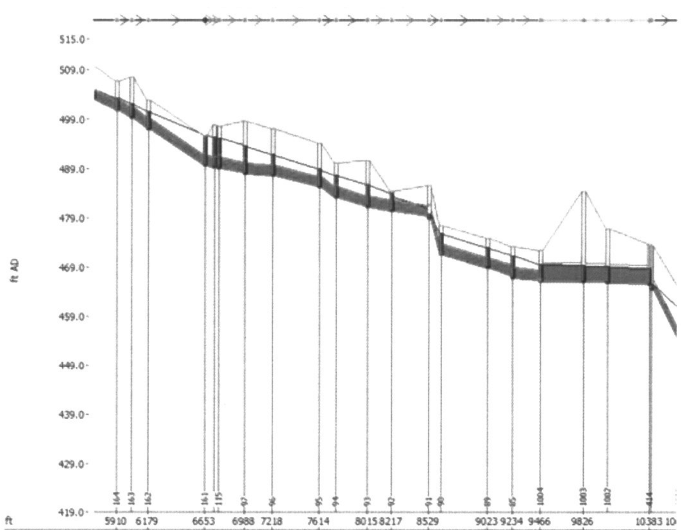
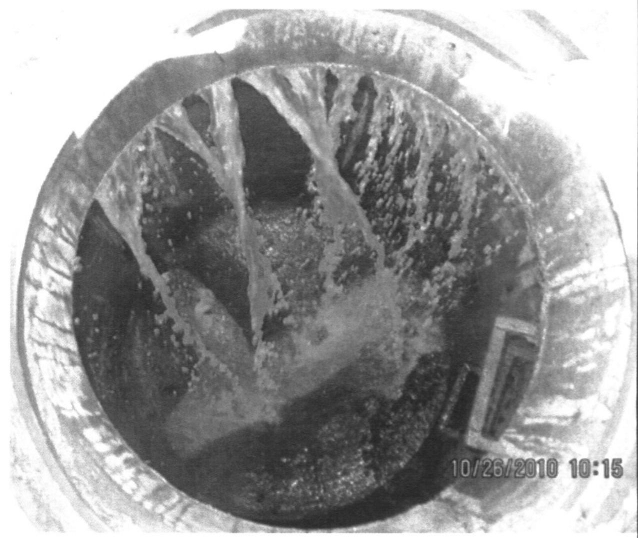
September 2011

System Evaluation Capacity Assurance Plan (SECAP) Phase II & III - Hot Springs, AR

Final Report

Hot Springs, Arkansas





prepared by

rjngroup

The Choice for Collection System Solutions

RJN Project Number
18-2341-01

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September 29, 2011

received
6, 1987

Mr. Larry Merriman
Utilities Project Manager
City of Hot Springs
111 Opera St.
Hot Springs, AR 71901

Subject: Sanitary Sewer Evaluation Study – Phase II & III Field Investigations and Hydraulic Capacity Analysis for the City of Hot Springs, Arkansas

Dear Mr. Merriman:

According to the December 16, 2008 Engineering Agreement, RJN is pleased to present this technical memorandum for the above referenced project.

This draft report includes the results of the field investigations, hydraulic capacity analysis, and recommendations completed during the study.

A summary of the recommendations is given in Table 1.

We appreciate the opportunity to work with the City of Hot Spring and the excellent cooperation from the City staff throughout the project. We look forward to continuing to work with the City of Hot Springs in the future. Should you have any questions, please call.

Very truly yours,
RJN GROUP, INC.

Dan Jackson

Daniel Jackson, P.E.
Project Manager

DJ/kb/18-2341-01
Enclosure

Table 6-E

SUMMARY OF RECOMMENDED IMPROVEMENT PLAN

Item	I/I Reduction Inflow[1/] (mgd)	I/I Reduction Infiltration (mgd)	Estimated Capital Cost[2/] Without I/I Reduction ($ Million)	Estimated Capital Cost[2/] With I/I Reduction ($ Million)
Manhole Rehabilitation (Priority 1)	5.601	1.461	7.022	7.022
Sewer Line Rehabilitation				
Point Repairs				
Priority 1	0.208	0.013	0.193	0.193
Priority 2	0.216	0.014	0.283	0.283
Complete Rehabilitation				
Priority 1	4.138	0.419	7.451	7.451
Priority 2	3.121	0.316	5.527	5.527
Inflow Removal[3/]				
Public Sector (Priority 1)	0.105	0.000	0.037	0.037
Private Sector (Priority 2)	10.405	0.000	2.313	2.313
Capacity Improvements				
Priority 1	N/A	N/A	47.340	27.629
Priority 2	N/A	N/A	28.557	25.175
New Grit Removal Chamber Davidson WWTP			2.300	2.300
Subtotal Priority 1			*62.043*	*42.332*
Subtotal Priority 2			*36.680*	*33.298*
Total	**23.794**	**2.223**	**101.023**	**77.930**

1/ *Based on projected 5-year/60-minute inflow.*

2/ *Includes estimated construction cost plus a 30 percent engineering service and contingency fee.*

3/ *It should be noted that interior building inspections were not included in this scope of services and that there are likely basement drains or sump pumps contributing I/I that were not identified during this study. An evaluation of the private grinder pumps was also not included in the scope of services for this project and are likely sources of I/I that were not identified.*

SANITARY SEWER EVALUATION STUDY WITH

HYDRAULIC CAPACITY ANALYSIS

PHASE II & III

TECHNICAL MEMORANDUM

CITY OF HOT SPRINGS, ARKANSAS

STATE OF ARKANSAS
REGISTERED PROFESSIONAL ENGINEER
No. 13978
DANIEL HUGH JACKSON

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

Date: 9/29/11 Registration No.: 13978

EXECUTIVE SUMMARY

RJN Group, Inc. was retained by the City of Hot Springs to perform a comprehensive Sanitary Sewer Evaluation and Capacity Assurance Plan (SECAP) with hydraulic capacity analysis. The purpose of this study was to identify I/I sources and develop a recommended plan for the elimination of those sources along with recommendations for capacity improvements across the City. The study consisted of field investigations, computer modeling for hydraulic capacity analysis and a plan to reduce I/I and improve the integrity and capacity of the system to remove wet-weather overflows.

The City of Hot Springs contains approximately 2,280,000 linear feet of gravity wastewater mains ranging in size from 6 inches to 48 inches in diameter. Along with the gravity mains exists an extensive pressurized system that includes approximately 290 pump stations, 1,200,000 linear feet of force mains, and over 3,000 grinder pumps. Field activities included:

- Manhole/visual pipe inspection
- GPS survey
- Smoke testing
- Dyed water testing
- TV inspection

Manhole/Cleanout Above and Below Ground Inspections

Manhole below ground and visual pipe inspections included the documentation of locations and an evaluation of the physical conditions of each structure. A total of 10,619 structures were physically inspected.

Smoke Testing/Rainfall Simulation

Smoke testing was performed across 83 percent of the gravity collection system. The portions of the gravity main that were not smoke tested were shown not to have excessive inflow or infiltration during the flow monitoring. Testing identified sources of inflow such as defective cleanouts, service laterals, main lines, storm sewer cross connections, area drains and downspouts. A total of 1,904,329 linear feet of sewer was inspected by smoke testing in the study area.

Dyed Water Flooding

Dyed water flooding was performed on potential main lines, cross connections, and manhole leaks to further pinpoint defect locations identified during smoke testing. A total of 419 dyed water tests were performed.

Television Inspection and Recommended Repairs

Closed circuit television inspection was attempted on 147,844 linear feet of the sewer system in the study area. TV inspection was used to identify the exact location of defects identified from smoke and dyed water testing and to document progressing defects.

Recommended repairs are summarized in Tables 5-C (point repairs) and Table 5-D (Complete line replacement). There are 93 point repairs and 97,723 linear feet of sewer pipe recommended for replacement.

GPS Survey and Mapping

GPS (Global Positioning System) survey was performed on 11,416 sewer manholes. Over 8,000 of the structures were measured to sub-centimeter level, while the remainder were surveyed to sub-meter level.

Mapping corrections were made on all sewer manholes and sewer lines within the study area.

Hydraulic Modeling

A hydraulic capacity analysis was performed on the entire gravity and pressurized system in Hot Springs. Included in this complex hydraulic model were 2.3 million linear feet of gravity mains, 1.2 million linear feet of force mains, over 290 pump stations, and over 3,000 grinders pumps. There were 41 gravity line segments (12,303 lf) 6 force mains (65,445 lf), and 8 pump stations recommended for capacity improvements. This was based on a 2-year design storm and the criteria where overloading of the sewer lines occur when the hydraulic gradient results in a sanitary sewer overflow (SSO).

Recommended Improvement Plan

Financial restraints, coupled with the complexity of the sanitary system led to recommendations built around several parameters. First, solutions were derived to eliminate only the reported overflows and were assigned "Priority 1". These ranged from inflow/infiltration removal projects, limited gravity sewer up-sizing, force main upgrades, and increased capacity at several pump stations. Priority 1 was further broken down to look at costs associated with the City undergoing inflow/infiltration projects and limited capacity improvements and also evaluated without any reduction in inflow/infiltration and only increasing capacities.

Next, solutions were developed for "Priority 2" improvements. These address areas which exhibit excessive surcharging during the design rain event. Priority 2 improvements were also evaluated by reducing inflow/infiltration with limited capacity enhancements and also with no reduction in inflow/infiltration and only capacity projects.

Third, solutions were developed for "Modeled/ Un-Verified" overflows. These were locations that the hydraulic model predicted overflows would occur during the design storm, however no documented overflow had been recorded. These locations need to be studied to see if indeed an overflow does occur. If so, then recommended solutions for these locations have been developed and are described in Chapter 4.

Below is a table which summarizes the recommended "Priority 1" and "Priority 2" solutions:

Table 6-E

SUMMARY OF RECOMMENDED IMPROVEMENT PLAN

	I/I Reduction			
Item	**Inflow[1/] (mgd)**	**Infiltration (mgd)**	**Estimated Capital Cost[2/] Without I/I Reduction ($ Million)**	**Estimated Capital Cost[2/] With I/I Reduction ($ Million)**
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CHAPTER 1

INTRODUCTION

This report is a supplement to the Hot Springs City-Wide Flow Monitoring Report dated August 2009. The flow monitoring determined that several basins had excessive I/I and were recommended for intensive field investigation to identify specific I/I sources. This Phase 2 supplemental report addresses the results of the field investigations and hydraulic capacity analysis of the Hot Springs sanitary sewer collection system.

OVERVIEW

The Sanitary Sewer Evaluation Study or SSES is a cost-effective method to evaluate the condition of sanitary sewer lines and access structures using various intensive field procedures and data analysis. Due to aging infrastructure, the sanitary collection system in the City of Hot Springs is susceptible to I/I or extraneous flow entering the system which can be excessive, expensive to treat, and contribute to wet-weather overflows.

Infiltration and Inflow may enter the sanitary sewer system during moderate storm events. Infiltration occurs when groundwater enters sewer lines and manholes. Inflow occurs when storm water runoff enters the sanitary sewer system through both public sector and private sector sources. These sources include cross connections with storm sewers, main line defects, vented manhole covers, defective frame seals, defective cleanouts, and direct connections to the sanitary sewer from downspouts and/or area drains.

Field investigations and analyses performed during this project included the following:

1. Manhole and Visual Pipe Inspection
2. Smoke Testing
3. Dyed Water Flooding
4. System Wide Mapping Updates
5. Television Inspection
6. Hydraulic Modeling
7. Data Analysis

DESCRIPTION OF THE STUDY AREA

The City of Hot Springs consists of 23 drainage basins. These drainage basins were divided into 65 meter basins for the 2009 Flow Monitoring Study and used during the Sanitary Sewer Evaluation Study. There are an estimated 12,114 manholes and 2,283,467 linear feet of sewer pipe in Hot Springs. Hot Springs has an extensive pressurized sewer system with approximately 290 pump stations, one (1) million feet of force mains, and over 3,000 grinder pumps located throughout the City. The following is a brief description of each drainage basin:

Mazarn

This drainage basin consists of 615 structures, and approximately 111,697 linear feet of gravity sewer and 216,910 linear feet of force mains. This drainage basin was sub-divided into 6 meter basins; HS01, HS02, HS03, HS59A, HS59B, and HS60.

Fairwood

This drainage basin consists of 1,040 structures, and approximately 206,854 linear feet of gravity sewer and 95,447 linear feet of force mains. This drainage basin was sub-divided into 4 meter basins; HS04, HS05, HS06, and HS08.

Hot Springs Creek

This drainage basin consists of 4,769 structures, and approximately 898,329 linear feet of gravity sewer and 67,644 linear feet of force mains. This drainage basin was sub-divided into 21 meter basins; HS14, HS16, HS17, HS32, HS33, HS34, HS35, HS36, HS38, HS39, HS40, HS42, HS43, HS44, HS45, HS46, HS49A, HS49B, HS50, HS58, and HS62.

HWY 270

This drainage basin consists of 79 structures, and approximately 10,617 linear feet of gravity sewer and 19,772 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS62.

Halteria

This drainage basin consists of 93 structures, and approximately 11,488 linear feet of gravity sewer and 17,691 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS58.

Port Au Prince

This drainage basin consists of 74 structures, and approximately 9,618 linear feet of gravity sewer and 18,881 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS58.

2nd Street

This drainage basin consists of 39 structures, and approximately 8,318 linear feet of gravity sewer and 104 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS58.

Molly Creek

This drainage basin consists of 289 structures, and approximately 47,440 linear feet of gravity sewer and 12,926 linear feet of force mains. This drainage basin was sub-divided into 4 meter basins; HS41, HS63, HS64, and HS65.

Hogan Creek

This drainage basin consists of 106 structures, and approximately 19,138 linear feet of gravity sewer and 5,825 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS61.

Hot Springs #2

This drainage basin consists of 323 structures, and approximately 54,968 linear feet of gravity sewer and 59,799 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS11.

Hot Springs #3
This drainage basin consists of 492 structures, and approximately 92,814 linear feet of gravity sewer and 176,580 linear feet of force mains. This drainage basin was sub-divided into 3 meter basins; HS09, HS10, and HS11.

Hot Springs #4
This drainage basin consists of 332 structures, and approximately 61,430 linear feet of gravity sewer and 46,168 linear feet of force mains. This drainage basin was sub-divided into 2 meter basins; HS47 and HS48.

Beverly Hills
This drainage basin consists of 43 structures, and approximately 10,611 linear feet of gravity sewer and 1,058 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS51.

Gulpha
This drainage basin consists of 2,329 structures, and approximately 451,533 linear feet of gravity sewer and 58,034 linear feet of force mains. This drainage basin was sub-divided into 15 meter basins; HS14, HS18, HS19, HS20, HS21, HS22, HS23, HS 24, HS25, HS26, HS27, HS28, HS29, HS30, and HS31.

Belvedere
This drainage basin consists of 52 structures, and approximately 10,735 linear feet of gravity sewer and 2,623 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS14.

Malvern Hwy
This drainage basin consists of 137 structures, and approximately 22,492 linear feet of gravity sewer and 13,768 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS13.

Wilson Mill
This drainage basin consists of 281 structures, and approximately 49,099 linear feet of gravity sewer and 30,754 linear feet of force mains. This drainage basin was sub-divided into 2 meter basins; HS12, and HS13.

Catherine Heights
This drainage basin consists of 329 structures, and approximately 69,020 linear feet of gravity sewer and 26,822 linear feet of force mains. This drainage basin was sub-divided into 3 meter basins; HS31, HS54, and HS57.

Carpenter Dam
This drainage basin consists of 221 structures, and approximately 41,473 linear feet of gravity sewer and 61,102 linear feet of force mains. This drainage basin was sub-divided into 2 meter basins; HS54 and HS56B.

Red Oak Ridge
This drainage basin consists of 87 structures, and approximately 16,429 linear feet of gravity sewer and 14,644 linear feet of force mains. This drainage basin was sub-divided into 1 meter basin; HS56A.

Hot Springs #1
This drainage basin consists of 108 structures, and approximately 17,157 linear feet of gravity sewer and 8,474 linear feet of force mains. This drainage basin was sub-divided into 3 meter basins; HS49B, HS51, and HS54.

Lakeside
This drainage basin consists of 92 structures, and approximately 19,271 linear feet of gravity sewer mains. This drainage basin was sub-divided into 1 meter basin; HS54.

Farrs Landing
This drainage basin consists of 87 structures, and approximately 19,129 linear feet of gravity sewer and 96,300 linear feet of force mains. This drainage basin was not sub-divided into a meter basin due to the lack of an ideal flow meter location.

Several meter basins overlapped with multiple drainage basins due to size or ideal flow monitoring locations. Therefore, for the purpose of this report several drainage basins had to be combined for comparison purposes relative to the flow analysis. Figure 1.1 is a key map showing the locations for all drainage basins. Exhibits 1 to 16 depict each drainage basin's boundary lines in more detail.

PROJECT APPROACH

The project approach for the City of Hot Springs Wastewater System Evaluation included prioritization of the basins based on City-wide flow monitoring and conducting field investigations starting with those basins that had the highest unit inflow rates, and then developing a recommended plan to reduce I/I and improve efficiency of the wastewater collection system utilizing hydraulic modeling. The key to a successful project is planning, foresight, and experience. The project team employed the following project approach for cost-effective results:

Field Investigations:

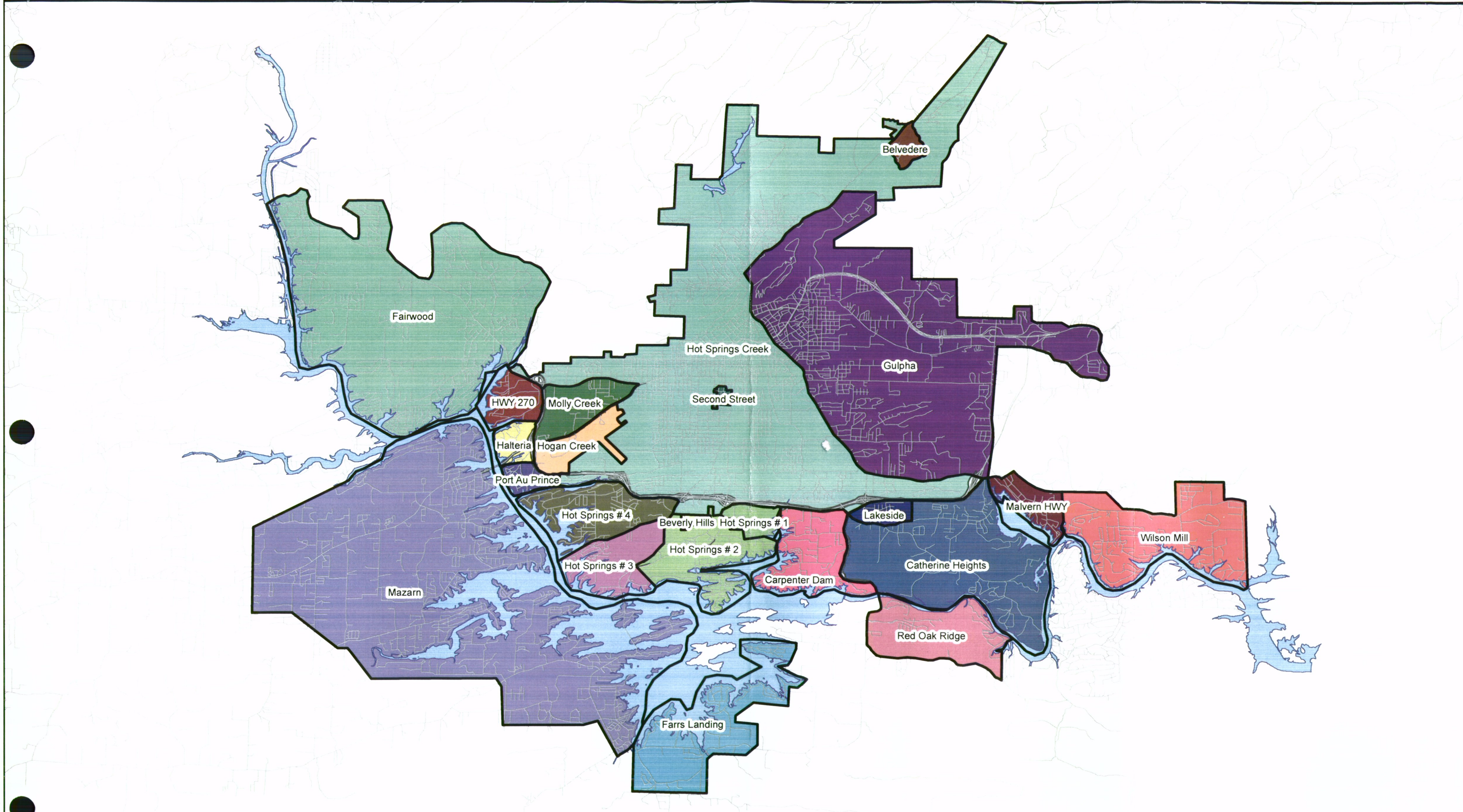
1. Manhole and Visual Pipe Inspections
2. Smoke Testing (57 of the 65 meter basins)
3. Dye Testing
4. System Wide Mapping Updates
5. Television Inspection

Hydraulic Modeling:

Modeling was performed on all diameter pipes (i.e. 6 inches and greater) for the following conditions:

1. Peak Dry And Wet-Weather Conditions
2. Design Storm – 5-Year/24-Hour

CITY OF HOT SPRINGS, AR



Legend

Belvedere, Beverly Hills, Carpenter Dam, Catherine Heights, Fairwood, Farrs Landing, Gulpha, HWY 270, Halteria, Hogan Creek, Hot Springs # 1, Hot Springs # 2, Hot Springs # 3, Hot Springs # 4, Hot Springs Creek, Lakeside, Malvern HWY, Mazarn, Molly Creek, Port Au Prince, Red Oak Ridge, Second Street, Wilson Mill

rjngroup

The Choice for Collection System Solutions

HOT SPRINGS NATIONAL PARK ARKANSAS

DRAINAGE BASIN LOCATI
KEY MAP
FIGURE 1.1

Data Analysis and Recommendations:

The recommended plan was formulated after carefully reviewing the results derived from the field investigation results and consists of the following: Recommendations for capacity improvements will be submitted with the final report.

1. Recommended I/I Removal
2. Manhole Rehabilitation
3. Line Replacements and Point Repairs
4. Cost to Implement the Recommended Plan

DEFINITIONS AND ABBREVIATIONS

This section contains definitions and abbreviations commonly used throughout this report.

(1) Infiltration (as defined by USEPA) - the water entering a sewer system and service connections from the ground through such means as, but not limited to, defective pipes, pipe joints, service connections, service laterals, or manhole walls.

(2) Inflow (as defined by USEPA) - the water discharged into a sewer system, including service connections, from such sources as roof leaders; cellar, yard, and area drains; foundation drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers, combined sewers, or catch basins; storm waters; surface runoff; or drainage.

(3) Excessive Infiltration and Inflow (I/I) - the extraneous clean water that enters the sanitary sewer system which can be eliminated on a cost-effective basis.

(4) Base Flow - wastewater flow exclusive of infiltration or inflow. Generally determined from water records during months when most of the water consumption is returned to the wastewater collection system.

(5) Permanent Infiltration - extraneous flow that enters the sewer system through the ground during periods of dry weather/low groundwater. Generally determined by subtracting base flow during winter months from the average daily dry-weather monitored flow.

(6) Peak Infiltration - the maximum extraneous flow that enters the wastewater collection system during high groundwater conditions after the inflow effects of a rain event have ended. Generally determined by subtracting dry-weather/low-groundwater flow (average daily dry-weather monitored flow) from flow recorded during periods of high groundwater.

(7) Average Daily Dry-Weather Flow - dry-weather/low-groundwater flow exclusive of dry-weather/high-groundwater (peak infiltration) and wet-weather (inflow) flow. Includes base flow and permanent infiltration only.

(8) Average Daily Dry-Weather Flow Peaking Factor - the ratio between the peak hourly flow rate and the average daily flow.

(9) 1-Year/60-Minute Storm - a storm event that produces 1.55 inches of rain per hour in the Hot Springs, Arkansas area and is expected to occur once in any given year.

(10) 5-Year/60-Minute Storm - a storm event that produces 2.32 inches of rain per hour in the Hot Springs, Arkansas area and has a 20 percent probability of occurring in a given year.

(11) Design Storm Event - a storm event selected for purposes of analyzing its effect on the wastewater collection system.

(12) gpd - gallons per day.

(13) mgd - million gallons per day.

(14) idm - inch-diameter-miles. The product of sewer pipe diameter in inches and length of sewer in feet divided by 5,280 feet.

(15) gpd/idm - gallons per day per inch-diameter-mile.

(16) Surcharge Condition – When the sewer flow depth equals or exceeds the diameter of the discharging sewer lines. (WEF Manual of Practice FD-6)

(17) Infiltration and Inflow (I/I) – A combination of infiltration and inflow wastewater volume in sanitary sewer.

CHAPTER 2

FIELD INVESTIGATION

RJN conducted sanitary sewer investigation activities throughout the City of Hot Springs. The objective was to identify and quantify sources of infiltration and inflow (I/I), identify sewer maintenance problems, and recommend a rehabilitation plan to reduce I/I and improve the overall efficiency of the collection system. Field investigation activities included the following:

1. Manhole and Visual Pipe Inspections
2. GPS Location taken for all Manholes
3. Rainfall Simulation
    a. Smoke Testing (57 of the 65 meter basins)
        i. Identification of Public Defects
        ii. Identification of Private Defects
    b. Dye Testing
        i. Potential Mainline/Storm Sewer Connections
        ii. Manhole Defects
4. Television Inspection (Defects identified from smoke testing and visual pipe)

Manhole and visual pipe inspection occurred throughout the City along with sub-centimeter or sub-meter global positioning of all manholes. Rainfall simulation or smoke testing occurred across 87 percent of the collection system. Meter Basins HS09, HS10, HS20, HS25, HS30, HS38, HS44, and HS48 totaling 292,782 linear feet were not tested. This was due to low infiltration and inflow recorded during Phase I – Flow Monitoring.

MAPPING

City of Hot Springs staff provided GIS data of the wastewater collection system at the initiation of the study. This included manholes, sewer lines, pump stations, and force mains. The locations of the assets had been populated using an array of methods from survey, to as-builts, to hand drawn maps.

All manholes that were located, 11,416, were surveyed. There were 797 manholes surveyed that were not inspected due to seized covers, manholes that were found by survey crews and not inspection crews, or locations that were inaccessible. This consisted of sub-centimeter accuracy from X, Y, and Z coordinates for all manholes on 10-inch and larger diameter sewer lines. This level of accuracy was needed in order to construct an accurate hydraulic model of the collection system. Structures on sewer lines less than 10-inches were surveyed to sub-meter accuracy for X and Y coordinates. However, it should be noted that 6,687 of the 10,173 manholes that were on sewer lines less than 10-inch in diameter were surveyed to the sub-centimeter level.

All structures and gravity sewer mains were revised based on position and configuration utilizing the survey. In addition, all manholes found during field investigations that were not shown on existing maps were assigned new nomenclature and added to the GIS.

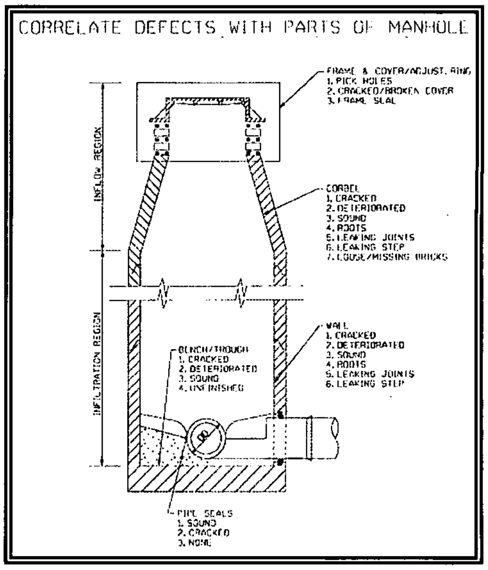
The attribute tables within the GIS files were also updated with field inspection data such as, inspection date, wall construction type, and manhole rim to invert depth. The updated GIS and layer files have been received by the City.

FIELD INVESTIGATIONS

MANHOLE AND VISUAL PIPE INSPECTIONS

Manhole and visual pipe inspection is that part of the survey where the physical condition of the sewer system is visually evaluated.

These inspections verified manhole location, pipe size, line segment continuity, and evaluated manhole and adjacent pipe condition. A sectional elevation of a typical manhole is shown on the right.



Manhole Inspections

The manhole/cleanout inspection procedure included recording the following observations:

1. Location and identification number
2. Potential for ponding or sheeting on manhole cover
3. Cover type, fit, description, distance above or below grade, evidence of inflow
4. Frame adjustment, seal, evidence of inflow
5. Corbel construction, condition, evidence of inflow
6. Wall construction, condition, evidence of infiltration
7. Bench/trough construction, condition, deposition, evidence of infiltration
8. Pipe seal condition, evidence of infiltration
9. Step condition
10. Manhole inside diameter
11. Surcharging or evidence of surcharging
12. Indication of groundwater infiltration

Inspections were performed on 10,619 of the 12,114 manholes (87.7 percent). Access structures not inspected included buried, not found, and inaccessible structures. Partial inspections were performed on any surcharged manholes. Manholes that were not inspected are indicated on the manhole information report included in Appendix A. An access structure inspection summary is given in Table 2-A, while a summary of manhole defects is given in Table 2-B.

Table 2-A

ACCESS STRUCTURE INSPECTION SUMMARY

Drainage Basin(s)	Total Structures	Inspected Structures	Not Inspected		
			Not Found Structures	Buried Structures	Inaccessible Structures
Mazarn	611	582	15	3	11
Fairwood	1,044	950	74	7	13
Hot Springs Creek, Hwy 270, Halteria, Port Au Prince	4,086	3,703	236	85	62
2nd Street	37	35	1	1	0
Molly Creek	735	647	53	19	16
Hogan Creek	120	102	13	4	1
Hot Springs #2, Hot Springs #3	719	646	51	12	10
Hot Springs #4	509	421	77	8	3
Beverly Hills	148	128	20	0	0
Gulpha, Belvedere	2,703	2,279	298	66	60
Malvern Hwy, Wilson Mill	419	322	41	47	9
Catherine Heights	160	127	12	11	10
Carpenter Dam	59	49	2	5	3
Red Oak Ridge	61	56	2	3	0
Hot Springs #1, Lakeside	599	487	64	39	9
Farrs Landing	104	85	3	6	10
Total	**12,114**	**10,619**	**962**	**316**	**217**

Table 2-B

SUMMARY OF MANHOLE DEFECTS

Drainage Basin(s)	Inflow: Cover Missing Bolts	Inflow: Cover with Pick Holes	Inflow: Defective Frame Seal	Inflow: Broken Frame	Inflow: Rim Leaks	Inflow: Defective Corbel	Infiltration: Defective Manhole Walls	Infiltration: Pipe Seals	Infiltration: Defective Bench/Trough
Mazarn	1	3	86	14	21	35	76	45	0
Fairwood	0	33	73	21	48	21	54	94	6
Hot Springs Creek, HWY 270, Halteria, Port Au Prince	16	1,004	756	112	119	804	902	513	56
2nd Street	0	14	31	0	0	16	15	18	3
Molly Creek	1	51	124	13	30	18	47	60	1
Hogan Creek	4	7	8	3	4	5	11	12	0
Hot Springs #2, Hot Springs #3	0	19	76	10	57	45	84	65	2
Hot Springs #4	0	54	57	4	16	14	25	38	0
Beverly Hills	0	30	18	4	11	29	24	12	0
Gulpha, Belvedere	2	483	303	44	142	251	310	283	25
Malvern HWY, Wilson Mill	0	4	9	7	23	13	11	22	0
Catherine Heights	0	14	17	2	5	1	4	15	0
Carpenter Dam	0	0	3	0	2	5	7	2	0
Red Oak Ridge	0	0	3	0	4	0	1	0	0
Hot Springs #1, Lakeside	1	44	37	12	23	8	27	37	1
Farrs Landing	0	0	4	1	7	2	6	4	0
Totals	**25**	**1,760**	**1,605**	**247**	**512**	**1,267**	**1,604**	**1,220**	**94**

Manhole inspection resulted in the identification of approximately 3.470 mgd of 1-year inflow and 1.474 mgd of infiltration. Major sources identified included defective frame seals, wall leaks, pick holes, and corbel leaks.

The largest contributor of manhole related inflow for this project was covers with pick holes. Field investigations identified 1,760 covers with pick holes contributing approximately 1.685 mgd.

Wall defects are a main source of infiltration. Field investigations identified 1,604 structures with wall cracks and/or leakage contributing approximately 0.668 mgd. Many of these defective manholes have root growth through the wall or pipe seals.

A total of 817 manholes located throughout the study area indicated evidence of surcharging. These manholes along with other field inspection results are shown on Exhibits 17 to 40. A detailed manhole inspection report is included in Appendix A.

Visual Pipe Inspections

Visual pipe inspection was also performed as part of the manhole inspection program with the following observations recorded:

1. Manhole identification numbers for connecting sewer lines
2. Flow direction in pipes
3. Pipe diameter and construction material
4. Amount of root growth
5. Amount and type of deposition
6. Structural condition and line/grade of pipe
7. Visible infiltration in pipe and/or from pipe seals
8. Depth from manhole rim to each pipe invert
9. Recommended method of cleaning
10. Depth and velocity of flow

Visual pipe inspection verifies pipe diameter, continuity, and aids in identifying pipe defects near the collection system access structures. Sewer lines in Hot Springs are primarily constructed of PVC with some areas of vitrified clay and concrete. The visual pipe inspections revealed 420 broken or cracked segments. Sewer lines that had visual inspection defects were places on the television inspection schedule. A computer output report listing the findings of the visual pipe inspections is given in Appendix B.

RAINFALL SIMULATION

A major field task in sewer system evaluation studies is locating infiltration and inflow sources by rainfall simulation. Types of infiltration and inflow sources identified by rainfall simulation include the following:

1. Roof downspouts, yard, and area drains
2. Defective building sewers, faulty connections, and defective cleanouts
3. Cross connections between sanitary sewers and storm sewers (indirect or direct)
4. Storm sewer sections, stream sections, ditch sections, and ponding areas which may cause infiltration and inflow
5. Structurally damaged sewers and manholes

Rainfall simulation can also be utilized with flow measurements to quantify infiltration and inflow from identified sources. Rainfall simulation techniques include smoke testing and dyed water flooding.

SMOKE TESTING

Smoke testing is a quick method for detecting infiltration and inflow sources in a sanitary sewer system. This method is very effective in detecting sources such as roof downspouts, yard and area drains, defective building sewers, faulty connections, defective cleanouts, and storm sewer cross connections. It can also be utilized during dry weather periods to detect inflow sources in the sewer main. During testing, observations are recorded by line segment as follows:

1. Location of line segment
2. Location of observed smoke leaks recorded at the:
    a. Curb
    b. Sidewalk
    c. Cleanout
    d. Building lateral; front, side or rear yard
    e. Driveway or area drain
    f. Downspout
    g. Building interior (resident must inform inspector)
3. Location of smoke observed from stormwater conveyance systems
4. Location of smoke along a main sewer line

A total of 2,928 potential sources of I/I were identified from the 1,904,329 linear feet of sewer lines that were smoke tested. As mentioned previously, only meter basins that demonstrated excessive I/I from the 2009 flow monitoring project were smoke tested. A total of 2,544 sources identified are from the private sector, while 384 sources are from the public sector. Smoke testing investigations identified 188 possible main line leaks, 155 catch basins, 11 defective cleanouts, and 30 building laterals as public I/I sources. Public building laterals are defined as potential building lateral leaks identified inside the edge of pavement or right-of-way. Private I/I sources included 1,216 defective cleanouts, 25 area drains, 10 downspouts, and 1,293 building laterals. These sources are represented in the pie chart on page 2-8 and accounted for by drainage basin in Table 2-C. A summary of Public and Private Sector defect totals is shown in Table 2-D.

Table 2-C

SMOKE TEST DATA

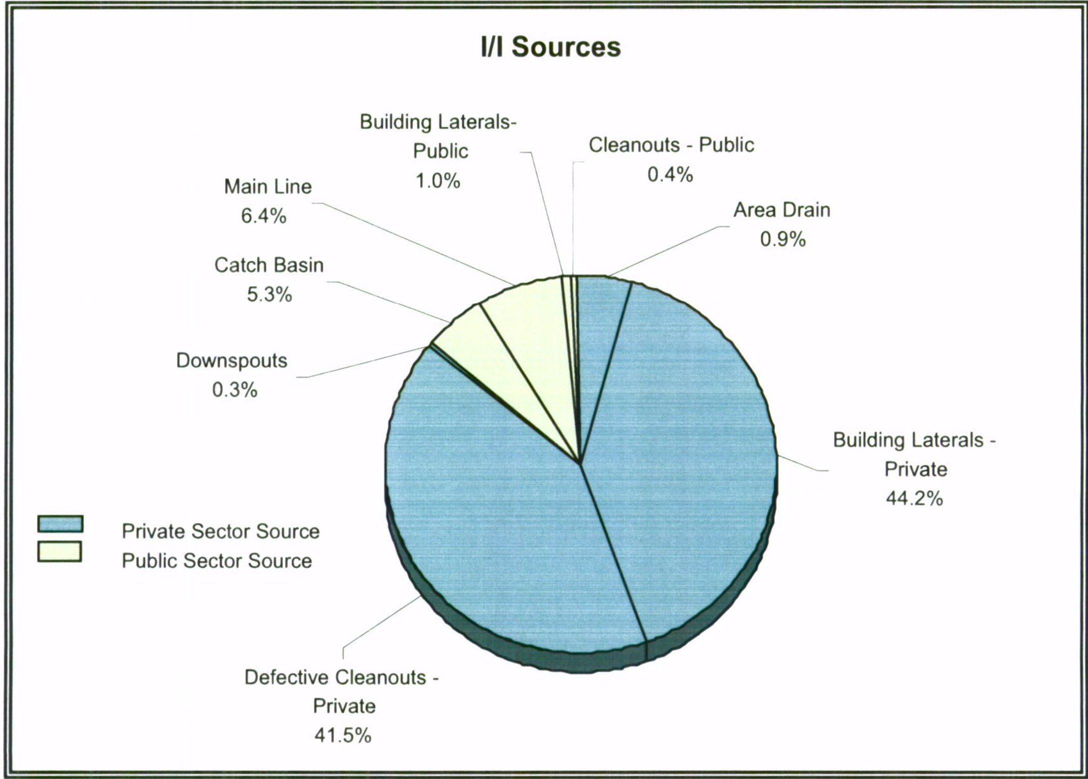
	Public Sector				*Private Sector*			
Basin	**Catch Basin**	**Possible Mainline**	**Building Lateral**	**Cleanout**	**Area Drain**	**Building Lateral**	**Cleanout**	**Downspouts**
Mazarn	0	0	0	1	0	17	53	0
Fairwood	0	3	0	0	2	39	147	0
Hot Springs Creek, HWY 270, Halteria, Port Au Prince	134	145	30	10	15	937	609	4
2nd Street	2	1	0	0	0	16	14	0
Molly Creek	2	0	0	0	0	24	50	1
Hogan Creek	0	1	0	0	1	4	4	0
Hot Springs #2, Hot Springs #3	1	0	0	0	2	14	21	0
Hot Springs #4	0	1	0	0	0	21	30	1
Beverly Hills	2	3	0	0	0	18	8	0
Gulpha, Belvedere	14	29	0	0	3	638	207	3
Malvern HWY, Wilson Mill	0	0	0	0	2	35	40	0
Catherine Heights	0	1	0	0	0	0	5	0
Carpenter Dam	0	1	0	0	0	0	8	0
Red Oak Ridge	0	0	0	0	0	0	1	1
Hot Springs #1, Lakeside	0	0	0	0	0	5	19	0
Farrs Landing	0	3	0	0	0	0	0	0
Total	**155**	**188**	**30**	**11**	**25**	**1,293**	**1,216**	**10**

Table 2-D

SUMMARY OF SMOKE TEST DATA

Type of Source	Quantity
Public Sector	
Catch Basin	155
Possible Main Line	188
Building Lateral	30
Cleanout	11
Subtotal	384
Private Sector	
Area Drain	25
Private Building Lateral	1,293
Private Cleanout	1,216
Downspouts	10
Subtotal	2,544
Total	**2,928**

A computer output report listing the findings of the smoke testing program is given in Appendix C.

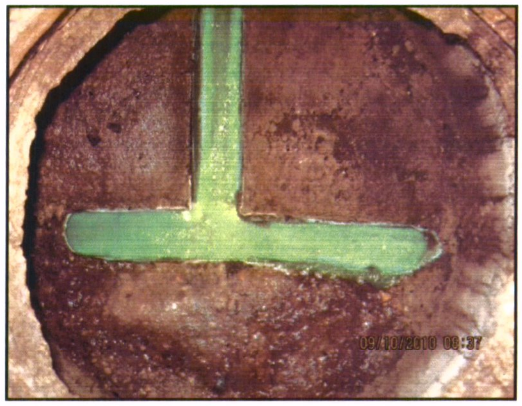


PUBLIC SECTOR DYED WATER TESTING

Public sector dyed water flooding was performed on potential main line and cross connection defects identified during smoke testing. In addition, more severe manhole defects located in areas subjective to ponding underwent dye testing. This was used to more accurately identify and quantify public sector inflow sources. A total of 192 dyed water flooding tests were performed on potential mainline or cross connections to storm drainage. One hundred twenty-one (121) were positive (63 percent). Of the 155 catch basins identified during smoke testing, 53 of them were unable to be dye tested due to the catch basin not being able to be safely plugged, no hydrant or ability to flood catch basin adequately, or the storm water system is deeper than the sewer system. A total of 215 manhole dye tests were conducted with 183 positive (85 percent).

The line segments that tested positive for dye the first time were added to a list for television inspection with concurrent dye in order to attempt to locate the source of possible smoke defects. Those that were negative or unable to dye test were added to a list to be televised to determine the condition of the line.

Dye from manhole defect



Dye from a main line defect

A summary of the dye water testing is included in Table 2-E. A computer output report listing the positive results of the dyed water testing is given in Appendix D.

TELEVISION INSPECTION

RJN reviewed the data collected during field investigations and identified approximately 147,844 linear feet of sewer line for television inspection and video review. Selections were based on known problem areas as well as defects identified during visual pipe inspection and smoke testing. Of the 147,844 linear feet of sewer lines that was identified, 143,273 linear feet were televised. This was due to the camera being blocked from one or both directions, or manholes that were not found. The recommendations can be found in Tables 5-A through 5-B in Chapter 5.

Table 2-E

PUBLIC SECTOR DYED WATER FLOODING

Basin	Catch Basin		Downspout		Mainline		Manhole		Total Dye Tests by Basin
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
Mazarn	0	0	0	0	0	0	18	7	**25**
Fairwood	0	0	0	0	1	1	25	0	**27**
Hot Springs Creek, HWY 270, Halteria, Port Au Prince	55	29	0	3	38	29	71	6	**231**
2nd Street	0	1	0	0	1	0	0	0	**2**
Molly Creek	1	2	0	0	0	0	4	3	**10**
Hogan Creek	0	0	0	0	1	0	3	1	**5**
Hot Springs #2, Hot Springs #3	0	0	0	0	0	0	6	1	**7**
Hot Springs #4	0	0	0	0	0	1	1	2	**4**
Beverly Hills	1	0	0	0	0	1	4	0	**6**
Gulpha, Belvedere	9	4	0	2	11	7	34	8	**75**
Malvern HWY, Wilson Mill	0	0	0	0	1	0	6	2	**9**
Catherine Heights	0	0	0	0	1	0	0	0	**1**
Carpenter Dam	0	0	1	0	0	1	1	0	**3**
Red Oak Ridge	0	0	0	0	0	0	0	0	**0**
Hot Springs #1, Lakeside	0	0	0	0	2	0	10	2	**14**
Farrs Landing	0	0	0	0	0	0	0	0	**0**
Total Defects	**66**	**36**	**1**	**5**	**56**	**40**	**183**	**32**	**419**

CHAPTER 3

I/I Source Analysis

Determination of Inflow

Inflow in a sanitary sewer system is defined as extraneous flow that is a direct result of stormwater runoff. Inflow may enter the sanitary sewer system through directly connected downspouts, area drains, cleanouts, and building sewers. Inflow may also enter the system through direct or indirect connections between the sanitary sewers and storm drains or ditches, sewer line defects, and through defective manhole covers, frame seals, corbels and manhole walls.

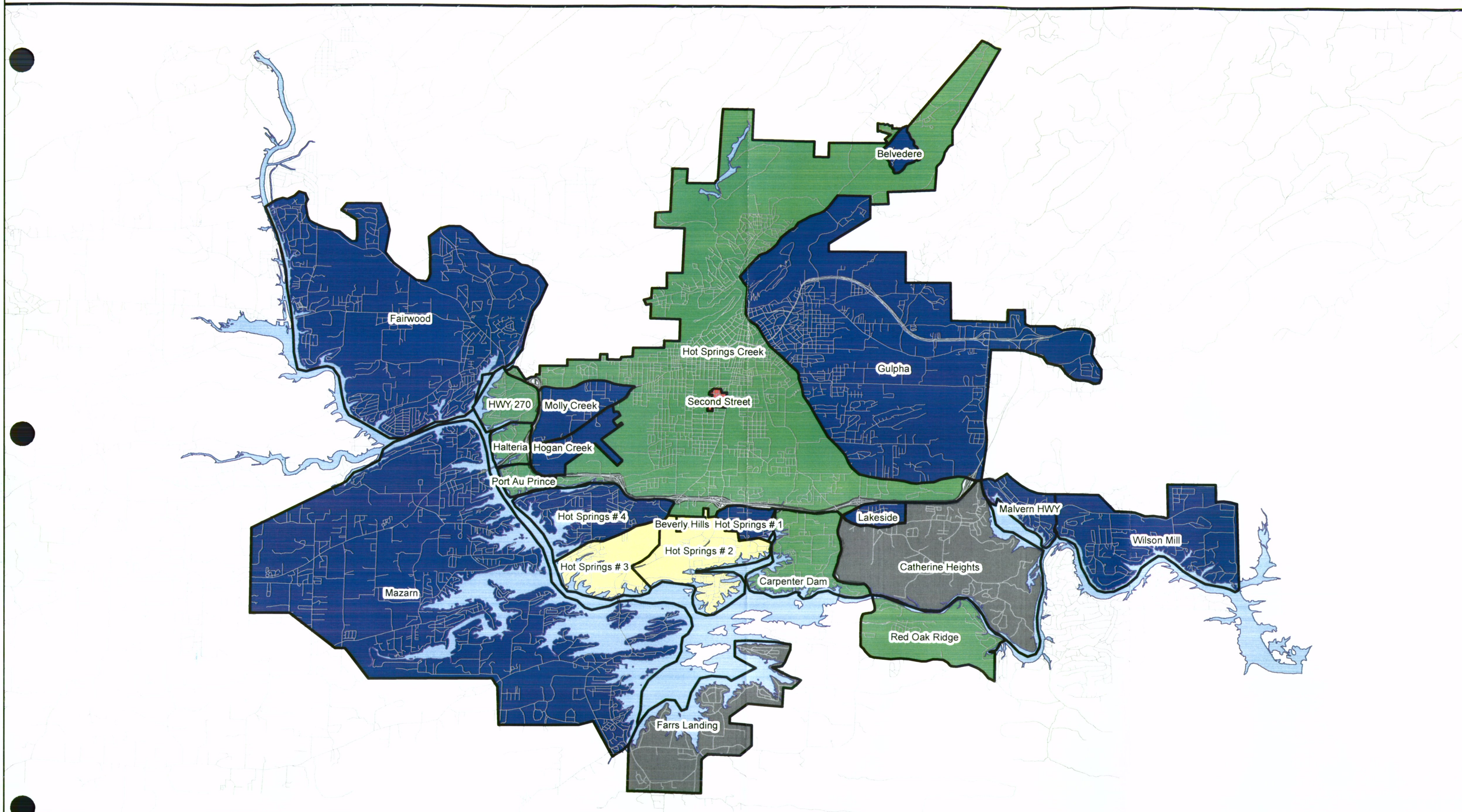
During the flow monitoring project, inflow projections were derived using the Q vs I method. For reference, Figure 3.1 shows unit inflow expressed in gallons per day per 1,000 linear feet of sewer depicting the relative magnitude of peak inflow amongst drainage basins.

Inflow Source Quantification

All inflow sources identified during manhole inspections and rainfall simulation were evaluated and quantified. Quantification of individual sources was based on a 1-year/60-minute storm and calculated using the orifice equation and rational formula. These two methods account for drainage area, grading, and surcharge type to produce an inflow rate. The summary of inflow identified by source type is given in Table 3-A and shown graphically on page 3-4.

In some drainage basins the inflow identified cannot be directly related to the field investigations due to the fact that only the gravity sewer system was investigated. Pump stations and grinder pumps were not investigated and the large number of grinder pumps are a likely source of I/I. In addition interior building inspections were not performed and therefore any likely basement drains or sump pumps were not identified as possible inflow sources. Any inflow or infiltration entering the system at those locations was not accounted for in this study however would be accounted for in the flow monitoring analysis. In addition, eight (8) of the sixty-five (65) basins were not smoke tested based on flow analysis. These eight metered basins were located in the following drainage sewersheds: Hot Springs Creek, Hot Springs #3, Hot Springs #4, and Gulpha. The extensive pressurized system and small portion of the sewer lines that were not smoke tested will lead to a lower percentage of identified inflow and infiltration typically discovered during a SSES. In particular, drainage basins that have a small number of grinder pumps had a higher percentage of identified inflow found. Drainage basins that have a high number of grinder pumps had a lower percentage of identified inflow discovered.

CITY OF HOT SPRINGS, AR



Legend

- N/A
- < 10,000
- 10,000 - 20,000
- 20,000 - 30,000
- 30,000 - 40,000
- > 40,000

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DRAINAGE INFLOW RATE
(GPD/1,000 FT)
FIGURE 3.1

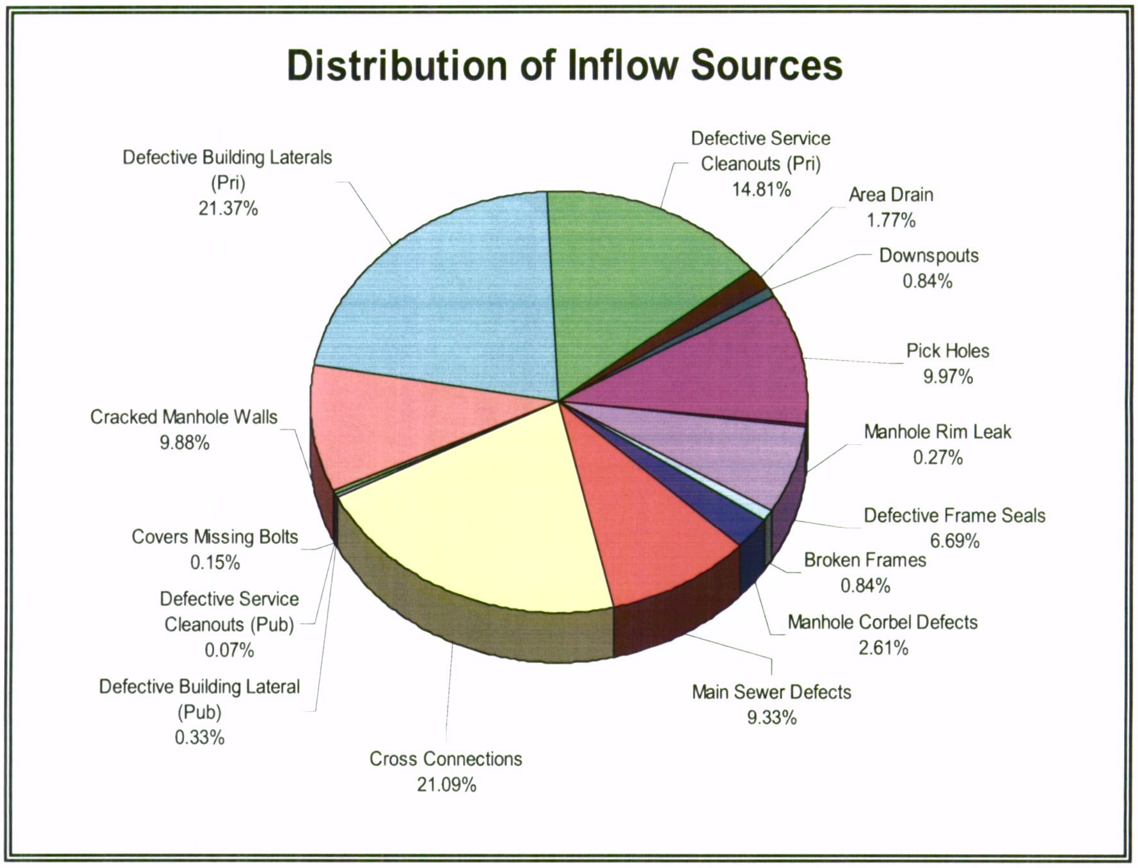
Table 3-A

DISTRIBUTION OF INFLOW SOURCES[2/]

Source	Quantity	1-Year/60-Minute Projected Peak Inflow (mgd)	Percent of Inflow[1/]
Public Sector Inflow			
Pick Holes	1,760	1.685	9.97
Manhole Rim Leaks	512	0.046	0.27
Defective Frame Seals	1,605	1.131	6.69
Broken Frames	247	0.142	0.84
Manhole Corbel Defects	1,267	0.441	2.61
Main Sewer Defects	148	1.577	9.33
Cross Connections	66	3.563	21.09
Defective Building Lateral	30	0.056	0.33
Defective Service Cleanouts	11	0.012	0.07
Cover Missing Bolts	25	0.025	0.15
Cracked Manhole Walls	183	1.670	9.88
Subtotal	5,854	10.348	61.23
Private Sector Inflow			
Defective Building Lateral	1,293	3.610	21.37
Defective Service Cleanouts	1,216	2.502	14.81
Area Drain	25	0.299	1.77
Downspouts	10	0.138	0.82
Subtotal	2,544	6.549	38.77
Total	**8,398**	**16.897**	**100.00**

1/ *Based on source data.*

2/ *It should be noted that interior building inspections were not included in this scope of services and that there are likely basement drains or sump pumps that were not identified during this study. An evaluation of the private grinder pumps was also not included in the scope of services for this project and are likely sources of I/I that were not identified.*



The total quantified inflow from all sources identified through field investigation was estimated to be approximately 16.897 mgd during a 1-year/60-minute design storm.

