

City of Oak Ridge, Tennessee

Sewer System Evaluation Study Results



June 2012

Table of Contents

SECTION I	1
INTRODUCTION	1
SECTION II	3
SCOPE OF INVESTIGATIVE WORK	3
A. GIS MAPPING	5
B. SMOKE TESTING	6
C. MANHOLE INSPECTIONS	8
D. RAINFALL DATA COLLECTION	10
E. CLOSED CIRCUIT TELEVISION (CCTV)	11
F. FLOW MONITORING AND OVERFLOWS	11
SECTION III	14
RESULTS	14
A. EMORY VALLEY SEWERSHED	14
B. EAST PLANT SEWERSHED	20
C. CENTRAL CITY SEWERSHED	25
D. Y-12 SEWERSHED	28
E. TURTLE PARK SEWERSHED	32
F. WEST END SEWERSHED	37

APPENDIX: (contained on CD or DVD as shown)

- A Maps (CD)
- B Smoke Testing Databases (CD)
- C Smoke Testing Field Maps (DVD C1 and C2)
- D Manhole Inspection Databases (CD)
- E CCTV Data (CD)

SECTION I

INTRODUCTION

The City of Oak Ridge has been engaged in a Sewer System Evaluation Survey (SSES) of its wastewater collection and transmission system. This activity has been performed in accordance with an EPA-approved Work Plan. In September 2010, the EPA issued an Administrative Order (No. CWA-04-2010-47722) for certain actions to be taken by the City. Section 13, Subsection iii, of the Order addresses the SSES activities. Generally, the SSES activities included the following major efforts:

- Manhole inspections
- Rainfall data collections
- Flow monitoring
- Smoke testing
- Closed circuit television inspection

There were companion efforts, which were being performed simultaneously with the SSES field activities. One major effort was developing a Management, Operations and Maintenance (MOM) Program for the City, including major investigation activities relating to pumping stations. Another major simultaneous effort was the development of a Capacity Assessment Report of the system. The City is current with all required submittals to date.

The required submittals following the field activities of the SSES include:

- Report results and
- Develop a Remediation Plan

The results are to be submitted within two (2) months of completing the survey. The field activities were completed within the twelve (12) months allocated by the order following the approval of the work plan. The Remediation Plan is due within two (2) months of submitting the results of the survey.

The City approached the SSES from many fronts. The City dedicated crews to perform the Smoke Testing and Manhole Inspection. A portion of the collection system was internally inspected with City personnel and equipment using closed circuit television technology (CCTV). The larger sewers and certain other areas were inspected using CCTV by contractors. The rainfall data collection and flow monitoring was a joint effort of City personnel and the consultant.

The results of the SSES are a large volume of data. The results will be reported in a summary text report. The collected data will be provided in electronic format. The body of the (text) report will have two (2) major sections. The first section will describe the methodology of each of the activities, and the second will report the results by sewershed.

This document is a compilation of data and not intended to give an interpretation. These results along with information contained in the companion document (Capacity Assessment Report) will be used collectively to develop the overall Rehabilitation Plan.

SECTION II

SCOPE OF INVESTIGATIVE WORK

The investigative work for the City of Oak Ridge has followed the guidelines set forth in the Sanitary Sewer Evaluation Study Work Plan. This included manhole inspections, smoke testing, closed circuit television inspections, flow monitoring, and rainfall monitoring on all sewer-systems flowing into the City of Oak Ridge wastewater treatment plant, which has a hydraulic capacity of 30 million gallons per day (MGD). This system encompasses approximately 1,255,000 linear feet of gravity sewer pipe, approximately 6,700 manholes, three major pumping stations with force mains, 32 smaller pumping stations with force mains, and privately owned laterals.

The major axis of the Oak Ridge sanitary sewer system basin is oriented approximately southwest - northeast, conforming to the ridge-and-valley topography of the Oak Ridge area. The system extends from Melton Hill Lake on the east southwestward approximately eleven miles. Along its minor axis, the system extends approximately five miles (at its widest point) southeast of Black Oak Ridge.

An evaluation was conducted of the previous sewer system evaluation studies. Based upon the review, the collection system was divided into six (6) sewersheds and correlating mini-systems. A sewershed is defined as the drainage area defined by a natural or artificial boundary in which sources of sewerage flow reach a common collection point. Within sewersheds are mini-systems, which are smaller individual sewer collection systems that flow to a common point within a sewershed. Figure II-1 shows the City of Oak Ridge Schematic Sanitary Sewer Mini-systems. The individual Sewershed Mini-system Location Map is shown on Figure II-2. Table II-1 lists the Collection System Sewersheds and their Mini-systems.

**Table II-1
City of Oak Ridge
Sewer System Evaluation Study and Results
Collection System Sewersheds
Mini-Systems**

Turtle Park Sewershed			
W-10	W-11	W-12	W-13
W-14	W-15	W-16	W-18B
W-18C	W-18D	W-18E	W-18F
W-18G	W-18H	W-25	W-28
W-30			

West End Sewershed				
W-17	W-20	W-22	W-24	W-27
W-27A	W-29	W-31	W-32	W-33
W-35				

Central City Sewershed				
W-5	W-5A	W-6	W-7	W-8
W-9	E-25			

Y-12 Sewershed				
W-2	W-3	W-4	W-18A	W-19
W-21	W-23	W-26	W-26A	W-34

East Plant Sewershed			
E-1	E-2	E-3	E-4
E-6	E-7	E-8	E-9
E-10	E-11	E-12	E-13A
E-13B	E-22	E-23	E-26
E-27	E-28	E-30	E-31

Table II-1 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
Collection System Sewersheds
Mini-Systems

Emory Valley Sewershed			
E-5A	E-5B	E-14	E-14A
E-15	E-16	E-17	E-18
E-19	E-20	E-21	E-24
E-29	E-29A	E-32	E-33
E-34	E-35	E-35A	E-36

Field investigations were conducted at a mini-system level. Once all mini-systems within a sewershed were complete, focus was shifted to another sewershed. This allowed for results to be sorted by mini-system and will aid in the sewer system rehabilitation planning process. Results from the field activities will be discussed in the following sections:

- GIS Mapping
- Smoke Testing
- Manhole Inspection
- Rainfall Data Collection
- Closed Circuit Television (CCTV)
- Flow Monitoring and Observed Sanitary Sewer Overflows

A. GIS MAPPING

The City, through its consultant, has developed the basic GIS of the wastewater system based on the City's "as-built" sewer drawings. As the investigative work was performed, its data was entered into the GIS. Therefore, as of late winter 2011, the GIS was current as to the condition of the sewerage system. Maps of the sewersheds are shown in Appendix A.

