APPENDIX D

SANITARY SEWER FLOW STUDY

By: CLS Services, Inc.

Dated: October 2021

VOLKERT, INC.
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VOLKERT

Sanitary Sewer Flow Study

for the

Board of Water and Sewer Commissioners of the City of Saraland

October 7, 2021

VOLKERT

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SECTION ONE: INTRODUCTION

Purpose and Scope

The purpose of this study is to provide the Board of Water and Sewer Commissioners of the City of Saraland (SWSS) and the engineers at Volkert, Inc. with accurate flow data to determine where and how much extraneous flow is entering the City of Saraland wastewater collection system.

There were 2 phases in this study. In the Phase 1, CSL Services, Inc. (CSL) technicians installed 6 flow meters to record wastewater flows for 90 days at selected manholes throughout the collection system. A rain gauge was installed at the wastewater treatment plant on Station Street for this same 90 day period. This was followed by an analysis of the data collected that included a comparison of wet and dry weather flows. For Phase 2, 4 meters to manholes upstream of manhole NC-00-001 to further isolate sources of extraneous wet weather flow in that portion of the system. The second phase data collection period lasted 60 days. Key project tasks included:

- Flow metering site investigations
- Flow meter installation and calibration
- Flow meter maintenance and data collection
- Flow data analysis
- Relocation of 4 meters for the second phase
- Flow data analysis
- Final Report

Project Planning

CSL was initially contacted by Volkert about a flow study in Saraland on October 21, 2020. A very general exchange of information about the size of the system and the objectives of the study along with a tentative scope of work and preliminary budget costs were discussed. Volkert requested that CSL submit a formal proposal for this study on December 11, 2020. Based on a request from CSL, Volkert provided photographs of each of the target locations for CSL to assess on January 18, 2021. A final agreement was executed between Volkert and CSL on February 22, 2021.

A schematic that shows the sites where flow meters were installed in both Phase 1 and Phase 2 is presented in **Figure 1** on the next page. **Figure 2** and **Figure 3** on the following pages present system maps for Phase 1 and Phase 2 with the sub-systems isolated by each flow meter highlighted in different colors. Site report sheets with detailed information for the flow meters and rain gauge are provided in **Appendix A**.

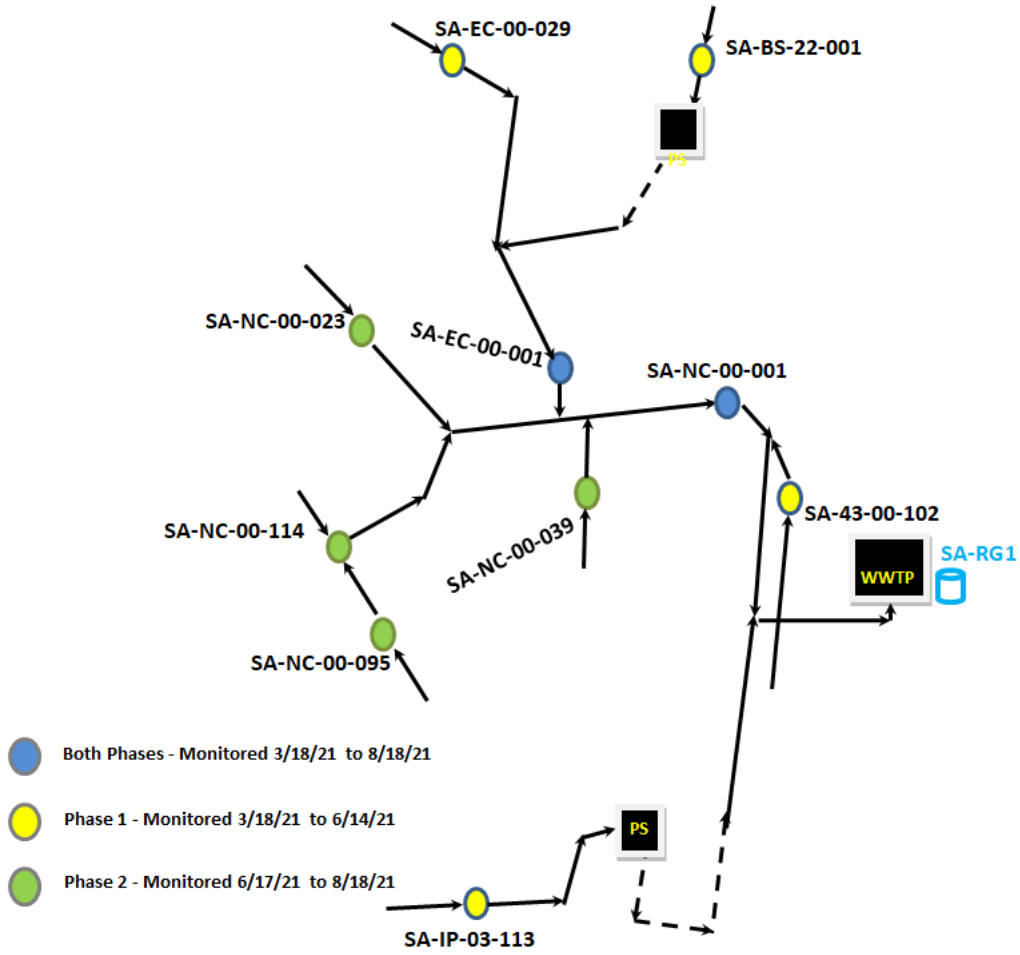


Figure 1. Flow Monitoring Schematic

Figure 2.

SARALAND WATER AND SEWER SERVICE
I/I STUDY AND ANALYSIS-PH. I

PHASE I	
Monitor Location (MH No.)	Upstream Pipe Length (ft.)
43-00-102	7,598
BS-22-001	40,693
EC-00-001	31,513
EC-00-029	157,450
IP-03-113	44,252
NC-00-001	103,629
TOTAL:	385,135

Legend

Ph. I Flow Monitors

MH_No

- 43-00-102
- BS-22-001
- EC-00-001
- EC-00-029
- IP-03-113
- NC-00-001

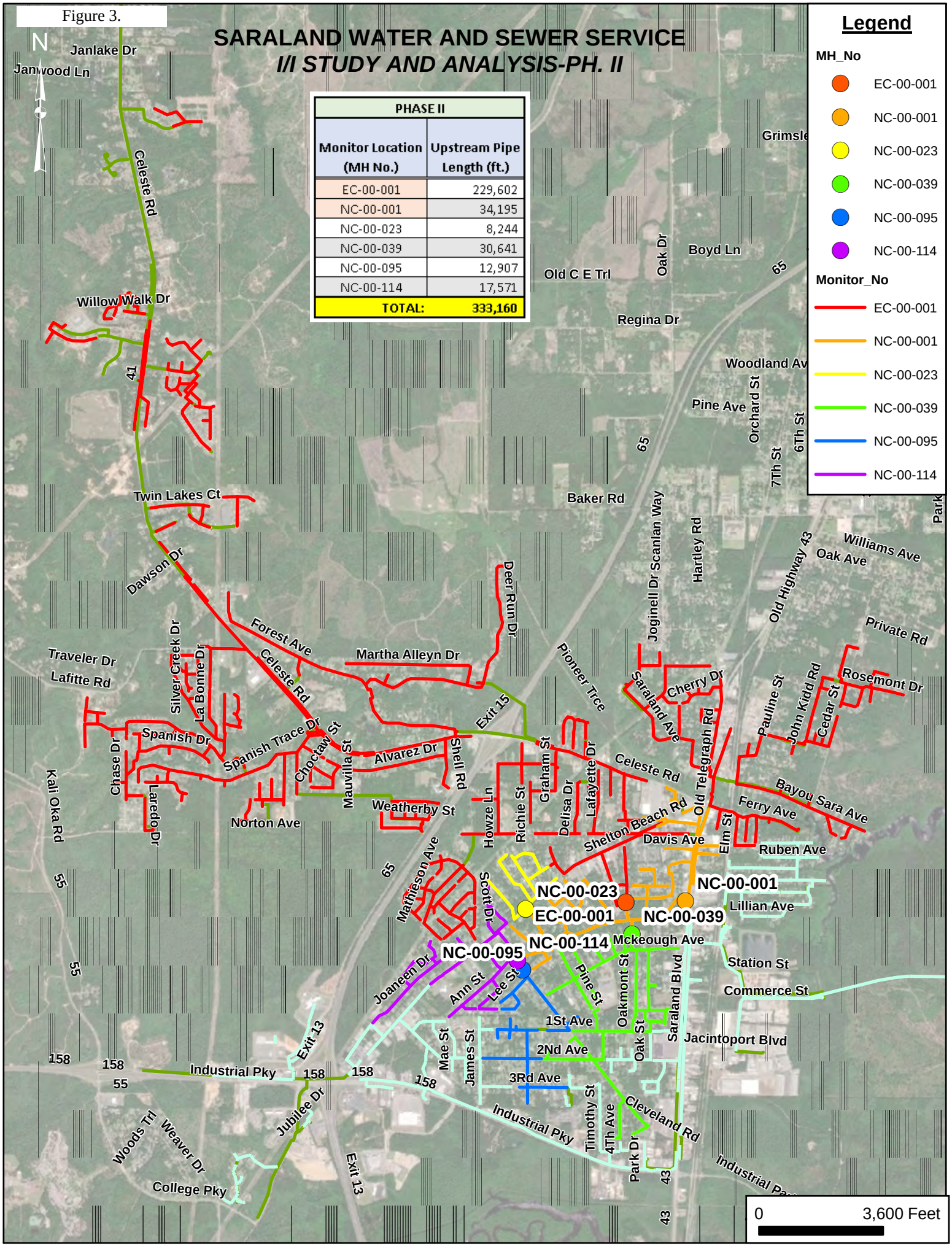
Ph. I Upstream Pipes

Monitor_No

- 43-00-102
- BS-22-001
- EC-00-001
- EC-00-029
- IP-03-113
- NC-00-001

0 3,600 Feet

Figure 3.


SARALAND WATER AND SEWER SERVICE
I/I STUDY AND ANALYSIS-PH. II
PHASE II
Monitor Location (MH No.) | Upstream Pipe Length (ft.)
EC-00-001 | 229,602
NC-00-001 | 34,195
NC-00-023 | 8,244
NC-00-039 | 30,641
NC-00-095 | 12,907
NC-00-114 | 17,571
TOTAL: | 333,160
Legend
MH_No
EC-00-001
NC-00-001
NC-00-023
NC-00-039
NC-00-095
NC-00-114
Monitor_No
EC-00-001
NC-00-001
NC-00-023
NC-00-039
NC-00-095
NC-00-114
N
Janlake Dr
Janwood Ln
Celeste Rd
Willow Walk Dr
Twin Lakes Ct
Dawson Dr
Forest Ave
Celeste Rd
Martha Alleyn Dr
Deer Run Dr
Traveler Dr
Lafitte Rd
Silver Creek Dr
La Bonne Dr
Spanish Dr
Spanish Trace Dr
Choctaw St
Mauvilla St
Alvarez Dr
Shell Rd
Exit 15
Chase Dr
Laredo Dr
Kali Oka Rd
Norton Ave
Weatherby St
Howze Ln
Richie St
Graham St
Delisa Dr
Lafayette Dr
Pioneer Trce
Celeste Rd
Shelton Beach Rd
Davis Ave
Elm St
Ferry Ave
Bayou Sara Ave
Ruben Ave
Old Telegraph Rd
Saraland Ave
Cherry Dr
Joginell Dr Scanlan Way
Hartley Rd
Old Highway 43
Oak Ave
Williams Ave
Private Rd
Rosemont Dr
Pauline St
John Kidd Rd
Cedar St
Baker Rd
Old C E Trl
Oak Dr
Boyd Ln
Regina Dr
Pine Ave
Orchard St
6Th St
7Th St
Woodland Av
Grimsle
Park
Mathieson Ave
Scott Dr
NC-00-023
EC-00-001
NC-00-095
NC-00-114
NC-00-001
NC-00-039
Lillian Ave
Mckeough Ave
Station St
Commerce St
Joaneen Dr
Ann St
Lee St
Pine St
Oakmont St
Saraland Blvd
1St Ave
2Nd Ave
3Rd Ave
Mae St
James St
Oak St
Jacintoport Blvd
Exit 13
Industrial Pky
Jubilee Dr
Woods Trl
Weaver Dr
College Pky
Timothy St
4Th Ave
Park Dr
Cleveland Rd
Industrial Pky
Industrial Pa
65
55
158
43
0
3,600 Feet

SECTION TWO: METHODS AND PROCEDURES

Equipment and Procedures

Flow Meters

CSL technicians completed the installation of the 6 FloWav flow meters and 1 Texas Electronics tipping bucket rain gauge on March 18, 2021. **Photograph** 1 presents a typical flow meter installation.

Photograph 1. Typical Flow Meter Installation

These flow meters were programmed to record depth and velocity readings at 15-minute intervals. Initial calibration consisted of no less than three independent verifications of both velocity and depth readings. Through wireless telemetry the data was uploaded each night to a secure website. The Phase 1 data collection period lasted from March 18, 2021 until the 4 of the meters were removed on June 15, 2021. The Phase 2 data collection period began on June 17, 2021 and lasted until August 18, 2021. All equipment was removed on August 19, 2021.

During the data collection period, the CSL technicians made scheduled visits to each site to confirm calibration and perform maintenance as needed. A CSL Project Engineer reviewed the data on a regular basis to ensure that any battery changes, sensor checks and scrubs, and sensor adjustments or replacements were made while technicians were on site. All maintenance procedures were conducted in accordance with manufacturer's recommendations and industry standards.

The tipping bucket rain gauge used for this project was installed at the Wastewater Plant. The location was carefully selected to avoid trees and any other obstructions that could affect rainfall patterns. Data from the rain gauge was also uploaded each night to the secure website.

Table 1 lists the nearest street address or best location description for each flow meter and rain gauge and the dates they were installed.

SITENAME	METER TYPE	PIPE DIA.	MH DEPTH	ADDRESS	INSTALL DATE
SA-43-00-102	Flowav	10	**10'7"**	226 Saraland Blvd. S.	3/16/2021
SA-BS-22-001	Flowav	15	**6'2"**	188 Saraland Blvd. N.	3/16/2021
SA-EC-00-001	Flowav / Shark	20	**17'8"**	217 Francis St.	3/17/2021
SA-EC-00-029	Flowav	18	**10'**	Across from 301 E. Ponce De Leon Dr.	3/17/2021
SA-IP-03-113	Flowav	18	**6'**	126 Industrial Pkwy.	3/16/2021
SA-NC-00-001	Flowav	30	**9'**	217 Saraland Blvd. S.	3/17/2021
SA-NC-00-023	Flowav	12	**10'**	521 Shelton Beach Rd by guardrail	6/16/2021
SA-NC-00-039	Flowav	8	**12' 6"**	Behind 134 McKeough Ave.	6/16/2021
SA-NC-00-095	Flowav	10	**10' 7"**	In road at 426 Cleveland Rd.	6/16/2021
SA-NC-00-114	Flowav	10	**9' 5"**	In road at 419 Cleveland Rd.	6/16/2021
SA-RG-1	RG-32A			WWTP 104 Station St.	3/17/2021

Table 1. Flow Meter and Rain Gauge Addresses

Field Safety

Field Safety is of the utmost importance to CSL. Each CSL field crew is provided a complete arsenal of general site, traffic, and confined space entry equipment including tripod entry systems, harnesses and gas meters. All confined space entry procedures were conducted in accordance with and by technicians that have been fully trained in OSHA 29 CFR 1910.146. Complete documentation of all safety procedures and confined space entry permits is stored at CSL's office for a period of two years.

