

Wastewater Collection System Evaluation Survey Basin 10 Final Report



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Director of Public Works

June 2009

I certify that this report was prepared under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Texas.


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TABLE OF CONTENTS

SECTION I	EXECUTIVE SUMMARY	1
SECTION II	SEWER SYSTEM EVALUATION AND RENEWAL PROGRAM	7
	A. MANHOLE INSPECTION/CONDITION ASSESSMENT	10
	B. SERVICE LATERAL CONDITION ASSESSMENT	11
	C. MAINLINE SEWER CONDITION ASSESSMENT	12
	D. DIGITAL PHOTOGRAPHS	13
	E. REHABILITATION PLAN	14
	F. RECOMMENDATIONS	15

LIST OF TABLES

I-1	INFILTRATION/INFLOW PRIORITY RANKING SUMMARY	1
I-2	COLLECTION SYSTEM SUMMARY	5
I-3	REHABILITATION SUMMARY	6
II-4	REHABILITATION SUMMARY	16

LIST OF FIGURES

I-1	STUDY AREAS MAP	3
I-2	BASIN 10 STUDY AREA MAP	4
II-1	REHABILITATION FLOW CHART	9
II-2	PROJECT PHOTOGRAPH SUMMARY	13

APPENDIX A – SUMMARY TABLES

**TABLE 1 – MANHOLE INVENTORY SUMMARY
AREA PHOTOGRAPHS
INTERNAL PHOTOGRAPHS**

**TABLE 2 – MANHOLE DEFECT SUMMARY
MANHOLE DEFECT PHOTOGRAPHS**

TABLE 3 – MANHOLE REHABILITATION SUMMARY

**TABLE 4 – MAINLINE SEWER INVENTORY
PIPE PHOTOGRAPHS**

TABLE 5 – REHABILITATION FROM SMOKE TESTING

TABLE 6 – MAINLINE PIPE REHABILITATION SUMMARY

APPENDIX B – SMOKE TESTING SKETCHES AND PHOTOGRAPHS

APPENDIX C – CCTV LOGS/PHOTOGRAPHS/DVD

MANHOLE REHABILITATION RECOMMENDATIONS MAP

MAINLINE REHABILITATION RECOMMENDATIONS MAP

I. Executive Summary

Pipeline Analysis, LLC was contracted by the City of Stephenville to implement a Phased Infiltration/Inflow Reduction Plan. The first phase of the project was the temporary flow monitoring of the collection system which resulted in delivery of the Temporary Flow Monitoring Final Report (October 2008). The flow report provided dry and wet weather flow data including the ranking of areas with high infiltration/inflow. The highest ranked basin was identified as Basin 10. Table I-1 presents the ranking of basins from the 2008 flow monitoring final report. Figure I-1 graphically presents the various basins and depicts the study area associated with Basin 10. Figure I-2 presents the Basin 10 study area map. This report presents the findings of a comprehensive sewer system evaluation of Basin 10.

Wastewater collection systems are composed of manholes, pipelines, and pump stations that will, over a period of time, deteriorate and require rehabilitation or replacement. The City of Stephenville has approximately 109 miles of sanitary sewer within the collection system. These collection system assets have a replacement value of approximately \$86.4 million. Sixty-five percent (65%) of the system is comprised of six inch pipeline with the predominate material being vitrified clay. Table I-2 presents a summary of the gravity sewer by pipe sizes.

<u>Priority Ranking</u>	<u>Meter Basin</u>
1	Basin 10
2	Basin 7
3	Basin 3
4	Basin 8
5	Basin 6
6	Basin 5
7	Basin 9
8	Basin 2
9	Basin 1
10	Basin 4

The most recognized result of system deterioration is high infiltration/inflow during wet weather. Infiltration/inflow is composed of groundwater and rainfall runoff that enters the collection system through broken pipelines, open pipe joints, vented manhole covers, defective manholes, unauthorized storm drain connections, roof drains, etc. The extraneous infiltration/inflow (commonly referred to as I/I) reduces the pipeline capacity to serve customers and may result in sanitary sewer overflows which are in violation of State and Federal regulations. To locate, identify the best means of repair, and estimate the cost of the most feasible alternative requires evaluation and testing of the wastewater collection system.