The largest contributor of inflow to the sanitary collection system is cross connections to the storm system. During smoke testing 155 catch basins tested positive with the majority surrounding the downtown area. All 102 catch basins were then dye tested to confirm the cross connection and also to quantify the amount of inflow attributed from the location. Dye test were not performed on the remaining 53 catch basins due to the catch basin not being able to be safely plugged, no hydrant or ability to flood catch basin adequately, or the storm water system is deeper than the sewer system. Several of the locations proved to be manhole defects and not actual cross connections. However, 66 locations tested positive. Of these 63 proved to be indirect crosses. An indirect cross connection is one where runoff from a storm event is exiting the storm lines and then traveling through the soil and entering the sanitary sewer system. Two (2) locations were confirmed as direct connections to the sanitary collection system and contributed 0.461 mgd of the 3.563 mgd 1-year/60-minute inflow attributed from cross connections. These locations are shown on Figures 3.2 to 3.3. In addition, the City of Hot Springs has disconnected these connections to the sanitary sewer system.

CITY OF HOT SPRINGS, AR

Legend

- Manholes
- Gravity Main
- Sewer Line with Direct Connection

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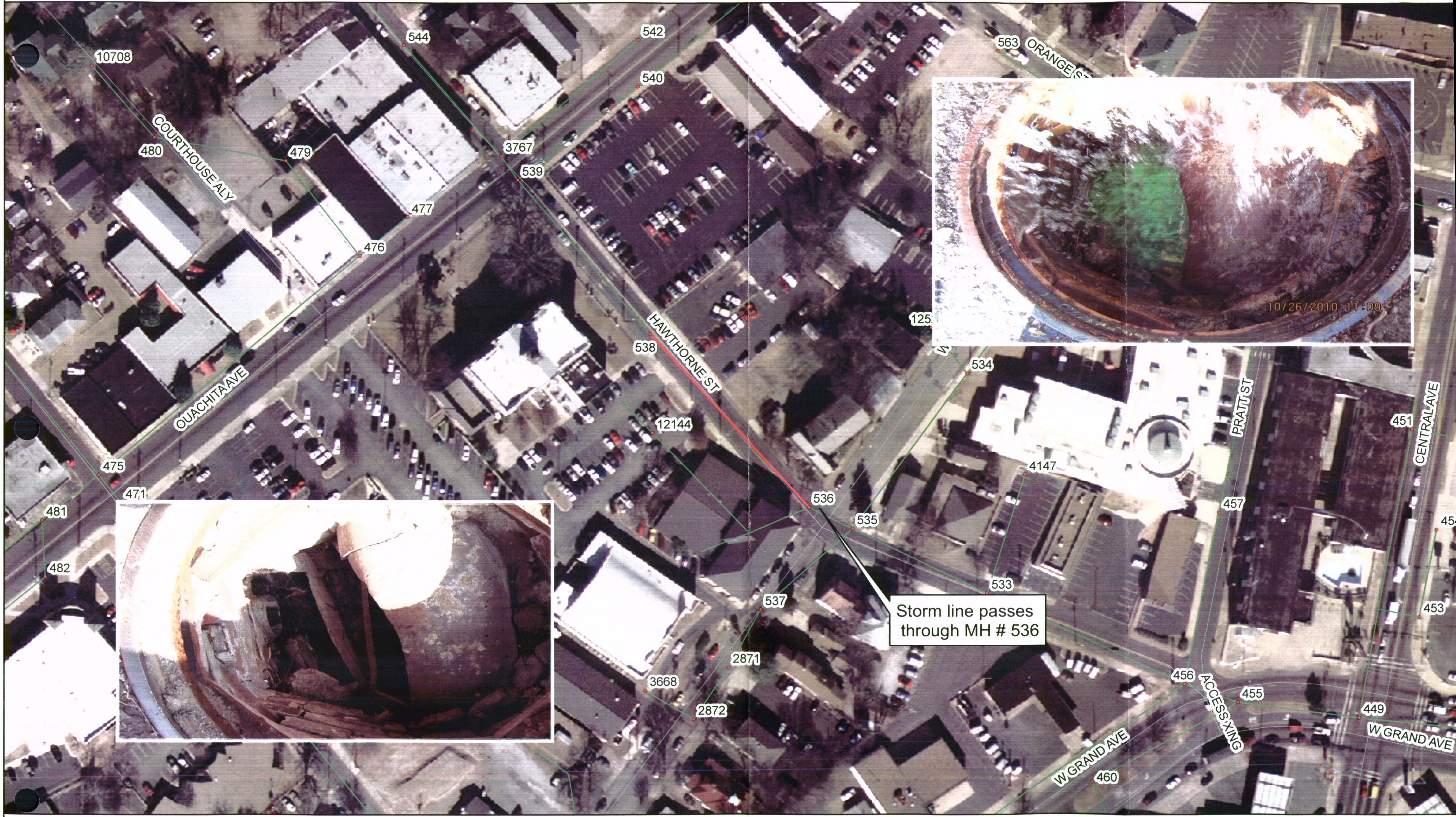
HOT SPRINGS

DIRECT CONNECTION
HOT SPRINGS CREEK
FIGURE 3.2

CITY OF HOT SPRINGS, AR



Legend

- Manholes
- Gravity Main
- Sewer Line with Direct Connection

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DIRECT CONNECTION
CARPENTER DAM
FIGURE 3.3

DETERMINATION OF INFILTRATION

Infiltration in a sanitary sewer system is defined as extraneous flow that enters the system through pipe joints, sewer line defects (including main sewer lines and building sewer lines), and defective manhole walls, benches, and pipe seals. Two types of infiltration can be determined during a study, permanent infiltration and peak infiltration. Permanent infiltration is defined as extraneous flow that enters the system through the ground during periods of dry-weather and low-groundwater. Peak infiltration is defined as the maximum extraneous flow that enters the sewer system during high-groundwater conditions after the inflow effects of a rain event have ended. Peak infiltration was determined during the Flow Monitoring Study and used during SSES to evaluate the effects of infiltration on the sewer system.

Analyses of wastewater infiltration were based on flow monitoring data and I/I source data from field investigations, specifically manhole and visual pipe inspection, rainfall simulation, and internal television inspection of sewer lines.

INFILTRATION SOURCE QUANTIFICATION

Each of the infiltration sources identified during field investigations was evaluated and quantified in reference to the corresponding meter basin and line segment. The infiltration rate was estimated based on the severity of the defect. A potential infiltration rate was estimated for each manhole and pipe defect that was observed but not actively leaking. The sum of all observed infiltration sources is referred to as total identified infiltration. The difference between total identified infiltration and peak monitored infiltration is total unidentified infiltration. Unidentified infiltration was monitored but not directly accounted for since the specific source remains unknown.

Total identified infiltration was quantified to be 1.474 mgd. The total identified infiltration is summarized by source type in Table 3-B.

Table 3-B

DISTRIBUTION OF INFILTRATION SOURCES[1/]

Source	**Quantity**	**Estimated Infiltration Rate (mgd)**	**Percent of Total Infiltration**[1/]
Manhole Defects			
Defective Manhole Walls	1,604	0.668	45.32
Pipe Seals	1,220	0.753	51.09
Bench/Trough Defect	94	0.053	3.59
Total	**2,918**	**1.474**	**100.00**

1/ *Based on identified infiltration.*

CHAPTER 4 MODEL DEVELOPMENT AND CAPACITY ANALYSIS

This Chapter provides a summary of the model development, calibration, and capacity analysis.

MODEL DESCRIPTION

In order to analyze the performance of the City of Hot Springs sanitary sewer system, a computer based hydraulic model was constructed. The hydraulic model was constructed and analyzed using the Infoworks CS software from Innovyze, Inc. Infoworks CS is a fully dynamic hydraulic model capable of analyzing large, complex sewer systems.

The objectives of this task were to:

- Create a complete sanitary sewer hydraulic model including the grinder/pressure system
- Calibrate the model to recreate current recorded flows and surcharge depth data
- Evaluate existing system capacity to transport dry- and wet-weather flows
- Simulate a 2-year/24-hour design storm on the calibrated system model to identify areas with insufficient capacity and overflows
- Develop a staged system implementation strategy to eliminate wet-weather sanitary sewer overflows (SSO's)
- Evaluate alternatives to optimize system performance

MODEL UPDATE

COLLECTION SYSTEM

The hydraulic model was constructed using data from the GPS survey, City provided GIS, and field inspections. Manholes on sewer mains 10 inches and larger in diameter as well as 3,500 manholes on 8-inch diameter and smaller mains were surveyed to sub-centimeter accuracy. The remaining manholes were modeled to sub-meter accuracy. In addition, RJN field staff performed inspections on all manholes located in the sewer system recording manhole diameters, invert depths, and pipe sizes. A total of 2.3 million linear feet of gravity mains were modeled.

The original project scope included modeling all sewer mains 10 inches and larger in diameter. During model construction, it became apparent that the 10-inch diameter and larger restriction would greatly limit the functionality of the model as an analysis tool, particularly within the grinder/pressure system. The hydraulic model was then modified to contain all pipes and structures in the sanitary sewer system. Modeling the entire system allowed more in-depth analysis and enabled the analysis of the grinder/pressure system as well as the major and sub-major pump stations within the system.

All data in the hydraulic model network was color coded / flagged to define its data source. More accurate information such as record drawings or survey data was used in preference to GIS or interpolated data.

PUMPING STATIONS

The hydraulic model includes 293 pump stations located within the sanitary sewer system. Some of the key pump stations modeled are Fairwood Pump Station, Gulpha Pump Station, Highway 270 Pump Station, Hogan Creek Pump Station, Hot Springs Creek Pump Station, Molly Creek Pump Station, and Mazarn #1-4 Pump Station.

Pump station geometry was entered into the model from record drawings and field investigation data provided by Garver Engineering. This data includes wet well sizes, pump curves, and pump control levels. When pump curves were not available, pump capacity was estimated at six times dry weather flow.

GRINDER/PRESSURE SYSTEM

The City of Hot Springs sewer system consists of a hybrid collection system of gravity and pressurized mains. The grinder/pressure system was constructed using GIS locations provided by the City. Pressure main diameters at all outfalls into the gravity system were verified by field crews. All other diameters were assigned from City GIS files.

In order to calculate the elevations of pressure mains, a 3D terrain model was generated using a 2 foot contour GIS file provided by the City of Hot Springs. All pressure mains were assumed to be four feet below the ground elevations from the terrain model. The mains were then adjusted to remain in pressure as needed for model stability. A total of 1.2 million linear feet of pressure mains were included in the hydraulic model.

A single grinder pump was added for each household assumed to be connected to the pressure system. In practice, there are often two houses connected to one grinder pump, however, one household per grinder pump was used for modeling purposes. The grinder wet well and pump curve data was supplied by Garver Engineering. Pump control levels were estimated based on the elevation of the grinder wet well.

MODEL CALIBRATION

PROCESS

Model calibration is necessary for the model to accurately represent the behavior of the sanitary sewer system. Model calibration is a process through which model variables and coefficients are adjusted through multiple iterations until flow, depth, and velocity matches actual flow meter data recorded during events. The model is calibrated to recreate sewer performance in both dry-weather and wet-weather conditions.

DRY-WEATHER

Dry-weather calibration ideally requires at least a 7-day period, including one weekend, unaffected by rainfall induced flows. The recorded flow data from the 2009 Phase I flow monitoring study was assessed in conjunction with the rainfall data and the period from March 3, 2009 through March 10, 2009 was selected as a representative dry-weather period.

Calibrating the model for dry-weather flow was achieved by modifying:

- Permanent groundwater infiltration rates

- Per capita flow rates
- Commercial / industrial flow rates

The calibration is considered successful when minimum flow, peak flow, and total volume at all meter sites matches recorded data within five (5) percent.

WET-WEATHER

Review of the wet-weather response to rainfall indicated that there is a significant amount of inflow and infiltration throughout the sewer system. An example of the wet-weather response is shown in Figure 4.1. Once the correct antecedent groundwater conditions were established, all modeled storm events produced consistent runoff and were used for calibration.

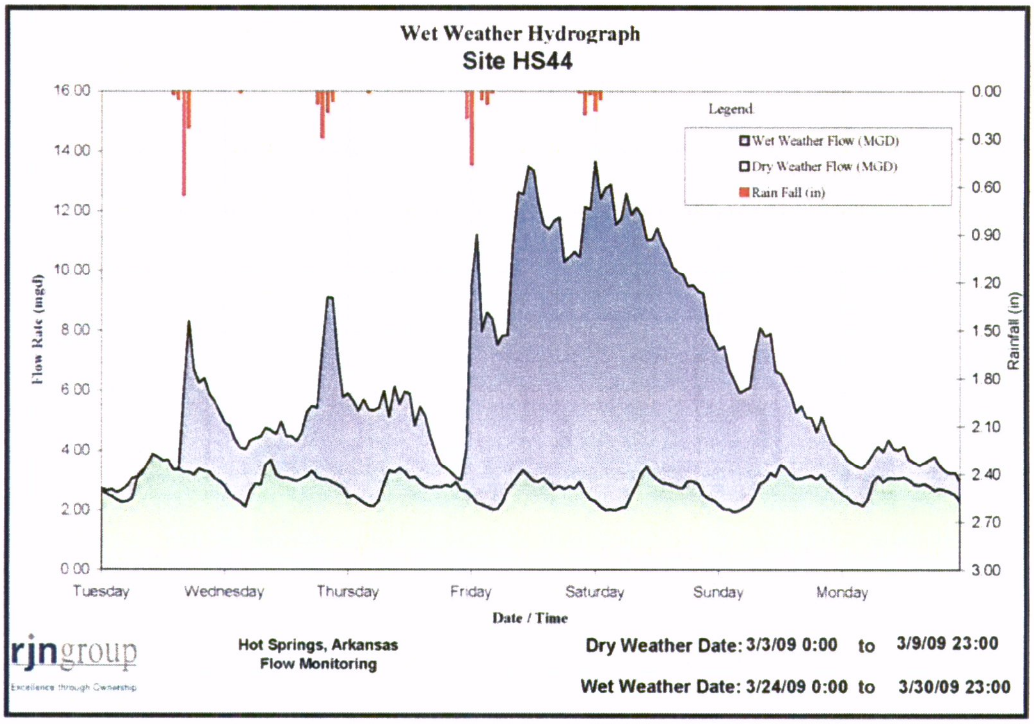


Figure 4.1: Wet-Weather Response

Wet-weather flows were generated in the model using both fixed response surfaces as well as infiltration flows:

- Up to three "fixed" response surface areas were calibrated for each subcatchment. These surface types are fundamentally independent of the catchment condition prior to the rainfall event and represent fast responses from areas such as illegally connected roof drainage and stormwater cross connections.
- Rainfall induced infiltration was modeled using hydrology in the Ground Infiltration Module (GIM) within Infoworks. This hydrological module has soil and groundwater storage zones and the inflow into the model is dependent upon the wetness of the catchment prior to the rainfall event, taking into account both preceding rainfall and

evaporation. These flows represent the delayed ingress of stormwater through the ground into the sewer system through cracks and leaks in sewers and private drains.

During the calibration process, peak flows, infiltration time, depth, surcharge time, and velocity was compared to all metered sites during rain events.

Special attention was given to the grinder/pressure system to ensure it was performing correctly. Velocities were verified to be consistent in all mains and that no pressure loss was occurring. Any loss in pressure would cause mathematical errors in the hydraulic calculations. Pump operating points were also checked against recorded field investigations and any discrepancies were corrected.

DESIGN STORM ANALYSIS

SYSTEM UPDATES

In order to analyze the system and identify capacity improvements under the design storm, the model was updated to reflect the planned improvement of the Fairwood Pump Station and force main. This main is currently under construction and will route flow from Fairwood Pump Station to Davidson WWTP. This main will also convey flow from Molly Creek Pump Station and Hot Springs Creek Pump Station. The location of the force main can be seen in Figure 4.2.

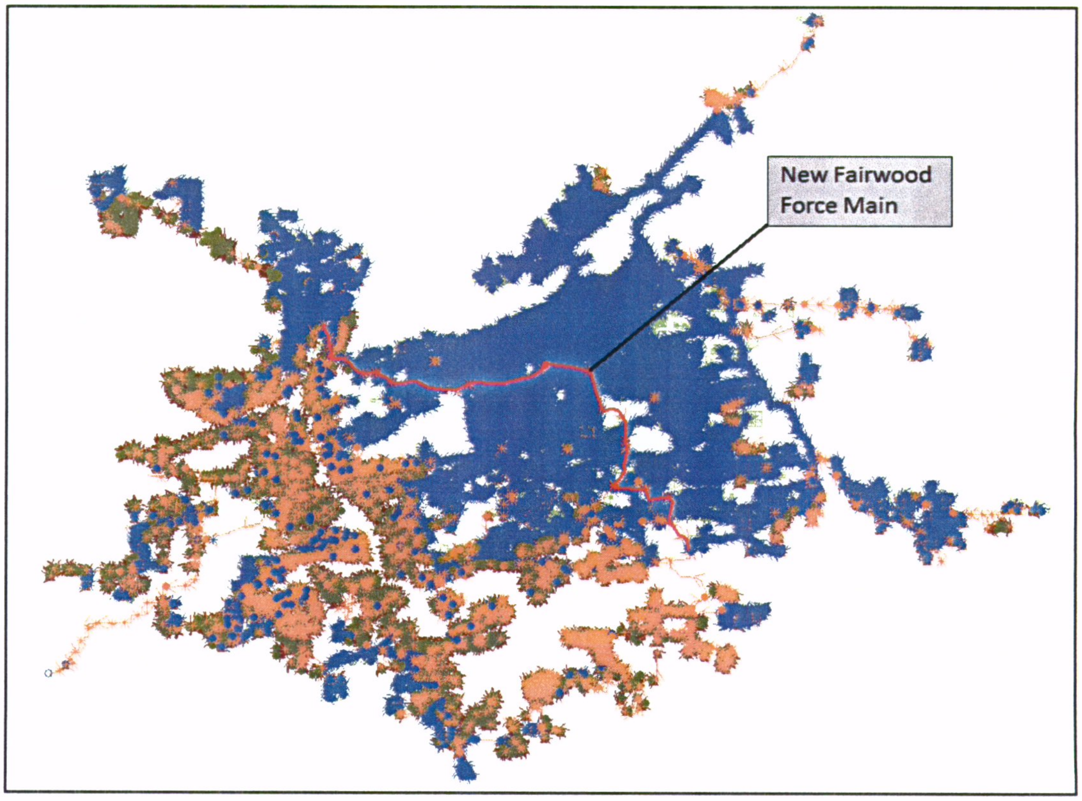


Figure 4.2: New Fairwood Force Main Route

OPERATIONAL ASSUMPTIONS

In addition to the force main update, assumptions were made on how the system can operate in wet weather conditions. All assumptions were verified with City of Hot Springs staff prior to the modeling of the design storm.

- Southwest Treatment Plant
    - Design Capacity: 1.85 MGD
    - Operational Capacity 1.0+/- MGD
- Davidson Treatment Plant
    - Design Capacity: 40 MGD
    - Operational Capacity 53.5 MGD
    - 80 MG storage available

DESIGN STORM

The design storm used for the model analysis is a 2-year/24-hour synthetic rainfall event. The design storm event was selected after consultation with the City of Hot Springs staff. The rainfall event was constructed according to NRCS design methods. The NRCS design storm is a 24-hour duration event that contains all 2-year events of smaller durations within it. The 2-year/24-hour storm event has a total rainfall of 4.3 inches with a peak 60-minute intensity of 1.9 inches/hour. The storm hyetograph can be seen in Figure 4.3.

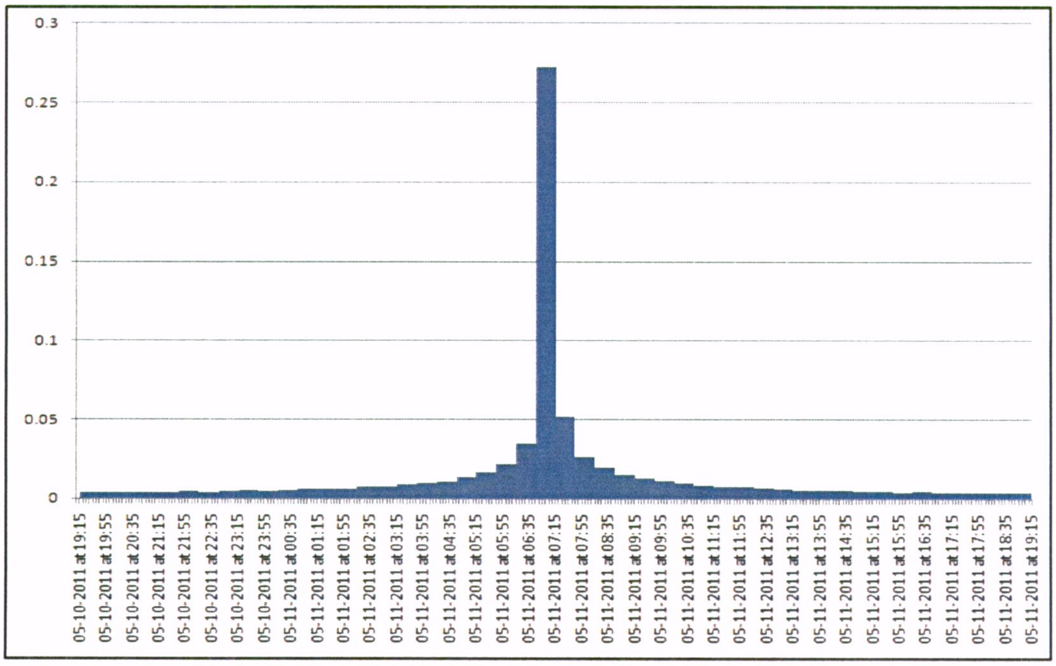


Figure 4.3: 2-Year/24-hour Design Storm Hyetograph

SYSTEM PERFORMANCE

The first step in analyzing the system performance was to isolate local basin capacity restrictions from overall system restrictions. The model was split into sub-sewersheds and each was given a free outfall to remove any downstream restrictions. By removing all downstream restrictions, individual basins can be analyzed for capacity. The outfall locations were placed at all major pump stations so that the pump station would not cause any hydraulic restrictions or backup. All capacity issues and overflows predicted by the model were recorded. Improvements were made to increase conveyance capacity and eliminate overflows within each sub-sewershed. The improvements fell into three categories, those that were required to eliminate reported/documented overflows, those that were required to eliminate excessive surcharging, and those that eliminated unconfirmed model predicted overflows. After the local capacity restrictions were resolved, the model was recombined to evaluate the overall system capacity issues. A discussion of the system performance for each major tributary area is in the following pages.

GULPHA PUMP STATION TRIBUTARY AREA

The Gulpha Pump Station is located on the eastern side of Hot Springs. This station is responsible for conveying flow from this part of the City to the Davidson WWTP. The station is configured with three pumps and has a design capacity of 13 MGD. During flow monitoring, only two pumps were functioning and the station capacity was limited to 9.3 MGD. The existing Gulpha force main diameter is 24 inches.

The main interceptor that feeds the Gulpha Pump Station is a 21-30 inch diameter sewer main that provides the majority of flow to the station. Figure 4.4 depicts the areas of the city that contribute flow to the Gulpha Pump Station. Currently, the interceptor is undersized to convey all flow to the station under the design storm event. Overflows are predicted by the model due to the capacity restriction. The pump station also introduces a hydraulic restriction due to its current pumping capacity. This leads to an increase in overflow volume upstream of the station. The existing hydraulic grade line of the Gulpha interceptor can be seen in Figure 4.5. All known reported wet weather overflows are shown on Figure 4.6.

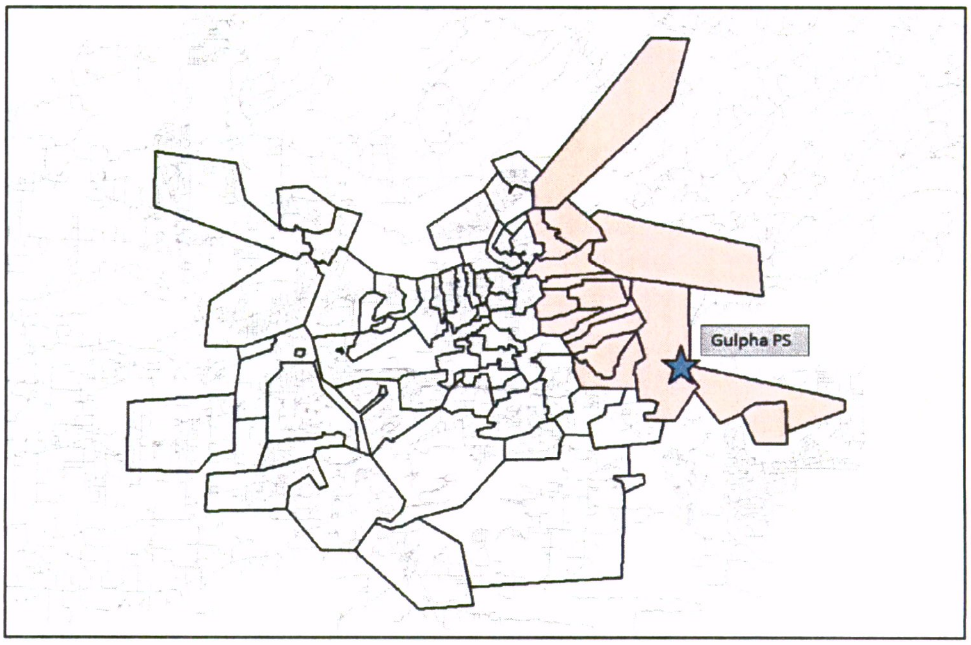
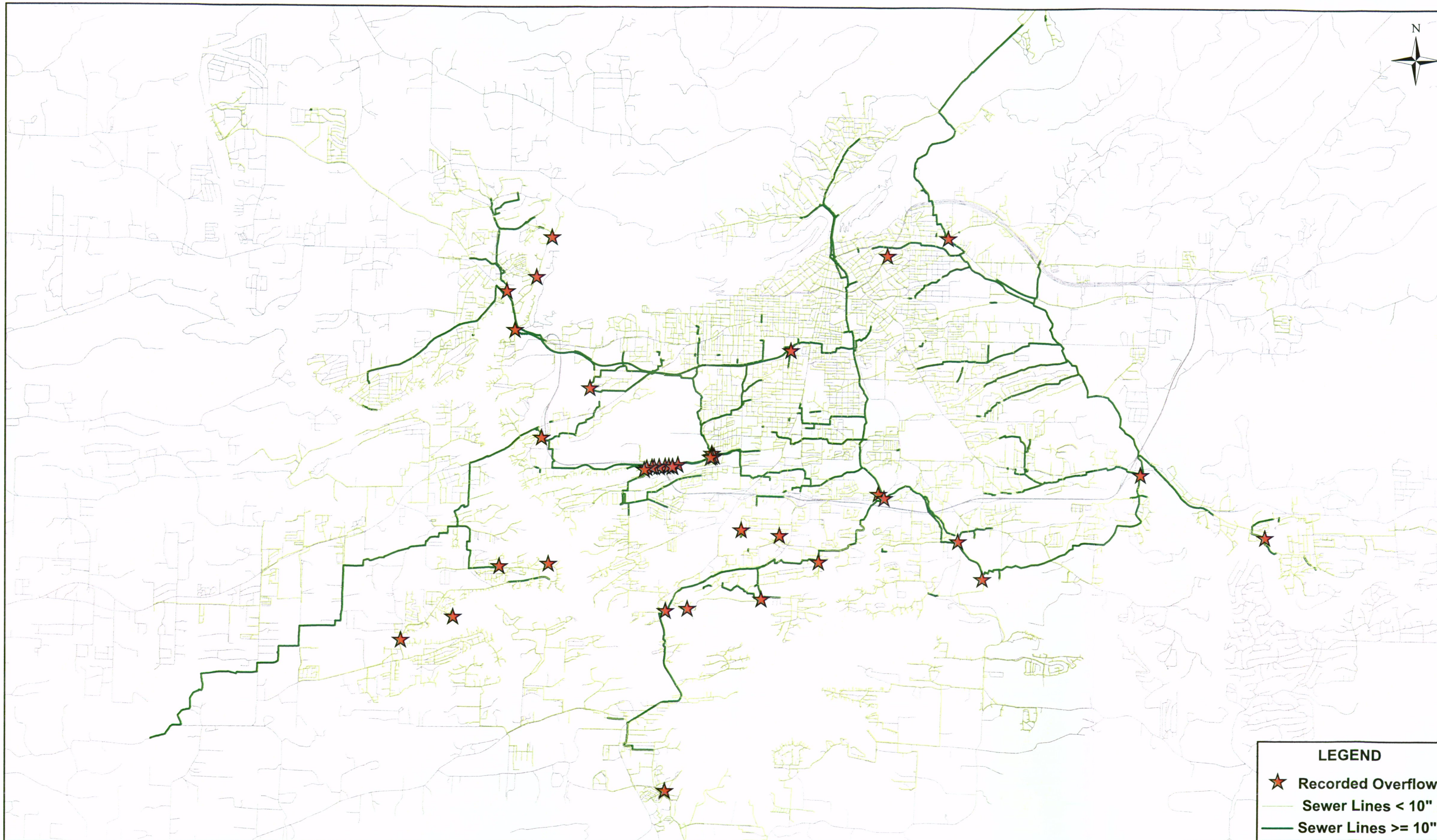


Figure 4.4: Gulpha Contributing Area

Known Overflows



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HOT SPRINGS
NATIONAL PARK
ARKANSAS

CITY OF HOT SPRING
KNOWN OVERFLOW
FIGURE 4.

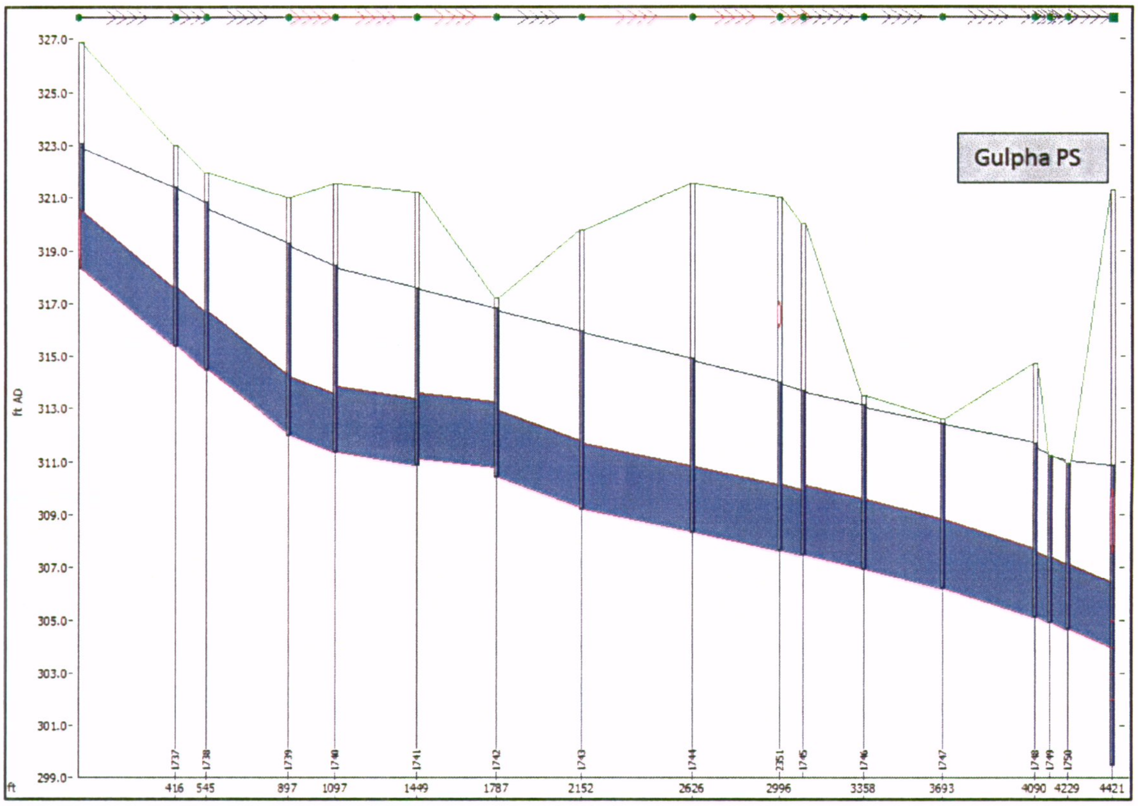


Figure 4.5: Gulpha Interceptor Hydraulic Grade Line

STOKES PUMP STATION TRIBUTARY AREA

The Stokes Pump Station currently has a design capacity of 20 MGD and receives flow from the central and western areas of Hot Springs. Figure 4.7 depicts the areas of the City that contribute flow to the Stokes Pump Station. The majority of the station's flow is received from an 18-inch diameter gravity main in Stokes Creek. The station is configured with triplex pumps into a 24-inch diameter force main.

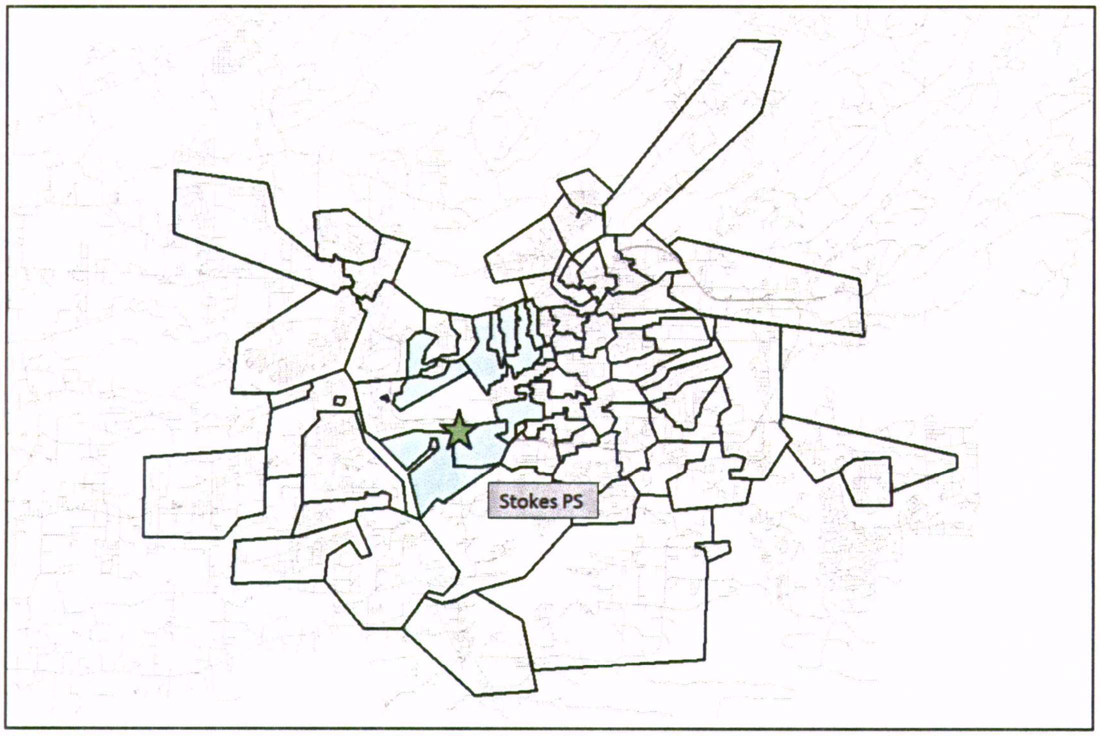


Figure 4.7: Stokes Pump Station Contributing Area

During the flow monitoring period in 2009, only one or two pumps were operating during wet weather conditions. Figure 4.8 shows the pump operations as recorded by the downstream flow monitor. This causes a severe reduction in capacity of the station. In addition, the 18-inch diameter gravity main is currently under capacity if the station was removed as the hydraulic restriction. These two restrictions cause several large overflows along Stokes Creek during wet weather events. These known overflows are shown on Figure 4.6.

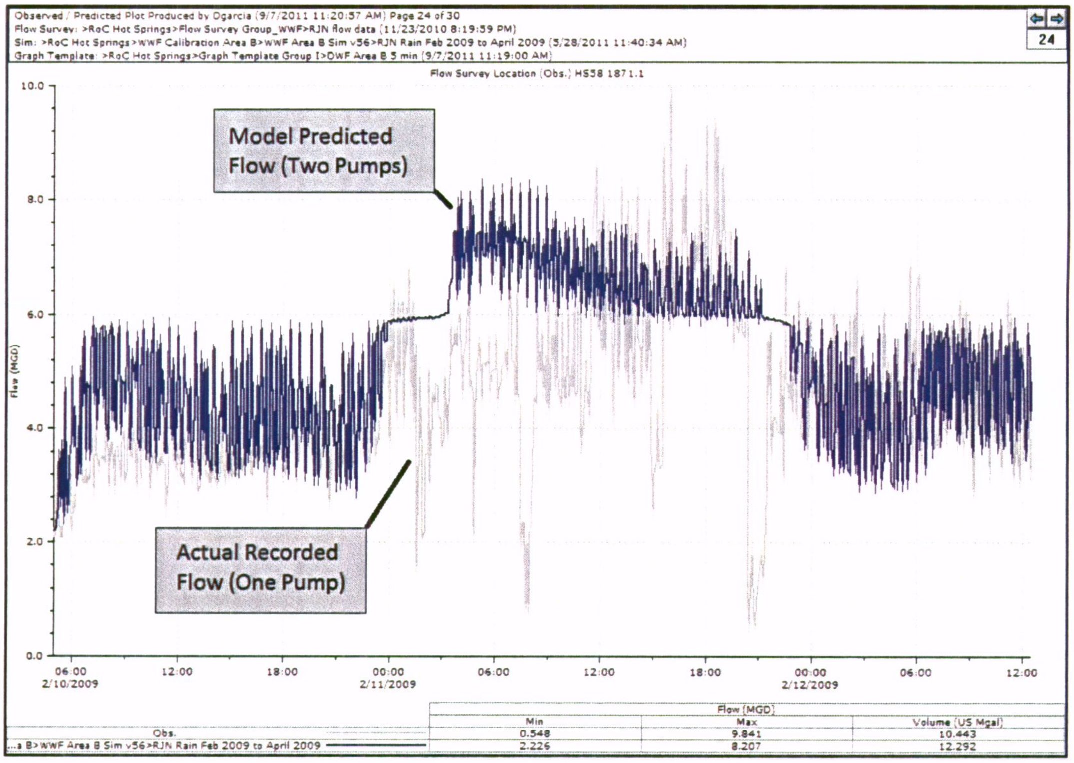


Figure 4.8: Stokes Pump Station Operations

HOT SPRINGS CREEK PUMP STATION TRIBUTARY AREA

The Hot Springs Creek Pump Station is the largest in the City and conveys the majority of flow to Davidson WWTP. The station is configured with triplex pumps at a design capacity of 40 MGD. A 30-inch diameter force main connects the pump station to Davidson WWTP. The pump station receives the majority of flow from the Hot Springs Creek interceptor. Figure 4.9 depicts the areas of the City that contribute flow to the Hot Springs Creek Pump Station. This 27-36 inch diameter line is currently conveying flow from Fairwood and the downtown areas.

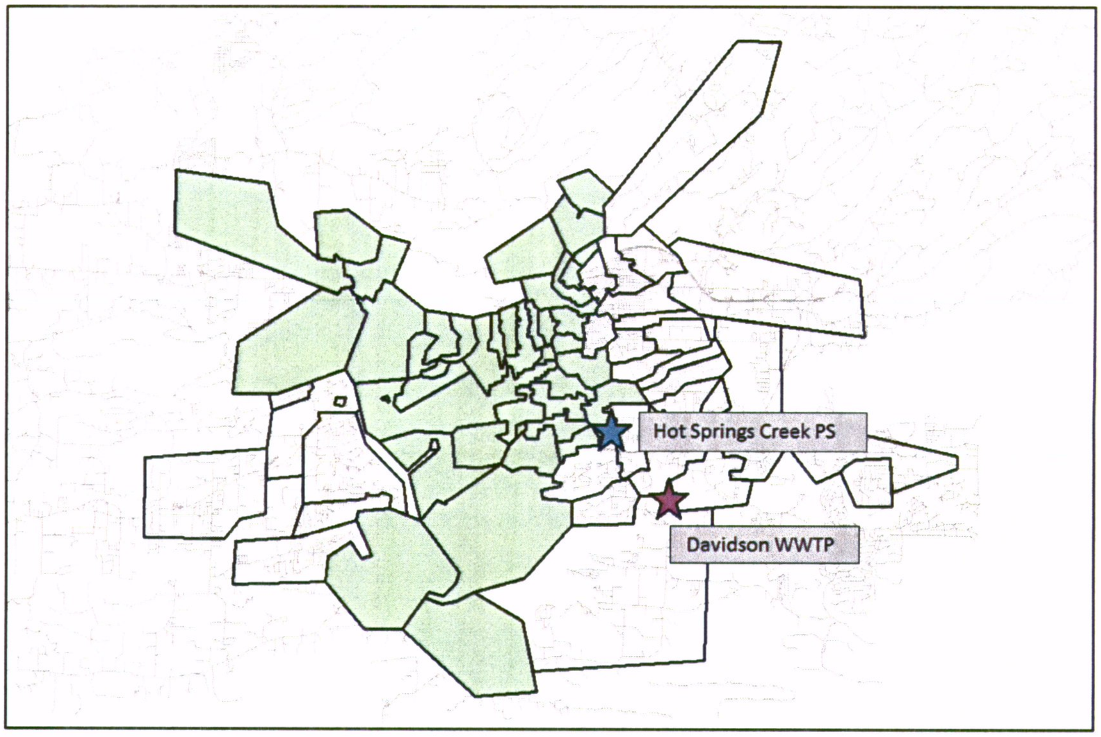


Figure 4.9: Hot Springs Creek Contributing Area

A new force main from the Fairwood Pump Station is currently under construction. This will remove the flow from the Fairwood area from the Hot Springs Creek Pump Station. In addition, the current 30-inch diameter force main from Hot Springs Creek will be abandoned and the station will be manifolded into the new force main from the Fairwood Pump Station.

With the pump station removed and the Fairwood flow re-directed through the new force main, the existing Hot Springs Creek interceptor is still predicted to be under capacity and cause overflows. Figure 4.10 shows a profile of the interceptor entering the pump station and one of the existing overflows. Reported wet weather overflows in this tributary area are shown in Figure 4.6

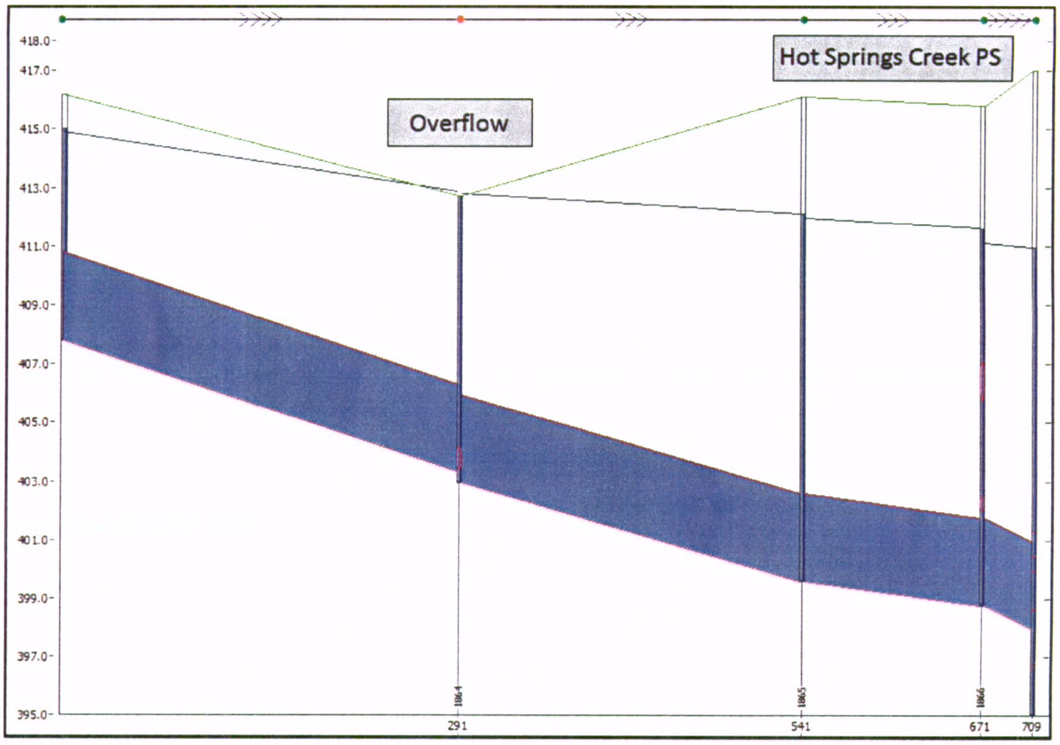


Figure 4.10: Hot Springs Creek Hydraulic Grade Line

SOUTHWEST WWTP/MAZARN DRAINAGE AREA

The majority of the Mazarn system is pressure sewer. The current configuration of the system allows flow to be directed to the Southwest WWTP or to the Davidson WWTP. This dual flow configuration is due to the low capacity of the Southwest WWTP.

The major cause of overflows in the Mazarn drainage area is the long route that flow has to travel from the upstream end of the system to the Southwest WWTP. The pressure in this long system becomes very high, preventing the pumps from injecting additional flow into the main. The existing route is shown in Figure 4.11. Reported wet weather overflows in this tributary area are shown in Figure 4.6.

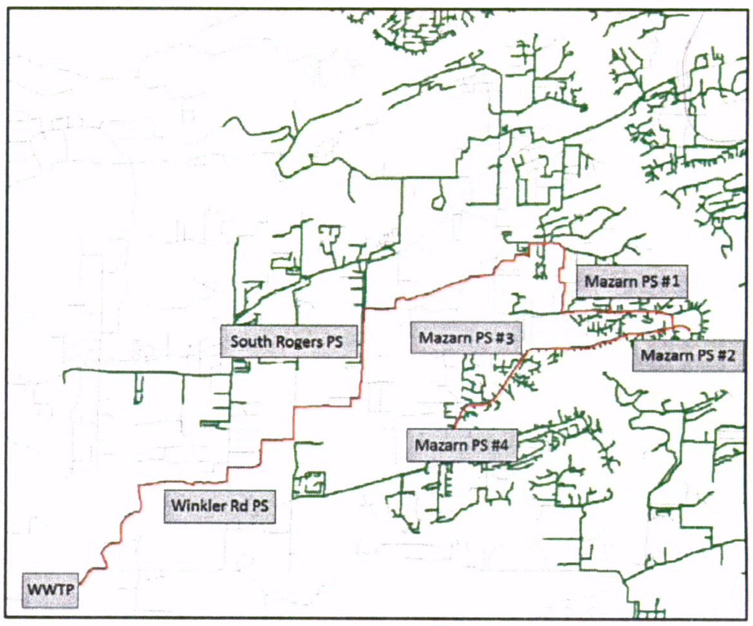


Figure 4.11: Existing Mazarn Flow Route

METHODOLOGY

Once the hydraulic model has been built, calibrated and existing system analyzed, it can be used to develop a cost effective system improvement plan. The improvements are designed by an iterative process based on the following guidelines:

- Optimize the use of existing infrastructure
- Maintain flow conveyance through the pump stations
- Eliminate system bottlenecks

The improvement plan was created in two phases. The first was to size all gravity lines to convey flow to the major pump stations. This was accomplished by replacing all major pump stations which showed to be a hydraulic restriction with a free outfall. By removing the pump stations as the restriction, the upstream gravity lines were isolated for improvement. Individual line segments were identified for improvement if they were under capacity once inflow and infiltration reduction had occurred. However, the final size of the line was calculated with no reduction applied for inflow and infiltration. This was done to allow for future growth and future deterioration of the system. Three line segments in the Hot Springs Creek Area were sized based on new slopes due to the very shallow slope.

During the improvement process, sewer lines were flagged in the model database to indicate if the improvement eliminated a reported overflow. These lines have been identified as Priority 1 improvements. All other local improvements were identified as Priority 2 as they are necessary to increase the capacity of the system and reduce excessive surcharging, but are not tied to a specific reported overflow.

Once the undersized gravity lines were sized, the pump stations were connected to the system and sized to convey the new flow. The pump station capacity was determined by replacing inadequate pumps with a single screw pump programmed based on the new incoming flow. Pump control levels have been designed to maximize in system storage while keeping surcharge levels three feet below the lowest upstream manhole. The Hogan Creek Pump Station in the Stokes area currently has capacity required to convey peak flows. However, the high control levels cause overflows to occur upstream. The controls were modified in the model to eliminate the overflows. Force mains were sized based on velocity and pressure limits. All new force mains were assumed to be four feet below the ground terrain model and follow alignments to minimize elevation gain.

As with the gravity improvements, force main and pump station improvements were categorized as Priority 1 or Priority 2 based on their elimination of reported overflows.

The recommendations do not take into account inflow and infiltration reduction from the replacement of interceptors in the Gulpha Drainage Area. It is recommended that following construction of the new interceptors, flow monitoring should be performed and the model updated. Once the model is updated, the pump station and force main sizing can be revised to reflect the new flows.

Based on the methodology described above, an improvement plan was developed for the required Priority 1 and Priority 2 "local" improvements as well as "system" improvements where an analysis of different alternatives was considered. A discussion of each of these plans is provided in the following pages.

REQUIRED LOCAL IMPROVEMENT PROJECTS

The following is a list of all local in-system projects that must be completed at a minimum and are common to all evaluated alternatives for "system" improvements.

- Complete construction of the Fairwood force main from Fairwood Pump Station to Hot Springs Creek Pump Station
- Increase capacity of 12,303 linear feet of gravity sewer main and 3,529 linear feet of force main based on Priority 1 identification (reported overflow elimination)
- Increase capacity of 67,424 linear feet of gravity sewer main and 732 linear feet of force main based on Priority 2 identification (excessive surcharge)
- Increase capacity of six (6) minor pump stations (Priority 1)
- Change control levels at Hogan Creek Pump Station
- Continue inflow/infiltration reduction program
- Investigate model predicted overflows that are not in the vicinity of known overflows

A map showing all the Priority 1 and Priority 2 recommendations is shown in Figure 4.12.

A summary of the Priority 1 local minor pump station improvements is shown on Table 4-A.

Table 4-A

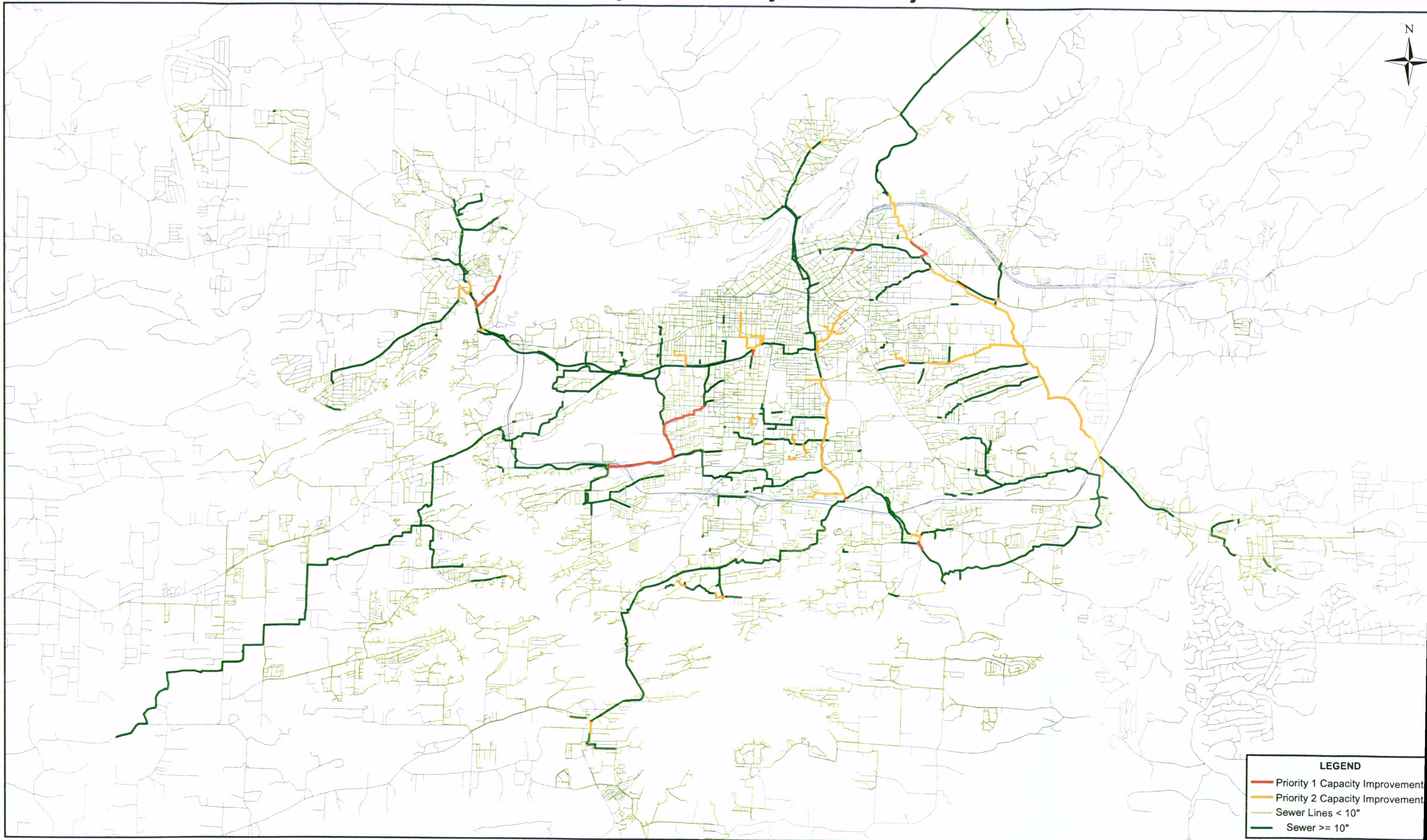
REQUIRED PRIORITY 1 LOCAL MINOR PUMP STATION CAPACITY IMPROVEMENT PROJECTS

Pump Station	Tributary Area	Existing Size (mgd)	Recommended Size (mgd)
Highway 270	Stokes	0.28	1.9
Hogan Creek	Stokes	3.40	Adjust pump on/off levels
Molly Creek	Stokes	2.77	3.6
PS 20	Stokes	0.19	1.0
Fairwood[1/]	Hot Springs Creek	1.80	5.8
Lakeside	Hot Springs Creek	0.58	2.8
Mazarn #1	Mazarn	0.90	1.0

1/ *Designed.*

A summary of the required Priority 1 local pipe line capacity improvements by major tributary is shown in Table 4-B. A summary of the required Priority 2 local pipe line capacity improvements by major tributary is shown in Table 4-C.