Data Analysis and I&I Analysis

Flow Data Analysis

During the course of the data collection period, a CSL Project Engineer reviewed all flow meter and rainfall data. Flow balancing, historical trend comparisons, scattergraph analysis and field calibration notes are all utilized in this process. These data QA/QC reviews ensure that the data provided is the most accurate and that any concerns such as systematic and random errors are flagged with proposed corrections.

I&I Analysis

CSL utilized the web-based analysis software developed by FlowWorks, Inc. to identify specific dry and wet weather average flows and peak flows in the sub-systems isolated by the 16 flow meters in this study. Wastewater flows from dry weather periods were then compared to wastewater flows measured during and after rain events. The differences between wet weather flows and dry weather flows (collectively referred to as I&I) were separated into two components.

Wet weather infiltration (WWI) is the extraneous flow that can persist throughout an entire wet season and is primarily due to elevated groundwater entering through cracked and broken pipes and manhole

walls. Rainfall-derived infiltration and inflow (RDII) is the extraneous flow that occurs as a direct result of rain events. RDII is primarily attributed to inflow (entering the system through sources such as shallow pipe defects, manhole lids, stormwater connections and defective cleanouts) and infiltration (entering through other means such as directly connected foundation drains and defective laterals in low-lying/ponded areas). The reason priorities are set for both WWI and RDII is because CCTV inspection is the recommended approach to find the defects that result in WWI and smoke testing is the recommended approach to find the defects that result in RDII.

Wet Weather Infiltration (WWI) and Rainfall-derived I&I (RDII) values were calculated for every site. WWI was determined by selecting the week with the highest wastewater flows that did not include a rainfall event and then subtracting the base wastewater flow from the total flow for that week.

To determine RDII values, an RDII Hydrograph was generated in FlowWorks for each rain event at each site. RDII Hydrographs for a selected rain event for all sites are included in **Appendix B**. The dark blue line represents the actual flow recorded for the wet weather event. The green line represents the dry weather flow pattern. The brighter red line represents the one hour average RDII, which is the difference between the actual flow and the dry weather pattern. By subtracting the dry weather flow pattern from the flow pattern associated with the rain event, RDII amounts were determined for each event.

Then a regression analysis was completed for each site. Plots of this analysis for all 10 sites are presented in **Appendix C.** For each site, the 24-hour flow volume was paired with the contributing 24-hour rain amount for each of the analyzed rains. This allows for the determination of a projected RDII volume that would result from a 2-year, 24-hour storm event.

SECTION THREE: RESULTS

Rainfall

The total rainfall recorded during the Phase 1 period was 21.14 inches. The largest single rain event occurred on April 10, 2021. **Table 2** below presents the 10 rainfall events that were used in Phase 1 analysis. Those events ranged from 0.38 to 2.58 inches. By comparison, a 2-year, 24-hour storm event for Saraland is about 5.65 inches according to the National Weather Service.

Dates	SA-RG Amount (in)
3/23/21 - 3/24/21	2.55
3/31/21	0.66
4/8/21	0.38
4/10/21	2.58
4/14/21 - 4/15/21	2.49
4/24/21	1.37
5/2/21 - 5/3/21	1.07
5/4/21 - 5/5/21	1.34
6/3/21 - 6/4/21	2.23
6/6/21 - 6/7/21	2.18

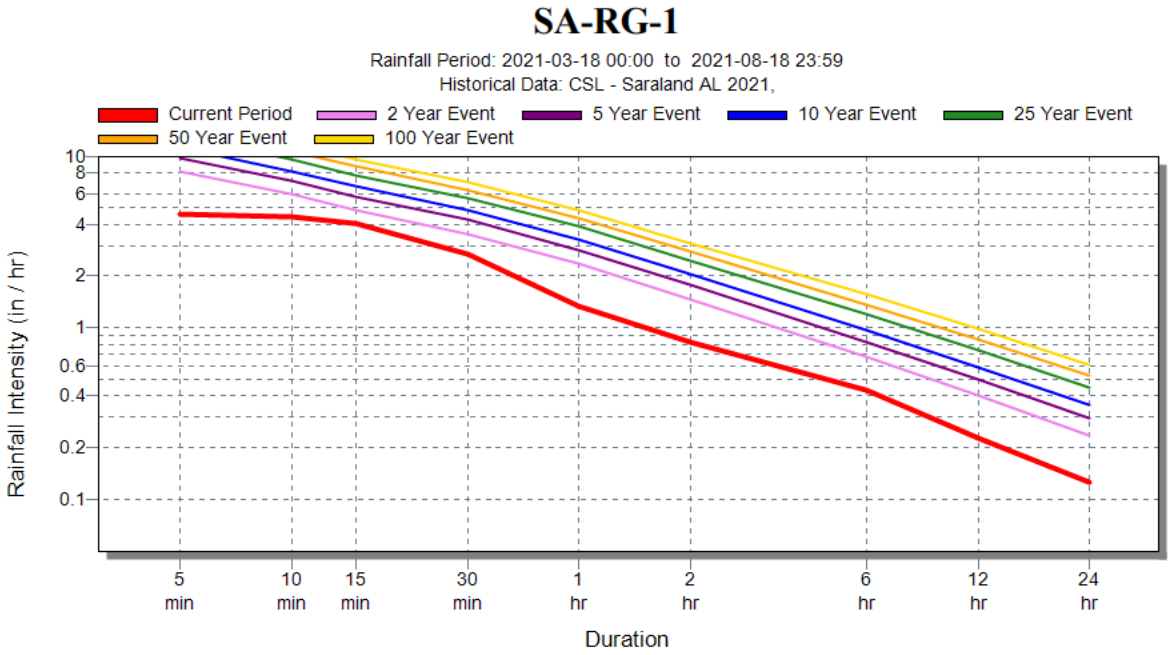
Table 2. Phase 1 Rain Events

The total rainfall recorded during the Phase 2 period was 17.79 inches. The largest single rain event occurred on June 21-22, 2021. **Table 3** below presents the 11 rainfall events that were used in Phase 2 analysis. Those events ranged from 0.46 to 3.40 inches.

Dates	SA-RG Amount (in)
6/18/21 - 6/19/21	2.95
6/21/21 - 6/22/21	3.40
6/30/21	1.02
7/5/21	0.96
7/8/21	0.71
7/12/21	0.46
7/16/21	0.78
7/17/21	0.52
7/19/21	0.63
7/20/21	1.34
8/2/21	0.79

Table 3. Phase 2 Rain Events

Intensity Duration Frequency Curves for Saraland were taken from the National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server. **Figure 4** below presents these IDF curves compared with the rainfall recorded during both phases this study.



Total Rainfall During Period: 38.93 in
Hours in Period: 3696.0 hrs

	5 min	10 min	15 min	30 min	1 hr	2 hrs	6 hrs	12 hrs	24 hrs
Current Period	4.56	4.44	4.04	2.66	1.34	0.82	0.43	0.23	0.13
2 Year Event	8.2	6.01	4.88	3.54	2.35	1.47	0.67	0.4	0.24
5 Year Event	9.82	7.19	5.84	4.27	2.84	1.78	0.83	0.5	0.3
10 Year Event	11.2	8.18	6.65	4.88	3.27	2.05	0.97	0.59	0.36
25 Year Event	13.1	9.58	7.78	5.73	3.88	2.45	1.19	0.73	0.44
50 Year Event	14.6	10.7	8.67	6.39	4.37	2.77	1.37	0.86	0.52
100 Year Event	16.1	11.8	9.57	7.06	4.88	3.12	1.58	0.99	0.61

Figure 4. IDF Curves and Rainfall Recorded at RG-1

Results Tables

Table 4 presents a summary of the results of Phase 1 and **Table 5** presents a summary of the results from Phase 2. The tables are divided into three sections: Sewer Sub-System Details, Dry Weather Results, and Wet Weather Results.

The Sewer Sub-System Details section presents the Site Name and the Pipe Diameter at each flow monitoring point. This section also presents the size of each sub-system in both inch-miles and linear feet. If silt is observed at the site, that box is highlighted in orange.

The Dry Weather Results section presents the Average Depth of flow during dry weather, the Average Depth as a percentage of the pipe diameter during dry weather, the Average Velocity during dry weather and the Average Flow during dry weather. This section also presents the Peak Depth of flow during dry weather, the Peak Depth as a percentage of the pipe diameter during dry weather, the Peak Velocity during dry weather and the Peak Flow during dry weather. If the Peak Depth exceeds 75% of the pipe diameter during dry weather, that could indicate a capacity issue and that box is highlighted in orange. If the Peak Velocity during dry weather did not exceed 2.0 feet per second (scouring velocity) during dry weather, that could allow silt and/or debris to build up in the pipe, and those boxes are highlighted in orange. While these areas are likely flushed out during rain events, they should be inspected during prolonged periods of dry weather.

The Wet Weather Results section presents results for both Wet Weather Infiltration (WWI) and Rainfall-derived I&I (RDII) and prioritizations based on both criteria. The reason priorities are set for both WWI and RDII is because CCTV is the recommended approach to find the defects that result in WWI and smoke testing is the recommended approach to find the defects that result in RDII. The columns in this section include the Net Wet Weather Infiltration (WWI) calculated for each Sub-System, the Net Wet Weather Infiltration per linear foot of gravity line in the Sub-System and a Priority ranking based on the Net Wet Weather Infiltration per linear foot. It is generally considered to be cost-effective to pursue remedial activities in areas that contribute WWI at rates greater than 5.0 gallons per day per linear foot (gpd/LF) of gravity line. Sub-Systems with WWI rates greater than 5.0 gpd/LF are highlighted in red. No sub-systems exceeded the 5.0 gpd/LF threshold.

Also included are the Net RDII volumes projected to occur in each sub-system during a 2-year, 24 hour rainfall event, the Net RDII per linear foot of gravity line in the Sub-System and a Priority ranking based on the Net RDII per linear foot of gravity line in the sub-system. It is generally considered to be cost-effective to pursue remedial activities in areas that contribute RDII at rates greater than 5.0 gallons per day per linear foot (gpd/LF). Sub-systems with RDII rates greater than 5 gpd/LF are highlighted in red

The final two columns in this section show the Peak Depths recorded and the Manhole Depth at the monitoring point. Sub-systems where the Peak Depth recorded exceeded the Manhole Depth would be considered the highest priorities. None of the Peak Depths recorded during this study exceeded the Manhole Depths, however there were several sites where the Peak Depth was considerably greater than full pipe. Those boxes are highlighted in purple.

SUB-SYSTEM DETAILS				DRY WEATHER RESULTS								WET WEATHER RESULTS							
				Average				Peak											
Site	Pipe Diameter (in)	Sub System Size (LF)	Silt, Debris, Gravel, Grease	Depth (in)	Depth/ Diameter (%)	Velocity (fps)	Flow (mgd)	Depth (in)	Depth/ Diameter (%)	Velocity (fps)	Flow (mgd)	Net Wet Weather Infiltration (mgd)	Net Wet Weather Infiltration per LF (gpd/lf)	Priority	Net RDII 2 yr-24 hour (mgd)	Net RDII per LF (gpd/lf)	Priority	Peak Depth (in)	Manhole Depth (in)
SA-43-00-102	10	7,598	No	5.2	52.2%	0.60	0.116	8.3	82.9%	1.47	0.421	0.021	2.75	1	0.621	81.73	1	77.1	127
SA-BS-22-001	15	40,693	Yes	4.6	30.5%	0.73	0.156	9.5	63.2%	1.48	0.654	0.013	0.32	3	0.283	6.96	5	11.8	74
SA-EC-00-001	20	31,513	Yes	10.4	52.0%	0.93	0.728	15.1	75.7%	2.11	2.082	0.016	0.52	2	0.972	30.83	2	110.4	212
SA-EC-00-029	18	157,450	No	3.4	19.0%	1.66	0.322	8.1	45.1%	3.26	1.626	0.029	0.19	4	1.529	9.71	3	18.4	120
SA-IP-03-113	18	44,252	No	4.9	27.5%	1.36	0.353	6.6	36.4%	1.98	0.631	0.004	0.10	5	0.404	9.12	4	49.8	72
SA-NC-00-001	30	103,629	No	9.3	31.1%	1.08	0.939	12.5	41.6%	1.92	2.142	0.002	0.02	6	0.554	5.35	6	67.8	109

Table 4. Phase 1 Results Table

SUB-SYSTEM DETAILS				DRY WEATHER RESULTS								WET WEATHER RESULTS							
				Average				Peak											
Site	Pipe Diameter (in)	Sub System Size (LF)	Silt, Debris, Gravel, Grease	Depth (in)	Depth/ Diameter (%)	Velocity (fps)	Flow (mgd)	Depth (in)	Depth/ Diameter (%)	Velocity (fps)	Flow (mgd)	Net Wet Weather Infiltration (mgd)	Net Wet Weather Infiltration per LF (gpd/lf)	Priority	Net RDII 2 yr-24 hour (mgd)	Net RDII per LF (gpd/lf)	Priority	Peak Depth (in)	Manhole Depth (in)
SA-EC-00-001	20	229,602	Yes	9.8	48.8%	0.96	0.698	14.5	72.7%	1.64	1.479	0.043	0.19	4	1.717	7.48	5	113.7	212
SA-NC-00-001	30	34,195	No	9.1	30.4%	1.18	0.992	11.9	39.7%	1.91	1.907	0.015	0.43	2	0.237	6.92	6	70.1	109
SA-NC-00-023	12	8,244	No	0.8	6.8%	0.87	0.013	1.1	9.0%	1.38	0.031	0.005	0.61	1	0.405	49.12	1	42.7	125
SA-NC-00-039	8	30,641	No	2.4	30.3%	1.39	0.082	3.4	42.5%	2.08	0.176	0.003	0.09	6	0.274	8.95	4	79.7	150
SA-NC-00-095	10	12,907	No	1.2	12.3%	1.17	0.030	1.9	19.2%	1.88	0.071	0.002	0.15	5	0.248	19.25	3	42.1	127
SA-NC-00-114	10	17,571	No	2.4	24.2%	1.07	0.073	3.4	34.3%	1.78	0.144	0.006	0.35	3	0.447	25.46	2	65.1	113

Table 5. Phase 2 Results Table

SECTION FOUR: CONCLUSIONS AND RECOMMENDATIONS

Dry Weather Performance

The data indicates that peak dry weather flows at SA-43-00-102 and SA-EC-00-001 are reaching levels that may require capacity upgrades. On closer inspection, it is thought that the peak dry weather flows at SA-43-00-102 are likely attributable to discharges from the City's splash pad. It was noted that velocities at most sites fail to reach 2.0 fps during dry weather, but silt was only observed at SA-EC-00-001

Wet Weather Performance

There were no rainfall events that reached a 2-year storm threshold during either phase of this study, but there was enough rainfall to reach reasonable conclusions about which sub-systems contribute the most significant amounts of extraneous flow during wet weather.

Based on the data collected during both Phase 1 and Phase 2, WWI does not appear to be a significant issue. On the other hand, RDII is a significant issue throughout all sub-systems. As shown in **Table 4**, the top 2 RDII Priority Sub-systems identified in Phase 1, based on gpd/LF, are SA-43-00-102 and SA-EC-00-001. SA-43-00-102 contains about 7,598 LF of gravity line and SA-EC-00-001 contains about 31,513 LF of gravity line. Together the projected RDII contribution from these 2 sub-systems for a 2-year, 24-hour storm event is about 1.593 million gallons.