**Table I-1
Infiltration/Inflow
Priority Ranking
Summary**

By implementing a systematic sewer system evaluation consisting of inspecting, testing and repairing system defects, the City of Stephenville staff will minimize repair costs and extend the life of collection system assets. Identifying manhole and pipe defects early will allow less expensive repairs and minimize wet weather infiltration/inflow. This on-going program of collection system renewal will ensure asset life will be extended at the least cost. The City should budget for system renewal and systematically perform rehabilitation on an annual basis. The recommendations for the Basin 10 service area I/I reduction are:

1. Perform manhole rehabilitation as presented in this report. The estimated cost for the manhole rehabilitation identified in this report is \$38,420. The City repair crews have the expertise to perform various repairs and may consider performing many of the repairs recommended.
2. Private sector defects contribute to excessive infiltration/inflow. The City should implement a private sector repair program to address those defects. City staff have anticipated this need and are working with code enforcement. The estimated cost associated with private laterals is \$2,450.
3. Mainline repairs identified during this project are estimated to cost \$149,215. Future planning

should include costs for additional mainline renewal. The high percentage of 6-inch and 8-inch clay pipe will continue to be very problematic for the utility department.

4. It is recommended that the City of Stephenville continue its program of system evaluation and renewal. The total estimated rehabilitation cost for the Basin 10 recommendations presented is \$190,085.

Table I-3 presents a summary of the estimated cost for the repairs and improvements identified in this report.