Required Priority 1 and Priority 2 Local Projects



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HOT SPRINGS

CITY OF HOT SPRING
REQUIRED LOCAL PROJECT
FIGURE 4.

Table 4-B

REQUIRED PRIORITY 1 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	Recommended Diameter (in)	Construction Cost ($)
Gulpha Pump Station Tributary Area								
E Grand Ave	Gulpha	HS19	3108	3106	295	8	10	39,825
Upper Gulpha Interceptor	Gulpha	HS18	3938	4005	72	12	18	13,320
Upper Gulpha Interceptor	Gulpha	HS18	4005	4006	154	12	18	28,490
Upper Gulpha Interceptor	Gulpha	HS18	4006	4007	154	12	18	28,490
Upper Gulpha Interceptor	Gulpha	HS18	4007	4008	39	10	18	7,020
Upper Gulpha Interceptor	Gulpha	HS18	4008	4009	181	10	18	30,770
Upper Gulpha Interceptor	Gulpha	HS18	4009	4010	122	10	18	21,960
Upper Gulpha Interceptor	Gulpha	HS18	4010	4011	417	10	18	81,315
Upper Gulpha Interceptor	Gulpha	HS18	4011	4012	302	10	18	58,890
Upper Gulpha Interceptor	Gulpha	HS18	4012	4013	164	10	18	27,800
Upper Gulpha Interceptor	Gulpha	HS20	4013	4014	202	10	18	41,410
Upper Gulpha Interceptor	Gulpha	HS20	4014	4015	66	10	18	12,210
	Subtotal				2,168			391,500
Stokes Pump Station Tributary Area								
Stokes Interceptor	Hot Springs Creek	HS58	973	974	303	15	18	62,115
Stokes Interceptor	Hot Springs Creek	HS58	974	975	385	15	21	77,000
Stokes Interceptor	Hot Springs Creek	HS58	975	976	278	15	21	57,546
Stokes Interceptor	Hot Springs Creek	HS58	976	977	280	15	21	56,000
Stokes Interceptor	Hot Springs Creek	HS58	977	978	400	15	21	86,000
Stokes Interceptor	Hot Springs Creek	HS58	978	979	149	15	21	32,035
Stokes Interceptor	Hot Springs Creek	HS58	979	980	416	15	21	83,200
Stokes Interceptor	Hot Springs Creek	HS58	980	981	333	15	21	66,600

Table 4-B (Cont.)

REQUIRED PRIORITY 1 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	Recommended Diameter (in)	Construction Cost ($)
Stokes Interceptor	Hot Springs Creek	HS58	981	982	336	15	21	67,200
Stokes Interceptor	Hot Springs Creek	HS58	982	983	204	15	21	47,940
Stokes Interceptor	Hot Springs Creek	HS58	983	984	381	18	24	108,585
Stokes Interceptor	Hot Springs Creek	HS58	984	985	249	18	24	70,965
Stokes Interceptor	Hot Springs Creek	HS58	985	986	106	18	24	23,532
Stokes Interceptor	Hot Springs Creek	HS58	986	987	379	18	24	81,485
Stokes Interceptor	Hot Springs Creek	HS58	987	988	375	18	24	80,625
Stokes Interceptor	Hot Springs Creek	HS58	988	989	123	18	27	35,916
Stokes Interceptor	Hot Springs Creek	HS58	989	990	158	18	27	46,136
Stokes Interceptor	Hot Springs Creek	HS58	990	991	523	18	27	122,905
Stokes Interceptor	Hot Springs Creek	HS58	991	992	314	18	27	69,146
Stokes Interceptor	Hot Springs Creek	HS58	992	993	353	18	27	77,616
Stokes Interceptor	Hot Springs Creek	HS58	993	994	314	18	27	69,146
Stokes Interceptor	Hot Springs Creek	HS58	994	995	267	18	27	58,696
Stokes Interceptor	Hot Springs Creek	HS58	995	996	354	18	27	8,319
Stokes Interceptor	Hot Springs Creek	HS58	996	997	295	18	27	71,390
Stokes Interceptor	Hot Springs Creek	HS58	997	998	372	18	27	87,420
Stokes Interceptor	Hot Springs Creek	HS58	998	3630	367	18	27	86,245
Stokes Interceptor	Hot Springs Creek	HS58	2768	11270	258	18	33	96,050
Stokes Interceptor	Hot Springs Creek	HS58	3626	2768	228	18	30	73,287
Stokes Interceptor	Hot Springs Creek	HS58	3630	3626	21	18	27	5,082
Stokes Interceptor	Hot Springs Creek	HS58	11270	11271	371	18	33	142,951
Stokes Interceptor	Hot Springs Creek	HS58	11271	11272	314	18	33	116,882
Stokes Interceptor	Hot Springs Creek	HS58	11272	11273	154	18	33	57,139

Table 4-B (Cont.)

REQUIRED PRIORITY 1 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	Recommended Diameter (in)	Construction Cost ($)
Stokes Interceptor	Hot Springs Creek	HS58	11273	11274	327	18	33	121,756
Stokes Interceptor	Hot Springs Creek	HS58	11274	11275	50	18	33	18,563
Stokes Interceptor	Hot Springs Creek	HS58	11275	Stokes	37	24	33	13,913
	Subtotal				9,775			2,379,386
Hot Springs Creek Pump Station Tributary Area								
4th St & Greenwood Ave	Second Street	HS37	2304	2306	3	12	15	540
4th St & Greenwood Ave	Hot Springs Creek	HS62	2306	2nd Street	74	12	15	13,098
4th St & Greenwood Ave	Second Street	HS37	2302A	2304	245	10	15	40,425
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	1866	Hot Springs Creek PS	38	36	48	19,380
	Subtotal				359			73,443
	Total Gravity				**12,303**			**2,844,329**
Force Mains								
Hot Springs Creek Pump Station Tributary Area								
Albert Pike Rd FM	Fairwood	HS62	HsFMBreak 3370	9496	3010	4	8	346,150
Carpenter Dam Rd	Catherine Heights	HS54	HsFMBreak 317	HsFMBreak 318	519	8	10	88,196
	Subtotal				3,529			434,346
	Total Force Main				**3,529**			**434,346**

Table 4-C

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Gulpha Pump Station Tributary Area										
Gulpha Interceptor	Gulpha	HS26	1701	1702	394	21	30	197,000	27	171,390
Gulpha Interceptor	Gulpha	HS26	1702	1703	396	21	30	192,060	27	166,320
Gulpha Interceptor	Gulpha	HS26	1703	1704	207	21	30	100,395	27	86,940
Gulpha Interceptor	Gulpha	HS26	1704	1705	117	21	30	56,745	27	49,140
Gulpha Interceptor	Gulpha	HS26	1705	1706	293	21	30	142,105	27	123,060
Gulpha Interceptor	Gulpha	HS26	1706	1707	421	21	30	210,500	27	183,135
Gulpha Interceptor	Gulpha	HS26	1707	1708	197	21	30	98,500	27	85,695
Gulpha Interceptor	Gulpha	HS26	1708	1709	264	21	30	132,000	27	114,840
Gulpha Interceptor	Gulpha	HS26	1709	1710	160	21	33	88,000	27	69,600
Gulpha Interceptor	Gulpha	HS26	1710	1711	372	21	33	204,600	30	186,000
Gulpha Interceptor	Gulpha	HS26	1711	1712	399	21	33	222,243	30	202,293
Gulpha Interceptor	Gulpha	HS26	1712	1713	290	21	33	107,300	30	94,250
Gulpha Interceptor	Gulpha	HS27	1713	1714	312	21	33	173,784	30	158,184
Gulpha Interceptor	Gulpha	HS27	1714	1715	175	21	33	96,250	30	87,500
Gulpha Interceptor	Gulpha	HS27	1715	1716	269	21	33	147,950	30	134,500
Gulpha Interceptor	Gulpha	HS27	1716	1717	354	21	33	194,700	30	177,000
Gulpha Interceptor	Gulpha	HS27	1717	1718	185	21	33	101,750	30	92,500
Gulpha Interceptor	Gulpha	HS27	1718	1719	300	21	33	165,000	30	150,000
Gulpha Interceptor	Gulpha	HS28	1719	1720	99	21	33	55,143	30	50,193
Gulpha Interceptor	Gulpha	HS28	1720	1721	183	21	33	101,931	30	92,781

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Gulpha Interceptor	Gulpha	HS28	1721	1722	101	21	33	54,035	30	48,985
Gulpha Interceptor	Gulpha	HS28	1722	1723	519	21	33	285,450	30	259,500
Gulpha Interceptor	Gulpha	HS28	1723	1724	311	24	33	171,050	30	155,500
Gulpha Interceptor	Gulpha	HS28	1724	1725	326	24	33	179,300	30	163,000
Gulpha Interceptor	Gulpha	HS28	1725	1726	377	24	33	207,350	30	188,500
Gulpha Interceptor	Gulpha	HS31	1726	1727	305	24	36	187,575	33	167,750
Gulpha Interceptor	Gulpha	HS31	1727	1728	396	24	36	246,312	33	220,572
Gulpha Interceptor	Gulpha	HS31	1728	1729	602	24	36	374,444	33	335,314
Gulpha Interceptor	Gulpha	HS31	1729	1730	371	24	36	228,165	33	204,050
Gulpha Interceptor	Gulpha	HS31	1730	1731	415	24	36	255,225	33	228,250
Gulpha Interceptor	Gulpha	HS31	1731	1732	101	27	36	62,115	33	55,550
Gulpha Interceptor	Gulpha	HS31	1732	1733	339	27	36	208,485	33	186,450
Gulpha Interceptor	Gulpha	HS31	1733	1734	390	27	42	264,030	36	242,580
Gulpha Interceptor	Gulpha	HS31	1734	1735	396	27	42	265,320	36	243,540
Gulpha Interceptor	Gulpha	HS31	1735	1736	402	27	42	269,340	36	247,230
Gulpha Interceptor	Gulpha	HS31	1736	1737	416	27	42	278,720	36	255,840
Gulpha Interceptor	Gulpha	HS31	1737	1738	130	27	42	87,100	36	79,950
Gulpha Interceptor	Gulpha	HS31	1738	1739	351	27	42	235,170	36	215,865
Gulpha Interceptor	Gulpha	HS31	1739	1740	200	27	42	134,000	36	123,000
Gulpha Interceptor	Gulpha	HS31	1740	1741	353	30	42	238,981	36	219,566

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Gulpha Interceptor	Gulpha	HS31	1741	1742	337	30	42	225,790	42	225,790
Gulpha Interceptor	Gulpha	HS31	1742	1743	366	30	42	245,220	42	245,220
Gulpha Interceptor	Gulpha	HS31	1743	1744	474	30	42	320,898	42	320,898
Gulpha Interceptor	Gulpha	HS31	1744	2351	370	30	42	183,890	42	183,890
Gulpha Interceptor	Gulpha	HS31	1745	1746	260	32	42	174,200	42	174,200
Gulpha Interceptor	Gulpha	HS31	1746	1747	335	32	42	219,425	42	219,425
Gulpha Interceptor	Gulpha	HS31	1747	1748	397	32	42	265,990	42	265,990
Gulpha Interceptor	Gulpha	HS31	1748	1749	63	30	42	42,210	42	42,210
Gulpha Interceptor	Gulpha	HS31	1749	1750	77	30	42	50,435	42	50,435
Gulpha Interceptor	Gulpha	HS31	1750	Gulpha PS	192	30	42	129,984	42	129,984
Gulpha Interceptor	Gulpha	HS31	2351	1745	102	30	42	44,064	42	44,064
Gulpha Interceptor	Gulpha	HS21	4004	4283	255	21	27	110,925	24	99,450
Gulpha Interceptor	Gulpha	HS21	4073	4074	213	21	24	83,070	21	73,485
Gulpha Interceptor	Gulpha	HS21	4074	4075	213	21	24	83,070	21	73,485
Gulpha Interceptor	Gulpha	HS21	4075	4076	504	21	24	200,088	21	177,408
Gulpha Interceptor	Gulpha	HS21	4076	4077	307	21	24	119,730	21	105,915
Gulpha Interceptor	Gulpha	HS21	4077	4078	321	21	24	120,375	21	105,930
Gulpha Interceptor	Gulpha	HS21	4078	4079	172	21	24	67,080	21	59,340
Gulpha Interceptor	Gulpha	HS21	4079	4080	162	21	24	64,314	21	57,024
Gulpha Interceptor	Gulpha	HS21	4080	4081	269	21	27	118,898	24	106,793
Gulpha Interceptor	Gulpha	HS21	4081	4004	455	21	27	197,925	24	117,450

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Gulpha Interceptor	Gulpha	HS26	4083	4084	399	21	27	173,565	24	155,610
Gulpha Interceptor	Gulpha	HS26	4084	4141	376	21	30	190,632	24	149,272
Gulpha Interceptor	Gulpha	HS21	4100	4073	294	21	24	114,660	21	101,430
Gulpha Interceptor	Gulpha	HS21	4101	4100	271	21	24	105,690	21	93,495
Gulpha Interceptor	Gulpha	HS21	4102	4101	258	21	24	100,620	21	89,010
Gulpha Interceptor	Gulpha	HS21	4103	4102	254	21	24	99,060	21	87,630
Gulpha Interceptor	Gulpha	HS26	4141	1701	116	21	30	58,000	27	50,460
Gulpha Interceptor	Gulpha	HS26	4283	4083	199	21	27	86,565	24	77,610
Ridgeway St	Gulpha	HS23	1564	4627	163	8	12	30,970	10	29,340
Ridgeway St	Gulpha	HS23	1565	1564	153	8	12	26,775	10	25,245
Ridgeway St	Gulpha	HS23	1566	1565	183	8	12	32,025	10	30,195
Ridgeway St	Gulpha	HS23	1567	1566	369	8	12	64,575	10	60,885
Ridgeway St	Gulpha	HS23	1568	1567	22	8	10	3,630	10	3,630
Ridgeway St	Gulpha	HS23	1569	1568	316	8	10	52,140	10	52,140
Ridgeway St	Gulpha	HS27	1753	1713	311	15	21	64,377	21	64,377
Ridgeway St	Gulpha	HS25	1754	1753	141	15	21	29,187	21	29,187
Ridgeway St	Gulpha	HS25	1755	1754	136	15	21	28,152	18	26,112
Ridgeway St	Gulpha	HS25	1756	1755	84	15	21	15,540	18	14,280
Ridgeway St	Gulpha	HS25	1757	1756	400	15	21	80,000	18	72,000
Ridgeway St	Gulpha	HS25	1758	1757	322	15	21	64,400	18	57,960
Ridgeway St	Gulpha	HS25	1759	1758	405	15	21	87,075	18	78,975

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Ridgeway St	Gulpha	HS25	1760	1759	246	15	21	54,612	18	49,692
Ridgeway St	Gulpha	HS25	1761	1760	178	15	18	40,406	18	40,406
Ridgeway St	Gulpha	HS25	1762	1761	400	15	18	88,000	18	88,000
Ridgeway St	Gulpha	HS25	1763	1762	278	15	18	61,160	18	61,160
Ridgeway St	Gulpha	HS25	1764	1763	405	15	18	89,100	18	89,100
Ridgeway St	Gulpha	HS25	1765	1764	390	15	18	85,800	18	85,800
Ridgeway St	Gulpha	HS25	1766	1765	304	15	18	66,880	18	66,880
Ridgeway St	Gulpha	HS25	1767	1766	491	15	18	108,020	18	108,020
Ridgeway St	Gulpha	HS25	1768	1767	250	15	18	55,000	18	55,000
Ridgeway St	Gulpha	HS25	1769	1768	376	15	18	82,720	18	82,720
Ridgeway St	Gulpha	HS24	4561	4562	193	12	15	32,810	15	32,810
Ridgeway St	Gulpha	HS24	4562	4563	65	12	15	11,700	15	11,700
Ridgeway St	Gulpha	HS24	4563	4564	116	12	15	23,780	15	23,780
Ridgeway St	Gulpha	HS24	4564	4565	350	12	15	71,750	15	71,750
Ridgeway St	Gulpha	HS24	4565	4566	50	12	15	9,500	15	9,500
Ridgeway St	Gulpha	HS24	4566	4567	364	12	15	74,620	15	74,620
Ridgeway St	Gulpha	HS24	4567	4568	278	12	15	56,990	15	56,990
Ridgeway St	Gulpha	HS24	4568	4569	96	12	15	19,680	15	19,680
Ridgeway St	Gulpha	HS24	4569	1769	65	14	15	12,350	15	12,350
Ridgeway St	Gulpha	HS23	4627	4543	262	10	12	45,850	12	45,850
Spring St & Festival St	Gulpha	HS22	12451	4140	125	10	12	23,750	12	23,750

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Spring St & Festival St	Gulpha	HS22	12452	12451	123	10	12	21,525	12	21,525
Upper Gulpha Interceptor	Gulpha	HS18	1805	3299	56	10	12	7,560	12	7,560
Upper Gulpha Interceptor	Gulpha	HS18	1806	1807	198	10	15	35,640	12	32,670
Upper Gulpha Interceptor	Gulpha	HS18	1807	4115	238	10	15	36,890	12	32,130
Upper Gulpha Interceptor	Gulpha	HS18	3279	3296	220	10	15	36,300	12	33,000
Upper Gulpha Interceptor	Gulpha	HS18	3288	3279	245	10	15	46,550	12	42,875
Upper Gulpha Interceptor	Gulpha	HS18	3289	3289A	213	10	15	36,210	12	31,950
Upper Gulpha Interceptor	Gulpha	HS18	3290	3289	108	10	15	24,300	12	22,680
Upper Gulpha Interceptor	Gulpha	HS18	3295	3290	290	10	15	51,330	12	45,530
Upper Gulpha Interceptor	Gulpha	HS18	3296	1806	440	10	15	79,200	12	72,600
Upper Gulpha Interceptor	Gulpha	HS18	3297	3295	185	10	15	31,450	12	27,750
Upper Gulpha Interceptor	Gulpha	HS18	3298	3297	372	10	15	63,240	12	55,800
Upper Gulpha Interceptor	Gulpha	HS18	3299	3298	155	10	15	24,025	12	20,925
Upper Gulpha Interceptor	Gulpha	HS18	4108	4116	62	10	15	12,710	15	12,710
Upper Gulpha Interceptor	Gulpha	HS18	4114	4108	110	10	15	20,900	12	19,250
Upper Gulpha Interceptor	Gulpha	HS18	4115	4114	294	10	15	190	12	51,450
Upper Gulpha Interceptor	Gulpha	HS18	4116	4117	242	10	15	49,610	15	49,610
Upper Gulpha Interceptor	Gulpha	HS18	4117	4118	202	10	15	38,380	15	38,380
Upper Gulpha Interceptor	Gulpha	HS18	4118	4119	52	10	15	8,580	15	8,580
Upper Gulpha Interceptor	Gulpha	HS18	4119	4143	78	10	15	13,260	15	13,260
Upper Gulpha Interceptor	Gulpha	HS18	4142	3938	28	12	15	4,760	15	4,760

1/ *Size with corrected slope.*

2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Upper Gulpha Interceptor	Gulpha	HS18	4143	4142	128	10	15	21,760	15	21,760
Upper Gulpha Interceptor	Gulpha	HS18	3289A	3288	98	10	15	18,620	12	17,150
	Subtotal				32,613			13,392,810		12,337,005
Stokes Pump Station Tributary Area										
W Saint Louis St	Hot Springs Creek	HS40	2234	2233	303	8	10	40,905	10	40,905
W Saint Louis St	Hot Springs Creek	HS40	2238	2234	328	8	10	44,280	10	44,280
W Saint Louis St	Hot Springs Creek	HS40	2239	2238	40	8	10	6,000	10	6,000
W Saint Louis St	Hot Springs Creek	HS40	2251	2239	186	8	10	25,110	10	25,110
W Saint Louis St	Hot Springs Creek	HS40	2252	2251	159	10	10	23,850	10	23,850
W Saint Louis St	Hot Springs Creek	HS40	2254	2252	206	8	10	30,900	10	30,900
W Saint Louis St	Hot Springs Creek	HS40	2255	2254	173	8	10	23,355	10	23,355
W Saint Louis St	Hot Springs Creek	HS40	2257	2255	277	6	10	37,395	10	37,395
	Subtotal				1,672			231,795		231,795
Hot Springs Creek Pump Station Tributary Area										
4th St & Greenwood Ave	Hot Springs Creek	HS62	1257	1308	173	10	15	28,545	15	28,545
4th St & Greenwood Ave	Hot Springs Creek	HS62	1258	1257	150	8	12	20,250	12	20,250
4th St & Greenwood Ave	Hot Springs Creek	HS62	1259	1258	248	8	12	33,480	12	33,480
4th St & Greenwood Ave	Hot Springs Creek	HS62	1260	10023	75	8	12	10,125	12	10,125
4th St & Greenwood Ave	Hot Springs Creek	HS62	1307	2668	244	8	10	30,500	10	30,500

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
4th St & Greenwood Ave	Hot Springs Creek	HS62	1316	9956	34	8	10	4,250	10	4,250
4th St & Greenwood Ave	Hot Springs Creek	HS62	1321	9957	309	8	10	41,715	10	41,715
4th St & Greenwood Ave	Hot Springs Creek	HS62	1323	1321	95	8	10	12,825	10	12,825
4th St & Greenwood Ave	Hot Springs Creek	HS36	1361	9999	125	6	12	18,750	12	18,750
4th St & Greenwood Ave	Hot Springs Creek	HS36	1365	1361	249	6	12	37,350	12	37,350
4th St & Greenwood Ave	Hot Springs Creek	HS36	1366	1365	269	6	12	40,350	12	40,350
4th St & Greenwood Ave	Hot Springs Creek	HS36	1368	1366	291	6	12	43,650	12	43,650
4th St & Greenwood Ave	Hot Springs Creek	HS36	1369	1368	55	6	12	8,250	12	8,250
4th St & Greenwood Ave	Hot Springs Creek	HS36	1373	1369	354	6	12	53,100	12	53,100
4th St & Greenwood Ave	Hot Springs Creek	HS62	2307	2395	116	10	15	17,980	15	17,980
4th St & Greenwood Ave	Hot Springs Creek	HS36	2308	2307	386	10	12	52,110	12	52,110
4th St & Greenwood Ave	Hot Springs Creek	HS36	2310	2308	244	8	12	36,600	12	36,600
4th St & Greenwood Ave	Hot Springs Creek	HS36	2311	2310	18	8	12	2,430	12	2,430
4th St & Greenwood Ave	Hot Springs Creek	HS62	2395	1226	327	12	15	50,685	15	50,685
4th St & Greenwood Ave	Hot Springs Creek	HS36	2418	9991	14	8	12	1,890	12	1,890
4th St & Greenwood Ave	Hot Springs Creek	HS36	2419	2418	334	8	12	50,100	12	50,100
4th St & Greenwood Ave	Hot Springs Creek	HS62	2668	1257	106	10[2/]	10[2/]	13,250	10[2/]	13,250
4th St & Greenwood Ave	Hot Springs Creek	HS62	9956	1307	268	8	10	33,500	10	33,500
4th St & Greenwood Ave	Hot Springs Creek	HS62	9957	1316	16	8	10	2,160	10	2,160
4th St & Greenwood Ave	Hot Springs Creek	HS36	9988	2311	258	8	12	34,830	12	34,830
4th St & Greenwood Ave	Hot Springs Creek	HS36	9989	9988	195	8	12	26,325	12	26,325

1/ *Size with corrected slope.*

2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
4th St & Greenwood Ave	Hot Springs Creek	HS36	9990	9989	59	8	12	7,965	12	7,965
4th St & Greenwood Ave	Hot Springs Creek	HS36	9991	9990	41	8	12	6,150	12	6,150
4th St & Greenwood Ave	Hot Springs Creek	HS36	9999	2419	268	6	12	40,200	12	40,200
4th St & Greenwood Ave	Hot Springs Creek	HS62	10023	10024	125	8	12	16,875	12	16,875
4th St & Greenwood Ave	Hot Springs Creek	HS62	10024	1259	45	8	12	6,075	12	6,075
Albert Pike Rd	Highway 270	HS62	7770	7771	69	10	15	12,420	15	12,420
Albert Pike Rd	Highway 270	HS62	7771	7772	275	10	15	49,500	15	49,500
Albert Pike Rd	Highway 270	HS62	7772	7773	36	10	15	6,480	15	6,480
Albert Pike Rd	Highway 270	HS62	7773	Highway 270 PS	24	12	15	4,320	15	4,320
Albert Pike Rd	Fairwood	HS62	9452	9451	148	12	15	24,420	15	24,420
Albert Pike Rd	Fairwood	HS62	9453	9452	396	12	15	61,380	15	61,380
Albert Pike Rd	Fairwood	HS62	9454	9453	282	12	15	46,530	15	46,530
Albert Pike Rd	Fairwood	HS08	9455	9454	106	12	15	19,080	15	19,080
Albert Pike Rd	Fairwood	HS08	9456	9455	399	12	15	65,835	15	65,835
Albert Pike Rd	Fairwood	HS08	9457	9456	320	12	15	52,800	15	52,800
Albert Pike Rd	Fairwood	HS62	9493	Fairwood PS	45	12	18	8,775	18	8,775
Albert Pike Rd	Fairwood	HS62	9521	9493	391	12	18	76,245	18	76,245
Albert Pike Rd	Fairwood	HS62	9522	9521	15	12	18	2,775	18	2,775
Albert Pike Rd	Fairwood	HS62	9523	9522	201	12	18	34,170	18	34,170
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	85	1004	232	27	42	95,120	42	95,120

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	89	85	211	27	36	71,740	36	71,740
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	90	89	393	27	36	133,620	36	133,620
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	91	90	101	27	36	43,935	36	43,935
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	92	91	312	27	36	135,720	36	135,720
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	93	92	202	27	36	87,870	36	87,870
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	94	93	261	27	36	117,450	36	117,450
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	95	94	139	27	36	62,550	36	62,550
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	96	95	396	27	36	178,200	36	178,200
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	97	96	230	27	36	105,110	36	105,110
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	115	97	221	27	36	93,925	36	93,925
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	116	115	325	8	10	40,625	10	40,625
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	117	116	218	8	10	27,250	10	27,250
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	118	117	275	8	10	34,375	10	34,375
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	119	118	168	8	10	21,000	10	21,000
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	161	5337	79	27	36	28,045	36	28,045
Hot Springs Creek Interceptor	Hot Springs Creek	HS44	414	1897	9	27	42	4,410	42	4,410
Hot Springs Creek Interceptor	Hot Springs Creek	HS44	1002	414	355	46[1/]	42[1/]	175,435	42[1/]	175,435
Hot Springs Creek Interceptor	Hot Springs Creek	HS44	1003	1002	202	46[1/]	42[1/]	89,890	42[1/]	89,890
Hot Springs Creek Interceptor	Hot Springs Creek	HS44	1004	1003	360	48[1/]	42[1/]	155,520	42[1/]	155,520
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1300	1860	327	36	48	240,345	48	240,345
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1860	1861	166	36	48	122,010	48	122,010

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1861	1862	388	36	48	385,180	48	385,180
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1862	1863	288	36	48	158,400	48	158,400
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	1863	1864	291	36	48	160,050	48	160,050
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	1864	1865	250	36	48	139,250	48	139,250
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	1865	1866	131	36	48	66,810	48	66,810
Hot Springs Creek Interceptor	Hot Springs Creek	HS44	1897	1898	239	27	42	117,110	42	117,110
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1898	1899	368	27	42	182,896	42	182,896
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1899	1900	34	27	42	16,898	42	16,898
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1900	1901	296	27	42	147,112	42	147,112
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1901	1902	201	27	42	83,832	42	83,832
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1902	1903	271	27	42	136,855	42	136,855
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1903	1904	283	27	42	142,915	42	142,915
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1904	1905	389	27	42	196,445	42	196,445
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1905	1906	320	27	42	161,600	42	161,600
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1906	1912	183	27	42	92,415	42	92,415
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1911	1913	340	36	48	189,380	48	189,380
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1912	1911	109	36	48	60,713	48	60,713
Hot Springs Creek Interceptor	Hot Springs Creek	HS49A	1913	1300	317	36	48	235,214	48	235,214
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3714	3716	303	8	12	53,025	10	49,995
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3716	3717	292	8	12	51,100	10	48,180
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3717	3723	94	8	12	16,450	12	16,450

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3723	3724	150	8	12	26,250	12	26,250
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3724	3725	239	8	12	41,825	12	41,825
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3725	11179	121	8	12	21,175	12	21,175
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3726	3727	232	8	12	40,600	12	40,600
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3727	3728	330	8	12	44,550	12	44,550
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	3728	11481	162	8	12	21,870	12	21,870
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	3729	12242	118	10	12	20,650	12	20,650
Hot Springs Creek Interceptor	Hot Springs Creek	HS43	5337	115	36	27	36	15,300	36	15,300
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	11179	3726	142	8	12	24,850	12	24,850
Hot Springs Creek Interceptor	Hot Springs Creek	HS49B	11465	3737	79	6	8	11,850	8	11,850
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	11481	3729	123	8	12	16,605	12	16,605
Hot Springs Creek Interceptor	Hot Springs Creek	HS54	12242	1864	128	10	12	24,320	12	24,320
Lake Hamliton Dr	Hot Springs #2	HS11	8310	8311	294	8	10	44,100	10	44,100
Lake Hamliton Dr	Hot Springs #2	HS11	8311	8312	122	8	10	19,154	10	19,154
Lake Hamliton Dr	Hot Springs #2	HS11	8312	8313	141	8	10	22,137	10	22,137
Lake Hamliton Dr	Hot Springs #2	HS11	8313	8314	124	6	10	17,360	10	17,360
Lake Hamliton Dr	Hot Springs #2	HS11	8343	8344	311	10	15	65,932	15	65,932
Lake Hamliton Dr	Hot Springs #2	HS11	8344	8345	253	10	15	53,636	15	53,636
Lake Hamliton Dr	Hot Springs #2	HS11	8345	8346	192	10	15	33,984	15	33,984
Lake Hamliton Dr	Hot Springs #2	HS11	8346	8347	117	10	15	20,709	15	20,709

1/ *Size with corrected slope.*

2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Lake Hamliton Dr	Hot Springs #2	HS11	8347	Hot Springs #2 PS	17	12	15	3,604	15	3,604
Park Ave	Hot Springs Creek	HS16	3554	3552	323	6	10	43,605	10	43,605
Park Ave	Hot Springs Creek	HS16	3645	3541	135	8	10	18,225	10	18,225
Park Ave	Hot Springs Creek	HS16	3646	3645	61	6	10	8,235	10	8,235
Park Ave	Hot Springs Creek	HS16	3648	3646	256	6	10	34,560	10	34,560
Seneca St	Hot Springs Creek	HS45	868	867	82	8	12	11,070	12	11,070
Seneca St	Hot Springs Creek	HS45	2011	2008	203	8	12	35,525	12	35,525
Seneca St	Hot Springs Creek	HS45	2012	2011	147	8	12	25,725	12	25,725
Seneca St	Hot Springs Creek	HS45	2013	2012	123	8	12	21,525	12	21,525
Seneca St	Hot Springs Creek	HS45	2014	2013	128	8	10	21,120	10	21,120
Seneca St	Hot Springs Creek	HS45	2020	10668	119	6	8	15,470	8	15,470
Seneca St	Hot Springs Creek	HS45	2064	2070	130	6	8	16,250	8	16,250
Seneca St	Hot Springs Creek	HS45	2065	2064	334	6	8	41,750	8	41,750
Seneca St	Hot Springs Creek	HS45	2070	2010	259	6	8	29,785	8	29,785
Seneca St	Hot Springs Creek	HS45	2107	868	39	8	10	5,265	10	5,265
Seneca St	Hot Springs Creek	HS45	2110	2107	178	8	10	24,030	10	24,030
Seneca St	Hot Springs Creek	HS45	2111	2110	153	10	10	19,125	10	19,125
Seneca St	Hot Springs Creek	HS45	2117	2116	148	6	8	17,020	8	17,020
Seneca St	Hot Springs Creek	HS45	2119	2117	107	6	8	12,305	8	12,305
Seneca St	Hot Springs Creek	HS45	3678	2048	130	6	8	16,250	8	16,250

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Seneca St	Hot Springs Creek	HS45	3679	3678	302	6	8	37,750	8	37,750
Seneca St	Hot Springs Creek	HS45	9980	2020	284	6	8	39,760	8	39,760
Seneca St	Hot Springs Creek	HS45	9981	9980	198	6	8	24,750	8	24,750
Seneca St	Hot Springs Creek	HS45	10668	2019	8	6	8	920	8	920
Seneca St	Hot Springs Creek	HS45	12082	12084	166	8	10	20,750	10	20,750
Seneca St	Hot Springs Creek	HS45	12084	12085	16	8	10	2,000	10	2,000
Seneca St	Hot Springs Creek	HS45	12085	12086	29	8	10	3,915	10	3,915
Seneca St	Hot Springs Creek	HS45	12086	2111	72	8	10	9,000	10	9,000
Shady Grove Rd	Hot Springs Creek	HS42	168	167	163	12	18	30,155	18	30,155
Shady Grove Rd	Hot Springs Creek	HS42	169	168	183	12	18	31,110	18	31,110
Shady Grove Rd	Hot Springs Creek	HS42	170	169	59	12	18	10,030	18	10,030
Shady Grove Rd	Hot Springs Creek	HS42	176	1118	58	12	15	9,860	15	9,860
Shady Grove Rd	Hot Springs Creek	HS42	178	176	137	12	15	23,290	15	23,290
Shady Grove Rd	Hot Springs Creek	HS42	179	178	151	12	15	23,405	15	23,405
Shady Grove Rd	Hot Springs Creek	HS42	180	179	332	12	15	51,460	15	51,460
Shady Grove Rd	Hot Springs Creek	HS42	182	180	216	12	15	33,480	15	33,480
Shady Grove Rd	Hot Springs Creek	HS42	183	182	272	8	12	36,720	12	36,720
Shady Grove Rd	Hot Springs Creek	HS42	184	183	126	8	12	22,050	12	22,050
Shady Grove Rd	Hot Springs Creek	HS42	185	184	274	8	12	47,950	12	47,950
Shady Grove Rd	Hot Springs Creek	HS42	227	182	69	10[2/]	10[2/]	9,315	10[2/]	9,315
Shady Grove Rd	Hot Springs Creek	HS42	229	227	257	10[2/]	10[2/]	34,695	10[2/]	34,695

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Shady Grove Rd	Hot Springs Creek	HS42	230	229	266	8	10	35,910	10	35,910
Shady Grove Rd	Hot Springs Creek	HS42	231	709	207	6	8	23,805	8	23,805
Shady Grove Rd	Hot Springs Creek	HS42	236	231	201	6	8	25,125	8	25,125
Shady Grove Rd	Hot Springs Creek	HS42	238	10021	199	6	8	22,885	8	22,885
Shady Grove Rd	Hot Springs Creek	HS42	241	238	164	6	8	20,500	8	20,500
Shady Grove Rd	Hot Springs Creek	HS42	244	241	265	6	8	33,125	8	33,125
Shady Grove Rd	Hot Springs Creek	HS42	277	2266	161	6	8	20,125	8	20,125
Shady Grove Rd	Hot Springs Creek	HS42	278	277	242	6	8	33,880	8	33,880
Shady Grove Rd	Hot Springs Creek	HS42	280	278	235	6	8	29,375	8	29,375
Shady Grove Rd	Hot Springs Creek	HS42	709	230	130	6	8	16,250	8	16,250
Shady Grove Rd	Hot Springs Creek	HS42	1108	170	387	12	18	65,790	18	65,790
Shady Grove Rd	Hot Springs Creek	HS42	1118	1995	152	12	18	29,184	18	29,184
Shady Grove Rd	Hot Springs Creek	HS42	1995	2758	143	12	18	27,456	18	27,456
Shady Grove Rd	Hot Springs Creek	HS42	2266	182	125	6	8	15,625	8	15,625
Shady Grove Rd	Hot Springs Creek	HS42	2758	1108	109	12	18	18,530	18	18,530
Shady Grove Rd	Hot Springs Creek	HS42	10020	236	79	6	8	9,875	8	9,875
Shady Grove Rd	Hot Springs Creek	HS42	10021	10020	61	6	8	7,625	8	7,625
	Subtotal				31,747			8,049,521		8,043,571

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

Table 4-C (Cont.)

REQUIRED PRIORITY 2 LOCAL CAPACITY IMPROVEMENT PROJECTS BY TRIBUTARY AREA

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	No I-I Reduction Cost ($)	I-I Reduction Diameter (in)	I-I Reduction Cost ($)
Hot Springs Creek Tributary Area										
Carpenter Dam Rd	Catherine Heights	HS54	5257	5258	197	10	15	40,385	15	40,385
Carpenter Dam Rd	Catherine Heights	HS54	5258	5259	216	10	18	39,960	15	36,720
Carpenter Dam Rd	Catherine Heights	HS54	5259	Lakeside PS	69	10	18	12,765	15	11,730
Carpenter Dam Rd	Catherine Heights	HS54	5260	5257	336	8	15	52,080	15	52,080
Carpenter Dam Rd	Carpenter Dam	HS53	5263	5260	269	10	15	41,695	15	41,695
	Subtotal				1,086			186,885		182,610
Mazarn Tributary Area										
Marion Anderson Rd	Mazarn	HS60	9269	Mazarn #2 PS	17	10	12	2,550	12	2,550
Marion Anderson Rd	Mazarn	HS60	9270	9269	180	10	12	2,700	12	2,700
Marion Anderson Rd	Mazarn	HS60	9271	9270	109	10	12	16,350	12	16,350
	Subtotal				306			21,600		21,600
	Total Gravity				**67,424**			**21,882,611**		**20,816,581**
Force Mains										
Hot Springs Creek Pump Station Tributary Area										
Farrs Landing FM	Hot Springs #2	HS11	HsFMBreak 3069	HsFMBreak 2767	732	6	8	84,180	6	73,200
	Subtotal				732			84,180		73,200
	Total Force Main				**732**			**84,180**		**73,200**

1/ *Size with corrected slope.*
2/ *Recommended due to proximity between required projects.*

UNDOCUMENTED / MODEL PREDICTED OVERFLOWS

Several manholes that are not known overflow locations were predicted by the model to overflow during the design storm event and require verification by City staff. A map outlining the locations of the model predicted overflows can be seen in Figure 4.13. As such, sewerline projects were proposed to eliminate each of these modeled overflows. In all, there are four individual projects, totaling 17,909 feet of new 8-inch to 24-inch diameter sewer lines.

It is recommended that the City of Hot Springs conduct a site visit of each location to inspect for any evidence of overflow prior to initiating any improvement project. If no evidence is observed it is recommended that the City of Hot Springs visit each location and adjacent manholes during a heavy storm event to determine the level of surcharging and potential for overflows. These overflows may not actually occur and could be predicted by the model because model geometry is different than what actually exist in the system.

A summary of the minor pump station improvements to eliminate model predicted overflows is shown in Table 4-D.

Table 4-D

MINOR PUMP STATION IMPROVEMENTS TO ELIMINATE MODEL PREDICED OVERFLOWS

Pump Station	Tributary Area	Existing Size (mgd)	Recommended Size (mgd)
Wilsons Mill	Gulpha	0.47	0.87
Harold Drive	Stokes	0.53	0.57
Moonlight Bay	Hot Springs Creek	0.19	0.20
Quail House	Hot Springs Creek	0.74	1.08

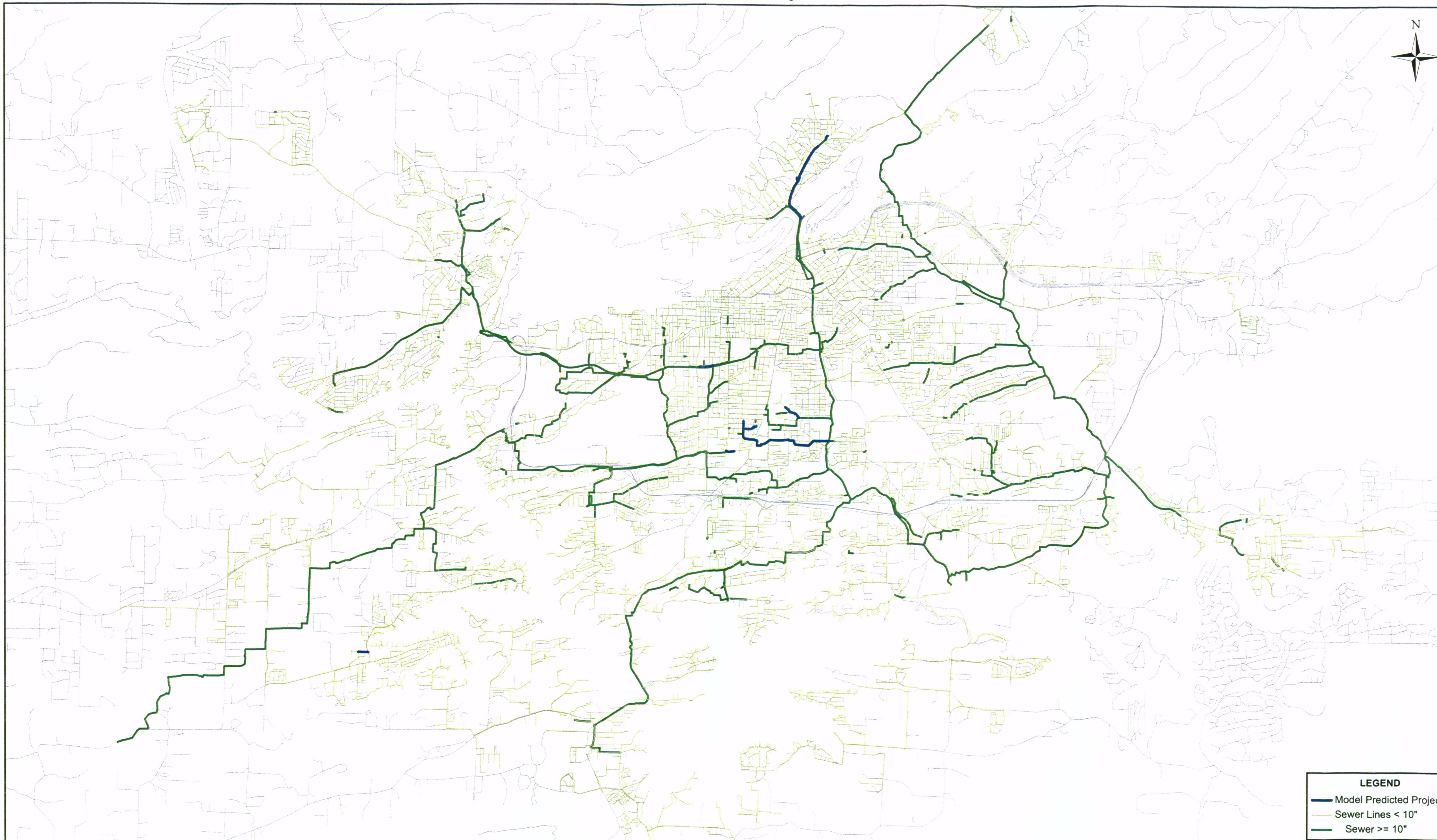
A summary of the improvements required to eliminate these overflows, if verified, is given in Table 4-E.

SYSTEM IMPROVEMENT PROJECTS

Following the local pipeline capacity improvements to convey flow to the major pump stations, the system was analyzed as a complete unit. This was necessary in order to assess the impact of local improvements on the overall system. This is important due to the complex interconnectivity of the sewer system. For this step the system was subdivided into five areas. These are the Gulpha Pump Station tributary area, Stokes Pump Station tributary area, Hot Springs Creek tributary area, Mazarn tributary area and the Davidson WWTP tributary area.

Several alternatives were evaluated in the model for each major tributary area. Each alternative was analyzed based on hydraulic impact, constructability, and cost. Options were reviewed with staff from the City of Hot Springs and the following paragraphs reflect the alternative solutions.

Model Predicted Projects



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HOT SPRINGS
NATIONAL PARK ARKANSAS

CITY OF HOT SPRING
MODEL PREDICTED PROJECT
FIGURE 4.1

Table 4-E

IMPROVEMENTS TO ELIMINATE MODEL PREDICTED OVERFLOWS (IF REQUIRED)

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	I-I Reduction Diameter (in)
Marion Anderson Road	Mazarn	HS02	9400	9398	61	6	8	8
Marion Anderson Road	Mazarn	HS02	9401	9400	240	6	8	8
Marion Anderson Road	Mazarn	HS02	9402	9401	347	6	8	8
Park Avenue	Hot Springs Creek	HS17	114	3447	103	8	18	18
Park Avenue	Hot Springs Creek	HS32	651	650	50	12	18	18
Park Avenue	Hot Springs Creek	HS17	661	667	198	12	18	18
Park Avenue	Hot Springs Creek	HS17	662	661	267	12	18	18
Park Avenue	Hot Springs Creek	HS17	663	662	147	12	18	18
Park Avenue	Hot Springs Creek	HS17	665	663	75	12	18	18
Park Avenue	Hot Springs Creek	HS17	666	665	331	12	18	18
Park Avenue	Hot Springs Creek	HS17	667	651	75	12	18	18
Park Avenue	Hot Springs Creek	HS17	1939	3446	171	8	18	18
Park Avenue	Hot Springs Creek	HS17	2660	3748	77	8	10	10
Park Avenue	Hot Springs Creek	HS17	3445	666	134	12	18	18
Park Avenue	Hot Springs Creek	HS17	3446	3445	32	12	18	18
Park Avenue	Hot Springs Creek	HS17	3447	1939	103	8	18	18
Park Avenue	Hot Springs Creek	HS17	3457	114	250	8	18	18
Park Avenue	Hot Springs Creek	HS17	3459	10625	163	8	18	18
Park Avenue	Hot Springs Creek	HS17	3462	3459	147	8	15	15
Park Avenue	Hot Springs Creek	HS17	3465	3462	187	8	15	15
Park Avenue	Hot Springs Creek	HS17	3477	3465	264	8	15	15
Park Avenue	Hot Springs Creek	HS17	3479	3477	175	8	15	15
Park Avenue	Hot Springs Creek	HS17	3483	3479	311	8	15	15

Table 4-E (Cont.)

IMPROVEMENTS TO ELIMINATE MODEL PREDICTED OVERFLOWS (IF REQUIRED)

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	I-I Reduction Diameter (in)
Park Avenue	Hot Springs Creek	HS17	3484	3483	188	8	15	15
Park Avenue	Hot Springs Creek	HS17	3488	3484	204	8	15	15
Park Avenue	Hot Springs Creek	HS17	3490	3488	395	8	15	15
Park Avenue	Hot Springs Creek	HS17	3513	3490	345	8	15	15
Park Avenue	Hot Springs Creek	HS17	3514	3515	18	10	15	15
Park Avenue	Hot Springs Creek	HS17	3515	3513	111	8	15	15
Park Avenue	Hot Springs Creek	HS16	3521	3514	375	10	15	15
Park Avenue	Hot Springs Creek	HS16	3540	3521	277	10	15	15
Park Avenue	Hot Springs Creek	HS16	3541	3540	82	10	15	15
Park Avenue	Hot Springs Creek	HS16	3544	3541	275	10	15	15
Park Avenue	Hot Springs Creek	HS16	3552	3551	14	6	10	10
Park Avenue	Hot Springs Creek	HS16	3581	3552	262	6	10	10
Park Avenue	Hot Springs Creek	HS16	3582	3581	53	6	10	10
Park Avenue	Hot Springs Creek	HS17	3748	3477	209	8	10	10
Park Avenue	Hot Springs Creek	HS17	10625	3457	180	8	18	18
S Patterson Street	Hot Springs Creek	HS39	1791	1792	115	10	15	15
S Patterson Street	Hot Springs Creek	HS39	1792	1793	158	10	15	15
S Patterson Street	Hot Springs Creek	HS39	1793	1794	363	10	15	15
S Patterson Street	Hot Springs Creek	HS39	1794	963	254	12	15	15
Seneca Street	Hot Springs Creek	HS45	730	2007	158	12	24	24
Seneca Street	Hot Springs Creek	HS45	867	2106	30	8	12	12
Seneca Street	Hot Springs Creek	HS45	884	2098	135	8	12	12
Seneca Street	Hot Springs Creek	HS44	1035	1013	309	8	12	12

Table 4-E (Cont.)

IMPROVEMENTS TO ELIMINATE MODEL PREDICTED OVERFLOWS (IF REQUIRED)

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	I-I Reduction Diameter (in)
Seneca Street	Hot Springs Creek	HS44	1036	1035	117	8	12	12
Seneca Street	Hot Springs Creek	HS44	1037	2795	104	8	12	12
Seneca Street	Hot Springs Creek	HS44	1930	1037	316	8	12	12
Seneca Street	Hot Springs Creek	HS45	2003	1899	216	12	27	27
Seneca Street	Hot Springs Creek	HS45	2004	2003	6	12	27	27
Seneca Street	Hot Springs Creek	HS45	2005	2004	408	15	27	27
Seneca Street	Hot Springs Creek	HS45	2006	2005	380	15	27	27
Seneca Street	Hot Springs Creek	HS45	2007	2006	216	12	24	24
Seneca Street	Hot Springs Creek	HS45	2008	730	56	12	24	24
Seneca Street	Hot Springs Creek	HS45	2009	2008	297	12	24	24
Seneca Street	Hot Springs Creek	HS45	2010	2009	346	12	24	24
Seneca Street	Hot Springs Creek	HS45	2031	2010	234	12	24	24
Seneca Street	Hot Springs Creek	HS45	2032	2031	279	12	24	24
Seneca Street	Hot Springs Creek	HS45	2033	2032	106	12	24	24
Seneca Street	Hot Springs Creek	HS45	2034	2033	187	12	24	24
Seneca Street	Hot Springs Creek	HS45	2035	2034	62	12	24	24
Seneca Street	Hot Springs Creek	HS45	2036	2035	270	12	24	24
Seneca Street	Hot Springs Creek	HS45	2037	2036	316	12	24	24
Seneca Street	Hot Springs Creek	HS45	2038	2037	296	12	24	24
Seneca Street	Hot Springs Creek	HS45	2039	2038	308	12	24	24
Seneca Street	Hot Springs Creek	HS45	2040	2039	123	12	24	24
Seneca Street	Hot Springs Creek	HS45	2041	2040	75	12	21	21
Seneca Street	Hot Springs Creek	HS45	2042	2041	248	12	21	21
Seneca Street	Hot Springs Creek	HS45	2043	2042	231	12	21	21
Seneca Street	Hot Springs Creek	HS45	2044	2043	72	12	21	21

Table 4-E (Cont.)

IMPROVEMENTS TO ELIMINATE MODEL PREDICTED OVERFLOWS (IF REQUIRED)

Project	City Basin	RJN Meter Basin	USMH	DSMH	Length (lf)	Existing Diameter (in)	No I-I Reduction Diameter (in)	I-I Reduction Diameter (in)
Seneca Street	Hot Springs Creek	HS45	2045	2044	153	12	21	21
Seneca Street	Hot Springs Creek	HS45	2046	2045	96	12	21	21
Seneca Street	Hot Springs Creek	HS45	2047	2046	310	12	18	18
Seneca Street	Hot Springs Creek	HS45	2085	2047	227	12	18	18
Seneca Street	Hot Springs Creek	HS45	2086	2085	196	10	18	18
Seneca Street	Hot Springs Creek	HS45	2092	2086	184	10	18	18
Seneca Street	Hot Springs Creek	HS45	2093	2092	32	10	18	18
Seneca Street	Hot Springs Creek	HS45	2094	2093	176	10	18	18
Seneca Street	Hot Springs Creek	HS45	2095	2094	200	10	18	18
Seneca Street	Hot Springs Creek	HS45	2096	2095	162	10	18	18
Seneca Street	Hot Springs Creek	HS45	2097	2096	348	8	15	15
Seneca Street	Hot Springs Creek	HS45	2098	2097	330	8	12	12
Seneca Street	Hot Springs Creek	HS45	2101	884	203	8	12	12
Seneca Street	Hot Springs Creek	HS45	2102	2101	76	8	12	12
Seneca Street	Hot Springs Creek	HS45	2106	2102	154	8	12	12
Seneca Street	Hot Springs Creek	HS45	2114	2097	324	6	8	8
Seneca Street	Hot Springs Creek	HS45	2116	2114	187	6	8	8
Seneca Street	Hot Springs Creek	HS44	2795	3788	117	8	12	12
Seneca Street	Hot Springs Creek	HS44	3788	1036	219	8	12	12
Seneca Street	Hot Springs Creek	HS46	6609	6598	149	8	10	10
Seneca Street	Hot Springs Creek	HS46	6610	6609	386	8	10	10
	Total				**17,909**			

GULPHA PUMP STATION TRIBUTARY AREA

The current 21-30 inch diameter interceptor providing flow to the Gulpha Pump Station is significantly under capacity. The interceptor is recommended to be increased in size to 27-42 inches in diameter. This will increase the peak flow and the volume at the pump station.

After the construction of the upstream Priority 1 and 2 local interceptor capacity improvements, the Gulpha Pump Station is projected to receive a peak wet-weather flow rate of approximately 30 MGD. This would most likely require construction of a new 30 MGD station versus upgrading of the existing station.

Increasing the Gulpha Pump Station to a capacity of 30 MGD will significantly overload the downstream pipeline system even more than currently exists. The existing Gulpha Pump Station discharges into a 24-inch diameter force main which flows into a 24-inch diameter gravity sewer before discharging into the Davidson WWTP. To alleviate overloading the downstream system and resulting sanitary sewer overflows (SSOs), several alternatives were evaluated. These included the following:

1. Construct a new force main to existing discharge point and construct new downstream gravity sewer to WWTP.

2. Construct parallel force main from Gulpha Pump Station to existing discharge point and construct parallel gravity sewer to WWTP.

3. Construct parallel force main from Gulpha Pump Station to WWTP.

4. Construct Flow Equalization Basin.

After evaluation of each alternative, Alternative No. 3 was selected. A summary of the components of this alternative is given in Table 4-F.

Table 4-F

GULPHA PUMP STATION
RECOMMENDED ALTERNATIVE NO. 3

Component	Quantity	Size	Unit
Pump Station	1	30	mgd
Parallel Force Main	16,016	30	Inch-diameter

Construction of this alternative is approximately $0.8 million less expensive than the other alternatives evaluated and along with the local capacity improvements will eliminate all of the known and model predicted SSOs in the tributary area. A summary of recommended alternative construction costs can be found in Table 4-J.

