6^{th} Street SSO Elimination

Phase I

City of Hoopeston, IL

October 04, 2016

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A. Background

In March of 2016, C2 Engineers received approval from the City of Hoopeston to complete a sanitary sewer study of approximately 8,700 feet of 8" and 10" sewers in the northeast part of the City, shown in Exhibit A of Appendix A. The purpose of the study is to isolate areas of frequent sanitary sewer backups, surcharging, and overflows and to provide the City with recommended methods of repair at these locations.

Surcharges in a sanitary sewer are typically caused by one, or a combination, of the following problems:

1. Insufficient sewer capacity
2. Groundwater infiltration
3. Stormwater inflow
4. Structural failures in the collection system
5. Mechanical/electrical failures

Sewers that are undersized will have frequent backups under normal usage and are unable to handle flows from the area it serves. Groundwater infiltration is a result of defective or poorly constructed pipes and manholes, the groundwater enters the sewer through broken pipes or unsealed joints. Stormwater inflow is from direct connections of downspouts, through open castings, or pick holes, of a manhole lid, or from cross connections from storm sewers. Structural failures will cause backups onto both public and private property resulting in EPA violations. Mechanical/electrical failures occur at pump stations and treatment plants, no pump stations were found serving this area.

C2 Engineers focused on identifying the cause(s) of surcharging by the following procedures:

1. Inspection of manholes for structural deficiencies, evidence of I&I (Infiltration and Inflow), and evaluation of current sewer capacity
2. Televising of sewer mains to reveal leaks, breaks, blockages, and bellies
3. Flow monitoring to divide the study area into sub-basins and to analyze flows within these sub-basins
4. Smoke testing to discover unwanted or illegal cross connections
5. Compilation and analysis of data collected to recommend improvements to the sanitary sewer system

B. Visual Evaluation of Sanitary Sewer Collection System

C2 Engineers performed a visual inspection conducted at each manhole within the study area to determine its structural condition and to identify signs of I&I. Based on the collected field data, the majority of manholes are structurally sound but show significant signs of infiltration due to leaks at the barrel joints, adjusting rings, and castings. Inflow through the manhole lids are common as several structures have open pick holes in the castings and sit lower than the surrounding ground. All structures lack chimney seals and several were found to have evidence of surcharging. Exhibit B, in Appendix A, details the current condition of each structure evaluated.

Pipe sizes and materials were verified and invert elevations were measured during inspection. Invert elevations are used to calculate the slope of each sewer run and is necessary in determining the capacity of the system. The existing capacity is calculated using Manning's Equation and compared to the peak theoretical flows. Peak theoretical flows are based on population and land use and are approximately 4 times the theoretical average flow (based on Illinois' Recommended Standards for Sewage Works). The information gathered during this phase of the study, color coded in Exhibit C of Appendix A and listed in the table below, indicates that the system is sized appropriately for the area it serves and eliminates insufficient sewer capacity as the cause of surcharging.

Location	Inside Pipe Dia.(in.)	Existing Sewer Capacity (GPD)	Theoretical Peak Flows (GPD)	Capacity at Peak Flow (%)
MH 190B - MH 192	9.9	1,654,386	283,600	17.1
MH 192 - MH 193	8.0	476,845	283,600	59.5
MH 193 - MH 194	8.0	459,910	266,800	58.0
MH 194 - MH 195	8.0	482,358	252,800	52.4
MH 195 - MH 196	8.0	670,429	45,800	6.8
MH 196 - MH 197	8.0	936,909	30,400	3.2
MH 197 - MH 198	8.0	936,909	19,800	2.1
MH 198 - MH 199	8.0	723,537	8,600	1.2
MH 199 - MH 199A	8.0	934,082	1,600	0.2
MH 148 - MH 195	10.0	685,097	238,800	34.9
MH 149 - MH 148	8.0	539,293	46,200	8.6
MH 150 - MH 149	8.0	529,397	29,400	5.6
MH 150 - MH 151	8.0	567,947	16,800	3.0
MH 151 - MH 152	8.0	459,910	4,200	0.9
MH 153 - MH 148	8.0	625,546	28,000	4.5
MH 154 - MH 153	8.0	454,125	14,000	3.1
MH 147 - MH 148	8.0	524,379	118,800	22.7
MH 146 - MH 147	8.0	308,517	118,800	38.5
MH 144A - MH 146	8.0	514,195	87,600	17.0
MH 144 - MH 144A	8.0	448,265	57,800	12.9
MH 145 - MH 144	8.0	465,624	11,200	2.4
MH 141 - MH 144	8.0	493,199	14,000	2.8
MH 142 - MH 141	8.0	738,009	4,200	0.6
MH 140 - MH 141	8.0	748,680	8,400	1.1

*Values above 100% capacity would indicate insufficiently sized sewers

Table 1: Existing Sewer Capacity Calculations

C. Television of Sanitary Sewer Collection System

Tele Scan, Inc. was hired by C2 Engineers to complete CCTV (closed circuit televising) inspection and reporting on the sanitary lines within the study area. Four major breaks and approximately seven sections of cracked pipe were visible in the televised sections. These breaks and cracks have the greatest potential for collapse resulting in costly emergency repairs. Approximately 17% of the pipe joints were found to have signs of infiltration. These leaking joints are another weak point along the sewer with the potential to collapse.

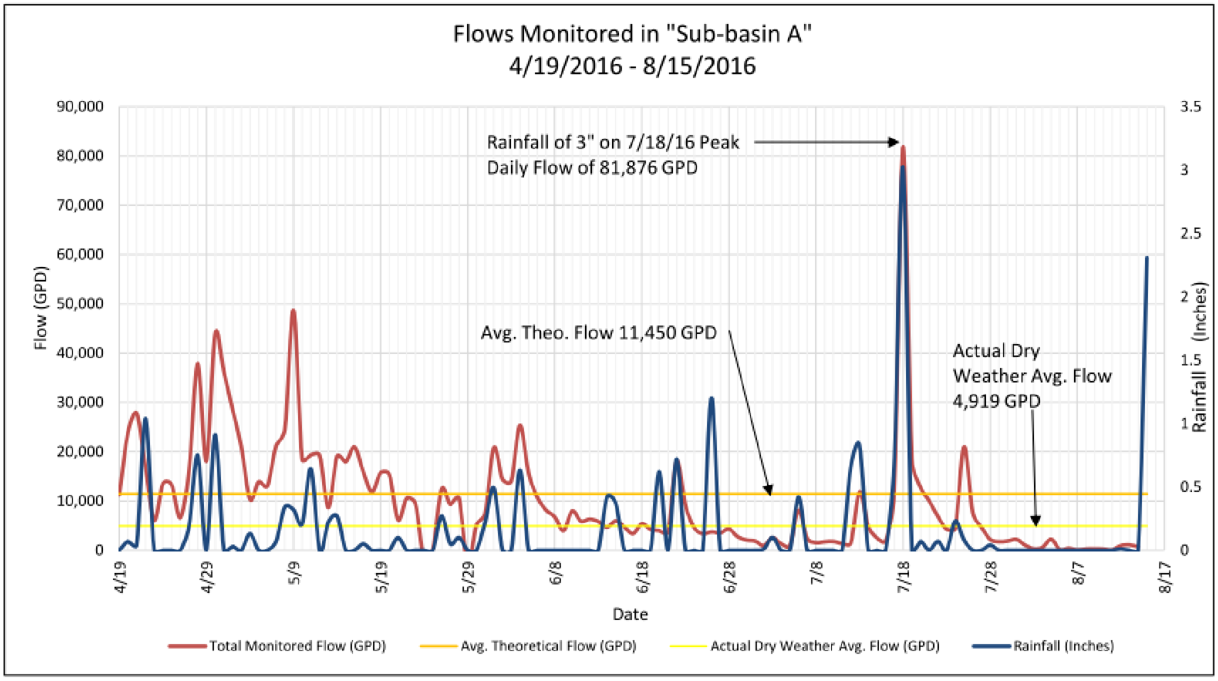
Blockages from grease and tree roots, minor sags and bellies, and several leaking lateral connections were also evident from the televising. Exhibit B, located in Appendix A, summarizes the TV inspection findings along these sewer runs. A copy of the televised inspection report and videos are included with this study.

D. Flow Monitoring of Sanitary Sewer Collection System

Three flow monitors were installed on April 19, 2016, for a 120 day data collection period ending on August 15, 2016. C2 Engineers installed the flow monitors to isolate three sub-basins within the study area, Exhibit D in Appendix A shows the flow monitor locations and sub-basins. Flow monitoring is a tool that provides flow data for a served area, this data is then analyzed to determine the magnitude and source(s) of I&I. Correlations between rainfall events and high flows can be concluded. Concentrating rehabilitation efforts in the locations having the worst I&I will provide a more cost effective means for improvements.

Dry weather average flows were calculated using monitored flow data that correspond to a 0” rainfall per day for 7 to 14 consecutive days. One significant rainfall event occurred on July 18, 2016, totaling 3”, and was selected for peak flow analysis. Peak wet weather flows over 4 times the dry weather average flows reveal excessive I&I issues that may compromise pipe capacity, resulting in surcharging or SSO’s.

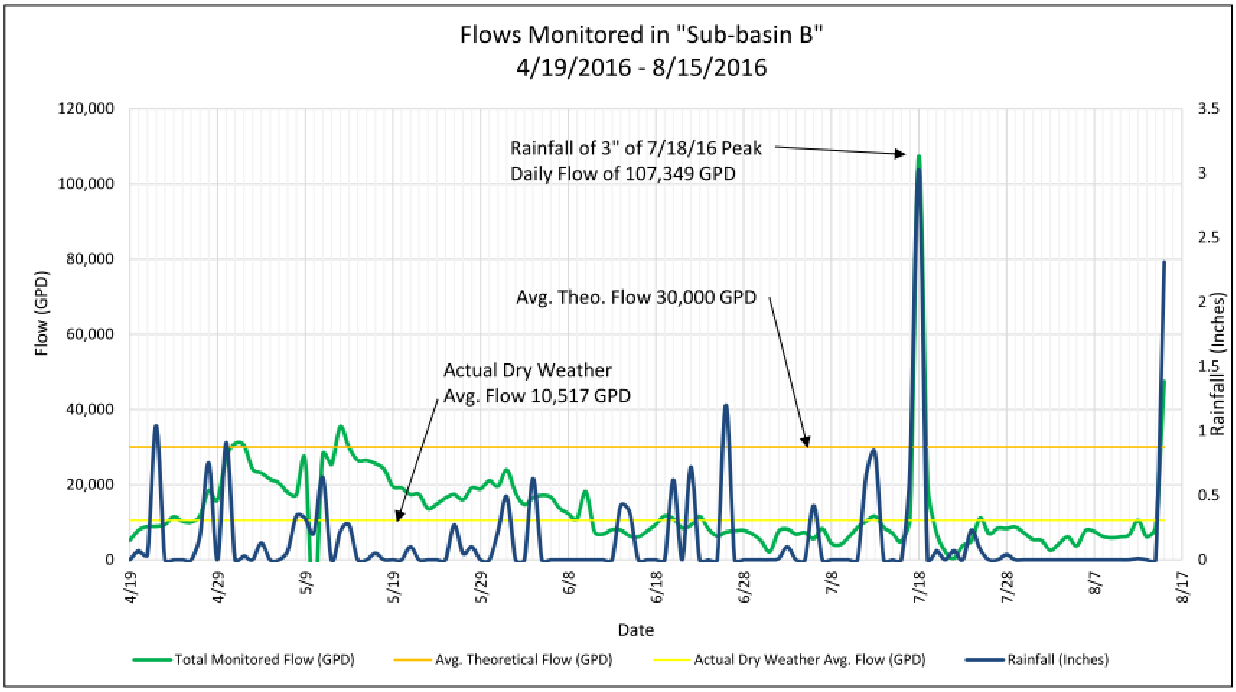
The following set of graphs compare rainfall events to total flows monitored, average dry weather flows, and theoretical flows within each sub-basin.



