City of Oak Ridge, Tennessee

Sewer System Evaluation Study Work Plan

March 2011

City of Oak Ridge, Tennessee

Sewer System Evaluation Study Work Plan

March 2011

Table of Contents

SECTION I

INTRODUCTION

City of Oak Ridge was issued an Administrative Order by the United States Environmental Protection Agency (EPA) which became effective on September 30, 2010. Within the order the City must develop a Sewer System Evaluation Study (SSES) Work Plan for EPA review and approval. The required work is to be completed within one year after approval of the work plan. The results of the evaluation survey must be submitted within two (2) months after completion of the survey.

The City has retained consulting engineering services with Lamar Dunn & Associates, Inc. (LD&A) to assist with the Administrative Order. As it relates to the SSES Work Plan, a committee of operating personnel and the consultant was established to evaluate and implement aspects of the work plan.

The City had a Sewer System Evaluation Survey (SSES) performed in the mid 1970's. Later, they entered into a letter agreement (May 16, 1991) with the Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control, for a Corrective Action Program relative to the sewer collection system. The previous SSES and Corrective Action Program have been reviewed to develop this EPA-SSES Work Plan

SECTION II

HISTORICAL OVERVIEW OF OAK RIDGE I/I PROGRAM

The City had a Sewer System Evaluation Survey (SSES) performed in the mid 1970's. In the same time frame a new wastewater treatment plant was constructed.

In 1991, the Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control, expressed concern to the City of Oak Ridge relative to sewer overflow and by-passing of untreated wastewater to Poplar Creek. The City offered a schedule for correction which TDEC considered acceptable. An agreement letter (May 16, 1991) for a Corrective Action Program was issued, which proposed a series of rehabilitation projects that would increase the wastewater treatment plant capacity to eliminate by-passing, and would decrease the amount of infiltration and inflow (I/I) into the collection system.

As part of the Corrective Action Program, the City issued construction contracts for Sewer and Lift Station Rehabilitation Projects. The cost for the sewer collection system rehabilitation activities to date is approximately $10,600,000.00. Eleven (11) of thirty-five (35) lift stations have been rehabilitated during the program. The approximate construction cost for the lift station rehabilitation projects is $2,500,000.00.

The City continues a point repair program. The point repair program is used to repair leaks or line collapses that are considered emergencies or a possible threat to public health and safety. The City has continued to inspect sewer by closed circuit television (CCTV) using in house personnel & equipment and physically inspecting manholes and performing smoke testing. The data from this work will be used in this evaluation.

SECTION III

INFRASTRUCTURE INVENTORY

As a work plan is developed to evaluate the sanitary sewer system, all of the infrastructure (assets) must be inventoried. Each asset is given a unique identifier (name) which shows on the GIS. The collection system is divided into sewersheds and mini-systems, which are defined below.

A. SEWERSHEDS AND MINI-SYSTEMS

Definitions:

Sewershed: The drainage area defined by a natural or artificial boundary in which sources of sewerage flow reaches a common collection point.

Mini System: Individual sewer collection systems which flows within a sewershed.

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. Figure III-1 shows the City of Oak Ridge Schematic Sanitary Sewer Mini Systems and the individual Sewershed Mini System Location Maps (Figure III-2 through Figure III-7). See the following Table III-1 for the Collection System Sewersheds Mini-Systems.

Table III-1
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

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

B. Lift Station Evaluation:

The City of Oak Ridge (COR) presently owns and operates thirty-five (35) lift stations within their wastewater collection system. Two (2) additional lift stations have been constructed by developers but, have not been accepted by the City at this time. Each lift station will be evaluated in an effort to determine the capacity, the condition of the mechanical, electrical, and site components to determine what improvements are needed to bring the station up to standards and to prioritize the required improvements. The evaluation data will also be inserted into the City's data base to provide readily accessible information about each station. The evaluation will include the following parameters:

1. General Information
    - A. Station name
    - B. Location: Physical address and other information such as location relative to lots, houses, etc.
    - C. Latitude and longitude
2. Mechanical Information
    - A. Station type: Submersible, suction lift, wet-well/ dry-well
    - B. Number of pumps, pump manufacturer and, serial numbers
    - C. Wet-well diameter, total depth, available storage and, invert elevation
3. Force Main
    - A. Size and material of construction
    - B. Length
    - C. Discharge elevation
4. Site Information
    - A. Fencing (yes/no)
    - B. Evidence of apparent overflow (yes/no)
5. Electrical Information
    - A. Power source and service (pole mounted or pad mount transformers, underground or overhead to station)
    - B. Transformer(s): Type (pad or pole mount), size, identification number(s)
    - C. Power feed: Voltage and number of phases
    - D. Main disconnect type (circuit breaker or fused) and size
    - E. Motor Control: Location (panel, MCC, etc.), controller type (across-the-line, soft start, VFD)
    - F. Motor Information: Horsepower and speed, brand and, serial number (if different than pumps)

G. Auxiliary Power: Type (diesel, gasoline, LP, none), generator brand, kW

6. Instrumentation
   A. Level Control: Bubbler, floats, pressure, probe, etc. and manufacturer
   B. Redundant Level Control: Availability (yes/no), number, type, and manufacturer
   C. Flow Meter: Availability (yes/no), type (pressure differential, mag meter, ultrasonic, etc.)
   D. Elapsed time meters (yes/no)
   E. Telemetry: Type (Ethernet, telephone, radio, etc.), and manufacturer
   F. Alarm type (horn, light, horn and light, telemetry, etc.)
   G. Control Sequence: Lead on/off, lag on/off, high level alarm, low level alarm, etc.
   H. Pressure gauge availability (yes/no)
7. Listing of other station equipment such as yard hydrant, air scrubber, communitor, influent screen, yard lighting, etc.
8. Other pertinent information concerning the station not covered in one of the above categories such as valve vault information, by-pass pump connection availability, access road description, issues that need to be addressed, potential safety issues, site specific issues, pump drawdown test results, etc.
9. Digital photographs will be taken of the lift station site, mechanical and electrical equipment, interior of the wet-well, and pumps.
10. Utilizing the serial numbers of the pumps, pump curves will be obtained from COR records or, from factory representatives.
11. A final determination of the overall station capacity, mechanical and electrical conditions will be made. The condition will be characterized as excellent, good, fair, poor, or replace.

C. <u>Force Mains:</u>

Each of the lift stations has a force main which will be reviewed, as follows:

1. Age

   COR construction records will be evaluated to determine the installation date.

2. Condition

   Pipe Coupons will be removed for evaluation in conjunction with the Lift Station evaluation pump curves and draw down test will determine the overall condition.
3. Size (Diameter)

   COR record drawings will be evaluated and physical inspection at the Lift Stations and discharge points will be utilized.
4. Length

   COR record drawings will be evaluated and surveying activities will be utilized for accuracy.

D. <u>Gravity Sewers:</u>

The gravity sewers include the City owned pipe network, as well as service laterals. Only the City sewers will be inventoried; however, lateral defects will be identified in the GIS. The inventory of City owned sewers is, as follows:

1. Age

   COR construction records will be evaluated to determine the installation date.
2. Condition

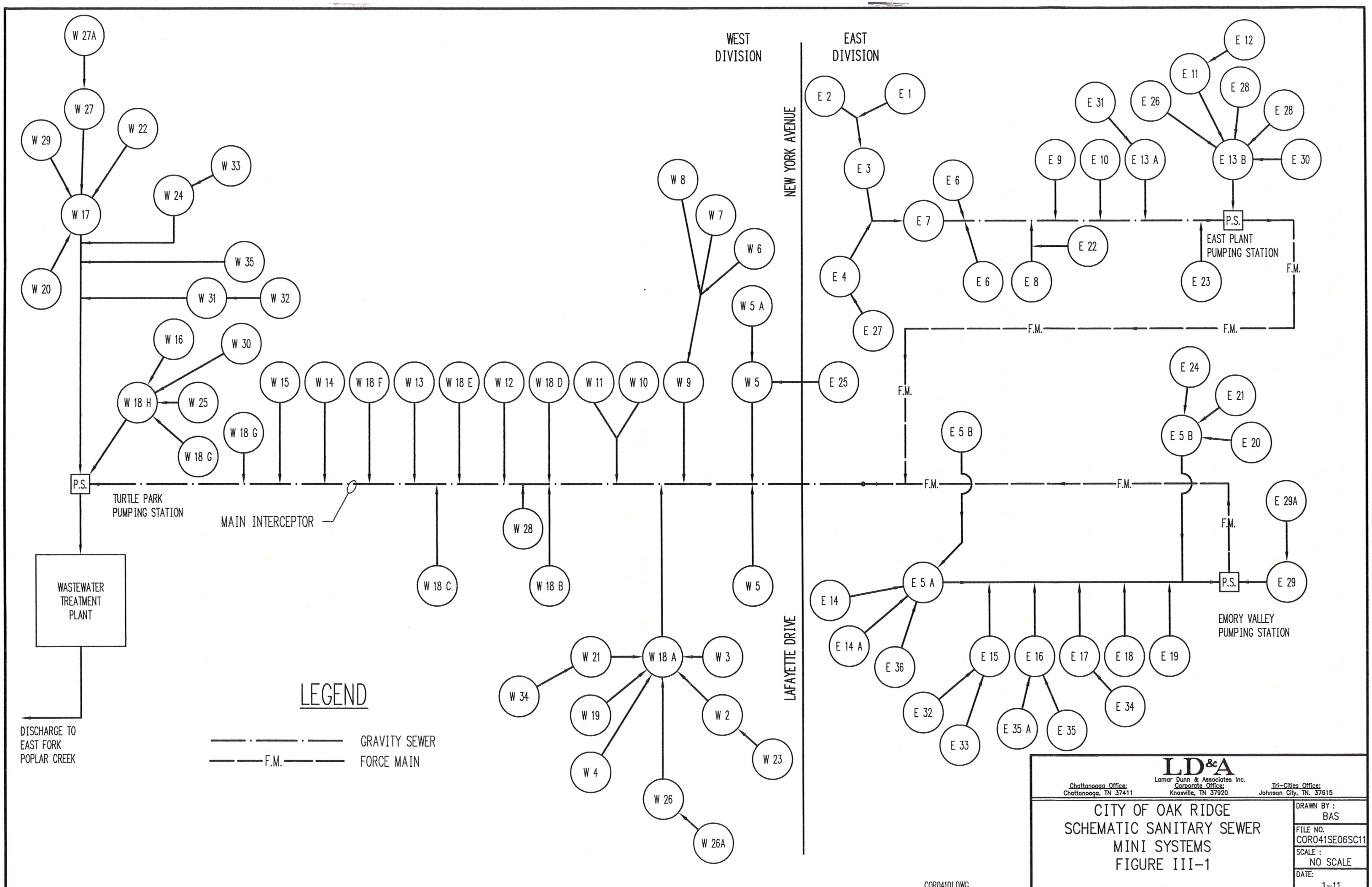
   Smoke Testing and Closed Circuit Television is currently in progress, which will be utilized to determine defects. The results will be updated in the Geographic Information System (GIS).
3. Size (Diameter)