Figure I-1
Study Areas

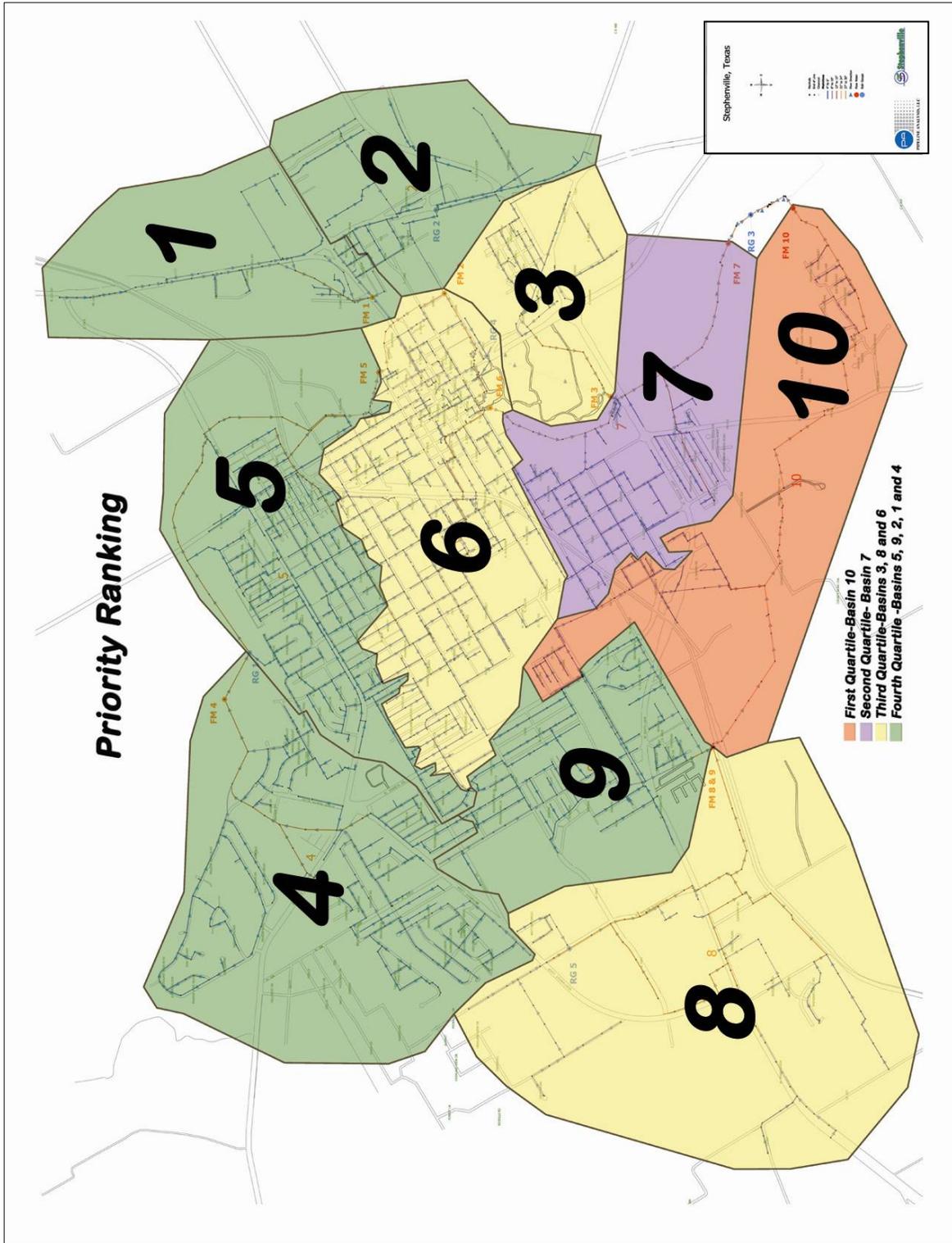
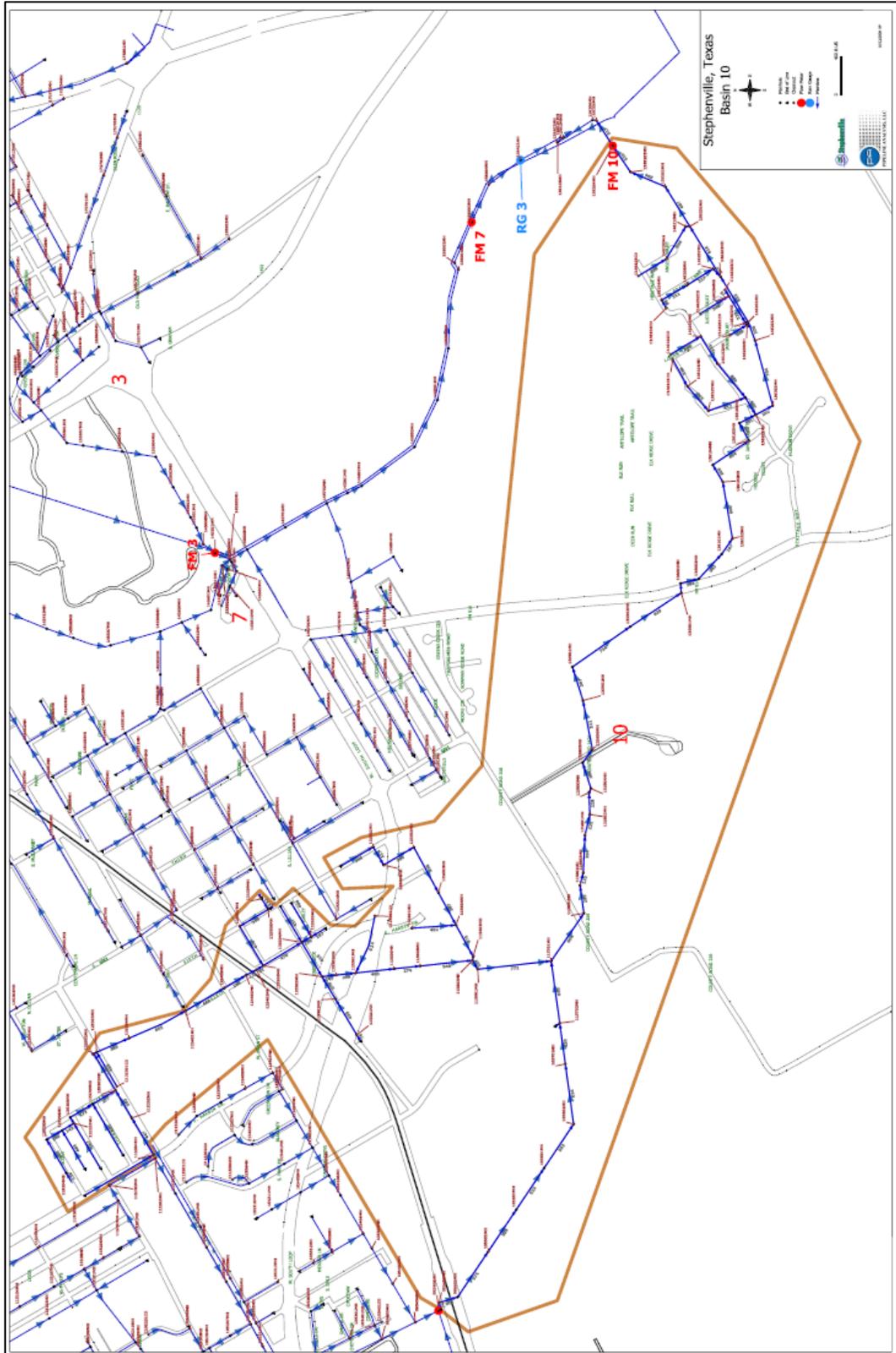