Graph 1A: Sub-basin A Flows and Rainfall Data

Manholes 199A through Manhole 195 contribute flows to Sub-basin A. Sub-basin A has approximately 1,392 linear feet of 8” sewer and encompasses the area east of Sixth Street to Ninth Street from the south side of Thompson to the north side of McCracken Ave. The total daily monitored flow has peaks corresponding to rain events with a steep decrease towards the dry weather average, this is an indication that inflow is a large contributor of unwanted flow. Sub-basin A has the largest wet weather peak of the three areas at 16.6 times that of the average dry weather flow.

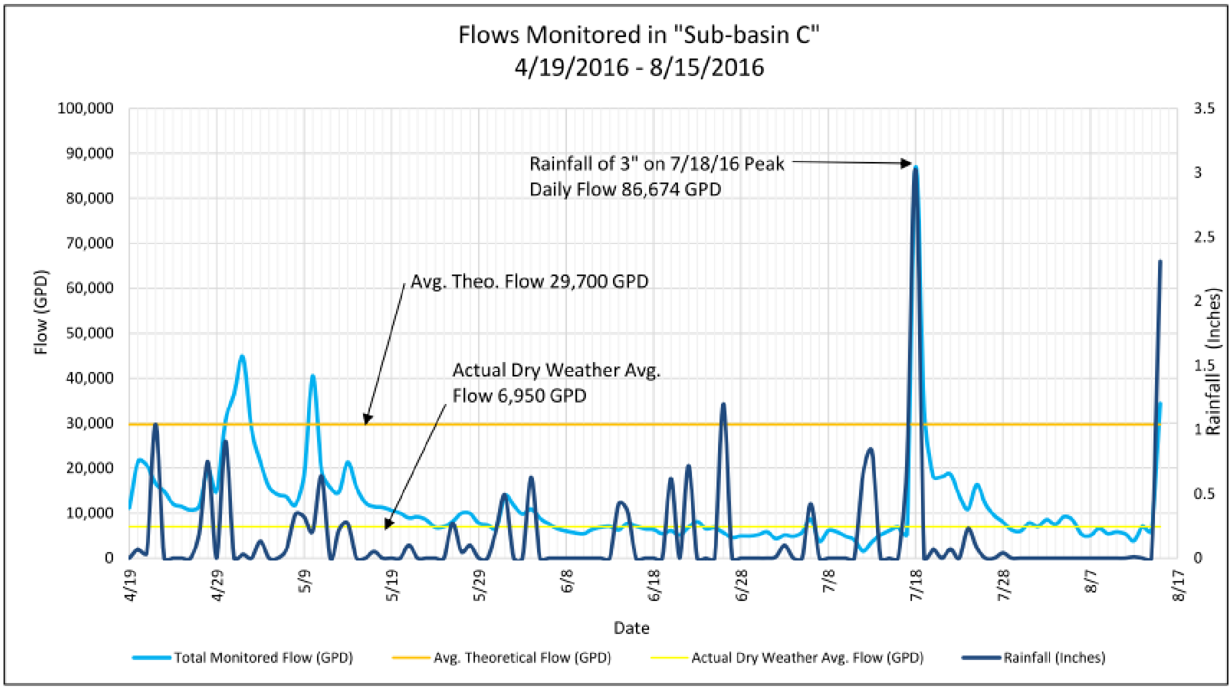
Graphs 1B-1D attached in Appendix A, show the instantaneous flow rates for Sub-basin A. Graph 1B shows the instantaneous flow for the duration of the monitoring period, flow noticeably changes as the result of both large or small amounts of rainfall. The 7/18/16 rain event caused an increase of flow by 39.6 times in a period of 2 hours, seen in Graph 1D; Graph 1C is included to show flow rates without rain during the same time frame a week prior. The change in flow from 4:30 am to 6:30 am increases by 2 times on a day without any rain. Sub-basin A experiences excessive I&I during storms.



Graph 2A: Sub-basin B Flows and Rainfall Data

Manholes 147 through 154 and the run from 148 to 195 contribute flow to Sub-basin B. Sub-basin B has approximately 2,808 linear feet of sewer and serves the area east of Fifth Street to Ninth from south Wyman Ave. to north Thompson. A monitor placed in the north invert of Manhole 195 captured data from both Sub-basin B and Sub-basin C combined, by subtracting data collected for Sub-basin C from data collected in the north invert of 195 we were able to isolate the area for Sub-basin B. The total daily monitored flow indicates infiltration is a large source of wet weather flow in Sub-basin B. The peak wet weather flow is 10.2 times the dry weather average flow in this area.

Graphs 2B-2D attached in Appendix A, show the instantaneous flow rates in Sub-basin B. The 7/18/16 rain event caused an increase of flow by 26 times in 3 hours of time shown in Graph 2D; again Graph 2C is included to show flow rates for the week prior during the same time frame as a typical flow rate without rain. The change in flow was 1.2 times during this period without rain. This sub-basin also has excessive I&I entering the system.



Graph 3A: Sub-basin C Flows and Rainfall Data

Manholes 140 through 147 contribute flow to Sub-basin C. Sub-basin C has approximately 2,330 linear feet of 8" sewer, serving the area east of Sixth Street to Ninth from Wyman Ave. to McNeil Ave., as well as east of Seventh St. to Ninth St. from McNeil Street to Judson Ave. The total daily flows collected in this sub-basin indicate that infiltration is a large contributor of unwanted flow. With more frequent rain events and saturated ground conditions, rainfall has a greater impact on infiltration and inflow problems than when the ground is unsaturated and has the ability to absorb more water. The peak wet weather flow in this sub-basin is 12.5 times the dry weather average flow.

Graphs 3B-3D attached in Appendix A show the instantaneous flow rates in Sub-basin C. The 7/18/16 rain event caused an increase of flow by 81 times over a 3 hour duration as seen in Graph 3D. An increase of flow by 5.8 times occurs on a normal day without rain as seen in graph 3C.

E. Smoke Testing of Sanitary Sewer Collection System

Tele Scan, Inc. conducted smoke testing in the study area to uncover defective laterals and cross connections of downspouts or storm sewers, all of which contribute to higher non-sanitary flows.

Approximately nine locations of smoke exiting at ground level were found in the study area, indicating the private lateral is defective (cracked, broken or has root intrusion). Five cleanout locations were observed to have smoke presence, indicating that the cleanout is broken or uncapped. Two locations of gutter/downspout tie-ins were found, this is a direct connection between storm water flow and the sanitary sewer. Eight locations of smoke exiting through basements/foundations were observed, indicating defective plumbing pipes or cross connections with floor drains. Defective private plumbing is hazardous to the homeowner because sewer gases are leaking at these points that smoke is observed.

Exhibit E of Appendix A details the findings of the smoke testing and a copy of Tele Scan's field observations are included with this report.

F. Recommended Improvements

The mainline sewer and manholes within the study area are in desperate need of repair. The system is handling excessive amounts of I&I, causing frequent SSO's and sewer backups and costing the City additional dollars of treatment costs annually.

Since all three sub-basins have significant peaks during wet weather flow we would propose that improvements be made to the entire study area. The most cost effective solution to reduce I&I in the mainline sewers is to install a cured in place pipe (CIPP) liner; this process is the least intrusive as access to the sewer is done through the manholes. The lining can be completed for a fraction of the cost of open cutting and replacing the sewers. It also provides the City with a "new" system that has a life span similar to installing new pipes. Some spot repairs and cleaning are necessary prior to lining.

The majority of manholes would benefit from joint injection to stop infiltration. A fast curing polyurethane grout is injected above leaks in the structure and expands 10-12 times the liquid volume, this will seal any existing holes. The structure is then covered in layer of quick setting mortar to further seal the manhole. As a final step to manhole rehabilitation, the structures need to be adjusted to grade, with new chimney seals and lids with sealed pickholes. Exterior chimney seals are recommended because they provide blocking of groundwater from the exterior of the structure and because most of the manholes will require minor excavation anyways to adjust to grade and replace the lids.

While the capacity of the sewer is not considered to be a threat, adding additional users to the system is not recommended at this time. The mainline sewer run from Manhole 195 to Manhole 192 is a restriction for growth as it exists. This 1,130 foot run of sewer would need to be removed and replaced at a steeper slope to receive flow from additional users. The construction cost would increase approximately by $40,000 with this option.

Private sewer rehabilitation is another issue that the City will need to address. Smoke testing revealed several locations on private property that are contributing unwanted flows to the system. The repairs necessary to correct the problems include lining the existing laterals, open cutting and replacing service lines, connection repairs, disconnection of downspouts, and repairs to defective plumbing pipes inside the home. The City will need to decide if the rehabilitation costs should be included with a public sewer improvement project or if it will be the responsibility the individual homeowners. The cost of each private sewer repair may vary from $500 to $3,500. An average cost of $1,250 was used per repair for the purpose of the cost estimate included in this study.

The Proposed Improvement are shown in Exhibit F and the Preliminary Opinion of Probable Cost for the Recommended Improvements is shown in Exhibit G, both located in Appendix A.

G. Funding Options

There are outside funding sources available for this type of project. Currently the USDA offers a loan with fixed low interest rates that are based on the City's median household income of the area served and the need for the project. This loan can be combined with available grants. IEPA also has a low interest loan available at 1.75% through June 30, 2017 with a possibility of some capital forgiveness for eligible applicants. The Illinois Department of Commerce and Economic Opportunity administers a CDBG program that annually awards grants for similar projects based on MHI, need and project readiness.