   COR record drawings will be evaluated and physical inspection of manholes will be utilized for accuracy.
4. Length

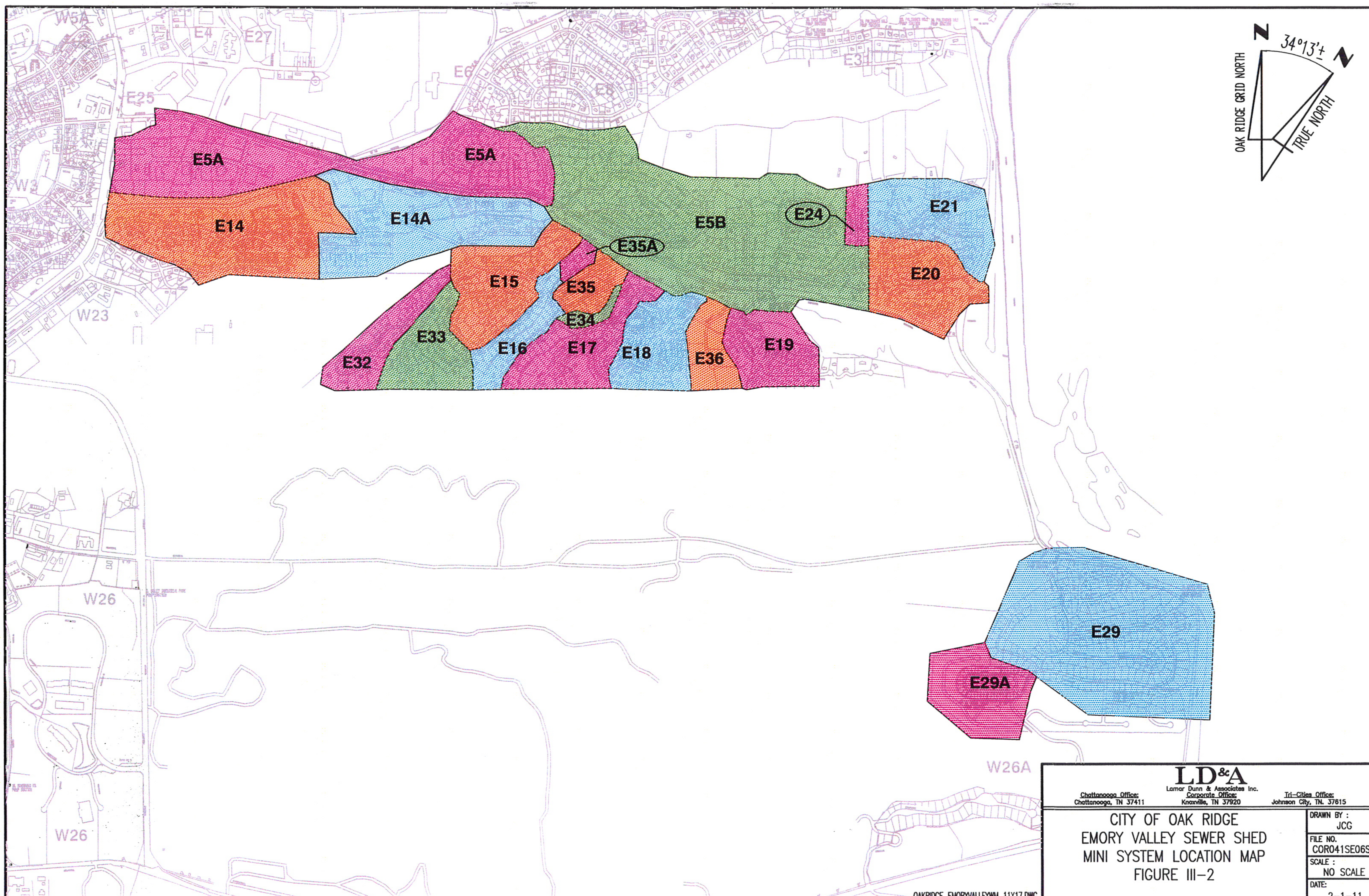
   COR record drawings will be evaluated and surveying activities will be utilized for accuracy.

E. <u>Manholes:</u>

All the manholes in the collection system will be inspected, and any new ones found will be added to the inventory.


WEST DIVISION
EAST DIVISION
NEW YORK AVENUE
LAFAYETTE DRIVE
W 27A
W 27
W 29
W 22
W 33
W 24
W 17
W 35
W 20
W 31
W 32
W 16
W 30
W 18 H
W 25
W 18 G
W 18 G
W 15
W 14
W 18 F
W 13
W 18 E
W 12
W 18 D
W 11
W 10
W 9
W 8
W 7
W 6
W 5 A
W 5
W 5
P.S.
TURTLE PARK PUMPING STATION
MAIN INTERCEPTOR
W 18 C
W 28
W 18 B
WASTEWATER TREATMENT PLANT
DISCHARGE TO EAST FORK POPLAR CREEK
LEGEND
GRAVITY SEWER
F.M.
FORCE MAIN
W 21
W 18 A
W 3
W 34
W 19
W 2
W 4
W 23
W 26
W 26A
E 2
E 1
E 3
E 4
E 27
E 6
E 7
E 6
E 8
E 22
E 9
E 10
E 31
E 13 A
E 26
E 11
E 12
E 28
E 28
E 13 B
E 30
P.S.
EAST PLANT PUMPING STATION
E 23
F.M.
F.M.
F.M.
F.M.
E 25
E 5 B
E 24
E 21
E 5 B
E 20
F.M.
F.M.
F.M.
E 29A
E 5 A
E 14
E 14 A
E 36
P.S.
E 29
EMORY VALLEY PUMPING STATION
E 15
E 16
E 17
E 18
E 19
E 32
E 33
E 35 A
E 35
E 34
COR04101.DWG
LD&A
Lamar Dunn & Associates Inc.
Chattanooga Office: Chattanooga, TN 37411
Corporate Office: Knoxville, TN 37920
Tri-Cities Office: Johnson City, TN 37615
CITY OF OAK RIDGE
SCHEMATIC SANITARY SEWER
MINI SYSTEMS
FIGURE III-1
DRAWN BY : BAS
FILE NO. COR041SE06SC11
SCALE : NO SCALE
DATE: 1-11

ORIGINAL



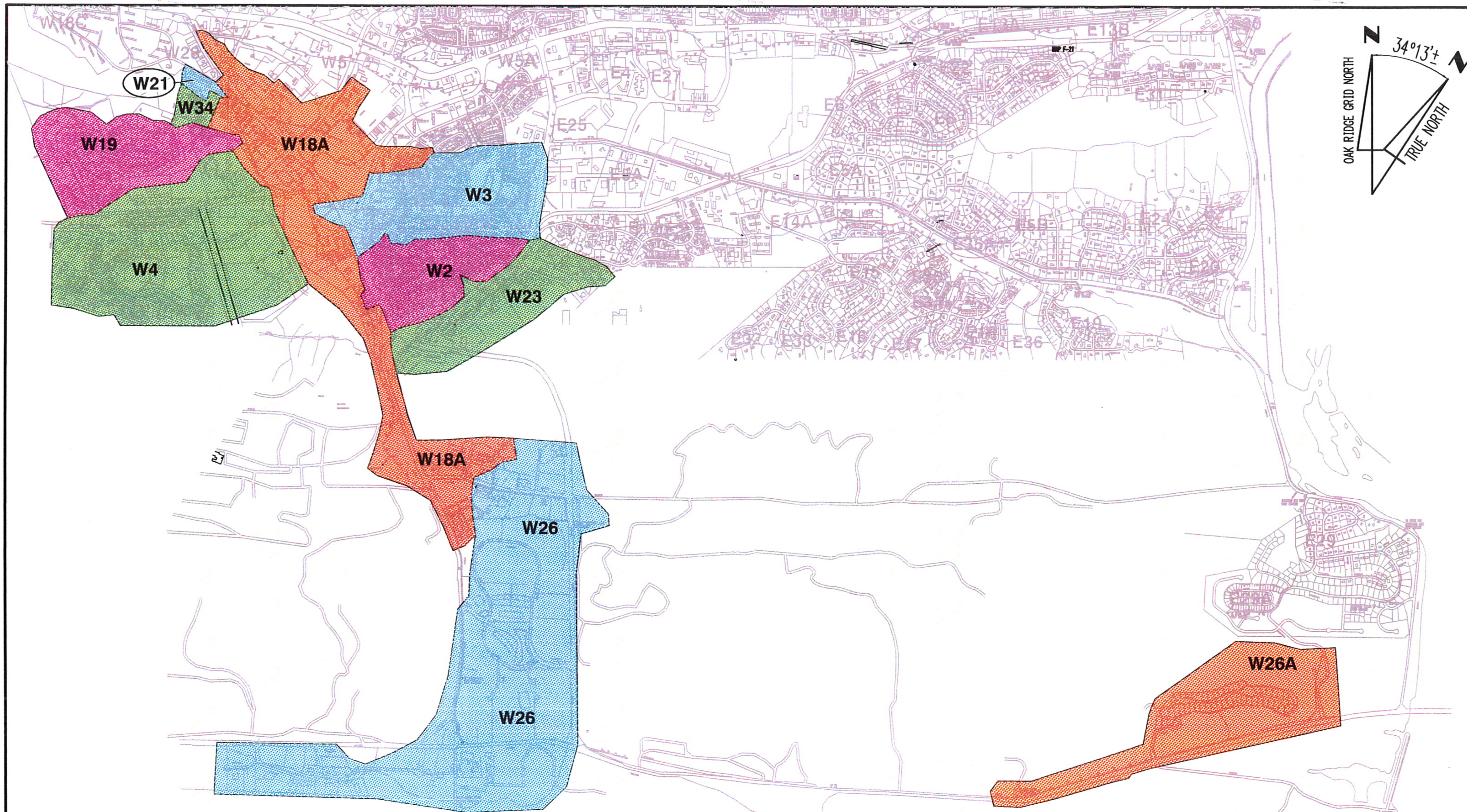
LD&A
Lamar Dunn & Associates Inc.

