	8	10	$ 55.00	$ 8,855.00								
306	g24m05	g24m04	161	8	10	$ 55.00	$ 8,855.00								
307	g24m04	g24m03	235	8	10	$ 55.00	$ 12,925.00								
310	g24sm02	g24sm01	174	8	10	$ 55.00	$ 9,570.00								
311	g24sm04	g24sm03	185.6	8	10	$ 55.00	$ 10,208.00								
312	g24sm03	g24sm02	145.6	8	10	$ 55.00	$ 8,008.00								
313	g24sm06	g24sm05	135	8	10	$ 55.00	$ 7,425.00								
314	g24sm05	g24sm04	100	8	10	$ 55.00	$ 5,500.00								
315	g24sm08	g24sm07	261.5	8	10	$ 55.00	$ 14,382.50								
316	g24sm07	g24sm06	135	8	10	$ 55.00	$ 7,425.00								
317	g24sm09	g24sm08	259	8	10	$ 55.00	$ 14,245.00								
318	g24sm01	g24m01	119.3	8	10	$ 55.00	$ 6,561.50								
346	g10wm13	g10wm12	165	8	10	$ 55.00	$ 9,075.00								
347	g10wm12	g10wm11	334	8	10	$ 55.00	$ 18,370.00								
348	g10wm11	g10wm10	212	8	10	$ 55.00	$ 11,660.00								
355	g23m02	g23m01	450	15	18	$ 85.00	$ 38,250.00								
359	g10wm16	g10wm15	294.8	8	10	$ 55.00	$ 16,214.00								
360	g10wm15	g10wm14	170.9	8	10	$ 55.00	$ 9,399.50								
361	g10wm14	g10wm13	13	8	10	$ 55.00	$ 715.00								
434	f22em07	f22em06	70	15	18	$ 85.00	$ 5,950.00								
435	f22em08	f22em07	428	15	18	$ 85.00	$ 36,380.00								
436	f22em11	f22em10	397	15	18	$ 85.00	$ 33,745.00								
437	f22em10	f22em08	399	15	18	$ 85.00	$ 33,915.00								
438	f22em12	f22em11	372	15	18	$ 85.00	$ 31,620.00								
564	g23m01	f22em12	450	15	18	$ 85.00	$ 38,250.00								

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-3:East

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	unit cost	Cost per Segment
505	D3M02	MH-1	320	12	15	$ 70.00	$ 22,400.00	529	C8M30	C8M29	359	18	21	$ 105.00	$ 37,695.00
506	D3M09	D3M08	269	10	15	$ 70.00	$ 18,830.00	530	C8M29	C8M28	359	18	21	$ 105.00	$ 37,695.00
507	D3M08	D3M07	292.2	10	15	$ 70.00	$ 20,454.00	531	C8M28	C8M27	205.9	18	21	$ 105.00	$ 21,619.50
508	d3m07	d3m06	267.8	10	15	$ 70.00	$ 18,746.00	532	C8M27	C8M26	120	18	21	$ 105.00	$ 12,600.00
510	d3m11	d3m10	88.3	10	15	$ 70.00	$ 6,181.00	572	C8NM02	C8NM01	125.2	15	18	$ 85.00	$ 10,642.00
511	d3m10	d3m09	385	10	15	$ 70.00	$ 26,950.00	614	C5M01	C8M32	165	12	15	$ 70.00	$ 11,550.00
512	D3M14	D3M13	289.4	10	15	$ 70.00	$ 20,258.00	619	C5M03	C5M02	323.5	12	15	$ 70.00	$ 22,645.00
513	D3M13	D3M12	79.7	10	15	$ 70.00	$ 5,579.00	620	C5M02	C5M01	16.5	12	15	$ 70.00	$ 1,155.00
514	D3M12	D3M11	229.1	10	15	$ 70.00	$ 16,037.00	747	E20M10	E20M09	386	15	18	$ 85.00	$ 32,810.00
515	D3M16	D3M15	351.2	10	15	$ 70.00	$ 24,584.00	748	E20M09	E20M08	179	15	18	$ 85.00	$ 15,215.00
516	D3M15	D3M14	281.6	10	15	$ 70.00	$ 19,712.00	749	E20M08	E20M07	150	15	18	$ 85.00	$ 12,750.00
517	D3M18	D3M17	352	10	15	$ 70.00	$ 24,640.00	750	e20m06	e20m04	323	15	18	$ 85.00	$ 27,455.00
518	D3M17	D3M16	352.1	10	15	$ 70.00	$ 24,647.00	751	E20M04	E20M03	160	15	18	$ 85.00	$ 13,600.00
519	D3M20	D3M19	187.9	10	15	$ 70.00	$ 13,153.00	752	E20M03	E20M02	306	15	18	$ 85.00	$ 26,010.00
520	D3M19	D3M18	350.5	10	15	$ 70.00	$ 24,535.00	753	E20M07	E20M06	195	15	18	$ 85.00	$ 16,575.00
521	d3m22	d3m21	358	10	15	$ 70.00	$ 25,060.00	758	E20M02	E20M01	203	15	18	$ 85.00	$ 17,255.00
522	D3M21	D3M20	170	10	15	$ 70.00	$ 11,900.00	759	E20M01	E19M11	60	15	18	$ 85.00	$ 5,100.00
523	D2M23	D3M22	48	10	12	$ 60.00	$ 2,880.00								
524	D3M05	D3M04	330	10	15	$ 70.00	$ 23,100.00								
525	D3M04	D3M03	327.5	10	15	$ 70.00	$ 22,925.00								
526	D3M03	D3M02	312.5	10	15	$ 70.00	$ 21,875.00								
527	C8M32	C8M31	250	15	18	$ 85.00	$ 21,250.00								
528	C8M31	C8M30	350	15	18	$ 85.00	$ 29,750.00								
529	C8M30	C8M29	359	15	18	$ 85.00	$ 30,515.00								
530	C8M29	C8M28	359	15	18	$ 85.00	$ 30,515.00								
531	C8M28	C8M27	205.9	15	18	$ 85.00	$ 17,501.50								
532	C8M27	C8M26	120	15	18	$ 85.00	$ 10,200.00								
533	C8M26	C8M25	380	15	21	$ 105.00	$ 39,900.00								
534	c8m25	c8m24	73.5	15	21	$ 105.00	$ 7,717.50								
535	C8M24	C8M23	300	15	21	$ 105.00	$ 31,500.00								
536	C8M23	C8M22	197	15	21	$ 105.00	$ 20,685.00								
537	c8m22	c8m21	137	15	21	$ 105.00	$ 14,385.00								
538	C8M21	C8M20	298.7	15	21	$ 105.00	$ 31,363.50								
539	C8M20	C8M19	306.6	15	21	$ 105.00	$ 32,193.00								
540	C8M19	C8M18	300	15	21	$ 105.00	$ 31,500.00								
541	C8M18	C8M17	224	15	24	$ 130.00	$ 29,120.00								
542	C8M17	C8M16	25	15	24	$ 130.00	$ 3,250.00								
543	C8M16	C8M15	233	18	24	$ 130.00	$ 30,290.00								
544	C8M15	C8M14	420	18	24	$ 130.00	$ 54,600.00								
545	C8M14	C8M13	326	18	24	$ 130.00	$ 42,380.00								
546	C8M13	C8M12	312	18	24	$ 130.00	$ 40,560.00								
547	C8M12	C8M11	314	18	24	$ 130.00	$ 40,820.00								
548	C8M11	C8M10	102.5	18	24	$ 130.00	$ 13,325.00								
549	C8M10	C8M09	411	18	24	$ 130.00	$ 53,430.00								
550	C8M09	C8M08	400	18	27	$ 160.00	$ 64,000.00								
551	C8M08	C8M07	470	18	27	$ 160.00	$ 75,200.00								
552	C8M07	C8M06	433	18	27	$ 160.00	$ 69,280.00								
553	C8M06	C8M05	212	18	27	$ 160.00	$ 33,920.00								
554	C8M05	C8M04	350	18	27	$ 160.00	$ 56,000.00								
555	C8M04	C8M03	341	18	27	$ 160.00	$ 54,560.00								
556	C8M03	C8M02	359	18	27	$ 160.00	$ 57,440.00								
570	C8NM04	C8NM03	148.8	10	12	$ 60.00	$ 8,928.00								
571	C8NM03	C8NM02	192.9	10	15	$ 70.00	$ 13,503.00								
572	C8NM02	C8NM01	125.2	10	15	$ 70.00	$ 8,764.00								
573	C8NM01	C8M27	188.4	10	18	$ 85.00	$ 16,014.00								
574	C8WM07	C8WM06	233.9	10	15	$ 70.00	$ 16,373.00								
575	C8WM06	C8WM05	323.3	10	15	$ 70.00	$ 22,631.00								
576	C8WM05	C8WM04	113.5	10	15	$ 70.00	$ 7,945.00								
577	C8WM04	C8WM03	190.7	10	15	$ 70.00	$ 13,349.00								
578	E18NM01	E18M05	250	8	15	$ 70.00	$ 17,500.00								
579	C8WM02	C8WM01	411	10	21	$ 105.00	$ 43,155.00								
580	C8WM01	C8M18	30	10	24	$ 130.00	$ 3,900.00								
583	C8WM10	C8WM09	140	8	15	$ 70.00	$ 9,800.00								
584	C8WM09	C8WM08	251	8	15	$ 70.00	$ 17,570.00								
585	C8WM08	C8WM07	254.4	8	15	$ 70.00	$ 17,808.00								
586	C8WM17	C8WM16	407	8	15	$ 70.00	$ 28,490.00								