H. General Conclusions

The system is reaching the end of its useful life and in need of repair leaving the City to determine what corrective actions to take. Preventative maintenance is a fraction of the cost of an emergency repair, an average emergency repair may cost $250 to $1,000/LF to fix a section of pipe whereas lining a sewer run costs approximately $50/LF.

The cost of doing nothing increases every year. Sewer backups and SSO's may become more frequent as the system continues to age causing a threat to public health and property. The wastewater treatment plant will also continue to treat the excess flows resulting in additional treatment costs.

CIPP lining the mainline sewer is the least intrusive and most cost effective solution to repair the collection system. The lined collection system would have the life expectancy similar to a new sewer of 50+ years.

Additionally this area of town has major drainage issues and sees frequent flooding. Reducing the stormwater in the sanitary sewer system will put a larger strain on the storm sewer, as it will have to handle the additional flow. With no changes to the existing drainage system, this area of town could see additional flooding.

APPENDIX A – Exhibits and Graphs for Report

C2 Engineers
Designing Higher Standards

DATE	REVISION		
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		PRINT DATE:	9/27/2016
		CHECKED BY:	SDC
		DESIGNED BY:	TMB

SCALEBAR:
0' 100' 200' 400'

CLIENT:
CITY OF
HOOPESTON
HOOPESTON, ILLINOIS

PROJECT NAME: 6th STREET SSO STUDY

SHEET TITLE: STUDY AREA

A

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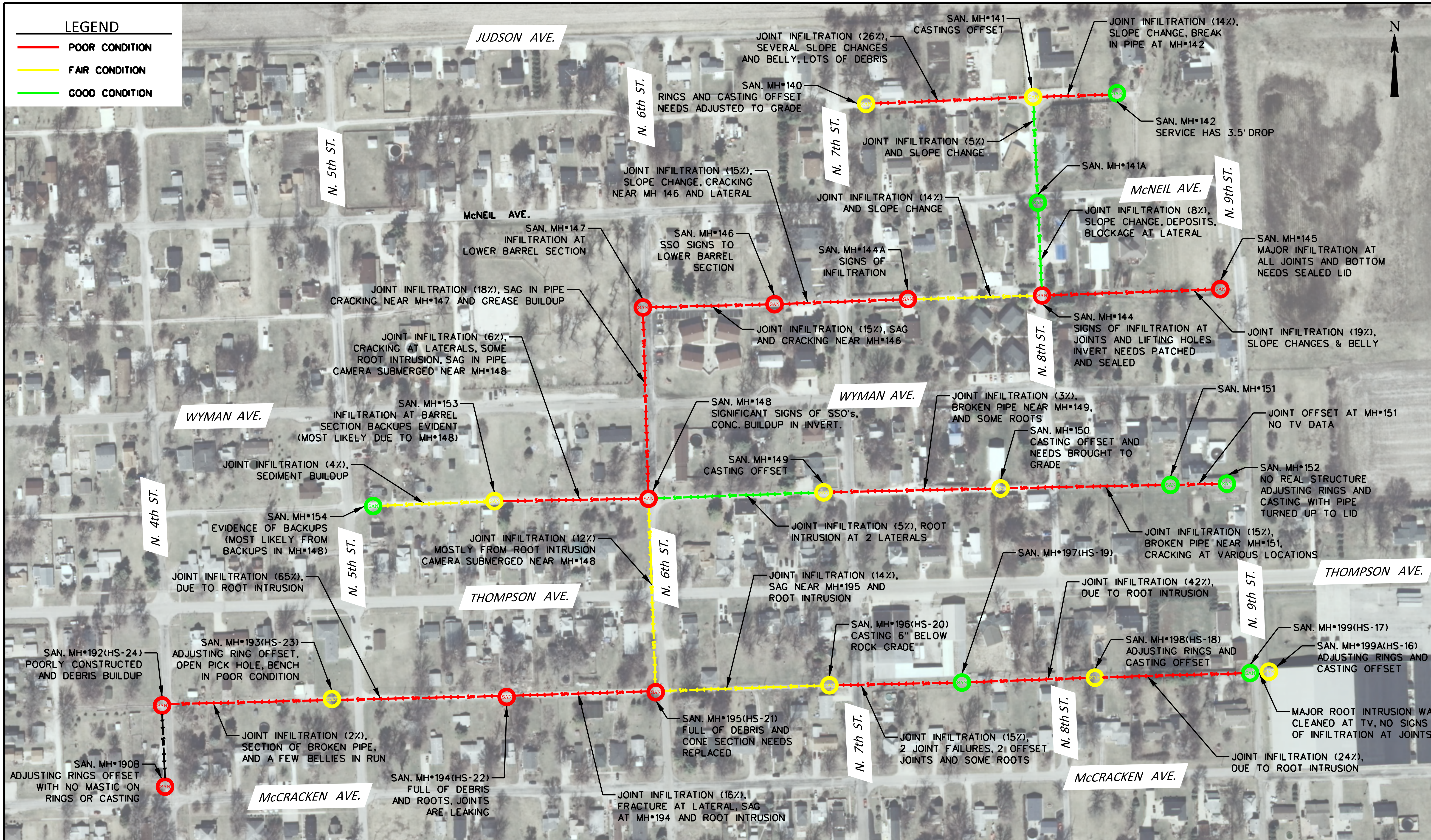

C2 Engineers
Designing Higher Standards

DATE	REVISION

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CHECKED BY: SDC
DESIGNED BY: TMB

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CLIENT:
CITY OF HOOPESTON
HOOPESTON, ILLINOIS

PROJECT NAME: 6th STREET SSO STUDY

SHEET TITLE: VISUAL ASSESSMENT OF EXISTING SYSTEM

B

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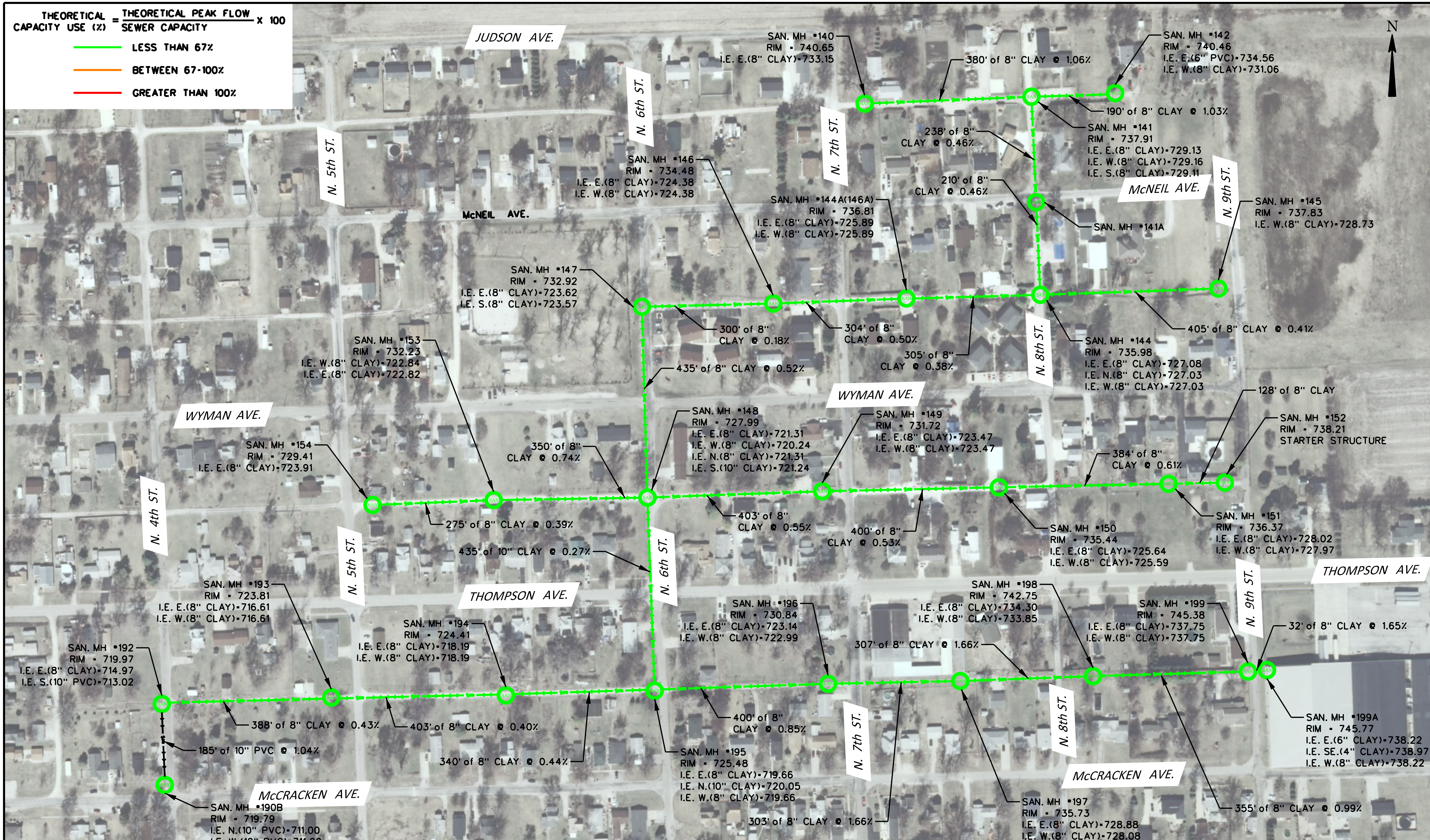