Chattanooga Office: Chattanooga, TN 37411
Corporate Office: Knoxville, TN 37920
Tri-Cities Office: Johnson City, TN. 37615

CITY OF OAK RIDGE
EMORY VALLEY SEWER SHED
MINI SYSTEM LOCATION MAP
FIGURE III-2

DRAWN BY : JCG
FILE NO. COR041SE06SC
SCALE : NO SCALE
DATE: 2-1-11

ORIGINAL



LD&A
Lamar Dunn & Associates Inc.

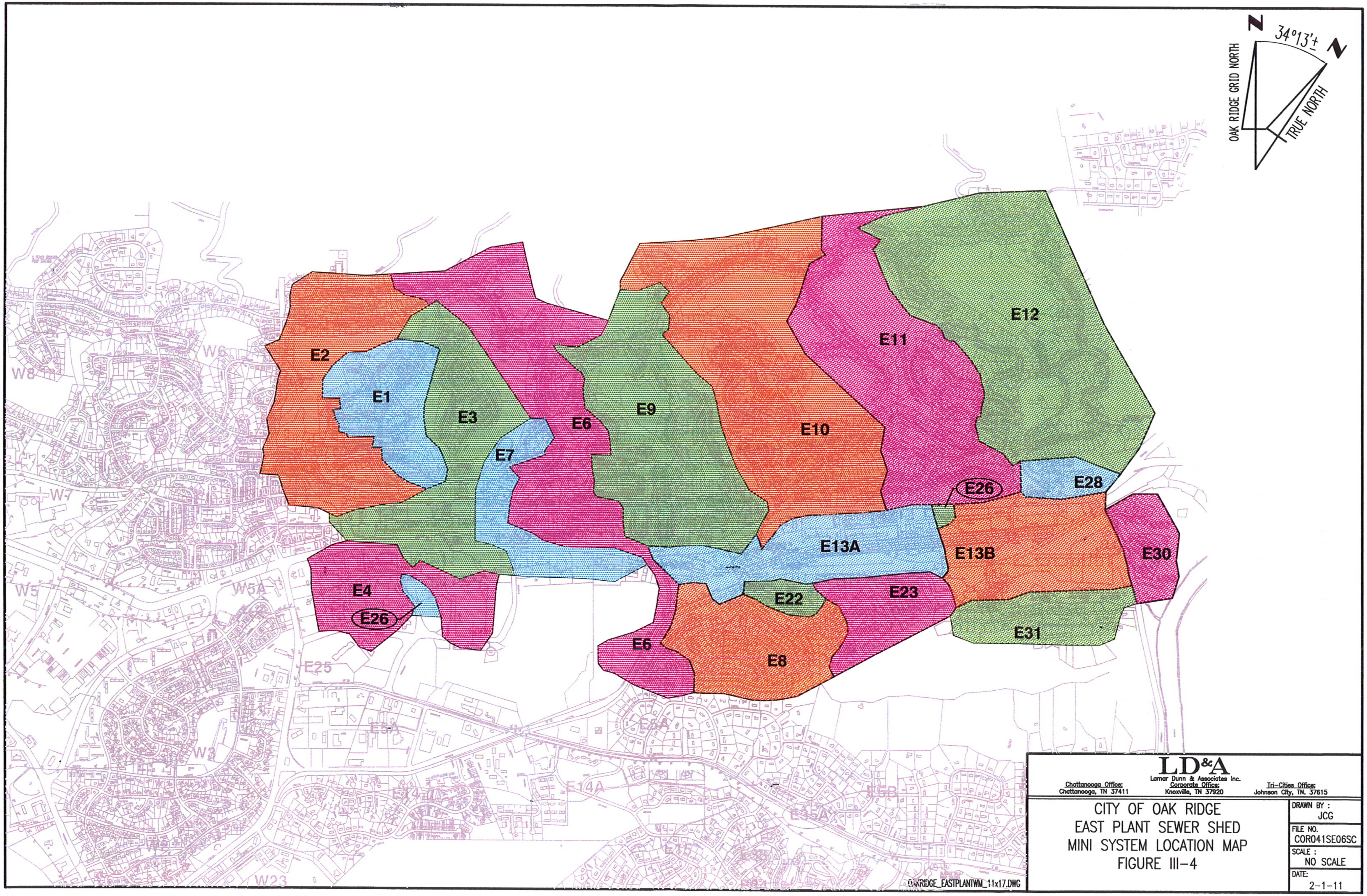
Chattanooga Office: Chattanooga, TN 37411
Corporate Office: Knoxville, TN 37920
Tri-Cities Office: Johnson City, TN. 37615