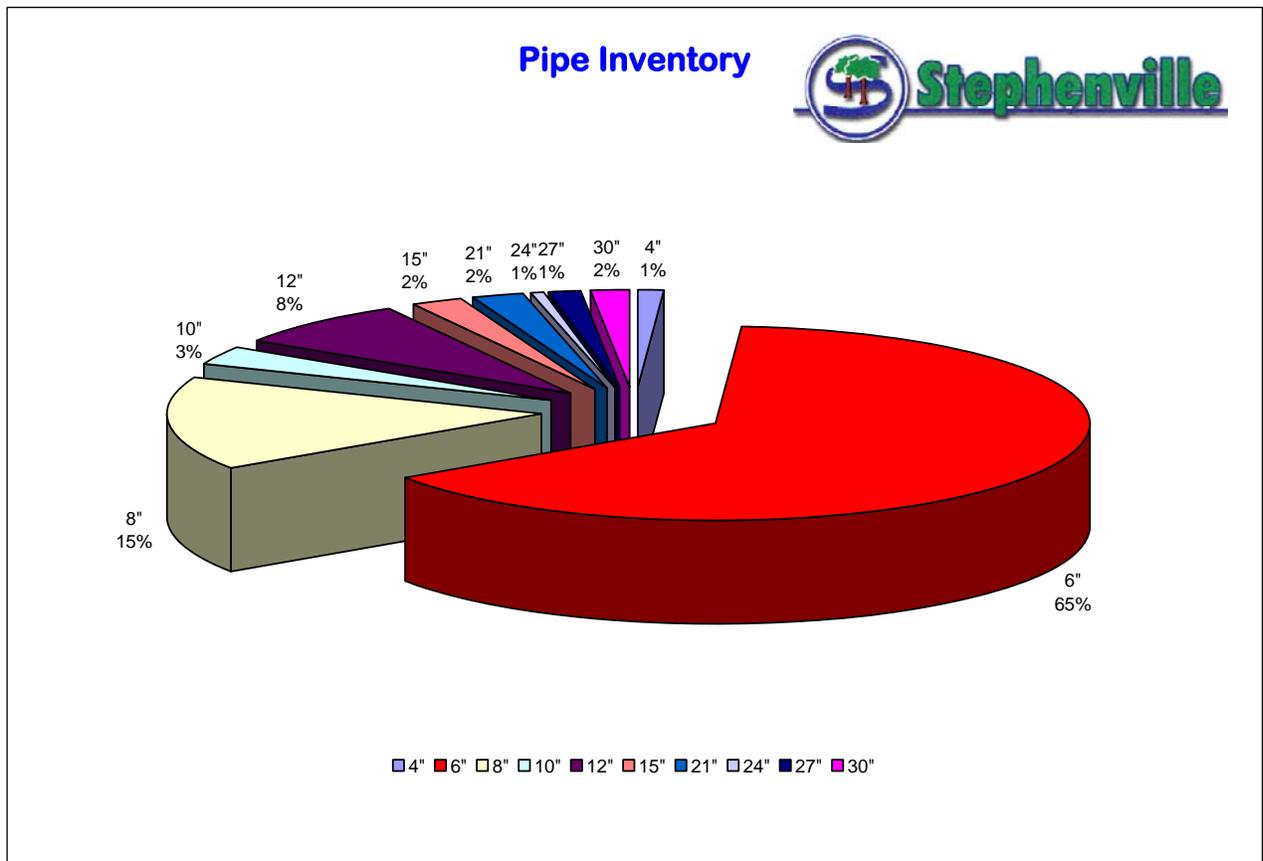
Figure I-2
Basin 10 Study Area



**Table I-2
Collection System Summary**

Pipe Size	Length	Percent
4"	6,187	1.1%
6"	372,169	64.6%
8"	88,988	15.4%
10"	17,388	3.0%
12"	45,342	7.9%
15"	13,405	2.3%
21"	11,317	2.0%
24"	3,422	0.6%
27"	8,156	1.4%
30"	10,003	1.7%
Total	576,377	100.0%

Estimated replacement value: \$86.4 million



**Table I-3
Rehabilitation Summary**

Recommended Manhole Rehabilitation (Table 3)	Quantity	Cost
Rehab 1: Replace Manhole Ring & Cover	19	\$ 13,300
Rehab 2: Realign and Seal Manhole Ring & Cover	5	\$ 1,750
Rehab 3: Raise Manhole to Grade	0	\$ -
Rehab 4: Repair Chimney/Cone and Coat	8	\$ 3,360
Rehab 5: Clean Manhole, Repair as Needed and Coat	14	\$ 9,460
Rehab 6: Reconstruct Manhole Bench & Invert	0	\$ -
Rehab 7: Install Inflow Protector Insert	45	\$ 7,990
Rehab 8: Stop I/I, Repair Pipe Seal and Coat	4	\$ 2,560
Rehab 9: Replace Manhole	0	\$ -
Rehab 10: Special Repair (see comment if specified)	0	\$ -
Sub-Total		\$ 38,420