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			DESIGNED BY: TMB				

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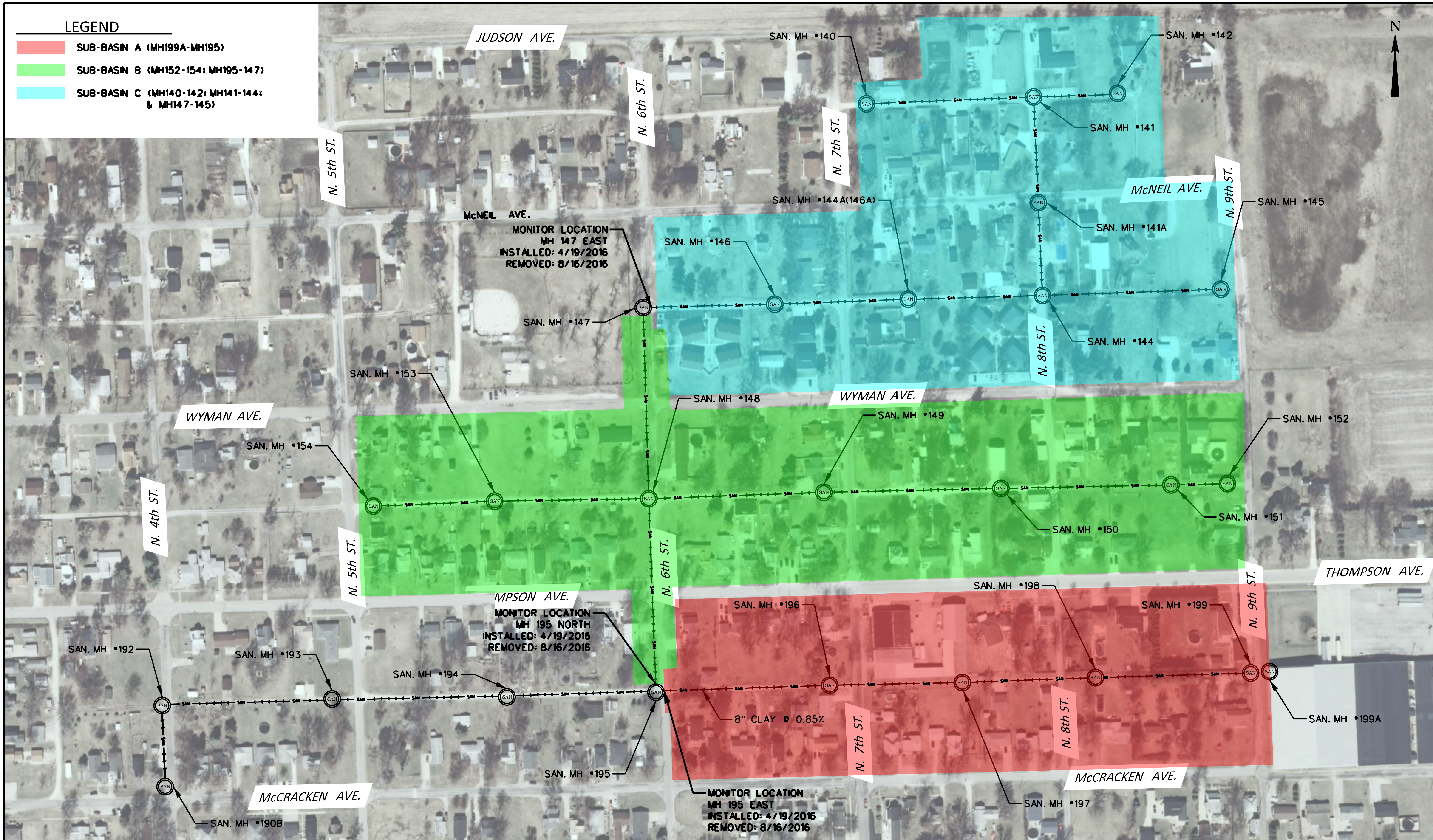

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			CHECKED BY: SDC				
			DESIGNED BY: TMB				

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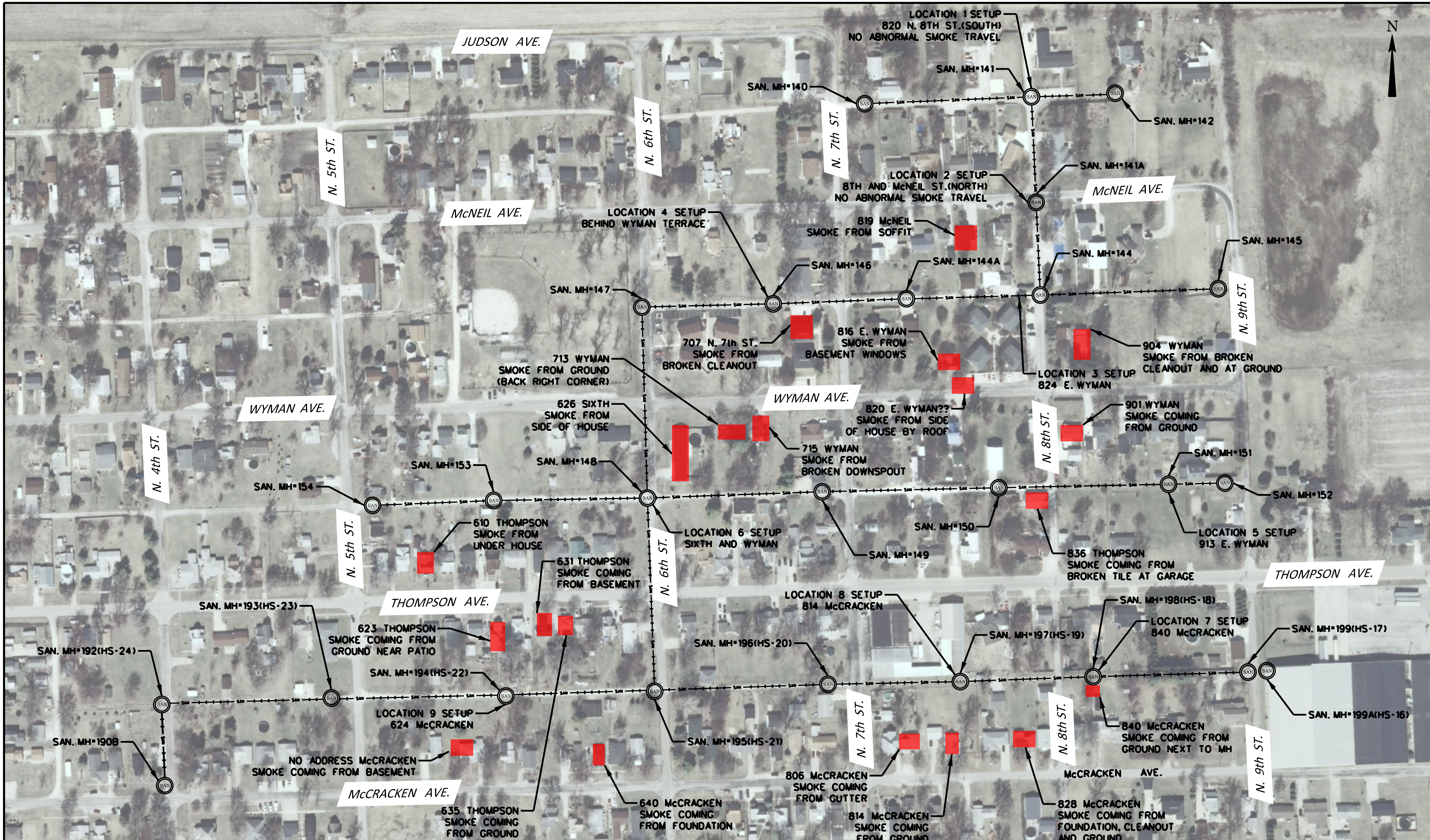

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Designing Higher Standards

DATE	REVISION

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CLIENT: CITY OF HOOPESTON
HOOPESTON, ILLINOIS

PROJECT NAME: 6th STREET SSO STUDY

SHEET TITLE: SMOKE TESTING RESULTS

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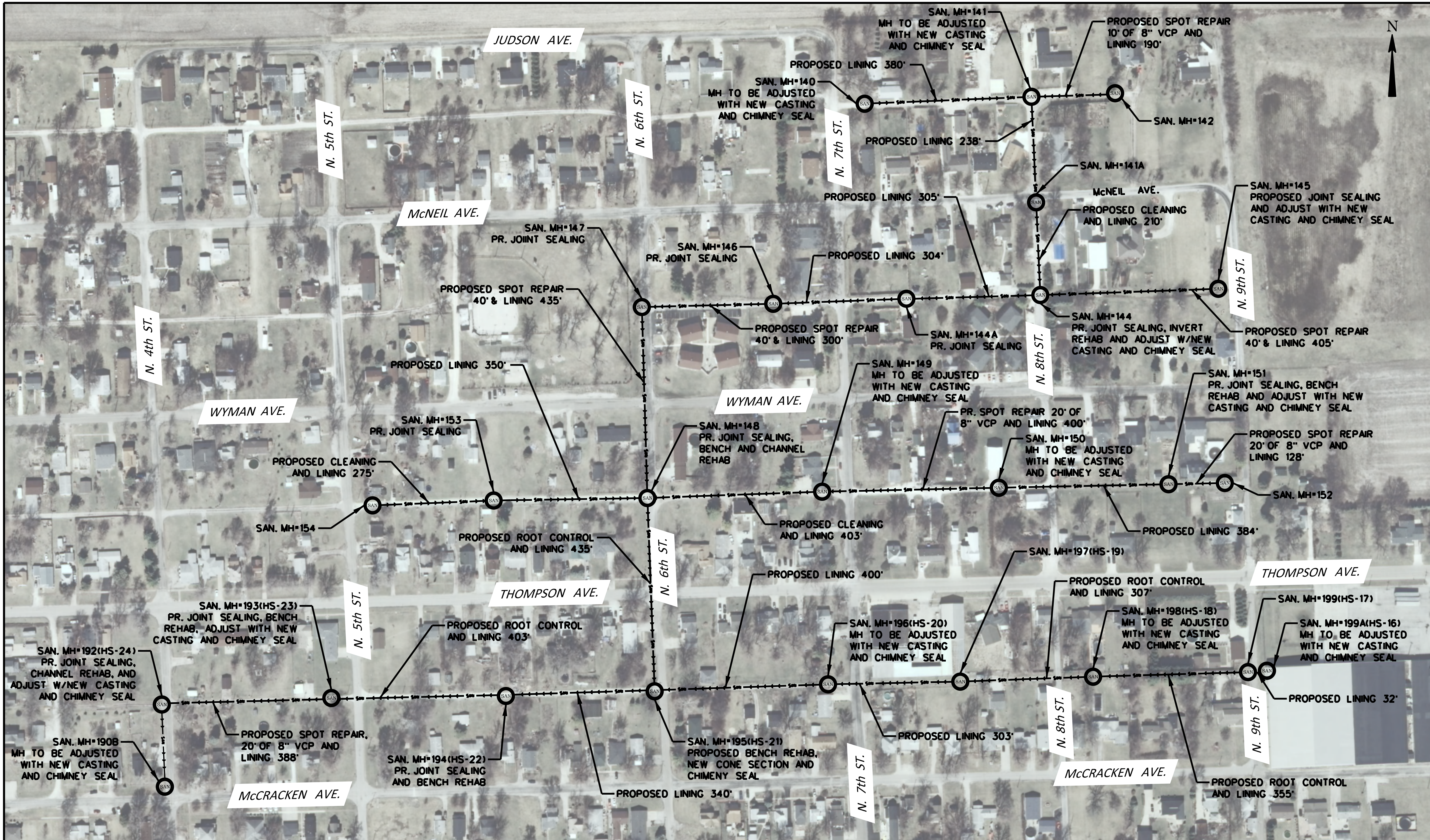