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-3:East (continued)

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	unit cost	Cost per Segment
587	C8WM16	C8WM15	281.7	8	15	$ 70.00	$ 19,719.00								
588	C8WM15	C8WM14	204	8	15	$ 70.00	$ 14,280.00								
589	C8WM14	C8WM13	332.1	8	15	$ 70.00	$ 23,247.00								
590	C8WM13	C8WM10	302.3	8	15	$ 70.00	$ 21,161.00								
591	C8WM18	C8WM17	268	8	10	$ 55.00	$ 14,740.00								
592	C7M02	C7M01	313	10	15	$ 70.00	$ 21,910.00								
593	C7M01	C8M19	330	10	15	$ 70.00	$ 23,100.00								
594	C7M05	C7M04	346.8	8	15	$ 70.00	$ 24,276.00								
595	C7M04	C7M03	229.1	10	15	$ 70.00	$ 16,037.00								
596	C7M03	C7M02	135	10	15	$ 70.00	$ 9,450.00								
597	C7M06	C7M05	300	8	15	$ 70.00	$ 21,000.00								
598	C7M08	C7M07	212.5	8	15	$ 70.00	$ 14,875.00								
599	c7m07	c7m06	173.4	8	15	$ 70.00	$ 12,138.00								
600	C7M09	C7M08	145	8	15	$ 70.00	$ 10,150.00								
601	C7M13	C7M12	300	8	15	$ 70.00	$ 21,000.00								
602	C7M15	C7M14	400	8	15	$ 70.00	$ 28,000.00								
603	C7M14	C7M13	260	8	15	$ 70.00	$ 18,200.00								
604	C7M16	C7M15	256	10	15	$ 70.00	$ 17,920.00								
605	C7M20	C7M19	305	8	15	$ 70.00	$ 21,350.00								
606	C7M19	C7M18	267.5	8	15	$ 70.00	$ 18,725.00								
607	C7M18	C7M17	250	8	15	$ 70.00	$ 17,500.00								
608	C7M17	C7M16	215	8	15	$ 70.00	$ 15,050.00								
609	C7M22	C7M21	350	8	15	$ 70.00	$ 24,500.00								
610	C7M21	C7M20	315	8	15	$ 70.00	$ 22,050.00								
611	C7M34	C7M22	353	8	15	$ 70.00	$ 24,710.00								
612	c5em02	c5em01	262	8	10	$ 55.00	$ 14,410.00								
613	c5em01	c5m01	351.7	8	10	$ 55.00	$ 19,343.50								
621	C5M05	C5M04	399.7	12	15	$ 70.00	$ 27,979.00								
622	C5M04	C5M03	302.4	12	15	$ 70.00	$ 21,168.00								
623	C5M09	C5M08	400	12	15	$ 70.00	$ 28,000.00								
624	C5M08	C5M07	400	12	15	$ 70.00	$ 28,000.00								
625	C5M11	C5M10	252.5	12	15	$ 70.00	$ 17,675.00								
626	C5M10	C5M09	400	12	15	$ 70.00	$ 28,000.00								
627	C5M12	C5M11	200	12	15	$ 70.00	$ 14,000.00								
628	C5M15	C5M14	323.2	8	15	$ 70.00	$ 22,624.00								
629	C5M14	C5M13	323.2	8	15	$ 70.00	$ 22,624.00								
630	C5M16	C5M15	330.2	8	10	$ 55.00	$ 18,161.00								
631	C5M07	C5M05	400	12	15	$ 70.00	$ 28,000.00								
632	C5M13	C5M12	66.3	12	15	$ 70.00	$ 4,641.00								
633	ETM05	ETM04	339	30	42	$ 285.00	$ 96,615.00								
634	ETM04	ETM03	366	30	42	$ 285.00	$ 104,310.00								
635	ETM03	ETM02	365	30	42	$ 285.00	$ 104,025.00								
636	ETM02	ETM01	400	30	42	$ 285.00	$ 114,000.00								
637	ETM01	SWM018	400	30	42	$ 285.00	$ 114,000.00								
638	ETM08	ETM07	379.2	30	42	$ 285.00	$ 108,072.00								
639	etm07	etm06	247	30	42	$ 285.00	$ 70,395.00								
640	ETM06	ETM05	342	30	42	$ 285.00	$ 97,470.00								
641	ETM11	ETM10	483	30	42	$ 285.00	$ 137,655.00								
642	ETM10	ETM09	349.3	30	42	$ 285.00	$ 99,550.50								
643	ETM09	ETM08	188.9	30	42	$ 285.00	$ 53,836.50								
644	ETM13	ETM12	503	30	42	$ 285.00	$ 143,355.00								
645	ETM12	ETM11	510.7	30	42	$ 285.00	$ 145,549.50								
646	E19M07	E19M06	510	27	36	$ 215.00	$ 109,650.00								
647	E19M04	E19M02	300	27	36	$ 215.00	$ 64,500.00								
648	E19M11	E19M10	267.9	18	21	$ 105.00	$ 28,129.50								
649	E19M10	E19M09	339.2	18	24	$ 130.00	$ 44,096.00								
650	E19M09	E189M08	336.6	18	36	$ 215.00	$ 72,369.00								
651	E19M08	E19M07	330	27	36	$ 215.00	$ 70,950.00								
652	E20EM02	E20EM01	502	27	36	$ 215.00	$ 107,930.00								
653	E20EM06	E20EM04	499.4	27	36	$ 215.00	$ 107,371.00								
654	E20EM04	E20EM03	357.6	27	36	$ 215.00	$ 76,884.00								
655	E20EM03	E20EM02	371	27	36	$ 215.00	$ 79,765.00								
657	E20EM12	E20EM08	500.7	27	36	$ 215.00	$ 107,650.50								
658	E20EM08	E20EM06	500	27	36	$ 215.00	$ 107,500.00								
659	d13sm02	d13sm01	45.9	12	18	$ 85.00	$ 3,901.50								
660	d13sm01	d9sm01	315	12	18	$ 85.00	$ 26,775.00								
662	E19M02	E19M01	310	27	36	$ 215.00	$ 66,650.00								

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-3:East (continued)