Data collected during Phase 1 also indicates that the remaining 4 sub-systems contribute substantial amounts of RDII during wet weather. Based on the fact that the Peak Flow Depth at SA-NC-00-001 was greater than the other 3 sub-systems, the decision was made to relocate 4 flow meters from Phase 1 to new locations upstream of SA-NC-00-001 for the Phase 2 study. The intent was to divide this larger SA-NC-00-001 sub-system into 5 smaller sub-systems that could also be prioritized according to RDII severity. The meter at SA-EC-00-001 was left in place as a subtraction meter.

As shown in **Table 5**, the top 2 Priority RDII Sub-systems identified in Phase 2, based on gpd/LF, are SA-NC-00-023 and SA-NC-00-114. SA-NC-00-23 contains about 8,244 LF of gravity line and SA-NC-00-114 contains about 17,751 LF of gravity line. Together the projected RDII contribution from these 2 sub-systems for a 2-year, 24-hour storm event is about 0.852 million gallons.

The flow meter that was placed in manhole SA-EC-00-029 during Phase 1 essentially isolates the portion of the SWSS collection system that is along Celeste Road, west of I-65. This is mostly a newer part of the collection system and was thought to be in good shape. However, data presented in **Table 4** shows that the projected RDII volume for a 2-year, 24-hour storm event from sub-system SA-EC-00-29 is 1.529 million gallons. This is the largest total by volume of all of the sub-systems in the study, but it only received the number 3 priority ranking on a gpd/LF basis because it is such a big sub-system. The Peak Depth recorded by this meter was just barely above full pipe, so it was felt that I&I reduction efforts in this area could be pursued after the top 4 sub-systems have been addressed.

Recommendations

A phased program of smoke testing during dry weather and manhole inspections during wet weather is the next step to take in the 4 RDII Priority Areas. Those areas are highlighted in the schematic presented in **Figure 5** below. This should identify specific defects that allow stormwater to enter the wastewater collection system during and shortly after rainfall events. Smoke testing in lines larger than 12 inches in diameter can provide mixed results. Fortunately, the vast majority of the lines in these highest priority areas are 8 and 10 inch lines and smoke testing should work well. Once specific defects have been identified, a rehabilitation project can be designed and completed.

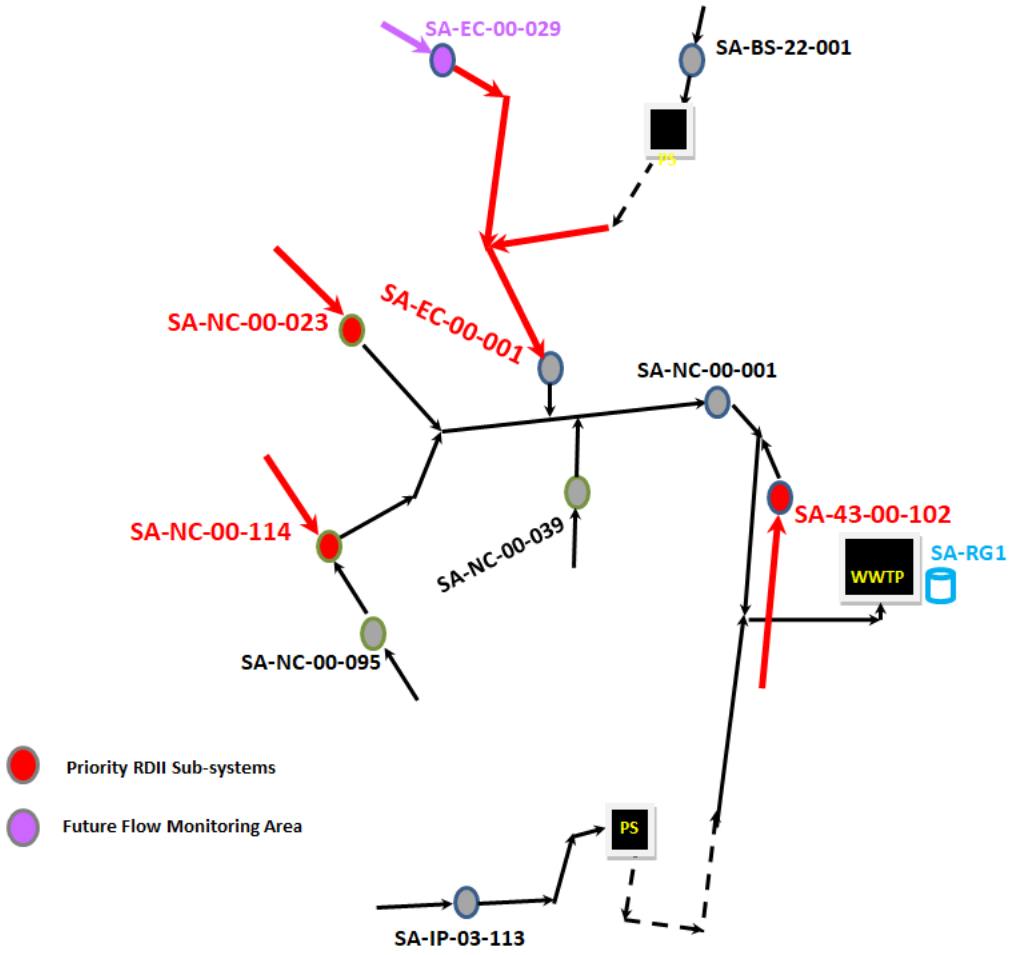


Figure 4. Priority RDII Areas and Future Flow Monitoring Area

At some point in the future, a flow study that divides the SA-EC-00-029 sub-system into 5 or 6 smaller sub-systems should be conducted. Depending on the results of that study, source detection and rehabilitation would likely be reduced to manageable sizes.

APPENDIX A. SITE REPORT SHEETS

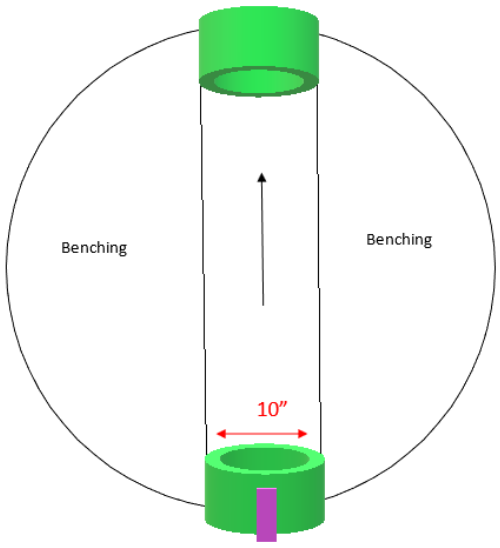
SITE REPORT

Project: Saraland TFM 2021		Date: 3/16/21	Name: J. Rodgers
Manhole #: SA-43-00-102	Pipe Diameter: 10”	Pipe Material: VCP	
Address/Location: 226 Saraland Blvd S			
Town: Saraland			
Latitude: N 30°48.90096’	Longitude: W 88°04.25934’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 10’7”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 294999	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo



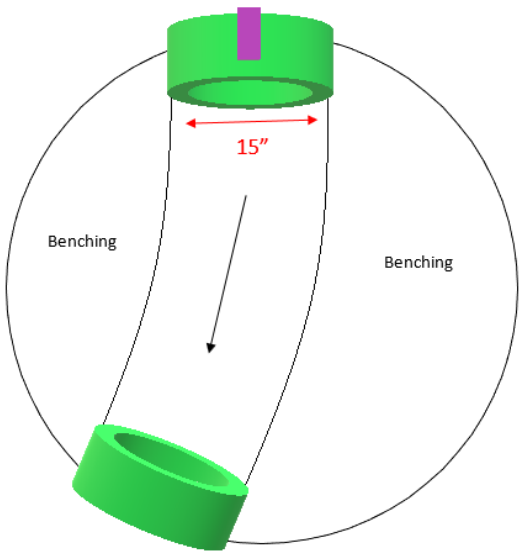
SITE REPORT

Project: Saraland TFM 2021		Date: 3/16/21	Name: J. Rodgers
Manhole #: SA-BS-22-001	Pipe Diameter: 15”	Pipe Material: PVC	
Address/Location: 188 Saraland Blvd N			
Town: Saraland			
Latitude: N 30°49.53474’	Longitude: W 88°04.14606’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 6’2”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 293375	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo



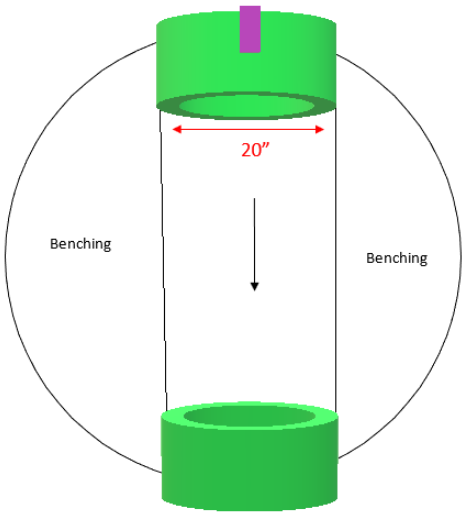
SITE REPORT

Project: Saraland TFM 2021		Date: 3/17/21	Name: J. Rodgers
Manhole #: SA-EC-00-001	Pipe Diameter: 20”	Pipe Material: RCP	
Address/Location: 217 Frances St			
Town: Saraland			
Latitude: N 30°48.99174’	Longitude: W 88°04.62288’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 17’8”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 295806	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo



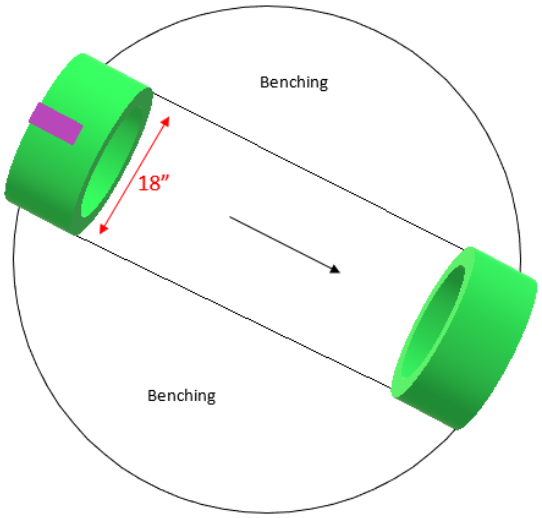
SITE REPORT

Project: Saraland TFM 2021		Date: 3/17/21	Name: J. Rodgers
Manhole #: SA-EC-00-029	Pipe Diameter: 18”	Pipe Material: CIP	
Address/Location: Across from 301 E Ponce De Leon Dr			
Town: Saraland			
Latitude: N 30°49.71606’	Longitude: W 88°04.9446’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 10’	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 293665	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo



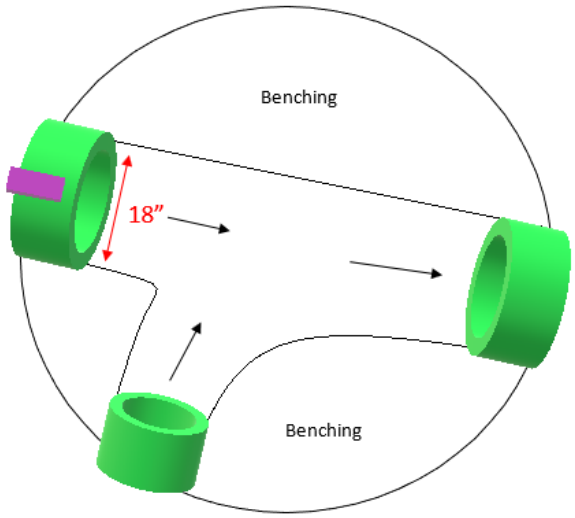
SITE REPORT

Project: Saraland TFM 2021		Date: 3/16/21	Name: J. Rodgers
Manhole #: SA-IP-03-113	Pipe Diameter: 18”	Pipe Material: PVC	
Address/Location: 126 Industrial Pkwy			
Town: Saraland			
Latitude: N 30°47.73726’	Longitude: W 88°04.64394’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 6’	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 294568	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: no evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo



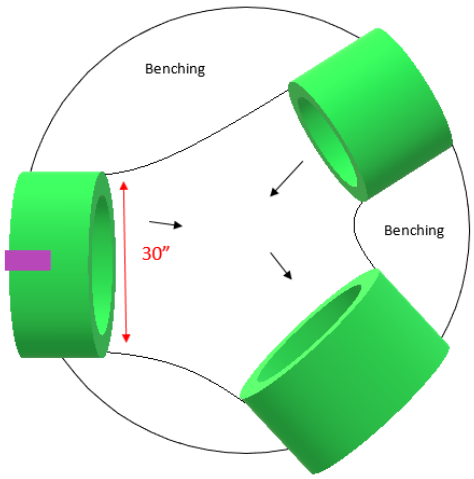
SITE REPORT

Project: Saraland TFM 2021		Date: 3/17/21	Name: J. Rodgers
Manhole #: SA-NC-00-001	Pipe Diameter: 30”	Pipe Material: CIP	
Address/Location: 217 Hwy 43			
Town: Saraland			
Latitude: N 30°49.00806’	Longitude: W 88°04.29372’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 9’1”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 294548	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: no evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo

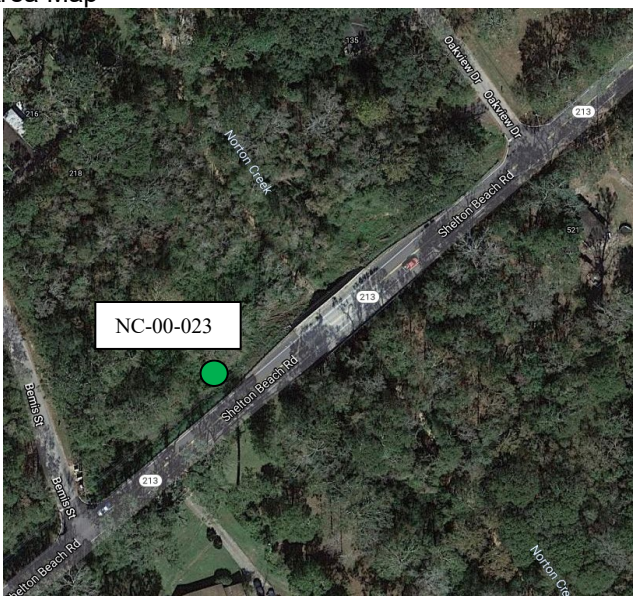


SITE REPORT

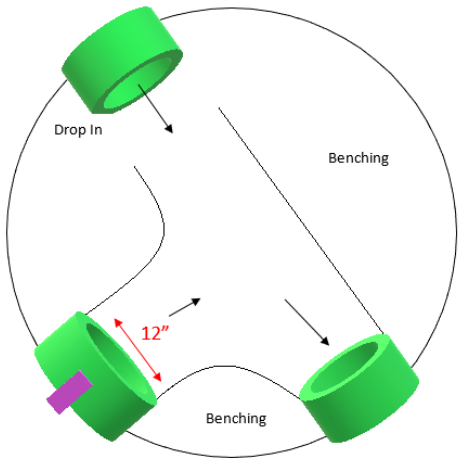
Project: Saraland TFM 2021		Date: 6/16/21	Name: J. Rodgers
Manhole #: SA-NC-00-023	Pipe Diameter: 12”	Pipe Material: CIP	
Address/Location: Shelton Beach Rd near guardrail			
Town: Saraland			
Latitude: N 30°48.95904’	Longitude: W 88°05.19954’	Access: Walk	
Safety: Standard, CSE		Manhole Depth: 10’5”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 294999	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map