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CLIENT: CITY OF HOOPESTON
HOOPESTON, ILLINOIS

PROJECT NAME: 6th STREET SSO STUDY

SHEET TITLE: PROPOSED IMPROVEMENTS

F

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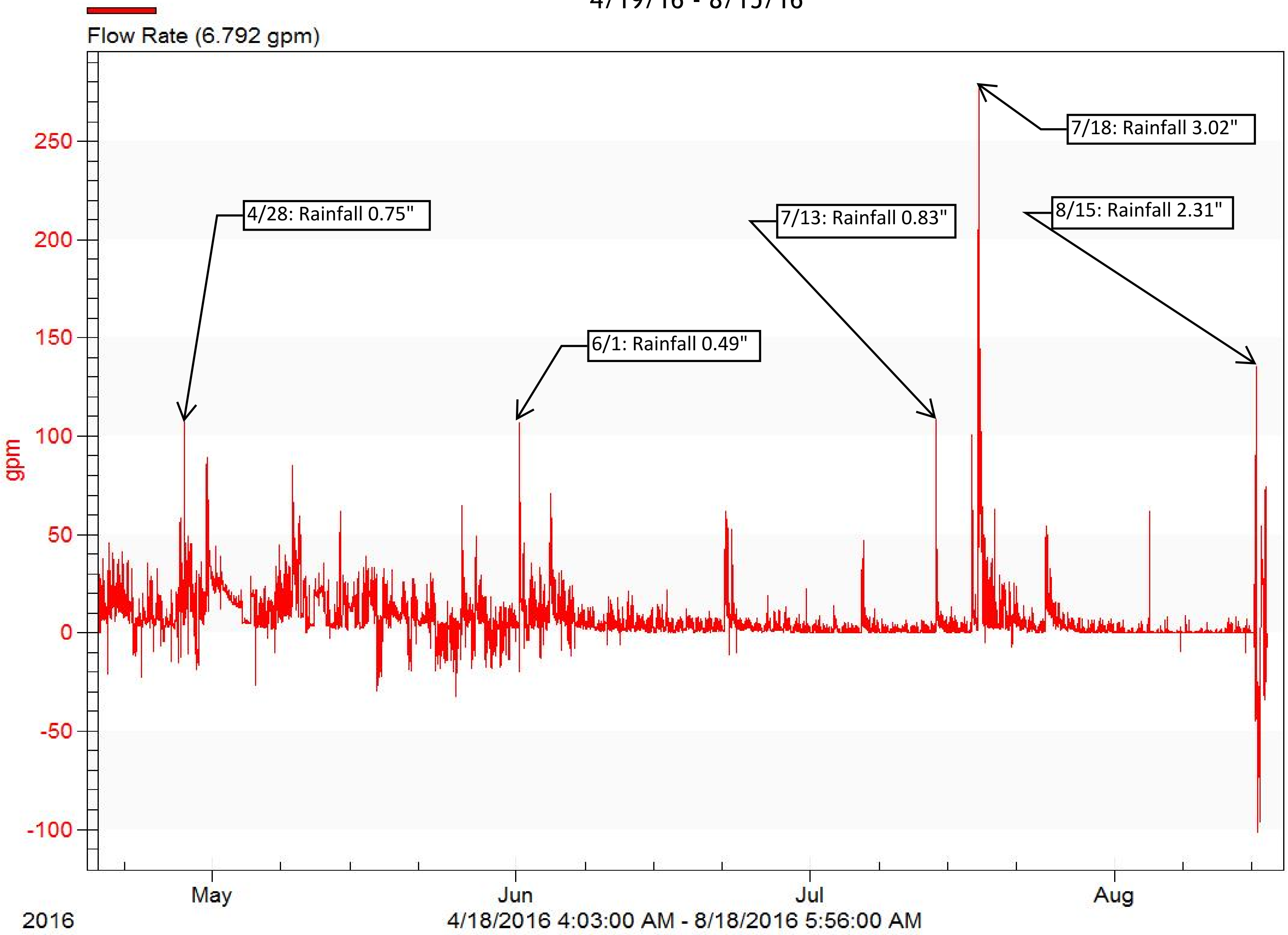
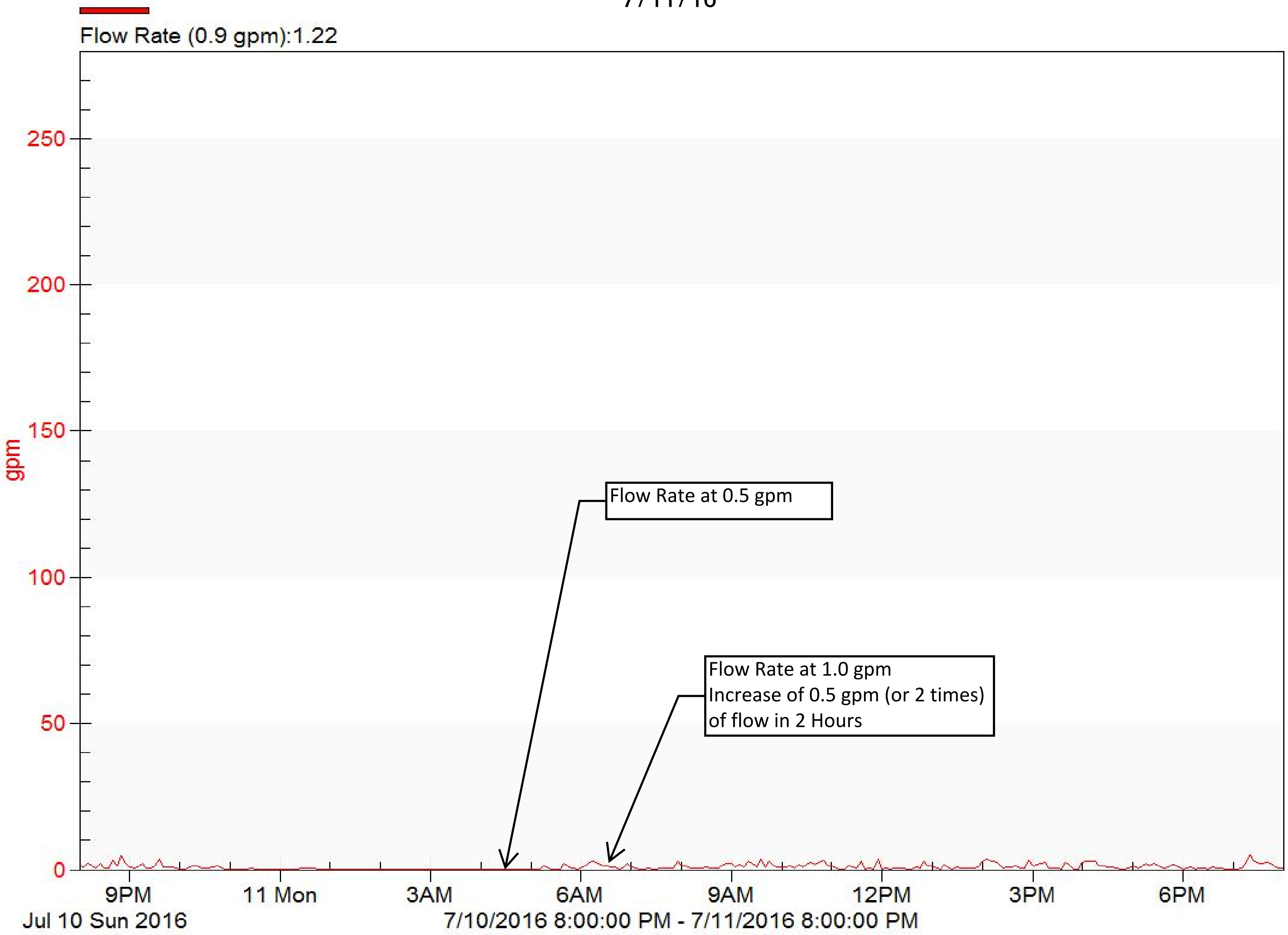
EXHIBIT G
PRELIMINARY OPINION OF PROBABLE COST

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL ITEM COST
MANHOLE				
JOINT SEALING AND GROUTING	MH	$1,000.00	11	$11,000.00
CHANNEL REHAB	EA.	$500.00	3	$1,500.00
BENCH REHAB	EA.	$500.00	5	$2,500.00
REMOVE AND REPLACE CONE SECTION	EA.	$2,000.00	1	$2,000.00
ADJUST MH W/NEW FRAME, LID, AND CHIMNEY SEAL	EA.	$1,300.00	13	$16,900.00
SEWER				
CIPP LINING, 8"	FT.	$30.00	7235	$217,050.00
CIPP LINING, 10"	FT.	$35.00	435	$15,225.00
8" VCP SPOT REPAIR (IN PVMT OR AGG ALLEY)	EA.	$5,000.00	7	$35,000.00
REINSTATE LATERALS (INCLUDES PROTRUDING)	EA.	$120.00	150	$18,000.00
PROTRUDING TAP REMOVAL	EA.	$300.00	6	$1,800.00
MAINLINE TO LATERAL SEAL	EA.	$350.00	150	$52,500.00
ROOT CONTROL	FT.	$3.00	1500	$4,500.00
PRIVATE SEWER REPAIR	EA.	$1,250.00	20	$25,000.00
GENERAL				
TV FINAL INSPECTION	FT.	$1.50	7670	$11,505.00
BYPASS	LS	$6,000.00	1	$6,000.00
CONTINGENCY (10%)				$42,048.00
ENGINEERING DESIGN AND BIDDING(10%)				$46,252.80
CONSTRUCTION INSPECTION (10%)				$46,252.80
			TOTAL COST	**$555,033.60**