The new pump station would be configured to allow dry-weather flow to use the existing 24-inch diameter main. During wet-weather events, the peak flow through the existing main would be limited to 6.7 MGD. This prevents overloading of the downstream gravity sewer main. All additional flow would be routed through a new 30-inch diameter force main that runs from the Gulpha Pump Station to Davidson WWTP. Figure 4.14 shows the location of the new 30-inch diameter force main.

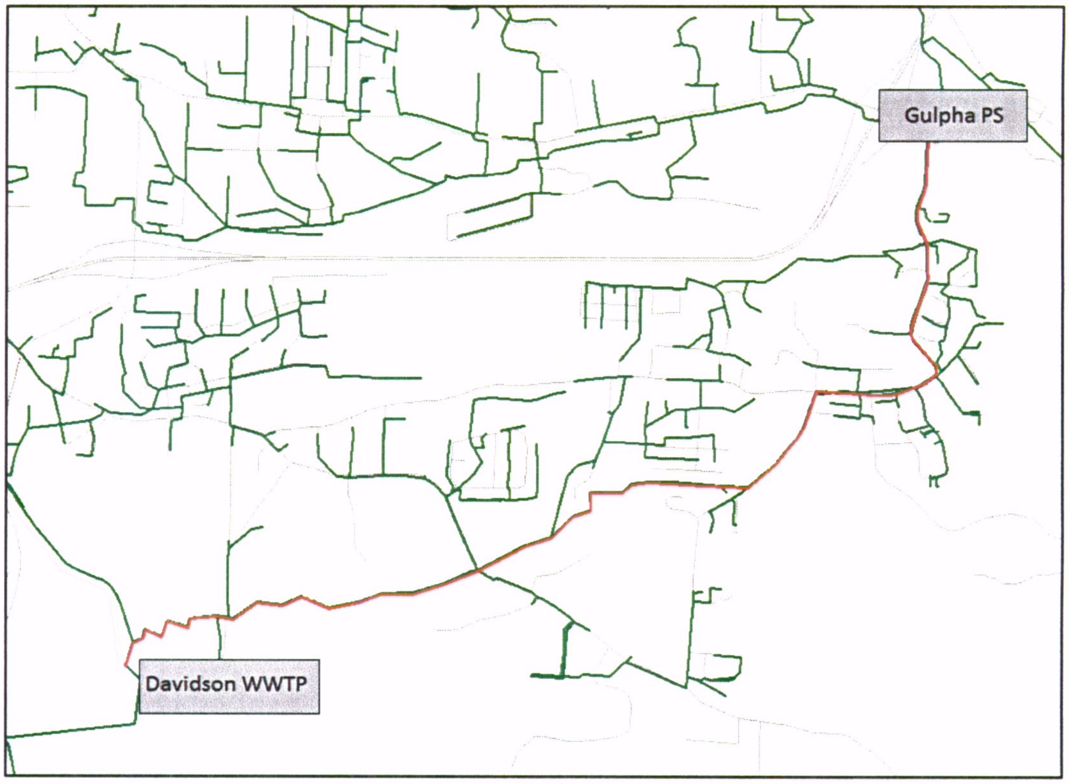


Figure 4.14: Gulpha Wet-Weather Parallel Force Main
Alternative No. 3

If inflow and infiltration reduction were taken into account for the pump station sizing, then the station would have a required capacity of approximately 25 MGD and the additional wet-weather force main would be a 27-inch diameter.

STOKES PUMP STATION TRIBUTARY AREA

The Stokes local system recommendations are similar to those upstream of the Gulpha Pump Station. The existing 18-inch diameter interceptor is currently under capacity and should be increased in size to 30 inches in diameter.

The new interceptor increases the peak flow and the volume at the existing pump station. If all three existing pumps at the existing Stokes Pump Station are fully operational, the current pump station has the capacity required to convey the increased flow. However, the existing 24-inch diameter force main would be outside the allowable velocity and pressure limits and increasing its diameter would overload the downstream system resulting in additional SSOs.

To alleviate this potential, several alternatives were evaluated. These alternatives included the following:

1. Construct a new force main to existing discharge point and increase capacity of the downstream gravity sewer, Hot Springs Creek Pump Station and force main.

2. Construct a new force main and connect to new Fairwood force main currently under construction.

3. Construct deep tunnel from the Stokes interceptor to the Hot Springs Creek Pump Station and eliminate requirements for local Stokes interceptor improvements.

4. Construct parallel force main from Stokes Pump Station to Davidson WWTP.

5. Construct flow equalization basin

After evaluation of each alternative, Alternative No. 4 was selected. A new 24-inch diameter force main would be constructed from the Stokes Pump Station to Davidson WWTP. The station would be configured to allow dry-weather to use the existing 24- inch diameter main. During wet weather events, the peak flow through the existing main would be limited to 7.6 MGD. This prevents overloading of the downstream gravity sewer main. All additional flow would be routed through the new force main shown in Figure 4.15. A summary of the selected alternatives is given in Table 4-G.

Table 4-G

STOKES PUMP STATION TRIBUTARY AREA RECOMMENDED ALTERNATIVE NO. 4

Item	Length (lf)	Diameter (in)
Parallel Force Main	29,751	24

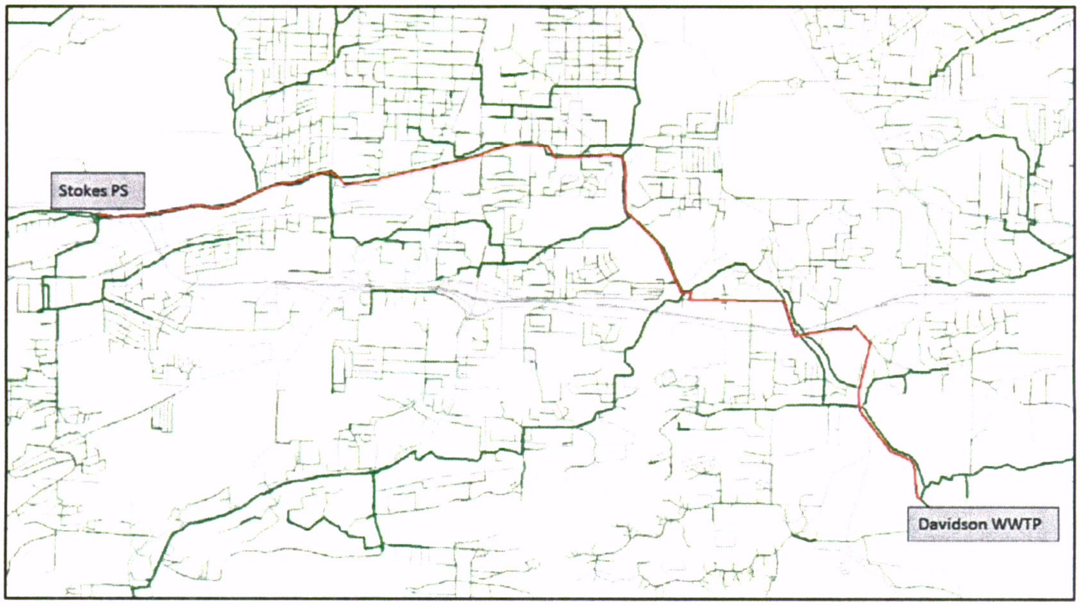


Figure 4.15 Stokes Wet-Weather Parallel Force Main Alternative No. 4

Construction of this selected alternative along with the local capacity improvements will eliminate all known and model predicted overflows in the Tributary Area. The selected alternative is also approximately $3.0 million less expensive than the other viable alternatives. A summary of recommended alternative construction costs can be found in Table 4-I.

HOT SPRINGS CREEK TRIBUTARY AREA

Although the Fairwood force main project is removing flow from the existing Hot Springs Creek interceptor, the interceptor is still predicted to have high surcharge levels and overflows. The interceptor requires an increase in size from 27-36 inches to 36-42 inches in diameter.

The increased size of the interceptor increases the peak wet-weather flow and volume at the pump station. The Hot springs Creek Pump Station would have to be increased in capacity to approximately 51 MGD.

The increased output of the pump station causes the proposed 36-inch diameter Fairwood force main to fall outside of velocity and pressure limits. To relieve this force main, several alternatives were evaluated. These include:

1. Using the proposed 36-inch diameter force main in conjunction with the existing 30-inch diameter force main for wet or dry weather.

2. Increasing the size of the proposed 36-inch diameter force main for wet and dry weather.

3. Increasing the size of the proposed 36-inch diameter force main and constructing a parallel force main for dry weather.

After evaluation of each alternative, Alternative No. 3 was selected. A summary of the components of this alternative is given in Table 4-H.

Table 4-H

HOT SPRINGS CREEK PUMP STATION TRIBUTARY AREA RECOMMENDED ALTERNATIVE NO. 3

Component	Quantity	Size	Unit
Pump Station	1	51	MGD
Increase Size of Proposed Force Main	11,182	42	Inch-diameter
Parallel Force Main	11,182	24	Inch-diameter

Since the selected alternative was the only hydraulically feasible alternative, the other solutions were not priced. A summary of recommended alternative construction costs can be found in Table 4-J.

The Hot Springs Creek Pump Station is currently slated to be manifolded into the new 36-inch diameter force main from Fairwood. This will create a new pressure system that pumps to Davidson WWTP. The new force main is designed to be 36 inches in diameter from Hot Springs Creek to Davidson WWTP. With the increased capacity of the pump station, this segment of the force main should be increased to 42 inches in diameter. Additionally, a 24-inch diameter force main should be constructed parallel to the 42-inch for use during wet-weather events. This dual force main configuration is necessary to maintain high enough dry weather velocities in the 42-inch diameter force main.

Hot Springs Creek Pump Station benefits the most from inflow and infiltration reduction. The station would not require any improvements under this scenario. The Fairwood force main from Hot Springs Creek to Davidson WWTP would still need to be increased to 42 inches in diameter from the designed size of 36 inches. The wet weather 24-inch diameter force main would not be required in this scenario.

MAZARN / SOUTHWEST WWTP TRIBUTARY AREA

The flow from the Mazarn system is currently routed through a lengthy pressure system before it reaches the Southwest WWTP. To eliminate the long route, it is recommended to construct a new 10-inch diameter force main from Mazarn Pump Station #4 and manifolded into the force main from South Rogers Pump Station. This new pressure system will re-route flow from upstream of Mazarn Pump Station #4. The location of the new force main and the tie-in to the existing pressure system is shown in Figure 4.16. The new force main will significantly reduce the length of pressure main that flow must travel through. In addition, the new route will save on long-term operations and maintenance costs from the elimination of re-pumping.

The Southwest WWTP currently has an operational capacity of approximately 1.0 MG. This limits the amount of flow that can be treated from the Mazarn area of the City. In order to limit the flow at the plant to this volume during wet-weather periods, the valve at Pump Station 70 West #4 must be configured to permanently direct flow across Lake Hamilton. In addition, volume from the South Rogers diversion should be limited to 0.2 MG during wet weather events. These changes limit the peak 24-hour volume at the Southwest WWTP to below the operational capacity.

Recommended improvements are shown on Table 4-I.

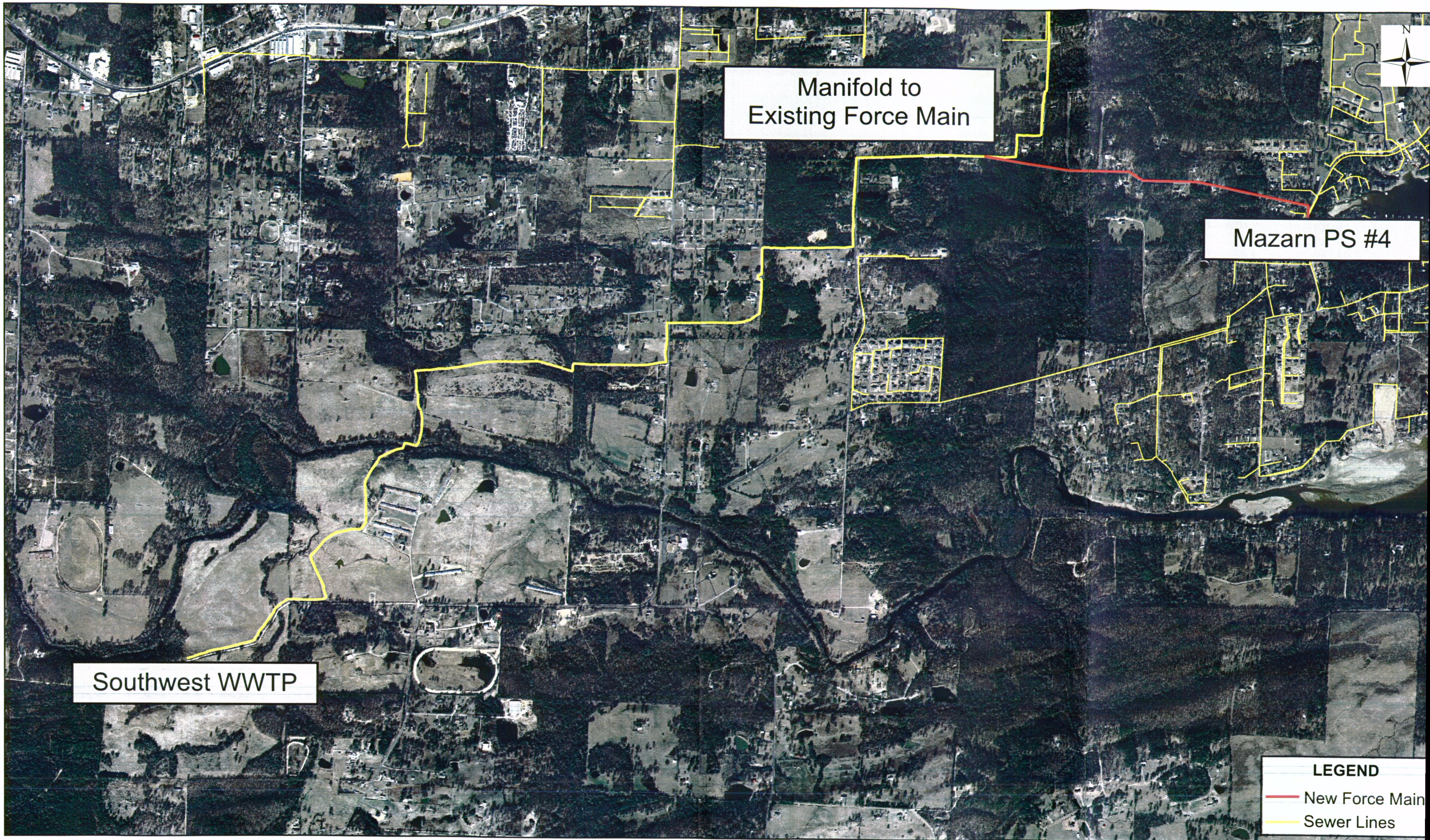
Table 4-I

MAZARN / SOUTHWEST WWTP TRIBUTARY AREA RECOMMENDED IMPROVEMENTS

Component	Quantity	Size	Unit
Mazarn PS # 4	1	1.25	MGD
New Force Main	4,996	10	Inch-diameter

A summary of the recommended alternative construction costs can be found in Table 4-J.

MAZARN PS #4 FORCE MAIN



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HOT SPRINGS

CITY OF HOT SPRING
NEW MAZARN FORCE MAI
FIGURE 4.1

DAVIDSON WWTP

With the recommended capacity improvements and not taking credit for inflow and infiltration reduction, the peak design storm flow rate received at the Davidson WWTP is predicted to be approximately 104 MGD. The peak 24-hour volume of flow is predicted to be approximately 73 MG. This rate greatly exceeds the capacity of the existing grit chamber and splitter box at the headworks of the plant. The existing capacity of the grit chamber and splitter box is 53 MGD. The plant is currently equipped to handle the peak 24-hour volume when the treatment capacity of 40 MG is combined with the available storage of 80 MG. The storage is predicted to be empty 96 hours after the peak of the design storm event.

It will be necessary to construct a new 55 MGD grit removal system before the existing headworks of the plant. This new system will treat excess wet weather flow and feed directly to the existing equalization basin and only be utilized during wet weather events. Two possible scenarios for the location of the new grit removal system can be seen in Figures 4.17 and 4.18. Since the limits of this existing study stopped at the headworks of the WWTPs, an additional evaluation of the new grit removal system, WWTP headworks, and treatment facilities should be undertaken to develop a final conceptual design and construction cost.

Table 4-J

RECOMMENDED ALTERNATIVE CONSTRUCTION COSTS

Area	Estimated Construction Cost ($ Million)
Gulpha	24.5
Stokes	10.4
Hot Springs Creek	22.3
Mazarn	1.1

OVERFLOWS

Each overflow identified by the City has been analyzed in the hydraulic model. A total of nine overflows were unable to be re-created in the model due to lack of data at smaller pump stations within the grinder/pressure system. Table 4-K shows all reported overflows and the Priority 1 project associated with eliminating that overflow. Overflows unable to be re-created have been identified as "No Improvement" at this time until the actual pump station data (configuration, pump curves, etc.) can be provided by the City and the model re-run to determine if the nine overflows are capacity or maintenance related.

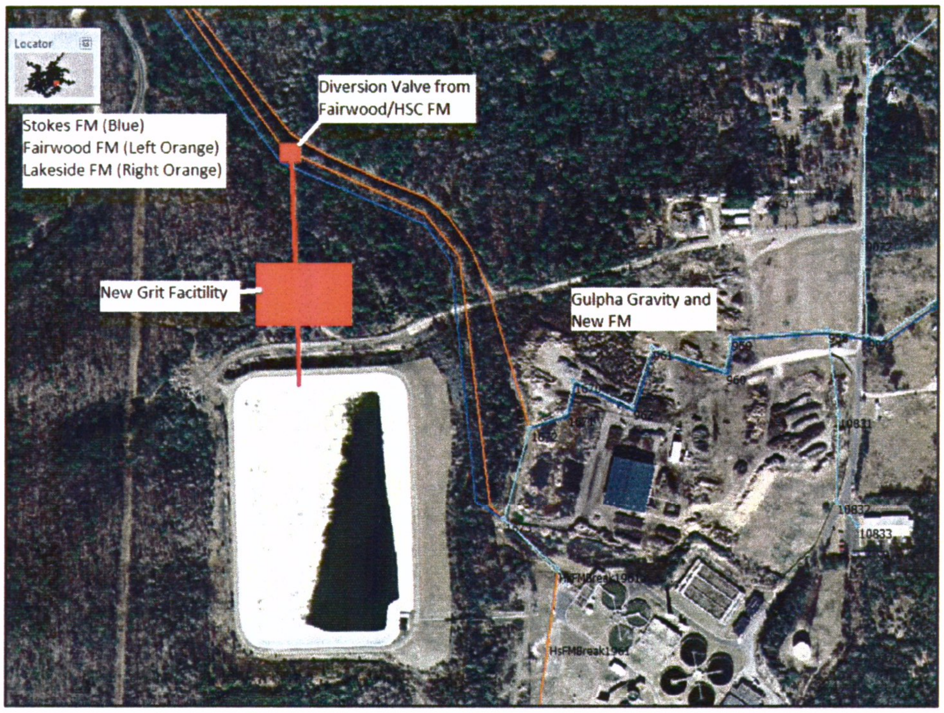


Figure 4.17: New Grit Removal System Location #1

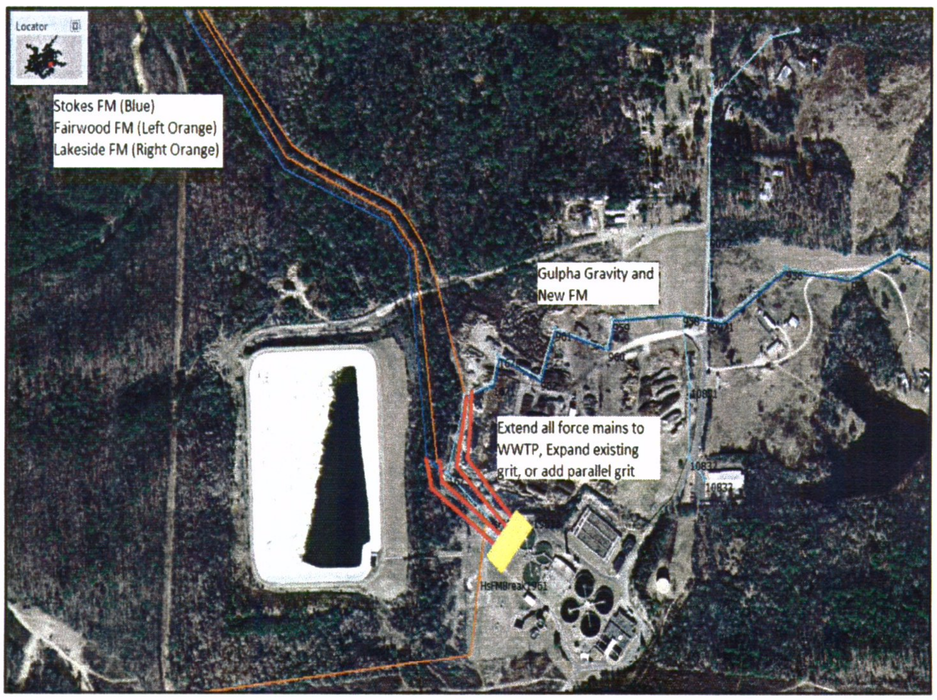


Figure 4.18: New Grit Removal System Location #2

Table 4-K

PRIORITY 1 PROJECT RELATIONSHIP TO ELIMINATION OF REPORTED OVERFLOWS

Structure	Project
3938	Upper Gulpha Interceptor
3109	East Grand Avenue
1635	No Imp (Mid America)
9493	Albert Pike Road
9518	Albert Pike Road
7773	Albert Pike Road
6536	Stokes Interceptor
6563	Stokes Interceptor
6535	Stokes Interceptor
991	Stokes Interceptor
11270	Stokes Interceptor
2768	Stokes Interceptor
998	Stokes Interceptor
3630	Stokes Interceptor
3626	Stokes Interceptor
11271	Stokes Interceptor
11272	Stokes Interceptor
11273	Stokes Interceptor
11274	Stokes Interceptor
3729	Hot Springs Creek Pump Station
3933	No Imp (Beverly Hills)
9268	Mazarn FM
9250	Mazarn FM
7537	No Imp (UNK 126)
9306	Mazarn FM
9299	Mazarn FM
10332	No Imp (Hwy 290)
12442	Hogan Creek
12567	No Imp (PS 110)
2306	4th Street & Greenwood Avenue
1866	Hot Springs Creek Pump Station
1752	Gulpha Pump Station
7521	No Imp (PS 64)
7117	Molly Creek
8347	No Imp (Hot Springs #2)
8182	No Imp (Hot Springs #1)
5259	Lakeside
WWTP	Davidson WWTP
Hot Springs #3	No Imp (Hot Springs #3)

Chapter 5 Recommended Rehabilitation

Recommended Manhole Rehabilitation

Manhole I/I defects identified during field investigation were analyzed together to obtain recommendations for rehabilitation for each manhole and a cost to perform rehabilitation work. The recommended rehabilitation for each manhole addresses both Inflow and Infiltration defects identified within each manhole. Of the 12,114 manholes studied, a total of 4,735 manholes were identified as needing rehabilitation. A summary of the recommended manhole rehabilitation is shown in Table 5-A. Individual manhole rehabilitation recommendations are included in Appendix H. The recommended rehabilitation for a manhole may change during the design project (Phase IV).

A list of typical rehabilitation methods for manholes and associated construction costs for both inflow and infiltration defects is given in Table 5-B.

Sewer Replacement/Rehabilitation

Television inspection data was evaluated for repair of specific I/I and maintenance defects. I/I defects are those defects where smoke was visible along a main line and dyed water flooding confirmed the defect. Maintenance defects are those defects that would justify repair or replacement based on their potential to cause future maintenance problems in the sewer system. Maintenance defects include sections of broken or cracked pipe and sections of pipe with sags, root intrusion, or other defects. The maintenance defects may not be large sources of I/I and would not be recommended for repair based on I/I removal alone, but they are recommended for repair to improve system reliability. The television inspection data was evaluated to determine if a sewer segment should be completely rehabilitated or if a point repair should be made. Other considerations used were existing or known problematic areas, diameter of the line, and recommendations for adjacent line segments.

A total of 143,273 linear feet of sewer televised was reviewed by RJN of an attempted 147,844 linear feet. A summary of the line segments reviewed is listed in Appendix E.

Table 5-A

RECOMMENDED MANHOLE REHABILITATION

Rehabilitation Description[2/]	Number of Manholes	Estimated Inflow[1/] (mgd)	Estimated Infiltration (mgd)	Construction Cost ($)
Replace Cover/Frame/Frame Seal	2,298	1.795	0.050	2,299,200
Install Bolts/Gasket for Bolted Cover	11	0.016	0.000	770
Seal Corbel Only	68	0.034	0.016	34,000
Seal Corbel & Replace Cover/Frame/Frame Seal	68	0.090	0.009	104,550
Seal Corbel & Replace Frame Seal	67	0.063	0.008	84,275
Seal Wall Only	356	0.055	0.353	298,480
Coat Manhole and Grout Lower 18" of Manhole	310	0.078	0.078	233,304
Grout Lower 18" of Manhole	407	0.000	0.350	122,100
Complete Manhole Rehab w/ New Frame and Cover	275	0.342	0.145	517,056
Complete Manhole Rehab w/o New Frame and Cover	84	0.041	0.076	137,151
Replace Cover/Frame/Frame Seal & Grout Lower 18"	167	0.137	0.076	214,325
Replace Cover/Frame/Frame Seal & Seal Wall	69	0.124	0.033	122,999
Replace Cover/Frame/Frame Seal & Coat Manhole	477	0.636	0.207	1,149,763
Install Bolts/Gasket for Bolted Cover & Seal Walls	1	0.000	0.001	443
Install Bolts/Gasket for Bolted Cover & Coat Manhole	3	0.004	0.001	5,974
Install Bolts/Gasket for Bolted Cover and Grout Lower 18" of Manhole	2	0.002	0.001	740
Repair Frame Seal & Grout Lower 18" of Manhole	72	0.042	0.057	76,200
Total	**4,735**	**3.459**	**1.461**	**5,401,330**

1/ *Based on 1-year/60-minute storm.*
2/ *Final rehabilitation recommendations should be determined in design phase.*

Table 5-B

TYPICAL MANHOLE REHABILITATION CONSTRUCTION COSTS[1/]

Description	Estimated Construction Cost ($)
Replace Cover/Frame/Frame Seal	925-1,075
Install Bolts/Gasket for Bolted Cover	70
Repair Frame Seal	675-825
Seal Corbel Only	500
Seal Corbel & Replace cover/Frame/Frame Seal	1,425-1,575
Seal Corbel & Replace Frame Seal	1,175-1,325
Seal Wall Only	100[2/]
Coat Manhole and Grout Lower 18"	400[2/]
Grout Lower 18" of Manhole	300
Complete Manhole Rehab w/ New Frame and Cover	1,325-1,475[2/]
Complete Manhole Rehab w/o New Frame and Cover	1,075-1,325[2/]
Replace Cover/Frame/Frame Seal & Grout Lower 18"	1,225-1,375
Replace Cover/Frame/Frame Seal & Seal Wall	1,125-1,375[2/]
Replace Cover/Frame/Frame Seal & coat Manhole & Grout Lower 18"	1,325-1,575
Install Bolts/Gasket for Bolted Cover & Seal Walls	170[2/]
Install Bolts/Gasket for Bolted Cover & Coat Manhole & Grout Lower 18"	570[2/]
Install Bolts/Gasket for Bolted Cover & Seal Corbel	600
Install Bolts/Gasket for Bolted Cover & Repair Frame Seal	745-895
Install Bolts/Gasket for Bolted Cover & Grout Lower 18" of Manhole	370
Repair Frame Seal & Grout Lower 18" of Manhole	975-1125
Coat Manhole	100[2/]
Coat Manhole and Grout Lower 18" of Manhole	400

1/ *Construction costs are based on recent bids in the area.*
2/ *Unit cost will vary per vertical foot.*

Based on the review of television inspection, point repairs are recommended at 93 locations and complete rehabilitation/replacement is recommended for 459 line segments totaling 97,723 linear feet. Table 5-C lists a summary of point repairs by drainage basin. Table A in the Appendix provides a more detailed list of all point repairs. Table 5-D lists a summary of lines recommended for complete rehabilitation by drainage basin. Preliminary construction recommendations for complete line rehabilitation have been made based on television review. These include open cut, pipe bursting, and cured-in-place-pipe (CIPP). Table B in the Appendix provides a more detailed list of all lines to be completely rehabilitated. The recommended diameters listed in Table B may change as a result of capacity analysis that will be included in the final report. Lines requiring rehabilitation are shown on Exhibits 41 to 57.

It should be emphasized that the rehabilitation of these line segments is not based on elimination of overflows or the amount of inflow and infiltration removed. The recommended line rehabilitations will not only remove I/I, but will greatly improve transport performance and system reliability. It is also recommended during the final design phase that the rehabilitation or replacement of the upstream and downstream manholes be evaluated. If the method of rehabilitation chosen is pipe bursting or CIPP lining, the manholes may remain and be rehabilitated. If the method of rehabilitation is open cut, the manholes may be replaced as part of the project. These issues will be examined and determined during the detail design in Phase IV.

Table 5-C

SUMMARY OF RECOMMENDED POINT REPAIRS

Drainage Basin(s)	Number of Point Repairs	Estimated Construction Cost ($)
Mazarn	0	0
Fairwood	2	13,500
Hot Springs Creek, HWY 270, Halteria, Port Au Prince	60	326,000
2nd Street	2	10,000
Molly Creek	4	25,000
Hogan Creek	0	0
Hot Springs #2, Hot Springs #3	0	0
Hot Springs #4	2	13,000
Beverly Hills	1	5,000
Gulpha, Belvedere	19	109,000
Malvern HWY, Wilson Mill	0	0
Catherine Heights	2	10,000
Carpenter Dam	1	8,500
Red Oak Ridge	0	0
Hot Springs #1, Lakeside	0	0
Farrs Landing	0	0
Total	**93**	**520,000**

Table 5-D

SUMMARY OF SEWER LINES RECOMMENDED FOR COMPLETE REHABILITATION BASED ON TV INSPECTION DATA AND REVIEW

	Preliminary Rehabilitation Method						Estimated Construction Cost
	CIPP		*Pipe Bursting*		*Open Cut*		
Drainage Basin(s)	**Number of Lines**	**Linear Feet (lf)**	**Number of Lines**	**Linear Feet (lf)**	**Number of Lines**	**Linear Feet (lf)**	**($)**
Mazarn	0	0	0	0	0	0	0
Fairwood	0	0	7	1,073	0	0	166,315
Hot Springs Creek, HWY 270, Halteria, Port Au Prince	33	8,057	225	45,565	34	7,455	9,693,525
2nd Street	0	0	2	438	0	0	67,890
Molly Creek	9	1,390	10	2,449	0	0	568,015
Hogan Creek	0	0	2	375	0	0	58,125
Hot Springs #2, Hot Springs #3	0	0	0	0	0	0	0
Hot Springs #4	0	0	2	394	0	0	61,070
Beverly Hills	0	0	1	463	0	0	71,765
Gulpha, Belvedere	34	7,430	81	18,084	18	4,335	4,598,720
Malvern HWY, Wilson Mill	0	0	0	0	0	0	0
Catherine Heights	0	0	0	0	0	0	0
Carpenter Dam	0	0	0	0	0	0	0
Red Oak Ridge	0	0	0	0	0	0	0
Hot Springs #1, Lakeside	1	215	0	0	0	0	23,650
Farrs Landing	0	0	0	0	0	0	0
Total	**77**	**17,092**	**330**	**68,841**	**52**	**11,790**	**15,421,075**

RECOMMENDED INFLOW REMOVAL FROM SERVICE LINE SOURCES

Inflow into the wastewater collection system comprised the largest component of the total peak flow during wet-weather periods. Inflow sources that were identified during field survey activities are listed on the total inflow source report included in Appendix F.

A total of 2,324 inflow sources identified during the field survey investigations are recommended for removal. The indicated sources consist of 33 public sector and 2,291 private sector sources which will be eliminated through rehabilitation. This will remove 10.510 mgd of 5-year/60-minute inflow at an estimated construction cost of $1.807 million. A summary of recommended inflow removal is given in Table 5-E and a detailed report is included in Appendix K. approval

Table 5-E

SUMMARY OF RECOMMENDED INFLOW REMOVAL FROM SERVICE LINE SOURCES[1/]

Source	Quantity	1-Year/60-Minute Projected Peak Inflow (mgd)	5-Year/60-Minute Projected Peak Inflow (mgd)	Estimated Construction Cost ($)
Public Sector				
Defective Building Lateral	22	0.053	0.086	26,400
Defective Service Cleanouts	11	0.012	0.019	1,925
Subtotal	33	0.065	0.105	28,325
Private Sector Inflow				
Defective Building Lateral	1,041	3.494	5.660	1,479,500
Defective Service Cleanouts	1,215	2.502	4.053	212,625
Area Drain	25	0.299	0.484	85,000
Downspouts	10	0.138	0.224	2,000
Subtotal	2,291	6.423	10.405	1,779,125
Total	**2,324**	**6.488**	**10.510**	**1,807,450**

1/ *It should be noted that interior building inspections were not included in this scope of services and that there are likely basement drains or sump pumps that were not identified during this study. An evaluation of the private grinder pumps was also not included in the scope of services for this project and are likely sources of I/I that were not identified.*

CHAPTER 6

SUMMARY OF RECOMMENDED IMPROVEMENT PLAN

The recommended improvement plan consists of work to be performed in the public and private sector of the collection system. The plan includes inflow repairs, infiltration repairs, sewer line replacement/rehabilitation, maintenance repairs, and capacity improvements including pipelines, pump stations, and force mains. The cost to perform the recommended plan is given in capital cost which includes construction plus 20 percent contingency and 10 percent engineering costs. Cost for land acquisition for new pump stations is not included. Costs in this report are in 2011 dollars. Any inflation that occurs between the submission of this report and start of construction is not accounted for in this report. The recommended plan is discussed in the following sections.

The estimated cost and improvement plan does not include the cost of other lift station improvements identified by Garver Engineers, Inc. The only lift station and force main improvements included in this plan are for ones requiring capacity improvements. The plan also does not include any cost associated with the Fairwood Pump Station and force main improvements nor the planned SCADA system and backup power system.

RECOMMENDED MANHOLE REHABILITATION

The recommended rehabilitation plan for manholes includes the rehabilitation of 4,735 manholes contributing approximately 1.461 mgd of infiltration and 5.601 mgd of 5-year inflow. The estimated 2011 capital cost is approximately $7.022 million. The manholes recommended for rehabilitation are presented in the computer printout in Appendix H. A summary of the recommended plan for manhole rehabilitation is given in Table 6-A.

RECOMMENDED SEWER LINE REHABILITATION

Sewer line rehabilitation is recommended for 354 line segments totaling 74,287 linear feet and sewer line point repairs at 66 locations. A detailed discussion of the recommended plan for sewer line repair is included in Chapter 5. A summary of the plan is given in Table 6-B. A detailed list of line segments that are recommended for point repairs and rehabilitation is included in Tables 5-C and 5-D.

Table 6-A

SUMMARY OF RECOMMENDED MANHOLE REHABILITATION PLAN

Rehabilitation Description[2/]	Number of Manholes	Estimated Inflow[1/] (mgd)	Estimated Infiltration (mgd)	Estimated Capital Cost[3/] ($)
Replace Cover/Frame/Frame Seal	2,298	2.903	0.050	2,988,960
Install Bolts/Gasket for Bolted Cover	11	0.026	0.000	1,001
Seal Corbel	68	0.055	0.016	44,200
Seal Corbel & Replace Cover/Frame/Frame Seal	68	0.146	0.009	135,915
Seal Corbel & Replace Frame Seal	67	0.102	0.008	109,558
Seal Wall	356	0.089	0.353	388,024
Coat Manhole and Grout Lower 18" of Manhole	310	0.126	0.078	303,295
Grout Lower 18" of Manhole	407	0.000	0.350	158,730
Complete Manhole Rehab w/ New Frame and Cover	275	0.554	0.145	672,173
Complete Manhole Rehab w/o New Frame and Cover	84	0.066	0.076	178,296
Replace Cover/Frame/Frame Seal & Grout Lower 18"	167	0.222	0.076	278,623
Replace Cover/Frame/Frame Seal & Seal Wall	69	0.201	0.033	159,899
Replace Cover/Frame/Frame Seal & Coat Manhole	477	1.030	0.207	1,494,692
Install Bolts/Gasket for Bolted Cover & Seal Walls	1	0.000	0.001	576
Install Bolts/Gasket for Bolted Cover & Coat Manhole	3	0.006	0.001	7,766
Install Bolts/Gasket for Bolted Cover and Grout Lower 18" of Manhole	2	0.003	0.001	962
Repair Frame Seal & Grout Lower 18" of Manhole	72	0.068	0.057	99,060
Total	**4,735**	**5.601**	**1.461**	**7,021,730**

1/ *Based on 5-year/60-minute storm.*

2/ *Final rehabilitation recommendations should be determined in design phase.*

3/ *Includes estimated construction cost plus a 30 percent engineering service and contingency fees.*

Table 6-B

SUMMARY OF RECOMMENDED SEWER REHABILITATION[1/]

Item	I/I Removal: Inflow[3/]	I/I Removal: Infiltration	Estimated Capital Cost[2/] ($ Million)
Priority 1			
Point Repairs	0.208	0.013	0.193
Complete Rehabilitation	4.138	0.419	7.451
Subtotal	*4.346*	*0.432*	*7.644*
Priority 2			
Point Repairs	0.216	0.014	0.283
Complete Rehabilitation	3.121	0.316	5.527
Subtotal	*3.337*	*3.174*	*5.810*
Total	**7.683**	**0.762**	**13.454**

1/ *Lines recommended for complete rehabilitation to remove I/I, correct structural or maintenance defects and may or may not be directly related to any sanitary sewer overflow elimination.*

2/ *Includes estimated construction cost plus a 30 percent engineering service and contingency fee.*

3/ *Based on 5-year/60-minute storm*

RECOMMENDED INFLOW REMOVAL FROM SERVICE LINE SOURCES

The recommended plan for service line inflow removal includes the repair of all identified sources discovered through field procedures. Each area of rehabilitation is addressed in the following sections.

Public Sector. There are 33 identified public sector sources contributing 0.105 mgd of 5-year/60-minute inflow that are recommended for repair. The capital cost to remove these public sector sources is approximately $0.037 million. A computer printout of the inflow sources recommended for repair is given in Appendix G.

The projected inflow reduction is based on the assumption that comprehensive rehabilitation repairs will be completed for the identified I/I sources and that the repairs will effectively eliminate I/I from those identified sources.

Private Sector. There are 2,291 identified private sector sources contributing 10.405 mgd of 5-year/60-minute inflow. The capital cost to remove these private sector sources is approximately $2.313 million. It should be noted that these repairs and costs are the responsibility of the homeowner and not the City of Hot Springs. A computer printout of the inflow sources recommended for repair is given in Appendix G.

A summary of the recommended plan for inflow removal is given in Table 6-C.

Table 6-C

SUMMARY OF RECOMMENDED PLAN FOR SERVICE LINE INFLOW REMOVAL

Item	Quantity of Sources	5-Year Inflow Reduction (mgd)	Estimated Capital Cost[1/] ($ Million)
Public Sector	33	0.105	0.037
Private Sector[2/]	2,291	10.405	2.313
Total	**2,324**	**10.510**	**2.350**

1/ *Includes estimated construction cost plus a 30 percent engineering service and contingency fee.*

2/ *Private sector defect repairs are the responsibility of the homeowner and not the City of Hot Springs.*

It should be noted that interior building inspections were not included in this scope of services and that there are likely basement drains or sump pumps contributing I/I that were not identified during this study. Also, an evaluation of the private grinder pumps was not included in the scope of services for this project and are likely sources of I/I that were not identified.

CAPACITY IMPROVEMENTS

Recommended capacity improvements will eliminate the occurrence of wet-weather overflows during the design storm event and provide improved efficiency in the transportation of the wastewater flow. The recommended Priority 1 capacity improvements include 41 gravity sewer segments containing approximately 12,302 linear feet, 6 force mains totaling approximately 65,445 linear feet, and 8 pump station improvements. The recommended Priority 2 capacity improvements include 308 gravity sewer segments containing approximately 67,424 linear feet and one force main totaling approximately 732 linear feet. There are an additional 93 gravity sewer segments containing approximately 17,909 linear feet and 3 pump stations that would require capacity improvements to eliminate wet-weather overflows predicted by the hydraulic model that have not been observed as actual overflows during storm events. These locations should be investigated further during wet-weather periods to determine if the overflows actually occur or only predicted by the model due to possible inaccurate pipe sizes or slopes. The estimated capital cost of the capacity improvements is approximately $75.897 million accounting for no reduction in inflow and infiltration and $52.804 million if recommended public inflow and infiltration repairs are taken into account. Gravity lines identified for capacity improvements were selected by accounting for I/I reduction. If I/I reduction was not part of the plan an additional $23.083 million dollars would be required to construct additional capacity improvements. As discussed in Chapter 4, additional capacity improvements may be required to eliminate model predicted overflows. A summary of projects that are recommended for capacity improvements is given in Table 6-D.

SUMMARY OF RECOMMENDED PLAN

The recommended plan includes repairing 2,324 inflow sources, rehabilitation of 4,735 manholes, 354 sewer lines, and point repairs at 66 locations. In addition, 359 gravity segments, 7 force main segments, and 8 pump stations are in need of up-sizing for capacity purposes. Approximately 2.223 mgd of infiltration will be eliminated by implementation of the recommended plan. The peak 5-year inflow in the basins is projected to be reduced by 23.794 mgd after rehabilitation of the recommended inflow sources.

The total capital cost to implement the recommended plan is approximately $77.930 million if I/I reduction is accounted for and approximately $101.013 million if not accounted for. The total capital cost consists of $0.037 million for inflow removal in the public sector, $2.313 million for inflow removal in the private sector, $7.022 million for manhole rehabilitation, and $13.454 million for main sewer rehabilitation. Capacity improvements result in a cost of $52.804 million with I/I reduction or $75.897 million without I/I reduction. A summary of the recommended plan is given in Table 6-E.

Although the scope of services for this project ended at the headworks of the wastewater treatment plants, a preliminary analysis of the headwork grit removal chamber at Davidson WWTP was performed. This was done because of the need to utilize the full storage potential of the EQ Basin at the WWTP. It is anticipated that a new grit removal chamber will be required at a construction cost of $2.3 million. Although this cost is included in the recommended improvement plan, it is recommended that the City undertake a more detailed study of the Davidson WWTP headworks and treatment unit prior to proceeding with this project.

Table 6-D

SUMMARY OF RECOMMENDED PLAN FOR CAPACITY IMPROVEMENTS

Project[1/]		Length (ft)	No I-I Reduction Capital Cost[2/] ($)	With I-I Reduction Capital Cost[2/] ($)
PRIORITY 1 PROJECTS				
Gravity Mains				
E. Grand Ave		295		
Upper Gulpha Interceptor		1,873	457,178	457,178
	Gravity Subtotal	*2,168*	*508,950*	*508,951*
Force Main				
Gulpha Pump Station Force Main		16,016	5,621,686	5,205,265
	Force Main Subtotal	*16,016*	*5,621,686*	*5,205,265*
Pump Station				
Gulpha Pump Station			8,360,300	6,999,980
	Pump Station Subtotal		*8,360,300*	*6,999,980*
	Priority 1 Total		14,490,936	12,714,196
PRIORITY 2 PROJECTS				
Gravity Mains				
Gulpha Interceptor		20,192	14,321,445	12,998,981
Ridgeway St		8,159	2,170,446	2,119,174
Spring St & Festival St		247	58,858	58,858
Upper Gulpha Interceptor		4,014	859,905	662,380
	Gravity Subtotal	*32,613*	*17,410,653*	*15,839,393*
	Priority 2 Total		17,410,653	15,839,393
	Gulpha Total		**31,901,589**	**28,553,589**
Hot Springs Creek Pump Station/Davidson WWTP Tributary Area				
Priority 1 Projects				
Gravity Mains				
4th St & Greenwood Ave		321	70,282	70,282
Hot Springs Creek Interceptor		38	25,194	25,194
	Gravity Subtotal	*359*	*95,476*	*95,476*
Force Mains				
Albert Pike Rd Force Main		3,010	449,995	450,055
24-Inch Parallel to Fairwood Force Main[3/]		11,182	3,198,052	N/A
Carpenter Dam Rd Force Main		519	114,655	N/A
	Force Main Subtotal	*14,711*	*3,762,702*	*450,055*

1/ *Projects are gravity sewer main only unless otherwise stated.*
2/ *Includes estimated construction cost plus a 30 percent engineering service and contingency fee.*
3/ *Does not include cost of Fairwood Force Main with increased diameter of 42-inch from 36-inch currently designed.*

Table 6-D (Cont.)

SUMMARY OF RECOMMENDED PLAN FOR CAPACITY IMPROVEMENTS

Project[1/]		Length (ft)	No I-I Reduction Capital Cost[2/] ($)	With I-I Reduction Capital Cost[2/] ($)
Pump Stations				
Highway 270 PS			486,200	486,200
Hot Springs Creek PS			14,453,400	N/A
Molly Creek PS			71,500	71,500
PS20			262,600	262,600
Lakeside PS			725,400	618,800
	Pump Station Subtotal		*15,999,100*	*1,439,100*
	Priority 1 Total		**19,857,278**	**1,984,631**
Priority 2 Projects				
Gravity Mains				
4th St & Greenwood Ave		5,490	1,016,945	782,265
Albert Pike Rd		2,706	604,149	604,149
Hot Springs Creek Interceptor		12,427	6,717,932	5,161,690
Lake Hamliton Dr		1,570	364,801	364,801
Park Ave		775	136,013	136,013
Seneca St		3,354	586,378	586,378
Shady Grove Rd		5,425	1,038,161	1,038,161
Carpenter Dam Rd		1,086	242,951	237,393
	Gravity Subtotal	*32,833*	*10,707,328*	*8,910,850*
Force Main				
Farrs Landing FM		732	109,434	95,160
	Force Main Subtotal	*732*	*109,434*	*95,160*
	Priority 2 Total		**10,816,762**	**9,006,010**
	Hot Springs Creek Total		**30,674,040**	**10,990,641**
Stokes Pump Station Tributary Area				
Priority 1 Projects				
Gravity Main				
Stokes Interceptor		9,775	3,093,202	3,090,202
	Gravity Subtotal	*9,775*	*3,093,202*	*3,090,202*
Force Main				
Stokes Force Main		29,751	8,508,872	8,508,872
	Force Main Subtotal	*29,751*	*8,508,872*	*8,508,872*
	Priority 1 Total		**11,602,073**	**11,599,074**

Table 6-D (Cont.)

SUMMARY OF RECOMMENDED PLAN FOR CAPACITY IMPROVEMENTS

Project[1/]		Length (ft)	No I-I Reduction Capital Cost[2/] ($)	With I-I Reduction Capital Cost[2/] ($)
Priority 2 Projects				
Gravity Main				
W Saint Louis St		1,672	301,334	301,334
	Gravity Subtotal	*1,672*	*301,334*	*301,334*
	Priority 2 Total		**301,334**	**301,334**
	Stokes Total		**11,903,407**	**11,900,408**
Mazarn/Southwest WWTP Tributary Area				
Priority 1 Projects				
Force Main				
Mazarn Force Main		4,966	1,097,486	1,097,486
	Force Main Subtotal	*4,966*	*1,097,486*	*1,097,486*
Pump Stations				
Mazarn #1 PS			45,500	N/A
Mazarn #4 PS			247,000	234,000
	Pump Station Subtotal		*292,500*	*234,000*
	Priority 1 Total		**1,389,986**	**1,331,486**
Priority 2 Projects				
Gravity Main				
Marion Anderson Rd		306	28,080	28,080
	Gravity Subtotal	*306*	*28,080*	*28,080*
	Priority 2 Total		**28,080**	**28,080**
	Mazarn Total		**1,418,066**	**1,359,566**
Gravity Total		***79,726***	***32,145,022***	***28,774,286***
Force Main Total		***66,177***	***19,100,180***	***15,356,838***
Pump Station Total			***24,651,900***	***8,673,080***
	GRAND TOTAL	***145,903***	***75,897,102***	***52,804,204***

Table 6-E

SUMMARY OF RECOMMENDED IMPROVEMENT PLAN

Item	I/I Reduction: Inflow[1/] (mgd)	I/I Reduction: Infiltration (mgd)	Estimated Capital Cost[2/] Without I/I Reduction ($ Million)	Estimated Capital Cost[2/] With I/I Reduction ($ Million)
Manhole Rehabilitation (Priority 1)	5.601	1.461	7.022	7.022
Sewer Line Rehabilitation				
Point Repairs				
Priority 1	0.208	0.013	0.193	0.193
Priority 2	0.216	0.014	0.283	0.283
Complete Rehabilitation				
Priority 1	4.138	0.419	7.451	7.451
Priority 2	3.121	0.316	5.527	5.527
Inflow Removal[3/]				
Public Sector (Priority 1)	0.105	0.000	0.037	0.037
Private Sector (Priority 2)	10.405	0.000	2.313	2.313
Capacity Improvements				
Priority 1	N/A	N/A	47.340	27.629
Priority 2	N/A	N/A	28.557	25.175
New Grit Removal Chamber Davidson WWTP			2.300	2.300
Subtotal Priority 1			*62.043*	*42.332*
Subtotal Priority 2			*36.680*	*33.298*
Total	**23.794**	**2.223**	**101.023**	**77.930**

1/ *Based on projected 5-year/60-minute inflow.*

2/ *Includes estimated construction cost plus a 30 percent engineering service and contingency fee.*

3/ *It should be noted that interior building inspections were not included in this scope of services and that there are likely basement drains or sump pumps contributing I/I that were not identified during this study. An evaluation of the private grinder pumps was also not included in the scope of services for this project and are likely sources of I/I that were not identified.*

CONSTRUCTION STAGING PLAN

Construction of the recommended improvements must be completed by 2018 for the City of Hot Springs to be in compliance with the schedule submitted as part of the ADEQ Administrative Order. It is recommended that the construction of improvements be completed in stages to allow for the elimination of the most wet-weather sanitary sewer overflows (SSOs) in the quickest time possible. The City-wide improvement plan has been broken down into four areas. These stages are as follows:

1. Stokes Pump Station Tributary Area – Includes all pipeline improvements tributary to the Stokes Pump Station as well as the new force main from Stokes Pump Station to the Davidson WWTP. Improvements in this area will eliminate 18 wet-weather SSOs.

2. Mazarn / Southwest WWTP Tributary Area – The limited amount of work in this area includes the new force main from Mazarn #4 and minor pump station upgrades. Improvements will eliminate 4 wet-weather SSOs.

3. Hot Springs Creek Pump Station Tributary Area – This would consist of all pipeline work tributary to the Hot Springs Creek Pump Station as well as parallel force main to the Davidson WWTP. A total of 4 wet-weather SSOs will be eliminated by these improvements.

4. Gulpha Pump Station Tributary Area – These improvements will include all pipeline and manhole improvements upstream of the Gulpha Lift Station. After completion of this work it is recommended that post-rehabilitation flow monitoring be performed to determine the proper sizing of the new Gulpha Pump Station and parallel force main to the Davidson WWTP. This will eliminate 3 SSOs.

In order to meet the ADEQ AO schedule it is anticipated that much of the design work of the anticipated stages would be concurrently.

A brief summary of the anticipated improvements in each tributary area is given below.

Stokes Pump Station Tributary Area

These improvements will consist of several projects. The main interceptor discharging into Stokes Pump Station will require upsizing from the existing 18-inch diameter to 30 inches in diameter. A new 24-inch force main that flows from the Stokes Pump Station to the Davidson WWTP would be constructed parallel to the existing 24-inch force main. Both gravity and force main line work is required along Albert Pike Road. Additionally, the Highway 270, Molly Creek, and PS20 Pump Stations necessitate minor upsizing. The improvements also include all of the recommended manhole and sewer line replacement/rehabilitation work. The new grit removal chamber at the Davidson WWTP should be completed prior to placing the improvements in service

Mazarn / Southwest WWTP Tributary Area

Mazarn consists of 4 projects. A new 10-inch diameter force main will need to be constructed that from Mazarn PS#4 that manifolds into the existing force main which discharges at the Southwest WWTP from South Rodgers Pump Station. The result of this new force main will prevent additional capacity improvements in Mazarn except for Mazarn PS#1. The additional gravity line work is along Marion Anderson Road. Mazarn PS#1 and Mazarn PS#4 will need to be upsized. If the projected I/I Reduction is achieved, capacity enhancements at Mazarn #1 will not be required.

Hot Springs Creek Pump Station Tributary Area

The Hot Springs Creek Stage consists of 13 projects. The currently designed Fairwood force main needs to include a 42-inch diameter section leading to Davidson WWTP from where Hot Springs Creek Pump Station manifolds into the force main. A new 24-inch force main shall be constructed parallel to the 42-inch Fairwood force main to convey the wet-weather flow from Hot Springs Creek Pump Station to the Davidson WWTP. Additionally, the Lakeside Pump Station requires upsizing. Accounting for full predicted I/I reduction may prevent Hot Springs Creek Pump Station from requiring modifications. Not accounting for or achieving I/I reduction would necessitate the pump station to be upsized from the current 40 MGD capacity to a capacity of 51 MGD. Additionally, taking credit for the I/I reduction the parallel 24-inch force main would not need to be constructed, but the Fairwood force main still needs to be increased in the downstream sections. Hot Springs Creek Interceptor and several other gravity mains located throughout the Hot Springs Creek Drainage Basin provide insufficient conveyance and therefore require upsizing.