2005									2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment		Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	unit cost	Cost per Segment
663	E19M01	ETM13	317	27	36	$ 215.00	$ 68,155.00									
664	d9sm04	d9sm03	321.8	15	18	$ 85.00	$ 27,353.00									
667	d9sm06	d9sm05	33	15	18	$ 85.00	$ 2,805.00									
668	d9sm05	d9sm04	258.2	15	18	$ 85.00	$ 21,947.00									
669	d9sm08	d9sm07	257.5	15	18	$ 85.00	$ 21,887.50									
670	d9sm07	d9sm06	261.6	15	18	$ 85.00	$ 22,236.00									
671	d9sm10	d9sm09	348.4	15	18	$ 85.00	$ 29,614.00									
672	d9sm09	d9sm08	94.5	15	18	$ 85.00	$ 8,032.50									
673	E18M04	E18M03	306	10	18	$ 85.00	$ 26,010.00									
674	E18M03	E18M02	360	10	18	$ 85.00	$ 30,600.00									
675	E18m02	E18M01	375	10	18	$ 85.00	$ 31,875.00									
676	E18M01	ETM13	400	10	18	$ 85.00	$ 34,000.00									
679	E18M05	E18M04	209	10	18	$ 85.00	$ 17,765.00									
680	E18EM04	E18EM03	300	8	15	$ 70.00	$ 21,000.00									
681	E18EM03	E18EM02	300	8	15	$ 70.00	$ 21,000.00									
682	E18M02	E18M01	300	8	15	$ 70.00	$ 21,000.00									
683	E18EM01	E18M05	300	8	15	$ 70.00	$ 21,000.00									
684	E18EM08	E18EM07	400	8	15	$ 70.00	$ 28,000.00									
685	E18EM07	E18EM06	292.8	8	15	$ 70.00	$ 20,496.00									
686	E18EM11	E18EM10	291	8	12	$ 60.00	$ 17,460.00									
687	E18EM10	E18EM09	350	8	12	$ 60.00	$ 21,000.00									
688	E18EM09	E18EM08	337	8	15	$ 70.00	$ 23,590.00									
689	E18EM13	E18EM12	162	8	12	$ 60.00	$ 9,720.00									
690	e18em12	e18em11	137	8	12	$ 60.00	$ 8,220.00									
691	e18em06	e18em05	300	8	15	$ 70.00	$ 21,000.00									
692	E18EM05	E18EM04	400	8	15	$ 70.00	$ 28,000.00									
694	C8M01	E20EM12	242	21	30	$ 190.00	$ 45,980.00									
695	E28M02	E28M01	360	8	15	$ 70.00	$ 25,200.00									
696	E28M01	ETM06	280	8	15	$ 70.00	$ 19,600.00									
697	E28M04	E28M03	353.8	8	15	$ 70.00	$ 24,766.00									
698	E28M03	E28M02	310.5	8	15	$ 70.00	$ 21,735.00									
699	E28M06	E28M05	389.5	8	12	$ 60.00	$ 23,370.00									
700	E28M05	E28M04	351.8	8	15	$ 70.00	$ 24,626.00									
701	E19M06	E19M05	230	27	36	$ 215.00	$ 49,450.00									
702	E19M05	E19M04	260	27	36	$ 215.00	$ 55,900.00									
706	E19NM01	E19M05	400	8	24	$ 130.00	$ 52,000.00									
709	C8M02	C8M01	350	18	27	$ 160.00	$ 56,000.00									
710	D13SM12	D13SM11	336	12	15	$ 70.00	$ 23,520.00									
712	D9WM01	D13SM10	545	12	18	$ 85.00	$ 46,325.00									
713	D13SM11	D13SM10	184	12	15	$ 70.00	$ 12,880.00									
714	D13SM10	D13SM09	165	12	18	$ 85.00	$ 14,025.00									
715	D13SM09	D13SM08	327	12	18	$ 85.00	$ 27,795.00									
716	D13SM08	D13SM07	174	12	18	$ 85.00	$ 14,790.00									
717	D13SM07	D13SM06	146	12	18	$ 85.00	$ 12,410.00									
729	E20WM09	E20WM08	247.2	12	15	$ 70.00	$ 17,304.00									
730	E20WM08	E20WM07	427.9	12	15	$ 70.00	$ 29,953.00									
731	E20WM07	E20WM06	248.3	12	15	$ 70.00	$ 17,381.00									
732	E20WM06	E20WM05	248	12	15	$ 70.00	$ 17,360.00									
733	E20WM05	E20WM04	308	12	15	$ 70.00	$ 21,560.00									
734	E20WM04	E20WM03	308.6	12	15	$ 70.00	$ 21,602.00									
735	E20WM03	E20WM02	175	12	15	$ 70.00	$ 12,250.00									
736	E20WM02	E20WM01	201.4	12	15	$ 70.00	$ 14,098.00									
740	E21SM02	E21SM01	279.5	8	10	$ 55.00	$ 15,372.50									
741	E21SM01	E20WM09	16.5	8	12	$ 60.00	$ 990.00									
754	D13SM06	D13SM05	130	12	18	$ 85.00	$ 11,050.00									
755	D13SM05	D13SM04	150	12	18	$ 85.00	$ 12,750.00									
756	D13SM04	D13SM03	110	12	18	$ 85.00	$ 9,350.00									
757	D13SM03	D13SM02	170	12	18	$ 85.00	$ 14,450.00									
760	C14M21	C14M20	248.5	8	15	$ 70.00	$ 17,395.00									
761	C14M20	C14M19	241.5	8	15	$ 70.00	$ 16,905.00									
762	C14M19	C14M18	175.4	8	15	$ 70.00	$ 12,278.00									
763	C14M16	C14M15	100	8	15	$ 70.00	$ 7,000.00									
764	C14M15	C14M14	200	8	15	$ 70.00	$ 14,000.00									
765	C14M14	C14M13	301	8	15	$ 70.00	$ 21,070.00									
766	C14M13	C14M12	315.3	8	15	$ 70.00	$ 22,071.00									
767	C14M12	C14M11	309.1	10	15	$ 70.00	$ 21,637.00									
768	C14M11	C14M10	328.5	10	15	$ 70.00	$ 22,995.00									

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-3:East (continued)

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	unit cost	Cost per Segment
769	C14M10	C14M09	353.5	10	15	$ 70.00	$ 24,745.00								
770	C14M09	C14M08	276.3	10	15	$ 70.00	$ 19,341.00								
771	C14M08	C14M07	261.9	10	15	$ 70.00	$ 18,333.00								
772	C14M07	C14M06	328.7	10	15	$ 70.00	$ 23,009.00								
773	C14M06	C14M05	349.8	10	15	$ 70.00	$ 24,486.00								
774	C14M05	C14M04	401.6	10	18	$ 85.00	$ 34,136.00								
775	C14M04	C14M03	297.4	10	18	$ 85.00	$ 25,279.00								
776	C14M03	C14M02	375.3	10	18	$ 85.00	$ 31,900.50								
777	C14M24	C14M23	216.5	8	15	$ 70.00	$ 15,155.00								
778	c14m23	c14m22	118.5	8	15	$ 70.00	$ 8,295.00								
779	C14M22	C14M21	329.6	8	15	$ 70.00	$ 23,072.00								
780	C14M27	C14M26	361	8	15	$ 70.00	$ 25,270.00								
781	C14M26	C14M25	164.5	8	15	$ 70.00	$ 11,515.00								
782	C14M25	C14M24	282.3	8	15	$ 70.00	$ 19,761.00								
783	C14M29	C14M28	308.6	8	15	$ 70.00	$ 21,602.00								
784	c14m28	c14m27	35.2	8	15	$ 70.00	$ 2,464.00								
785	C14WM03	C14WM02	390	8	15	$ 70.00	$ 27,300.00								
786	C14WM02	C14WM01	385	8	15	$ 70.00	$ 26,950.00								
787	c14wm05	c14wm04	400	8	12	$ 60.00	$ 24,000.00								
788	C14WM04	C14WM03	212	8	12	$ 60.00	$ 12,720.00								
789	C14WM07	C14WM06	215	8	12	$ 60.00	$ 12,900.00								
790	C14WM06	C14WM05	200	8	12	$ 60.00	$ 12,000.00								
791	C14WM01	C14M18	57	8	15	$ 70.00	$ 3,990.00								
792	C14M18	C14M17A	300	8	15	$ 70.00	$ 21,000.00								
793	C14M17A	C14M17	350	8	15	$ 70.00	$ 24,500.00								
794	C14M17	C14M16A	130	8	15	$ 70.00	$ 9,100.00								
795	C14M16A	C14M16	330	8	15	$ 70.00	$ 23,100.00								
796	C14M02	E20EM08	302.3	10	18	$ 85.00	$ 25,695.50								
797	C4M26	C4M25	99	8	12	$ 60.00	$ 5,940.00								
798	C4M25	C4M24	315	8	12	$ 60.00	$ 18,900.00								
801	C4M24	C4M23	352.5	8	15	$ 70.00	$ 24,675.00								
802	C4M23	C4M22	195	8	15	$ 70.00	$ 13,650.00								
816	D9M39	D9M38	196.5	10	15	$ 70.00	$ 13,755.00								
817	D9M38	D9M37	332.3	10	15	$ 70.00	$ 23,261.00								
818	D9M37	D9M36	302.3	10	15	$ 70.00	$ 21,161.00								
819	D9M36	D9M35	301	10	15	$ 70.00	$ 21,070.00								
820	D9M35	D9M34	19	10	15	$ 70.00	$ 1,330.00								
821	D9M34	D9M33	325	10	15	$ 70.00	$ 22,750.00								
822	D9M33	D9M32	350	10	15	$ 70.00	$ 24,500.00								
823	D9M29	D9M27	271	10	15	$ 70.00	$ 18,970.00								
824	D9M27	D9M26	163	12	15	$ 70.00	$ 11,410.00								
825	d9m26	d9m25	164	12	15	$ 70.00	$ 11,480.00								
826	D9M25	D9M24	305	12	15	$ 70.00	$ 21,350.00								
827	D9M24	D9M23	163.2	12	15	$ 70.00	$ 11,424.00								
828	D9M23	D9M22	173	12	15	$ 70.00	$ 12,110.00								
829	D9M22	D9M21	262.7	12	15	$ 70.00	$ 18,389.00								
830	D9M21	D9M20	175	12	15	$ 70.00	$ 12,250.00								
831	d9m20	d9m19	30	12	15	$ 70.00	$ 2,100.00								
832	D9M19	D9M18	154	12	15	$ 70.00	$ 10,780.00								
833	D9M18	D9M17	200	12	15	$ 70.00	$ 14,000.00								
839	MH-1	d9m39	170	12	15	$ 70.00	$ 11,900.00								
840	E18AM01	E18EM03	390	8	15	$ 70.00	$ 27,300.00								
841	E18AM02	E18AM01	200	8	15	$ 70.00	$ 14,000.00								
842	E18AM03	E18AM02	400	8	15	$ 70.00	$ 28,000.00								
843	E18AM06	E18AM05	70	8	12	$ 60.00	$ 4,200.00								
844	E18AM05	E18AM04	320	8	12	$ 60.00	$ 19,200.00								
845	E18AM04	E18AM03	340	8	15	$ 70.00	$ 23,800.00								
846	E18AM12	E18AM11	350	8	10	$ 55.00	$ 19,250.00								
847	E18AM11	E18AM10	200	8	12	$ 60.00	$ 12,000.00								
848	E18AM10	E18AM09	400	8	12	$ 60.00	$ 24,000.00								
849	E18AM09	E18AM08	300	8	12	$ 60.00	$ 18,000.00								
850	E19AM03	E19AM02	407	21	36	$ 215.00	$ 87,505.00								
851	E19AM02	E19AM01	450	21	36	$ 215.00	$ 96,750.00								
852	E19AM06	E19AM05	112	27	36	$ 215.00	$ 24,080.00								
853	E19AM05	E19AM04	95	27	36	$ 215.00	$ 20,425.00								
854	E19AM04	E19AM03A	311.2	27	36	$ 215.00	$ 66,908.00								
855	e19am03a	E19AM03A	113.8	27	36	$ 215.00	$ 24,467.00								