Recommended From Smoke Testing (Table 5)	Quantity	Cost
Repairs from smoke testing (including service laterals)	13	\$ 2,450
Sub-Total		\$ 2,450

Recommended Mainline Rehabilitation (Table 6)	Quantity	Cost
Cured-In-Place Liner	1328	\$ 84,022
Pipe Burst or Replace	1086	\$ 54,378
Mainline Point Repair	3	\$ 10,815
Sub-Total		\$ 149,215

Estimated Total Rehabilitation Cost	Total	\$ 190,085
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II. Sewer System Evaluation and Renewal Program

The approach to the Stephenville sewer evaluation was organized around the objectives for this project:

- Infiltration/Inflow Reduction
- Collection system rehabilitation (renewal)
- Regulatory compliance
- Customer satisfaction
- Cost control

Wastewater collection system assets have a useful design life of approximately 75 to 100 years. Whether manholes or pipelines reach their useful life are to a great extent based on the materials of construction, soil condition, construction bedding, hydrogen sulfide concentrations, root intrusion, and sound maintenance practices. Collection system renewal is a continual process of “finding” system defects, prioritizing them, and “fixing” them. The goal for the collection system manager may be to inspect the collection system on a 5-year cycle. (Note that



Root intrusion at pipe joint. Segment 125506-125504.

critical sewers or those assets in flood prone areas may be on an annual cycle of inspection.) A five year cycle will require inspecting/testing 20% of the collection system (115,000 linear feet) annually. The results of the inspection will generate repairs to manholes and mainline sewers. Private sector defects will also be identified requiring enforcement of local codes and ordinances. Budgeting funds to find and fix defects is the least cost solution to extend the life of the collection system. Waiting for pipeline or manhole failure will result in replacement of the assets which is the most expensive alternative.

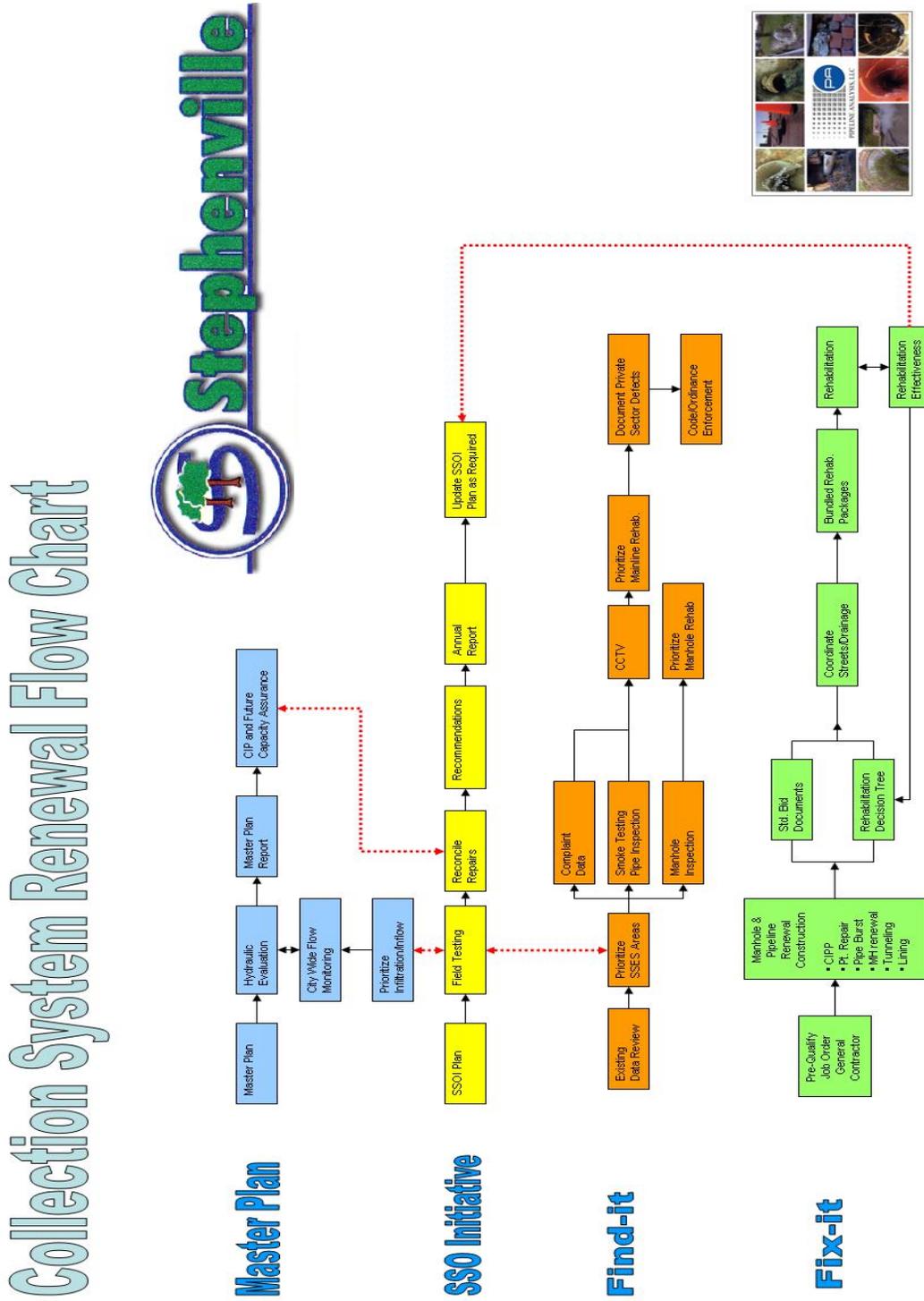
Collections system tools used to “find” defects include flow monitoring (to prioritize areas), manhole/pipe inspections, smoke testing, and CCTV inspection. These testing tools were used in the evaluation of the Basin 10 service area.