In order to perform an accurate sewer system evaluation, it was necessary to uniquely identify manholes and sewer pipes. This enabled unique records to be attached to each asset. The naming convention was developed and entered into the City's GIS system, allowing maps to be created for the field crews. Another benefit to using GIS for the naming convention was any previous alternate naming conventions

have been cross referenced in the system. An explanation of the identification nomenclature for manholes and sewer pipes follows:

An example of a manhole identifier is “MH:E5A-J16-30”. The “MH” term is the prefix for all identifiers that represent a manhole. The term “E5A” in the example indicates that the manhole is in the E5A mini-system. The term “J16” in the example indicates that the manhole is in grid J16 of the City of Oak Ridge’s legacy grid system. The last term, “30” in the example, is a sequential number applied to the manhole. Therefore, this manhole is manhole number 30 lying within the J16 grid, lying within mini-system E5A.

An example sewer pipe identifier is “SL:MH:E5A-J16-30,MH:E5A0J16-31”. In this example, “SL” is a prefix used to identify the asset as a sewer line. This is followed by the identifier for the upstream manhole (“MH:E5A-J16-30”), a comma, and then the identifier for the downstream manhole (“MH:E5A-J16-31”).

After the naming convention was developed, maps were printed and given to the field crews. All data was entered into electronic databases, which have been imported into ArcGIS by the name of the asset. Each manhole inspection was joined to its corresponding manhole where the inspection is easily queried. The photographs taken during the manhole inspection were also linked into the asset. Smoke testing was done in much the same way. Each smoke defect was photographed, and recorded with a GPS unit. The smoke defects were also measured from nearby reference points and marked on a field sketch. The smoke defects were incorporated into the GIS system by their GPS coordinates, and their triangulated measurements. Each smoke defect is linked to the inspection database, a .pdf of the field sketch, and photographs of the defect.

The final piece of the GIS mapping relative to the Sanitary Sewer Evaluation Study is the recording of rain gauge locations, flow monitoring locations, and overflow locations. This was integral for locating the flow monitors and the Capacity Assessment model calibration.


B. SMOKE TESTING

Smoke testing was undertaken by a combination of City of Oak Ridge crews and consultant crews. There were up to three crews compiled of four people. The crews included a crew leader, a recorder, and two crew members. All manholes and collection lines were smoked tested. Smoke testing is one of the most efficient and cost effective

methods of locating sources of inflow and infiltration problems within sewers. The smoke travels the path of least resistance and quickly pinpoints areas that allow inflow and infiltration into the collection system. Smoke testing identified broken manholes, illegal connections including roof drains, sump pumps, yard drains, uncapped lines, cracked mains and laterals, all of which are discussed in the Results section of this report. The smoke testing was entered into a database, and was subsequently entered into the GIS system. A copy of the smoke testing inspection form is included. The actual field data collected during smoke testing is displayed in Appendix B. Field sketches of the smoke locations are shown in Appendix C.

Information that was included in the smoke testing report:

- Location of all smoke sightings
- GPS Latitude/Longitude locations
- Pictures of smoke
- Addresses of sightings
- Mini-system number
- Map of the mini-system with location of smoke sightings


City of Oak Ridge Smoke Testing

Crew Leader: Date: ID:

Latitude * ' "

Longitude * ' "

Basin: <input type="text"/> MH Location of Blower: <input type="text"/> Leak Type: <input type="text"/> ▼ Leak Type Info: <input style="height: 20px;" type="text"/> Leak Severity: <input type="text"/> ▼	Upstream MH: <input type="text"/> Downstream MH: <input type="text"/> Distance from Downstream MH: <input type="text"/> ft Distance from Upstream MH: <input type="text"/> ft Sketch Number: <input style="height: 20px;" type="text"/>
--	---

Comments:

C. MANHOLE INSPECTIONS

Manhole inspections were completed by City of Oak Ridge and consultant crews. There were three crews comprised of three people each. The crews included a crew leader, a recorder, and a crew member. Each manhole visited was photographed, and a manhole inspection database was populated. These inspections were loaded into the GIS. A copy of the inspection form is included, and the results of the inspection include the following:

- Pictures of inside and outside of manhole
- Date and time of inspection
- Weather conditions
- Inspection status
- Sub Basin number
- GPS-Latitude/Longitude location
- Manhole elevation
- Amount of flow
- Old and new manhole number
- Manhole depth
- Top and invert elevation
- Manhole diameter
- Type of manhole cover
- Diameter of cover
- Manhole material
- Rehab recommendation
- Physical condition of base, cone, riser, steps, frame and cover
- Surge data
- Debris in manhole
- Pipe size and material
- Clock position of pipe
- Invert depth of pipe

The data collected during the manhole investigation is displayed in Appendix D.



City of Oak Ridge
Manhole Inspections

ID: 1

Crew Leader: Date: Time: Inspection Status:

Weather: Temperature: *F Sub Basin: Latitude * ' "

Longitude * ' "

MH Elevation:

Amount of Flow: % Top Elevation: ft MH Depth: ft Invert Elevation: ft

Location:

New MH #:

Old MH #:

MH Diameter: <input type="text"/> ft	Physical Condition	Leaking
WT FC: <input type="text"/>	Base Invert	<input type="text"/>
Cover Diameter: <input type="text"/> in	Cone	<input type="text"/>
FC Material: <input type="text"/>	Frame and Cover	<input type="text"/>
MH Walls: <input type="text"/>	Riser	<input type="text"/>
MH Material: <input type="text"/>	Steps	<input type="text"/>
MH Rehab Recommendation: <input type="text"/>	Surcharge	<input type="text"/>
	Debris	<input type="text"/>

	Clock Position	Pipe Material	Pipe Size	Depth	Notes:
Out	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Drop	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Invert 1	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Invert 2	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Invert 3	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Invert 4	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Invert 5	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	
Invert 6	<input type="text"/>	<input type="text"/>	<input type="text"/> in	<input type="text"/> ft	

D. RAINFALL DATA COLLECTION

As a sanitary sewer system experiencing inflow/infiltration (I/I) is evaluated, rainfall data collection is imperative. The system was evaluated under both wet and dry conditions. The ORDER had two parallel tasks for the City to execute (Capacity Assessment and SSES). Each of these tasks is interrelated. Therefore, the rainfall data has been collected as a part of both tasks.