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-3:East (continued)

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	unit cost	Cost per Segment
856	e19am08	e19am07	181.9	27	36	$ 215.00	$ 39,108.50								
857	E19AM07	E19AM06	86.2	27	36	$ 215.00	$ 18,533.00								
858	e19am10	e19am09	186	10	15	$ 70.00	$ 13,020.00								
859	E19AM09	E19AM08	54	10	21	$ 105.00	$ 5,670.00								
860	E19AM13	E19AM12	328	10	15	$ 70.00	$ 22,960.00								
861	E19AM12	E19AM11	329	10	15	$ 70.00	$ 23,030.00								
862	E19AM11	E19AM10	329	10	15	$ 70.00	$ 23,030.00								
863	e19am16	e19am15	385	10	15	$ 70.00	$ 26,950.00								
864	e19am15	e19am14	300	10	15	$ 70.00	$ 21,000.00								
865	E19AM14	E19AM13	300	10	15	$ 70.00	$ 21,000.00								
866	E19AM17	E19AM16	225	10	15	$ 70.00	$ 15,750.00								
867	E19AM20	E19AM19	237	10	15	$ 70.00	$ 16,590.00								
868	E19AM25	E19AM24	350	10	15	$ 70.00	$ 24,500.00								
869	E19AM24	E19AM23	350	10	15	$ 70.00	$ 24,500.00								
870	E19AM23	E19AM22	320.4	10	15	$ 70.00	$ 22,428.00								
871	E19AM22	E19AM21	150	10	15	$ 70.00	$ 10,500.00								
872	E19AM21	E19AM20	300	10	15	$ 70.00	$ 21,000.00								
873	E19AM31	E19AM30	290	8	15	$ 70.00	$ 20,300.00								
874	E19AM30	E19AM29	269	8	15	$ 70.00	$ 18,830.00								
875	e19am29	e19am28	330	8	15	$ 70.00	$ 23,100.00								
876	E19AM28	E18AM27	343	10	15	$ 70.00	$ 24,010.00								
877	E19AM27	E19AM26	399	10	15	$ 70.00	$ 27,930.00								
878	e19am26	e19am25	28	10	15	$ 70.00	$ 1,960.00								
879	E19AM36	E19AM35	145.4	8	15	$ 70.00	$ 10,178.00								
880	E19AM35	E19AM34	268	8	15	$ 70.00	$ 18,760.00								
881	E19AM34	E19AM33	272	8	15	$ 70.00	$ 19,040.00								
882	E19AM33	E19AM32	330	8	15	$ 70.00	$ 23,100.00								
883	E19AM32	E19AM31	106	8	15	$ 70.00	$ 7,420.00								
884	E19AM39	E19AM38	99.6	8	15	$ 70.00	$ 6,972.00								
885	E19AM38	E19AM37	426.4	8	15	$ 70.00	$ 29,848.00								
886	E19AM37	E19AM36	396.6	8	15	$ 70.00	$ 27,762.00								
887	E19AM43	E19AM42	163.4	8	15	$ 70.00	$ 11,438.00								
888	E19AM42	E19AM41	281.6	8	15	$ 70.00	$ 19,712.00								
889	E19AM41	E19AM40	400.4	8	15	$ 70.00	$ 28,028.00								
890	E19AM40	E19AM39	330	8	15	$ 70.00	$ 23,100.00								
891	E19AM45	E19AM44	279	10	15	$ 70.00	$ 19,530.00								
892	E19AM44	E19AM43	211.8	10	15	$ 70.00	$ 14,826.00								
893	E19AM47	E19AM46	234.6	10	15	$ 70.00	$ 16,422.00								
894	E19AM46	E19AM45	324	10	15	$ 70.00	$ 22,680.00								
895	E19AM50	E19AM49	277.6	10	15	$ 70.00	$ 19,432.00								
896	E19AM49	E19AM48	260	10	15	$ 70.00	$ 18,200.00								
897	E19AM48	E19AM47	138.8	10	15	$ 70.00	$ 9,716.00								
898	E19AM53	E19AM52	225.4	8	12	$ 60.00	$ 13,524.00								
899	E19AM52	E19AM51	176.3	10	15	$ 70.00	$ 12,341.00								
900	E19AM51	E19AM50	167.3	10	15	$ 70.00	$ 11,711.00								
906	E19AM19	E19AM18	313	10	15	$ 70.00	$ 21,910.00								
907	E19AM18	E19AM17	316.5	10	15	$ 70.00	$ 22,155.00								
909	E20EM01	E19AM08	492.9	27	36	$ 215.00	$ 105,973.50								
910	E19AM01	E19M09	433.5	21	36	$ 215.00	$ 93,202.50								
916	D9M12	D9M11	350	15	18	$ 85.00	$ 29,750.00								
917	d9m11	d9m10	323	15	18	$ 85.00	$ 27,455.00								
918	d9m10	d9m09	372	15	18	$ 85.00	$ 31,620.00								
919	d9m09	d9m08	147	15	18	$ 85.00	$ 12,495.00								
920	d9m08	d9m07	147	15	18	$ 85.00	$ 12,495.00								
921	D9M07	D9M06	295	15	18	$ 85.00	$ 25,075.00								
922	d9m06	d9m05	185	15	18	$ 85.00	$ 15,725.00								
923	D9M05	D9M04	347	15	18	$ 85.00	$ 29,495.00								
924	d9m04	d9m03	360	15	18	$ 85.00	$ 30,600.00								
925	d9m03	d9m02	254	15	18	$ 85.00	$ 21,590.00								
926	d9m02	d9m01	400	15	18	$ 85.00	$ 34,000.00								
927	d9m01	d9sm11	483	15	18	$ 85.00	$ 41,055.00								
936	D9M13	D9M12	360	15	18	$ 85.00	$ 30,600.00								
937	E20SM10	E20SM09	110	10	15	$ 70.00	$ 7,700.00								
938	E20SM09	E20SM08	220	10	15	$ 70.00	$ 15,400.00								
939	E20SM08	E20SM07	220	10	15	$ 70.00	$ 15,400.00								
940	E20SM07	E20SM06	210	10	15	$ 70.00	$ 14,700.00								
941	E20SM06	E20SM05	215	10	15	$ 70.00	$ 15,050.00								

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-3:East (continued)

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	unit cost	Cost per Segment
942	E20SM05	E20SM04	170	10	15	$ 70.00	$ 11,900.00								
943	E20SM04	E20SM03	120	10	15	$ 70.00	$ 8,400.00								
944	E20SM03	E20SM02	130	10	15	$ 70.00	$ 9,100.00								
945	E20SM02	E20SM01	175	10	15	$ 70.00	$ 12,250.00								
946	E20SM15	E20SM14	140	10	15	$ 70.00	$ 9,800.00								
947	E20SM14	E20SM13	320	10	15	$ 70.00	$ 22,400.00								
948	E20SM13	E20SM12	300	10	15	$ 70.00	$ 21,000.00								
949	E20SM12	E20SM11	300	10	15	$ 70.00	$ 21,000.00								
950	E20SM11	E20SM10	55	10	15	$ 70.00	$ 3,850.00								
951	d20sm01	e19m11	70	10	15	$ 70.00	$ 4,900.00								
952	d9sm11	d9sm10	283.4	15	18	$ 85.00	$ 24,089.00								
953	D9M32	1334	420	10	15	$ 70.00	$ 29,400.00								
954	1334	D9M29	50	10	15	$ 70.00	$ 3,500.00								
955	E18AM08	E18AM06	200	8	12	$ 60.00	$ 12,000.00								
956	C7M12	C7M11A	310	8	15	$ 70.00	$ 21,700.00								
957	C7M11A	C7M11A	300	8	15	$ 70.00	$ 21,000.00								
958	C7M11	C7M10	79	8	15	$ 70.00	$ 5,530.00								
959	C7M10	C7M09	320	8	15	$ 70.00	$ 22,400.00								