Area photo

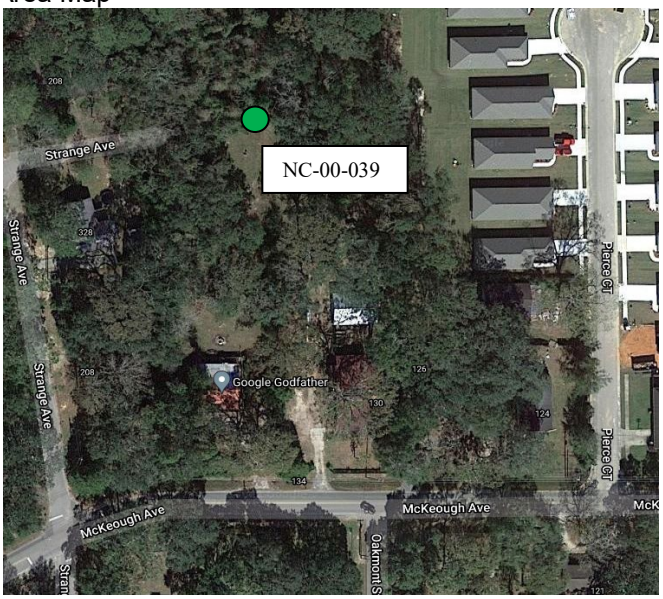


SITE REPORT

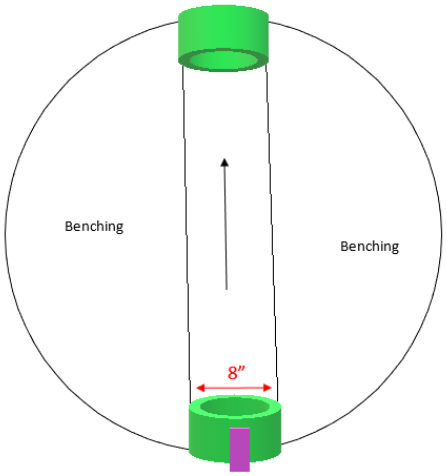
Project: Saraland TFM 2021		Date: 6/16/21	Name: J. Rodgers
Manhole #: SA-NC-00-039	Pipe Diameter: 8”	Pipe Material: VCP	
Address/Location: Behind 204 McKeough Ave in edge of woods			
Town: Saraland			
Latitude: N 30°48.84408’	Longitude: W 88°04.5819’	Access: Walk	
Safety: Standard, CSE		Manhole Depth: 12’6”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 293665	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map



Area photo



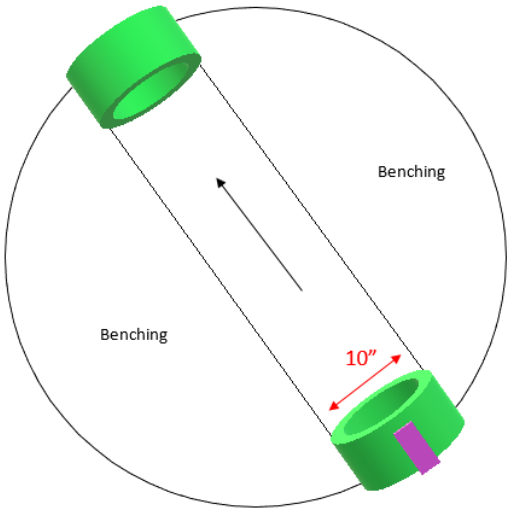
SITE REPORT

Project: Saraland TFM 2021		Date: 6/16/21	Name: J. Rodgers
Manhole #: SA-NC-00-095	Pipe Diameter: 10”	Pipe Material: PVC	
Address/Location: Cleveland Rd just north of Sara Oaks Dr			
Town: Saraland			
Latitude: N 30°48.6747’	Longitude: W 88°05.1918’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 10’7”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 293467	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo



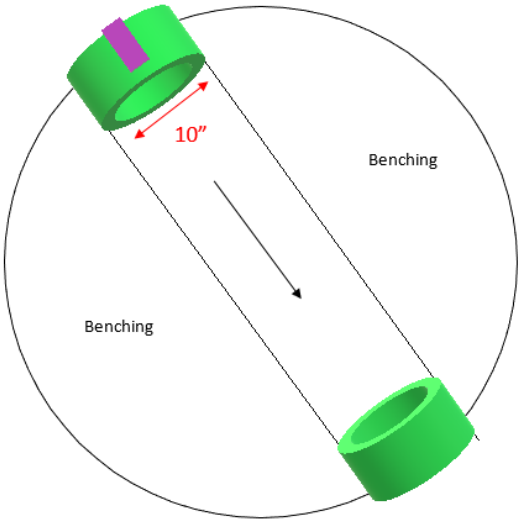
SITE REPORT

Project: Saraland TFM 2021		Date: 6/16/21	Name: J. Rodgers
Manhole #: SA-NC-00-114	Pipe Diameter: 10”	Pipe Material: PVC	
Address/Location: Cleveland Rd in front of Cleveland Rd Church of God			
Town: Saraland			
Latitude: N 30°48.71478’	Longitude: W 88°05.21772’	Access: Drive	
Safety: Standard, CSE		Manhole Depth: 9’5”	
Gas Investigation: Good	Manhole Condition: Fair	Traffic: Standard	
Flow Meter: Flowav	Serial #: 294568	Sensor Configuration: pressure depth, Doppler Velocity	

Site Comments: evidence of surcharge. Sensor is installed in the upstream pipe.
Silt: None

Area Map

Area photo

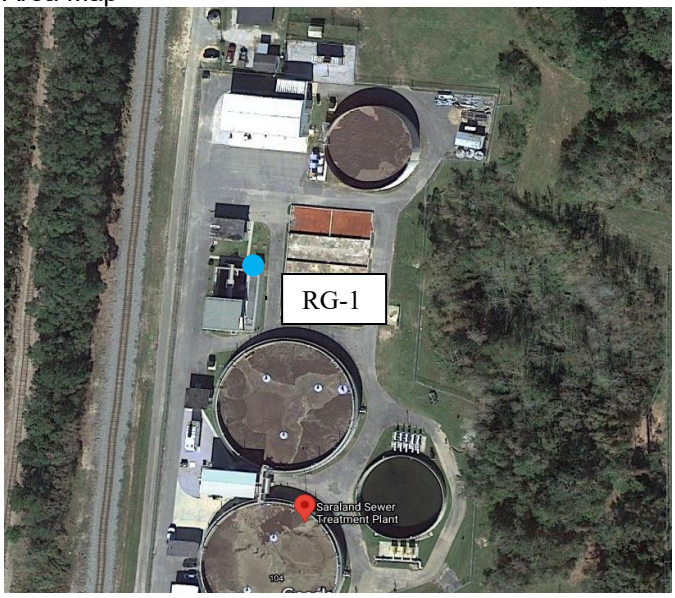


SITE REPORT

Project: Saraland TFM 2021	Date: 3/16/2021	Name: J. Rodgers
Manhole #: SA-RG-1	Town: Saraland	
Address/Location: At WWTP 104 Station St		
Latitude: N 30°48.87072’	Longitude: W 88°04.07658’	Access: Drive
Meter: RG-32A with TI Tipping Bucket	Rain Gauge Serial #: 22209940	

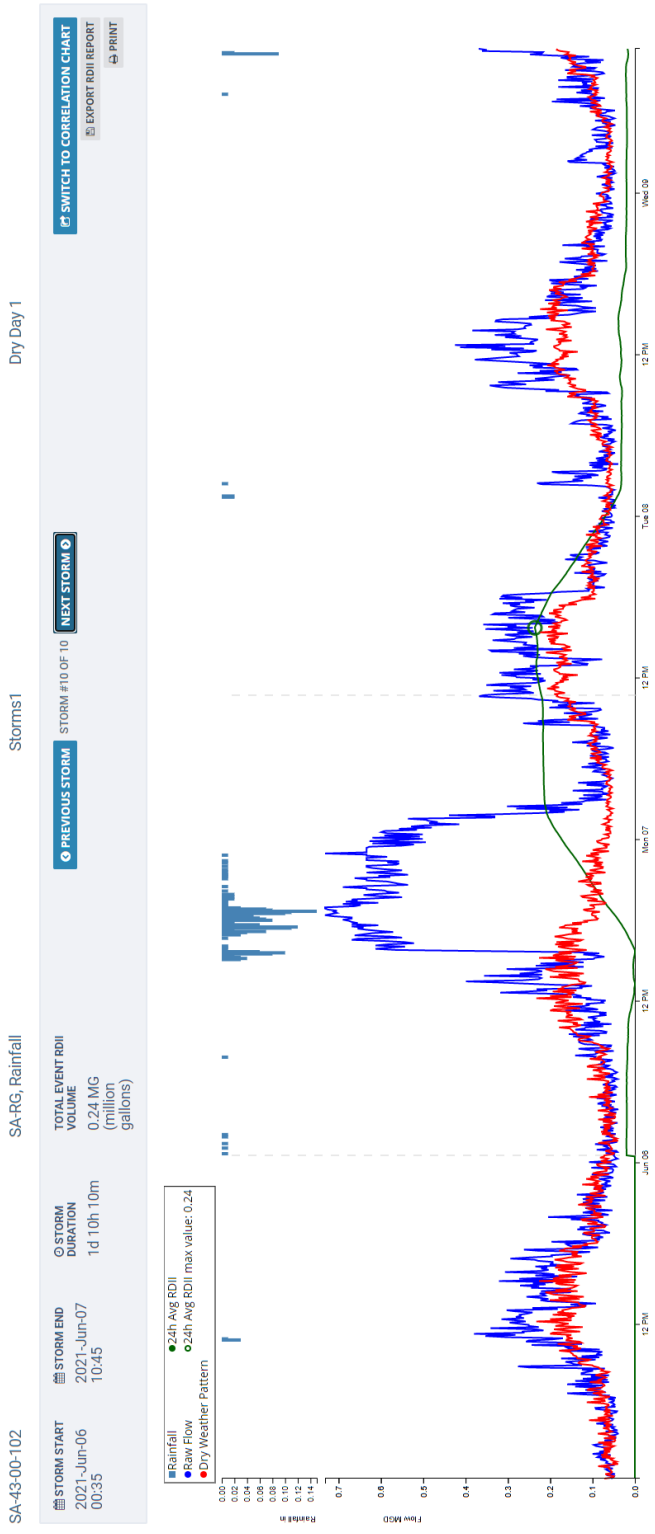
Site Comments, if any:

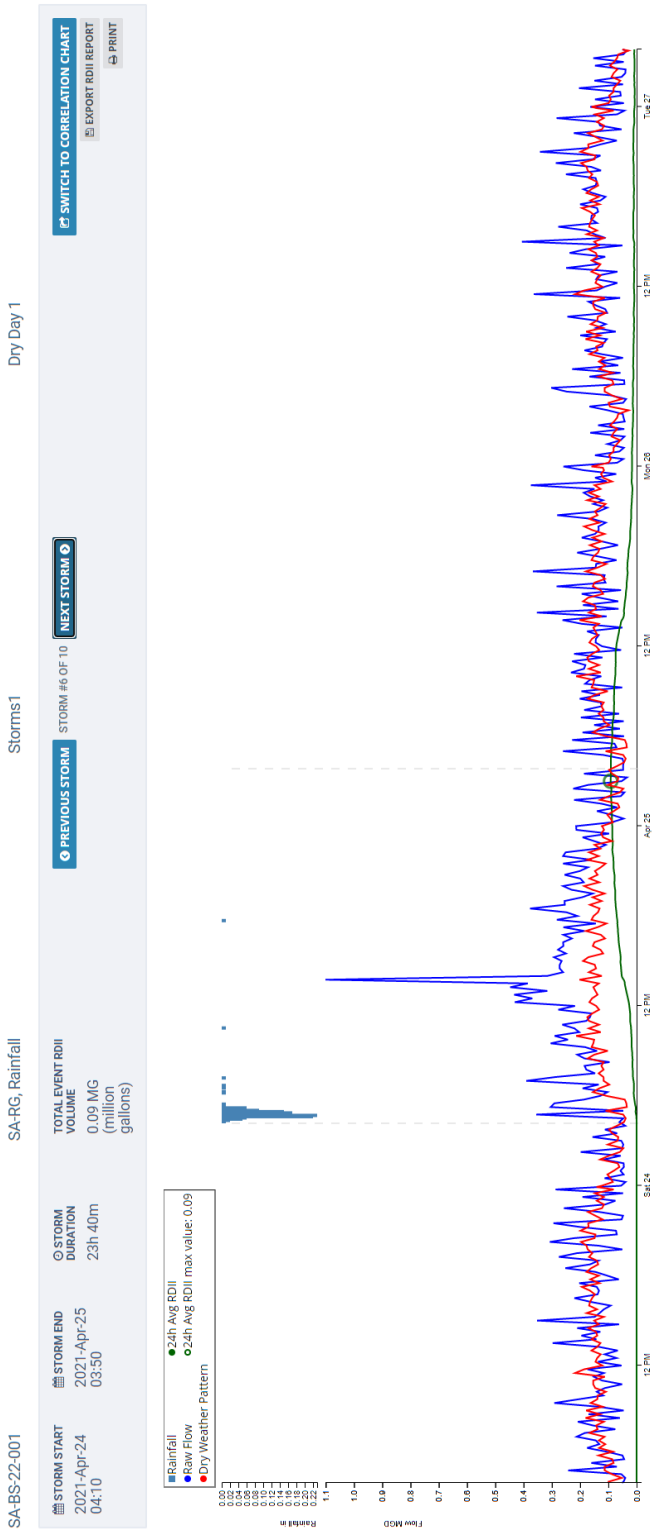
Area Map

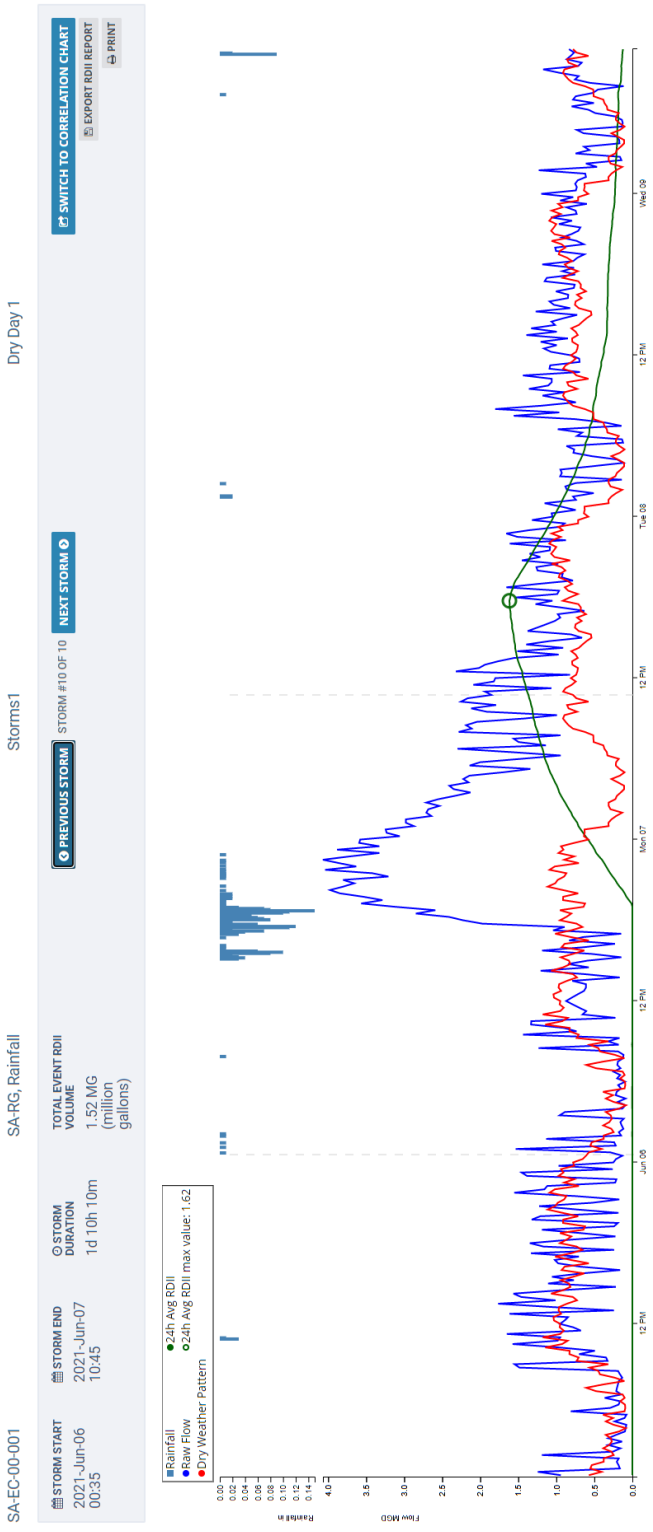


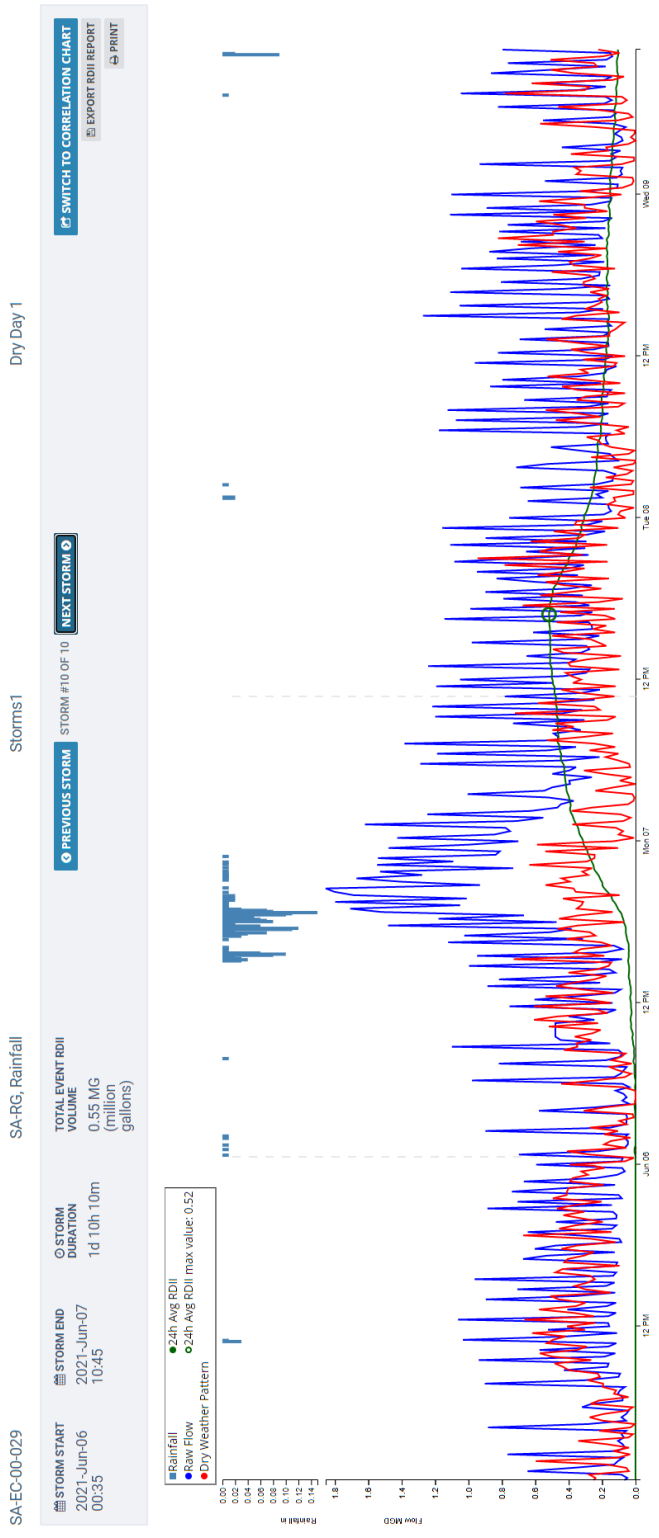
Area photo

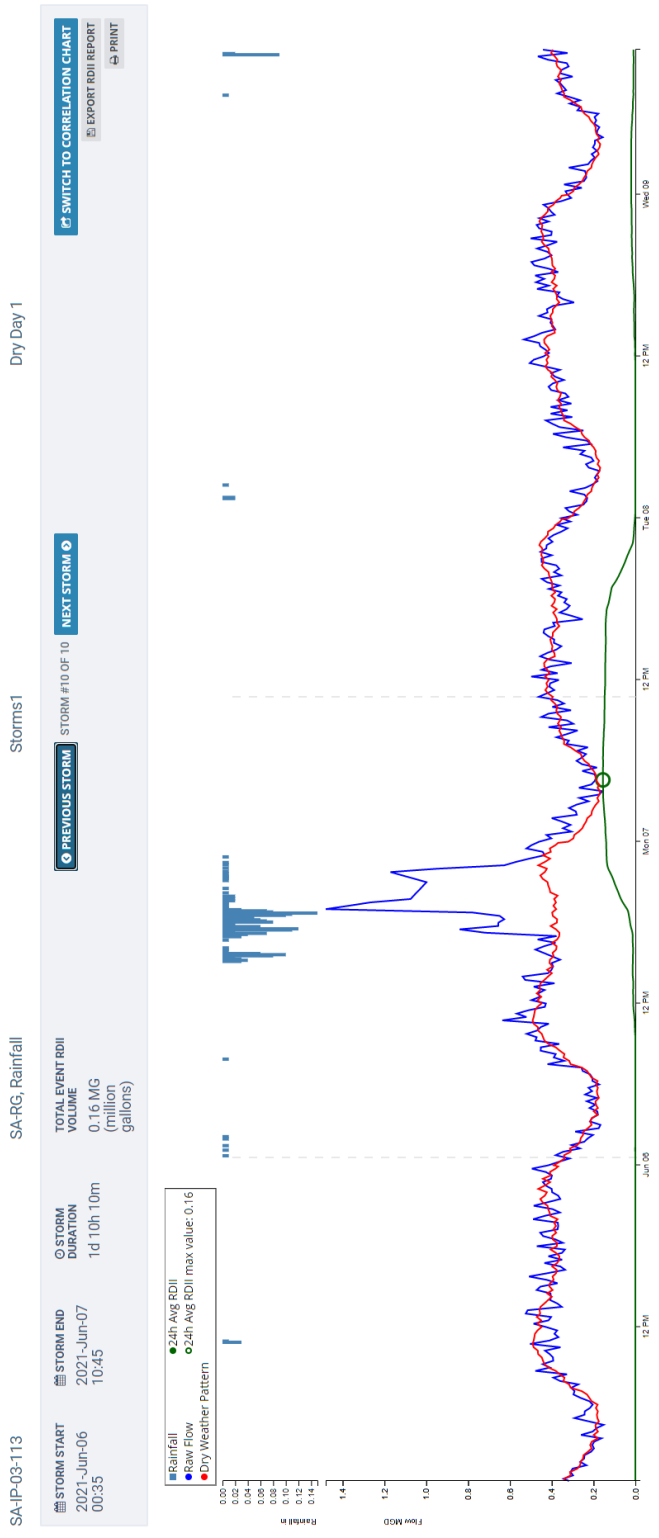
APPENDIX B. RDII HYDROGRAPHS

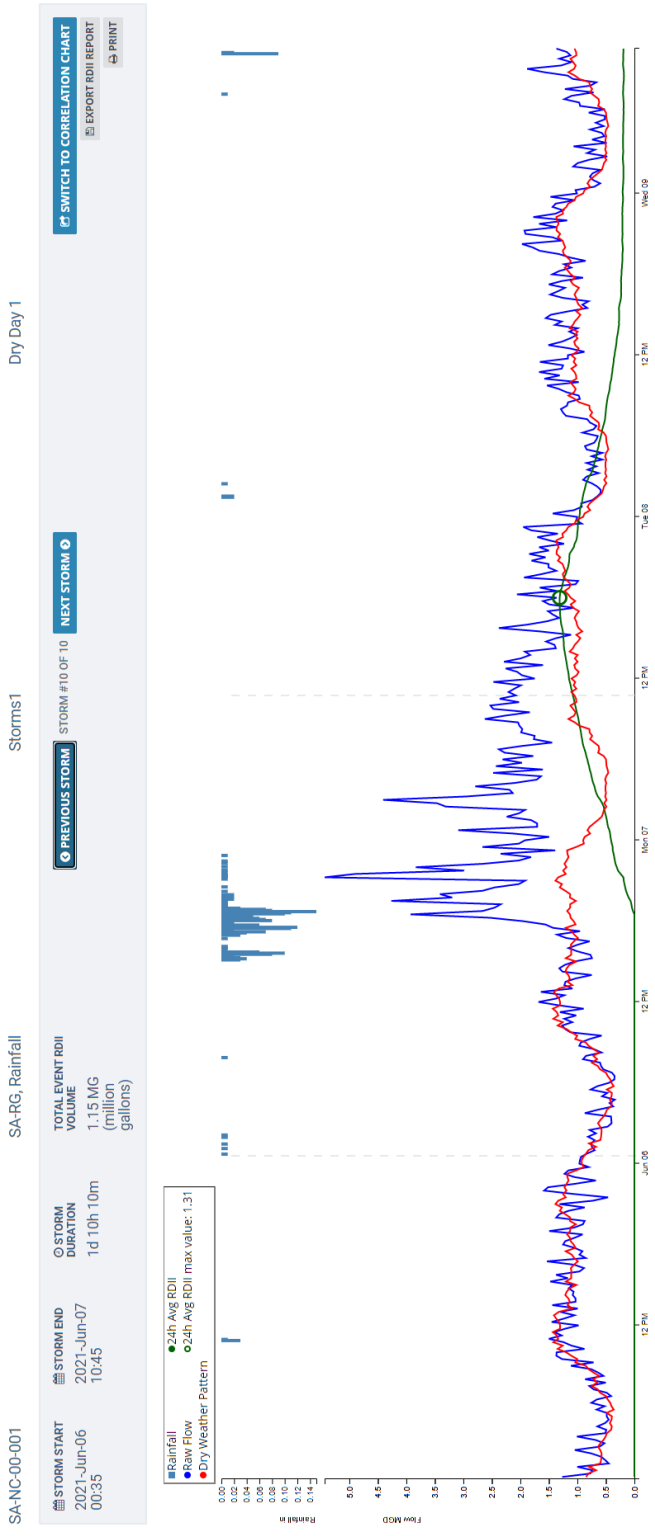

SA-43-00-102
SA-RG, Rainfall
Storms1
Dry Day 1
STORM START
2021-Jun-06
00:35
STORM END
2021-Jun-07
10:45
STORM DURATION
1d 10h 10m
TOTAL EVENT RDII VOLUME
0.24 MG
(million
gallons)
PREVIOUS STORM
STORM #10 OF 10
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.24
Rainfall in
Flow MGD
Jun 06
Mon 07
Tue 08
Wed 09
12 PM


SA-BS-22-001
SA-RG, Rainfall
Storms1
Dry Day 1
STORM START
2021-Apr-24
04:10
STORM END
2021-Apr-25
03:50
STORM DURATION
23h 40m
TOTAL EVENT RDII VOLUME
0.09 MG
(million
gallons)
PREVIOUS STORM
STORM #6 OF 10
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.09
Rainfall in
Flow MGD
12 PM
Sat 24
Apr 25
Mon 26
Tue 27

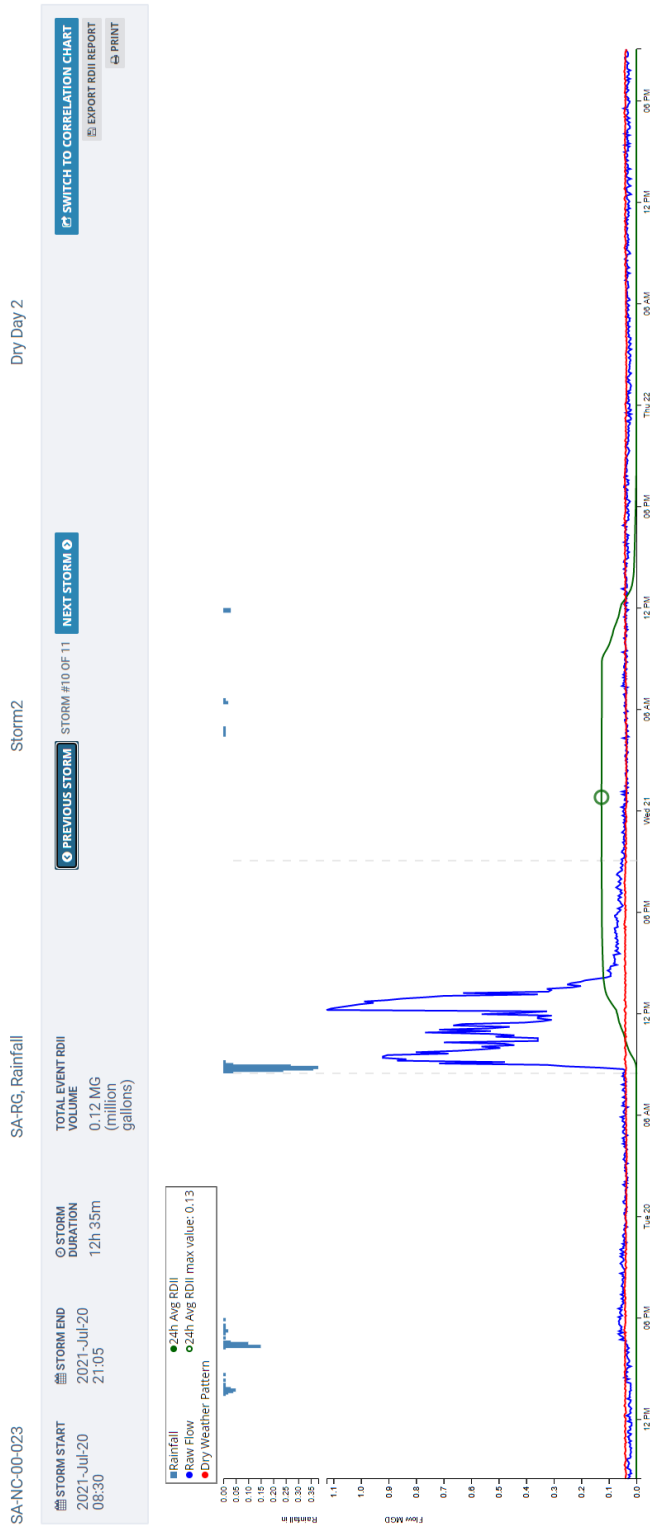

SA-EC-00-001
SA-RG, Rainfall
Storms1
Dry Day 1
STORM START
2021-Jun-06
00:35
STORM END
2021-Jun-07
10:45
STORM DURATION
1d 10h 10m
TOTAL EVENT RDII VOLUME
1.52 MG
(million
gallons)
PREVIOUS STORM
STORM #10 OF 10
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 1.62
Rainfall in
Flow MGD
Jun 06
Mon 07
Tue 08
Wed 09
12 PM