EXISTING RAINFALL GAUGES AND HISTORICAL RAINFALL RECORDS

A search of NOAA websites and other sources identified the following available rainfall data. There are three gauge records available that will be useful. A gauge off Laboratory Road at Roane State College has hourly data available from 2002 to the present. This gauge is in the east-central area of the sewer basin. Hourly data from 1999 to the present and 1999 to 2006 are also available from gauges at Y-12 West and Y-12-East, respectively. Y-12 is a DOE facility located in the south-central area of the sewer basin.

NEW RAINFALL GAUGES

The sewer basin is approximately 11 miles long and 5 miles wide (at its maximum width). All but 4 of the 88 mini-systems lie in the valley between Black Oak Ridge and Pine Ridge in the central and northeast part of the basin, and between Black Oak Ridge and East Fork Ridge in the southwestern part of the basin. Since rainfall depths and intensities can vary significantly over a basin of this size, multiple gauges were required to obtain adequate areal coverage of the sewer basin. In addition, systems with significant short-term (inflow) and intermediate term (first infiltration) rainfall-derived inflow and infiltration (RDII) response, a relatively short time step is required for modeling. Therefore, short interval rainfall data was desired.

- Rain Gauge #1: This gauge is installed at the City of Oak Ridge Waste Water Treatment Plant. This is a secure area located in the southwestern third of the basin.
- Rain Gauge #2: This gauge is located at the City of Oak Ridge Public Works Department complex. This is a secure area located in the central third of the sewer basin.

- Rain Gauge #3: This gauge is installed at the City of Oak Ridge East Plant Lift Station. This is a secure area located in the northeastern third of the sewer basin.

Field calibration of the gauges was not required since the gauges were pre-calibrated at the factory. The rain gauges were prepared, installed, operated and maintained in strict accordance with the user manual. Each gauge was located in a clear area away from trees and buildings that could block the natural fall of rain. Maintenance consists of routine inspection, cleaning, and replacement of the battery.

E. CLOSED CIRCUIT TELEVISION (CCTV)

Closed circuit television inspections were undertaken by a combination of City of Oak Ridge crews and consultant crews. All manholes and collection lines were video tested. CCTV inspections provide video and pictures of defects within the pipe. It is also very important in that it notes potential maintenance problems of roots and grease. Smoke testing identified illegal connections, cracked mains and laterals, broken pipes, and many other pipe defects, which will be discussed in the Results section of this report. The CCTV testing was completed using the GIS naming conventions, and coded with NASSCO PACP codes. This allowed for uniform coding, and importing into CUES Granite XP. The Granite program provides a useful tool for querying, viewing, and sharing the CCTV information. It also allows for an easy import/export to ArcGIS. Appendix E displays CCTV data.

F. FLOW MONITORING AND OVERFLOWS

As part of the SSES, a determination was needed for dry weather flow rates and flow rates resulting from various storm events. Oak Ridge installed flow meters to determine actual flows within the system at various locations. The data collected from rainfall gauges, flow monitors, and physical inspections was used in the hydraulic model to calculate flows and for the reduction of I/I to eliminate overflows. Sewer flow data was collected at selected locations in order to estimate dry weather and wet weather flow rates. There are three categories of flow monitors:

- **Permanent flow meters** are located at the wastewater treatment plant and at two of the lift stations.
- **Semi-permanent flow meters** are located at strategic points in the main sewer system.
- **Temporary flow meters** are located at strategic points in the sewersheds. These meters will be rotated among the sewersheds.

The permanent monitoring locations are listed below. These are pre-existing and were not specifically selected for the purposes of this study. However, the flow records from these locations have been used to supplement the monitors deployed specifically for this assessment.

- Emory Valley Lift Station effluent
- East Plant Lift Station effluent
- Oak Ridge Wastewater Treatment Plant influent and effluent

The semi-permanent monitoring locations are located at points on the main gravity interceptor and on the influent to three major lift stations. It was intended that these meters remain in place throughout the duration of the monitoring program. These six locations were selected to provide continuous flow data for primary conveyances in the system.

- Emory Valley Lift Station influent gravity line
- East Plant Lift Station influent gravity line
- Main Interceptor gravity line downstream of force main discharge on Laboratory Road, east of the intersection with Lafayette Drive
- Main Interceptor gravity line downstream of inflow from mini-system W18A, located near the intersection of Oak Ridge Turnpike and Illinois Avenue
- Main interceptor gravity line downstream of inflow from mini-system W13, located off Oak Ridge Turnpike, near intersection with Louisiana Avenue
- Main interceptor gravity line influent to Turtle Park Lift Station

Temporary monitoring stations are located at the primary outlets of each sewershed. In addition, monitoring stations were located at key points within the sewershed to define flow records for sub-sewersheds and to monitor previous overflow locations.

Each unit was regularly field calibrated and maintained in strict accordance with the manufacturers' manuals. Maintenance was performed following major storm events, when data is downloaded or monthly, whichever occurs first. Maintenance generally consisted of:

- checking the physical stability and security of the installation
- clearing the band and cables of any debris
- cleaning the sensor
- checking/replacing desiccant and filters
- checking/replacing the operating and backup batteries
- real-time operating status checks

Detailed records of overflows were available, including all overflows for the last five years. Overflows were documented on standard forms with information such as address or location of overflow, type of occurrence (e.g., at a manhole or at a house back-up), the dates and times when the overflow started and ended, an estimate of the overflow volume, the cause of the overflow, remedial measures, and overflow destination (e.g., to a creek or to a storm drain). This data was routinely summarized in tabulation-style reports that provide the address or location and the dates and times when the overflow started and ended. These overflowing manholes were also entered into the GIS. Manholes that had an overflow concern were field verified during rain events. The Capacity Assessment Report contains the rainfall data, overflow information, flow measurements, as well as pipe capacities.