CITY OF OAK RIDGE
Y-12 SEWER SHED
MINI SYSTEM LOCATION MAP
FIGURE III-3

DRAWN BY: JCG
FILE NO. COR041SE06SC
SCALE: NO SCALE
DATE: 2-1-11

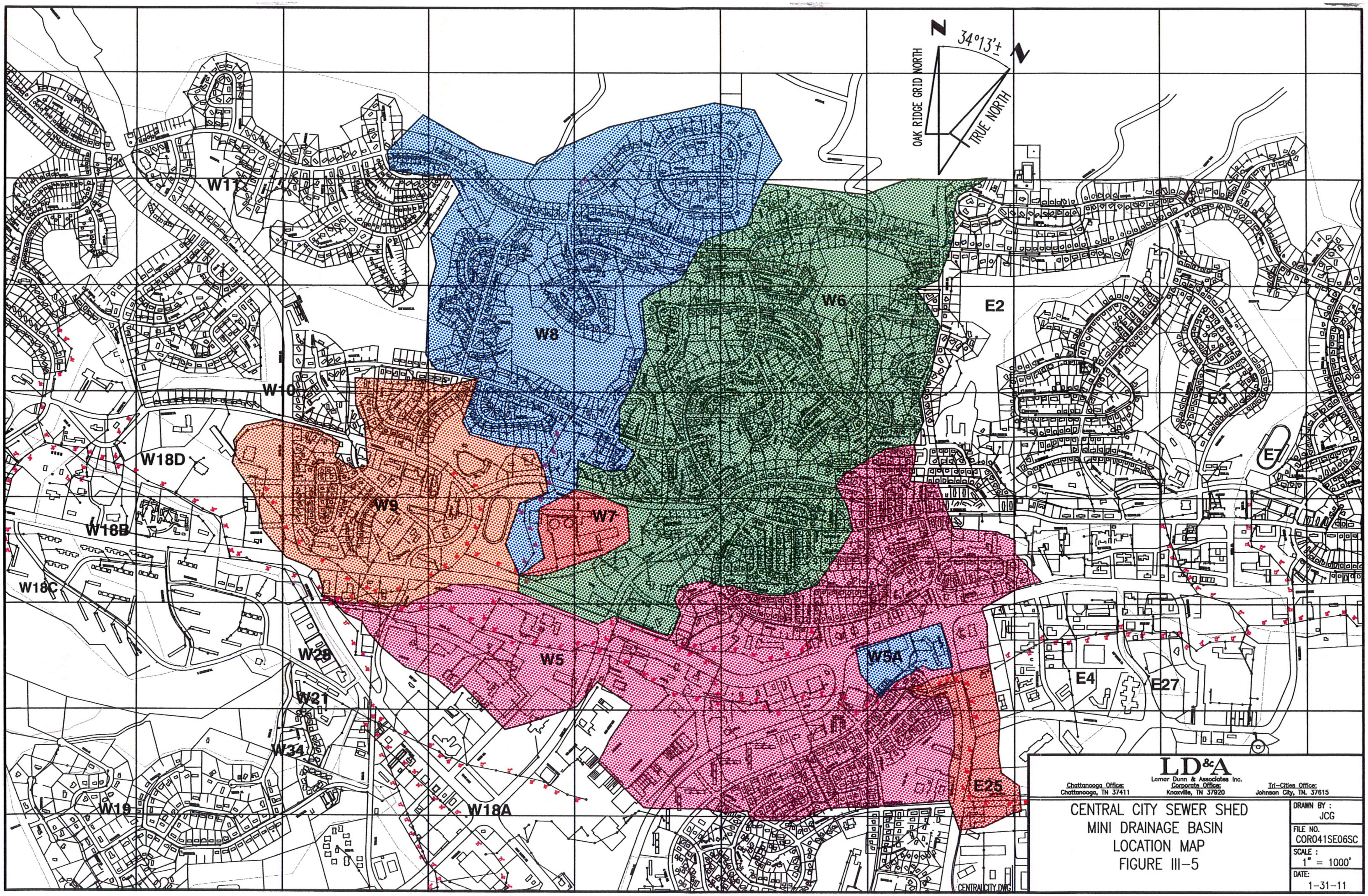
Y-12_11X17.DWG

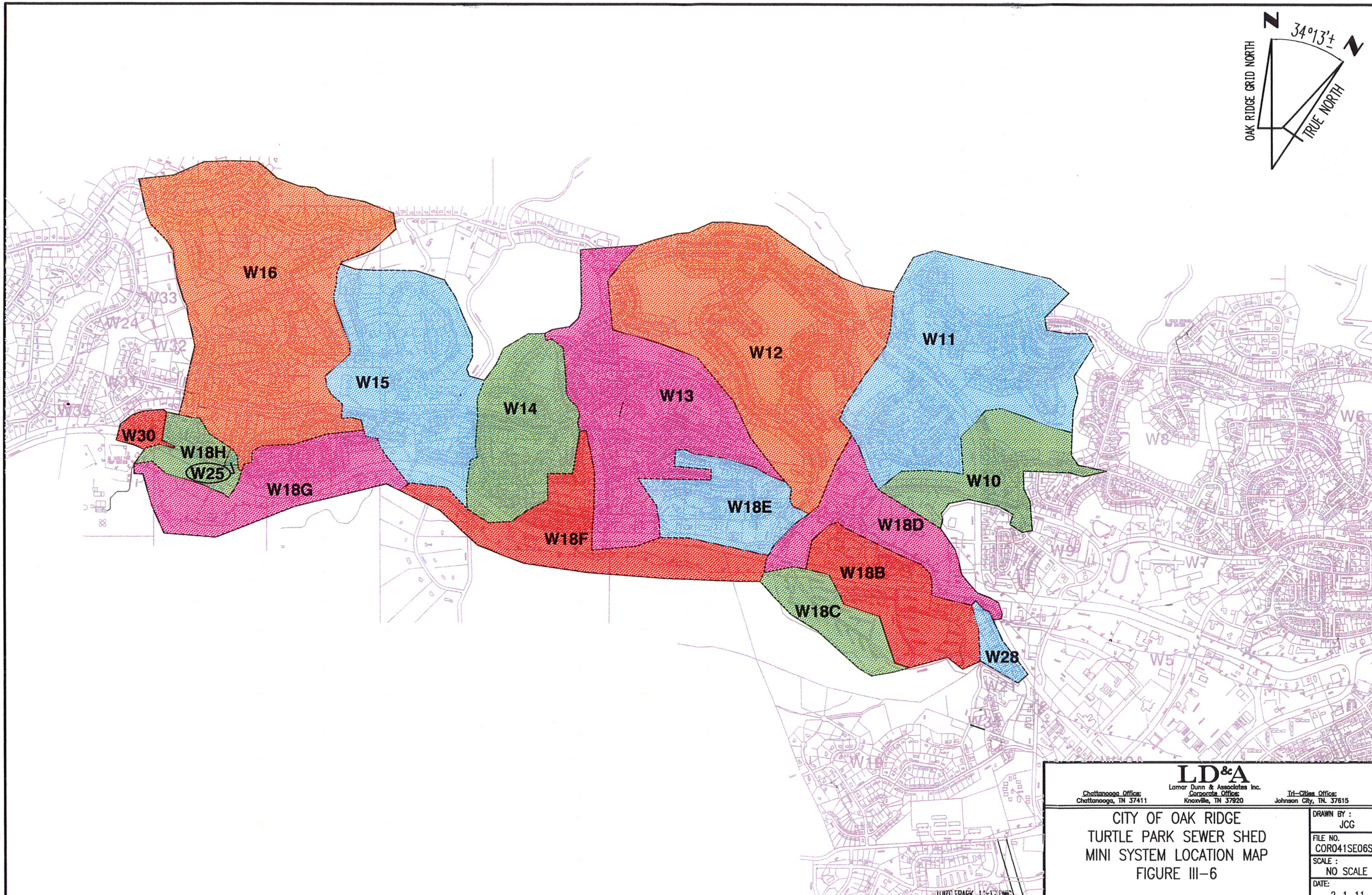
ORIGINAL



34°13'±
OAK RIDGE GRID NORTH
TRUE NORTH
E2
E1
E3
E6
E7
E9
E10
E11
E12
E26
E28
E13A
E13B
E30
E4
E26
E22
E23
E31
E6
E8
W8
W6
W7
W5
W5A
E25
E5A
W3
E14
E14A
E5B
E35A
W23
LD&A
Lamar Dunn & Associates Inc.
Chattanooga Office: Chattanooga, TN 37411
Corporate Office: Knoxville, TN 37920
Tri-Cities Office: Johnson City, TN. 37615
CITY OF OAK RIDGE
EAST PLANT SEWER SHED
MINI SYSTEM LOCATION MAP
FIGURE III-4
DRAWN BY: JCG
FILE NO. COR041SE06SC
SCALE: NO SCALE
DATE: 2-1-11
OAKRIDGE_EASTPLANTWM_11x17.DWG

ORIGINAL


N
34°13'+
N
OAK RIDGE GRID NORTH
TRUE NORTH
W11
W10
W18D
W18B
W18C
W9
W8
W7
W6
W5
W5A
W28
W21
W34
W19
W18A
E2
E3
E7
E4
E27
E25
LD&A
Lamar Dunn & Associates Inc.
Chattanooga Office: Chattanooga, TN 37411
Corporate Office: Knoxville, TN 37920
Tri-Cities Office: Johnson City, TN 37615
CENTRAL CITY SEWER SHED
MINI DRAINAGE BASIN
LOCATION MAP
FIGURE III-5
DRAWN BY: JCG
FILE NO. COR041SE06SC
SCALE: 1" = 1000'
DATE: 1-31-11
CENTRALCITY.DWG



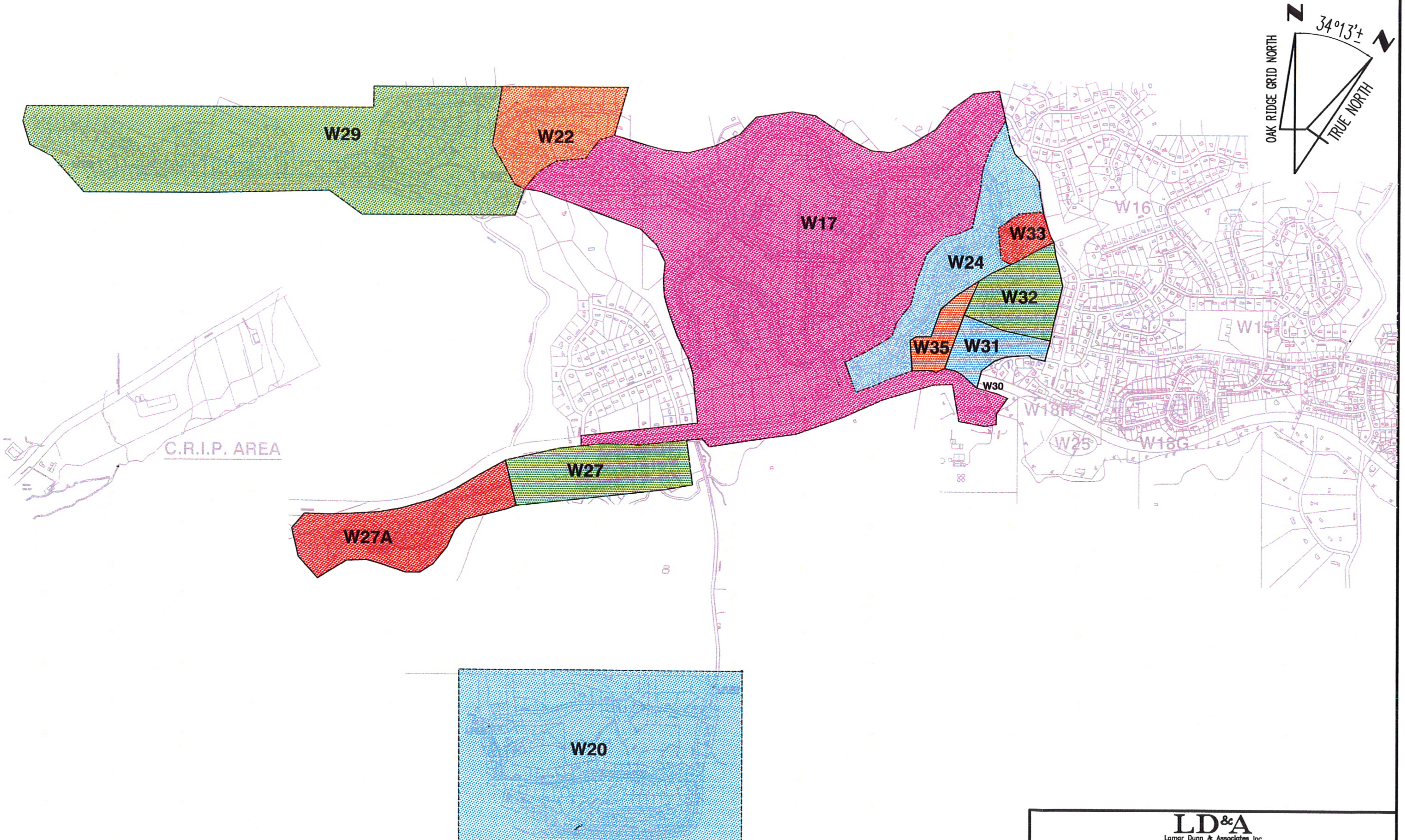
LD&A
Lamar Dunn & Associates Inc.

Chattanooga Office: Chattanooga, TN 37411 | Corporate Office: Knoxville, TN 37920 | Tri-Cities Office: Johnson City, TN. 37615

CITY OF OAK RIDGE
TURTLE PARK SEWER SHED
MINI SYSTEM LOCATION MAP
FIGURE III-6

DRAWN BY : JCG
FILE NO. COR041SE06SC
SCALE : NO SCALE
DATE: 2-1-11

ORIGINAL



LD&A
Lamar Dunn & Associates Inc.

Chattanooga Office:
Chattanooga, TN 37411

Corporate Office:
Knoxville, TN 37920

Tri-Cities Office:
Johnson City, TN. 37615

CITY OF OAK RIDGE
WEST END SEWER SHED
MINI SYSTEM LOCATION MAP
FIGURE III-7

DRAWN BY : JCG
FILE NO. COR041SE06SC
SCALE : NO SCALE
DATE: 2-1-11

WESTEND_11X17.DWG

SECTION IV

RAINFALL DATA

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

A. EXISTING RAINFALL GAUGES AND HISTORICAL RAINFALL RECORDS

Due to the United States Department of Energy (DOE) facilities and federal research activities in and near Oak Ridge, a number of rainfall gauges have been deployed in the area. A search of NOAA web sites and other sources identified the following available rainfall data.

- Ongoing rainfall data, and limited historical rainfall data, collected at multiple gauges at Oak Ridge National Laboratories (ORNL), are available. However, these gauges are located off Bethel Valley Road, several miles south of the extreme southwestern part of the sewer basin, and are separated from the sewer basin by Chestnut Ridge, Pine Ridge, and East Fork Ridge. Ongoing rainfall data collected at the East Tennessee Technology Park (ETTP) is also available. However, ETTP is located several miles southwest of the southwestern boundary of the sewer basin. Therefore, due to spatial concerns and other considerations, the utility of this data for analysis is limited. There are also several other gauge records available that have limited use for similar reasons.
- 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.

B. 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 are 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. A 10- or 15-minute time step is a reasonable increment. While short interval depths may be interpolated from long interval (i.e., 1-hour) data, the inflow and first infiltration components of the RDII response may be excessively masked. Therefore, short interval rainfall data is desired. Since rainfall depths and intensities can vary significantly over a basin of this size, multiple gauges are required to obtain adequate areal coverage of the sewer basin. Therefore, three new primary rain gauges will be deployed.

- Rain Gauge #1: This gauge will be 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 will be installed 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 will be 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.