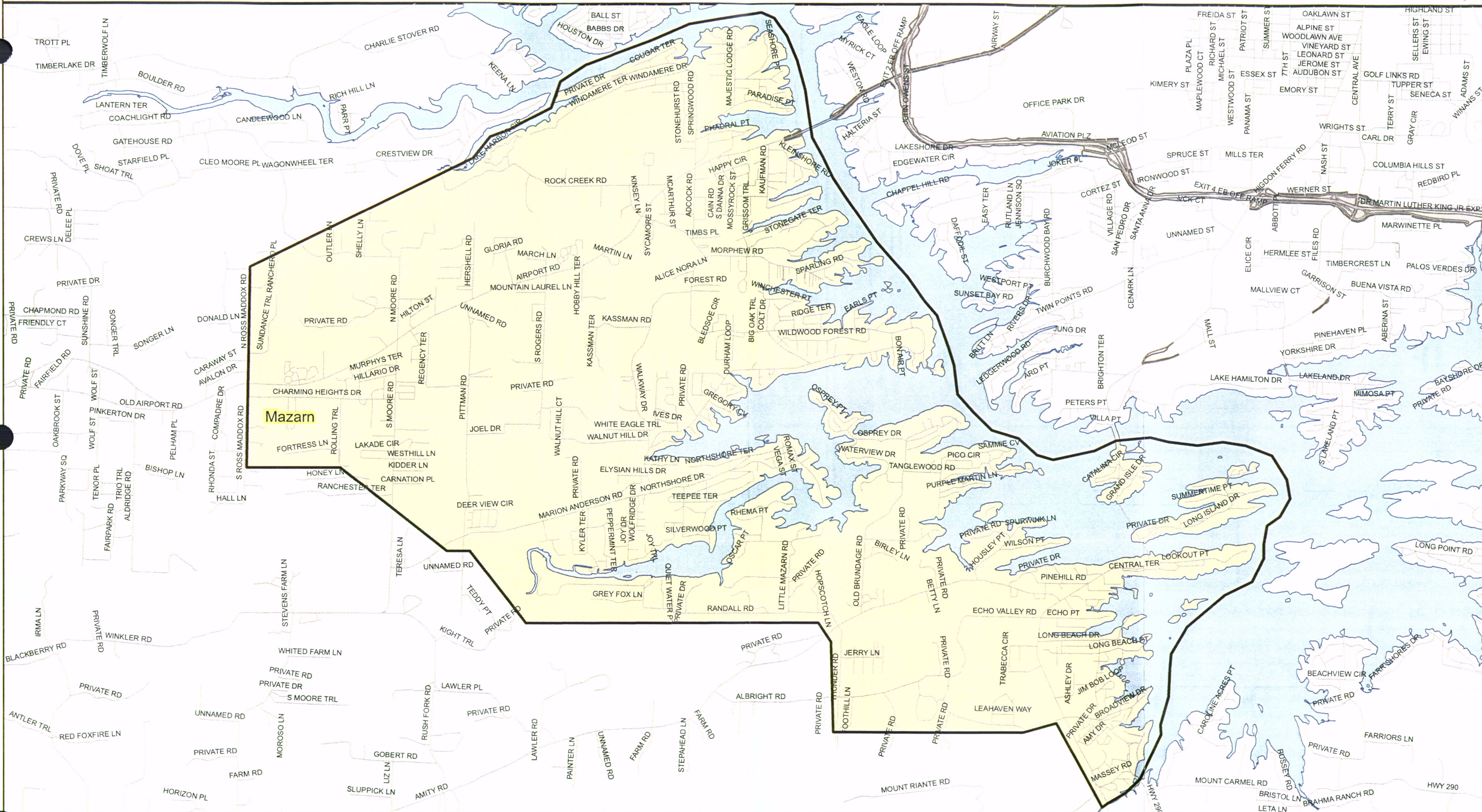
Gulpha Pump Station Tributary Area

The Gulpha Stage consists of multiple projects. Several sewer lines and manholes require replacement/rehabilitation for I/I reduction and structural replacement/rehabilitation. The main interceptor in the Gulpha Drainage Basin requires upsizing from 21-30 inch diameter to 27-42 inches in diameter. In addition, upsizing other various locations of the gravity mains is also necessary. A new 30-inch diameter force main is required from the Gulpha Pump Station to Davidson WWTP to transport wet-weather events. The Gulpha Pump Station requires upsizing to convey the increased flow.

Davidson WWTP

The Davidson WWTP is currently constructed to handle a peak 24-hour volume of 40 MG with an additional 80 MG of available storage and the grit chamber/splitter box has a 53 MGD capacity. With the I/I reduction not accounted for and recommended improvements, the predicted 24-hour peak volume would be approximately 73 MG at the Davidson WWTP. This will exceed the capacity of the current grit chamber/splitter box. A new 50 MGD grit removal system built before the existing headworks of the plant is recommended at a cost of approximately $2.3 million. As previously stated a study of the Davidson WWTP headworks and treatment units prior to proceedings with this project is recommended. This new system will remove grit from wet-weather flows and conveyed directly to the existing equalization basin. The grit should be removed and dewatered in units independent of the headworks.

CITY OF HOT SPRINGS, AR



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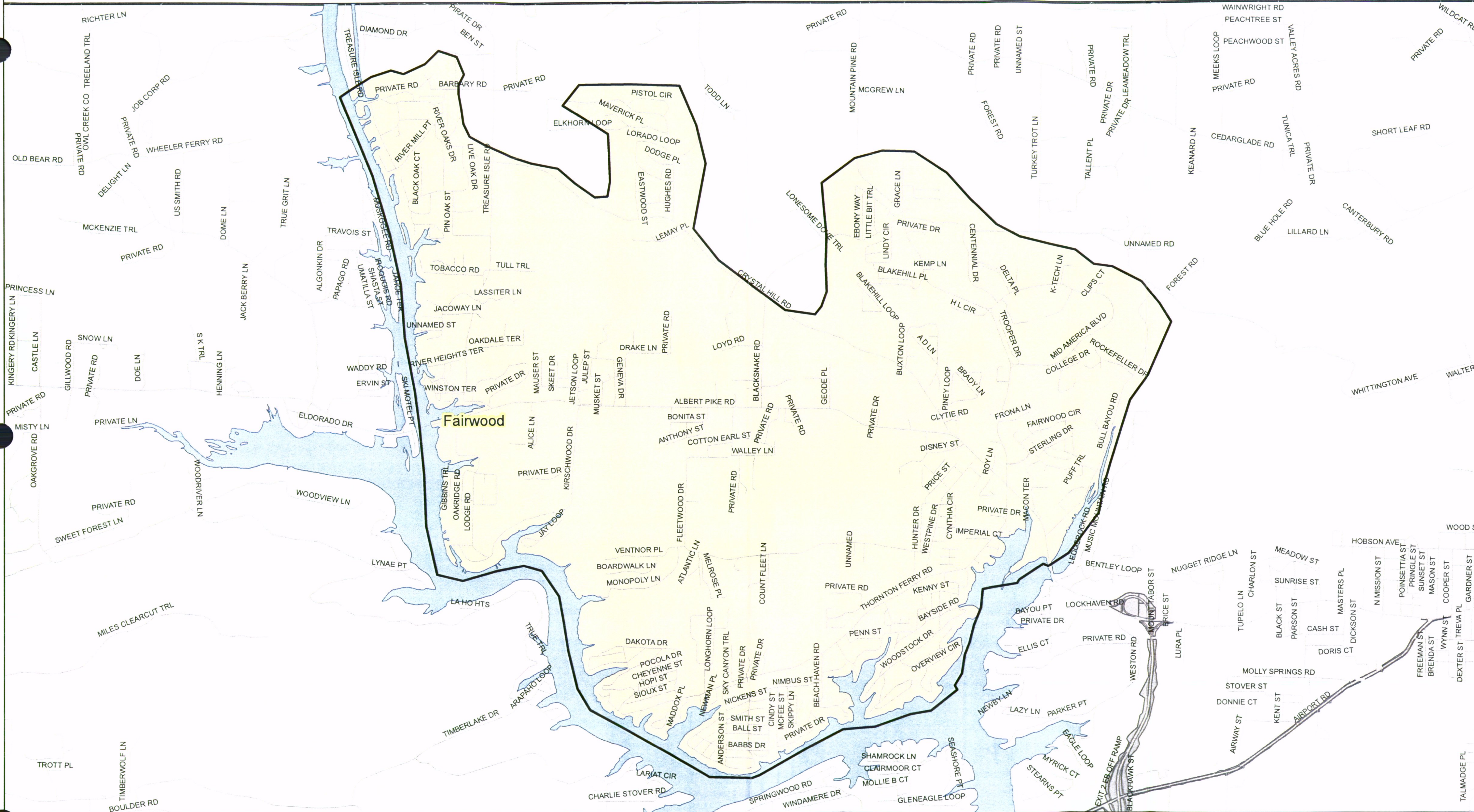
LEGEND

BASIN BOUNDARY

BASIN BOUNDARIES
MAZARN
EXHIBIT 01

CITY OF HOT SPRINGS, AR



LEGEND

BASIN BOUNDARY

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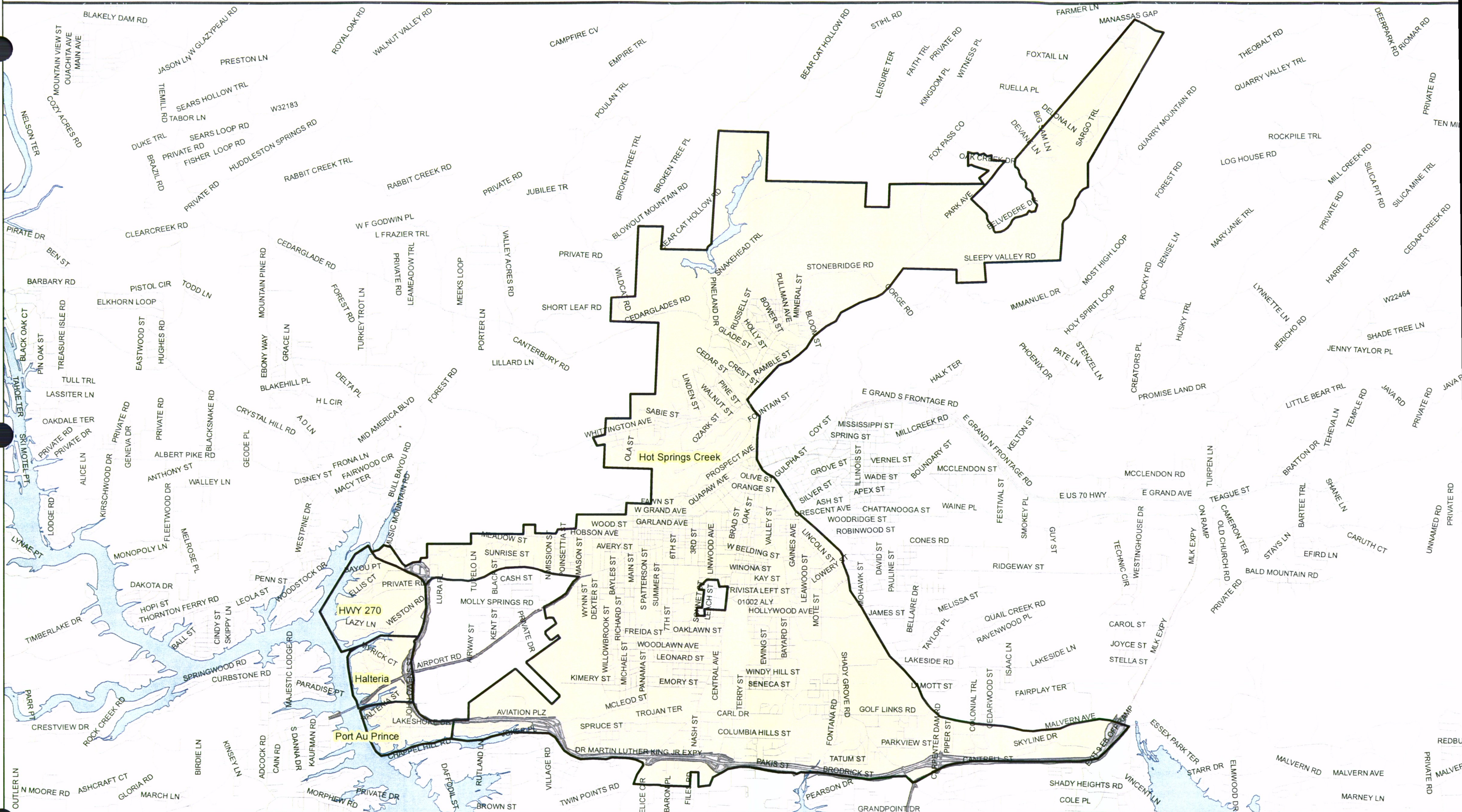
BASIN BOUNDARIES
FAIRWOOD
EXHIBIT 02

CITY OF HOT SPRINGS, AR



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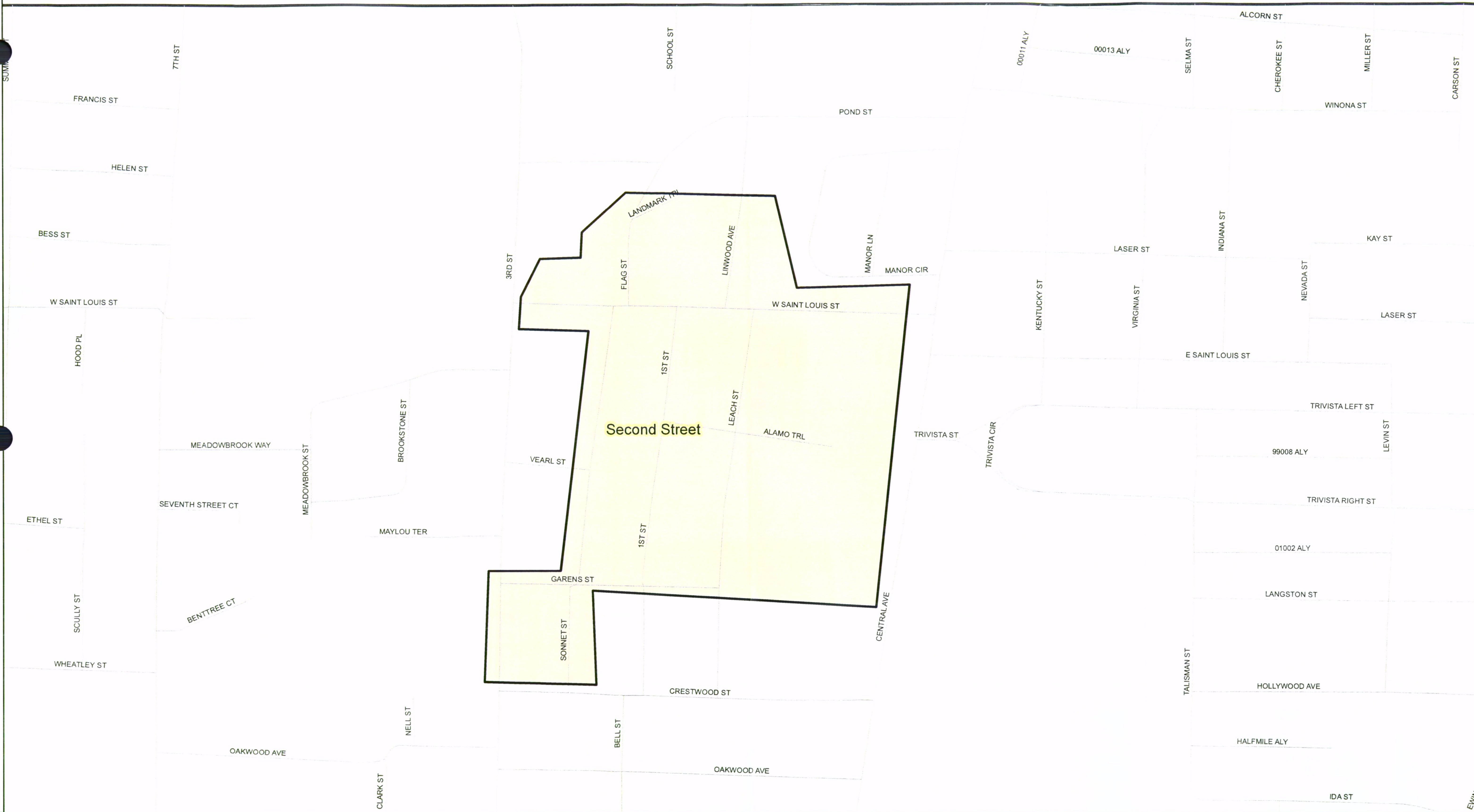
LEGEND

BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
HOTSPRINGS CREEK, HWY 27
HALTERIA, & PORT AU PRINCE
EXHIBIT 03

CITY OF HOT SPRINGS, AR



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LEGEND

BASIN BOUNDARY

BASIN BOUNDARIES
2ND STREET
EXHIBIT 04

CITY OF HOT SPRINGS, AR

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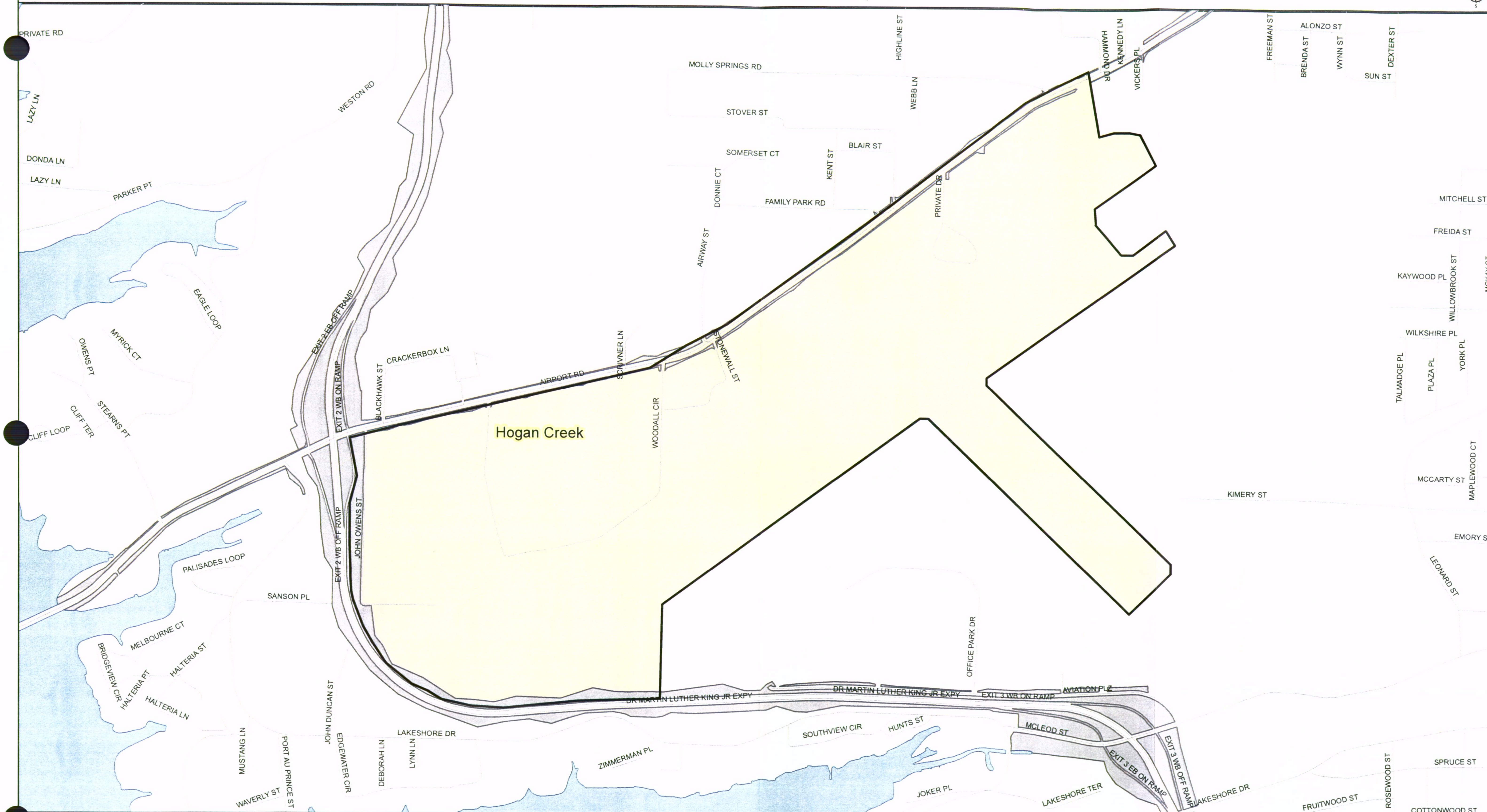
LEGEND
BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
MOLLY CREEK
EXHIBIT 05

CITY OF HOT SPRINGS, AR



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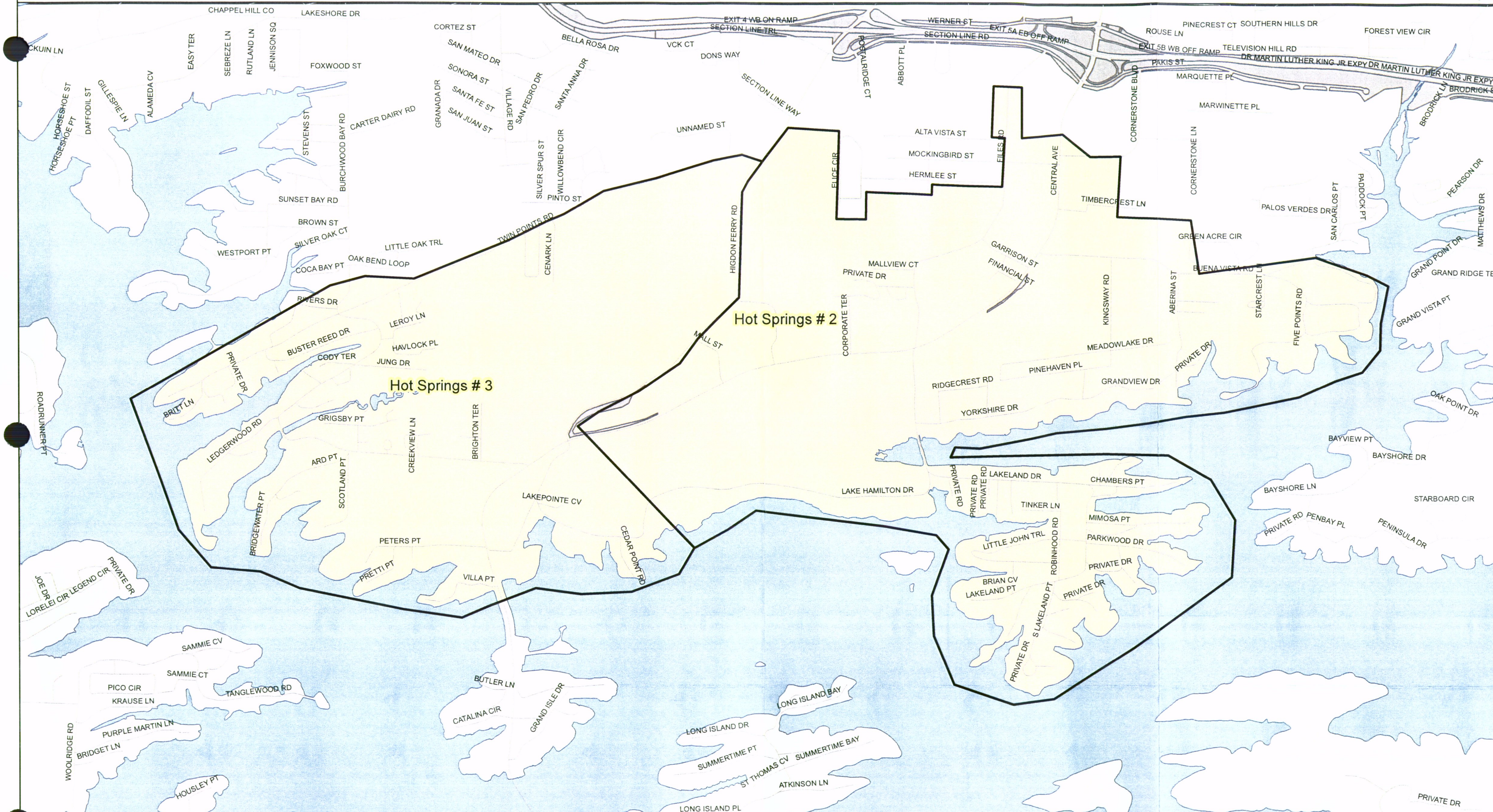
LEGEND
BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
HOGAN CREEK
EXHIBIT 06

CITY OF HOT SPRINGS, AR



LEGEND

BASIN BOUNDARY

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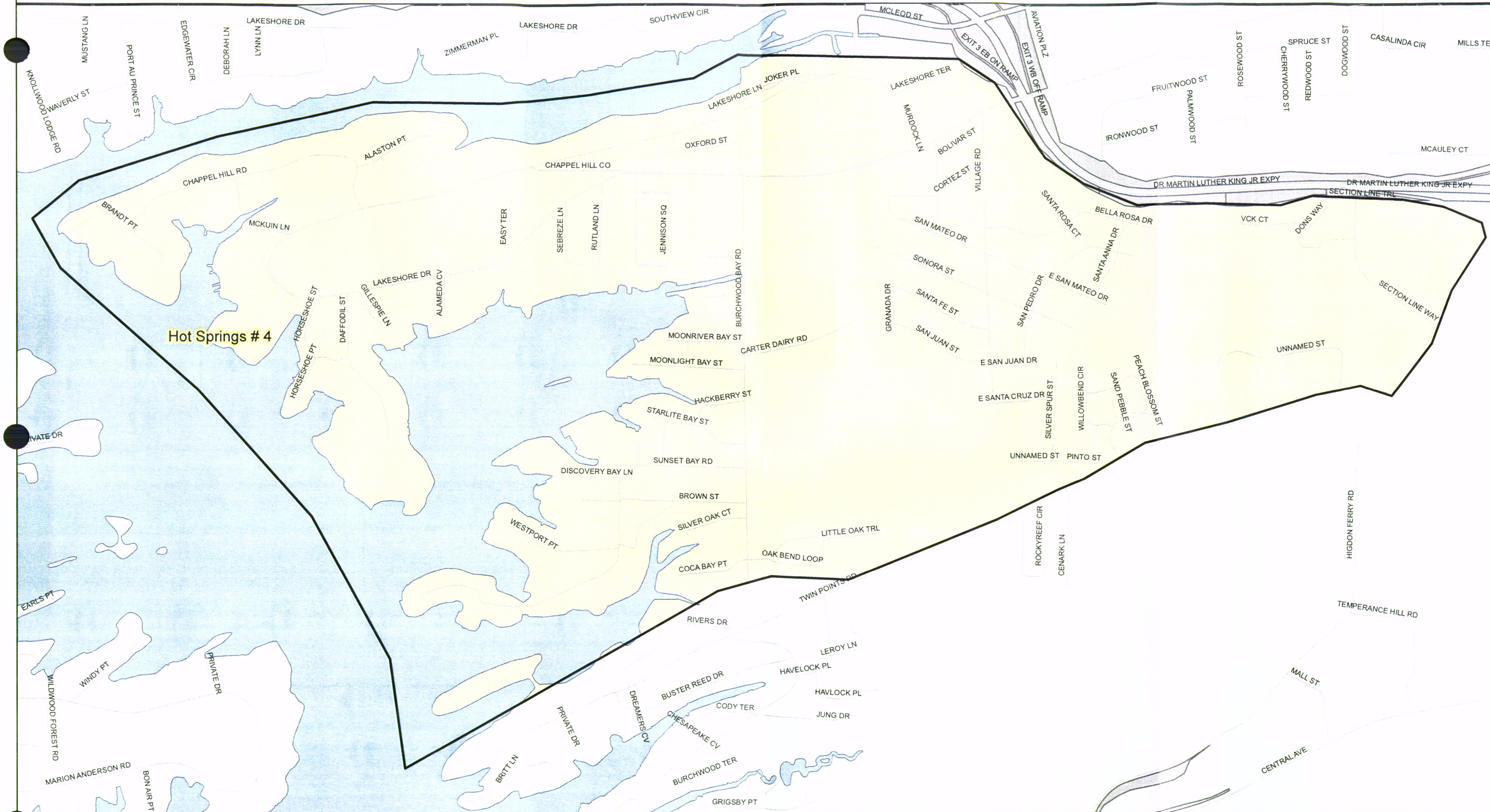
BASIN BOUNDARIES
HOT SPRINGS #2 & HOTSPRINGS #3
EXHIBIT 07

CITY OF HOT SPRINGS, AR



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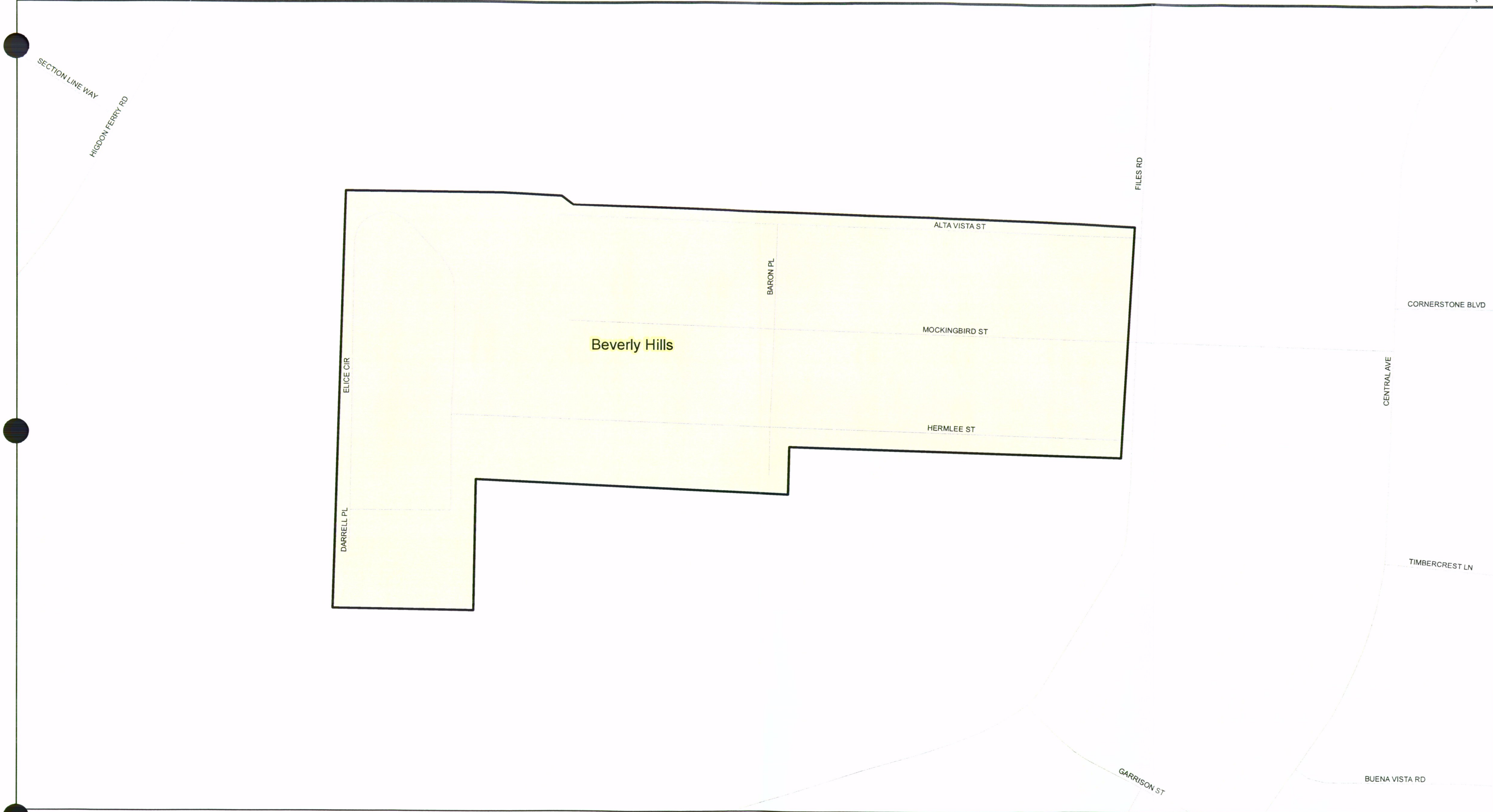
LEGEND
BASIN BOUNDARY

BASIN BOUNDARIES
HOT SPRINGS #4
EXHIBIT 08

CITY OF HOT SPRINGS, AR



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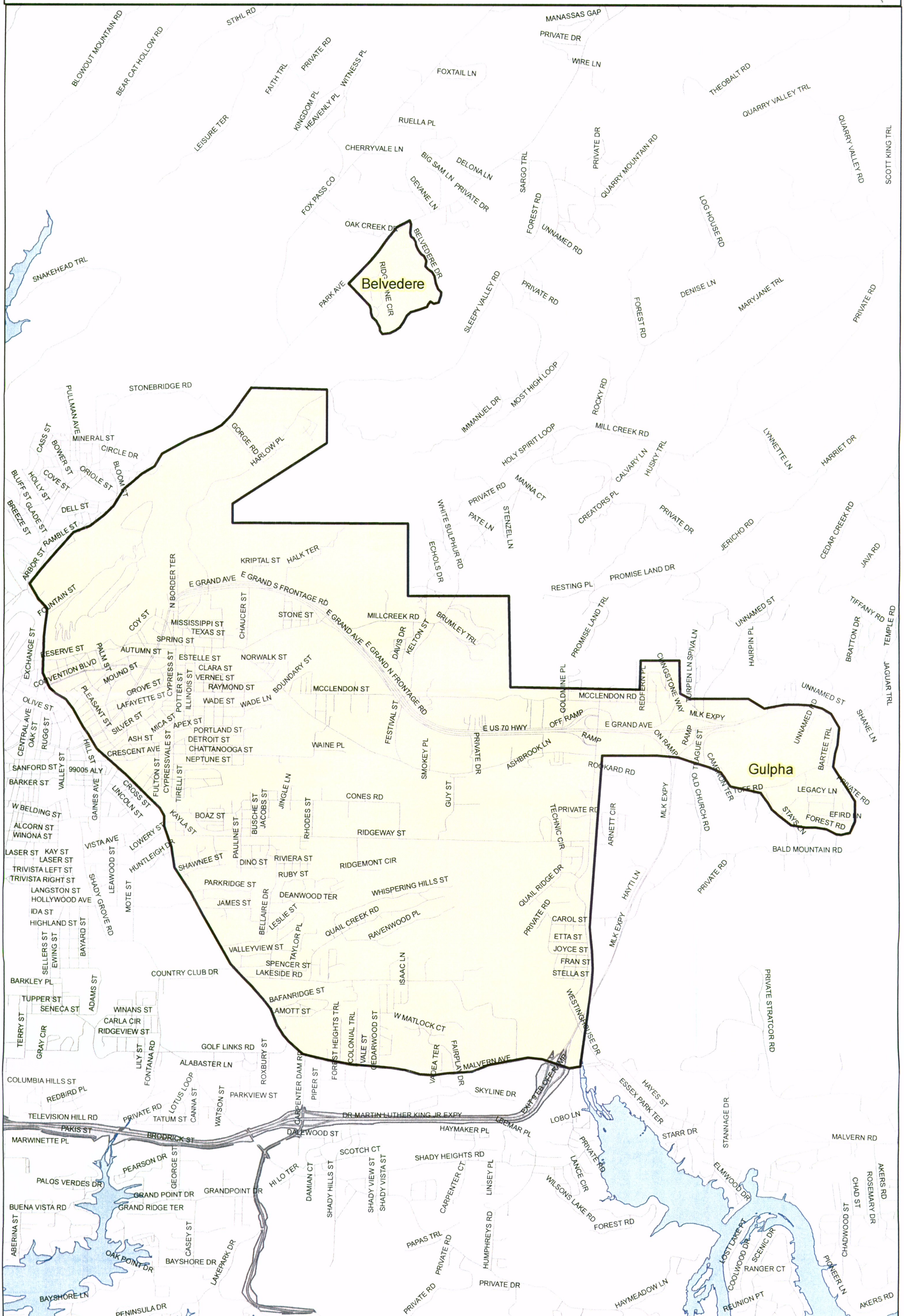
LEGEND

BASIN BOUNDARY

BASIN BOUNDARIES
BEVERLY HILLS
EXHIBIT 09

CITY OF HOT SPRINGS, AR



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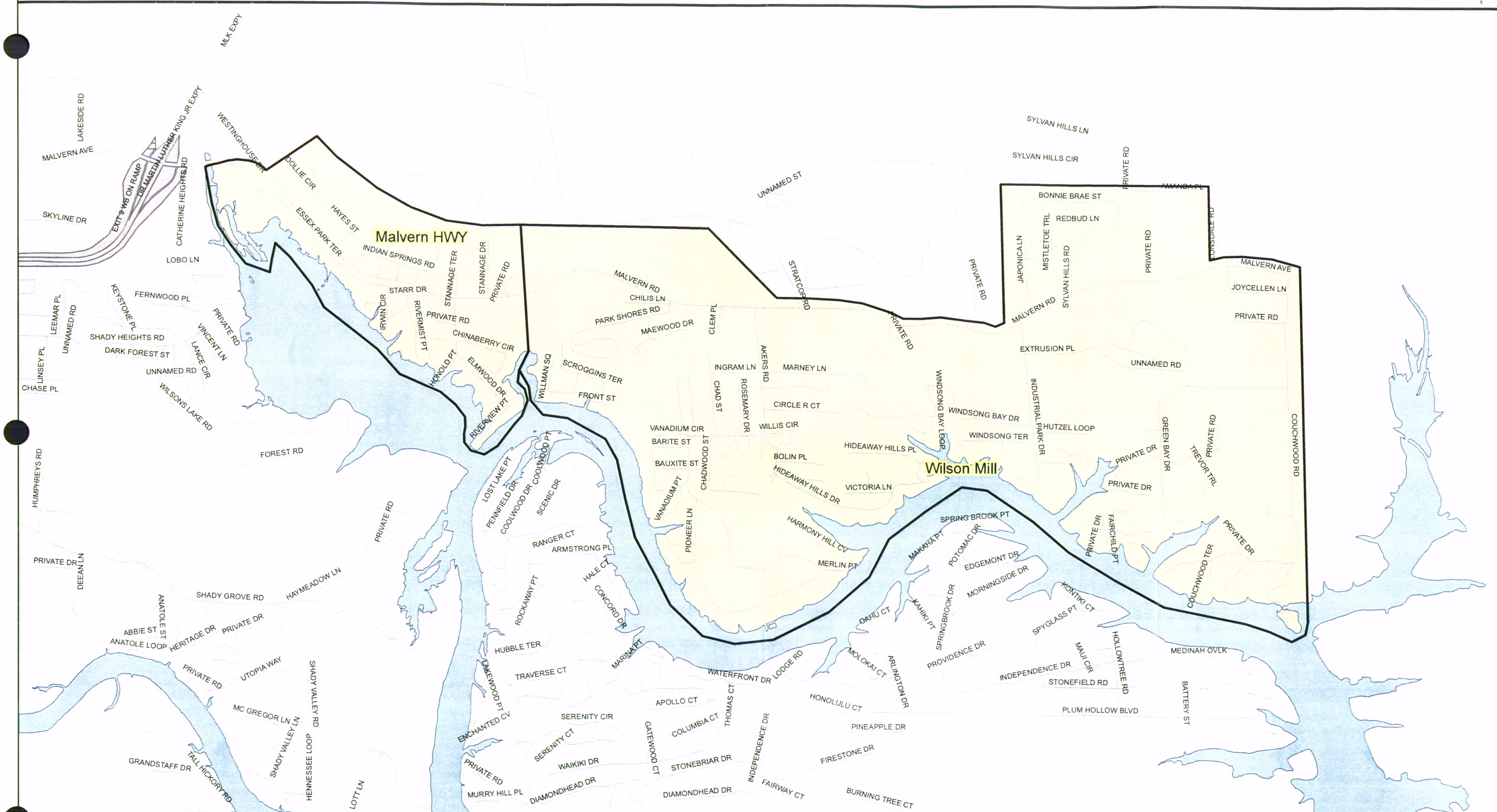
LEGEND

BASIN BOUNDARY

BASIN BOUNDARIES
GULPHA & BELVEDERE
EXHIBIT 10

CITY OF HOT SPRINGS, AR



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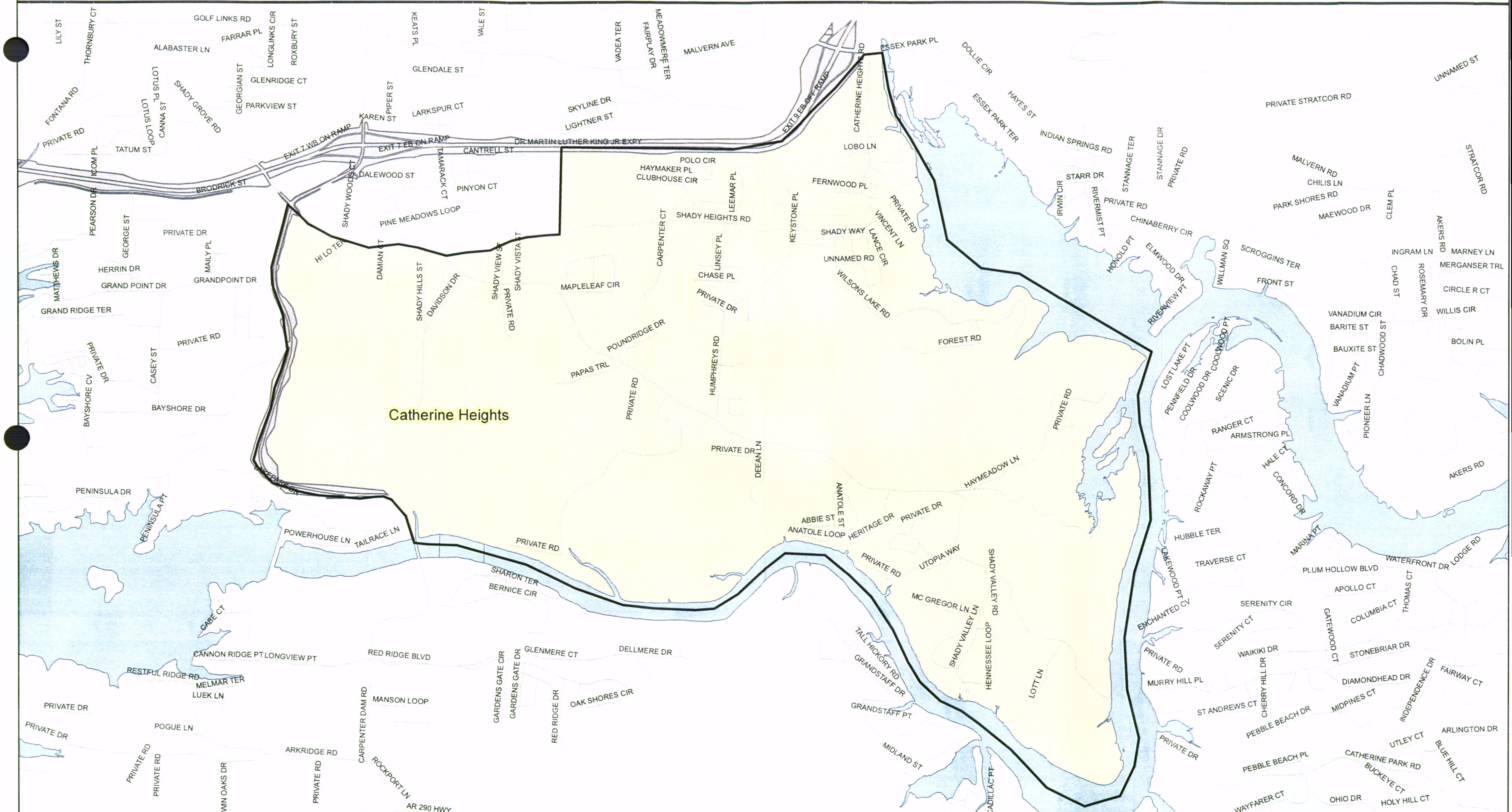
LEGEND

BASIN BOUNDARY

BASIN BOUNDARIES
MALVERN HWY & WILSON MILL
EXHIBIT 11

CITY OF HOT SPRINGS, AR



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LEGEND

BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
CATHERINE HEIGHTS
EXHIBIT 12

CITY OF HOT SPRINGS, AR

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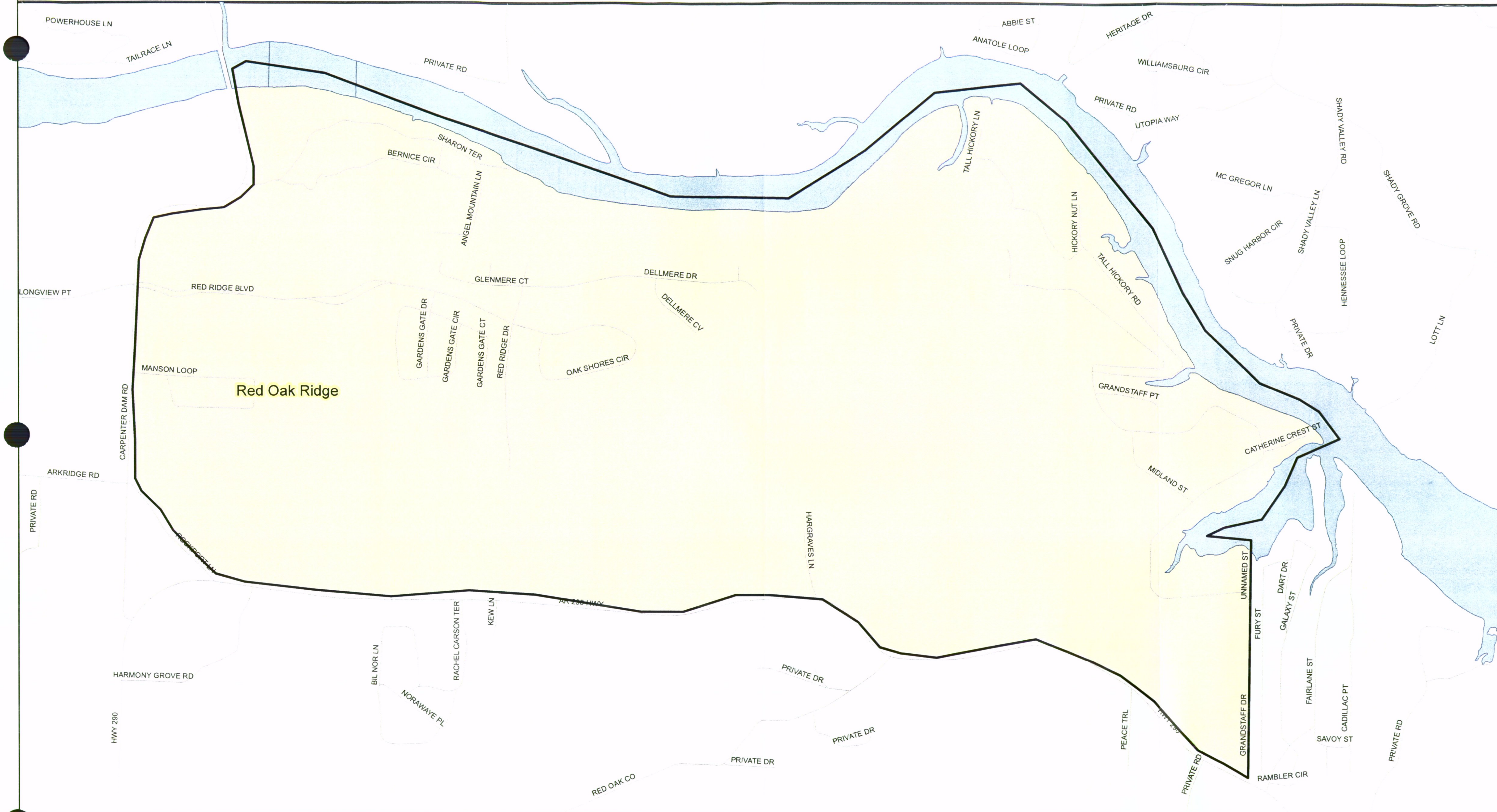
LEGEND
BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
CARPENTER DAM
EXHIBIT 13

CITY OF HOT SPRINGS, AR



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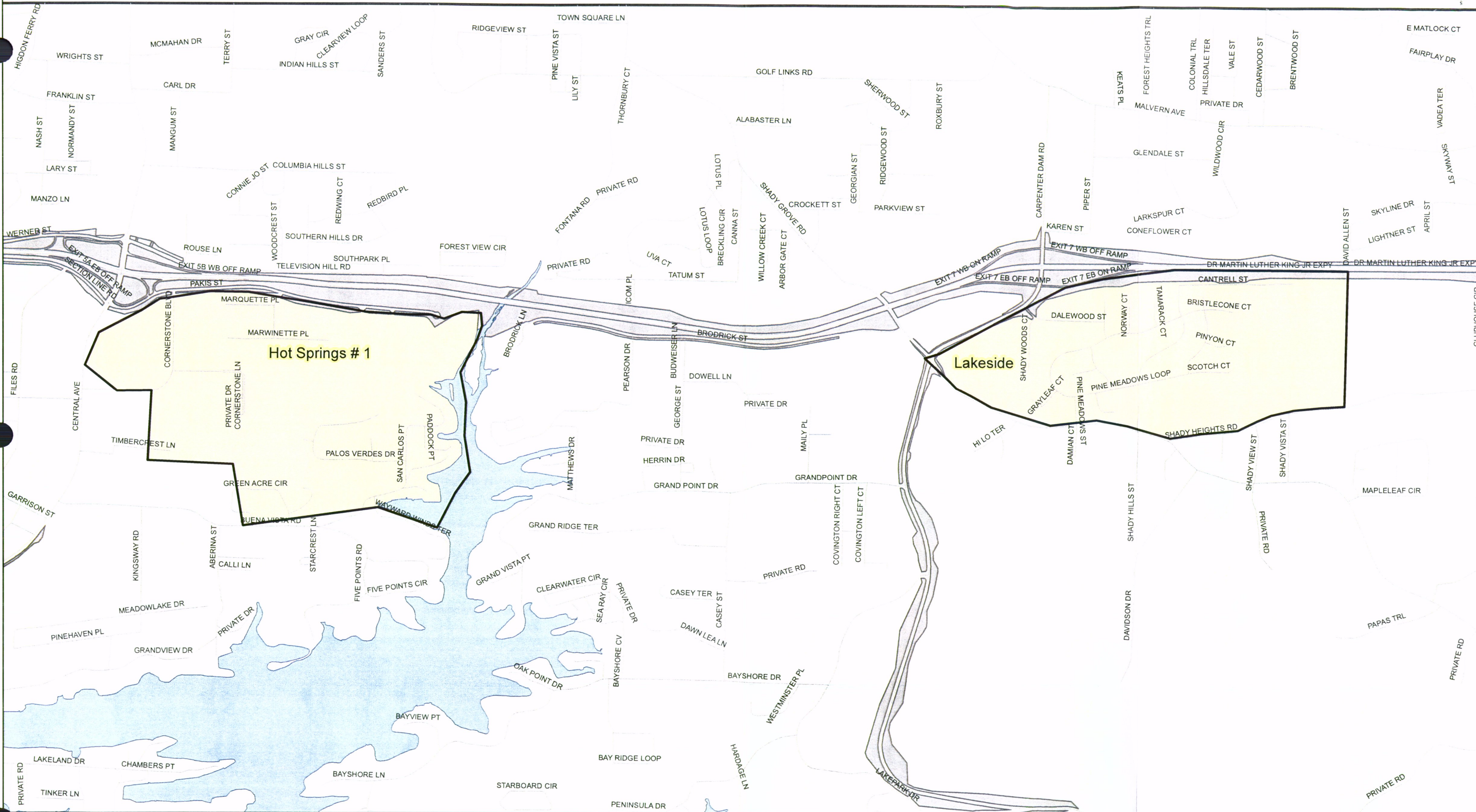
LEGEND

BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
RED OAK RIDGE
EXHIBIT 14

CITY OF HOT SPRINGS, AR



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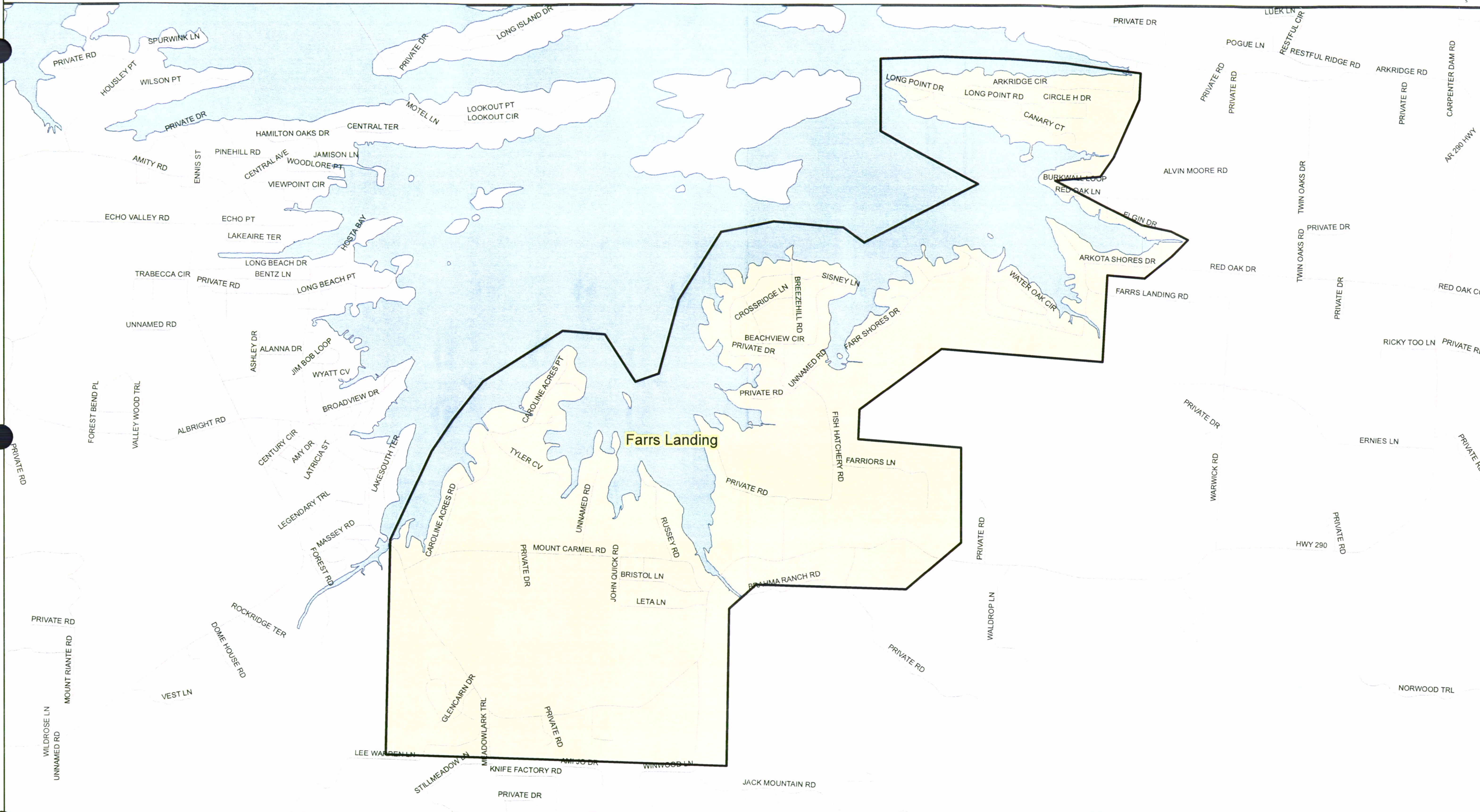
LEGEND