SECTION III**RESULTS**

Results of the field investigations were accumulated in Access database form, in ArcGIS, and in Granite XP. The investigations were also exported to Excel in order for calculations to be made. The methods of compiling the data allowed for different ways to query the investigations and develop a rehab plan. The results have been grouped together by sewersheds, as this is how rehabilitation of the system will be conducted.

A. EMORY VALLEY SEWERSHEDManhole Inspections

Manhole Inspections within the Emory Valley Sewershed were compiled into Access Databases, and entered into ArcGIS. Each database calculated a final recommendation, which is listed below in Table III-1.

**Table III-1
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed
Manhole Inspections**

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
E-5A	50	2	16	0	1	0
E-5B	61	15	48	0	6	0
E-14	38	1	18	0	3	0
E-14A	41	11	24	0	0	0
E-15	36	0	7	0	1	1
E-16	3	0	3	0	4	0
E-17	27	0	5	0	5	0
E-18	23	0	5	0	1	0
E-19	20	3	3	0	0	0
E-20	20	0	3	0	0	0
E-21	18	1	0	0	1	0

Table III-1 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
E-24	3	1	1	0	0	0
E-29	82	0	2	1	2	0
E-29A	16	0	9	0	0	0
E-32	18	0	2	0	0	1
E-33	5	5	7	0	0	1
E-34	5	0	2	0	0	0
E-35	9	0	7	0	0	0
E-35A	4	0	1	0	0	0
E-36	0	0	7	0	0	0
TOTAL	479	39	170	1	24	3

Emory Valley contains approximately 716 manholes, with 479 needing no rehab, 39 needing major rehab, and 170 requiring minor rehab. Table III-2 considers the need for a new frame and cover, risers, or grade rings requiring minor rehabilitation. It sorts the mini-systems within Emory Valley by percentage of manholes needing major rehab, minor rehab, or no rehab.

Table III-2
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed
Manhole Rehabilitation

MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
E-36	0.00%	0.00%	100.00%
E-33	27.78%	27.78%	44.44%
E-16	30.00%	0.00%	70.00%
E-5B	46.92%	11.54%	41.54%
E-14A	53.95%	14.47%	31.58%
E-35	56.25%	0.00%	43.75%

Table III-2 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed
Manhole Rehabilitation

MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
E-24	60.00%	20.00%	20.00%
E-14	63.33%	1.67%	35.00%
E-29A	64.00%	0.00%	36.00%
E-34	71.43%	0.00%	28.57%
E-5A	72.46%	2.90%	24.64%
E-17	72.97%	0.00%	27.03%
E-19	76.92%	11.54%	11.54%
E-18	79.31%	0.00%	20.69%
E-15	80.00%	0.00%	20.00%
E-35A	80.00%	0.00%	20.00%
E-32	85.71%	0.00%	14.29%
E-20	86.96%	0.00%	13.04%
E-21	90.00%	5.00%	5.00%
E-29	94.25%	0.00%	5.75%

Smoke Testing

Emory Valley contains almost 150,000 feet of pipe. As the system was inspected, 501 smoke defects were identified and cataloged. The smoke defects were categorized into manhole, main line, lateral, catch basin, storm sewer, and roof leader locations. An “other” category was used if a smoke defect did not fit into one of the main types. The following Table III-3 shows the data for Emory Valley.

**Table III-3
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed
Smoke Testing**

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
E5A	19	2	18	2	0	0	1
E5B	68	30	51	5	0	0	2
E14	36	2	19	0	0	2	1
E14A	14	0	12	0	0	0	0
E15	26	1	10	0	0	0	0
E16	8	0	10	0	0	0	0
E17	16	2	4	1	0	0	0
E18	9	2	6	0	0	0	0
E19	6	1	3	0	0	0	0
E20	3	0	9	2	0	1	1
E21	5	0	8	0	0	0	0
E24	3	2	4	0	0	0	0
E29	11	0	8	0	0	0	0
E29A	0	0	9	0	0	0	0
E32	10	0	4	0	0	0	0
E33	5	0	1	0	0	0	0
E34	2	0	2	0	0	0	0
E35	7	0	3	1	0	0	0
E35A	3	0	0	0	0	0	0
E36	0	0	7	1	0	0	0
Total	251	42	188	12	0	3	5

This information was used to develop a defect count per feet of pipe. Table III-4 is sorted to show the highest number of defects per feet of pipe.

Table III-4
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed
Smoke Testing Defects

EMORY VALLEY SEWERSHED			
MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECTS PER FT
E24	824	9	0.011
E16	2482	18	0.007
E36	1210	8	0.007
E5B	28345	156	0.006
E14	11902	60	0.005
E35	2799	11	0.004
E34	1038	4	0.004
E15	9848	37	0.004
E32	3802	14	0.004
E17	7207	23	0.003
E20	5184	16	0.003
E18	6268	17	0.003
E21	4828	13	0.003
E35A	1198	3	0.003
E5A	19108	42	0.002
E19	5074	10	0.002
E14A	13672	26	0.002
E29A	5281	9	0.002
E33	3664	6	0.002
E29	15043	19	0.001
Total	148777	501	

CCTV

Emory Valley contained 1,361 pipe defects in approximately 150,000 feet of pipe. Table III-5 lists the defects by mini-system, ordered by the highest number of defects per foot of pipe.