The principal rain gauges will be Hach units. Specifications for the Hach rain gauges and accessories are as follows:

- Hach Data Logging Rain Gauge, Product Number 2459
- Tipping bucket type with 8-inch diameter collector/funnel with SS screen
- 0.01-inch resolution
- 5% accuracy at 0.5-inches per hour
- epoxy coated aluminum and anodized aluminum material
- base mounting plate with 3-point spring-loaded leveling adjustment
- solid state memory pack with battery backing
- capacity of 10,080 reporting readings (e.g., 70 days at 10 minutes)
- replaceable 9 VDC alkaline battery (approximately 6 months life)
- data download to PC via RS232 interface
- software for data download and management

C. CALIBRATION AND MAINTENANCE OF NEW RAIN GAUGES

Field calibration of the gauges will not be required since the gauges are pre-calibrated at the factory. The rain gauges will be prepared, installed, operated and maintained in strict accordance with the user manual. The 19-page manual provides detailed instructions for the gauge. Each gauge will be located in a clear area away from trees and buildings which would block the natural fall of rain. The base plate will be mounted on a firm, flat surface and leveled. Maintenance will consist of routine inspection, cleaning, and replacement of the battery.

D. RAINFALL DATA QA/QC

The downloaded rainfall data will be imported to and managed with EPA's Sanitary Sewer Overflow Analysis and Planning (SSOAP) software. The quality and completeness of the data will be evaluated as follows:

- Recorded rainfall events will be compared to events determined for the other two primary gauges to identify any gross inconsistencies in event dates/times, durations and depths. If gross inconsistencies are indicated, further review of the data will be conducted.
- The data from an individual gauge will be analyzed and plotted graphically in SSOAP, and reviewed to identify any anomalous readings (missing data points, spikes, or other inconsistencies). If inconsistencies are indicated, further review of the data will be conducted.
- When inconsistencies are suspected in the data collected at one of the primary gauges, data from the other primary gauges and records available from other sources will be used to evaluate and possibly rectify the data. For example, patterns from the other primary gauges may be used along with hourly or daily data at other gauges to reconstitute part or all of a problematic record. However, record reconstitution will be limited to minor inconsistencies. The default policy will be to exclude the rainfall event or events from QA/QC approval.

E. DESIGN STORM

Unless determined otherwise by the rainfall and overflow analysis (discussed below), the design rainfall event will be the 2-year, 24-hour storm. The 2-year, 24-hour event will be synthesized using the balanced "frequency storm" method (USACE, 2010). This method generates a storm that retains all established depth-duration relationships for any span of time within the event. A similar method was used to develop the well-known original generalized Natural Resources Conservation Service 24-hour rainfall patterns (NRCS/SCS, 1986). The method proposed here will tailor this approach to

Oak Ridge and will be based on more recent rainfall analyses than used in the development of the NRCS distributions. The depths and durations used for the development of the pattern will be extracted from NOAA Atlas 14, Volume 2 (NOAA, 2004). For convenience, the pattern will be developed using the US Army Corps of Engineers computer program, HEC-HMS (USACE, 2010) and extracted for importing into SSOAP.

The 2-year, 24-hour storm theoretically represents a relatively frequent event. However, as synthesized, the depth (in excess of 3 inches) and the worst-case within-storm intensities represent a reasonable test for the system capacity. Most long events of equal or greater depth are of lower intensity, and shorter events of equal or greater intensity are usually of lower total depth.

F. OAK RIDGE LONG-TERM DEPTH-DURATION-FREQUENCY RAINFALL DATA

The NOAA Atlas 14 Volume 2 web site reports the following point rainfall depth-duration-frequency data (partial duration series) for Oak Ridge:

Table IV-1
Oak Ridge Depth-Duration Data for 2-Year Event *(NOAA Atlas 14, Volume 2)*

Average Tr	5 min	10 min	15 min	30 min	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr
2 -year	0.40"	0.63"	0.80"	1.10"	1.38"	1.62"	1.75"	2.17"	2.71"	3.32"

G. REVIEW OF OVERFLOWS AND RAINFALL DATA

Local rainfall data and sewer overflow records for the last 5 years will be reviewed. A combined chart of overflows versus daily rainfall will be prepared. Hourly data for selected representative events associated with overflows will be analyzed with SSOAP. The objectives of this review will be to:

- Identify any overflow versus rainfall correlations, trends or overflow thresholds that may provide additional insight into the selection of the design storm.
- Determine if an observed recorded rainfall event approximates the synthetic design storm depth, duration and intensity sufficiently that it may be used as the general pattern for the design storm. Observed storms are usually preferable due to the ability to compare actual observed field flow conditions to modeled alternatives.

H. OAK RIDGE RAINFALL DATA FOR LAST FIVE YEARS

As previously discussed, there are two existing rainfall gauges in the sewer basin with records spanning the past 5 years; the gauge off Laboratory Road and the gauge in the western part of Y-12. These records provide hourly and daily data and should be representative of the east-central and south-central areas of the sewer basin. Since many of the problematic overflows occur in the eastern part of the basin, these records will be the primary records used in the review of historical data. In order to address the western part of the sewer basin, hourly and daily data from a gauge at the East Tennessee Technology Park (ETTP) will be used to supplement the other data. The ETTP data is available from 2001 to the present. However the gauge is located several miles southwest of the southwest boundary of the sewer basin and caution will be used when making inferences using the data.

I. SANITARY SEWER OVERFLOWS (SSOS) FOR LAST FIVE YEARS

Detailed records of overflows are available, including all overflows for the last five years. Overflows are 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 is routinely summarized in tabulation-style reports that provide the address or location, and the dates and times when the overflow started and ended. These summary reports will be used to chart overflows versus rainfall.

J. GROUNDWATER

The influence of regional groundwater on base dry weather flows will be evident from the analysis of dry weather flow records, as discussed in Section V. Likewise, the influence of groundwater on wet weather flows will be evident from the RDII analysis. The modeling concept developed for the study specifically includes these influences in the flow calculations, and no further adjustments should be necessary. However, flow calculations which include areas with significant potential for groundwater contributions will be carefully reviewed to ensure that the results are reasonable. For example, Figure IV-1 is extracted from FEMA FIRM 47001C0281F. The figure shows the floodplain along Poplar Creek, in the area just upstream of the Turtle Park Pump Station. In this area, the 42-inch interceptor parallels the north side of the creek, in the floodplain. The potential for groundwater influences in this area are high, the magnitude of which depends on the condition of the sewer and manholes.

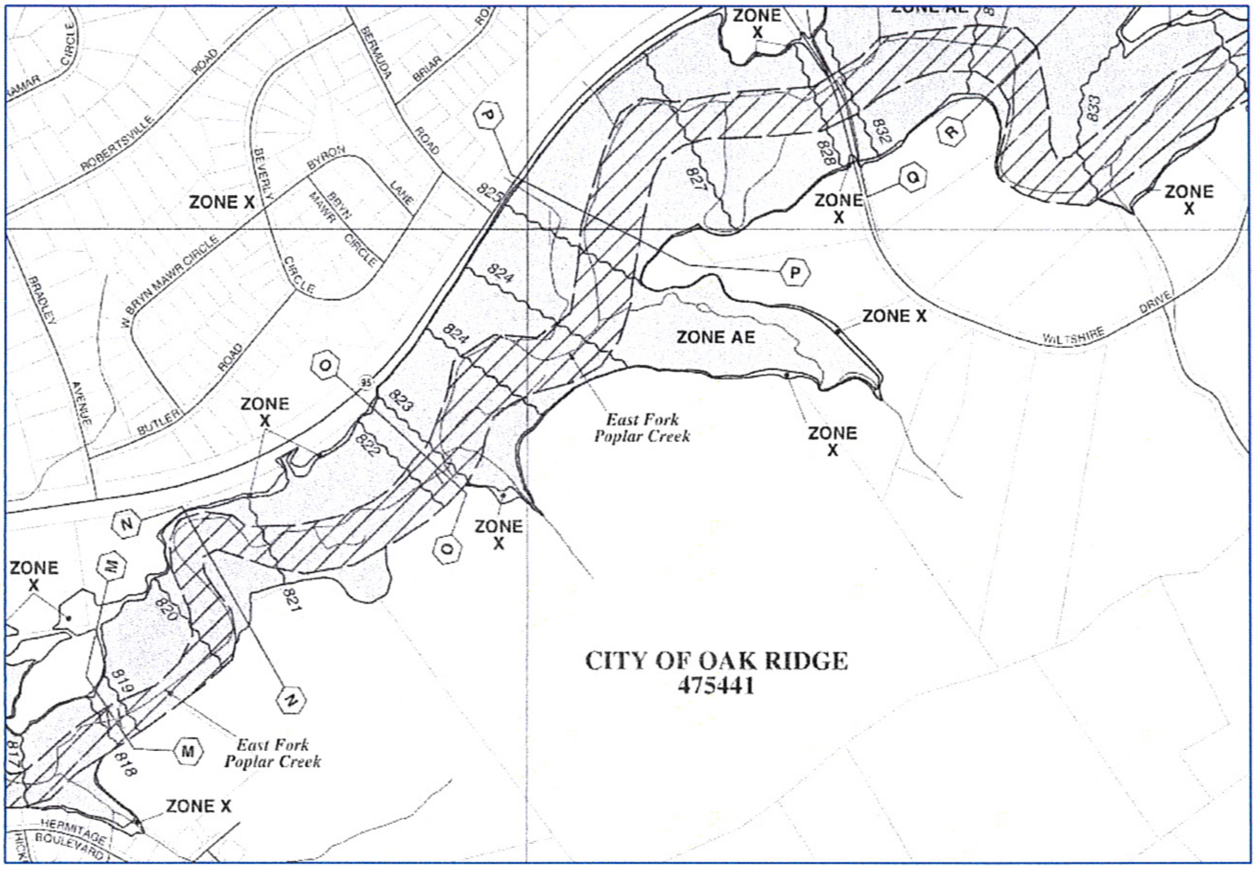


Figure IV-1 Poplar Creek Floodplain

SECTION V

ESTIMATED FLOW RATES

As a part of the SSES, a determination is needed for dry weather flow rates and flow rates resulting from various storm events. Oak Ridge will be installing flow meters to determine actual flows within the system at various locations. A part of a companion task to the ORDER is to develop a hydraulic model of the system to determine capacity. The data collected from rainfall gauges, flow monitors, and physical inspections will be used for the reduction of I/I to eliminate overflows. The plan for estimating the flows is discussed below.

A. <u>OVERVIEW OF MONITORING</u>

Sewer flow data will be collected at selected locations in order to estimate dry weather and wet weather flow rates. There will be three categories of flow monitors:

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

It is proposed that an eleven (11) month monitoring period be initially planned, and adjusted if necessary to obtain sufficient flow data.