BASIN BOUNDARY

HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
HOT SPRINGS #1 & LAKESIDE
EXHIBIT 15

CITY OF HOT SPRINGS, AR



LEGEND

BASIN BOUNDARY

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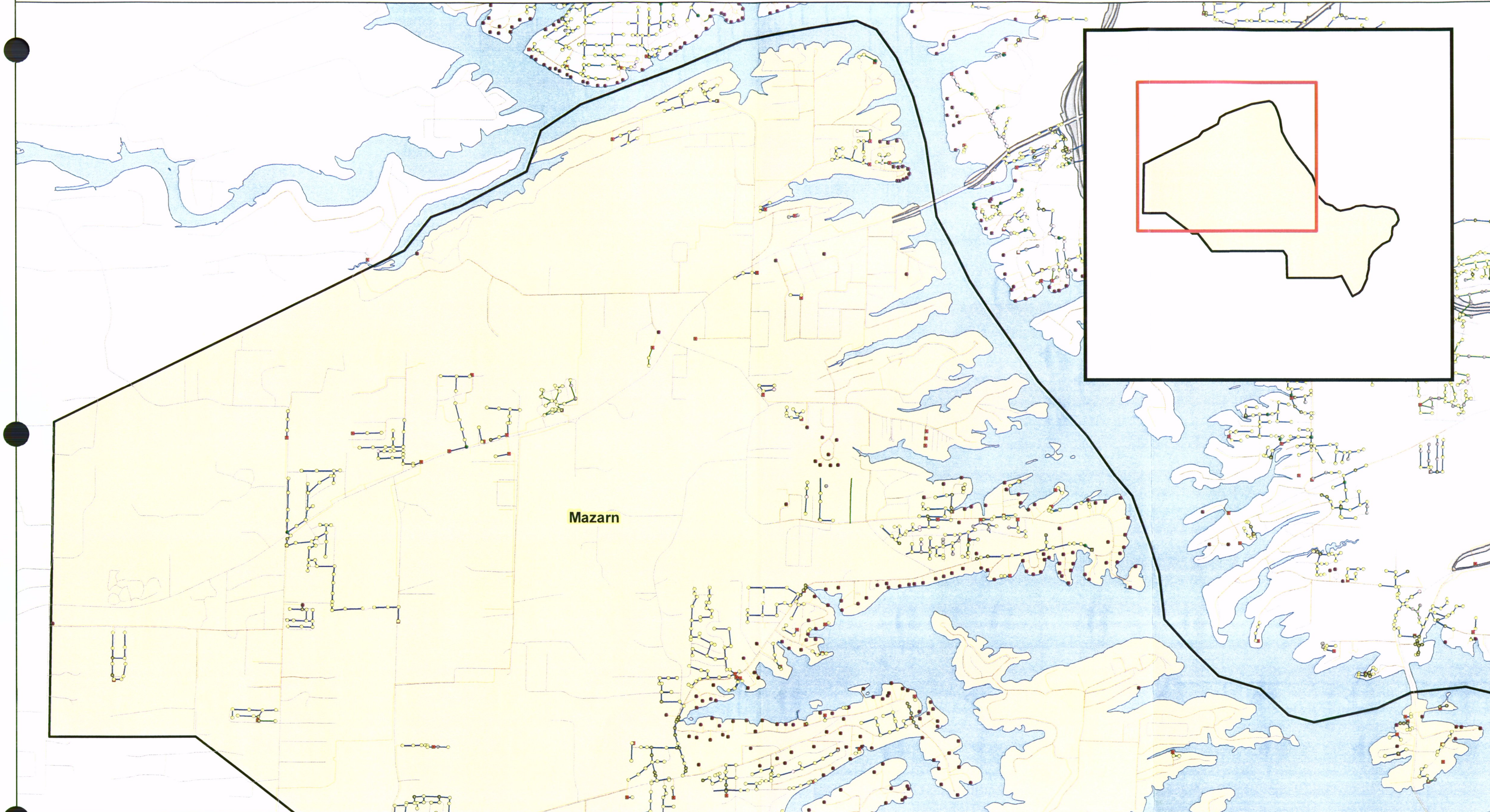
HOT SPRINGS NATIONAL PARK ARKANSAS

BASIN BOUNDARIES
FARRS LANDING
EXHIBIT 16

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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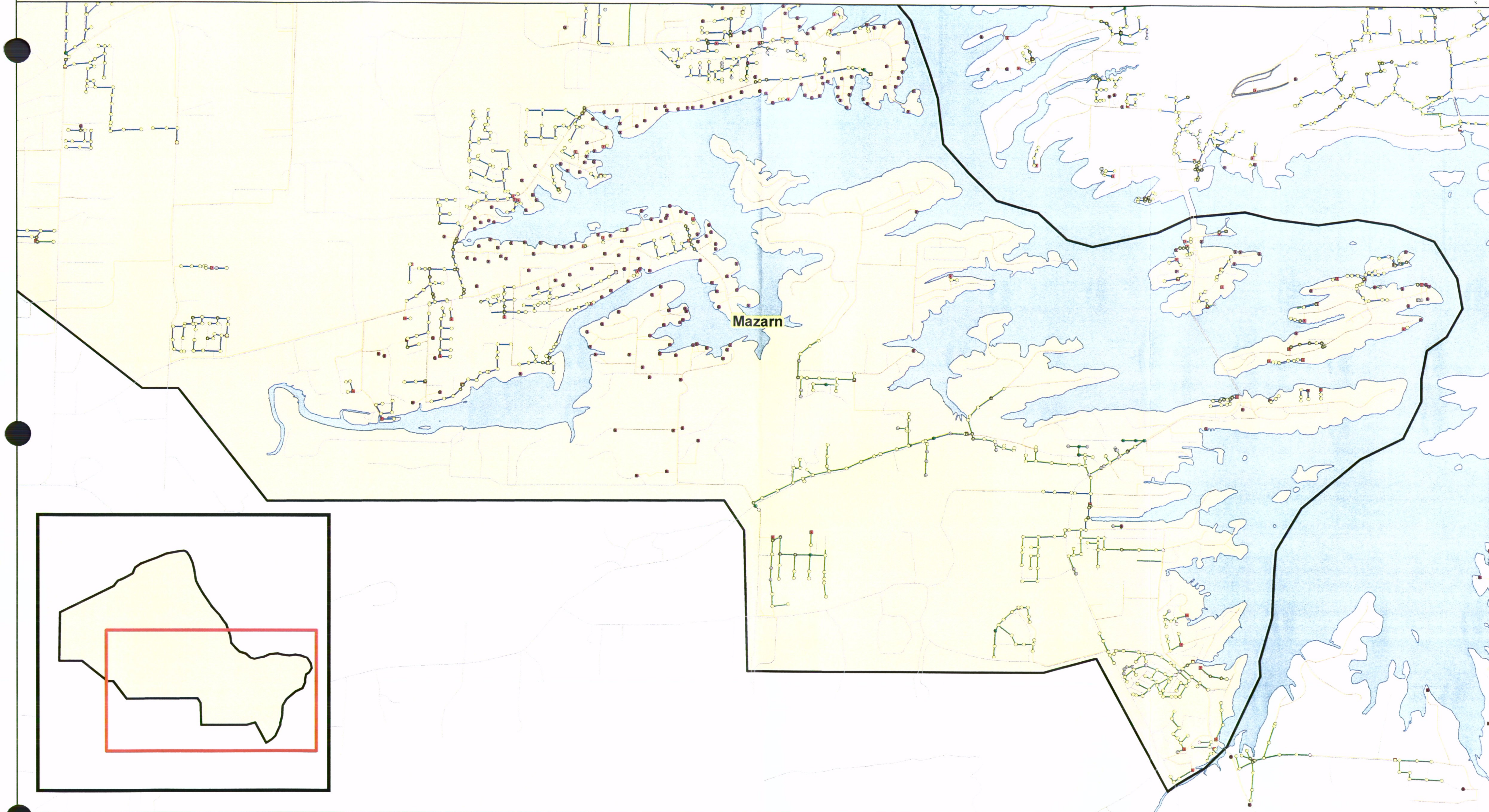
FIELD INVESTIGATIONS
MAZARN, NORTH
EXHIBIT 17

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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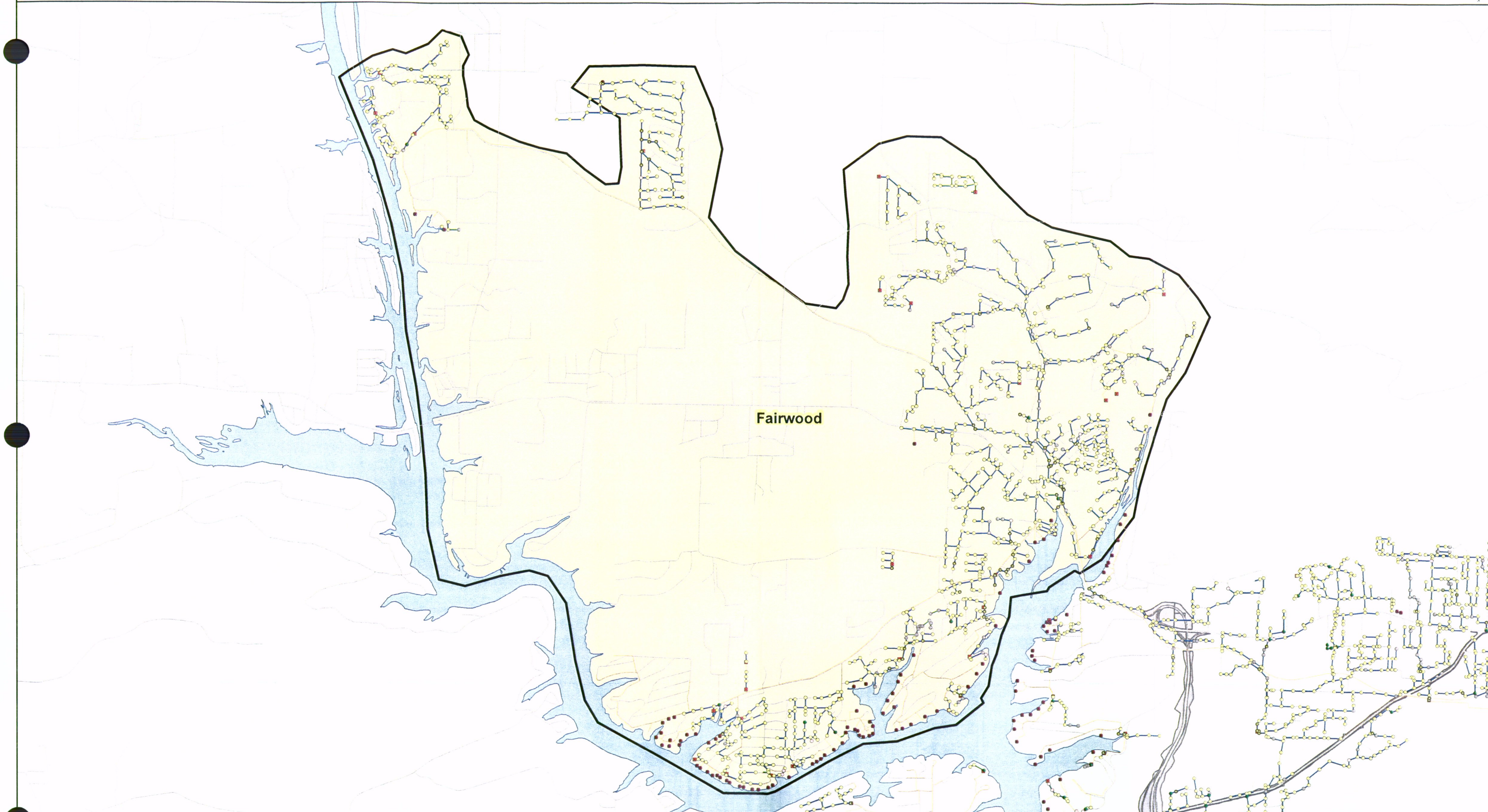
HOT SPRINGS

FIELD INVESTIGATIONS
MAZARN, SOUTH
EXHIBIT 18

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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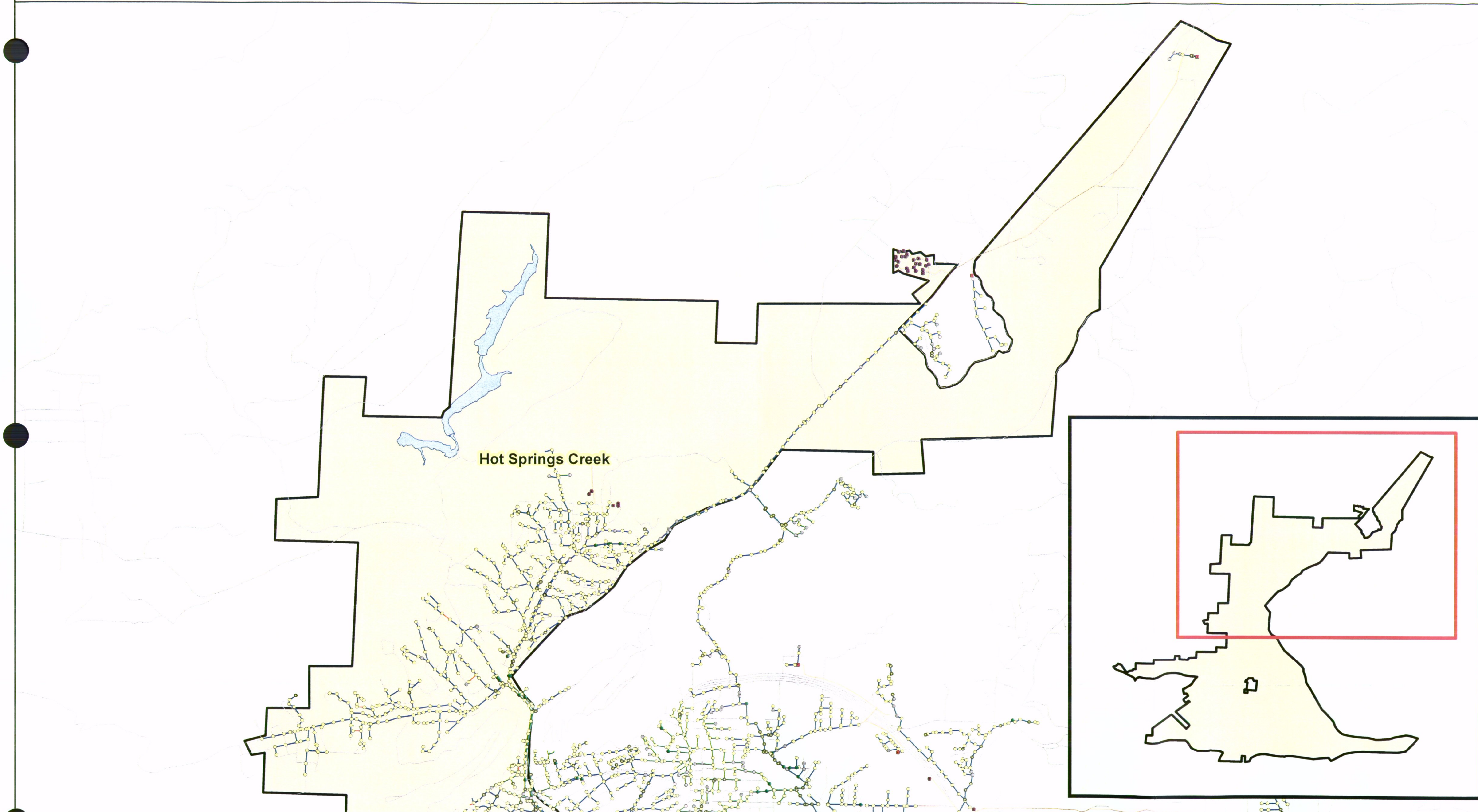
FIELD INVESTIGATIONS
FAIRWOOD
EXHIBIT 19

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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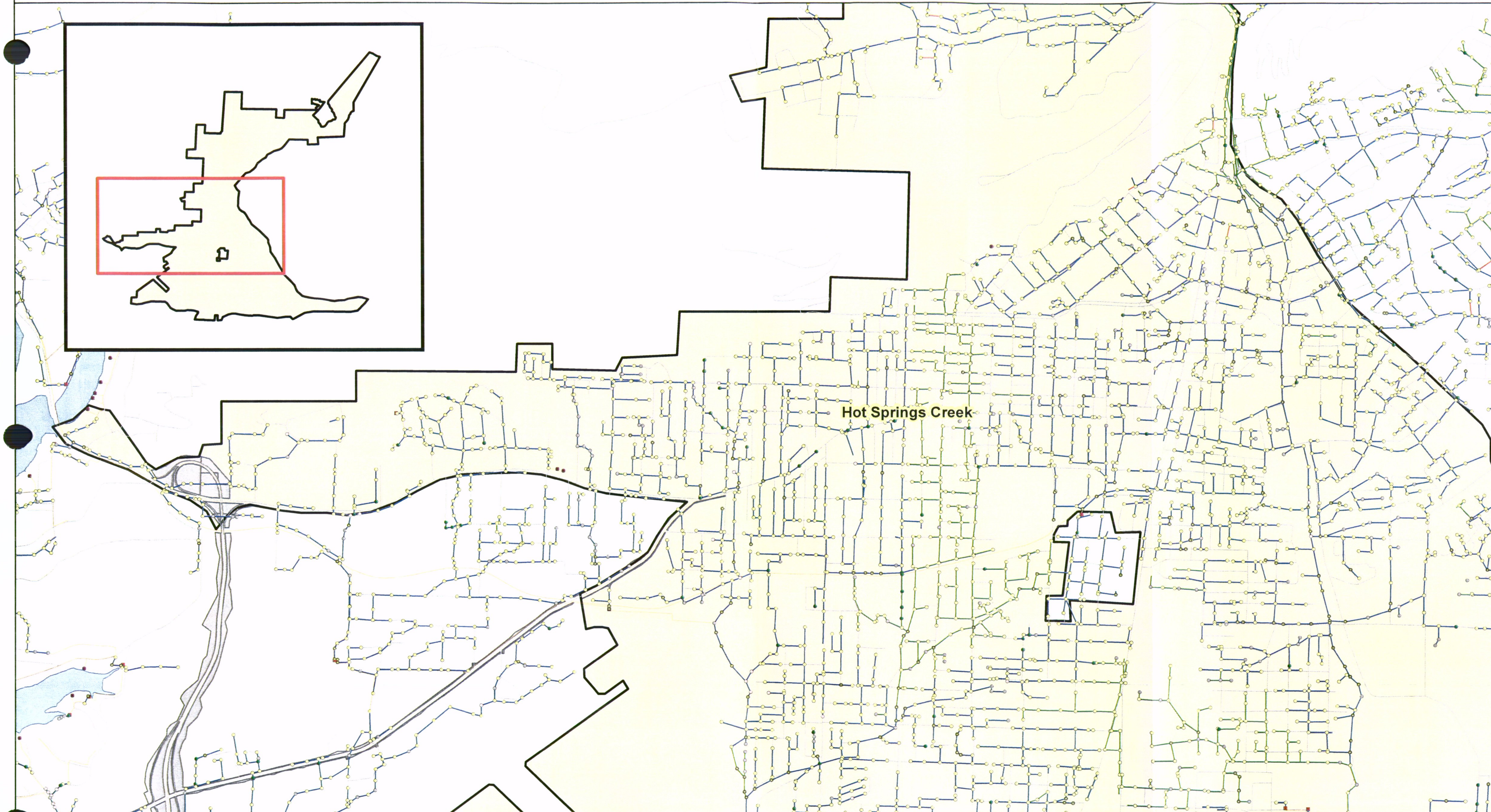
FIELD INVESTIGATIONS
HOT SPRINGS, NORTH
EXHIBIT 20

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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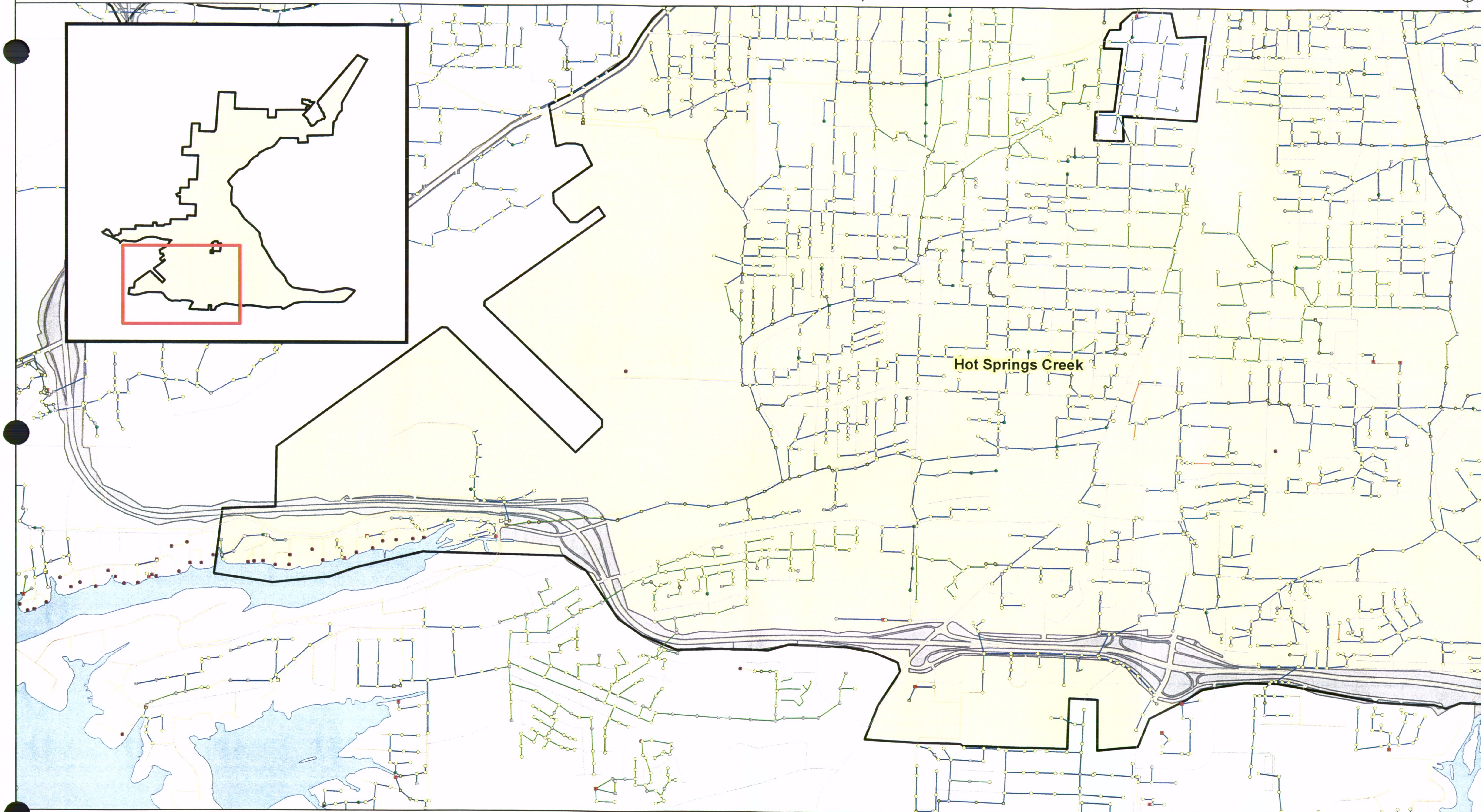
FIELD INVESTIGATIONS
HOT SPRINGS, CENTRAL
EXHIBIT 21

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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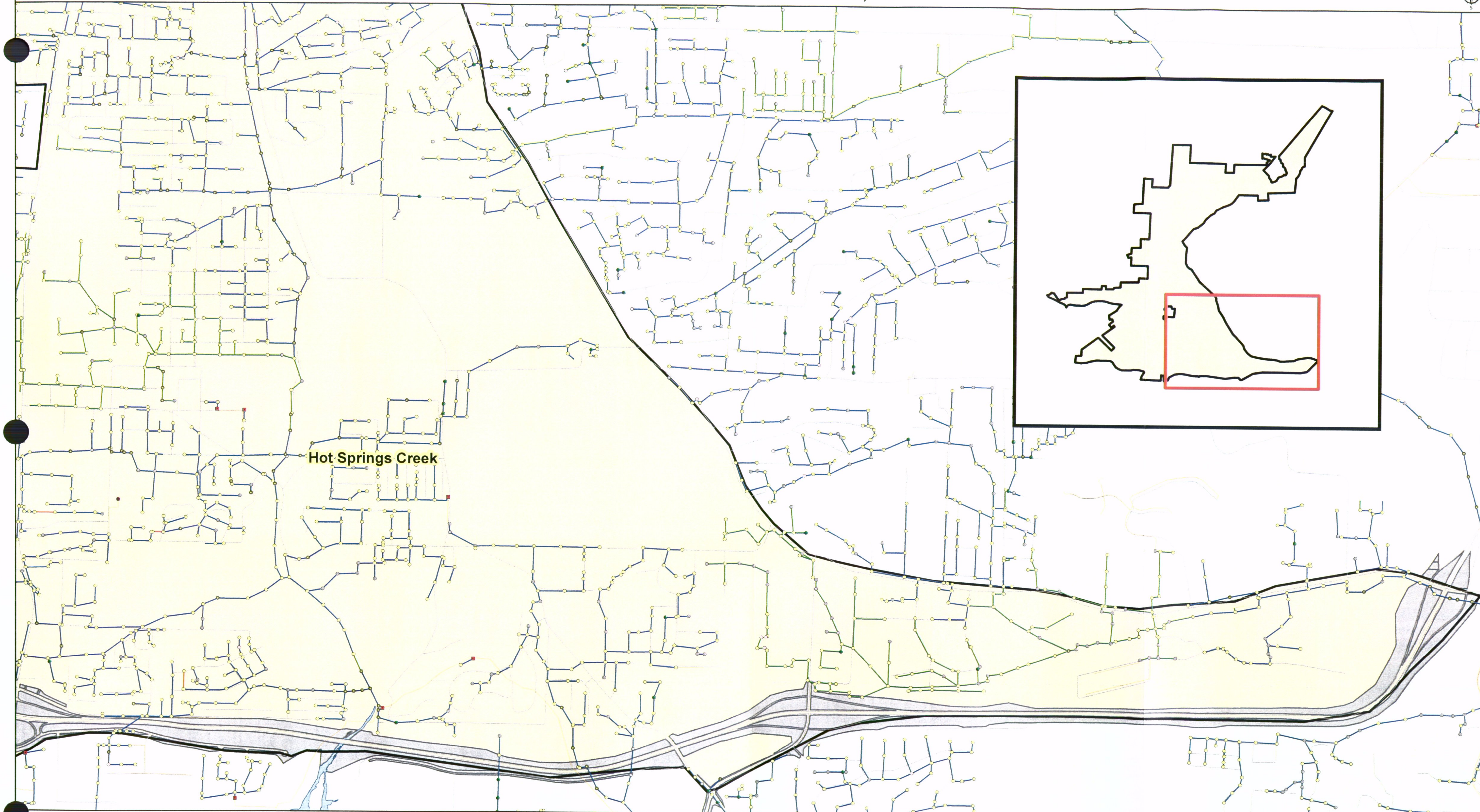
HOT SPRINGS NATIONAL PARK ARKANSAS

FIELD INVESTIGATIONS
HOT SPRINGS, SOUTH WEST
EXHIBIT 22

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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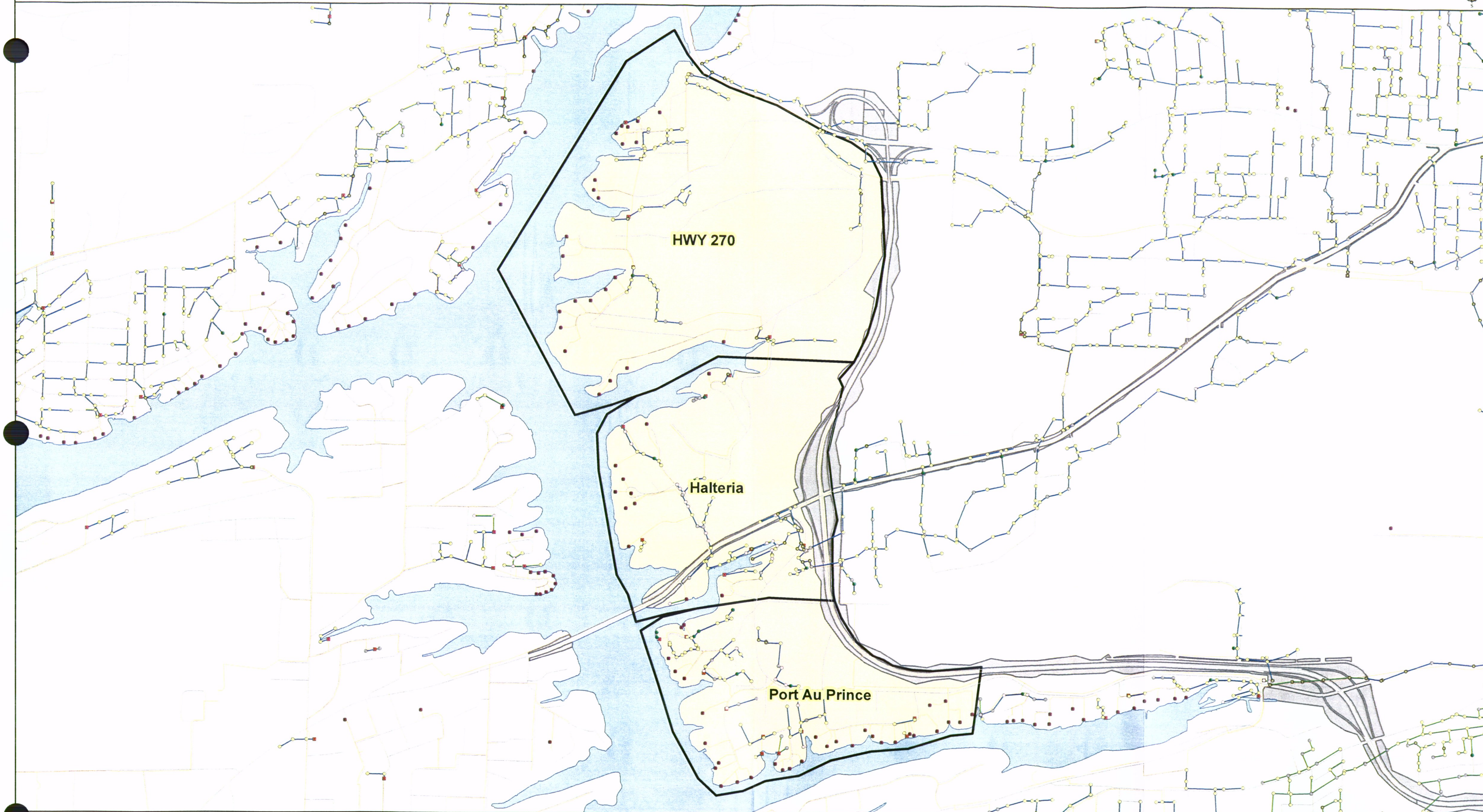
FIELD INVESTIGATIONS
HOT SPRINGS, SOUTH EAST
EXHIBIT 23

CITY OF HOT SPRINGS, AR



Legend

Buried Manholes	Inspected Manholes	Pump Stations	Gravity Main
Not Found Manholes	Inaccessible Manholes	Grinder Pumps	Smoke Test Lines
	Evidence of Surcharge	Force Main	Dye Test Lines

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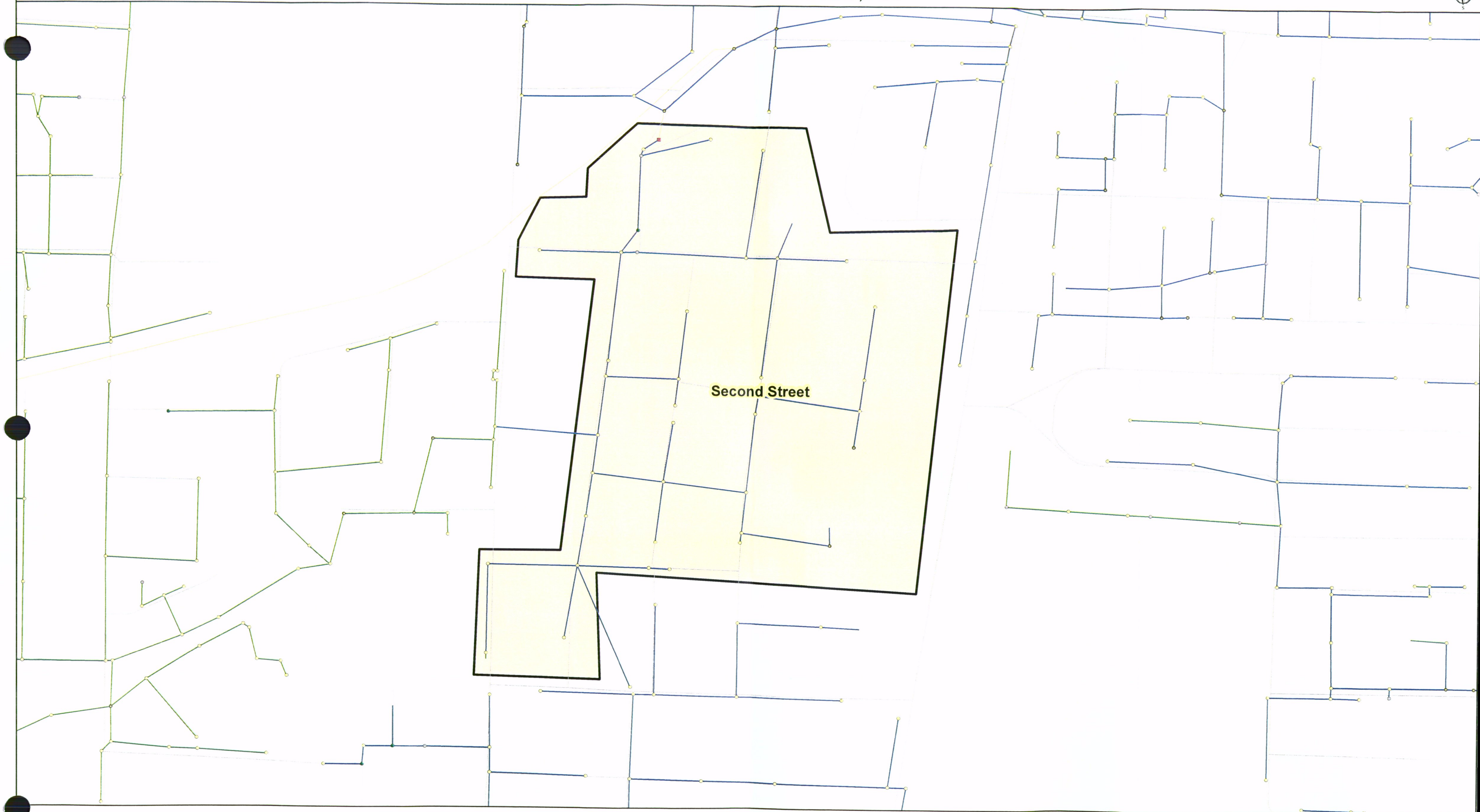
FIELD INVESTIGATIONS
HWY 270, HALTERIA, & PORT AU PRINCE
EXHIBIT 24

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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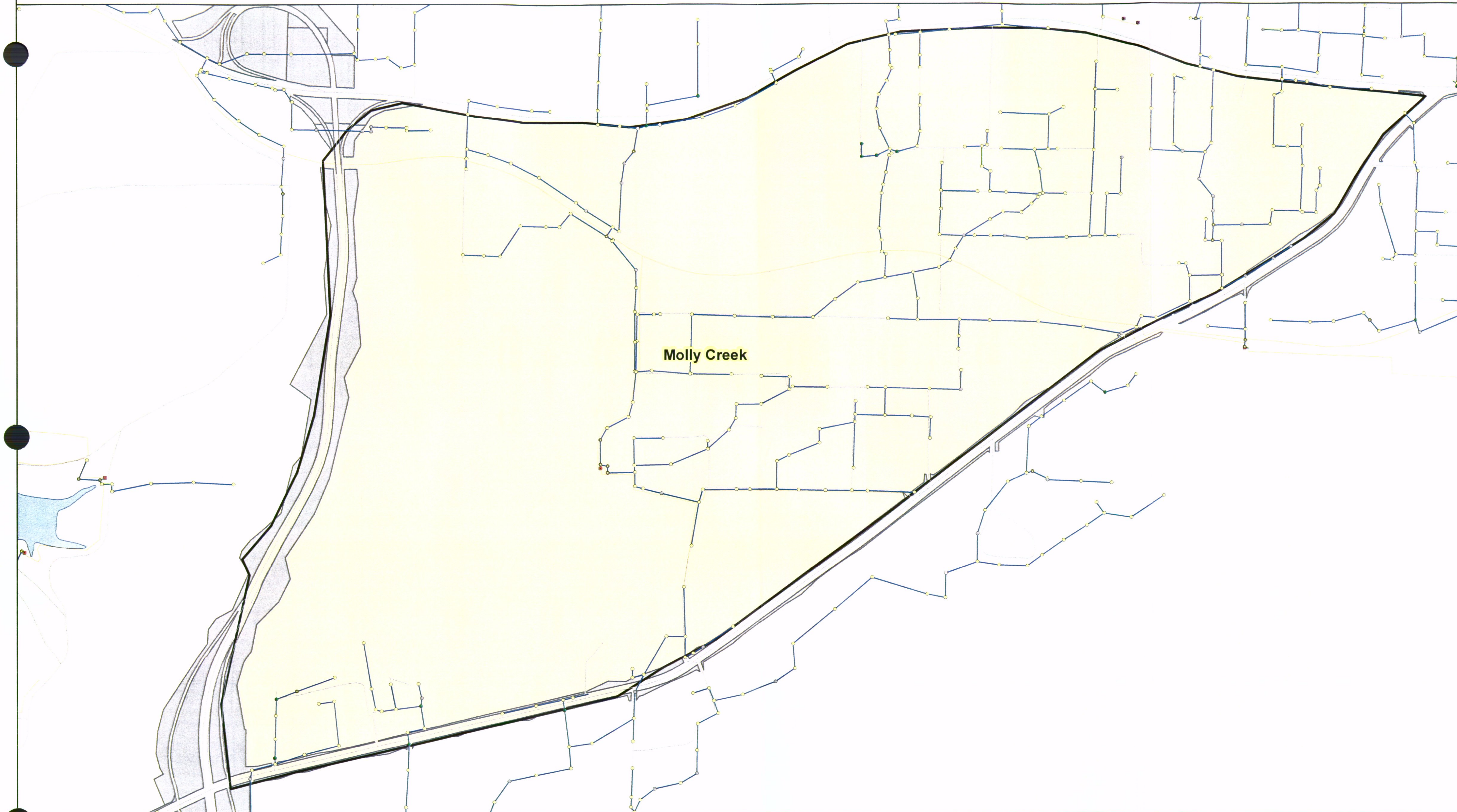
FIELD INVESTIGATIONS
2ND STREET
EXHIBIT 25

CITY OF HOT SPRINGS, AR



Legend

Buried Manholes
Not Found Manholes
Inspected Manholes
Inaccessible Manholes
Evidence of Surcharge
Pump Stations
Grinder Pumps
Force Main
Gravity Main
Smoke Test Lines
Dye Test Lines

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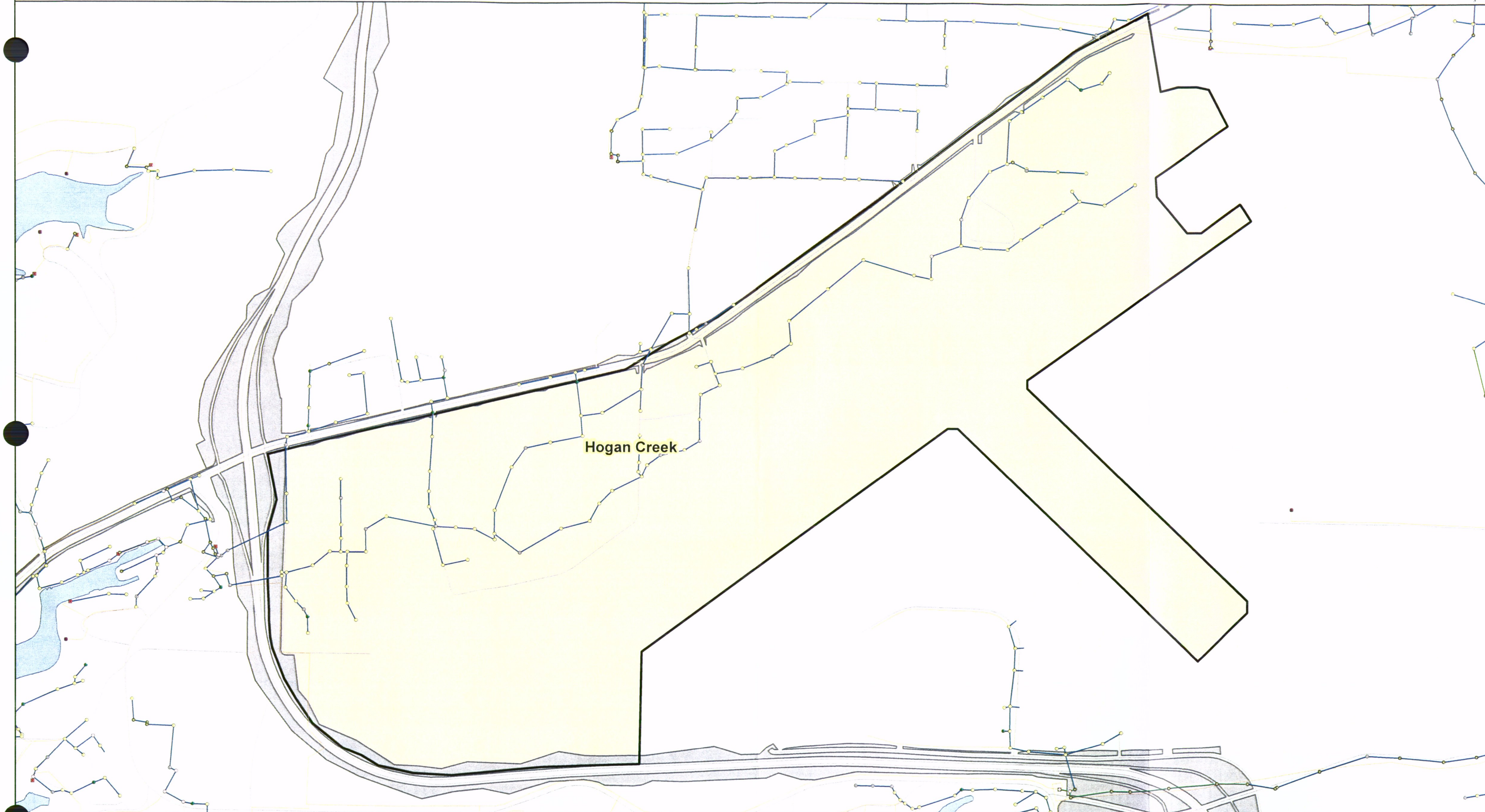
FIELD INVESTIGATIONS
MOLLY CREEK
EXHIBIT 26

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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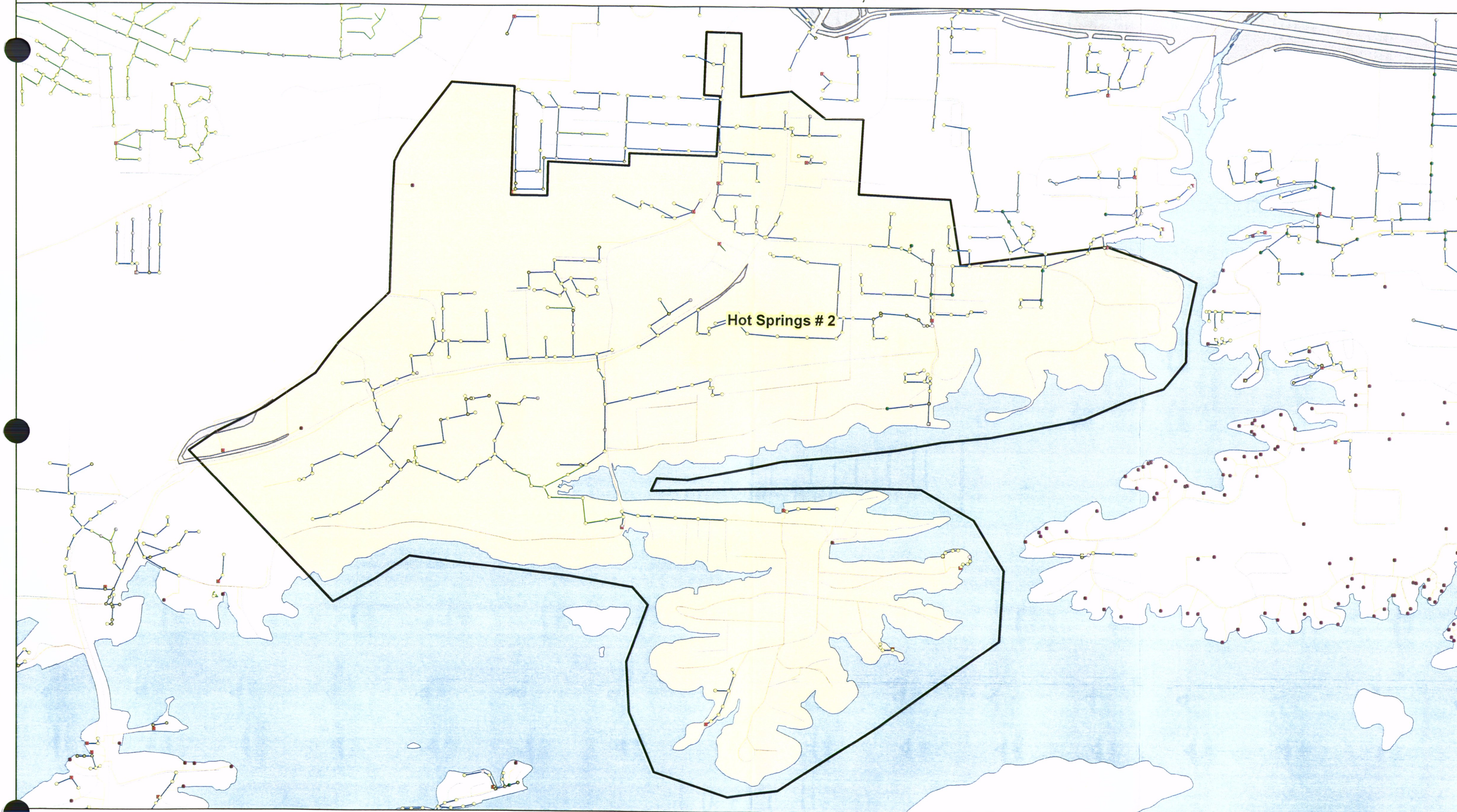
FIELD INVESTIGATIONS
HOGAN CREEK
EXHIBIT 27

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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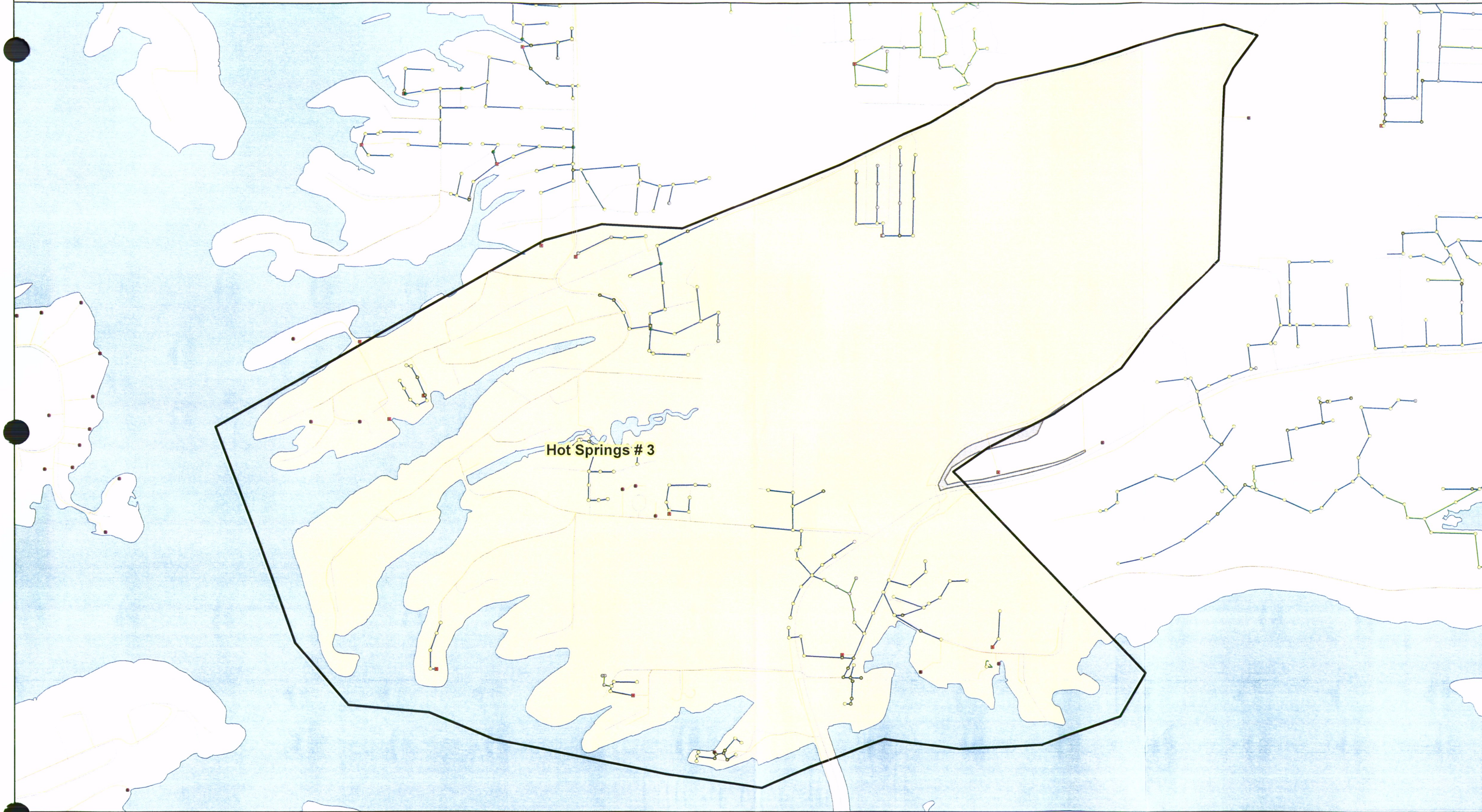
FIELD INVESTIGATIONS
HOT SPRINGS #2
EXHIBIT 28

CITY OF HOT SPRINGS, AR



Legend

Buried Manholes
Not Found Manholes
Inspected Manholes
Inaccessible Manholes
Evidence of Surcharge
Pump Stations
Grinder Pumps
Force Main
Gravity Main
Smoke Test Lines
Dye Test Lines

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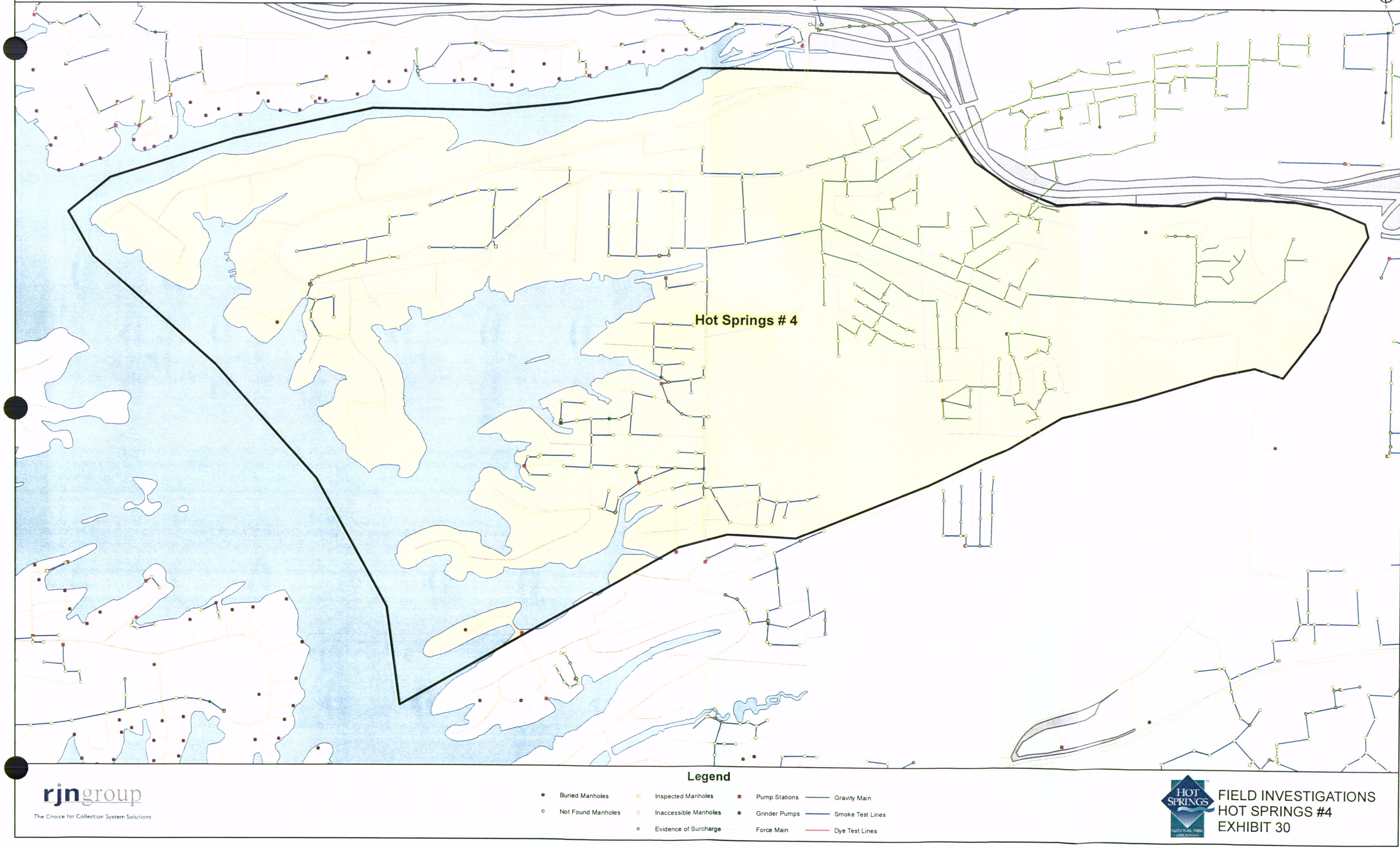
FIELD INVESTIGATIONS
HOT SPRINGS #3
EXHIBIT 29