Table III-5
City of Oak Ridge
Sewer System Evaluation Study and Results
Emory Valley Sewershed
CCTV Inspection

MINI SYSTEM	FEET OF PIPE	CCTV DEFECTS	DEFECTS PER FT
E24	824	38	0.046
E5B	28345	581	0.020
E5A	19108	247	0.013
E36	1210	12	0.010
E17	7207	65	0.009
E35A	1198	10	0.008
E33	3664	30	0.008
E20	5184	41	0.008
E14	11902	80	0.007
E16	2482	16	0.006
E18	6268	40	0.006
E19	5074	28	0.006
E15	9848	47	0.005
E29A	5281	23	0.004
E21	4828	16	0.003
E29	15043	45	0.003
E34	1038	3	0.003
E14A	13672	29	0.002
E35	2799	5	0.002
E32	3802	5	0.001
Total	148777	1361	

B. EAST PLANT SEWERSHEDManhole Inspections

Manhole Inspections within the East Plant Sewershed were compiled into Access Databases, and entered into ArcGIS. Each database calculated a final recommendation, which is listed below in Table III-6.

**Table III-6
City of Oak Ridge
Sewer System Evaluation Study and Results
East Plant Sewershed
Manhole Inspections**

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
E-1	18	2	61	0	4	0
E-2	119	4	40	0	0	0
E-3	36	1	71	0	5	1
E-4	30	2	16	1	1	1
E-6	171	0	48	0	13	0
E-7	50	1	24	0	0	1
E-8	55	4	11	0	2	0
E-9	135	4	61	1	17	0
E-10	129	27	98	0	5	1
E-11	43	6	157	0	5	0
E-12	222	6	58	1	21	0
E-13A	23	1	10	0	2	1
E-13B	17	3	14	0	0	0
E-22	5	0	5	0	0	0
E-23	22	2	6	0	1	0
E-26	4	0	0	0	0	0
E-27	4	0	0	0	0	0
E-28	10	2	5	0	1	0
E-30	22	0	5	0	0	0
E-31	17	1	17	0	0	0
TOTAL	1132	66	707	3	77	5

East Plant Sewershed contains approximately 1,990 manholes with 1,132 needing no rehab, 66 need major rehab, and 707 require minor rehab. Table III-7 considers the need for a new frame and cover, risers, or grade rings requiring minor rehabilitation. It sorts the mini-systems within East Plant by percentage of manholes needing major rehab, minor rehab, or no rehab.

Table III-7
City of Oak Ridge
Sewer System Evaluation Study and Results
East Plant Sewershed
Manhole Rehabilitation

EAST PLANT SEWERSHED			
MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
E-11	20.38%	2.84%	76.78%
E-1	21.18%	2.35%	76.47%
E-3	31.58%	0.88%	67.54%
E-31	48.57%	2.86%	48.57%
E-10	49.62%	10.38%	40.00%
E-13B	50.00%	8.82%	41.18%
E-22	50.00%	0.00%	50.00%
E-28	55.56%	11.11%	33.33%
E-4	58.82%	3.92%	37.25%
E-9	61.93%	1.83%	36.24%
E-13A	62.16%	2.70%	35.14%
E-7	65.79%	1.32%	32.89%
E-23	70.97%	6.45%	22.58%
E-12	72.08%	1.95%	25.97%
E-2	73.01%	2.45%	24.54%
E-6	73.71%	0.00%	26.29%
E-8	76.39%	5.56%	18.06%
E-30	81.48%	0.00%	18.52%
E-26	100.00%	0.00%	0.00%
E-27	100.00%	0.00%	0.00%

Smoke Testing

East Plant contains approximately 335,000 feet of pipe. As the system was inspected 929 smoke defects were identified and cataloged. The smoke defects were categorized into manhole, main line, lateral, catch basin, storm sewer, and roof leader locations. An “other” category was used if a smoke defect did not fit into one of the main types. Table III-8 shows the data for East Plant.

**Table III-8
City of Oak Ridge
Sewer System Evaluation Study and Results
East Plant Sewershed
Smoke Testing**

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
E1	19	4	5	0	0	0	0
E2	42	7	10	0	0	1	0
E3	33	7	5	2	0	1	0
E4	16	1	6	1	4	0	0
E6	33	13	13	0	0	0	6
E7	8	0	5	0	0	0	1
E8	16	5	13	0	0	0	0
E9	87	27	38	3	0	0	0
E10	87	15	42	3	2	1	1
E11	52	9	43	2	0	0	2
E12	64	4	20	0	0	1	8
E13A	13	2	13	1	0	0	1
E13B	15	0	0	1	0	1	0
E22	6	0	2	0	0	0	0
E23	16	1	8	0	0	0	0
E26	2	0	0	0	0	0	0
E27	1	0	0	0	0	0	0
E28	5	0	2	0	0	0	1
E30	7	0	10	0	0	0	1
E31	16	0	16	0	0	0	0
Total	538	95	251	13	6	5	21

This information was used to develop a defect count per feet of pipe. Table III-9 is sorted to show the highest number of defects per feet of pipe.

Table III-9
City of Oak Ridge
Sewer System Evaluation Study and Results
East Plant Sewershed
Smoke Testing Defects

MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECTS PER FT
E31	5576	32	0.006
E30	3899	18	0.005
E9	35897	155	0.004
E22	1890	8	0.004
E23	6138	25	0.004
E10	43152	151	0.003
E11	33082	108	0.003
E13A	9317	30	0.003
E4	9861	28	0.003
E26	787	2	0.003
E8	14072	34	0.002
E28	3349	8	0.002
E3	20775	48	0.002
E13B	7648	17	0.002
E12	44300	97	0.002
E2	28031	60	0.002
E1	14205	28	0.002
E6	37606	65	0.002
E27	725	1	0.001
E7	14000	14	0.001
Total	334310	929	

CCTV

East Plant contained 5,170 pipe defects in approximately 334,000 feet of pipe. Table III-10 lists the defects by mini-system, ordered by the highest number of defects per foot of pipe.