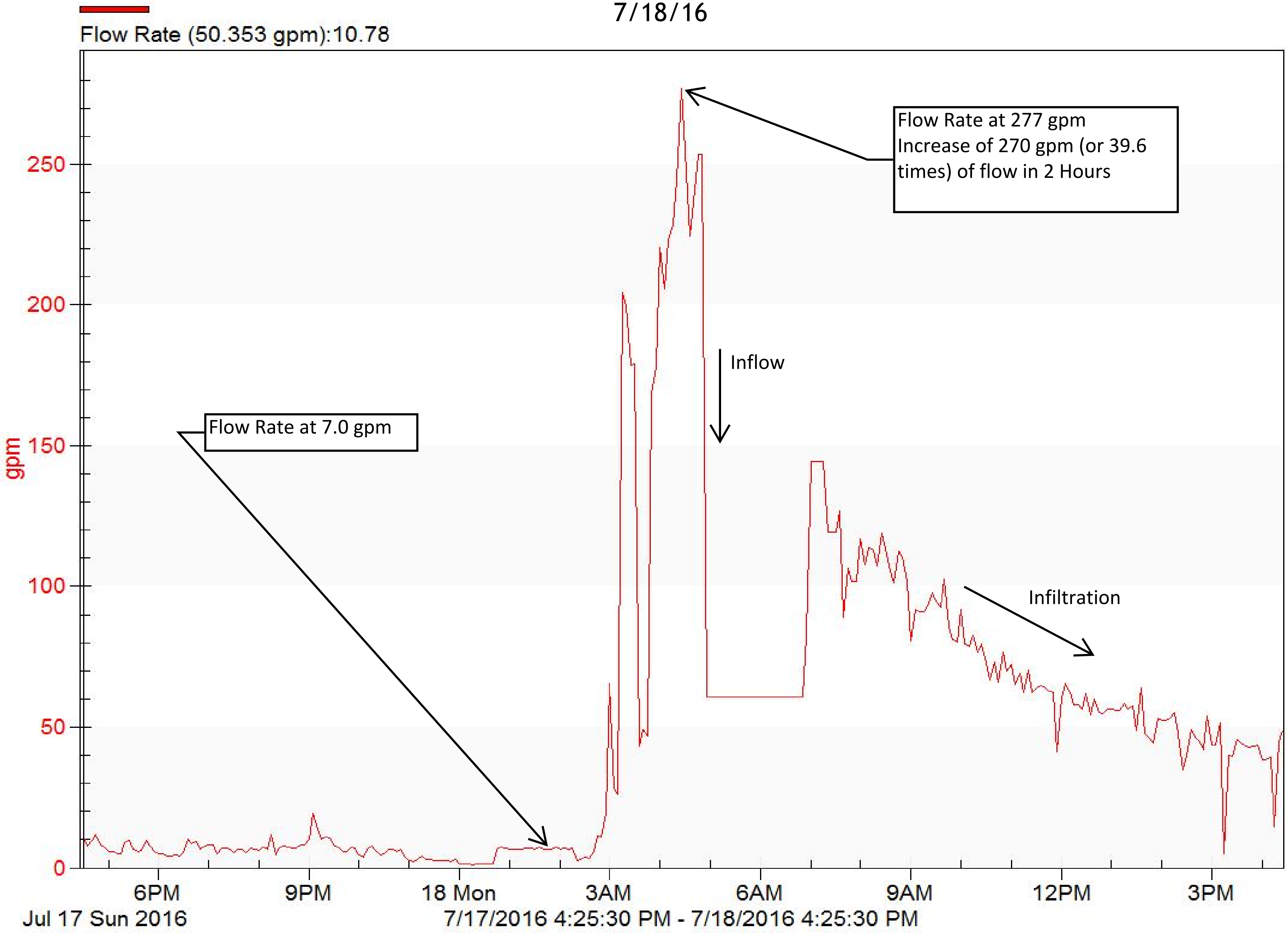
Graph 1B
Monitored Flow Rate
Sub-basin A
4/19/16 - 8/15/16

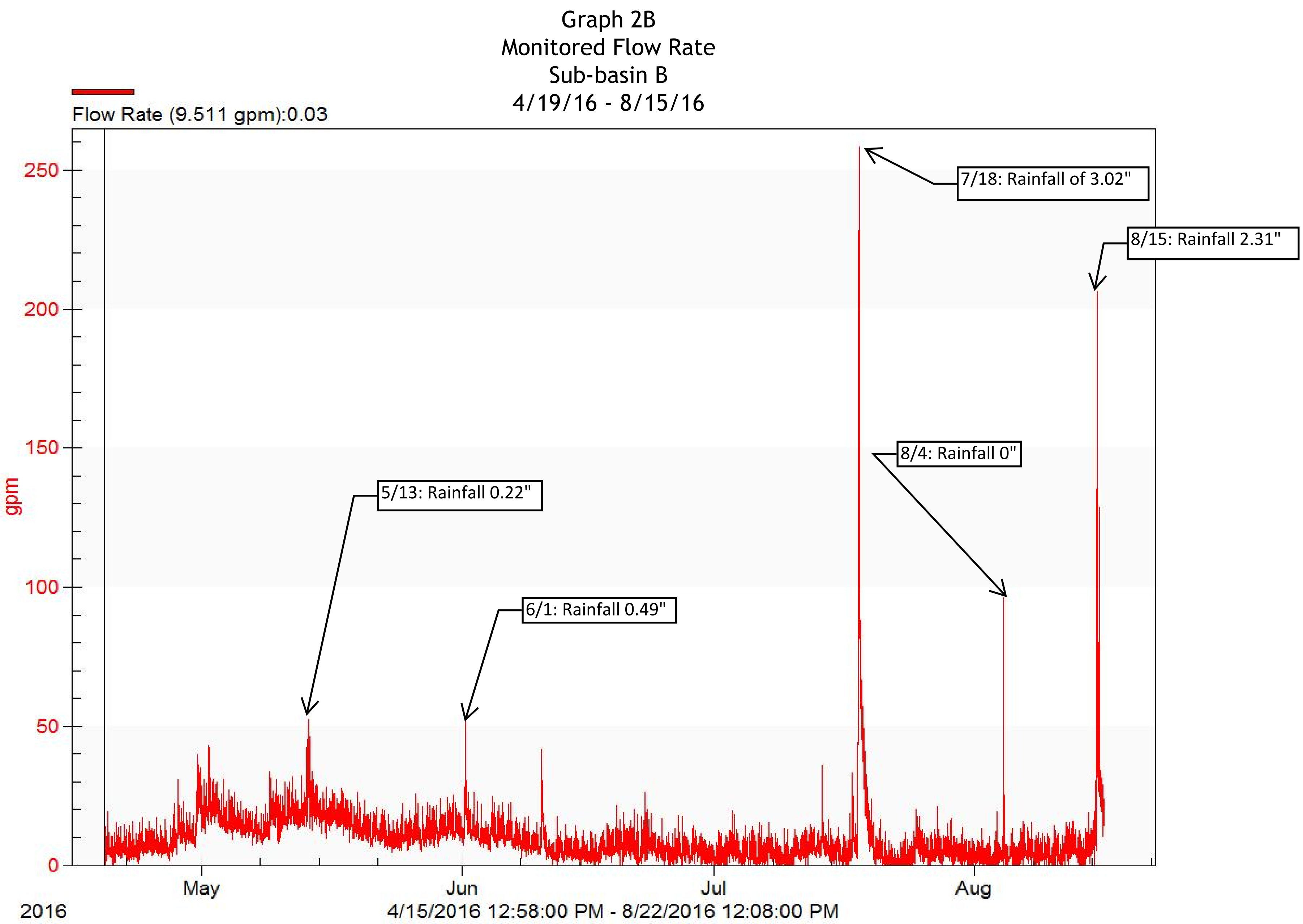


Graph 1C
Monitored Flow Rate
Sub-basin A
7/11/16



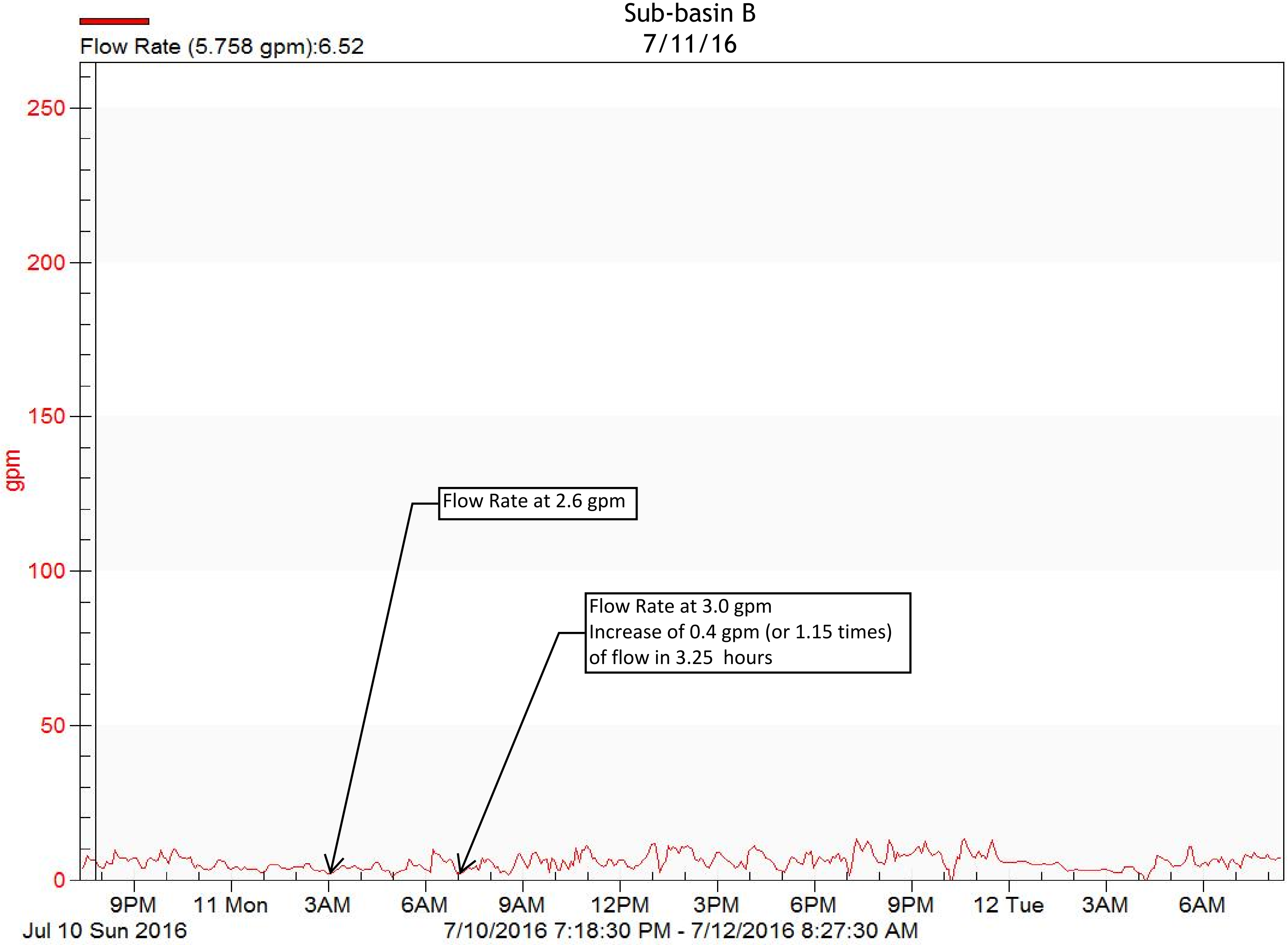
Graph 1D
Monitored Flow Rate
Sub-basin A
7/18/16