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-4:Northeast

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment
314	w29m5	w29m4	332.5	10	15	$ 70.00	$ 23,275.00	547	mh-17	mh-16	1344.9		15	$ 70.00	$ 94,143.00
315	w29m4	w29m3	400	10	15	$ 70.00	$ 28,000.00	548	mh-16	mh-15	1111		15	$ 70.00	$ 77,770.00
316	w29m3	w29m2	400	10	15	$ 70.00	$ 28,000.00	550	mh-15	mh-18	1026.7		18	$ 85.00	$ 87,269.50
317	w29m2	w29m1	370	10	15	$ 70.00	$ 25,900.00	551	mh-18	mh-12	1293.6		18	$ 85.00	$ 109,956.00
318	w29m1	nem018	367.3	10	15	$ 70.00	$ 25,711.00	552	mh-12	mh-13	1656.1		18	$ 85.00	$ 140,768.50
339	a1nm17	a1nm16	340	8	12	$ 60.00	$ 20,400.00	553	mh-13	mh-14	1753.2		18	$ 85.00	$ 149,022.00
341	a1nm19	a1nm18	297	8	12	$ 60.00	$ 17,820.00	554	mh-14	mh-10	773.9		18	$ 85.00	$ 65,781.50
342	a1nm18	a1nm17	327	8	12	$ 60.00	$ 19,620.00	555	mh-10	mh-9	1391.3		21	$ 105.00	$ 146,086.50
343	a1nm21	a1nm20	340	8	10	$ 55.00	$ 18,700.00	557	mh-9	mh-19	1294.6		21	$ 105.00	$ 135,933.00
344	a1nm20	a1nm19	293	8	10	$ 55.00	$ 16,115.00	558	mh-19	mh-7	1441.4		21	$ 105.00	$ 151,347.00
345	a1nm23	a1nm22	247	8	10	$ 55.00	$ 13,585.00	559	mh-7	mh-3	1185.3		21	$ 105.00	$ 124,456.50
346	a1nm22	a1nm21	340	8	10	$ 55.00	$ 18,700.00	560	mh-3	mh-4	1488.5		24	$ 130.00	$ 193,505.00
347	a1nm25	a1nm24	400	8	10	$ 55.00	$ 22,000.00	561	mh-4	mh-5	1231.8		24	$ 130.00	$ 160,134.00
348	a1nm24	a1nm23	202	8	10	$ 55.00	$ 11,110.00	562	mh-5	mh-6	1528.6		24	$ 130.00	$ 198,718.00
349	a1nm27	a1nm26	229	8	10	$ 55.00	$ 12,595.00	563	mh-6	mh-2	1017.6		24	$ 130.00	$ 132,288.00
350	a1nm26	a1nm25	400	8	10	$ 55.00	$ 22,000.00	564	mh-2	nem054	866.5		24	$ 130.00	$ 112,645.00
								574	mh-27	mh-26	1935.6		15	$ 70.00	$ 135,492.00
								575	mh-26	mh-25	1186.1		15	$ 70.00	$ 83,027.00
								576	mh-25	mh-24	993.5		15	$ 70.00	$ 69,545.00
								577	mh-24	mh-23	558.9		18	$ 85.00	$ 47,506.50
								578	mh-23	mh-22	723		18	$ 85.00	$ 61,455.00
								579	mh-22	mh-21	386.1		18	$ 85.00	$ 32,818.50
								580	mh-21	mh-20	1109.5		18	$ 85.00	$ 94,307.50
								581	mh-20	a1am17	761.1		18	$ 85.00	$ 64,693.50
								588	mh-30	mh-29	620		18	$ 85.00	$ 52,700.00
								589	mh-29	mh-28	1230.9		18	$ 85.00	$ 104,626.50
								590	mh-28	nem018	1059.2		18	$ 85.00	$ 90,032.00
								594	mh-35	mh-34	848.5		18	$ 85.00	$ 72,122.50
								595	mh-34	mh-33	1127.8		18	$ 85.00	$ 95,863.00
								596	mh-33	nem017	1195.5		18	$ 85.00	$ 101,617.50

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-1:Southwest

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment
169	swm090	swm089	385	10	12	$ 60.00	$ 23,100.00	165	SWM094	SWM093	292.1	10	15	$ 70.00	$ 20,447.00
237	swm018	swm017	289	36	42	$ 285.00	$ 82,365.00	166	SWM093	SWM092	325	10	15	$ 70.00	$ 22,750.00
238	swm017	swm016	292	36	42	$ 285.00	$ 83,220.00	167	SWM092	SWM091	330	10	15	$ 70.00	$ 23,100.00
239	swm016	swm015	447	36	42	$ 285.00	$ 127,395.00	168	SWM091	SWM090	310	10	15	$ 70.00	$ 21,700.00
240	swm015	swm014	410	36	42	$ 285.00	$ 116,850.00	169	SWM090	SWM089	385	12	15	$ 70.00	$ 26,950.00
241	swm014	swm013	612.5	36	42	$ 285.00	$ 174,562.50	170	SWM089	SWM088	365	12	15	$ 70.00	$ 25,550.00
242	swm013	swm012	514.5	36	42	$ 285.00	$ 146,632.50	171	SWM088	SWM087	365	12	15	$ 70.00	$ 25,550.00
243	swm012	swm011	513	36	42	$ 285.00	$ 146,205.00	172	SWM087	SWM086	360	12	15	$ 70.00	$ 25,200.00
244	swm011	swm010	478	36	42	$ 285.00	$ 136,230.00	173	SWM086	SWM085	360	12	15	$ 70.00	$ 25,200.00
245	swm010	swm009	478	36	42	$ 285.00	$ 136,230.00	174	SWM085	SWM084	360	12	15	$ 70.00	$ 25,200.00
246	swm009	swm008	478	36	42	$ 285.00	$ 136,230.00	175	SWM084	SWM03	361.8	12	15	$ 70.00	$ 25,326.00
247	swm008	swm007	478	36	42	$ 285.00	$ 136,230.00	294	K35M04	K35M03	175	8	18	$ 85.00	$ 14,875.00
248	swm007	swm006	368	36	42	$ 285.00	$ 104,880.00	295	K35M03	K35M02	190	15	18	$ 85.00	$ 16,150.00
249	swm006	swm005	365	36	42	$ 285.00	$ 104,025.00	296	K35M02	K35M01	246	15	18	$ 85.00	$ 20,910.00
250	swm005	swm004	365.4	36	42	$ 285.00	$ 104,139.00	297	K35M01	KM13	357	15	18	$ 85.00	$ 30,345.00
251	swm004	swm003	499.6	36	42	$ 285.00	$ 142,386.00	300	KM13	KM12	383	15	18	$ 85.00	$ 32,555.00
252	swm003	swm002	500	36	42	$ 285.00	$ 142,500.00	301	KM12	KM11	38.3	15	18	$ 85.00	$ 3,255.50
253	swm002	swm001	437.6	36	42	$ 285.00	$ 124,716.00	302	KM11	KM10	50	15	18	$ 85.00	$ 4,250.00
289	i30m01	sem007	190	10	24	$ 130.00	$ 24,700.00	303	KM10	KM09	404.6	15	18	$ 85.00	$ 34,391.00
								304	KM09	KM08	371	15	18	$ 85.00	$ 31,535.00
								412	MH-12	K35M04	185.4		18	$ 85.00	$ 15,759.00
								413	MH-11	MH-12	303		18	$ 85.00	$ 25,755.00
								414	MH-10	MH-11	380.5		18	$ 85.00	$ 32,342.50
								415	MH-9	MH-10	430.4		18	$ 85.00	$ 36,584.00
								416	MH-8	MH-9	331		18	$ 85.00	$ 28,135.00
								417	MH-7	MH-8	372.8		18	$ 85.00	$ 31,688.00
								418	MH-7	MH-7	413.9		18	$ 85.00	$ 35,181.50
								419	MH-5	MH-6	373.3		18	$ 85.00	$ 31,730.50
								420	MH-4	MH-5	304.8		18	$ 85.00	$ 25,908.00
								421	MH-3	MH-4	324.7		18	$ 85.00	$ 27,599.50
								423	MH-61	MH-3	332.9		18	$ 85.00	$ 28,296.50
								424	MH-1	MH-61	329		18	$ 85.00	$ 27,965.00
								426	MH-62	MH-1	843.4		18	$ 85.00	$ 71,689.00
								427	MH-46	MH-62	190.4		15	$ 70.00	$ 13,328.00
								428	MH-45	MH-46	357.8		15	$ 70.00	$ 25,046.00
								429	MH-44	MH-45	316.9		15	$ 70.00	$ 22,183.00
								430	MH-43	MH-44	396.7		15	$ 70.00	$ 27,769.00
								431	MH-42	MH-43	408.5		15	$ 70.00	$ 28,595.00
								432	MH-41	MH-42	529.5		15	$ 70.00	$ 37,065.00
								433	MH-40	MH-41	584.2		15	$ 70.00	$ 40,894.00
								434	MH-39	MH-40	714.3		15	$ 70.00	$ 50,001.00
								436	MH-63	MH-39	508.7		15	$ 70.00	$ 35,609.00
								437	MH-37	MH-63	543.6		15	$ 70.00	$ 38,052.00
								438	MH-36	MH-37	467.4		15	$ 70.00	$ 32,718.00
								439	MH-35	MH-36	474.6		15	$ 70.00	$ 33,222.00
								440	MH-34	MH-35	428.3		15	$ 70.00	$ 29,981.00
								441	MH-33	MH-34	390.4		15	$ 70.00	$ 27,328.00
								442	MH-32	MH-33	445.3		15	$ 70.00	$ 31,171.00
								443	MH-31	MH-32	517.7		15	$ 70.00	$ 36,239.00
								444	MH-30	MH-31	404		15	$ 70.00	$ 28,280.00
								445	MH-29	MH-30	502.2		15	$ 70.00	$ 35,154.00
								446	MH-47	MH-6	336.8		15	$ 70.00	$ 23,576.00
								447	MH-48	MH-47	397.6		15	$ 70.00	$ 27,832.00
								448	MH-49	MH-48	434.5		15	$ 70.00	$ 30,415.00
								449	MH-50	MH-49	557		15	$ 70.00	$ 38,990.00
								450	MH-51	MH-50	536.5		15	$ 70.00	$ 37,555.00
								451	MH-52	MH-51	496.6		15	$ 70.00	$ 34,762.00
								452	MH-53	MH-52	549.6		15	$ 70.00	$ 38,472.00
								453	MH-54	MH-53	428.7		15	$ 70.00	$ 30,009.00
								454	MH-55	MH-54	512.5		15	$ 70.00	$ 35,875.00
								455	MH-56	MH-55	441.6		15	$ 70.00	$ 30,912.00
								456	MH-57	MH-56	475.4		15	$ 70.00	$ 33,278.00
								457	MH-58	MH-57	692.9		15	$ 70.00	$ 48,503.00
								458	MH-59	MH-58	460.5		15	$ 70.00	$ 32,235.00
								459	MH-60	MH-59	335.8		15	$ 70.00	$ 23,506.00
								460	MH-14	MH-62	348.2		15	$ 70.00	$ 24,374.00
								461	MH-15	MH-14	388.6		15	$ 70.00	$ 27,202.00