B. <u>SELECTION OF MONITORING SITES</u>

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 will be 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 proposed at points on the main gravity interceptor, and on the influent to three major lift stations. It is 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. Specific locations will be selected that will minimize the extent to which the meters will be affected by adverse conduit hydraulics.

- 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

The **temporary monitoring locations** will be finalized during the assessment. Up to five monitoring stations will be rotated in groups for each of the six sewersheds:

- Turtle Park
- West End
- Central City
- Y-12
- East Plant
- Emory Valley

Temporary monitoring stations will be located at the primary outlets of each sewershed. In addition, monitoring stations will be located at key points within the sewershed to define flow records for sub-sewersheds. .

Preliminary locations for the primary outlet monitoring stations, and selected sub-sewershed monitors for the sewersheds, are discussed below:

- Turtle Park: Turtle Park Lift Station influent from mini-system W18H, and at locations in the sewershed discharging to the main interceptor between the lift station and the intersection of Oak Ridge Turnpike and Illinois Avenue
- West End: Downstream of 6-inch diameter force main off Oak Ridge Turnpike near intersection with Nebraska Avenue

- Central City: Inflow to the main interceptor from mini-system W9 and inflow to the main interceptor from mini-system W5, and at points located in the commercial/business area between the intersection of Oak Ridge Turnpike and Illinois Avenue and the intersection of Lafayette Drive and Laboratory Road; a sub-sewershed monitor will be placed at the effluent from the junction of mini-systems W6, W7 and W8
- Y-12: As discussed above, a semi-permanent monitor will be assigned to record inflow to the main interceptor from mini-system W18A, located near the intersection of Oak Ridge Turnpike and Illinois Avenue
- East Plant: Likewise, the influent to the East Plant station will have a semi-permanent monitor; sub-sewershed monitors will be located downstream of the effluent from mini-system E13B and downstream of the effluent from mini-systems E3 and E4
- Emory Valley: In this case also, the influent to the Emory Valley station will have a semi-permanent flow monitor; sub-sewershed monitors will be placed at the effluent from mini-systems E5A and E5B

In addition, temporary monitors will be deployed at key locations upstream of problem overflow areas.

C. OAK RIDGE WET AND DRY SEASONS

Historically, precipitation in Oak Ridge has been heaviest in November through July. During this period, mean monthly precipitation varies from 4.32 inches (April) to 5.72 inches (March). The driest months are August through October, with mean monthly depths ranging from 3.02 inches (October) to 3.75 inches (September). Mean annual precipitation is 55.05 inches. (NWS, 2010.) Table ?? provides the mean monthly point precipitation for Oak Ridge.

Table V-1
Mean Monthly and Annual Precipitation, Oak Ridge, TN (NWS, 2010)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
5.13”	4.50”	5.72”	4.32”	5.14”	4.64”	5.16”	3.39”	3.75”	3.02”	4.86”	5.42”	55.05”

D. DRY SEASON MONITORING

In order to characterize dry weather flows, the monitoring program will include (a) periods of seasonally low flows and/or (b) dry periods distinctly separated in time from wet weather events. Situation (a) will be applicable to all permanent monitoring records since those monitors have been in place for an extended period of time, and will be left in place indefinitely. If normal climatic conditions exist during the monitoring program, situation (a) would likely be applicable to the semi-permanent monitoring records as well, since the monitoring period will span at least portions of the dry season. However, it is not expected that all of the temporary monitors will be deployed at all temporary monitoring sites during dry seasons due to the rotation of these gauges. Therefore, situation (b) may be typical of some of the temporary flow monitoring records. However, with appropriate antecedent conditions, it is anticipated that such data would be suitable for flow estimating purposes.

E. WET SEASON MONITORING

In order to characterize wet weather flows, the monitoring program must include periods of high flow. Similar to the dry weather monitoring conditions discussed above, the permanent monitoring records and possibly the semi-permanent monitoring records would include wet season records. However, it is not expected that all of the temporary monitors will be deployed at all temporary monitoring sites during wet seasons due to the rotation of these gauges. Therefore, some of the temporary wet weather flow monitoring records may include wet weather events during dry seasons. However, with appropriate antecedent conditions, it is anticipated that such data would be suitable for flow estimating purposes.

F. FLOW METER EQUIPMENT

Two types of monitors will be used for this study:

- Marsh-McBirney Flo-Tote Model 260 (six units presently available)
- Hach Flo-Tote Model 3 Sensor, Mounting Band and Logger (five units presently available)

The Marsh-McBirney and Hach meter installations are similar. (The Hach meter assembly is basically a more recent version of the Marsh-McBirney meter.) They consist of a debris-shedding transducer sensor, positioned on or near the bottom of the conduit, and held in place by a mounting band. The signal from the sensor is relayed to the primary module by cable. The primary module is usually hung from a ladder rung or other anchor point in the manhole. The primary module has a low voltage operating battery and a backup battery. A storage device in the primary module stores the depth and velocity readings from the sensor. This data is downloaded using a laptop PC via an RS232 communications cable interface. Flo-Ware software installed on the laptop is used to download, analyze and manage the data. Flow is computed as flow area (based on pipe geometry and depth) times average flow velocity. The data may be displayed in tables or graphically, or prepared as file data for export and use in other applications. The units are accompanied by detailed manuals that describe the appropriate setup, calibration, use and maintenance of the equipment.

G. FLOW METER CALIBRATION

Each unit will be field calibrated, and a record of the calibration process will be maintained. The manuals accompanying the Marsh-McBirney and Hach units provide detailed site calibration instructions. The procedure consists of making independent velocity and depth measurements, and computing flow, then comparing those with the values reported by the units. A calibration worksheet is provided with the Marsh-McBirney units and a software "wizard" is provided for use with the Hach units.

H. FLOW METER MAINTENANCE

The units will be maintained in strict accordance with the manufacturers' manuals. Maintenance will be performed following major storm events, when data is downloaded, or monthly, whichever occurs first. Maintenance checks will be documented on forms and photographically. Maintenance will generally consist 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

I. FLOW DATA QA/QC

Flow records retrieved from the flow monitors will be imported to SSOAP for QA/QC review of selected flow periods.

- High flow periods and low flow periods will be compared with rainfall data to ensure that the flow regimes are consistent with the rainfall regimes, and are not the result of blockages or other factors.

- Graphical displays of flow versus time (hydrographs) will be reviewed to identify spikes, missing data, or other anomalies that would require additional review.
- Scatter diagrams of depth versus velocity will be reviewed to ensure that the data is consistent (Sands and Stevens, 1995) and to identify surcharge events.
- Dry weather flow diurnal patterns will be reviewed to identify any anomalous patterns.

J. FLOWS

The rainfall and flow data will be used to calibrate a computer hydraulic model of the sewer system. The development of the model is described in detail in the Capacity Assessment Plan. The model will be used in the present study to estimate dry weather and wet weather flows. These are reviewed briefly below. Please refer to the Capacity Assessment Plan for a more comprehensive review.

K. BASE DRY WEATHER ANALYSIS

Dry weather flow consists of wastewater flow plus regional groundwater inflow/infiltration. The two components may be separated on the basis that the regional groundwater portion is usually relatively constant (varying only seasonally) while the wastewater portion varies hour-to-hour, usually with a daily pattern.

For each flow monitoring location, SSOAP will be used to analyze the flow data for periods with no significant wet weather influences. From this analysis, typical daily flow patterns for the monitored system will be determined for weekdays and weekend days. Also, typical regional groundwater inflow/infiltration rates will be estimated for each monitoring location. In addition, from the monitoring record an estimate of high groundwater flows will be made. (Minimum night-time flows in residential areas, and dry weather winter flows when lawn watering and recreational uses are minimal may provide useful insight to regional groundwater I/I.)

L. WET WEATHER FLOW ANALYSIS

Using the rainfall and wet weather flow data, and the results of the dry weather flow analysis, SSOAP will be used to separate the wet weather flow and dry weather flow components of the wet weather flow hydrographs. This decomposition analysis will permit determination of the RDII component of the hydrographs, as well as the total volume of RDII.

Prior to the RDII unit hydrograph derivations, the sub-sewershed for each monitoring location must be determined. A sub-sewershed is defined as the portion of the service area upstream of the monitoring location that contributes wet weather flow to the system. The sub-sewersheds will be delineated using the GIS model of the sewer basin, and will typically consist of several mini-systems. The sewer collection system network, land use, and topography will be used to estimate the sub-sewershed boundaries. Care will be taken to not significantly over or under estimate the sub-sewershed areas to avoid inconsistencies in the subsequent RDII analysis.

Once the RDII hydrographs and sub-sewershed areas have been determined for a monitoring location, SSOAP will be used to estimate the RDII volume, time-to-peak, and recession characteristics. The triangular unit hydrograph method will be used wherein three separate unit hydrographs are employed to represent the short term, intermediate term, and long term flow response to storm events. The RDII characteristics for each unit hydrograph (R, T and K) will be estimated using the graphical tools within SSOAP. R represents the ratio of RDII volume to rainfall volume. T is the time of peak of the unit hydrograph. K is the unit hydrograph recession time expressed as a multiplier of T. Trial R, T and K values will be used until the observed RDII hydrograph and the computed RDII hydrograph are within reasonable agreement, while conserving the magnitude of total R (i.e., the sum of R for all three unit hydrographs) for the event. Initial selection of abstraction (interception and depression storage) parameters will be based on guidance contained in the SWMM (EPA, 2010) reference manual.

SECTION VI

HISTORICAL FLOW/OVERFLOW DATA

There is an abundance of data relative to flows and overflows within the Oak Ridge collection system. For the purpose of this work, at least a five (5) year record will be reviewed.

The City has already developed a SORP which addresses overflows. The data collected for that document and even more recent data will be used in the review. The SSO's will have at least the following:

- Location
- Cause
- Volume
- Rainfall

In addition to the SSO data, five (5) years of treatment plant operating reports will be reviewed.

SECTION VII

INVESTIGATIVE ACTIVITIES

The physical inspections of the sewer system are described below. This work is a continuation of the activities which began in the 1990's. Each of the activities is described below. The proposed schedule for the activities is shown in Section XI.