CITY OF HOT SPRINGS, AR



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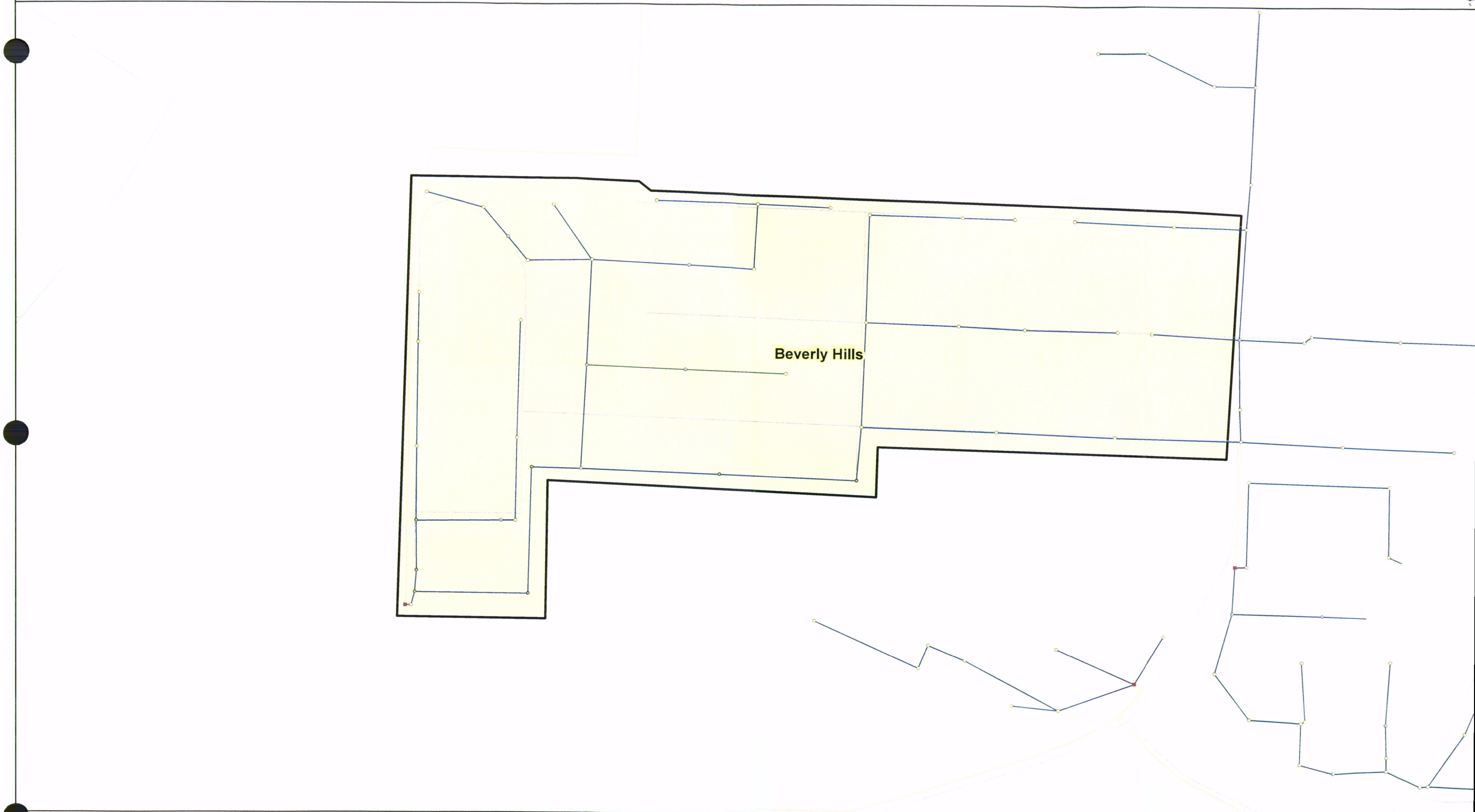
FIELD INVESTIGATIONS
HOT SPRINGS #4
EXHIBIT 30

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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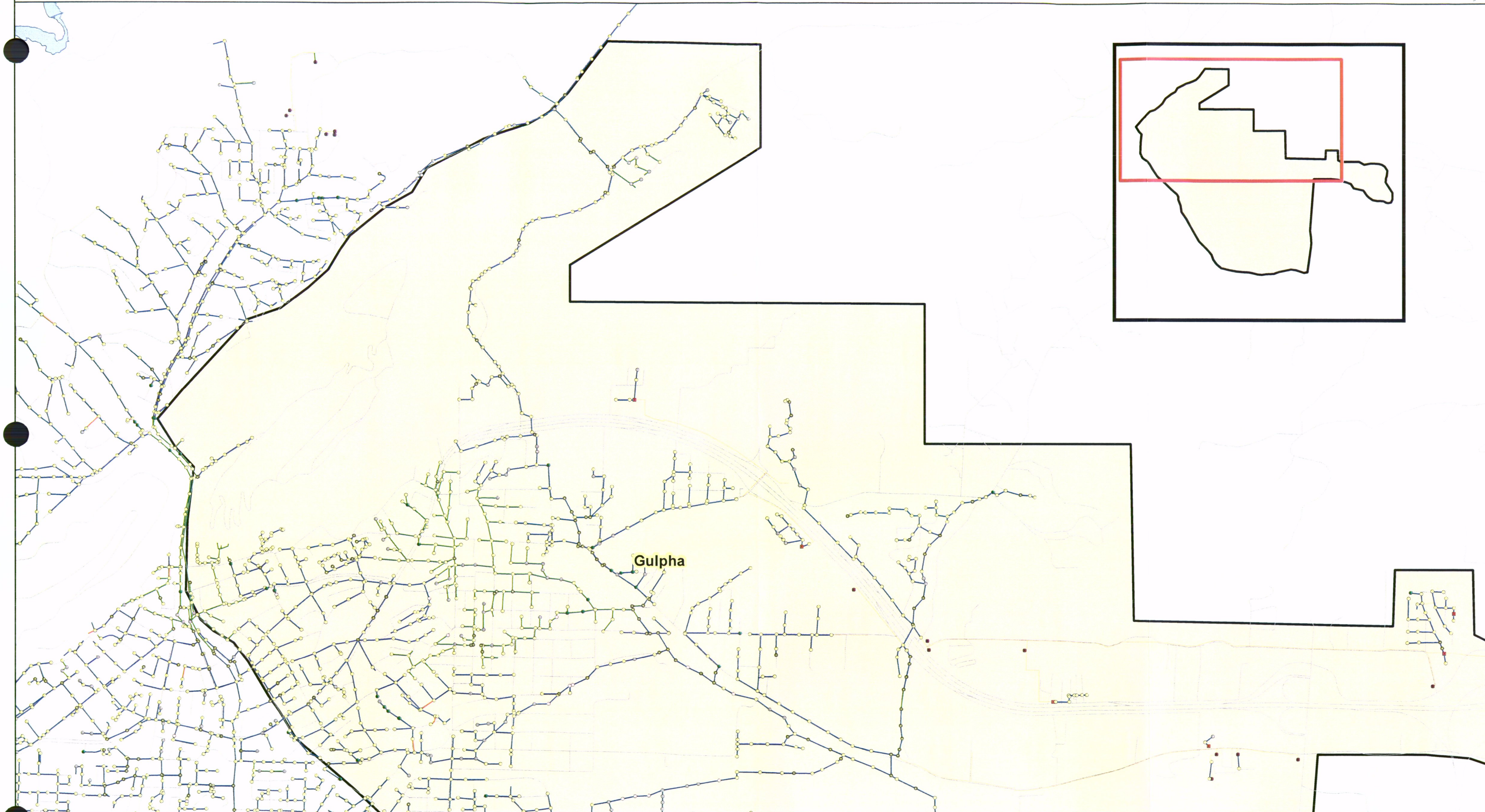
FIELD INVESTIGATIONS
BEVERLY HILLS
EXHIBIT 31

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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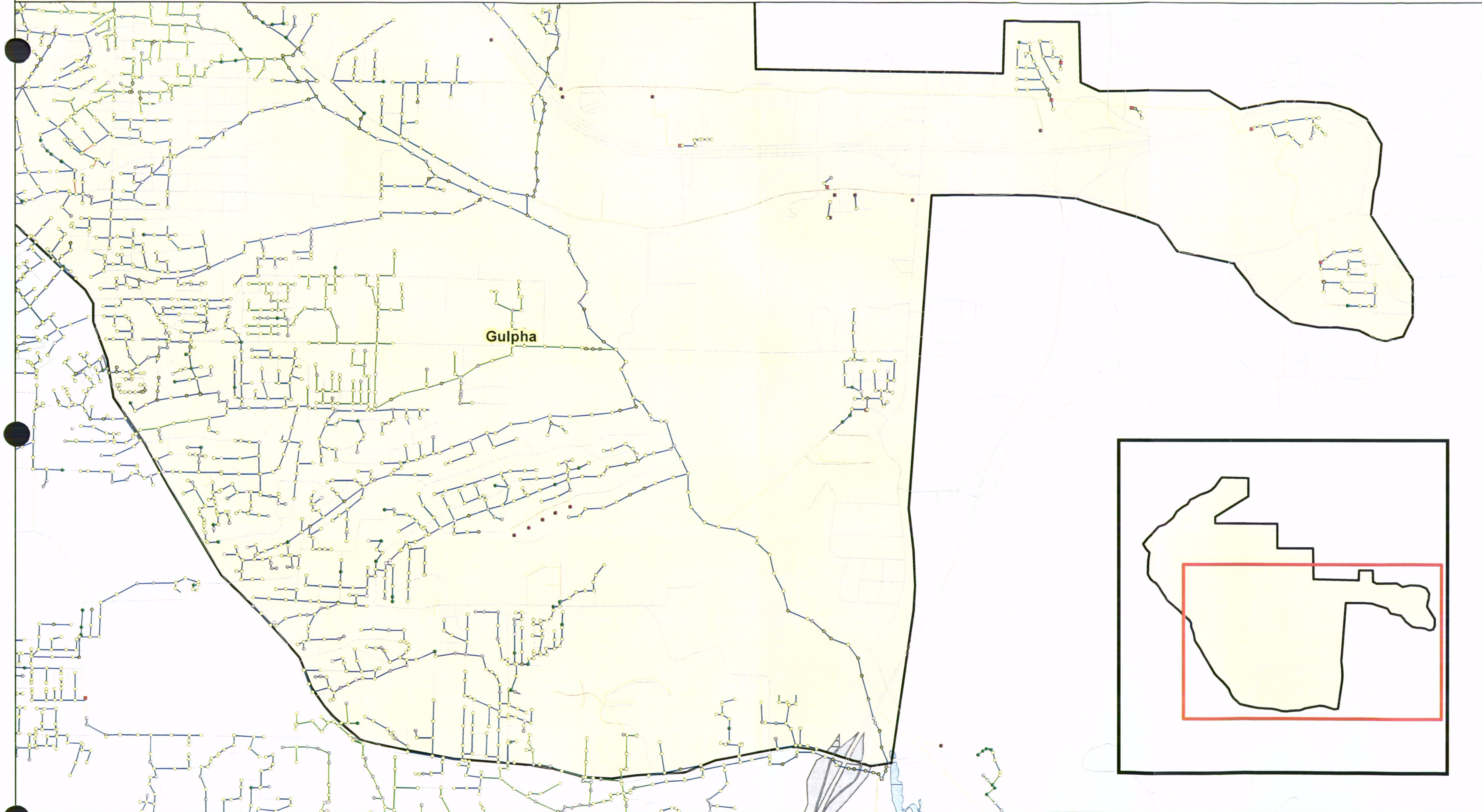
FIELD INVESTIGATIONS
GULPHA, NORTH
EXHIBIT 32

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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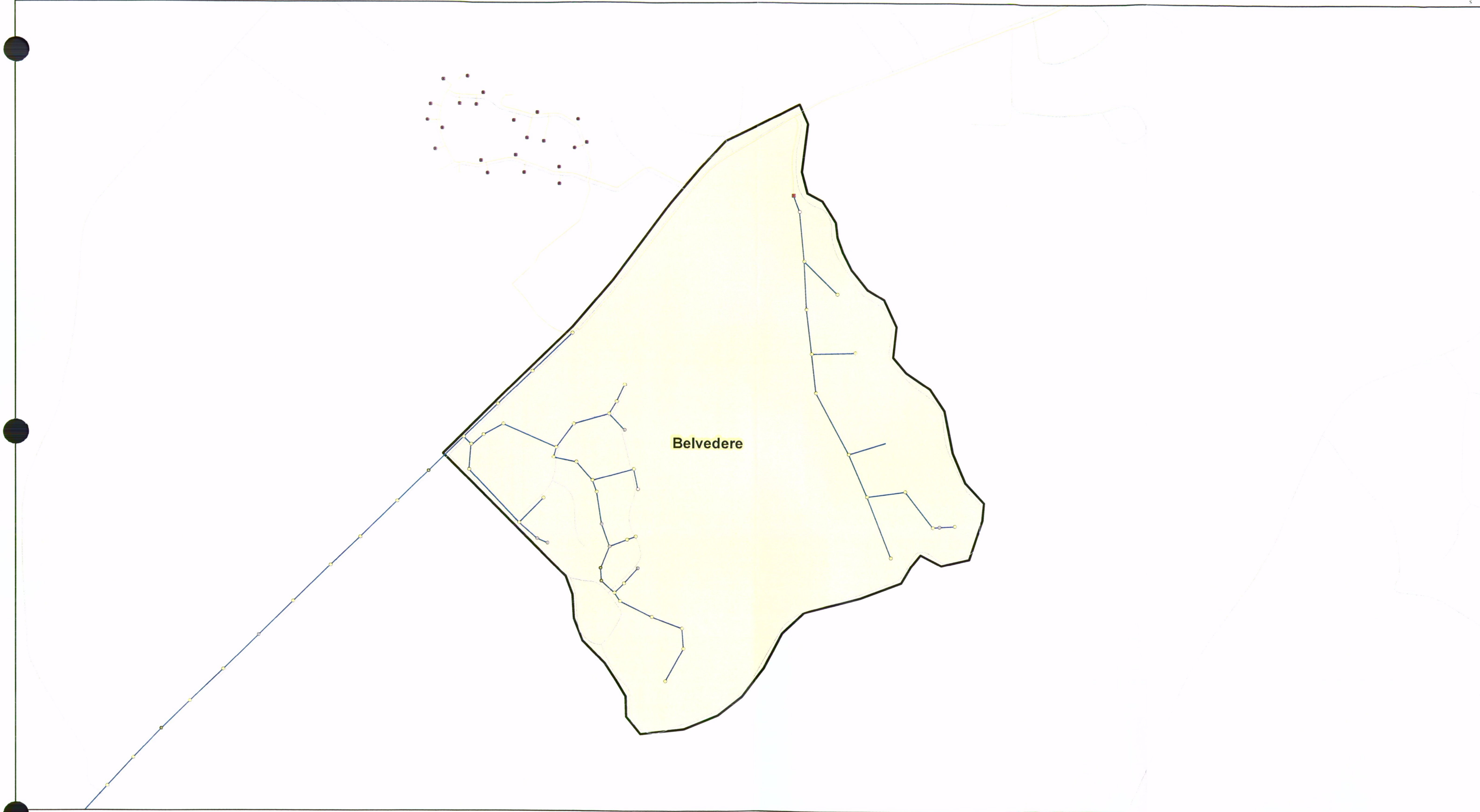
The Choice for Collection System Solutions

FIELD INVESTIGATIONS
GULPHA, SOUTH
EXHIBIT 33

CITY OF HOT SPRINGS, AR



Legend

Buried Manholes	Inspected Manholes	Pump Stations	Gravity Main
Not Found Manholes	Inaccessible Manholes	Grinder Pumps	Smoke Test Lines
	Evidence of Surcharge	Force Main	Dye Test Lines

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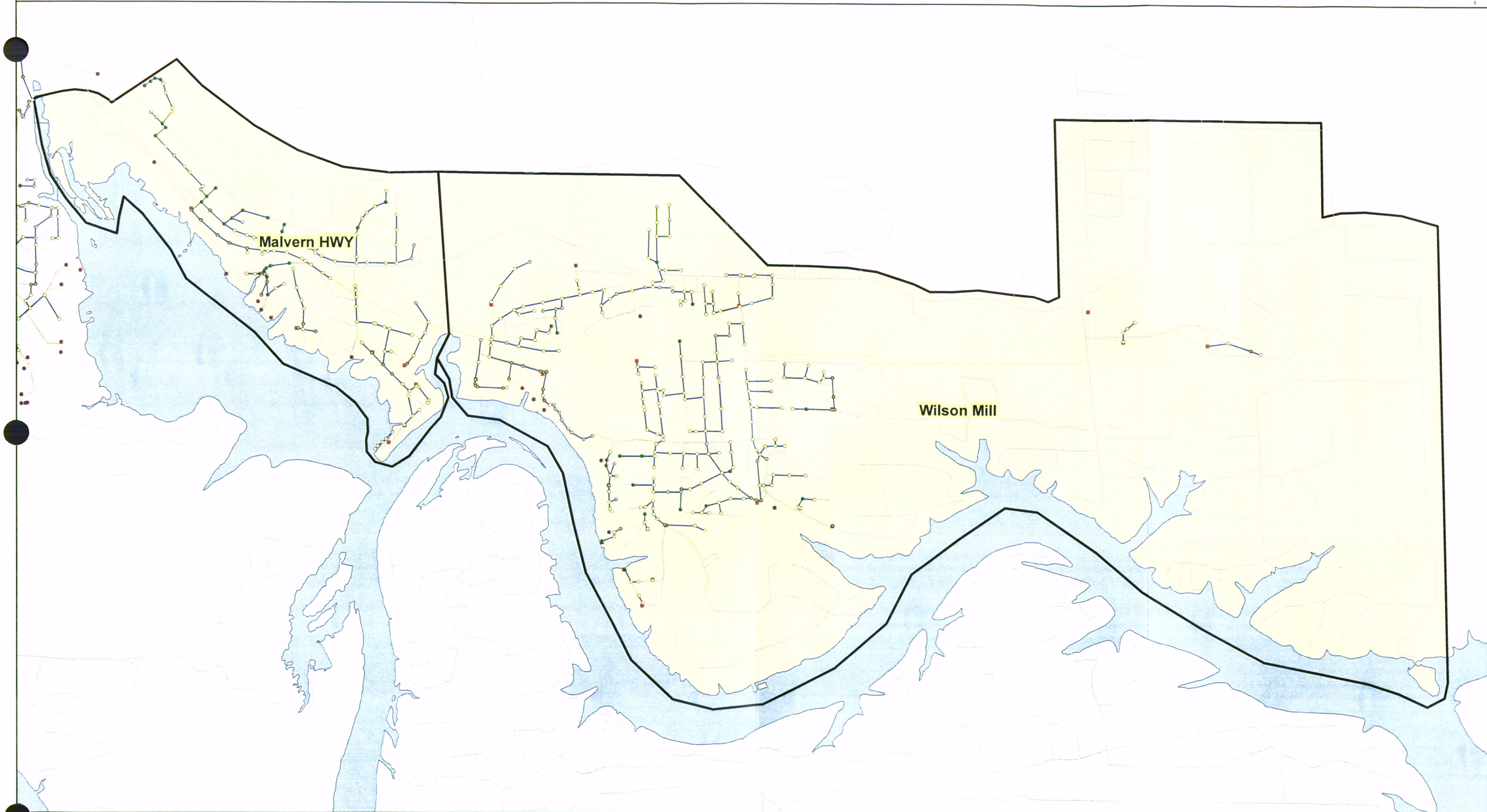
HOT SPRINGS

FIELD INVESTIGATIONS
BELVEDERE
EXHIBIT 34

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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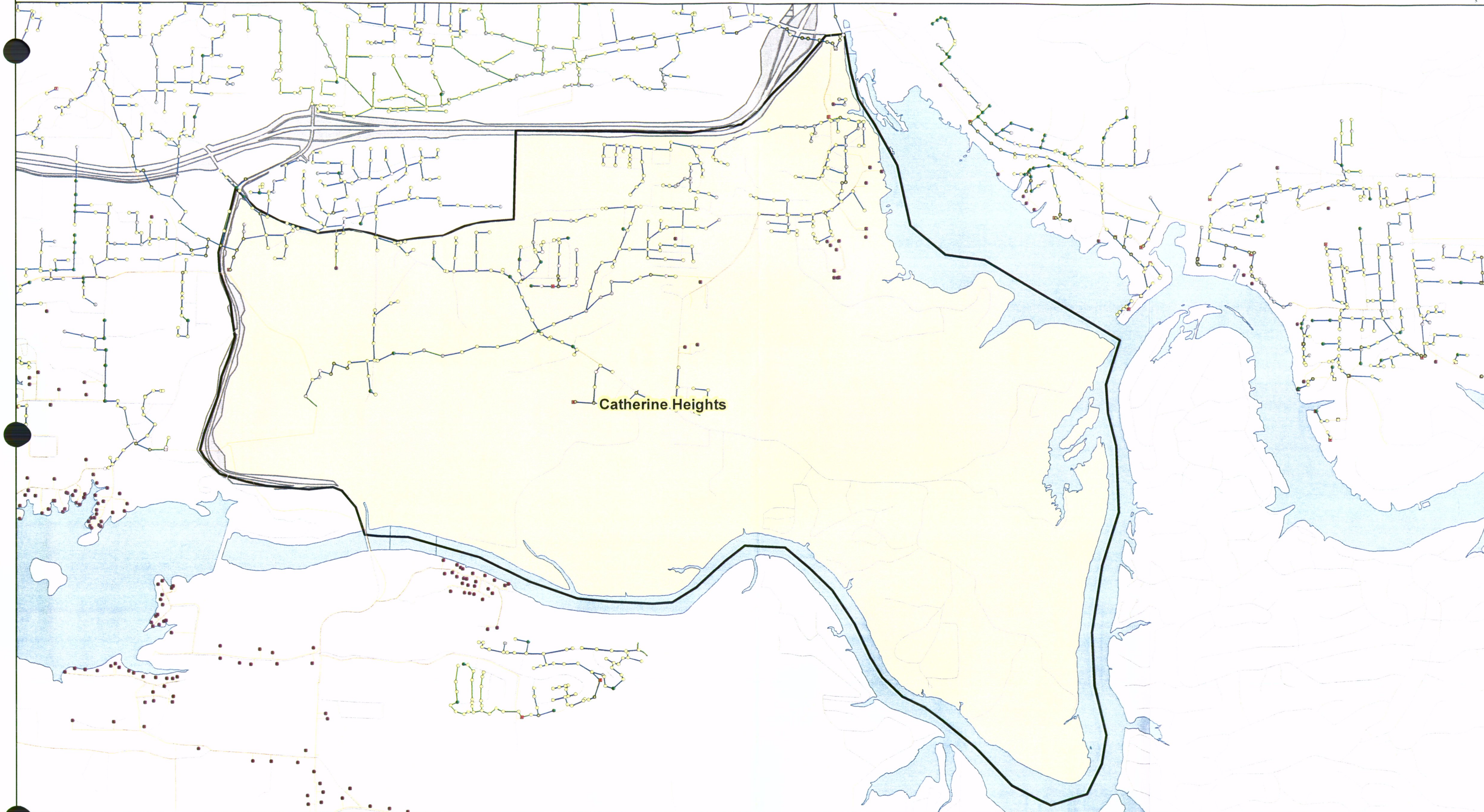
HOT SPRINGS NATIONAL PARK ARKANSAS

FIELD INVESTIGATIONS
MALVERN HWY & WILSON MILL
EXHIBIT 35

CITY OF HOT SPRINGS, AR



Legend

Buried Manholes	Inspected Manholes	Pump Stations
Not Found Manholes	Inaccessible Manholes	Grinder Pumps
	Evidence of Surcharge	Force Main
Gravity Main	Smoke Test Lines	Dye Test Lines

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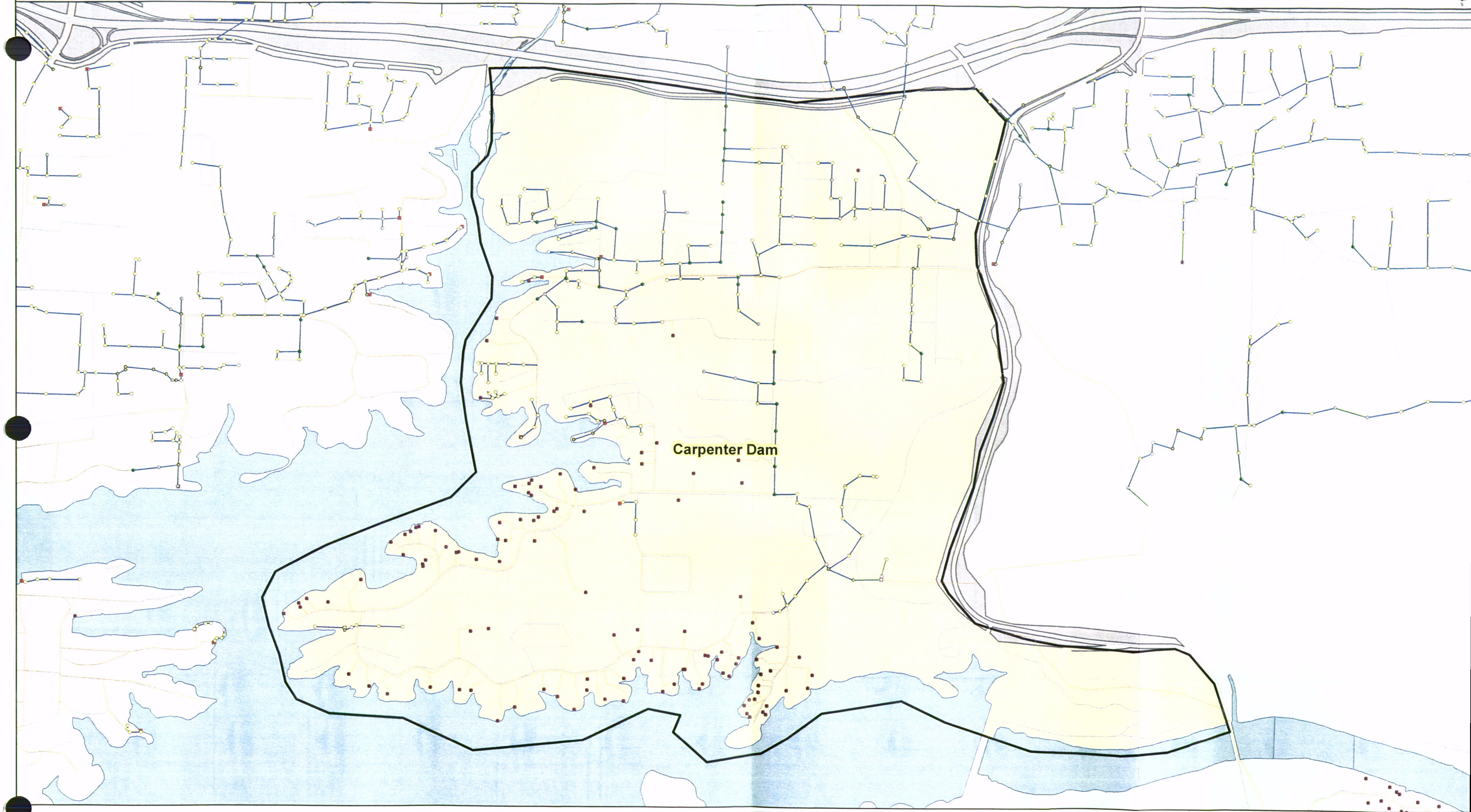
FIELD INVESTIGATIONS
CATHERINE HEIGHTS
EXHIBIT 36

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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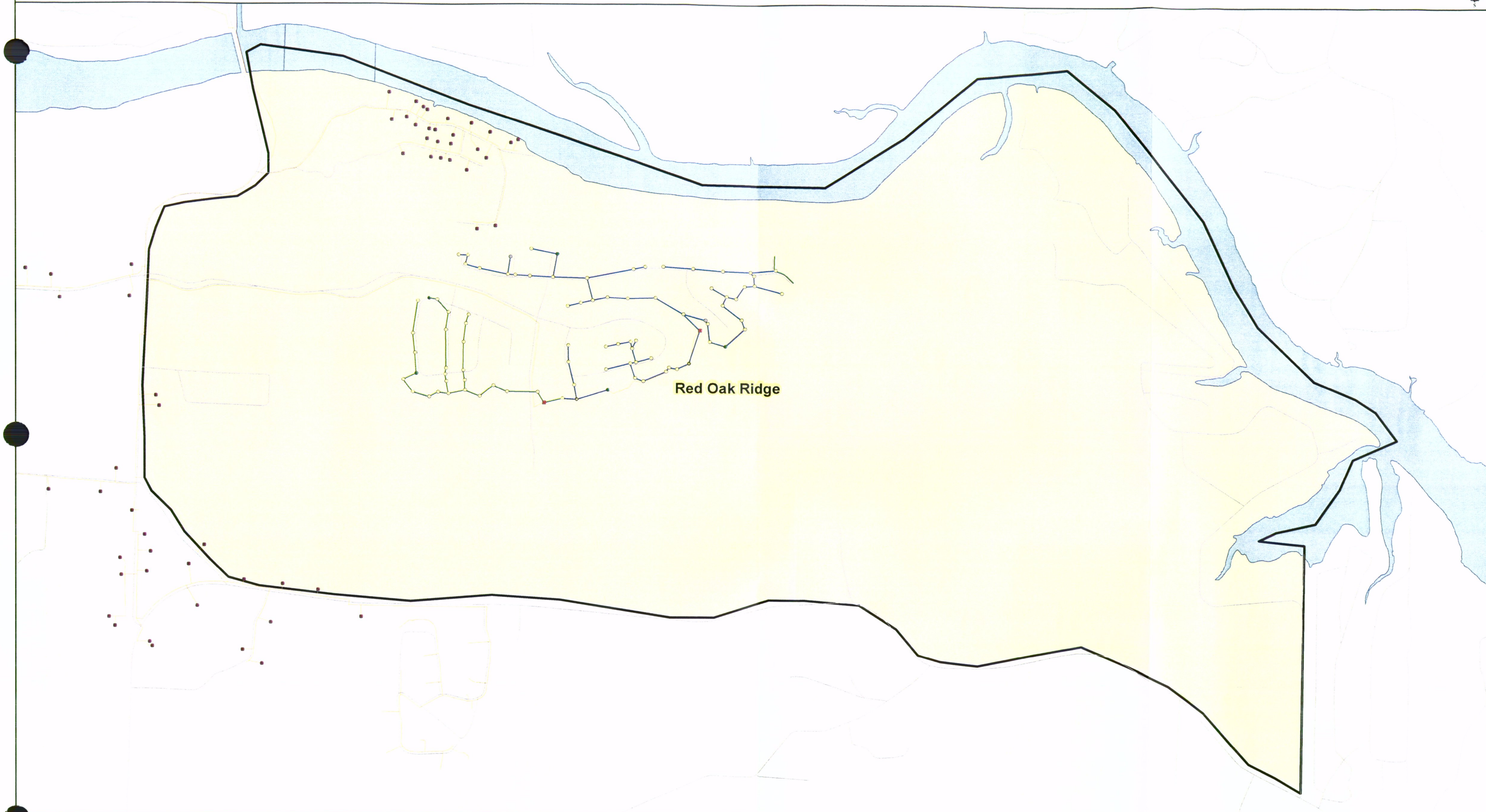
HOT SPRINGS

FIELD INVESTIGATIONS
CARPENTER DAM
EXHIBIT 37

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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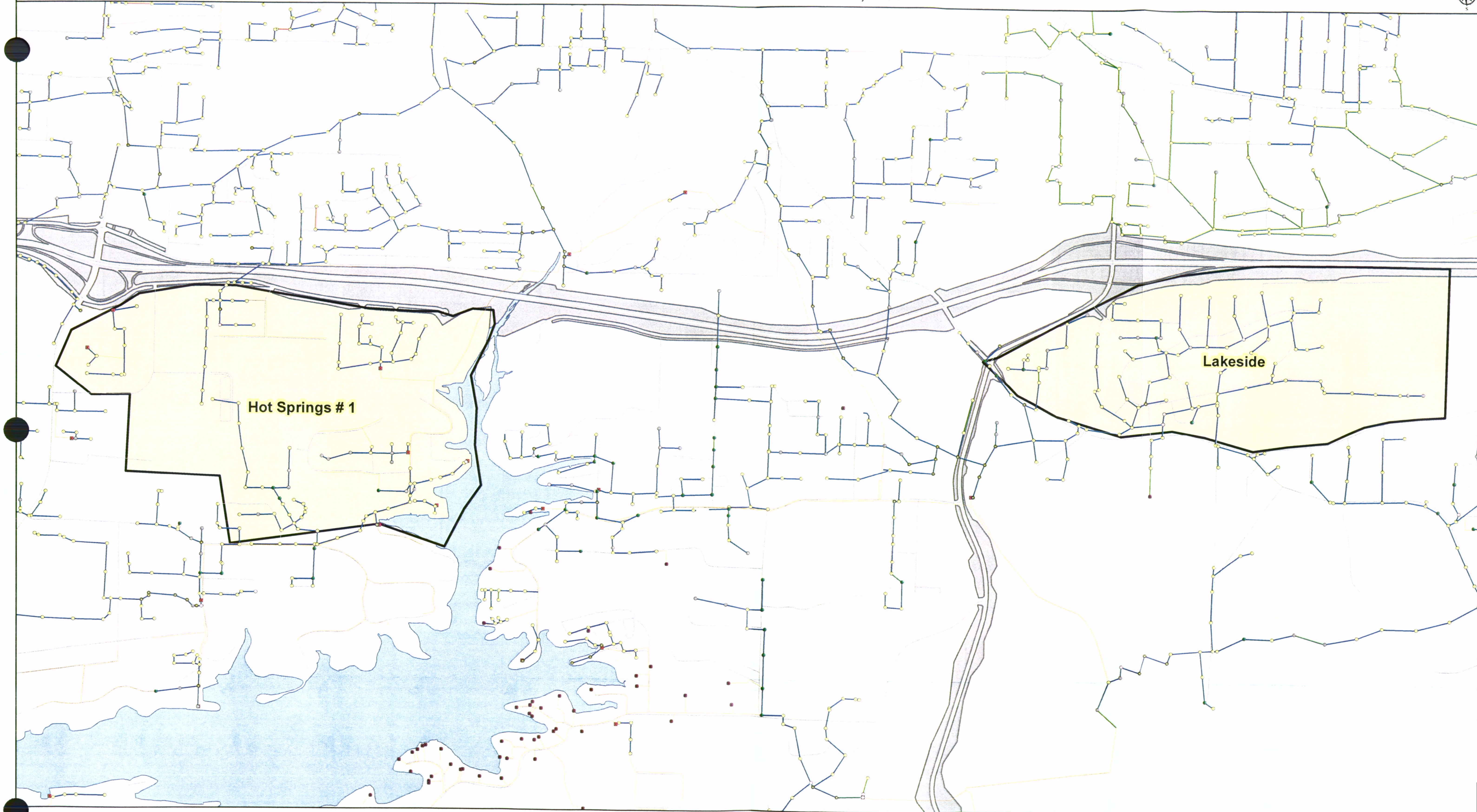
HOT SPRINGS NATIONAL PARK ARKANSAS

FIELD INVESTIGATIONS
RED OAK RIDGE
EXHIBIT 38

CITY OF HOT SPRINGS, AR



Legend

Buried Manholes	Inspected Manholes	Pump Stations
Not Found Manholes	Inaccessible Manholes	Grinder Pumps
	Evidence of Surcharge	Force Main

Gravity Main
Smoke Test Lines
Dye Test Lines

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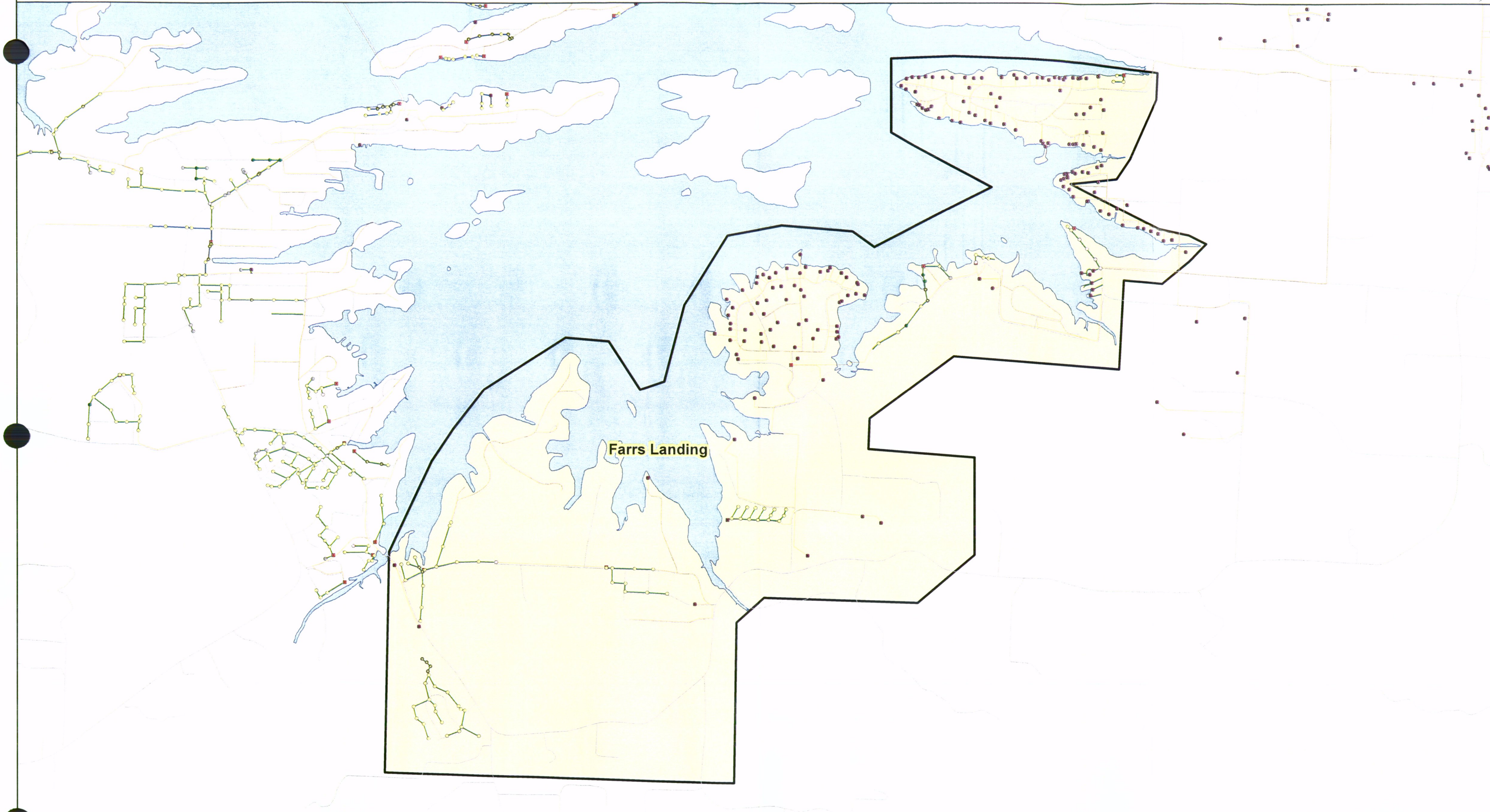
FIELD INVESTIGATIONS
HOT SPRINGS #1 & LAKESIDE
EXHIBIT 39

CITY OF HOT SPRINGS, AR



Legend

- Buried Manholes
- Not Found Manholes
- Inspected Manholes
- Inaccessible Manholes
- Evidence of Surcharge
- Pump Stations
- Grinder Pumps
- Force Main
- Gravity Main
- Smoke Test Lines
- Dye Test Lines

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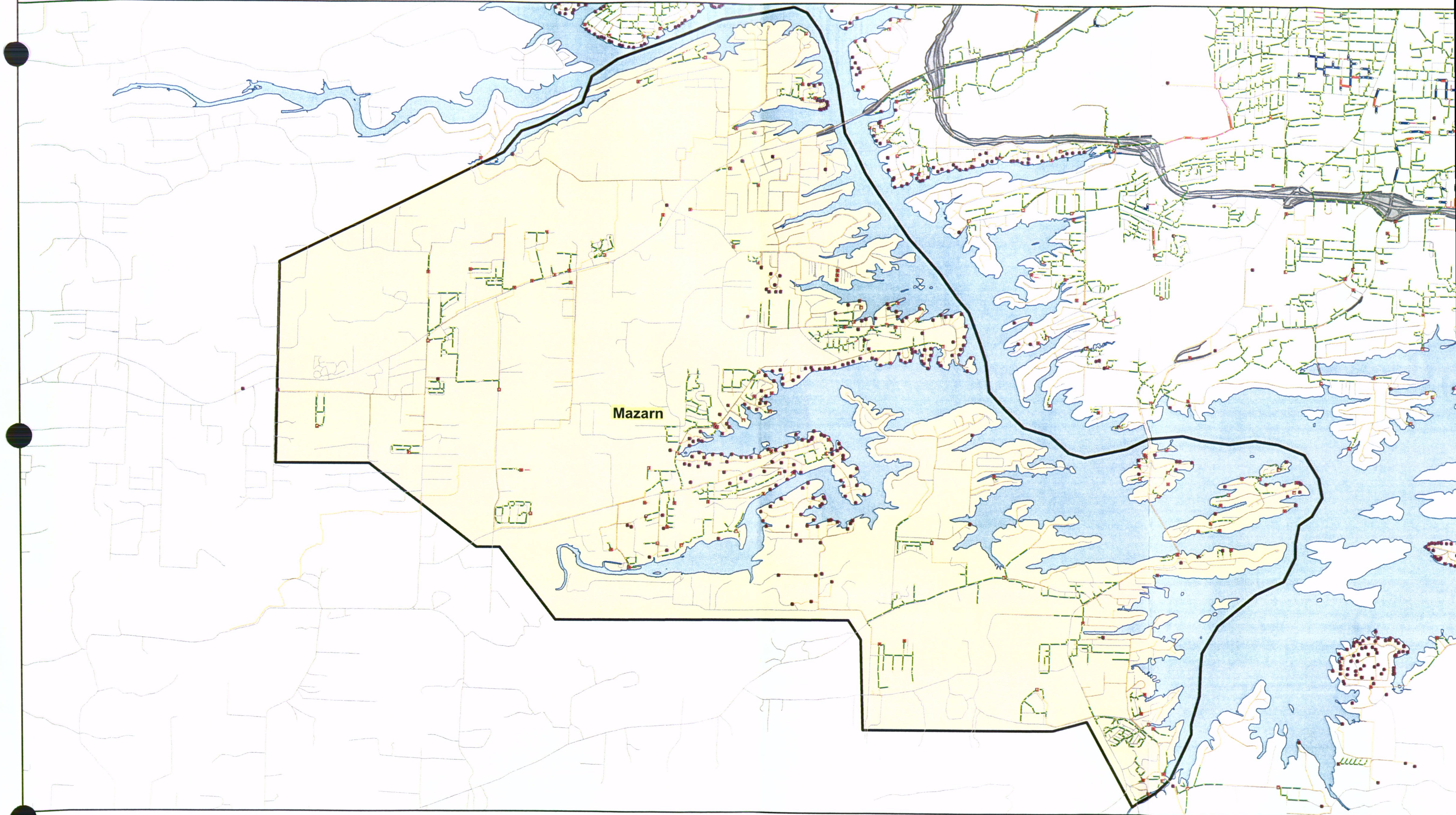
HOT SPRINGS

FIELD INVESTIGATIONS
FARRS LANDING
EXHIBIT 40

CITY OF HOT SPRINGS, AR



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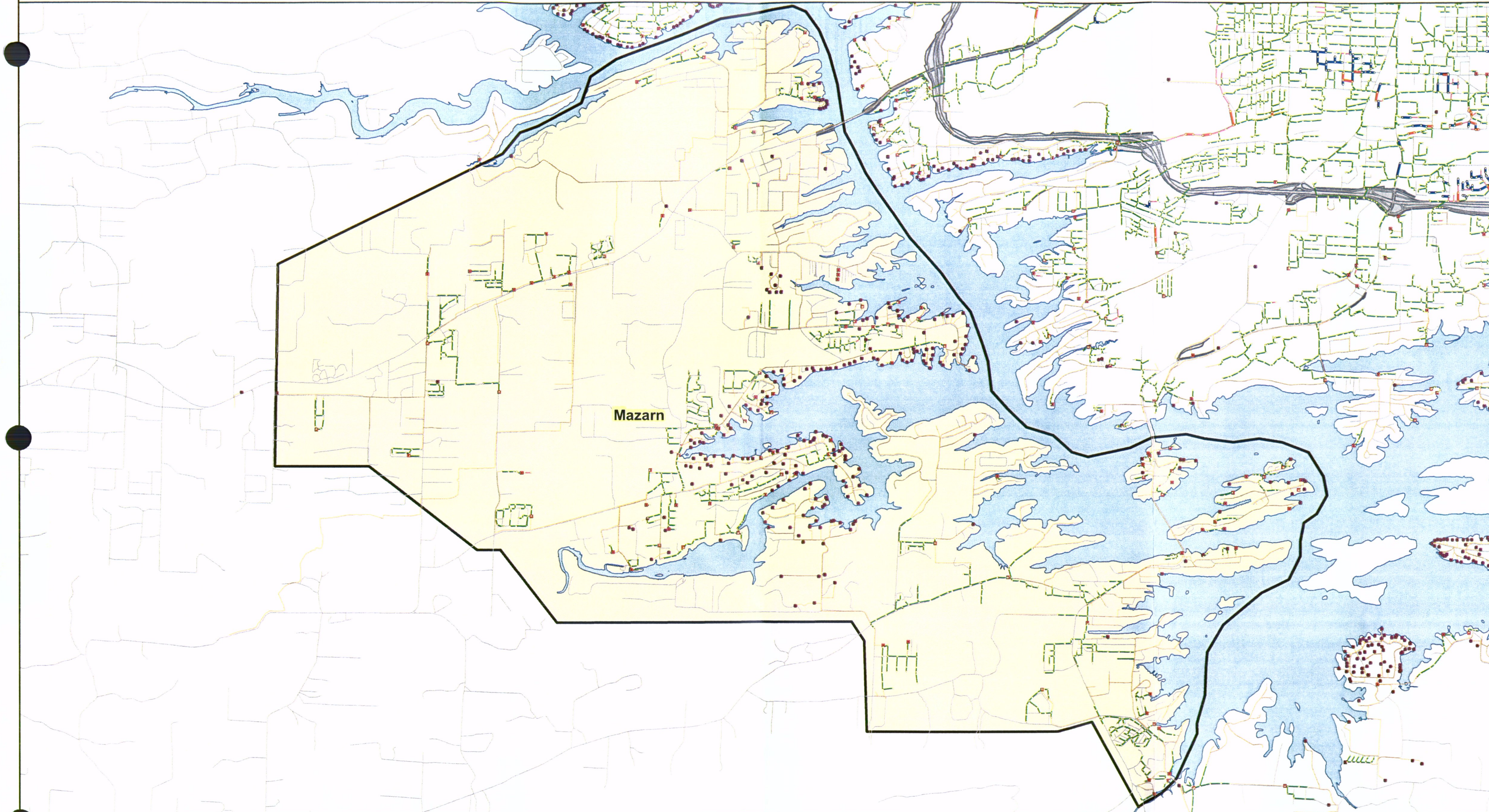
Legend

- Gravity Mains
- Lines Televised Requiring No Rehb
- Recommended Point Repairs
- Recommended Complete Rehab

HOT SPRINGS NATIONAL PARK ARKANSAS

PRELIMINARY RECOMMENDATIONS
MAZARN
EXHIBIT 41

CITY OF HOT SPRINGS, AR



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The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehb
- Recommended Point Repairs
- Recommended Complete Rehab

HOT SPRINGS

PRELIMINARY RECOMMENDATIONS
MAZARN
EXHIBIT 41

CITY OF HOT SPRINGS, AR

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The Choice for Collection System Solutions

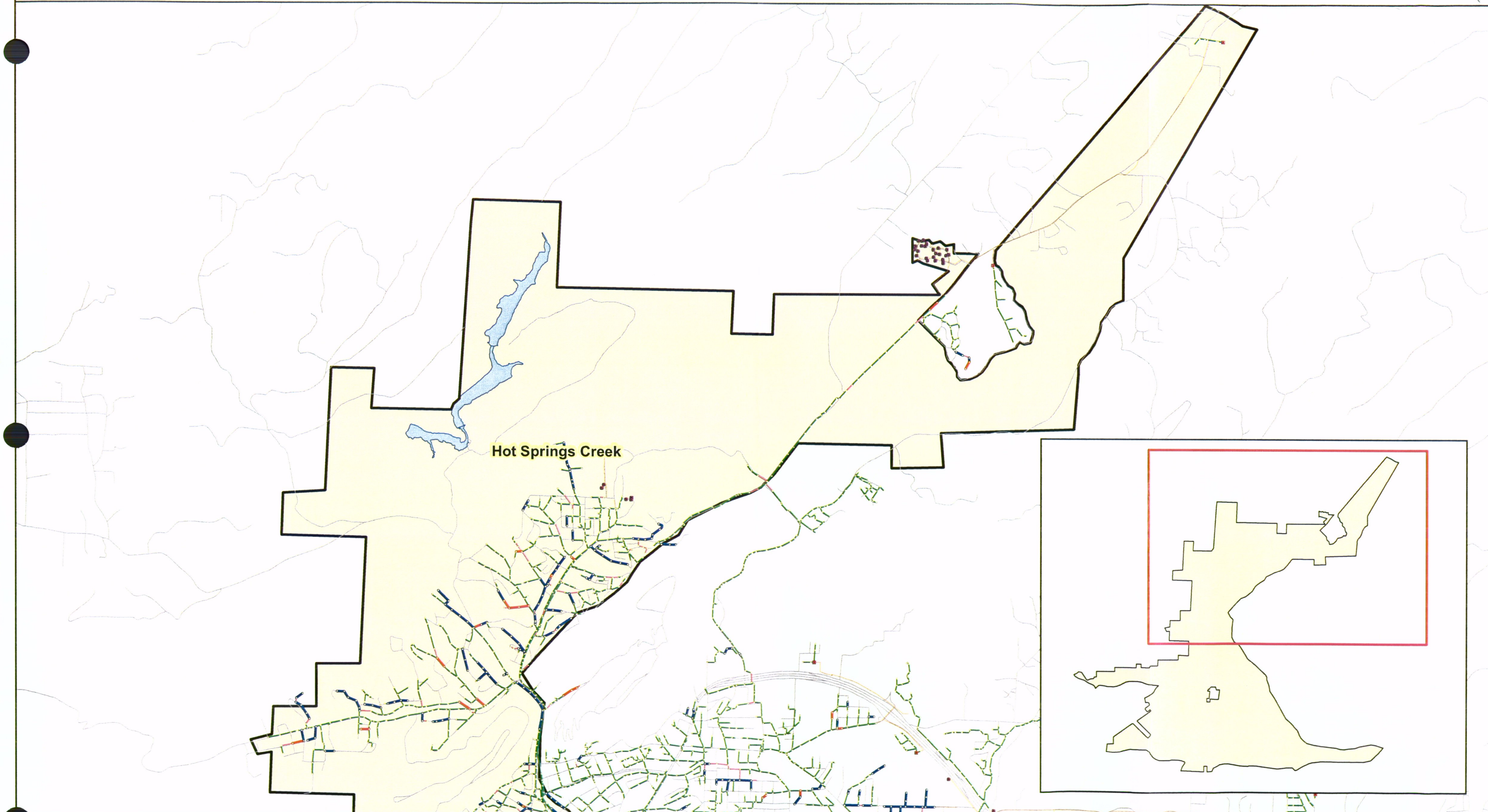
Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