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-1:Southwest

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment
								462	MH-16	MH-15	364.8		15	$ 70.00	$ 25,536.00
								463	MH-17	MH-16	402.7		15	$ 70.00	$ 28,189.00
								464	MH-18	MH-17	288.4		15	$ 70.00	$ 20,188.00
								465	MH-19	MH-18	287.7		15	$ 70.00	$ 20,139.00
								466	MH-20	MH-19	329.6		15	$ 70.00	$ 23,072.00
								467	MH-21	MH-20	257.8		15	$ 70.00	$ 18,046.00
								468	MH-22	MH-21	331.9		15	$ 70.00	$ 23,233.00
								469	MH-23	MH-22	423.5		15	$ 70.00	$ 29,645.00
								470	MH-24	MH-23	460.1		15	$ 70.00	$ 32,207.00
								471	MH-25	MH-24	408.9		15	$ 70.00	$ 28,623.00
								472	MH-26	MH-25	364.7		15	$ 70.00	$ 25,529.00
								473	MH-27	MH-26	264.7		15	$ 70.00	$ 18,529.00
								474	MH-28	MH-27	324.6		15	$ 70.00	$ 22,722.00
								499	MH-70	SWM094	475.3		15	$ 70.00	$ 33,271.00
								500	MH-69	MH-70	929.4		15	$ 70.00	$ 65,058.00
								501	MH-68	MH-69	925.6		15	$ 70.00	$ 64,792.00
								502	MH-67	MH-68	938.7		15	$ 70.00	$ 65,709.00
								503	MH-66	MH-67	935.6		15	$ 70.00	$ 65,492.00
								505	MH-84	MH-66	877.1		15	$ 70.00	$ 61,397.00
								506	MH-64	MH-84	719.8		15	$ 70.00	$ 50,386.00
								507	MH-65	MH-84	176.2		15	$ 70.00	$ 12,334.00
								508	MH-71	MH-65	261.1		15	$ 70.00	$ 18,277.00
								509	MH-72	MH-71	455.5		15	$ 70.00	$ 31,885.00
								510	MH-73	MH-72	423.7		15	$ 70.00	$ 29,659.00
								511	MH-74	MH-73	434.4		15	$ 70.00	$ 30,408.00
								512	MH-75	MH-74	350.1		15	$ 70.00	$ 24,507.00
								513	MH-76	MH-75	327.4		15	$ 70.00	$ 22,918.00
								514	MH-77	MH-76	365.7		15	$ 70.00	$ 25,599.00
								515	mh-78	mh-77	351.2		15	$ 70.00	$ 24,584.00
								516	MH-79	MH-78	392.3		15	$ 70.00	$ 27,461.00
								517	MH-80	MH-79	423.9		15	$ 70.00	$ 29,673.00
								518	MH-81	MH-80	307.2		15	$ 70.00	$ 21,504.00
								519	MH-82	MH-81	299.9		15	$ 70.00	$ 20,993.00
								520	MH-83	MH-82	421.9		15	$ 70.00	$ 29,533.00
								560	MH-85	SWM064	354.7		24	$ 130.00	$ 46,111.00
								561	MH-86	MH-85	523.4		24	$ 130.00	$ 68,042.00
								562	MH-87	MH-86	542.1		24	$ 130.00	$ 70,473.00
								563	MH-88	MH-87	605.4		24	$ 130.00	$ 78,702.00
								564	MH-89	MH-88	596.4		24	$ 130.00	$ 77,532.00
								565	MH-90	MH-89	585.7		24	$ 130.00	$ 76,141.00
								566	MH-91	MH-90	607.5		24	$ 130.00	$ 78,975.00
								567	MH-92	MH-91	888.8		24	$ 130.00	$ 115,544.00
								568	MH-93	MH-92	732.7		24	$ 130.00	$ 95,251.00
								569	MH-94	MH-93	551.8		24	$ 130.00	$ 71,734.00
								571	MH-124	MH-94	457.7		24	$ 130.00	$ 59,501.00
								572	MH-96	MH-124	459.5		24	$ 130.00	$ 59,735.00
								573	MH-97	MH-96	486		24	$ 130.00	$ 63,180.00
								574	MH-98	MH-97	798.4		24	$ 130.00	$ 103,792.00
								575	MH-99	MH-98	1027.1		24	$ 130.00	$ 133,523.00
								576	MH-100	MH-99	1260.7		21	$ 105.00	$ 132,373.50
								577	MH-101	MH-100	713.3		21	$ 105.00	$ 74,896.50
								578	MH-102	MH-101	775.5		21	$ 105.00	$ 81,427.50
								579	MH-103	MH-102	1053.5		21	$ 105.00	$ 110,617.50
								580	MH-104	MH-103	966.4		21	$ 105.00	$ 101,472.00
								581	MH-105	MH-104	744		21	$ 105.00	$ 78,120.00
								582	MH-106	MH-105	774		18	$ 85.00	$ 65,790.00
								583	MH-107	MH-106	461		18	$ 85.00	$ 39,185.00
								584	MH-108	MH-107	322.1		18	$ 85.00	$ 27,378.50
								585	MH-109	MH-108	502.6		18	$ 85.00	$ 42,721.00
								586	MH-110	MH-109	576.8		18	$ 85.00	$ 49,028.00
								587	MH-111	MH-110	524.6		18	$ 85.00	$ 44,591.00
								588	MH-112	MH-111	783.8		18	$ 85.00	$ 66,623.00
								589	MH-113	MH-112	517.5		18	$ 85.00	$ 43,987.50
								590	MH-114	MH-113	775.6		18	$ 85.00	$ 65,926.00
								591	MH-115	MH-114	829.2		18	$ 85.00	$ 70,482.00
								592	MH-116	MH-115	605.8		15	$ 70.00	$ 42,406.00