Table III-10
City of Oak Ridge
Sewer System Evaluation Study and Results
East Plant Sewershed
CCTV Inspection

MINI SYSTEM	FEET OF PIPE	CCTV DEFECTS	DEFECTS PER FT
E28	3349	90	0.029
E2	28031	716	0.026
E9	35897	860	0.024
E10	43152	940	0.022
E1	14205	255	0.018
E6	37606	611	0.016
E12	44300	662	0.015
E13A	9317	134	0.014
E8	14072	170	0.012
E11	33082	373	0.011
E7	14000	117	0.008
E30	3899	31	0.008
E4	9861	66	0.007
E22	1890	12	0.006
E13B	7648	48	0.006
E23	6138	36	0.006
E3	20775	46	0.002
E31	5576	3	0.001
E26	787	0	0
E27	725	0	0
Total	334310	5170	

C. CENTRAL CITY SEWERSHEDManhole Inspections

Manhole Inspections within the Central City Sewershed were compiled into Access databases, and entered into ArcGIS. Each database calculated a final recommendation, which is listed below in Table III-11.

**Table III-11
City of Oak Ridge
Sewer System Evaluation Study and Results
Central City Sewershed
Manhole Inspection**

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
W-5	104	5	188	0	5	0
W-5A	9	0	3	0	0	0
W-6	224	13	126	0	1	2
W-7	11	0	0	0	0	0
W-8	120	9	60	0	1	0
W-9	96	0	7	0	3	0
E-25	18	0	1	1	0	0
TOTAL	582	27	385	1	10	2

Central City Sewershed contains approximately 1,007 manholes, with 582 needing no rehab, 27 needing major rehab, and 385 require minor rehab. Table III-12 considers the need for a new frame and cover, risers, or grade rings requiring minor rehabilitation. It sorts the mini-systems within Central City by percentage of manholes needing major rehab, minor rehab, or no rehab.

Table III-12
City of Oak Ridge
Sewer System Evaluation Study and Results
Central City Sewershed
Manhole Rehabilitation

CENTRAL CITY SEWERSHED			
MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
W-5	34.44%	1.66%	63.91%
W-6	61.20%	3.55%	35.25%
W-8	63.16%	4.74%	32.11%
W-5A	75.00%	0.00%	25.00%
E-25	90.00%	0.00%	10.00%
W-9	90.57%	0.00%	9.43%
W-7	100.00%	0.00%	0.00%

Smoke Testing

Central City contains approximately 186,000 feet of pipe. As the system was inspected, 320 smoke defects were identified and cataloged. The smoke defects were categorized into manhole, main line, lateral, catch basin, storm sewer, and roof leader locations. An "other" category was used if a smoke defect did not fit into one of the main types. Table III-13 shows the data for Central City.

Table III-13
City of Oak Ridge
Sewer System Evaluation Study and Results
Central City Sewershed
Smoke Testing

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
W5	34	3	42	2	0	1	1
W5A	0	0	0	0	0	0	0
W6	62	10	49	7	0	3	4
W7	3	0	0	0	0	0	0

Table III-13 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
Central City Sewershed
Smoke Testing

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
W8	25	4	33	0	0	0	0
W9	20	3	6	3	0	0	2
E25	1	0	2	0	0	0	0
Total	145	20	132	12	0	4	7

This information was used to develop a defect count per feet of pipe. Table III-14 is sorted to show the highest number of defects per feet of pipe.

Table III-14
City of Oak Ridge
Sewer System Evaluation Study and Results
Central City Sewershed
Smoke Testing Defects

MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECT PER FT
W6	62199	135	0.002
W8	35357	62	0.002
W9	21896	34	0.002
W7	2014	3	0.001
W5	57907	83	0.001
E25	4707	3	0.001
W5A	1918	0	0.000
Total	185998	320	

CCTV

Central City contained 1,859 pipe defects in approximately 186,000 feet of pipe. Table III-15 lists the defects by mini-system, ordered by the highest number of defects per foot of pipe.

Table III-15
City of Oak Ridge
Sewer System Evaluation Study and Results
Central City Sewershed
CCTV Defects

MINI SYSTEM	FEET OF PIPE	CCTV DEFECTS	DEFECTS PER FT
W9	21896	316	0.014
W6	62199	767	0.012
W5	57907	505	0.009
W8	35357	270	0.008
W5A	1918	1	0.001
W7	2014	0	0.000
E25	4707	0	0.000
Total	185998	1859	

D. Y-12 SEWERSHEDManhole Inspections

Manhole Inspections within the Y-12 Sewershed were compiled into Access Databases, and entered into ArcGIS. Each database calculated a final recommendation, which is listed below in Table III-16.

Table III-16
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
Manhole Inspection

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
W-2	53	9	31	0	2	0
W-3	33	0	127	0	3	0
W-4	142	1	19	1	10	1
W-18A	116	3	27	3	9	1
W-19	32	5	43	0	0	0
W-21	6	0	0	0	0	0
W-23	48	2	13	0	1	0
W-26	156	2	20	0	4	0
W-26A	29	0	55	0	6	0
W-34	9	0	2	0	0	0
TOTAL	624	22	337	4	35	2

Y-12 Sewershed contains approximately 1,024 manholes with 624 needing no rehab, 22 needing major rehab, and 337 requiring minor rehab. Table III-17 considers the need for a new frame and cover, risers, or grade rings requiring minor rehabilitation. It sorts the mini-systems within Y-12 by percentage of manholes needing major rehab, minor rehab, or no rehab.

Table III-17
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
Manhole Rehabilitation

MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
W-3	20.25%	0.00%	79.75%
W-26A	32.22%	0.00%	67.78%
W-19	40.00%	6.25%	53.75%
W-2	55.79%	9.47%	34.74%

Table III-17 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
Manhole Rehabilitation

MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
W-18A	72.96%	1.89%	25.16%
W-23	75.00%	3.13%	21.88%
W-4	81.61%	0.57%	17.82%
W-34	81.82%	0.00%	18.18%
W-26	85.71%	1.10%	13.19%
W-21	100.00%	0.00%	0.00%

Smoke Testing

Y-12 contains approximately 199,000 feet of pipe. As the system was inspected, 281 smoke defects were identified and cataloged. The smoke defects were categorized into manhole, main line, lateral, catch basin, storm sewer, and roof leader locations. An “other” category was used if a smoke defect did not fit into one of the main types. Table III-18 shows the data for Y-12.