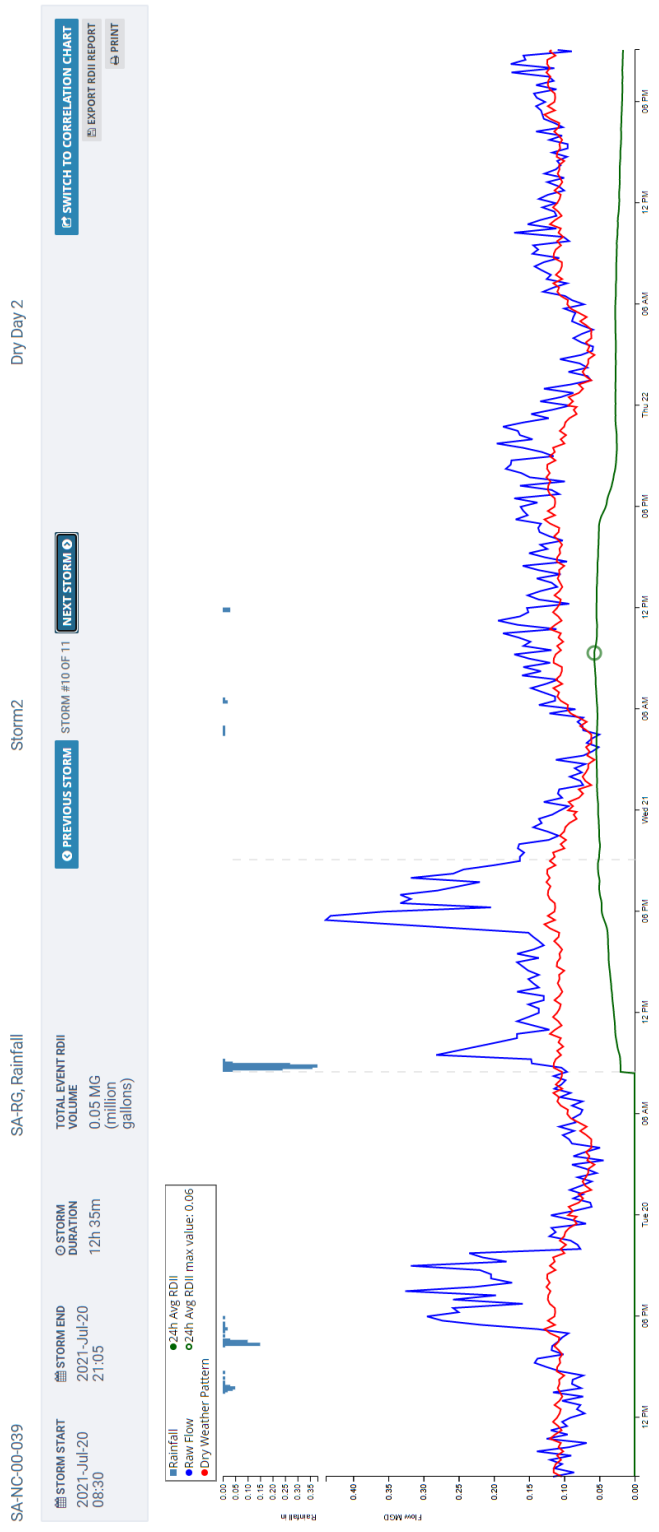

SA-EC-00-029
SA-RG, Rainfall
Storms1
Dry Day 1
STORM START
2021-Jun-06
00:35
STORM END
2021-Jun-07
10:45
STORM DURATION
1d 10h 10m
TOTAL EVENT RDII VOLUME
0.55 MG
(million
gallons)
PREVIOUS STORM
STORM #10 OF 10
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.52
Rainfall in
Flow MGD
Jun 06
Mon 07
Tue 08
Wed 09
12 PM

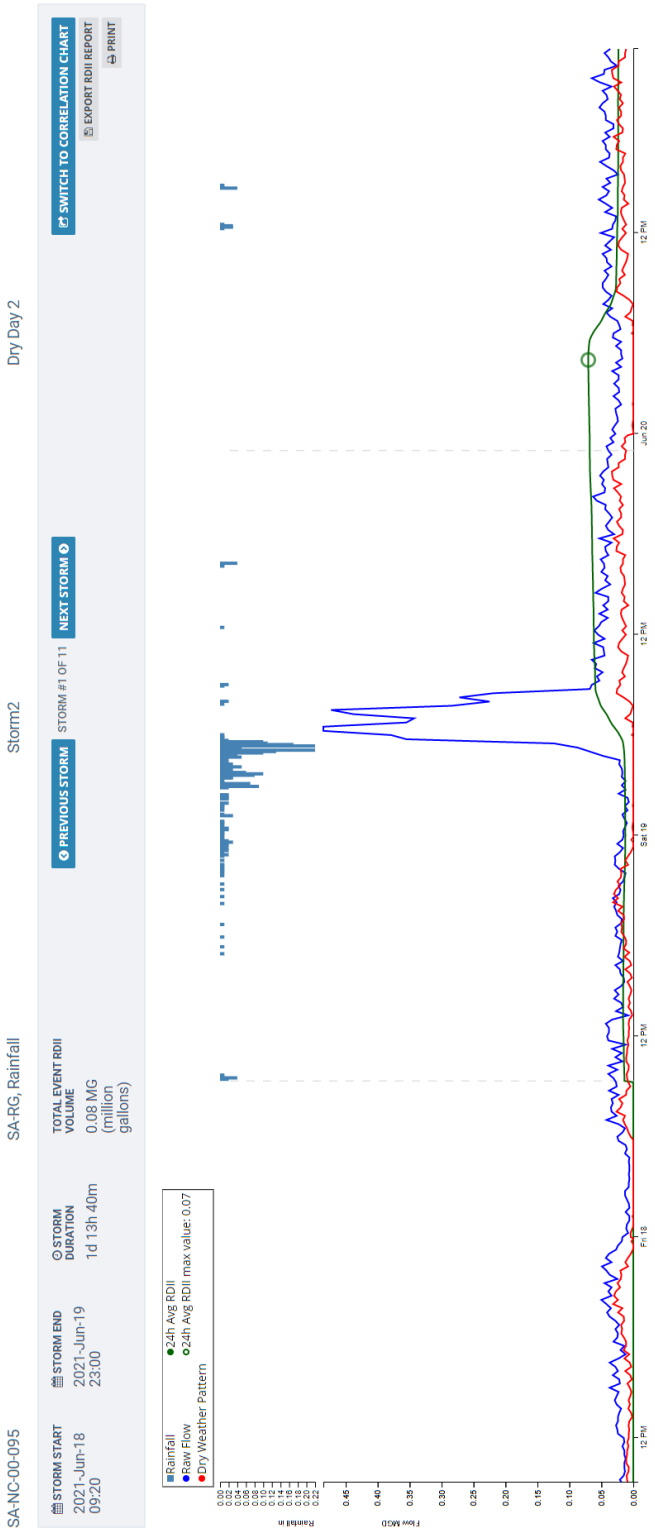

SA-IP-03-113
SA-RG, Rainfall
Storms1
Dry Day 1
STORM START
2021-Jun-06
00:35
STORM END
2021-Jun-07
10:45
STORM DURATION
1d 10h 10m
TOTAL EVENT RDII VOLUME
0.16 MG
(million
gallons)
PREVIOUS STORM
STORM #10 OF 10
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.16
Rainfall in
Flow MGD
12 PM
Jun 06
Mon 07
Tue 08
Wed 09

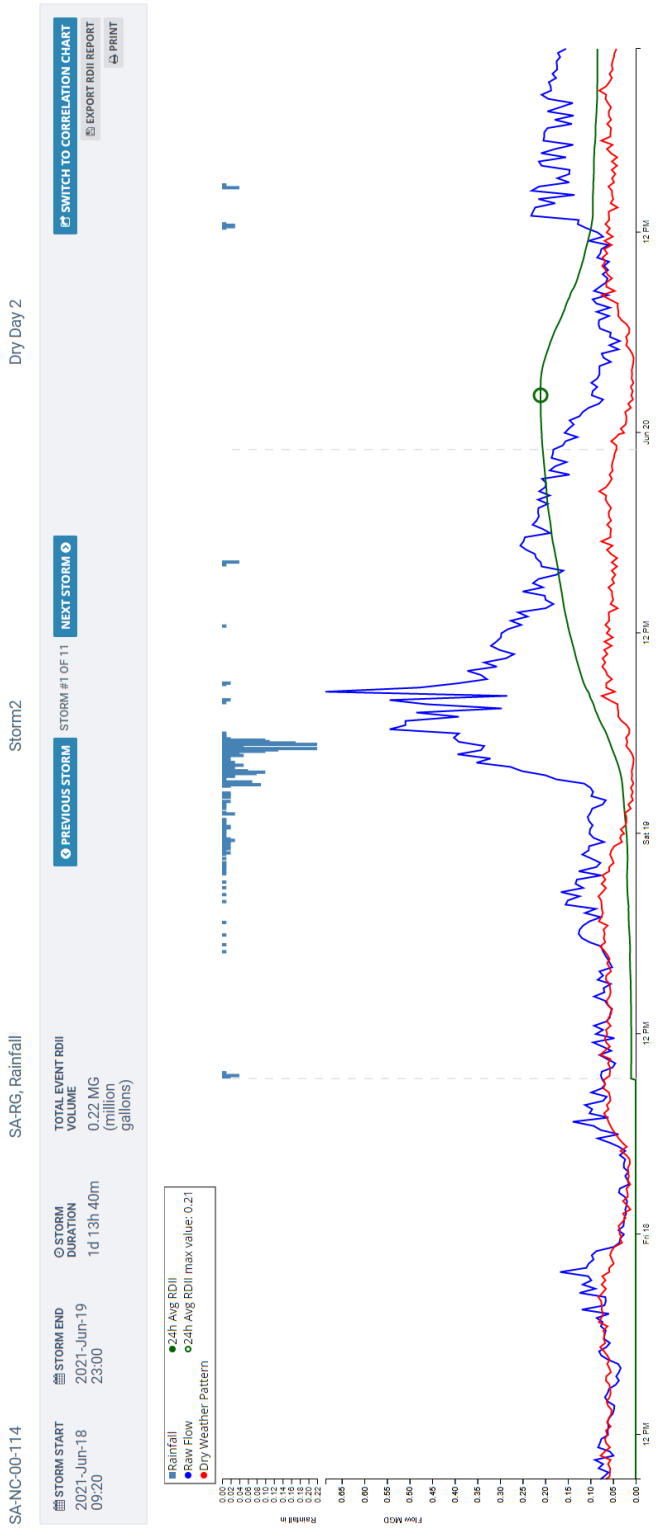

SA-NC-00-001
SA-RG, Rainfall
Storms1
Dry Day 1
STORM START
2021-Jun-06
00:35
STORM END
2021-Jun-07
10:45
STORM DURATION
1d 10h 10m
TOTAL EVENT RDII VOLUME
1.15 MG
(million
gallons)
PREVIOUS STORM
STORM #10 OF 10
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 1.31
Rainfall in
Flow MGD
Jun 06
Mon 07
Tue 08
Wed 09
12 PM


SA-NC-00-001
SA-RG, Rainfall
Storm2
Dry Day 2
STORM START
2021-Jun-18
09:20
STORM END
2021-Jun-19
23:00
STORM DURATION
1d 13h 40m
TOTAL EVENT RDII VOLUME
1.94 MG
(million
gallons)
PREVIOUS STORM
STORM #1 OF 11
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 2.00
Rainfall in
Flow MGD
12 PM
Fri 18
Sat 19
Jun 20

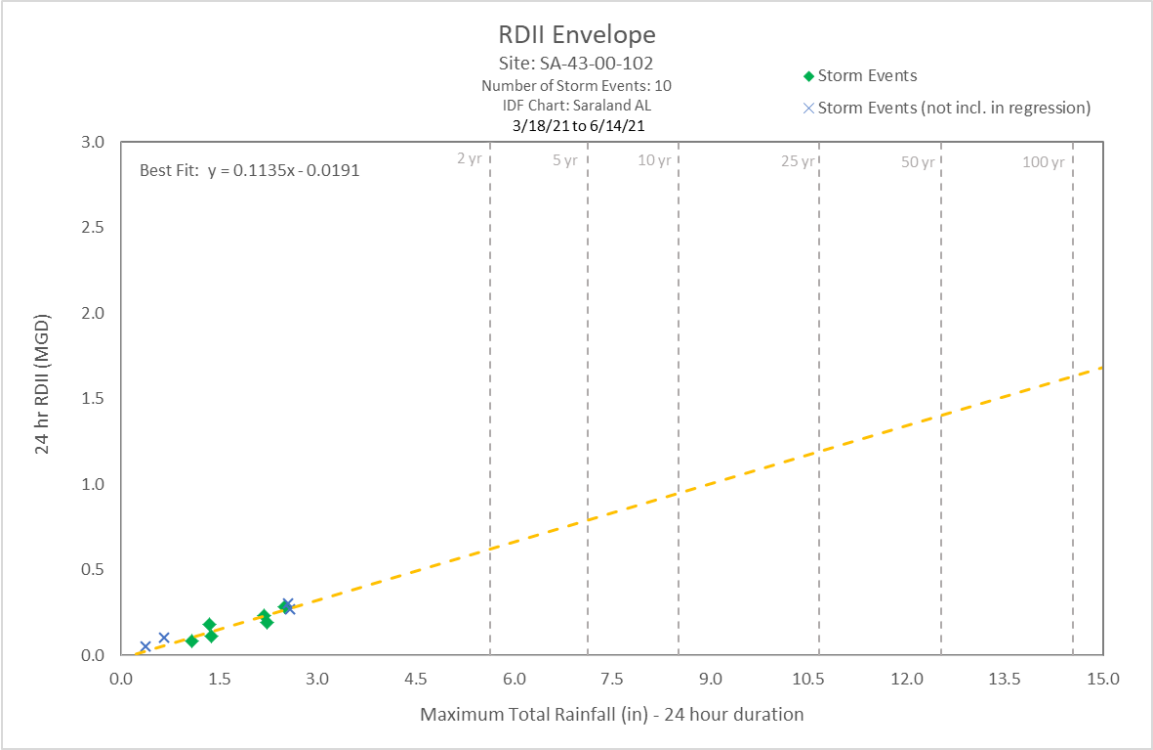

SA-NC-00-023
Dry Day 2
Storm2
SA-RG, Rainfall
STORM START
2021-Jul-20
08:30
STORM END
2021-Jul-20
21:05
STORM DURATION
12h 35m
TOTAL EVENT RDII VOLUME
0.12 MG
(million
gallons)
PREVIOUS STORM
STORM #10 OF 11
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.13
Rainfall in
Flow MGD
12 PM
08 PM
Tue 20
08 AM
12 PM
08 PM
Wed 21
08 AM
12 PM
08 PM
Thu 22
08 AM
12 PM
08 PM