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-1:Southwest

2005								2055							
Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment	Pipe ID	Starting Manhole	Ending Manhole	Length	Original Size	Proposed Size	Unit Cost	Cost per Segment
								593	MH-117	MH-116	744.9		15	$ 70.00	$ 52,143.00
								594	MH-118	MH-117	576.2		15	$ 70.00	$ 40,334.00
								595	MH-119	MH-118	781.4		15	$ 70.00	$ 54,698.00
								596	MH-120	MH-119	712.5		15	$ 70.00	$ 49,875.00
								597	MH-121	MH-120	273.9		15	$ 70.00	$ 19,173.00
								598	MH-122	MH-121	529.2		15	$ 70.00	$ 37,044.00
								599	MH-123	MH-122	664.1		15	$ 70.00	$ 46,487.00
								627	MH-125	SWM046	456.3		18	$ 85.00	$ 38,785.50
								628	MH126	MH-125	667.6		18	$ 85.00	$ 56,746.00
								629	MH-127	MH-126	519.3		18	$ 85.00	$ 44,140.50
								630	MH-128	MH-127	466.2		18	$ 85.00	$ 39,627.00
								631	MH-129	MH-128	439.1		18	$ 85.00	$ 37,323.50
								632	MH-130	MH-129	404.2		18	$ 85.00	$ 34,357.00
								633	MH-131	MH-130	348.2		18	$ 85.00	$ 29,597.00
								634	MH-132	MH-131	521.3		18	$ 85.00	$ 44,310.50
								635	MH-133	MH-132	843		18	$ 85.00	$ 71,655.00
								636	MH-134	MH-133	551.4		18	$ 85.00	$ 46,869.00
								637	MH-135	MH-134	644.2		18	$ 85.00	$ 54,757.00
								638	MH-136	MH-135	869.4		18	$ 85.00	$ 73,899.00
								639	MH-137	MH-136	819.4		15	$ 70.00	$ 57,358.00
								640	MH-138	MH-137	567		15	$ 70.00	$ 39,690.00
								641	MH-139	MH-138	517.6		15	$ 70.00	$ 36,232.00
								642	MH-140	MH-139	320		15	$ 70.00	$ 22,400.00
								643	MH-141	MH-140	1047.5		15	$ 70.00	$ 73,325.00
								644	MH-142	MH-141	911.1		15	$ 70.00	$ 63,777.00
								645	MH-143	MH-142	1061.6		15	$ 70.00	$ 74,312.00
								646	MH-144	MH-143	921.7		15	$ 70.00	$ 64,519.00
								647	MH-145	MH-144	766.7		15	$ 70.00	$ 53,669.00
								648	MH-146	MH-145	824.9		15	$ 70.00	$ 57,743.00
								649	MH-147	MH-146	804.5		15	$ 70.00	$ 56,315.00
								650	MH-148	MH-136	747.3		15	$ 70.00	$ 52,311.00
								651	MH-149	MH-148	681		15	$ 70.00	$ 47,670.00
								652	MH-151	MH149	413.2		15	$ 70.00	$ 28,924.00
								653	MH-150	MH-151	510.4		15	$ 70.00	$ 35,728.00
								686	MH-162	MH-163	868.1		24	$ 130.00	$ 113,000.00
								688	MH-163	MH-164	1291.6		24	$ 130.00	$ 168,000.00
								690	MH-164	MH-165	923.3		24	$ 130.00	$ 121,000.00
								692	MH-165	MH-166	1271.6		24	$ 130.00	$ 166,000.00
								694	MH-166	MH-167	1704.7		24	$ 130.00	$ 222,000.00
								696	MH-167	MH-168	1640.3		24	$ 130.00	$ 214,000.00
								698	MH-168	MH-169	1389.7		24	$ 130.00	$ 181,000.00
								700	MH-169	MH-170	1680.2		24	$ 130.00	$ 219,000.00
								702	MH-170	MH-171	1885.5		24	$ 130.00	$ 246,000.00
								704	MH-171	MH-172	1478.4		24	$ 130.00	$ 193,000.00
								706	MH-172	MH-173	1778		24	$ 130.00	$ 232,000.00
								708	MH-173	MH-174	1267.2		15	$ 70.00	$ 89,000.00
								710	MH-174	MH-175	1212.3		15	$ 70.00	$ 85,000.00
								712	MH-175	MH-176	1122.8		15	$ 70.00	$ 79,000.00
								713	MH-176	MH-84	925.3		15	$ 70.00	$ 65,000.00
								714	01-00-00-003443	MH-162	1095.4		24	$ 130.00	$ 143,000.00
								715	MH-85	01-00-00-003443	594.4		24	$ 130.00	$ 78,000.00

* Pipes highlighted in pink represent proposed pipes needed for future development. Unhighlighted pipes represent existing pipes to be rehabilitated.

Table 10-8										
2005										
			Southwest		Northeast		East		Downtown	
Item	Units	Unit Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
10" PVC Wastewater Pipe, open cut	LF	$ 55.00	0	$ -	2451	$ 134,805.00	1841	$ 101,277.00	5362	$ 294,888.00
12" PVC Wastewater Pipe, open cut	LF	$ 60.00	385	$ 23,100.00	964	$ 57,840.00	4699	$ 281,952.00	0	$ -
15" PVC Wastewater Pipe, open cut	LF	$ 70.00	0	$ -	1870	$ 130,886.00	54773	$ 3,834,082.00	0	$ -
18" PVC Wastewater Pipe, open cut	LF	$ 85.00	0	$ -	0	$ -	13018	$ 1,106,547.00	2566	$ 218,110.00
21" PVC Wastewater Pipe, open cut	LF	$ 105.00	0	$ -	0	$ -	2726	$ 286,198.50	0	$ -
24" PVC Wastewater Pipe, open cut	LF	$ 130.00	190	$ 24,700.00	0	$ -	3137	$ 407,771.00	0	$ -
27" PVC Wastewater Pipe, open cut	LF	$ 160.00	0	$ -	0	$ -	2915	$ 466,400.00	0	$ -
30" PVC Wastewater Pipe, open cut	LF	$ 190.00	0	$ -	0	$ -	242	$ 45,980.00	0	$ -
36" PVC Wastewater Pipe, open cut	LF	$ 215.00	0	$ -	0	$ -	8008	$ 1,721,677.00	0	$ -
42" RCP Wastewater Pipe, open cut	LF	$ 285.00	7526	$ 2,144,796.00	0	$ -	4873	$ 1,388,833.50	0	$ -
48" RCP Wastewater Pipe, open cut	LF	$ 330.00	0	$ -	0	$ -	0	$ -	0	$ -
54" RCP Wastewater Pipe, open cut	LF	$ 380.00	0	$ -	0	$ -	0	$ -	0	$ -
4' Manhole (assume 1.5MH/Segment)	EA	2500	29	$ 71,250.00	24	$ 60,000.00	528	$ 1,320,000.00	48	$ 120,000.00
Extra depth 4' manhole(assume average depth is 1	VF	150	200	$ 29,925.00	168	$ 25,200.00	3696	$ 554,400.00	336	$ 50,400.00
Pavement Replacement (assume 1.3SY/LF)	SY	$ 85.00	10531	$ 895,116.30	6870	$ 583,970.40	125101	$ 10,633,602.85	10306	$ 875,999.80
Total (2009 Dollars)			**8,101**	**$ 3,188,887.30**	**5,285**	**$ 992,701.40**	**96,232**	**$ 22,148,720.85**	**7,928**	**$ 1,559,397.80**
Contingency (30%)				$ 956,666.19		$ 297,810.42		$ 6,644,616.26		$ 467,819.34
Subtotal				**$ 4,145,553.49**		**$ 1,290,511.82**		**$ 28,793,337.11**		**$ 2,027,217.14**
Engineering (7.5%)				$ 310,916.51		$ 96,788.39		$ 2,159,500.28		$ 152,041.29
Survey (2.5%)				$ 103,638.84		$ 32,262.80		$ 719,833.43		$ 50,680.43
Project Administation (10%)				$ 414,555.35		$ 129,051.18		$ 2,879,333.71		$ 202,721.71
Inspection (2.5%)				$ 103,638.84		$ 32,262.80		$ 719,833.43		$ 50,680.43
Material Testing (2%)				$ 82,911.07		$ 25,810.24		$ 575,866.74		$ 40,544.34
Total (2009 Dollars)				**$ 5,161,000.00**		**$ 1,607,000.00**		**$ 35,848,000.00**		**$ 2,524,000.00**