Table III-18
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
Smoke Testing

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
W2	5	1	14	3	0	0	0
W3	19	2	4	0	0	0	2
W4	28	3	12	0	0	0	3
W18A	25	0	11	1	0	0	0
W19	36	0	12	0	0	0	0
W21	3	0	0	0	0	0	0
W23	6	0	9	0	0	0	0
W26	40	1	18	0	0	0	0

Table III-18 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
Smoke Testing

W26A	11	0	7	0	0	0	0
W34	4	0	1	0	0	0	0
Total	177	7	88	4	0	0	5

This information was used to develop a defect count per feet of pipe. Table III-19 is sorted to show the highest number of defects per feet of pipe.

Table III-19
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
Smoke Testing Defects

MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECTS PER FT
W19	15283	48	0.003
W34	1908	5	0.003
W21	1387	3	0.002
W26	35672	59	0.002
W2	15967	23	0.001
W4	37298	46	0.001
W23	12617	15	0.001
W18A	33206	37	0.001
W26A	18062	18	0.001
W3	27437	27	0.001
Total	198837	281	

CCTV

Y-12 contained 643 pipe defects in approximately 199,000 feet of pipe. Table III-20 lists the defects by mini-system, ordered by the highest number of defects per foot of pipe.

Table III-20
City of Oak Ridge
Sewer System Evaluation Study and Results
Y-12 Sewershed
CCTV Inspection

MINI SYSTEM	FEET OF PIPE	CCTV DEFECTS	DEFECTS PER FT
W4	37298	239	0.006
W21	1387	8	0.006
W3	27437	123	0.004
W18A	33206	121	0.004
W19	15283	44	0.003
W2	15967	42	0.003
W23	12617	29	0.002
W26	35672	31	0.001
W26A	18062	6	0.000
W34	1908	0	0.000
Total	198837	643	

E. TURTLE PARK SEWERSHEDManhole Inspections

Manhole Inspections within the Turtle Park Sewershed were compiled into Access Databases, and entered into ArcGIS. Each database calculated a final recommendation, which is listed below in Table III-21.

**Table III-21
City of Oak Ridge
Sewer System Evaluation Study and Results
Turtle Park Sewershed
Manhole Inspection**

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
W-10	44	0	3	0	2	0
W-11	142	3	34	0	32	0
W-12	204	0	8	1	13	0
W-13	107	8	45	0	1	0
W-14	14	0	59	0	12	0
W-15	18	1	75	0	6	0
W-16	133	2	24	1	1	0
W-18B	39	1	19	0	7	0
W-18C	18	1	9	0	0	0
W-18D	39	4	5	0	0	0
W-18E	13	0	40	0	3	0
W-18F	59	1	4	0	0	0
W-18G	40	7	35	0	3	0
W-18H	4	0	20	0	4	0
W-25	2	0	0	0	0	0
W-28	5	0	2	0	0	0
W-30	1	0	4	0	3	0
TOTAL	882	28	386	2	87	0

Turtle Park Sewershed contains approximately 1,385 manholes, with 882 needing no rehab, 28 needing major rehab, and 386 require minor rehab. Table III-22 considers the need for a new frame and cover, risers, or grade rings requiring minor rehabilitation. It sorts the mini-systems within Turtle Park by percentage of manholes needing major rehab, minor rehab, or no rehab.

Table III-22
City of Oak Ridge
Sewer System Evaluation Study and Results
Turtle Park Sewershed
Manhole Rehabilitation

MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
W-30	12.50%	0.00%	87.50%
W-18H	14.29%	0.00%	85.71%
W-14	16.47%	0.00%	83.53%
W-15	18.00%	1.00%	81.00%
W-18E	23.21%	0.00%	76.79%
W-18G	47.06%	8.24%	44.71%
W-18B	59.09%	1.52%	39.39%
W-18C	64.29%	3.57%	32.14%
W-13	66.46%	4.97%	28.57%
W-11	67.30%	1.42%	31.28%
W-28	71.43%	0.00%	28.57%
W-18D	81.25%	8.33%	10.42%
W-16	82.61%	1.24%	15.53%
W-10	89.80%	0.00%	10.20%
W-12	90.27%	0.00%	9.29%
W-18F	92.19%	1.56%	6.25%
W-25	100.00%	0.00%	0.00%

Smoke Testing

Turtle Park contains approximately 268,000 feet of pipe. As the system was inspected, 526 smoke defects were identified and cataloged. The smoke defects were categorized into manhole, main line, lateral, catch basin, storm sewer, and roof leader locations. An "other" category was used if a smoke defect did not fit into one of the main types. Table III-23 shows the data for Turtle Park.

Table III-23
City of Oak Ridge
Sewer System Evaluation Study and Results
Turtle Park Sewershed
Smoke Testing

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
W10	9	0	7	0	0	0	0
W11	65	2	13	1	0	0	5
W12	55	6	39	1	1	0	1
W13	24	5	34	0	2	0	0
W14	18	2	12	0	0	0	0
W15	14	0	13	0	0	0	0
W16	49	3	8	0	0	0	2
W18B	6	0	1	0	0	0	0
W18C	11	0	1	1	0	0	0
W18D	5	0	8	0	0	0	0
W18E	3	0	10	0	0	0	0
W18F	14	0	4	0	0	0	0
W18G	16	3	31	0	0	0	1
W18H	5	0	1	0	0	0	0
W25	0	0	1	0	0	0	0
W28	2	1	8	0	0	0	0
W30	1	0	1	0	0	0	0
Total	297	22	192	3	3	0	9

This information was used to develop a defect count per feet of pipe. Table III-24 is sorted to show the highest number of defects per feet of pipe.