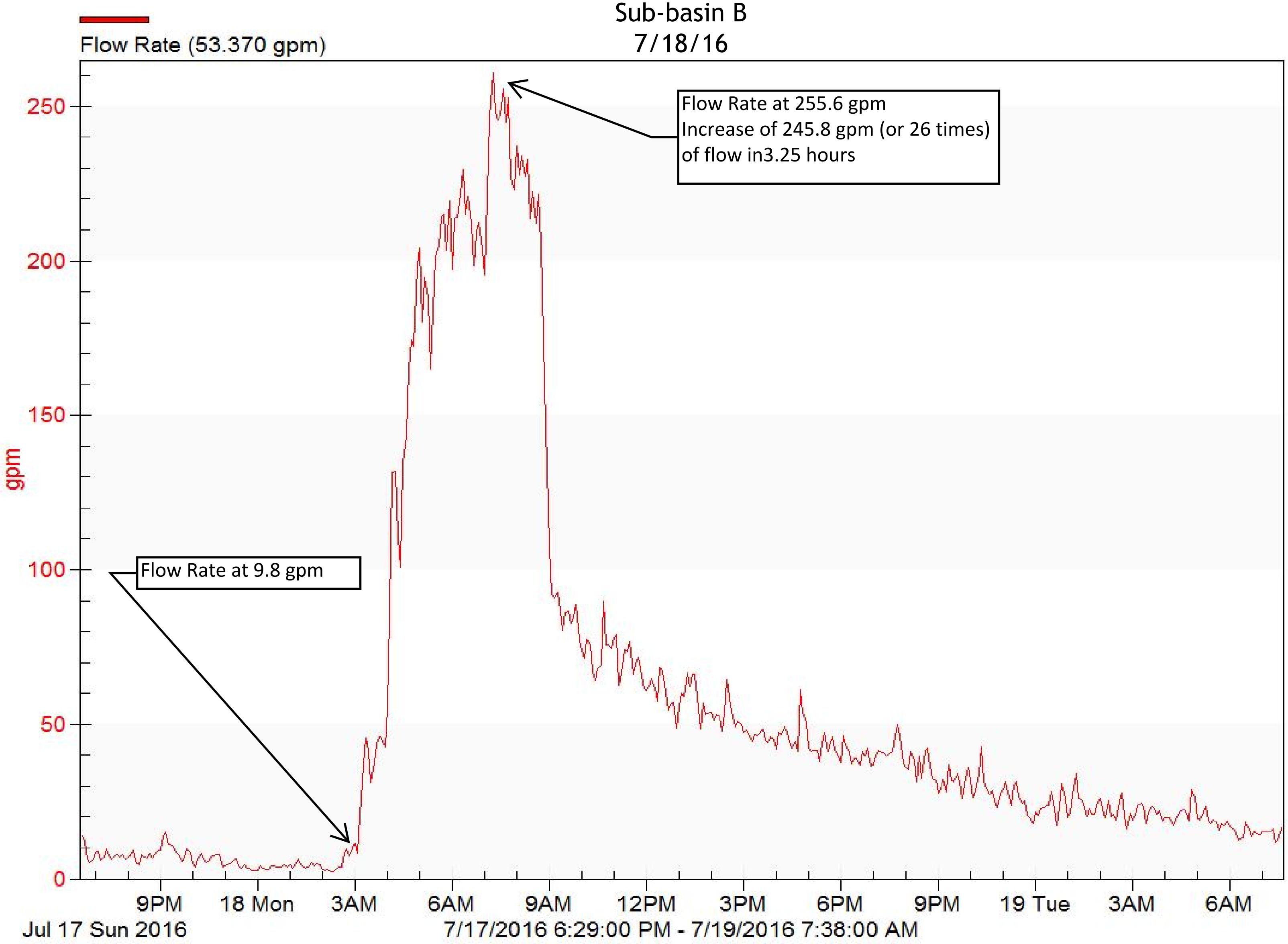


Graph 2B
Monitored Flow Rate
Sub-basin B
4/19/16 - 8/15/16
Flow Rate (9.511 gpm):0.03
gpm
250
200
150
100
50
0
May
Jun
Jul
Aug
2016
4/15/2016 12:58:00 PM - 8/22/2016 12:08:00 PM
7/18: Rainfall of 3.02"
8/15: Rainfall 2.31"
8/4: Rainfall 0"
5/13: Rainfall 0.22"
6/1: Rainfall 0.49"

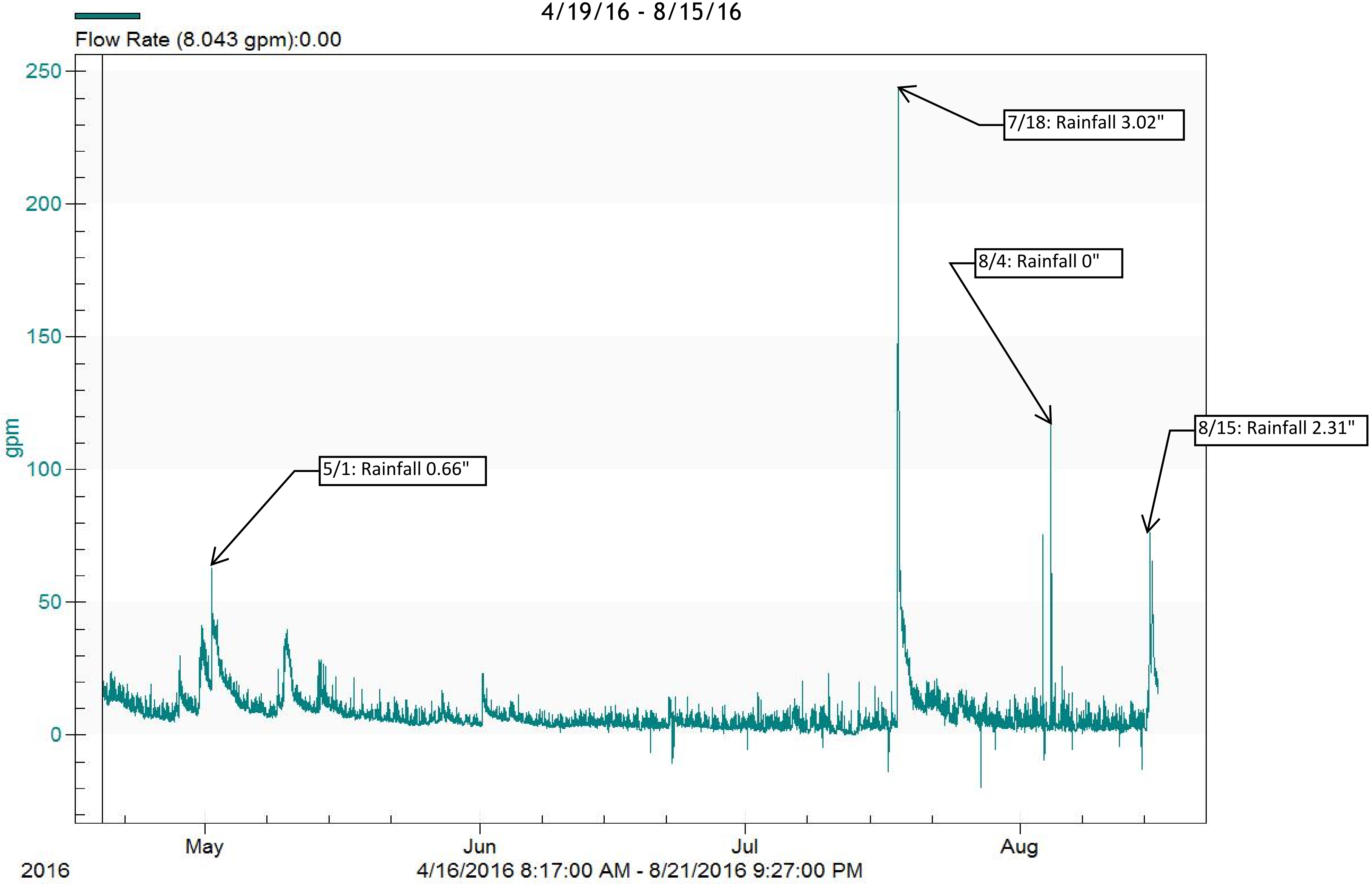
Graph 2C
Monitored Flow Rate
Sub-basin B
7/11/16



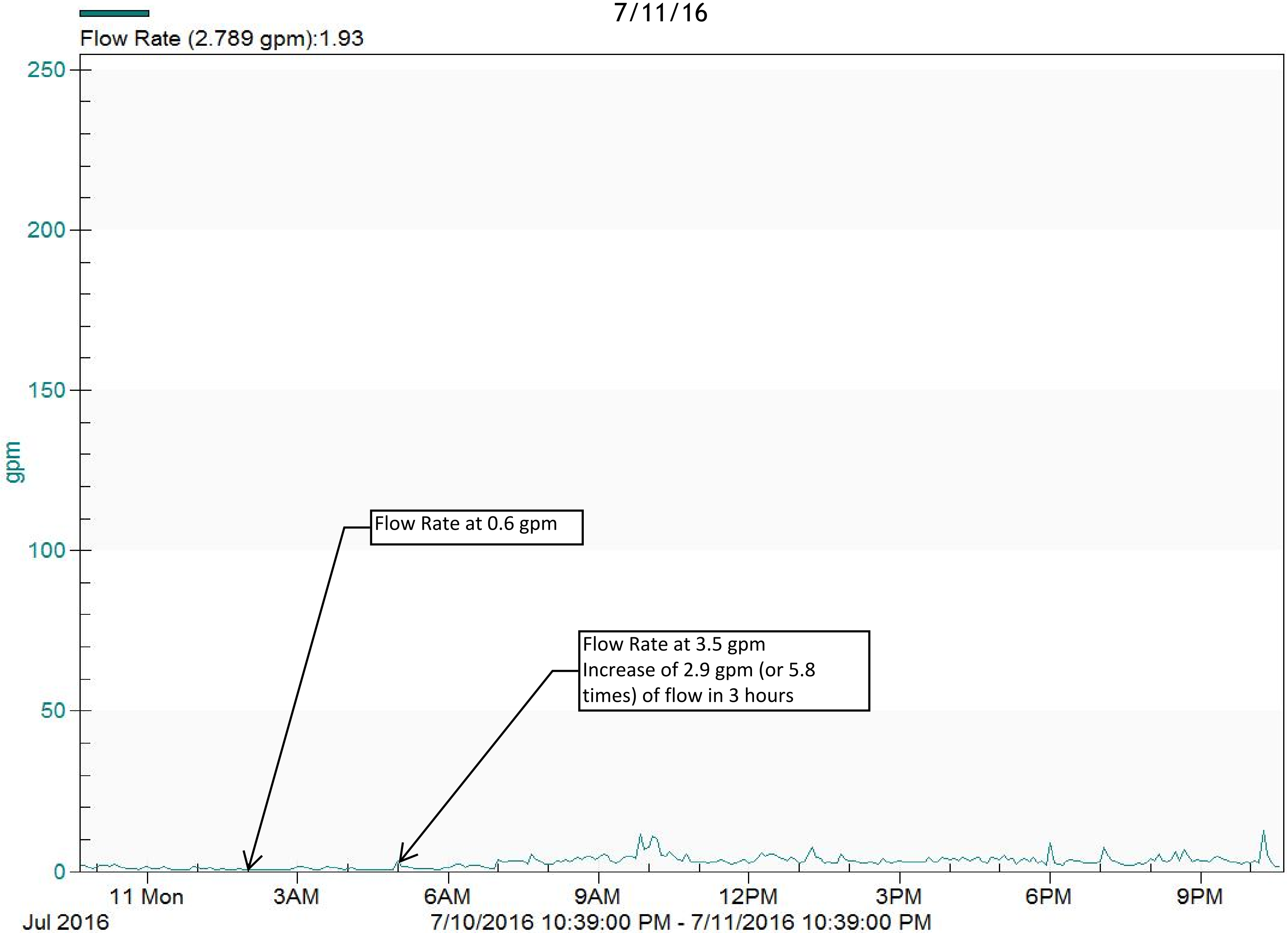
Graph 2D
Monitored Flow Rate
Sub-basin B
7/18/16