HOT SPRINGS NATIONAL PARK ARKANSAS

PRELIMINARY RECOMMENDATIONS FAIRWOOD EXHIBIT 42

CITY OF HOT SPRINGS, AR



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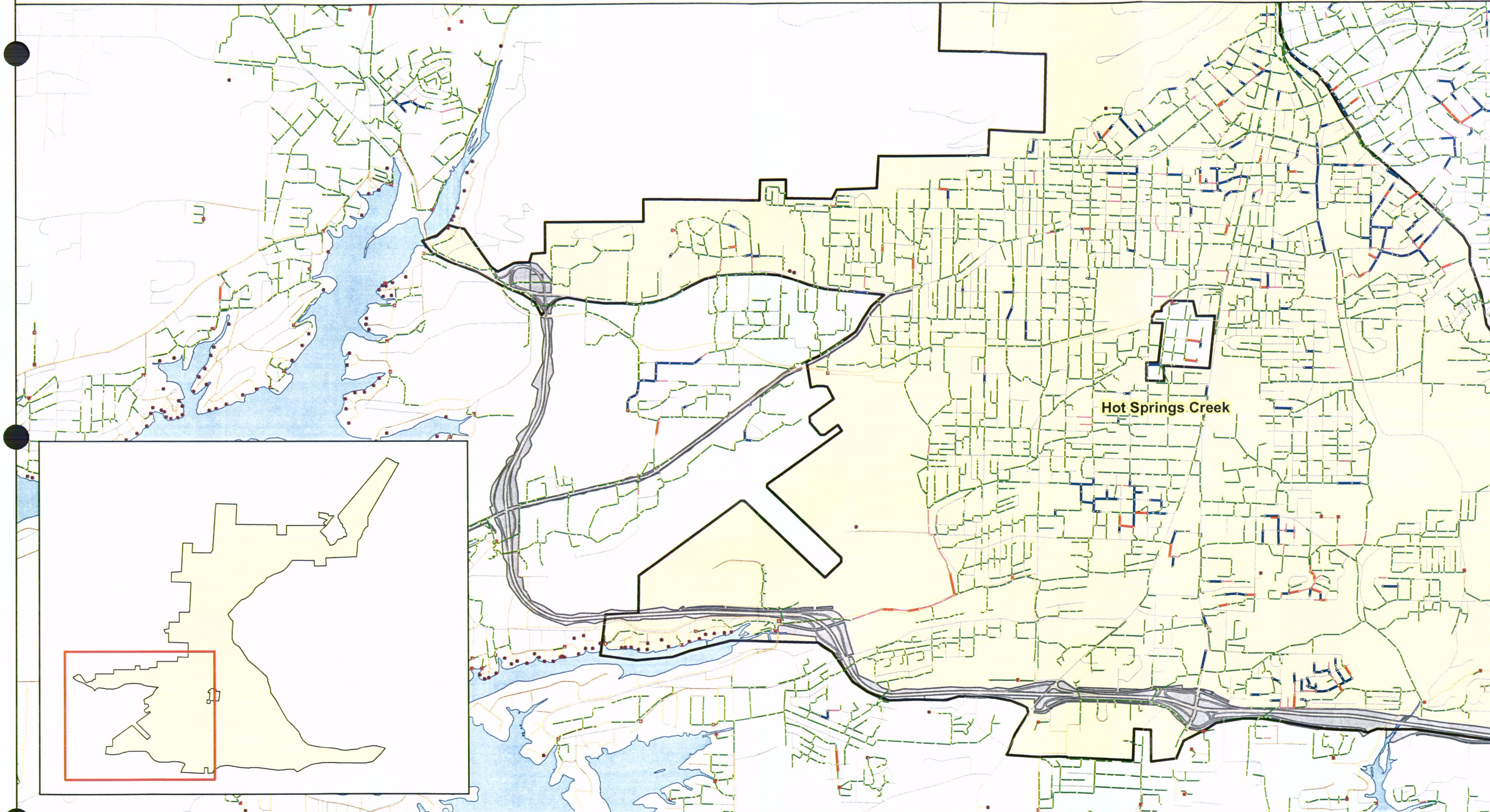
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

PRELIMINARY RECOMMENDATIONS
HOT SPRINGS CREEK, NORTH
EXHIBIT 43

CITY OF HOT SPRINGS, AR



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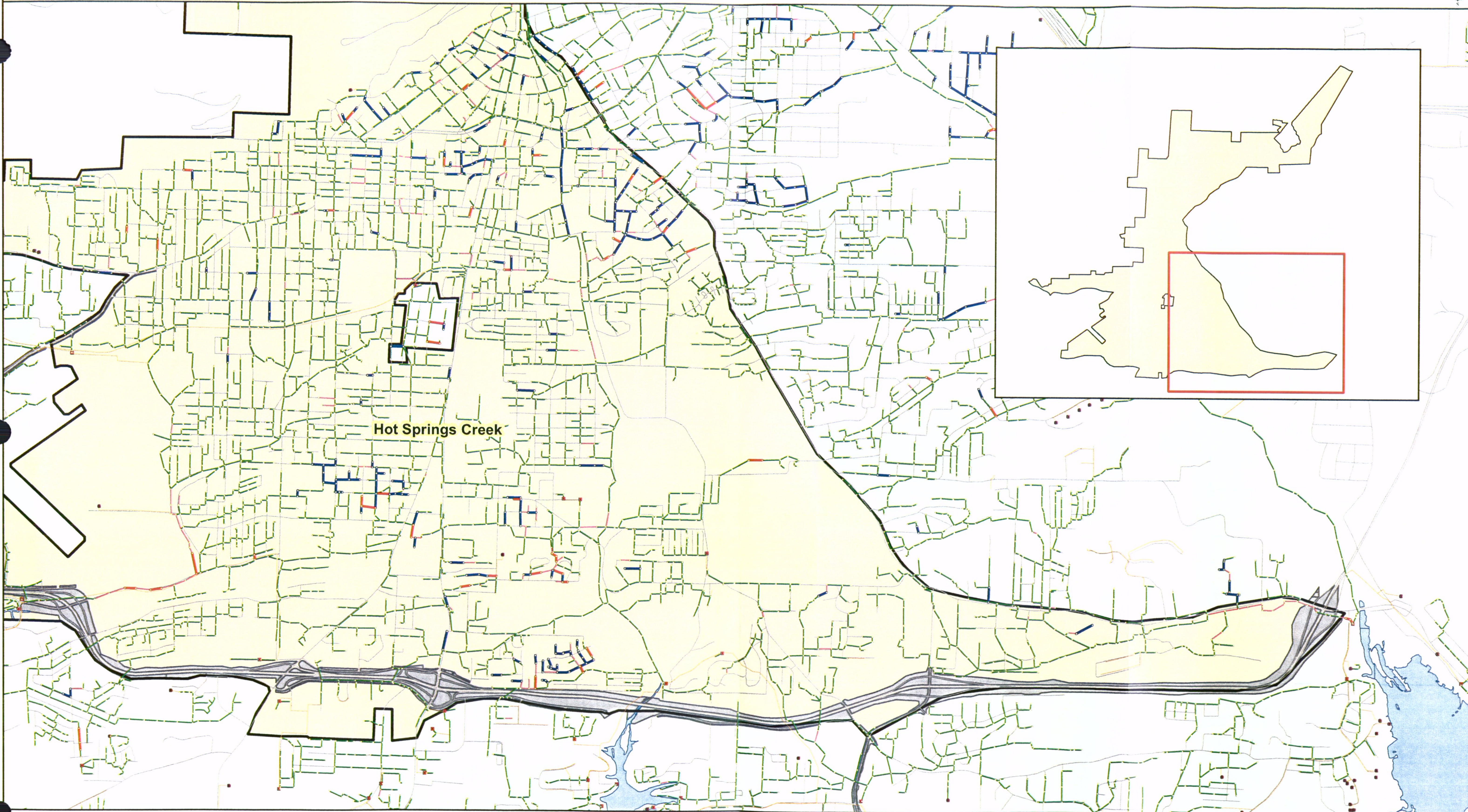
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehb
- Recommended Point Repairs
- Recommended Complete Rehab

PRELIMINARY RECOMMENDATIONS
HOT SPRINGS CREEK, SOUTHWEST
EXHIBIT 44

CITY OF HOT SPRINGS, AR



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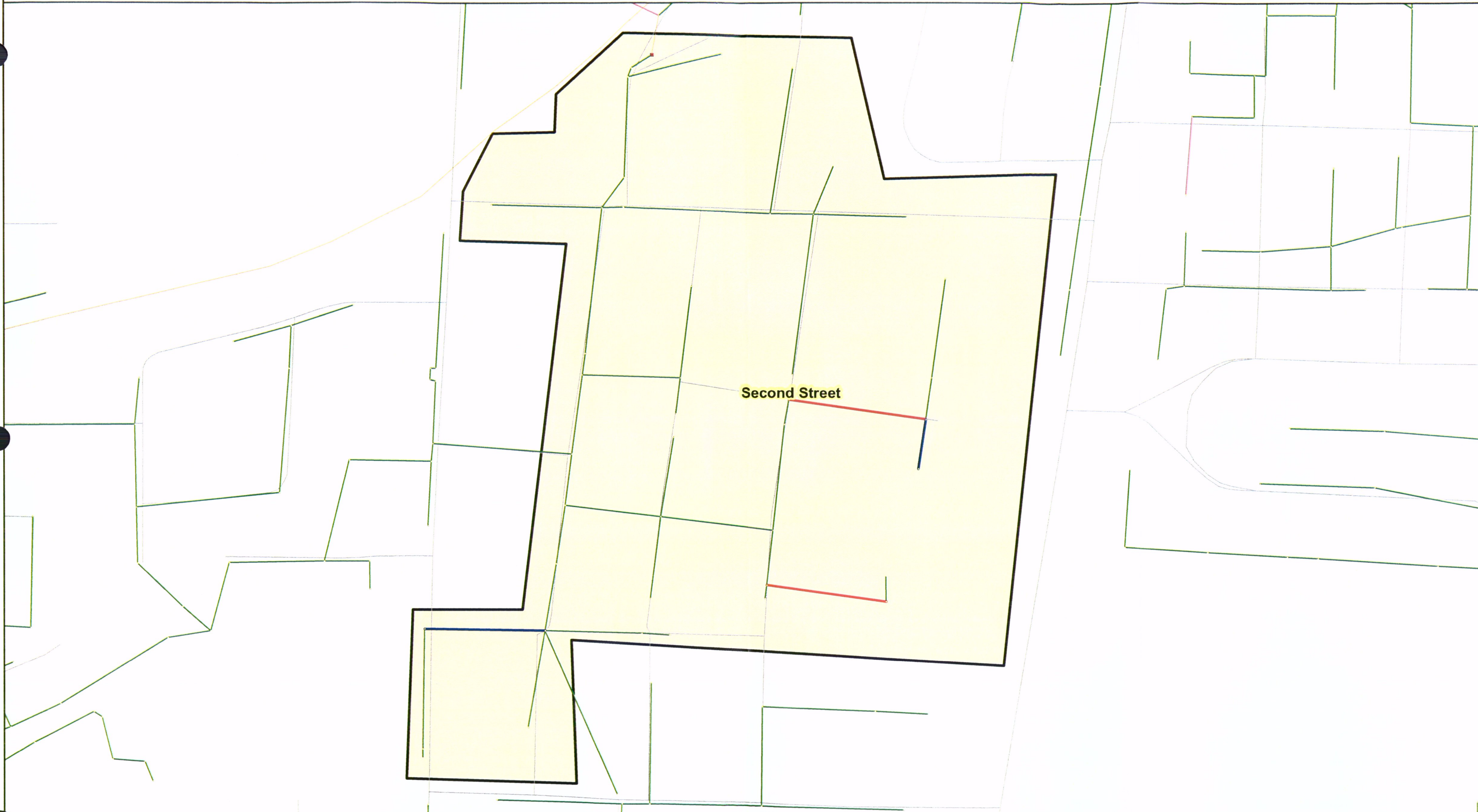
PRELIMINARY RECOMMENDATIONS
HOT SPRINGS CREEK, SOUTHEAST
EXHIBIT 45

CITY OF HOT SPRINGS, AR



Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

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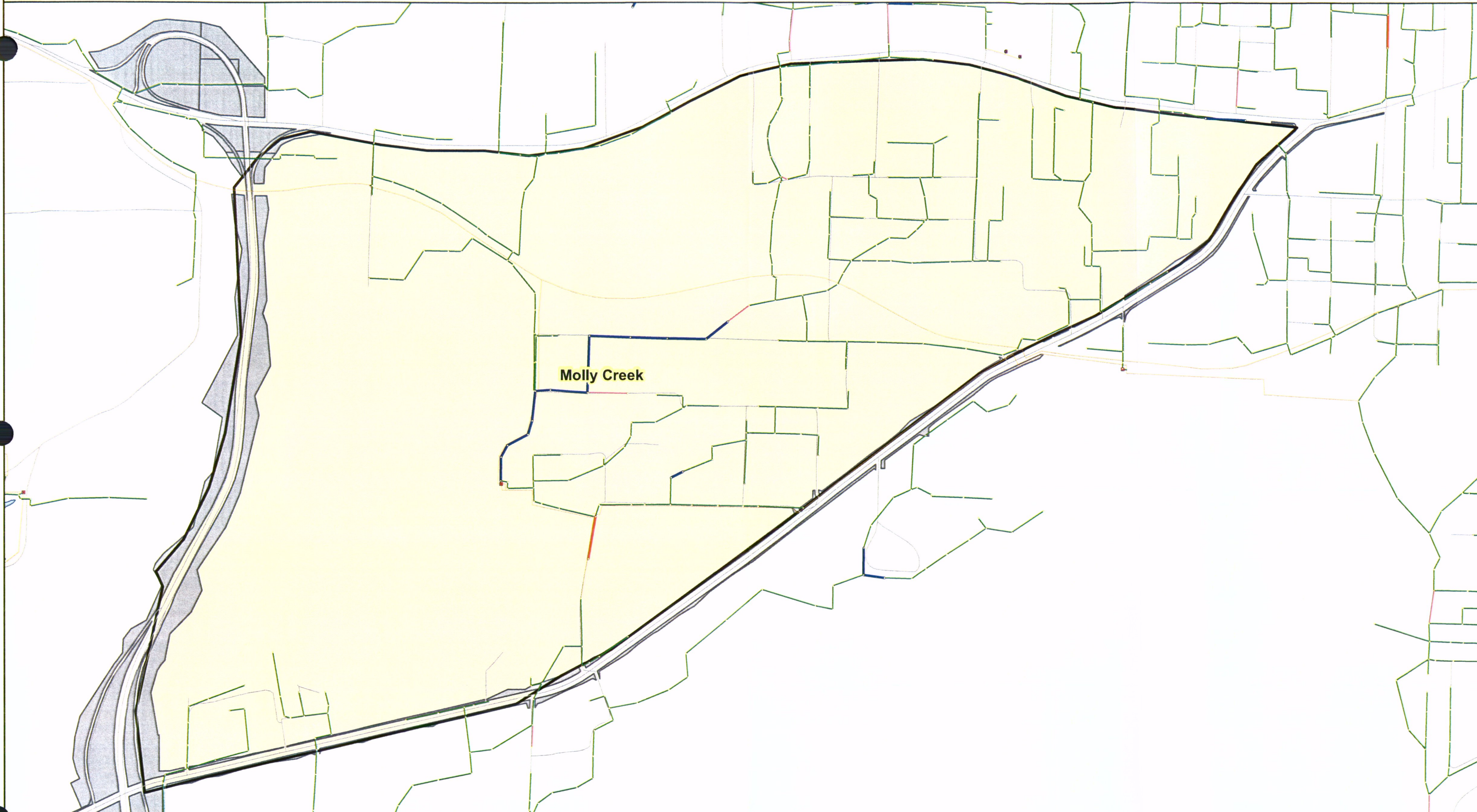
HOT SPRINGS NATIONAL PARK ARKANSAS

PRELIMINARY RECOMMENDATIONS
2ND STREET
EXHIBIT 46

CITY OF HOT SPRINGS, AR



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The Choice for Collection System Solutions

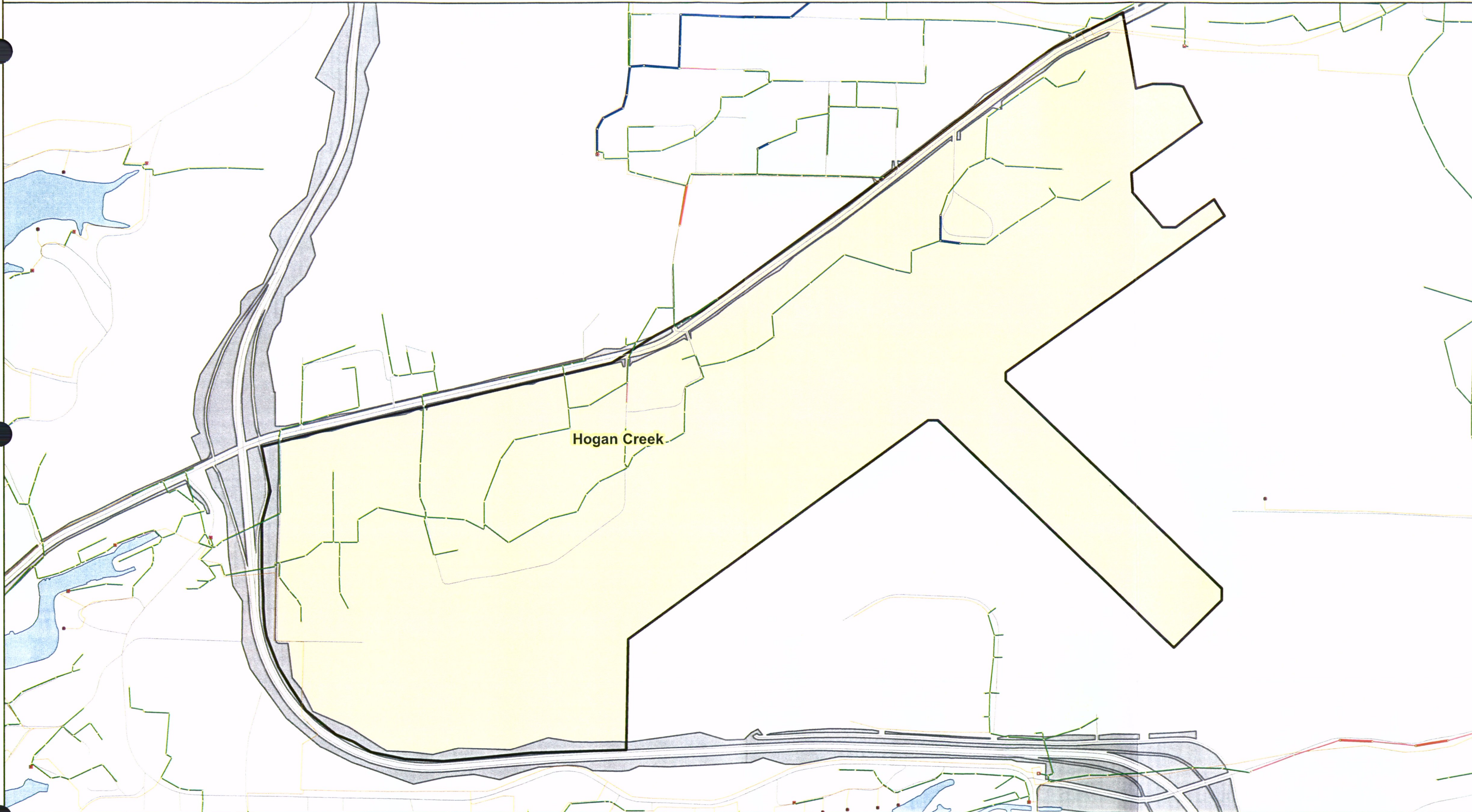
Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

HOT SPRINGS NATIONAL PARK ARKANSAS

PRELIMINARY RECOMMENDATIONS
MOLLY CREEK
EXHIBIT 47

CITY OF HOT SPRINGS, AR



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The Choice for Collection System Solutions

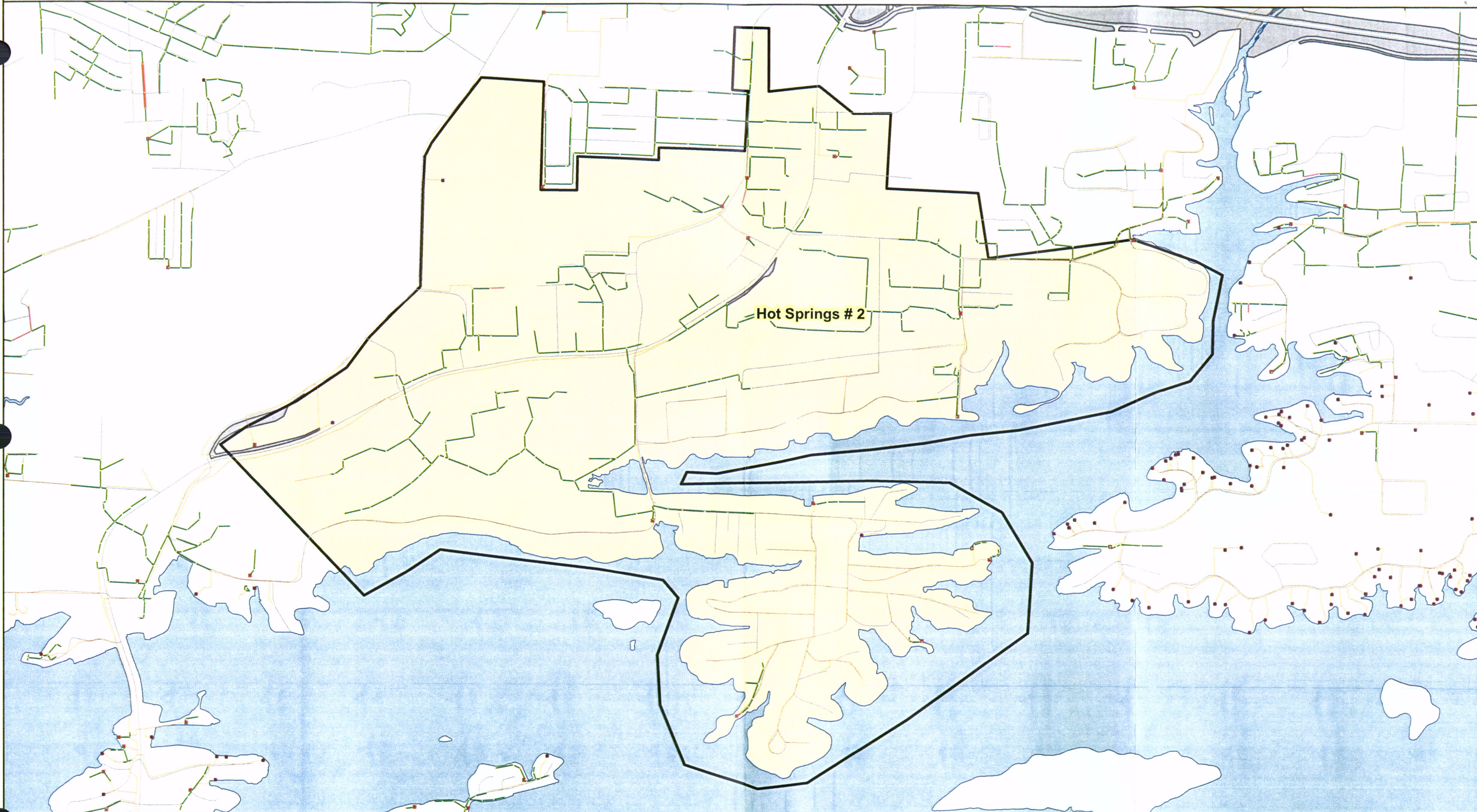
Legend

Gravity Mains
Recommended Point Repairs
Lines Televised Requiring No Rehab
Recommended Complete Rehab

HOT SPRINGS

PRELIMINARY RECOMMENDATIONS
HOGAN CREEK
EXHIBIT 48

CITY OF HOT SPRINGS, AR



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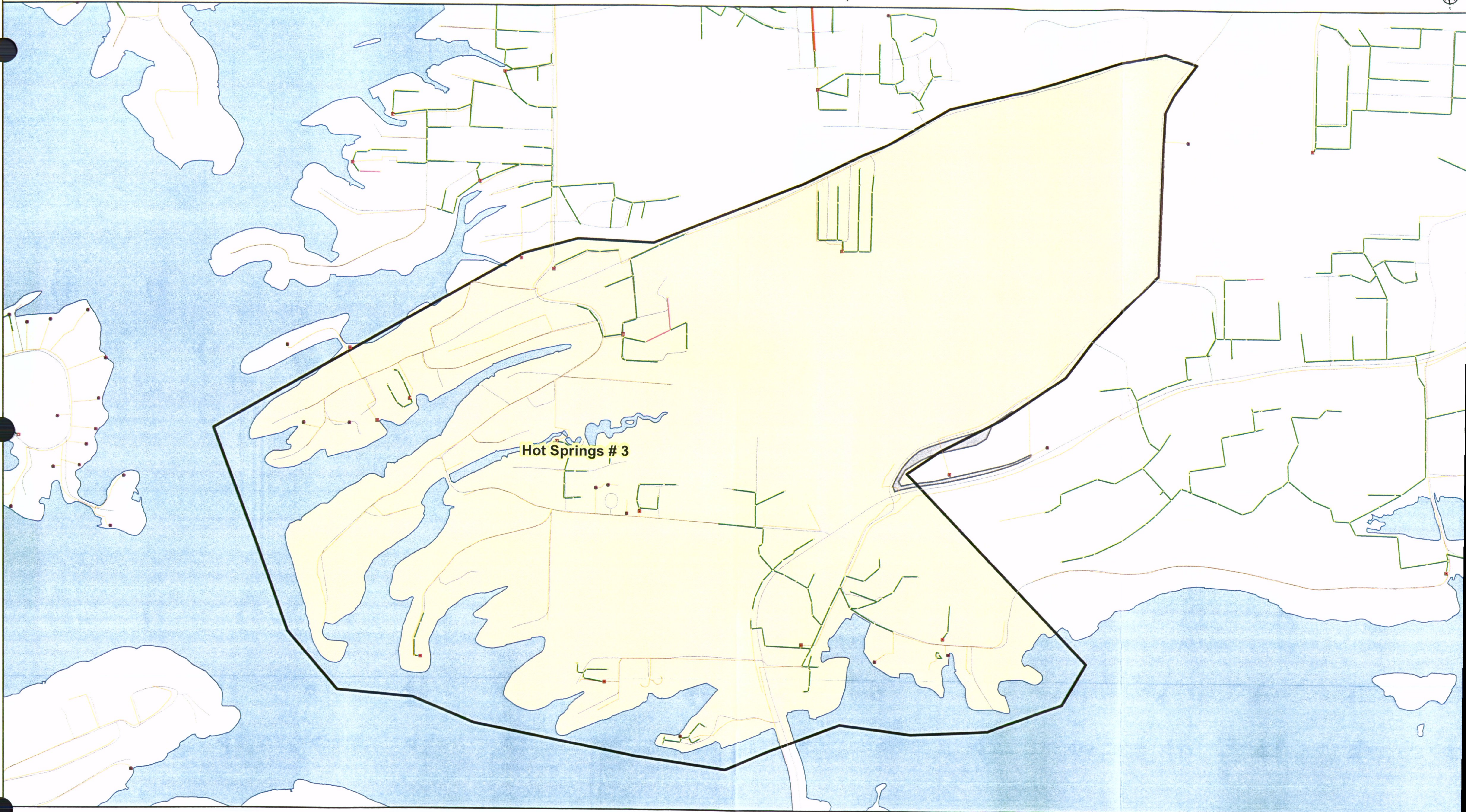
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

PRELIMINARY RECOMMENDATIONS
HOT SPRINGS #2
EXHIBIT 49

CITY OF HOT SPRINGS, AR



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The Choice for Collection System Solutions

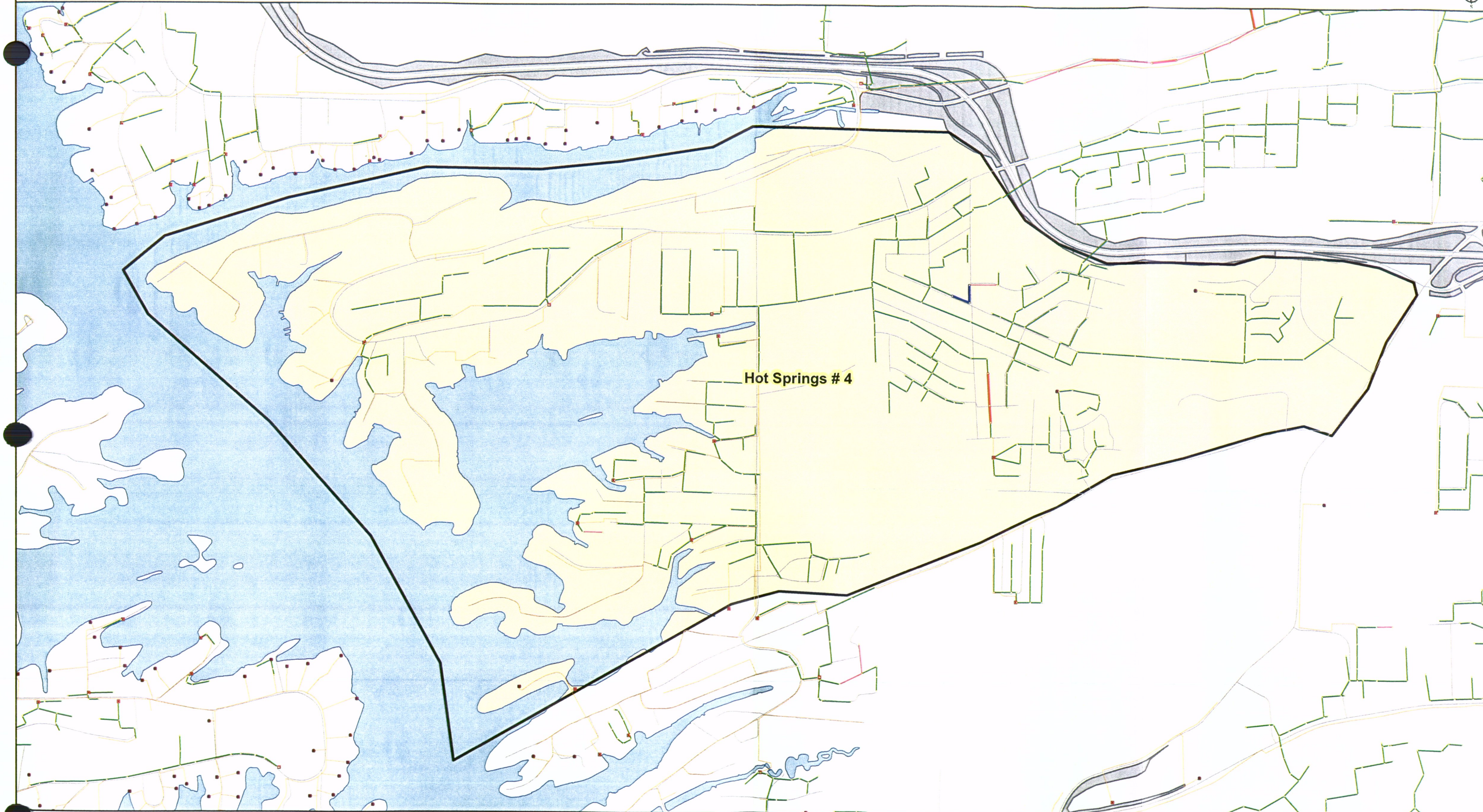
Legend

- Gravity Mains
- Recommended Point Repairs
- Lines Televised Requiring No Rehab
- Recommended Complete Rehab

HOT SPRINGS

PRELIMINARY RECOMMENDATIONS
HOT SPRINGS #3
EXHIBIT 50

CITY OF HOT SPRINGS, AR



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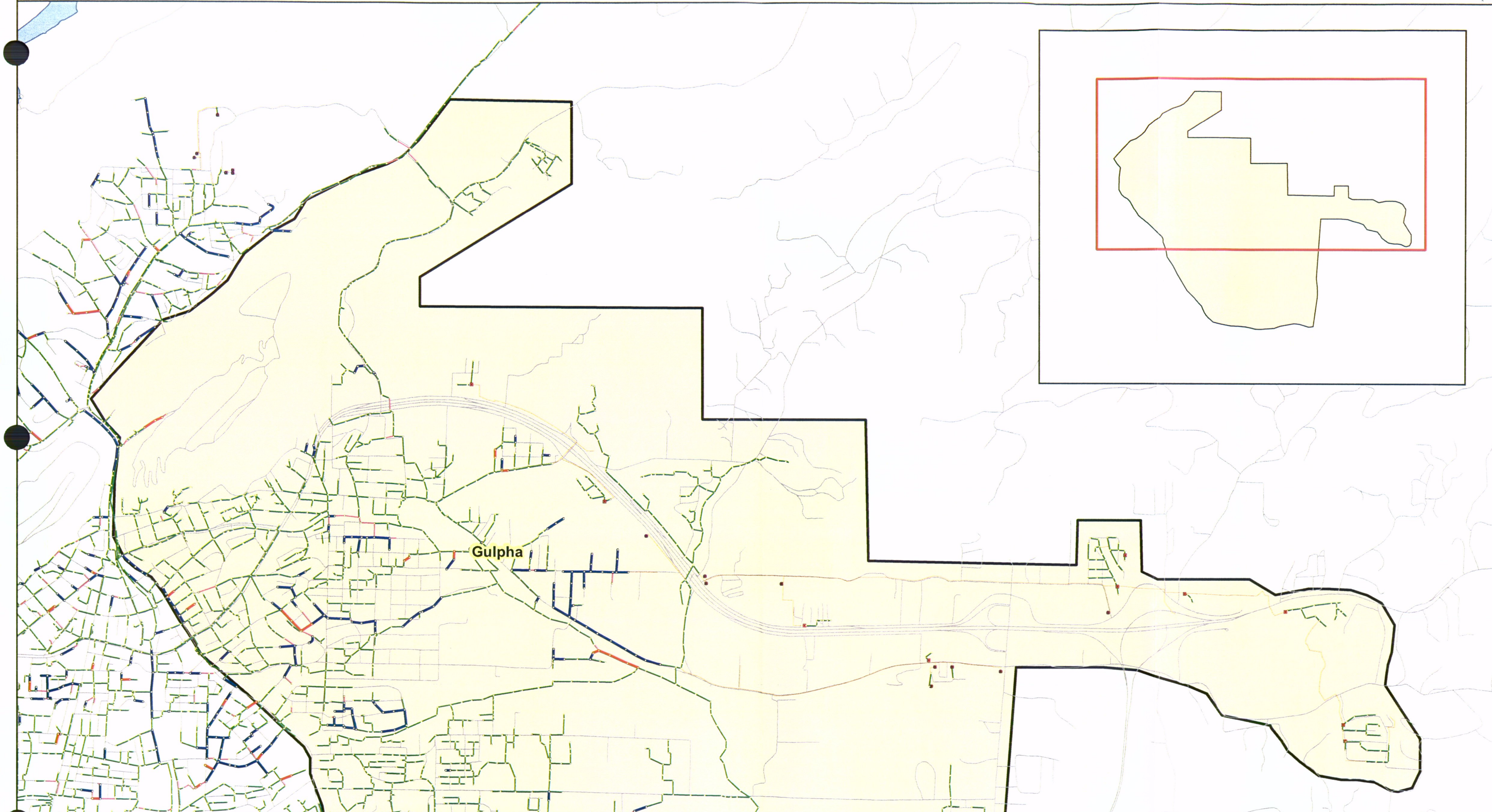
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehb
- Recommended Point Repairs
- Recommended Complete Rehab

PRELIMINARY RECOMMENDATIONS
HOT SPRINGS #4
EXHIBIT 51

CITY OF HOT SPRINGS, AR



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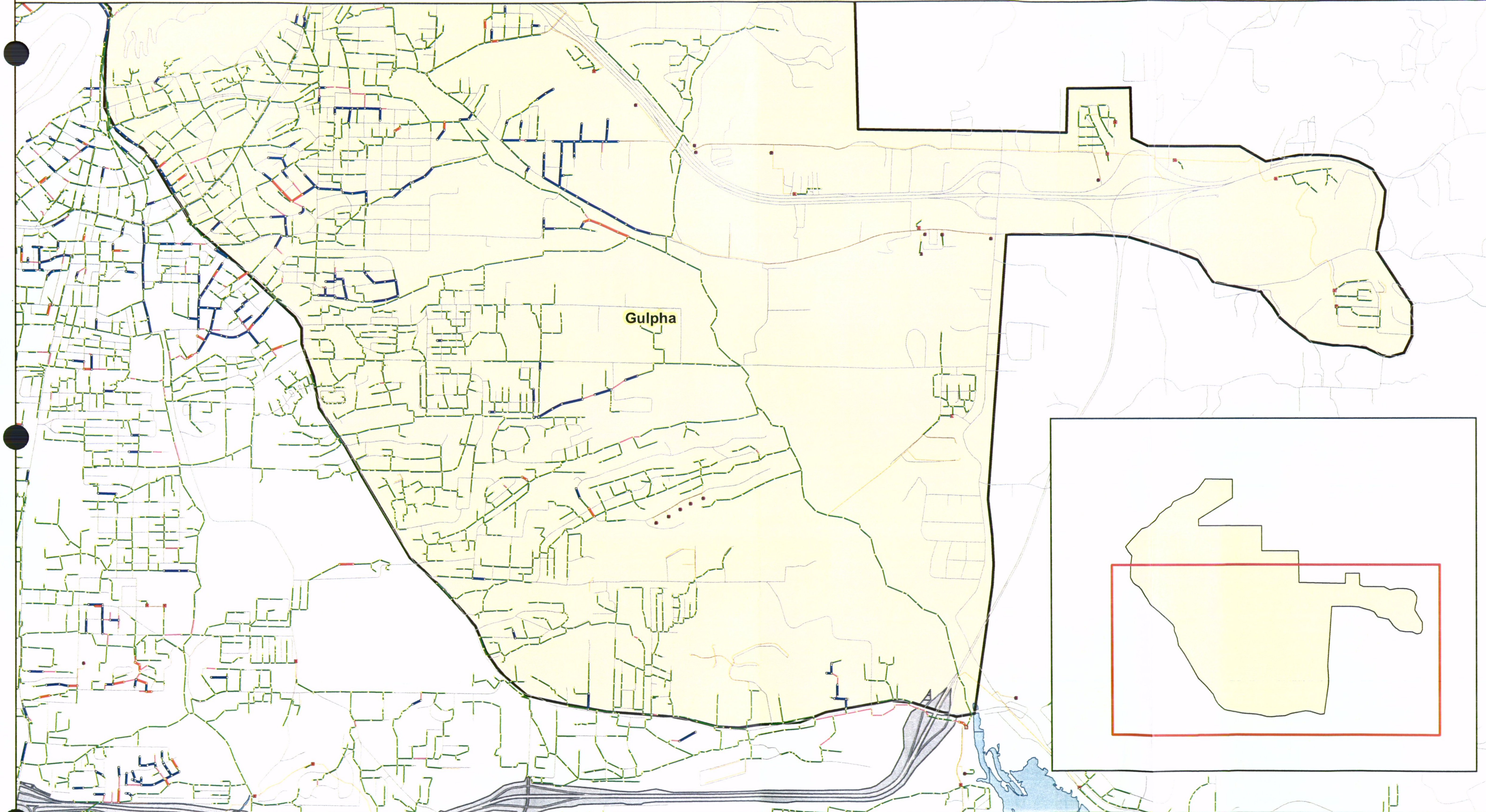
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Recommended Point Repairs
- Lines Televised Requiring No Rehab
- Recommended Complete Rehab

PRELIMINARY RECOMMENDATIONS
GULPHA, NORTH
EXHIBIT 52

CITY OF HOT SPRINGS, AR



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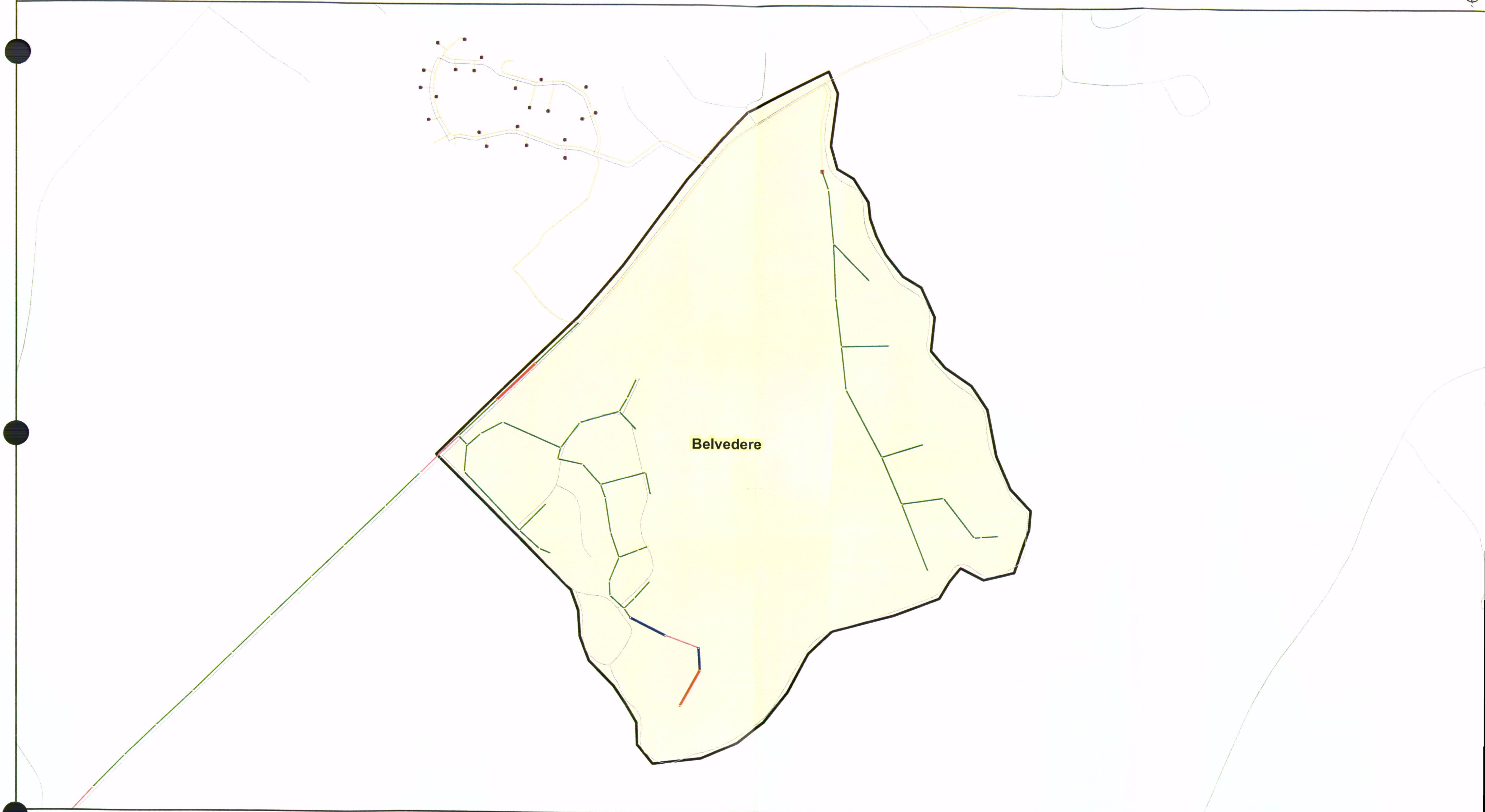
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

PRELIMINARY RECOMMENDATIONS
GULPHA, SOUTH
EXHIBIT 53

CITY OF HOT SPRINGS, AR



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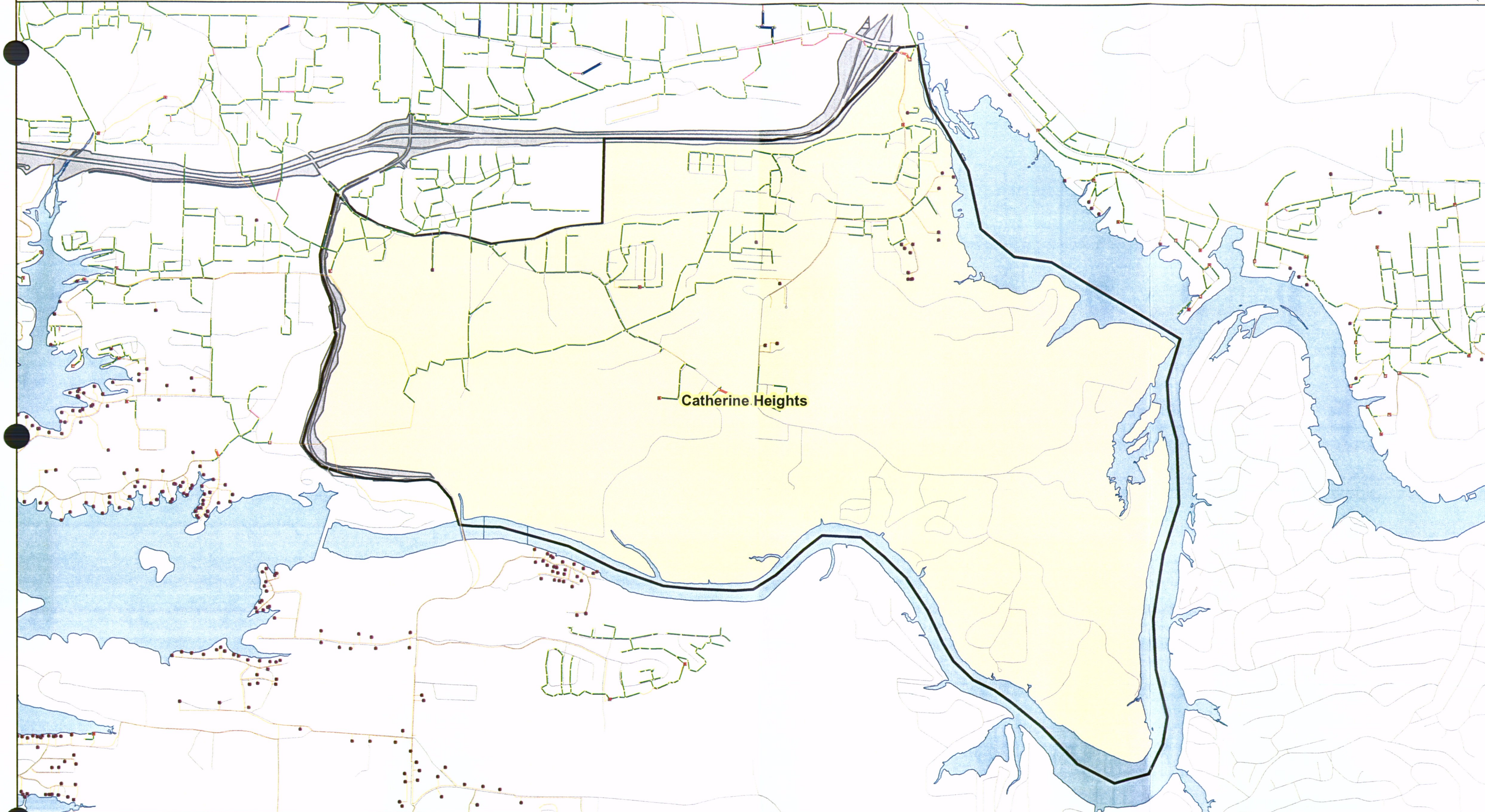
The Choice for Collection System Solutions

Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

PRELIMINARY
RECOMMENDATIONS
BELVEDERE
EXHIBIT 54

CITY OF HOT SPRINGS, AR



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The Choice for Collection System Solutions

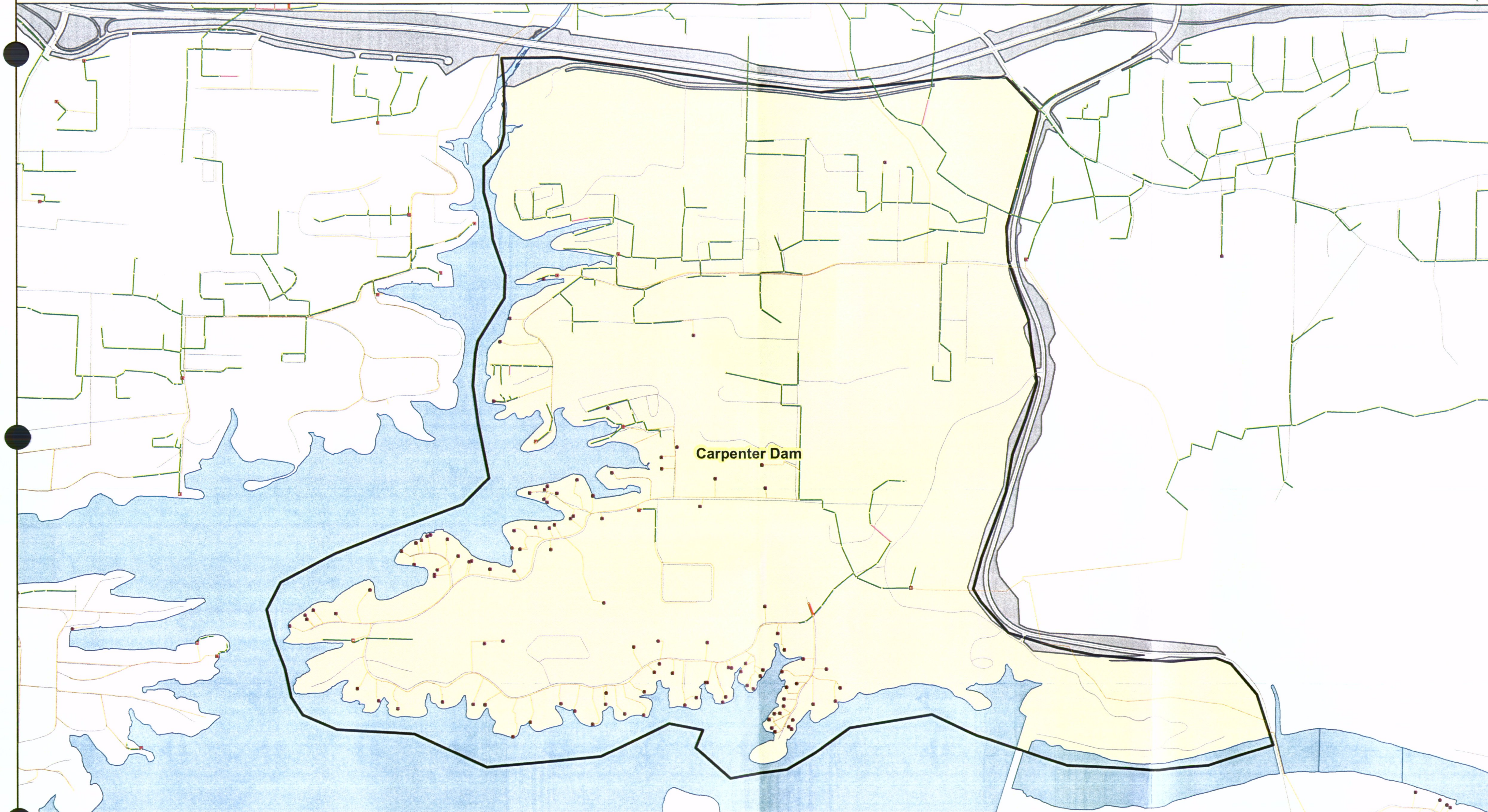
Legend

- Gravity Mains
- Lines Televised Requiring No Rehb
- Recommended Point Repairs
- Recommended Complete Rehab

HOT SPRINGS NATIONAL PARK ARKANSAS

PRELIMINARY RECOMMENDATIONS
CATHERINE HEIGHTS
EXHIBIT 55

CITY OF HOT SPRINGS, AR



Legend

- Gravity Mains
- Lines Televised Requiring No Rehab
- Recommended Point Repairs
- Recommended Complete Rehab

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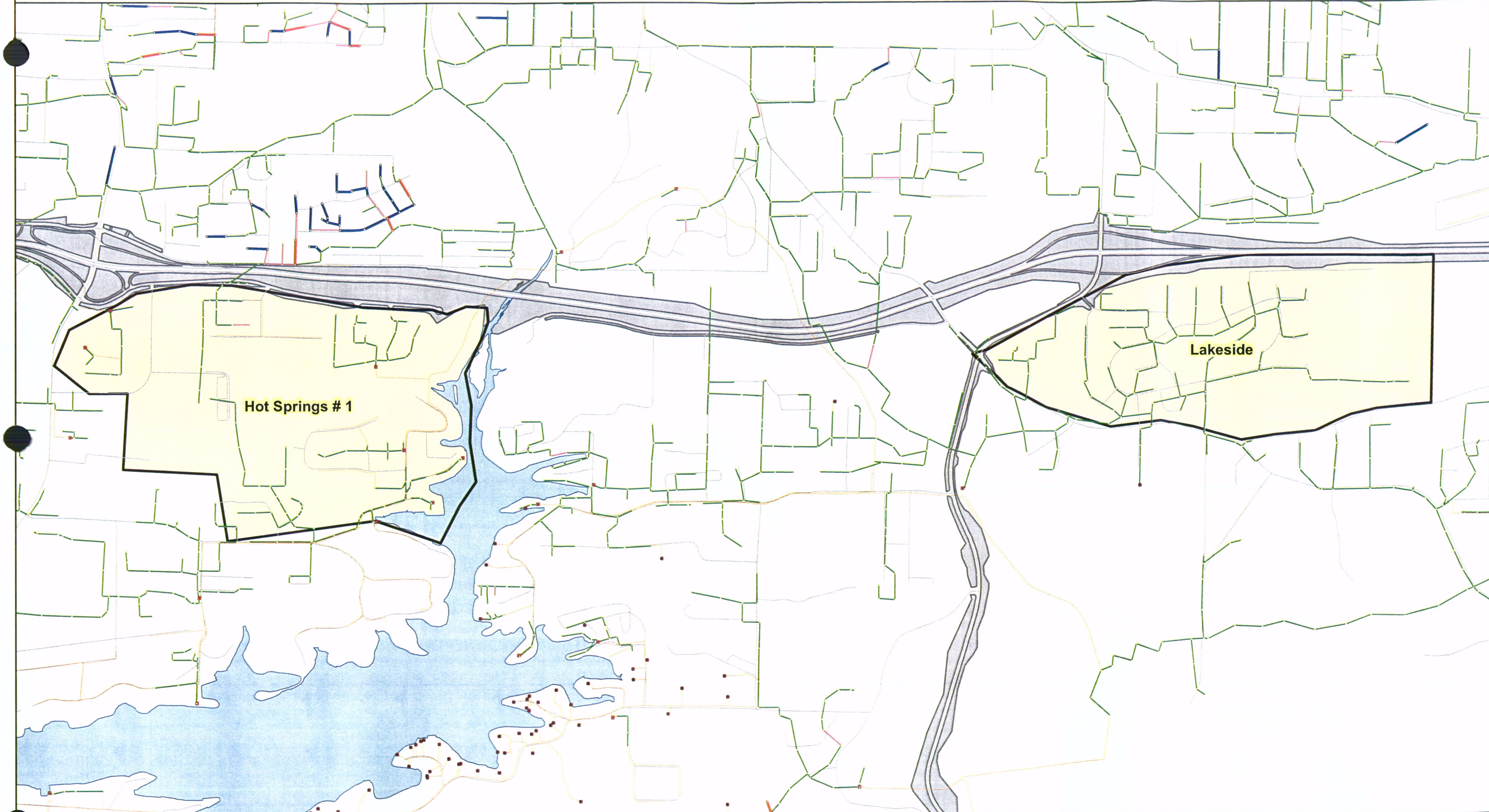
HOT SPRINGS NATIONAL PARK ARKANSAS

PRELIMINARY RECOMMENDATIONS
CARPENTER DAM
EXHIBIT 56

CITY OF HOT SPRINGS, AR



Legend

- Gravity Mains
- Lines Televised Requiring No Rehb
- Recommended Point Repairs
- Recommended Complete Rehab

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PRELIMINARY RECOMMENDATIONS
HOT SPRINGS #1 & LAKESIDE
EXHIBIT 57

MAP(S)/PLAN(S) SCANNED IN SEPARATE FILE