A. MANHOLE INSPECTION

A thorough inspection of all manholes will be performed and recommendations made for further action needed on manhole rehabilitation or replacement. A copy of the manhole inspection form is included. The results of the inspection will 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
- Surcharge data
- Debris in manhole
- Pipe size and material
- Clock position of pipe
- Invert depth of pipe

LD&A

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: %

Location

New MH #

Old MH #

Top Elevation: ft MH Depth ft Invert Elevation: ft

MH Diameter: ft

WT FC:

Cover Diameter: in

FC Material:

MH Walls:

MH Material

MH Rehab Recommendation:

	Physical Condition	Leaking
Base Invert		
Cone		
Frame and Cover		
Riser		
Steps		
Surcharge		
Debris		

	Clock Position	Pipe Material	Pipe Size	Depth
Out			in	ft
Drop			in	ft
Invert 1			in	ft
Invert 2			in	ft
Invert 3			in	ft
Invert 4			in	ft
Invert 5			in	ft
Invert 6			in	ft

Notes:

B. SMOKE TESTING:

After the manholes are inspected, the manholes and collection lines will be smoke tested. Smoke testing is one of the most efficient and cost effective methods of locating sources of inflow and infiltration problems with sewers. The smoke will travel the path of least resistance and quickly shows up at sites that allow Inflow and Infiltration into the collection system. Smoke will identify broken manholes, illegal connections including roof drains, sump pumps, yard drains, uncapped lines, cracked mains and laterals. A copy of the smoke testing inspection form is included.

Information that will be 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

LD&A

City of Oak Ridge Smoke Testing

Crew Leader: ____ Date: ____ ID: ____

Latitude ____° ____' ____"

Longitude ____° ____' ____"

Basin: ____

MH Location of Blower: ____

Leak Type: ____

Leak Type Info: ____

Leak Severity: ____

Upstream MH: ____

Downstream MH: ____

Distance from Downstream MH: ____ ft

Distance from Upstream MH: ____ ft

Sketch Number: ____

Comments: ____

C. CLOSED CIRCUIT TELEVISION (CCTV) INSPECTION:

Closed circuit television (CCTV) is used by the Wastewater Collection Department to visually inspect the internal conditions of pipes and sub surface structures. CCTV is used basically for the following reasons:

- Scheduled inspections of the wastewater collection lines
- Documentation of sewer network topography and connections; Generation of high-quality data for development of long-term wastewater management plans.
- Emergency situations to determine the cause of stoppages, overflows, or other problems within the collection system
- Effective focusing of capital resources on sewer repair, replacement, and rehabilitation.

D. DYE TESTING/FLOODING:

Dye testing is a method used to locate rain or ground water entry points into the sanitary sewer system. The dye test can be performed on any dwelling connected to the sanitary sewer system. During this process, non-toxic dyed water is introduced into roof drain leaders, driveway drains, or area drains. In some instances, dyed water is injected into the ground around foundations to check for the illegal connection of foundation drains. After introducing the dyed water, the downstream sanitary sewer manhole is checked, or if a clean out /inspection port is present, it is checked for dyed water. Dye testing with a non-toxic dye is one way of determining where a pipe or structure drains, if it is not obvious by observation or on existing plans or records. By conducting dye testing, inappropriate connections can be identified.

SECTION VIII

AREAS OF CONCERN

The primary and initial areas of concern are those referred to as critical mini-systems. However, as the hydraulic model is developed, other areas may come to attention.

"Critical Mini-Systems" are defined as those mini-systems that:

- have experienced sanitary sewer overflows within the past five (5) years
- have, or have had within the past five (5) years, a constructed overflow built
- are upstream of areas experiencing sanitary sewer overflows or having constructed overflows

Overflow reports for the period September 2005 through December 2010 have been reviewed. Table VIII-1 summarizes manholes, and the associated mini-systems, that have constructed overflows. Table VIII-2 summarizes all other manholes and locations that have experienced overflows during the review period.

Table VIII-1
Constructed Overflows

Manhole*	Mini-System Where Located	Address	Contributing Mini-Systems (Whole or Part)
D9-43	W11	143 Iroquois Road	W11
D14-37	W6	120 Porter Road	W6
D1007	E11	119 Athens Road	E11
F701	E9, E13A	100 Dresden Road	E1, E2, E3, E4, E6, E7, E9, E27
F702	E13A	Belgrade Road	E1, E2, E3, E4, E6, E7, E9, E27
F703	E13A	Coalyard Road	E1, E2, E3, E4, E6, E7, E9, E27
F903	E13A	535 Oak Ridge Turnpike	E1, E2, E3, E4, E6, E7, E9, E10, E27
G15-13	W5A, E25	117 North Purdue Avenue	W5A, E25
J11-14	W18A	216 South Illinois Avenue	W4, W18A
L24-1	E20	697 Melton Lake Drive	E20, E21
MB-03	W6	Providence Road	W6
N55-7	W13	165 Louisiana Avenue	W13

** "Old" manhole numbering system, which was used in overflow report entries*

Manholes experiencing sanitary sewer overflows within the past five (5) years are tabulated below in Table VIII-2.

Table VIII-2
Manholes Experiencing Overflows

Mini System	Manhole*	Address
E12	E23-C1005A	130 Athens Road
E12	C23-26	319 East Drive
E12	G22-14	Old East Plant
E12	MH	119 Athens Road
E12	C1005	138 Athens Road
E13B	Pump Station	East Plant Pump Station
E13B	B22-14	East Plant Pump Station
E13B	Pump Station	East Plant Pump Station
E13B	Pump Station	East Plant Pump Station
E13B	G19-F702	535 Oak Ridge Turnpike
E13B	E22-13	151 Cairo Lane
E13B	G22-13	151 Cairo Lane
E13B	G22-14	151 Cairo Lane
E13B	F22	Cairo Lane
E13B	Pump Station	East Plant Pump Station
E13B	Pump Station	East Sewer Pump Station
E13B	G22-18	E Sewer Plant
E14A	J18-1	100 Elmhurst Drive
E19	G22-14	151 Cairo Lane
E19	M22-5	105 Belle Creek Drive
E29A	P26-2	18 Radisson Cove
E30	G24-8	100 Melton Lake Peninsula
E35A	K20-8	107 Columbia Drive
E35A	F17-D414	23 E Tennessee Avenue
E5B	BO 10" FM	Emory Valley/Columbia
E5B	K22-9	136 Balboa Circle
E8	H20-6-C-1	19 Converse Lane
E8	MH 6-C-1	19 Converse Lane
E8	G20-3	Coe Road Lift Station
W12	D9-25	137 Jarrett Lane

Table VIII-2
Manholes Experiencing Overflows
(continued)

Mini System	Manhole*	Address
W12	C8-8	365 Jefferson Avenue
W12	C8-L54-12	365 Jefferson Avenue
W12	D4-15	242 Jefferson Avenue
W12	L54-9	341 Livingston Avenue
W12	MH	247 Jefferson Avenue
W12	C8-42	113 Jarrett Lane
W12	MH	253 Jefferson Avenue
W12	D9-6	215 Jefferson Avenue
W14	E6-N56-5	123 Seneca Road South
W14	C-06	124 Seneca Road North
W14	D06-N56-5	121 Seneca Road South
W14	C6	110 Station Lane
W15	D5-8	103 Briar Road
W16	C3-25	103 Mohawk Road
W16	B-3-9	144 Montana Avenue
W16	MH	E Melbourne/Robertsville
W16	MH	111 Woodridge
W16	A3-3	106 Woodridge Lane
W16	M-59-20	110 Bradley Avenue
W17	AN3W	1129 Outer Drive
W17	C1-W-10	123 Normandy Road
W17	B2-W-3	1037 West Outer Drive
W17	B01	147 Nebraska Avenue
W17	B1W-6	113 Newridge Road
W18B	F10-AO-16	Villanova Road
W18B	E9-A9-5	298 Roberstsville Road
W18B	W-18B	1650 Oak Ridge Turnpike
W18D	E10-AP-5	Iroquois Road
W18D	E10-2-82	Iroquois Road
W18G	E2-5	200 Hermitage Blvd
W18G	D2-3	Monterey Road
W18G	D5-40	127 Sanford Lane
W19	H11-3	189 Tusculum Drive

Table VIII-2
Manholes Experiencing Overflows
(continued)

Mini System	Manhole*	Address
W19	H113A	191 Tusculum Drive
W2	H2W-5	211 Gum Hollow Road
W2	H2W-5	211 Gum Hollow Road
W2	MH	102,104,108 Paris Lane
W20	H-4W	111 Graceland Road
W20	MH	215 Gum Hollow
W26	S14-A	Scarboro Road
W29	AW5-3	106 Willian Lane
W29	A4W-9	112 Whippoorwill Drive
W3	K13	107 Morris Lane
W3	K13-41B	235 Manhattan Avenue
W3	S49-4A	235 Manhattan Avenue
W3	R48-33B	168 Manhattan Avenue/Woodland School
W3	B3-12	Manhattan Avenue(Hollow)
W5	G15-D-40	117 N Perdue Avenue
W5	G15-D-40	117 N Perdue Avenue
W5	G15-D-40	117 N Perdue Avenue
W5	G11-8	1403 Oak Ridge Turnpike
W5	G11-8	1403 Oak Ridge Turnpike
W5	G15-13	117 Perdue Avenue
W5	E14-D109	116 Newkirk Lane East
W5	G11-8	1403 Oak Ridge Turnpike
W5	B11-8	A K Bissell Park
W5	G13-12	1284 Main Street
W5	G11-8	1403 Oak Ridge Turnpike
W5	G15-13	117 N Perdue Avenue
W5	E15-OJV-1	101 Newcomb Road West
W5	G11-8	A K Bissell Park
W5	G15-13	131 Marquette
W5	DA-31	102 E Pasadena Road
W8	C13-18	360 Outer Drive West
W8	MH-T1	142 Hillside
W8	T-73	256 Highland Avenue

Table VIII-2 Manholes Experiencing Overflows (continued)		
Mini System	**Manhole***	**Address**
W8	31-3	22/220 Hillside Road
W8	MH D11-7	105 N Hickory Lane
WWTP	E2	200 Monterey Road
WWTP	MH D-1W-15	2760 Oak Ridge Turnpike

** "Old" manhole numbering system, which was used in overflow report entries*

Overflows defining the Critical Mini-Systems are primarily due to excessive inflow and infiltration from heavy rainfall events.