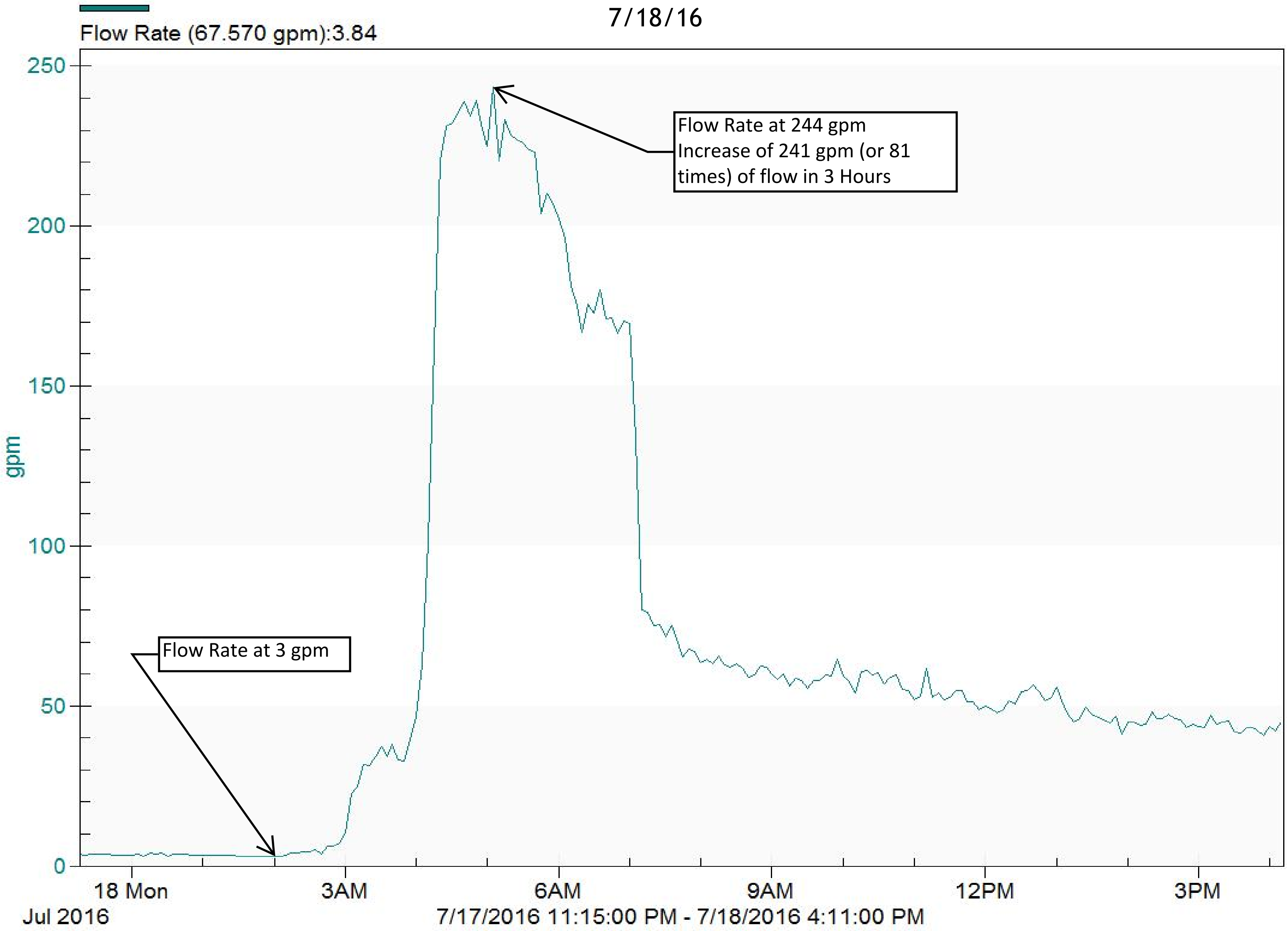
Graph 3B
Monitored Flow Rate
Sub-basin C
4/19/16 - 8/15/16



Graph 3C
Monitored Flow Rate
Sub-basin C
7/11/16



Graph 3D
Monitored Flow Rate
Sub-basin C
7/18/16



APPENDIX B – Photos

MH 194: Full of Debris, Roots, Joints Leaking

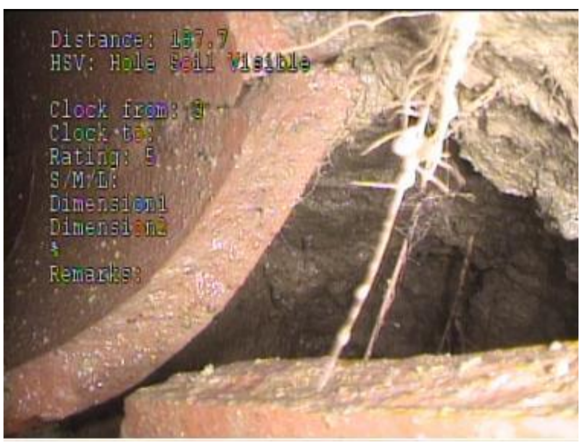
MH 147: Infiltration at Barrel Section

MH 145: Major Infiltration at Joints Leaking

MH 148:Buildup in Invert, Signs of SSO's

MH 144: Infiltration at Joints, Lifting Holes, Invert Needs Patched

MH 140: Rings and Casting Offset, Full of Debris and Needs Adjusted to Grade

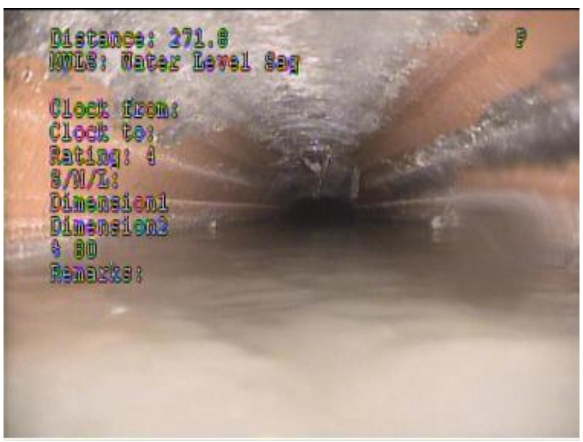


MH 142-141: Break in Pipe near MH 142

MH 145-144: Leaking at Joint

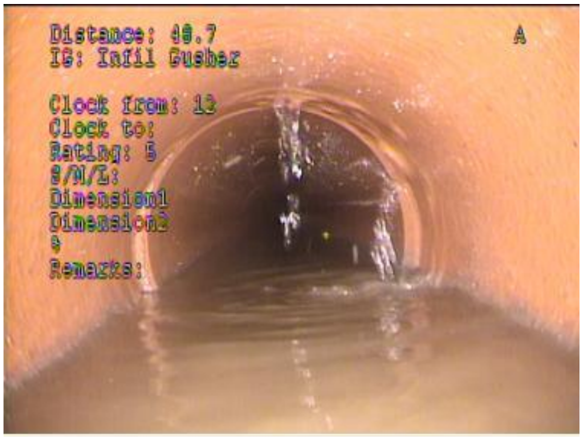
MH 146-147: Break in Pipe near MH 146

MH 150-151: Break in Pipe 100’ from MH151

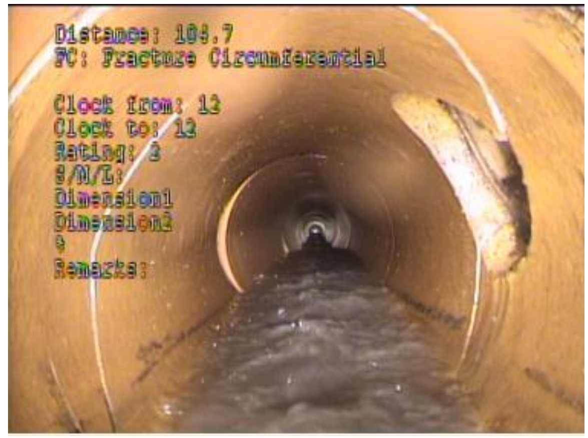


MH 147-148: Sag in Pipe

MH 151-152: Joint Offset near MH151

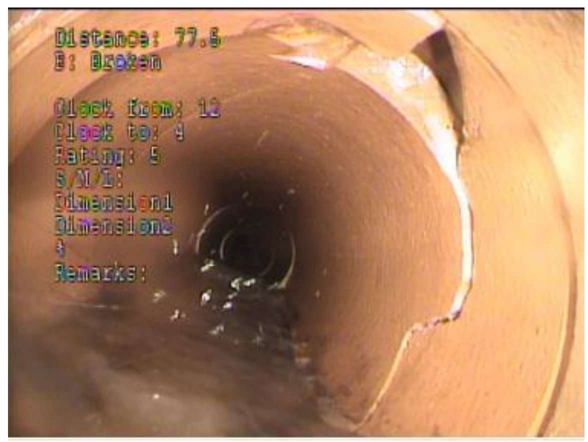


MH 153-148: Infiltration at Joint



MH 195-194: Circumferential Cracking at Lateral

MH 198-197: Major Root Intrusion



MH 193-192: Break in Pipe, 77’ from MH 193