Table III-24
City of Oak Ridge
Sewer System Evaluation Study and Results
Turtle Park Sewershed
Smoke Testing Defects

MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECTS PER FT
W28	1322	11	0.008
W18C	4175	13	0.003
W18G	16876	51	0.003
W25	379	1	0.003
W12	43075	103	0.002
W13	29822	65	0.002
W11	39693	86	0.002
W14	16044	32	0.002
W16	34955	62	0.002
W10	9319	16	0.002
W30	1425	2	0.001
W18H	4335	6	0.001
W18D	9851	13	0.001
W15	20885	27	0.001
W18E	11083	13	0.001
W18F	15723	18	0.001
W18B	9232	7	0.001
Total	268194	526	

CCTV

Turtle Park contained 3,988 pipe defects in approximately 268,000 feet of pipe. Table III-25 lists the defects by mini-system, ordered by the highest number of defects per foot of pipe.

**Table III-25
City of Oak Ridge
Sewer System Evaluation Study and Results
Turtle Park Sewershed
CCTV Inspection**

TURTLE PARK SEWERSHED			
MINI SYSTEM	FEET OF PIPE	CCTV DEFECTS	DEFECTS PER FT
W12	43075	1064	0.025
W16	34955	857	0.025
W11	39693	415	0.010
W10	9319	371	0.040
W15	20885	349	0.017
W18B	9232	255	0.028
W18E	11083	177	0.016
W14	16044	152	0.009
W18G	16876	145	0.009
W18C	4175	86	0.021
W18F	15723	60	0.004
W13	29822	29	0.001
W18D	9851	15	0.002
W18H	4335	7	0.002
W25	379	4	0.011
W28	1322	2	0.002
W30	1425	0	0.000
Total	268194	3988	

F. WEST END SEWERSHED

Manhole Inspections

Manhole Inspections within the West End Sewershed were compiled into Access Databases, and entered into ArcGIS. Each database calculated a final recommendation, which is listed below in Table III-26.

**Table III-26
City of Oak Ridge
Sewer System Evaluation Study and Results
West End Sewershed
Manhole Inspection**

MINI SYSTEM	NONE	MAJOR	MINOR	RAISE MH	NEW F/C	RISER/F&C GRADE RINGS
W-17	122	2	55	3	6	0
W-20	70	0	14	0	1	0
W-22	8	0	20	0	2	0
W-24	10	2	3	0	0	0
W-27	27	0	5	0	0	0
W-27A	25	0	5	0	0	0
W-29	47	0	84	3	9	0
W-31	6	0	5	0	0	0
W-32	12	1	1	0	0	0
W-33	2	0	2	0	0	0
W-35	2	0	4	0	0	0
TOTAL	331	5	198	6	18	0

West End Sewershed contains approximately 558 manholes, with 331 needing no rehab, 5 needing major rehab, and 198 require minor rehab. Table III-27 considers the need for a new frame and cover, risers, or grade rings to be in need of minor rehabilitation. It sorts the mini-systems within West End by percentage of manholes needing major rehab, minor rehab, or no rehab.

Table III-27
City of Oak Ridge
Sewer System Evaluation Study and Results
West End Sewershed
Manhole Rehabilitation

MINI SYSTEM	% NO REHAB	% MAJOR REHAB	% MINOR REHAB
W-22	26.67%	0.00%	73.33%
W-29	32.87%	0.00%	67.13%
W-35	33.33%	0.00%	66.67%
W-33	50.00%	0.00%	50.00%
W-31	54.55%	0.00%	45.45%
W-17	64.89%	1.06%	34.04%
W-24	66.67%	13.33%	20.00%
W-20	82.35%	0.00%	17.65%
W-27A	83.33%	0.00%	16.67%
W-27	84.38%	0.00%	15.63%
W-32	85.71%	7.14%	7.14%

Smoke Testing

West End contains almost 114,000 feet of pipe. As the system was inspected, 159 smoke defects were identified and cataloged. The smoke defects were categorized into manhole, main line, lateral, catch basin, storm sewer, and roof leader locations. An “other” category was used if a smoke defect did not fit into one of the main types. Table III-28 shows the data for West End.

Table III-28
City of Oak Ridge
Sewer System Evaluation Study and Results
West End Sewershed
Smoke Testing

MINI SYSTEM	MANHOLE	MAIN LINE	LATERAL	CATCH BASIN	STORM SEWER	ROOF LEADER	OTHER
W17	45	1	18	0	0	0	0
W20	6	0	3	0	0	0	0
W22	8	0	0	0	0	0	0
W24	6	0	1	0	0	0	0
W27	2	0	2	0	0	0	0
W27A	5	0	3	0	0	0	0
W29	38	0	12	0	0	0	0
W31	1	0	3	0	0	0	0
W32	2	0	0	0	0	0	0
W33	1	1	0	0	0	0	0
W35	0	0	1	0	0	0	0
Total	114	2	43	0	0	0	0

This information was used to develop a defect count per feet of pipe. Table III-29 is sorted to show the highest number of defects per feet of pipe.

Table III-29
City of Oak Ridge
Sewer System Evaluation Study and Results
West End Sewershed
Smoke Testing Defects

MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECTS PER FT
W33	535	2	0.004
W29	23941	50	0.002
W31	2272	4	0.002
W22	4680	8	0.002
W27A	4703	8	0.002
W17	44019	64	0.001
W24	5393	7	0.001
W32	2450	2	0.001

Table III-29 (continued)
City of Oak Ridge
Sewer System Evaluation Study and Results
West End Sewershed
Smoke Testing Defects

MINI SYSTEM	FEET OF PIPE	TOTAL DEFECTS	DEFECTS PER FT
W35	1228	1	0.001
W27	6473	4	0.001
W20	17769	9	0.001
Total	113463	159	

CCTV

West End contained 439 pipe defects in approximately 113,000 feet of pipe. Table III-30 lists the defects by mini-system, ordered by the highest number of defects per foot of pipe.

Table III-30
City of Oak Ridge
Sewer System Evaluation Study and Results
West End Sewershed
CCTV Inspection

MINI SYSTEM	FEET OF PIPE	CCTV DEFECTS	DEFECTS PER FT
W17	44019	363	0.008
W29	23941	25	0.001
W27	6473	19	0.003
W31	2272	7	0.003
W24	5393	6	0.001
W22	4680	5	0.001
W27A	4703	5	0.001
W32	2450	4	0.002
W35	1228	4	0.003
W20	17769	1	0.000
W33	535	0	0.000
Total	113463	439	