SECTION IX

METHODS OF REHABILITATION

Sewer rehabilitation options have developed over the years. Besides the traditional excavation-and-replace pipe replacement, new trenchless methods and procedures are put into practice every day, giving wastewater utilities much to consider. Because complete system replacement rarely is financially viable, many communities are taking the trenchless rehabilitation path. Oak Ridge has experience with each of the techniques below:

A. SEWERS:

1. Excavation and Replace

A determination has been made that the traditional sewer replacement method of excavation and replacing is the preferred methods to replace old and defective collection line. It is one of the only ways to correct sags and humps in the pipeline due to differential soil settlement, and is sometimes the only method that can be used because of the severity of the structural deterioration of the pipe. In some cases the severe misalignment of the pipe will not allow other techniques to be used. However, excavation and replacement can be very disruptive at the surface because utilities in the vicinity of the lines need to be protected, traffic needs to be controlled around the construction, and costs of excavation and replacement are equal to new sewer construction.

Pipe line replacement results in:

- The correction of misalignment of pipe
- Increase in the hydraulic capacity
- Repair of improper service connections
- Elimination of direct sources of storm water entry
- Removal of incidental Inflow and Infiltration sources

Pipe line replacement is performed by contractors and in-house personnel.

2. Pipe Bursting

Trenchless pipe replacement, allowing pipe replacement without having to remove existing pipes, involves inserting a cone-shaped bursting tool into the existing pipe, pulling it through the host pipe using a static pull cable or actuated tool, and breaking the pipe as the tool moves forward. In the static cable version, a pull cable is strung through the pipe and connected at the other end to a winch or backhoe, which pulls the cable (and bursting tool) through the pipe. In the actuated tool version, a pneumatically driven hammer mechanism pounds the tool through the pipe while a cable winch pulls the tool lightly to keep it stable. Afterward a length of replacement pipe is assembled by butt-welds above ground to the appropriate length, attached to the bursting tool, and then pulled into the newly fractured host pipe, thereby replacing it. Laterals are reconnected in a separate operation so the new pipe can "relax," or contract to a stable length after being stretched. Generally, pipe bursting works best with clay, cast-iron, or un-reinforced concrete sewers and in clay and silt soils.

Pipe bursting has been the choice in areas that would have severe problems with:

- Traffic disruption and control
- Disruption to properties (access to and easement use)
- Paving damage
- Shoring requirements
- Excavation dewatering
- Noise
- Restoration (paving, driveways, sidewalks, fences, landscaping)

Pipe line bursting is performed by contractors.

3. Slip Lining

Slip lining involves inserting a new pipe into an old pipe through an insertion pit. This process may or may not require flow by-passing. The process leaves an annular space between the host pipe and liner, which can be sealed at the ends or filled with grout along the length. Slip lining is not as flexible as other pipe lining options and cannot negotiate curves or offsets. However, this lining is a good option for many replacement problems. Pipe liners can eliminate the need for excavation and as a result, the installation costs can be 50% to 80% of excavation and replacement.

Slip Lining has been the choice in the following situations:

- No Increase in hydraulic capacity
- Traffic disruption and control
- Disruption to properties (access to and easement use)
- Paving damage
- Shoring requirements
- Excavation dewatering
- Noise
- Restoration (paving, driveways, sidewalks, fences, landscaping)

Slip Lining is performed by contractors.

4. Pipe Lining

Pipe lining is another method in which the existing pipe does not have to be removed. This procedure involves inserting a liner into the existing pipe, which renews the interior surface and can increase the structural capacity of the old pipeline. With pipe lining the pipe will be repaired with no damage to the streets. There are two (2) basic types of lining options: thermoset (cure-in-place) liners, or thermoplastic (fold-and-form) liners.

- Thermoset (cure-in-place) liners:

  Thermoset liners are cloth-like fiber shells filled with thermosetting resin, usually polyester. Liner installation is a three-step process, beginning with "wetting out," in which resin is applied to the inside of the fiber shell liner tube and forced to go deep within the cloth fibers. Then the liner is placed into the pipe via a manhole (after flow has been by-passed elsewhere). Next, the material is filled with water to invert the tube into the pipeline and curing begins. Curing the pipe involves heating the water used in the second step and circulating it in the pipe for a certain period of time (depending on the size of the repair).

  When this step is complete, the liner is mechanically bonded to the interior of the existing pipe. The cured liner is very rigid and corrosion-resistant.

- Thermoplastic (fold-and-form) liners:

Thermoplastic polyvinyl chloride (PVC) or HDPE liners have been deformed to fit easily within an existing pipe. The liner is heated with hot water or steam to soften it and then is inserted into the sewer through a manhole. Once the liner is in place, heat and pressure are applied to mold the material to the pipe's round shape. Once in place, the liner then is cooled to retain its shape, fitting snugly inside the pipe without adhering to the surface, so they can be replaced easily, if necessary.

Some of the advantages for pipe lining are:

- Trenchless
- Strong
- Cures fast
- Reliable
- Earth friendly
- Long lasting
- Easy to install
- Cost competitive
- Non-disruptive
- Speed of installation
- Restores pipe integrity

5. Point Repairs

Often, a sewer problem is limited to one or two areas, so point repairs are more economical than a total pipe replacement. Many point repairs do not require excavation, and the method (excavation and replace of short segments, internal repair fittings, or chemical grouting) depends on the nature of the defect.

- Excavation and Replace

This requires excavating at the location for the point repair, removing the failed segment of pipe, then replacing the segment and reconnect using a flexible coupling or a hard connection coupling. Stabilize the repaired area with stone or concrete and backfill the area.

- Mechanical Method:

This method involves a sheet-metal sleeve that is placed over the repair area and expanded into place. The sleeve has locking tabs to prevent collapse once installed, and the portion of the sleeve in contact with the pipe is often coated with a hydrophilic chemical to seal leaks.

- Cure-in-place method:

The cure-in-place method involves an ambient temperature-cured resin, much like the cure-in-place liners. A clamp is placed over the repair and expanded into place with an air-filled bladder, which is left in place for a certain amount of time to allow the resin to cure.

- Chemical grout

Chemical Grout is usually made up of hydrophilic polymers that are injected into cracks and leaking joints. Specially designed remote-control devices, called packers, force the grout into the crack or joint.

B. MANHOLES:

Manholes are a necessary part of our collection system which allows for access so proper preventive and emergency maintenance can be provided. Manholes repairs are performed by entering the manhole and making the repairs or digging the manhole out to make the repairs.

Issues that require a dig out of the manhole:

- Total replacement
- Manhole boot to pipe repair or replacement
- Raise or lower a manhole
- Repairs to frame and cover

Issues that can be repaired by entering the manhole:

- Grouting
- Invert repairs
- Step repairs
- Leak repairs

Please see the following information for trenchless technologies rehabilitation methods:

1. Preformed Manhole Units - One-piece monolithic manhole unit that is made to be installed within an existing concrete, brick, or precast manhole.
2. Liners: Poured in Place Concrete - is a poured-in-place thick-wall, seamless concrete manhole liner that extends from the bench to the frame. After segmented, stackable steel forms are positioned into the manhole, concrete is carefully poured into the forms. When the concrete has sufficiently cured, the forms are disassembled and removed.
3. Liners: Cured in Place (C.I.P.) - a one-size fits-all liner made to fit all manhole types including barrel sections, eccentric and concentric cones constructed of brick and mortar, pre-cast, or block. The liner is usually constructed with polyester circular-knit which is vacuum impregnated with either a silicate or polyurethane resin depending on the application and is cured under pressure at ambient temperatures in about one hour.
4. Cementitious Coatings/Grouts - is a modified rapid setting cementitious mortar used for horizontal, vertical and overhead patching of concrete and masonry. The mortar is sprayed or hand trowel applied to minimum 1/2-inch thickness.
5. Polymer Based Coatings/Grouts - epoxy coating liners that protect concrete and steel surfaces in the wastewater industry, which can be applied by brush, roller, trowel or spray.
6. Mechanical Seals/Inserts – PVC, Stainless or HDPE insert installed between entry casting and precast concrete cones and flat top sections for a corrosion resistant and watertight connection.

SECTION X

COST OF REHABILITATION VS. COST OF TRANSPORTATION AND TREATMENT

The activities of this Administrative Order are the continuation of earlier activities. The wastewater treatment plant has a hydraulic capacity of thirty (30) million gallons per day (MGD). It has been previously determined that it is neither economically or environmentally sound for a large treatment facility to be constructed. Therefore, this analysis will review the treatment cost utilizing the existing treatment plant. The transportation cost will review the movement within the collection system (including pumping). The rehabilitation cost will also be compared to the cost of bigger transportation facilities.

SECTION XI

SCHEDULE OF PLANNED ACTIVITIES

A. MANHOLE INSPECTIONS

The City's resources are being used with some assistance from the consultant for field activities. The best time to perform manhole inspections is in the wet season. All manholes will be inspected by March 1, 2012.

B. SMOKE TESTING

This activity should only be done during times when the groundwater is at a low elevation. Wet soil does not allow smoke to move through easily; thus, during wet seasons, the quality of data will be suspect. It is the intent of the City to have the entire system tested by late fall of 2011. As a part of the previous program, a new round of testing began in late 2010.

The program will be executed on a sewershed basis. The 2010 activities tested most of the Emory Valley sewershed and a portion of the East Plant Sewershed. When the 2011 season arrives, those two sewersheds will be completed first.

It is planned to have at least three (3) crews in the field to complete all smoke testing before December 15, 2011.

C. CLOSED CIRCUIT TELEVISION (CCTV) INSPECTIONS

The City owns the equipment and has the manpower to have all the sewers less than fifteen (15") inches in diameter inspected during calendar 2011. Sewers greater than fifteen (15") inches in diameter will be inspected by contractors within the same schedule as the smaller pipe.

D. GEOGRAPHIC INFORMATION SYSTEM

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 above investigative work is performed, its data will be inputted into the GIS. Therefore, it is expected that by late winter 2011 – 2012, the GIS will be current as to the condition of the sewerage system.

Concurrently with the SSES activities as outlined in Section 16Biii of the Administrative Order, a Capacity Assessment study will be underway. As a part of those concurrent activities, flow measuring and rainfall data will be collected, entered into the GIS, and used in these system evaluation activities.

E. PUMPING STATION EVALUATIONS

All the stations will be inspected, data collected, and the condition evaluated by late summer of 2011.

F. FLOW MONITORING AND RAINFALL DATA COLLECTION

The City will acquire and install all necessary equipment ,as referenced earlier in this work plan, during the spring of 2011. The City has from past activities certain equipment with historical data which will be considered.

G COMPLETION OF EVALUATION SURVEY

The activities of the survey will be completed by early Spring 2012 (approximately April 15, 2012). Following the completed survey, the results will be submitted to the EPA within two (2) months (approximately June 15, 2012). All projected activities will be within the requirements of the Administrative Order.