Table 10-9

2055

			Southwest		Northeast		East		Downtown	
Item	Units	Unit Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
12" PVC Wastewater Pipe, open cut	LF	$ 60.00	0	$ -	0	$ -	0	$ -	0	$ -
15" PVC Wastewater Pipe, open cut	LF	$ 70.00	3814	$ 266,973.00	0	$ -	505	$ 35,350.00	0	$ -
18" PVC Wastewater Pipe, open cut	LF	$ 85.00	2215	$ 188,266.50	0	$ -	2087	$ 177,412.00	0	$ -
21" PVC Wastewater Pipe, open cut	LF	$ 105.00	0	$ -	0	$ -	1044	$ 109,609.50	0	$ -
24" PVC Wastewater Pipe, open cut	LF	$ 130.00	0	$ -	0	$ -	0	$ -	0	$ -
27" PVC Wastewater Pipe, open cut	LF	$ 160.00	0	$ -	0	$ -	0	$ -	0	$ -
30" PVC Wastewater Pipe, open cut	LF	$ 190.00	0	$ -	0	$ -	0	$ -	0	$ -
36" PVC Wastewater Pipe, open cut	LF	$ 215.00	0	$ -	0	$ -	0	$ -	0	$ -
42" RCP Wastewater Pipe, open cut	LF	$ 285.00	0	$ -	0	$ -	0	$ -	0	$ -
48" RCP Wastewater Pipe, open cut	LF	$ 330.00	0	$ -	0	$ -	0	$ -	0	$ -
54" RCP Wastewater Pipe, open cut	LF	$ 380.00	0	$ -	0	$ -	0	$ -	0	$ -
4' Manhole	EA	2500	30	$ 75,000.00	0	$ -	26	$ 63,750.00	0	$ -
Extra depth 4' manhole	VF	150	210	$ 31,500.00	0	$ -	179	$ 26,775.00	0	$ -
Pavement Replacement (assume 1.3SY/LF)	SY	$ 85.00	7837	$ 666,182.40	0	$ -	4727	$ 401,789.05	0	$ -
Total (2009 Dollars)			**6,029**	**$ 1,227,921.90**	**0**	**$ -**	**3,636**	**$ 814,685.55**	**0**	**$ -**
Contingency (30%)				$ 368,376.57		$ -		$ 244,405.67		$ -
Subtotal				**$ 1,596,298.47**		**$ -**		**$ 1,059,091.22**		**$ -**
Engineering (7.5%)				$ 119,722.39		$ -		$ 79,431.84		$ -
Survey (2.5%)				$ 39,907.46		$ -		$ 26,477.28		$ -
Project Administation (10%)				$ 159,629.85		$ -		$ 105,909.12		$ -
Inspection (2.5%)				$ 39,907.46		$ -		$ 26,477.28		$ -
Material Testing (2%)				$ 31,925.97		$ -		$ 21,181.82		$ -
Total (2009 Dollars)				**$ 1,987,000.00**		**$ -**		**$ 1,319,000.00**		**$ -**

Table 10-11										
2055-New Pipes										
			Southwest		Northeast		East		Downtown	
Item	Units	Unit Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
12" PVC Wastewater Pipe, open cut	LF	$ 60.00	0	$ -	0	$ -	0	$ -	0	$ -
15" PVC Wastewater Pipe, open cut	LF	$ 70.00	51204	$ 3,584,294.00	6571	$ 459,977.00	0	$ -	0	$ -
18" PVC Wastewater Pipe, open cut	LF	$ 85.00	17723	$ 1,506,412.50	16124	$ 1,370,540.00	0	$ -	0	$ -
21" PVC Wastewater Pipe, open cut	LF	$ 105.00	5513	$ 578,907.00	5313	$ 557,823.00	0	$ -	0	$ -
24" PVC Wastewater Pipe, open cut	LF	$ 130.00	26818	$ 3,486,392.00	6133	$ 797,290.00	0	$ -	0	$ -
27" PVC Wastewater Pipe, open cut	LF	$ 160.00	0	$ -	0	$ -	0	$ -	0	$ -
30" PVC Wastewater Pipe, open cut	LF	$ 190.00	0	$ -	0	$ -	0	$ -	0	$ -
36" PVC Wastewater Pipe, open cut	LF	$ 215.00	0	$ -	0	$ -	0	$ -	0	$ -
42" RCP Wastewater Pipe, open cut	LF	$ 285.00	0	$ -	0	$ -	0	$ -	0	$ -
48" RCP Wastewater Pipe, open cut	LF	$ 330.00	0	$ -	0	$ -	0	$ -	0	$ -
54" RCP Wastewater Pipe, open cut	LF	$ 380.00	0	$ -	0	$ -	0	$ -	0	$ -
4' Manhole	EA	2500	221	$ 551,250.00	45	$ 112,500.00	0	$ -	0	$ -
Extra depth 4' manhole	VF	150	1544	$ 231,525.00	315	$ 47,250.00	0	$ -	0	$ -
Pavement Replacement (assume 1.3SY/LF)	SY	$ 85.00	131636	$ 11,189,064.25	44383	$ 3,772,547.35	0	$ -	0	$ -
Total (2009 Dollars)			**101,259**	**$ 21,127,844.75**	**34,141**	**$ 7,117,927.35**	**0**	**$ -**	**0**	**$ -**
Contingency (30%)				$ 6,338,353.43		$ 2,135,378.21		$ -		$ -
Subtotal				**$ 27,466,198.18**		**$ 9,253,305.56**		**$ -**		**$ -**
Engineering (7.5%)				$ 2,059,964.86		$ 693,997.92		$ -		$ -
Survey (2.5%)				$ 686,654.95		$ 231,332.64		$ -		$ -
Project Administation (10%)				$ 2,746,619.82		$ 925,330.56		$ -		$ -
Inspection (2.5%)				$ 686,654.95		$ 231,332.64		$ -		$ -
Material Testing (2%)				$ 549,323.96		$ 185,066.11		$ -		$ -
Total (2009 Dollars)				**$ 34,195,000.00**		**$ 11,520,000.00**		**$ -**		**$ -**

EXHIBIT 10-1

CAPITAL IMPROVEMENT PLAN

STILLWATER WASTEWATER COLLECTION SYSTEM MASTER PLAN

Chapter 11
Conclusions and Recommendations

1. During the flow and precipitation monitoring, the recorded precipitation events were scattered sparsely over the sewer basins. A more comprehensive flow monitoring system could help provide better data quality.
    a. Some permanent flow and precipitation monitoring stations should be installed to provide peak rainfall and flow information for future work.
    b. A minimum of four permanent flow metering stations and four precipitation gauges should be installed, one per sewershed.

2. Wastewater master plans are dynamic and should be updated periodically, that is true for this project.
    a. The best time to update master plans is when the new census data are available. Therefore, this master plan should be updated in approximately 2012, and every ten years thereafter.

3. Wastewater master plans are planning level documents and more detailed information should be obtained on some of the sewersheds prior to the design of major facilities.
    a. Conduct I/I or SSES studies for all sewersheds beginning with the East basin. For maintenance purposes I/I studies should be conducted every twenty years.

4. The majority of the growth in the City of Stillwater is projected to occur in the surrounding areas of the existing city limits and adequate infrastructure should be in place to support that growth.
    a. Construct new lines around the city as needed to support future growth.
    b. Additional capacity at the wastewater treatment plant should be provided to accommodate growth.

5. Grease and root intrusion are reasonably common problems in all sewer systems, including that of the City of Stillwater. These issues can cause blockages and overflows.
    a. Create a program to routinely video and clean the sanitary sewer system.
    b. The entire system should be cleaned every four (4) years.
    c. The entire system should be video inspected every twenty (20) years.
    d. These tasks will require the commitment of funds to support the required City staff and provide the equipment needed.

6. The structural condition of the sewers in the City of Stillwater is fairly good. Steps should be made to repair and replace sewers that have deteriorated.

    a. A program of routine sanitary sewer replacements should be initiated with the goal of maintaining the system at an average life of 100 to 125 years.
    b. Develop design, construction and inspection standards for the new sewer infrastructure.

c. Continue to update the City design and construction standards to include materials of construction and design criteria that are appropriate for the City.
d. Provide good construction inspection on all new sewer construction. Making sure that the pipe is placed on proper embedment, has backfill that has been properly compacted, and that has been laid to the correct line and grade will provide a line that will provide a service life of 100 years. Good inspection is a very wise investment in the construction of municipal infrastructure.
e. Provide City inspection of all service connections to the sanitary sewer. Inspection of service connections is an important part of maintaining the integrity of the sewer system. The inspection should be performed only by trained city employees. Inflow and infiltration from house laterals can be a major source of extraneous flows in the collection system, resulting in unnecessary expense for the City. Since most State and municipal laws prohibit cities from directly making improvements on private property, the City cannot replace house laterals. Therefore, require house laterals to be inspected, tested, and repaired prior to selling the house. This will eliminate the problem of house laterals in about 20 years.