Rehabilitation methods available to extend the life of collection system assets (renewal of assets) include trenchless technologies that minimize the impact to customers. Manhole rehabilitation may include lining, sealing, installing water tight ring and covers, raising buried manholes to grade, replacing vented covers, etc. Mainline sewer rehabilitation may include cured-in-place pipe (CIPP), slip lining and upsizing or pipe replacement by pipe bursting. These “fix-it” technologies are expanding to service laterals which must be addressed by collection system managers.

Figure II-1 depicts the relationships between collection system planning and collection system rehabilitation. For example, the capacity analysis performed in a master plan will impact sewer system renewal. Knowing when a particular pipeline will require upsizing will impact the decision to rehabilitate the pipe. It may be more cost effective to defer rehabilitation (yet maintain the pipe) and replace the pipe as part of the capital improvement plan (CIP). Also, the least cost renewal plan may require deferring some rehabilitation until sufficient quantities are identified to reduce unit repair costs. Utilization of annual term contracts for collection system renewal is gaining favor as it speeds up the process of rehabilitation, thus keeping projects within annual budgets.

The most recognized result of system deterioration is high infiltration/inflow during wet weather. Infiltration/inflow is composed of groundwater and rainfall runoff that enters the collection system through broken pipelines, open pipe joints, vented manhole covers, defective manholes, unauthorized storm drain connections, roof drains, etc. The extraneous infiltration/inflow (commonly referred to as I/I) reduces the pipeline capacity to serve facilities and may result in sanitary sewer overflows which are in violation of State and Federal regulations. To locate, identify the best means of repair, and estimate the cost of the most feasible alternative requires evaluation and testing of the wastewater collection system.

Figure II-1
Rehabilitation Flow Chart



A. Manhole Inspection/Condition Assessment

Manhole inspection was performed on all accessible manholes within the designated study area. Approximately 115 structures consisting of mainline cleanouts and manholes are within the study area. The following inspections were performed:

1. The casting/cone condition and manhole cover were evaluated for such items as vented covers that are in low ponding areas since casting/cone connection and covers are possible sources of inflow.
2. Manhole walls were checked for integrity and signs of root intrusion, deterioration of mortar joints, loose or missing bricks, signs of surcharge, etc.
3. The bench was checked for type and depth of debris, flow conditions thru the manhole and any signs of settlement that may impede the achievement of design flows.
4. Influent and effluent lines in each manhole were compared to existing maps and corrections noted.
5. Inspection of each influent and effluent line to determine line conditions.
6. Any silt deposits that reduces flow capacity were noted and depth of silt recorded.



Basin 10
Manhole 136104 – Vented Cover

Manhole inspections provide basic data including line size, depth from rim to invert, and pipeline cover (i.e. street, yard, easement, alley, etc.). Appendix A presents a tabular summary of the findings. Table 1 (Appendix A) presents the summary of data collected during manhole inspections including an inventory of all manhole and cleanouts.