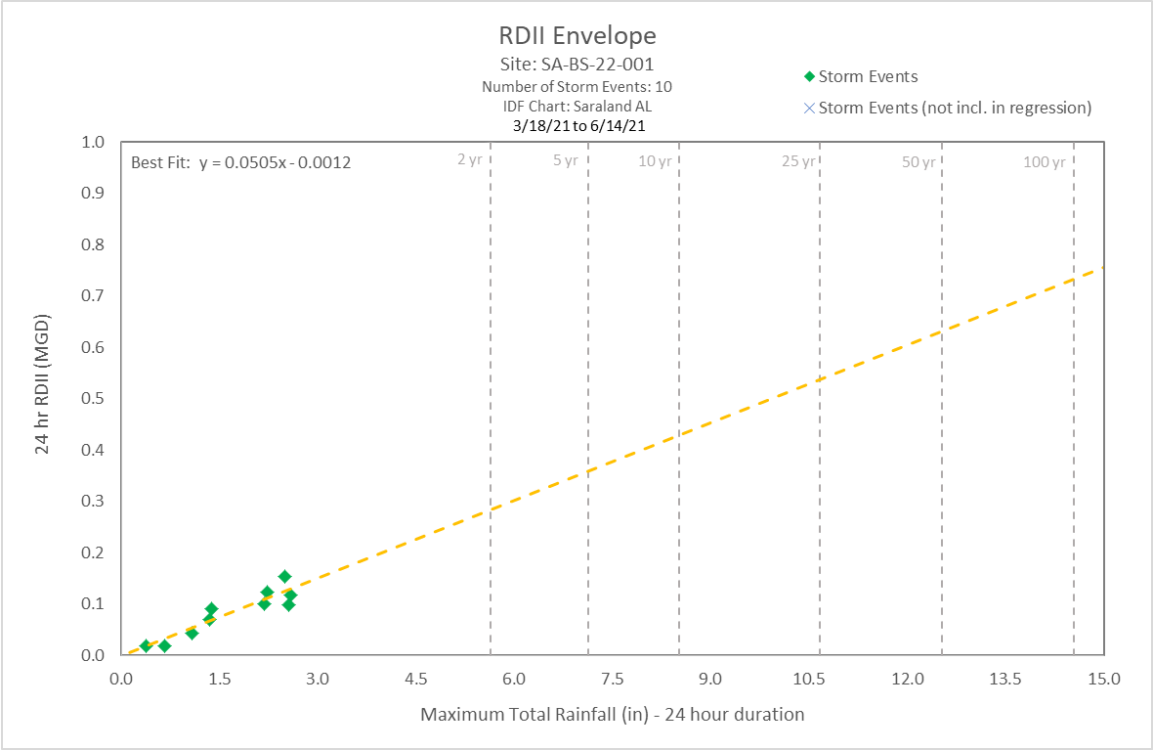

SA-NC-00-039
SA-RG, Rainfall
Storm2
Dry Day 2
STORM START
2021-Jul-20
08:30
STORM END
2021-Jul-20
21:05
STORM DURATION
12h 35m
TOTAL EVENT RDII VOLUME
0.05 MG
(million gallons)
PREVIOUS STORM
STORM #10 OF 11
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.06
Rainfall in
Flow MGD

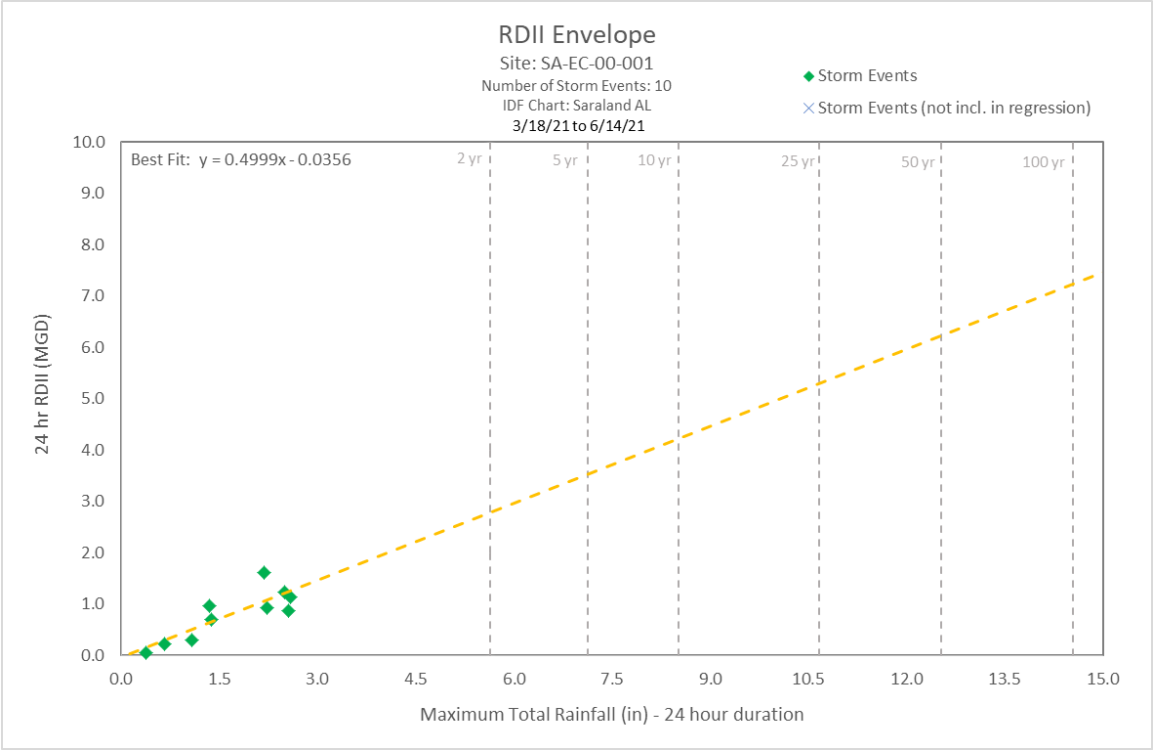

SA-NC-00-095
SA-RG, Rainfall
Storm2
Dry Day 2
STORM START
2021-Jun-18
09:20
STORM END
2021-Jun-19
23:00
STORM DURATION
1d 13h 40m
TOTAL EVENT RDII VOLUME
0.08 MG
(million
gallons)
PREVIOUS STORM
STORM #1 OF 11
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.07
Rainfall in
Flow MGD
12 PM
Fri 18
Sat 19
Jun 20

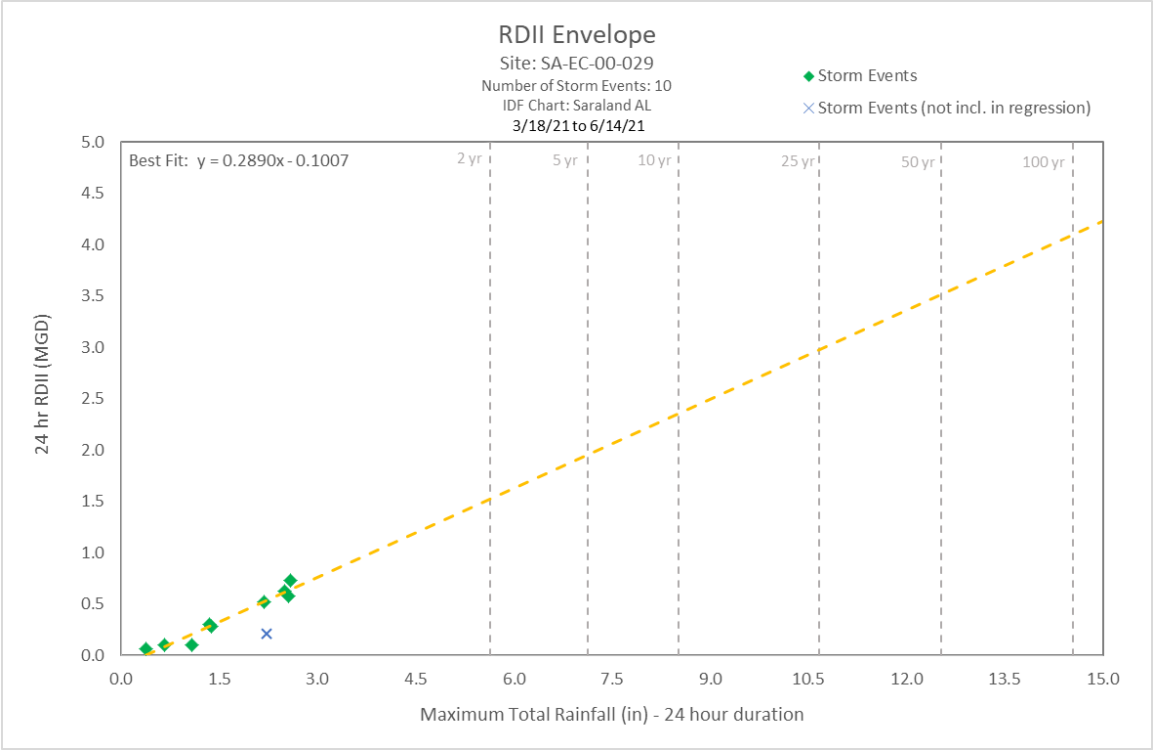

SA-NC-00-114
SA-RG, Rainfall
Storm2
Dry Day 2
STORM START
2021-Jun-18
09:20
STORM END
2021-Jun-19
23:00
STORM DURATION
1d 13h 40m
TOTAL EVENT RDII VOLUME
0.22 MG
(million
gallons)
PREVIOUS STORM
STORM #1 OF 11
NEXT STORM
SWITCH TO CORRELATION CHART
EXPORT RDII REPORT
PRINT
Rainfall
Raw Flow
Dry Weather Pattern
24h Avg RDII
24h Avg RDII max value: 0.21
Rainfall in
Flow MGD
12 PM
Fri 18
Sat 19
Jun 20

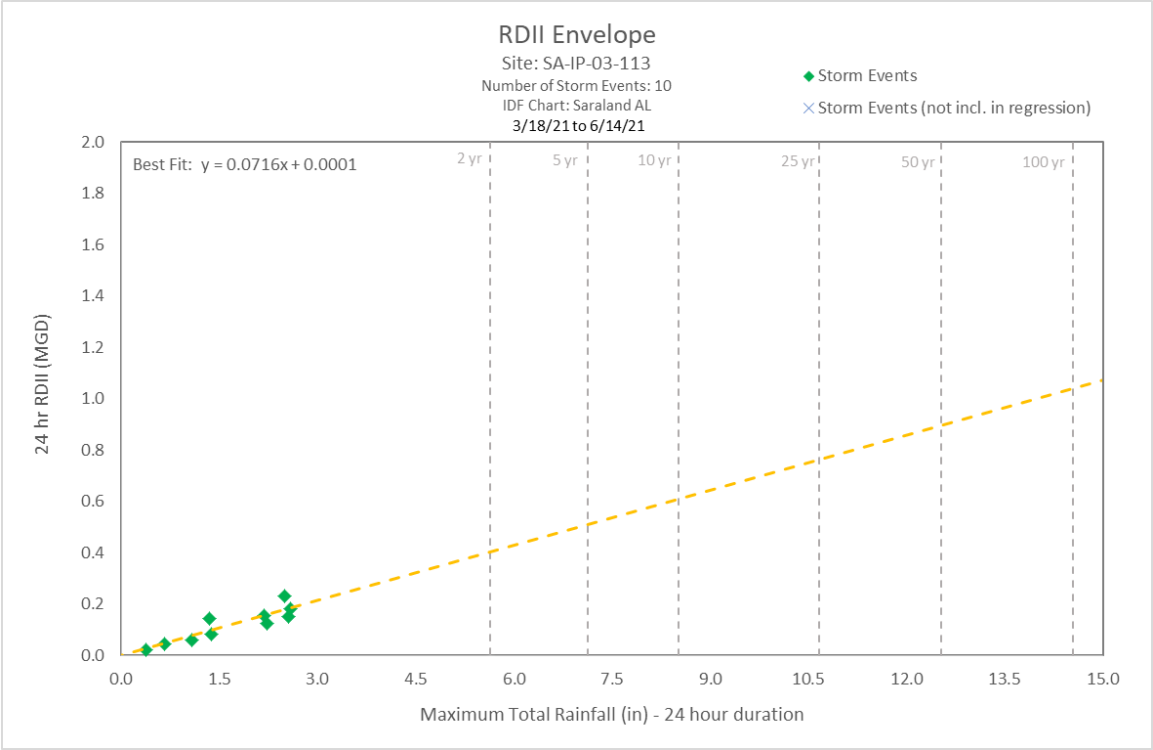
APPENDIX C. REGRESSION ANALYSES

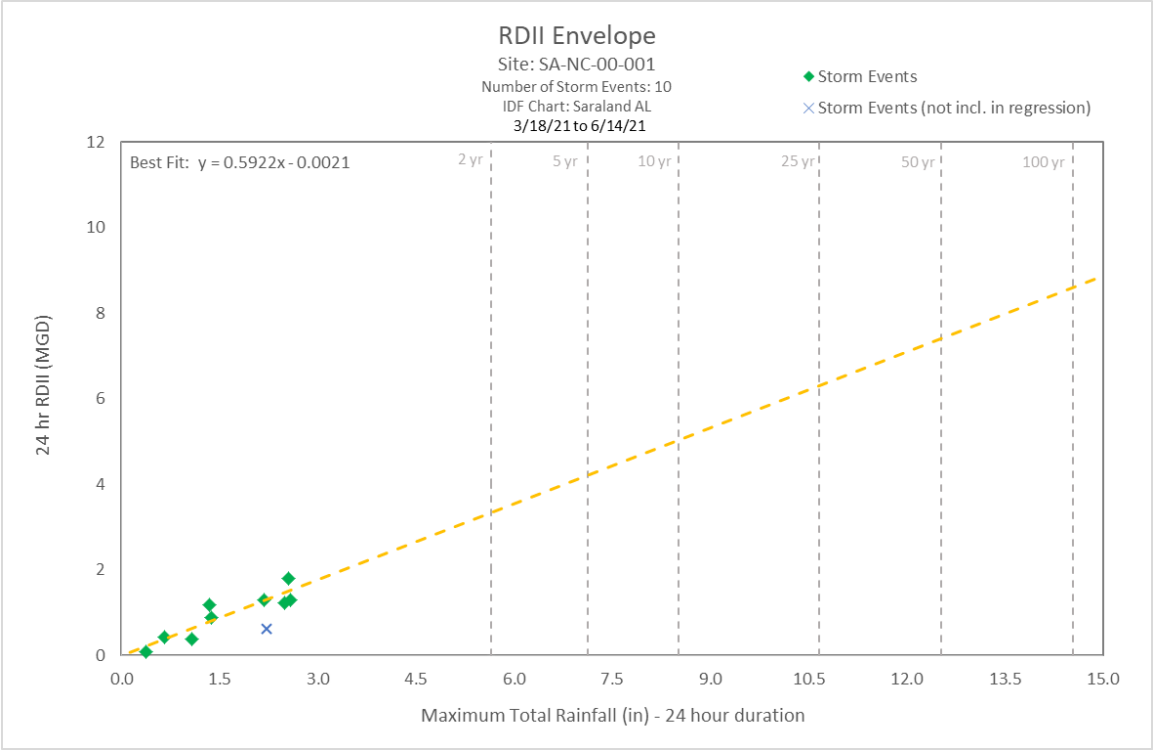

RDII Envelope
Site: SA-43-00-102
Number of Storm Events: 10
IDF Chart: Saraland AL
3/18/21 to 6/14/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.1135x - 0.0191
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration

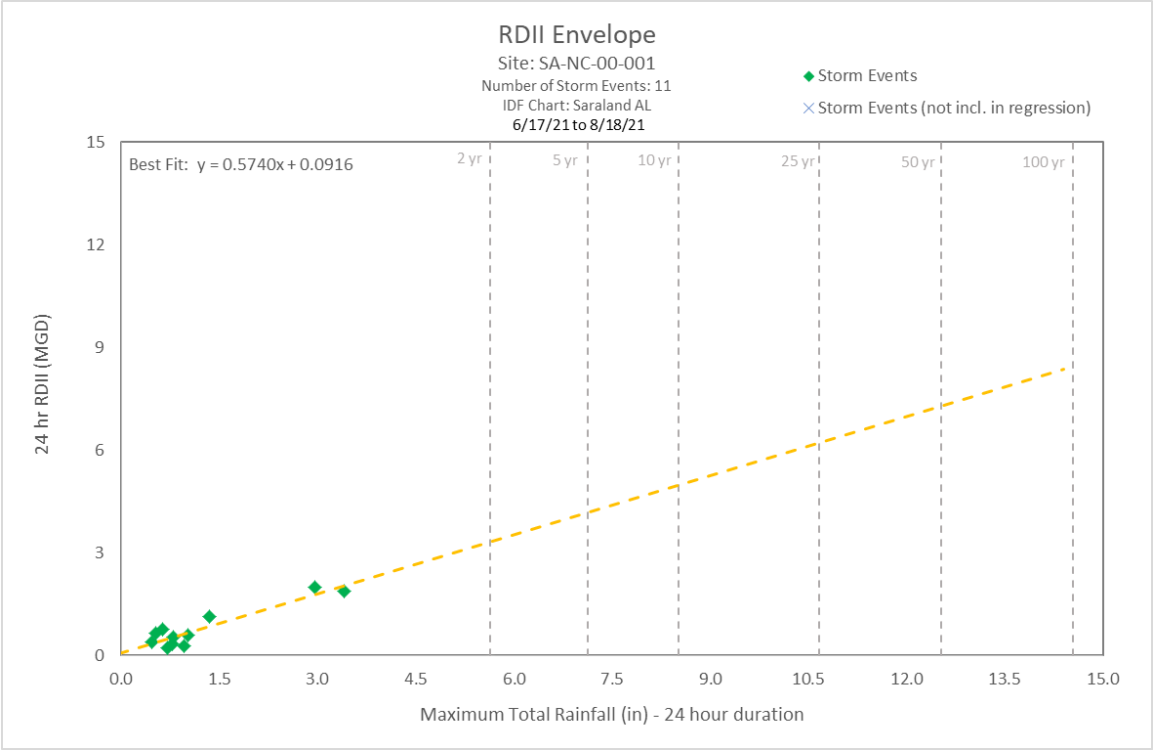

RDII Envelope
Site: SA-BS-22-001
Number of Storm Events: 10
IDF Chart: Saraland AL
3/18/21 to 6/14/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.0505x - 0.0012
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration

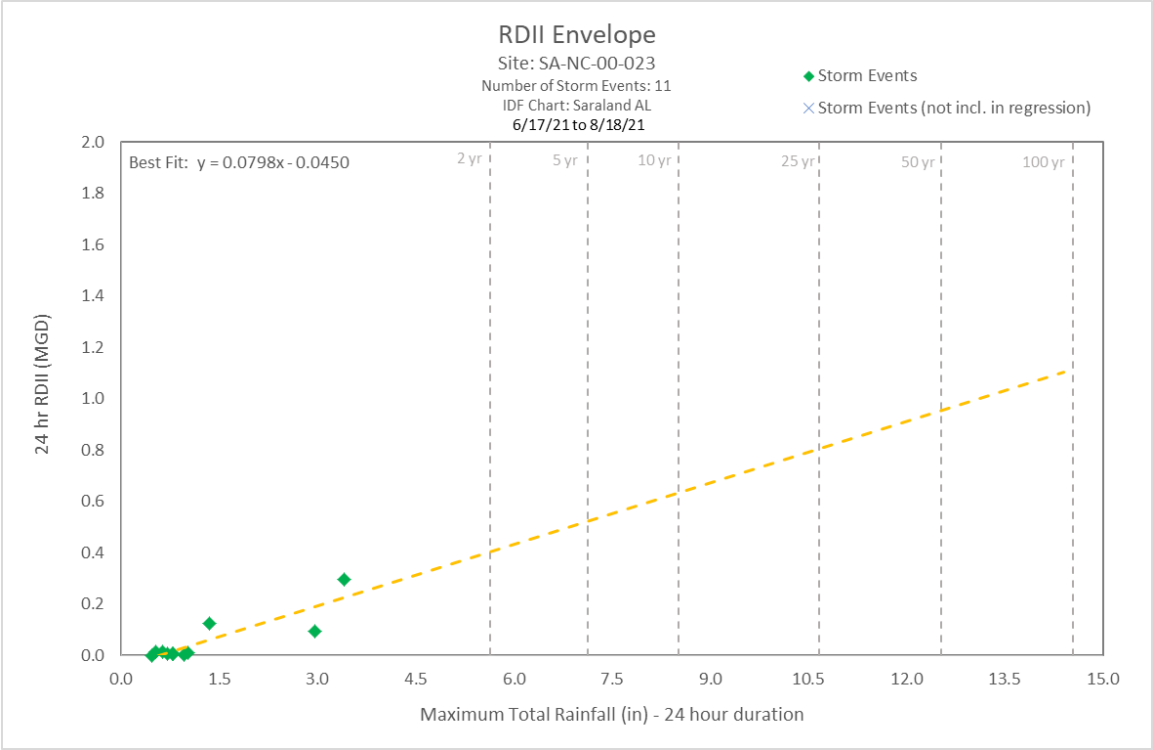

RDII Envelope
Site: SA-EC-00-001
Number of Storm Events: 10
IDF Chart: Saraland AL
3/18/21 to 6/14/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.4999x - 0.0356
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration

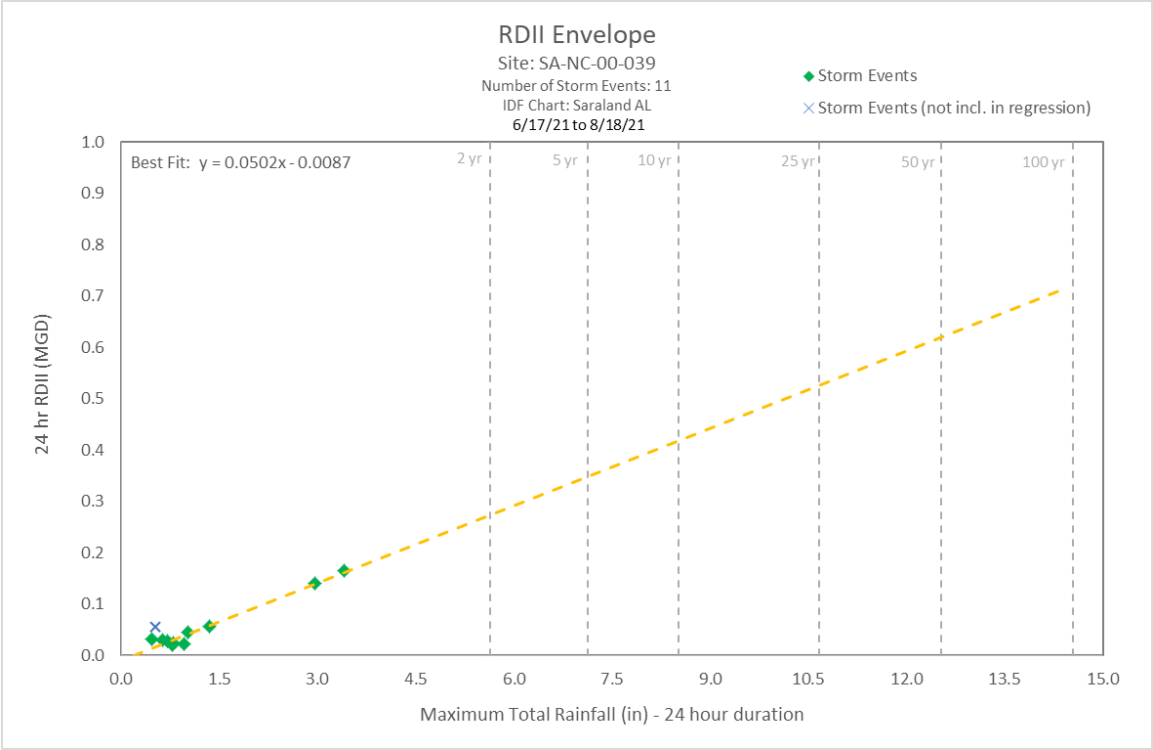

RDII Envelope
Site: SA-EC-00-029
Number of Storm Events: 10
IDF Chart: Saraland AL
3/18/21 to 6/14/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.2890x - 0.1007
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration

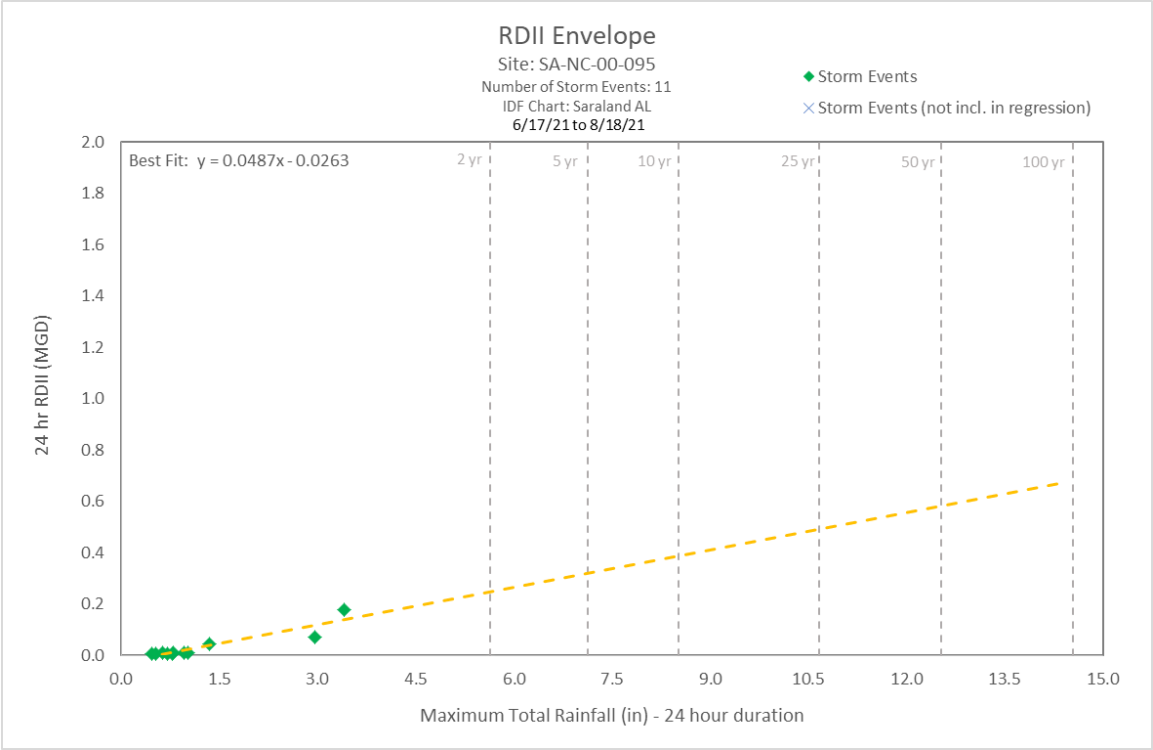

RDII Envelope
Site: SA-IP-03-113
Number of Storm Events: 10
IDF Chart: Saraland AL
3/18/21 to 6/14/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.0716x + 0.0001
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration

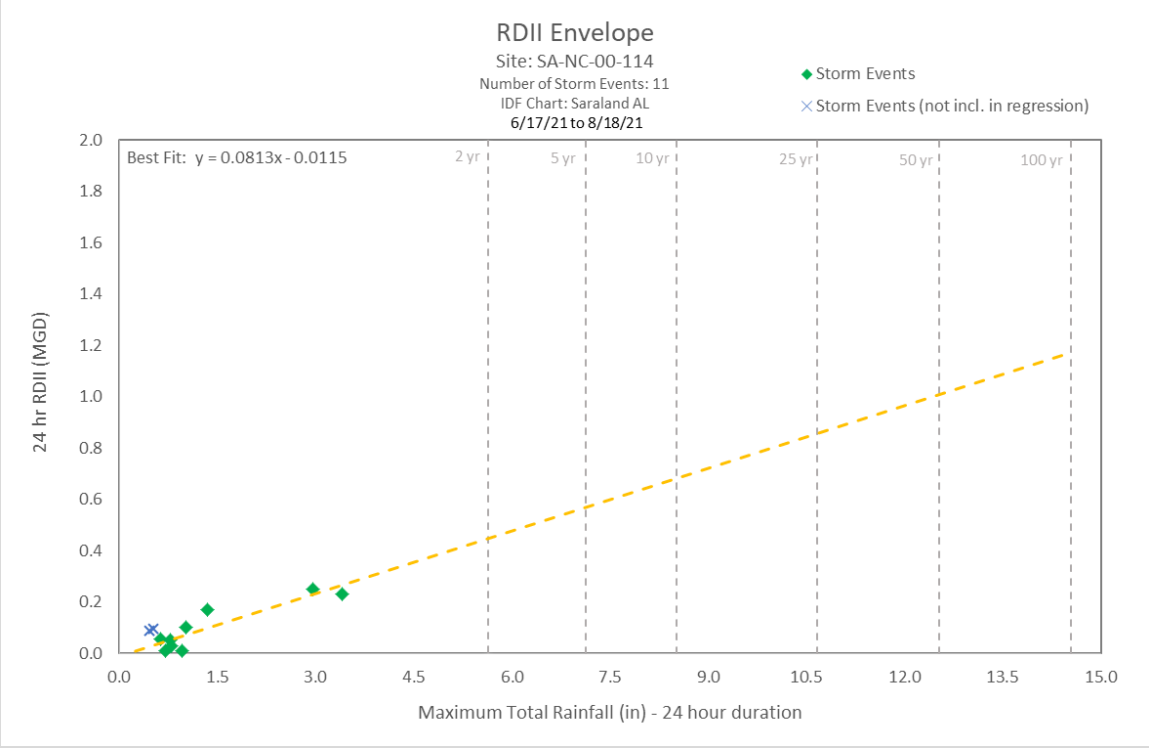

RDII Envelope
Site: SA-NC-00-001
Number of Storm Events: 10
IDF Chart: Saraland AL
3/18/21 to 6/14/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.5922x - 0.0021
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration


RDII Envelope
Site: SA-NC-00-001
Number of Storm Events: 11
IDF Chart: Saraland AL
6/17/21 to 8/18/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.5740x + 0.0916
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration


RDII Envelope
Site: SA-NC-00-023
Number of Storm Events: 11
IDF Chart: Saraland AL
6/17/21 to 8/18/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.0798x - 0.0450
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration


RDII Envelope
Site: SA-NC-00-039
Number of Storm Events: 11
IDF Chart: Saraland AL
6/17/21 to 8/18/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.0502x - 0.0087
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration


RDII Envelope
Site: SA-NC-00-095
Number of Storm Events: 11
IDF Chart: Saraland AL
6/17/21 to 8/18/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.0487x - 0.0263
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
Maximum Total Rainfall (in) - 24 hour duration


RDII Envelope
Site: SA-NC-00-114
Number of Storm Events: 11
IDF Chart: Saraland AL
6/17/21 to 8/18/21
Storm Events
Storm Events (not incl. in regression)
Best Fit: y = 0.0813x - 0.0115
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
24 hr RDII (MGD)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
13.5
15.0
Maximum Total Rainfall (in) - 24 hour duration

VOLKERT

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