Defects associated with manholes were recorded and are summarized in Table 2. Information for each defect is summarized and the corresponding digital photograph is referenced. Each defect identified during manhole inspection was reviewed and a rehabilitation method assigned. Rehabilitation recommendations for manholes are presented in Table 3. The estimated cost for the repair was determined and the severity of the defect prioritized. Table 3 presents information on the manhole location and references the supporting photographs. Priority 1 defects are the most severe and are recommended for immediate attention, while priority 2 defects are recommended for repair as funding allows. Priority 3 defects are minor in nature and do not warrant immediate repair. The total cost for Priority 1 and 2 manhole repairs is \$38,420.

B. Service Lateral Condition Assessment

In order to identify defects in the pipelines, a non-toxic smoke was forced into the sewer pipes. Breaks in the sewer pipes will allow the smoke to escape. Normally one line segment upstream and downstream of the manhole is tested at one time. Table 4 presents an inventory of all mainline sewer within Basin 10.

Field documentation of the defects is extremely important and include sketches of each system defect along with pertinent information for prioritizing the defects. Color digital photographs were taken to document each defect during smoke testing.

Pipeline repair recommendations are separated according to those on private property and municipal right of way. Table 4 presents the summary of recommended repairs on private and municipal laterals for each basin. Referenced smoke sketches and photographs are included in the electronic files that accompany this report. Abandoned service lines were identified at various locations and these service lines should be disconnected at the property line and a cleanout installed. In general, defects on private property are normally the responsibility of the property owner to repair and current city codes and ordinances should be used to ensure compliance.

Some defects were identified on the municipal right of way and may be the responsibility of the City of Stephenville. The recommended repair costs associated with private and municipal laterals is \$2,450 and are presented in Table 5. Appendix B presents location sketches for each defect identified in Table 5 along with documentation photographs.



Private service line defect identified during smoke testing.

C. Mainline Sewer Condition Assessment

A listing of mainline sewer repairs is presented in Table 6 for Basin 10. Each pipe entering and exiting the manhole was inspected and photographed. Internal color television inspection was undertaken on specific lines to visually establish the pipeline condition. Any structural problems or defects were digitally recorded along with a detailed log. The observation logs and digital video are presented in Appendix C. Internal inspection of specific sewer lines determined the best repair options, which in turn, will reduce overall project costs. The total cost for repairs to municipal pipelines is estimated at \$149,215.



Minor offset pipe joint.

D. Digital Photographs

Digital photographs were taken during the testing and inspection phases of the project. Approximately 530 digital photographs accompany this report. Figure II-2 presents a summary of the types of photographs taken and the nomenclature used when naming the digital files. Information that can be gathered from the photographs includes right of way condition, surface cover, manhole grade, etc.

**Figure II-2
Project Photograph Summary**

- 1) Area Photo = Manhole ID, A, Photo No.
Example: 125209A0036.jpg
Manhole: 125209
A=Area Photo
Photo No.0036
(Note: Photo taken in direction of outgoing pipe)



- 2) Internal Photo = Manhole ID, I, Photo No.
Example: 115305I0059.jpg
Manhole: 115305
I=Internal Photo
Photo No.0059 (Note: North to top of photo.)



- 3) Manhole Defect Photo = Manhole ID, M, Photo No.
Example: 125409M0083.jpg
Manhole: 125409
M= Manhole Defect
Photo No. 0083



- 4) Smoke Photo = Manhole ID, S, Photo No.
Example: C125207COS0001.jpg
Upstream Manhole: C125207CO
S=Smoke Defect
Photo No. 0001



- 5) Pipe Photo = Manhole ID, P, Photo No.
Example: 125605P0041.jpg
Manhole: 125605
P=Pipe Photo
Photo No. 0041



E. Rehabilitation Plan

This report provides preliminary recommendations concerning defects identified during field inspection and testing. A recommended repair plan for the identified deficiencies has been developed based on a priority ranking. The rehabilitation plan considered conventional rehabilitation methods including, but not limited to, the following:

- Cured In Place Pipe Liner (CIPP), Pipe Bursting, Open Cut Replacement
- Service Line Rehabilitation including repairing broken cleanouts
- Point Repairs
- Manhole rehabilitation
- Point Repairs and CCTV Inspection to assess the line segment

1. Service Line Rehabilitation

These defects are generally the responsibility of the property owner to repair. To facilitate these repairs the field location sketches and digital photographs are provided electronically. The street address and GPS coordinates for the defects are included in the summary tables and database. Note that the address listed may be an adjacent house if no house number could be determined in the field. Refer to the scanned defect sketches, GPS coordinates and digital photographs may be used to assist in relocating defects.

2. Point Repairs

Point repairs will be used to correct defects on the mainline or private service lines. When associated with pipe lining, a major defect must be repaired in order to install the liner. The cost basis for the point repair is a price per each and will vary depending on pipe size, depth and cover. Some mainline point repairs can utilize sectional liners if open cut is not practical. The final rehabilitation plans and specifications should review possible utility conflicts associated with open cuts. In some instances, the CCTV inspection of particular line segments could not be completed due to an obstruction. In these instances, a point repair is recommended followed by CCTV inspection in order to fully evaluate the pipeline.

3. Manhole Rehabilitation

Manhole rehabilitation recommendations include minor repairs or complete rehabilitation of the manhole, depending on the condition of the manhole. Minor repairs include installation of inserts, realigning or replacing the casting and sealing manhole walls. More substantial repairs include stopping I/I at the pipe seal, repairing the chimney and installation of spray-on liner.

4. Municipal Mainline Rehabilitation

Mainline rehabilitation may involve the use of multiple repair methods on a single line segment. The recommendations in this report are preliminary and may change in the final design due to utility conflicts, quantities of work to be performed and current construction costs. Supporting information for implementing repairs include CCTV logs, smoke sketches, digital photographs and digital video.

F. Recommendations

Based on the testing and evaluation of the Basin 10 service area, the following summarizes the findings and recommendations:

1. By periodically inspecting, testing and repairing defects, the City of Stephenville staff have reduced repair costs and extended the life of collection system assets. By identifying manhole and pipe defects early, the repairs tend to be less expensive and wet weather infiltration/inflow minimized. This on-going program of collection system renewal will ensure and extend asset life.
2. Staff should continue to address private sector rehabilitation using code enforcement, if necessary, to reduce infiltration/inflow from private sector defects.
3. The total estimated cost to correct defects for the study areas evaluated under this project is summarized in Table II-4 and is estimated at \$190,085.
4. The City should prepare final repair recommendations based on defects identified in this report. This final design effort should address current and future capacity needs for the study area. It is anticipated that many of the repairs can be performed in house. Close inspection during construction is recommended to ensure proper repairs are made.
5. The accompanying manhole and mainline rehabilitation maps provide a visualization of the recommendations. The service area maps were updated based on field inspections and GIS updates accompanying this report.

**Table II-4
Rehabilitation Summary**

Recommended Manhole Rehabilitation (Table 3)	Quantity	Cost
Rehab 1: Replace Manhole Ring & Cover	19	\$ 13,300
Rehab 2: Realign and Seal Manhole Ring & Cover	5	\$ 1,750
Rehab 3: Raise Manhole to Grade	0	\$ -
Rehab 4: Repair Chimney/Cone and Coat	8	\$ 3,360
Rehab 5: Clean Manhole, Repair as Needed and Coat	14	\$ 9,460
Rehab 6: Reconstruct Manhole Bench & Invert	0	\$ -
Rehab 7: Install Inflow Protector Insert	45	\$ 7,990
Rehab 8: Stop I/I, Repair Pipe Seal and Coat	4	\$ 2,560
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Recommended From Smoke Testing (Table 5)	Quantity	Cost
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Mainline Point Repair	3	\$ 10,815
Sub-Total		\$ 149,215

Estimated Total Rehabilitation Cost	Total	\$ 190,085
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**Note: Estimated costs do not include any capacity improvements.*

Table 1 - Manhole Inventory

Summary of manhole inspections including location address, materials of construction, depth, Area photographs, Manhole Lid Photographs, Internal Photographs and Pipe Photographs references.

Table 2 - Manhole Defect Summary

Each observed defect associated with manholes are summarized along with preliminary repair recommendations.

Table 3 - Manhole Rehabilitation Summary

The recommended repairs are summarized by repair method, estimated cost and priority ranking. This table differs from Table 2 in that multiple defects are reconciled by the repair method recommended. For example, multiple defects on the manhole wall will be resolved by cleaning and grouting the entire manhole wall. The priority ranking is based on the type of repairs required, severity of infiltration/inflow and structural integrity. Priority 1 and 2 repairs are recommended and should be budgeted for repair. Priority 3 repairs are considered minor in nature and should be re-evaluated in 3 to 5 years or added to a repair schedule as funds are available following priority 1 and 2 repairs.

Table 4 - Pipe Inventory - A tabular summary of pipe data is presented for each pipe segment. Physical information about each pipe is presented.

Table 5 - Smoke Testing Rehabilitation Summary

Presented is a listing of recommended pipeline repairs based on the smoke testing investigation. The estimated cost and priority ranking of each repair is presented along with an estimated repair cost. The corresponding sketch page for each repair is presented in Table 6. Both private service laterals and mainline repairs are presented, if applicable.

Table 6 - Mainline Rehabilitation

Based on the field inspection and testing, a listing of mainline repairs is summarized along with estimated repair costs.