Preliminary Engineering Report

Inflow and Infiltration Flow Study

Town of Yorktown, New York

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1.0 EXECUTIVE SUMMARY

The Town of Yorktown is located in Westchester County, New York. Refer to Figure 1 for a project location map. The Town owns a New York State Department of Environmental Conservation (NYSDEC) permitted wastewater treatment plant (WWTP) which serves residential and commercial customers within the Town (SPDES Permit No. NY0026743). The WWTP and wastewater collection system infrastructure, which includes 16 pump stations, 3,462 manholes, and approximately 124 miles of sanitary sewer collection pipes owned and operated by the Town.

The collection system is separated into the Peekskill Sewer District and Hallocks Mill Sewer District (HMSD) as shown in Figure 2. The Hallocks Mill Sewer District collection system is located within the New York City drinking water supply watershed and is comprised of approximately 1,712 manholes, 335,000 linear-feet of gravity sewer, and 11,500 linear-feet of forcemain which discharges to the Hallocks Mill (Town of Yorktown) WWTP. The Peekskill Sewer District collection system is located within the both the New York City watershed and Westchester County Sewer District and is comprised of approximately 320,000 linear-feet of gravity sewer, 1,750 manholes, and 30,000 linear-feet of forcemain which discharges to the Westchester County owned Peekskill WWTP.

Based on historical records, sewer overflows (SSO's) have occurred within the Peekskill Sewer District collection system. Few occurred as a result of blockages typical of many collection systems and most have occurred as a result of a broken forcemain. The SSO's have occurred primarily in the Hill/Lee Boulevard sewers and the area immediately adjacent, including the Farmwalk Pump Station Forcemain. Town operations staff have indicated that most of the SSO's resulting from a broken forcemain have occurred in the Farmwalk forcemain which is constructed of 2-inch PVC. The majority of the SSO's are a result of blockages that have occurred within the gravity sewers in the Hill/Lee Boulevard (Subbasin 9 and 10). These subbasins generally have a greater number of commercial discharges and the sewers have a shallow pitch.

As a result of overflows within the collection system, the Town of Yorktown and EDR recently negotiated an Order on Consent with the NYSDEC to address inflow and infiltration within the Peekskill Sewer District collection system maintained by the Town of Yorktown. As outlined in the Order on Consent dated May 15, 2019, the Town is to complete an Inflow and Infiltration Study by August 31, 2020.

The purpose of this study was to complete initial investigations to assist with identifying the basins within the Peekskill Sewer Disrtict where the most potential inflow and infiltration exists, comply with the executed Order on Consent and, based on the data, provide recommendations for additional field investigations to further identify potential sources on inflow and infiltration. The initial investigations included identifying the individual collection system basins, performing a limited flow monitoring program, and conducting dry-weather manhole inspections on 175 manholes within the Peekskill Sewer District.

Flow monitoring was conducted at 12 locations by ADS Environmental Services (ADS) between May 13, 2020 and July 26, 2020. Based on the analysis of data collected during the flow metering program, the following results were noted:

1. Base infiltration for Subbasins 8 and 11 exceeded equivalent EPA standards.
2. Based on the calculated wastewater flow results, it appears Basin 10 includes additional unidentified contributing sewers of wastewater flow.

In summary, recommendations for next steps to better identify the causes inflow and infiltration are as follows:

1. Complete cleaning, close circuit tv inspection (CCTV) in Subbasins 8 and 11.
2. Based on the results of cleaning and CCTV inspections, perform smoke and/or dye testing of areas to identify inflow sources that could not be verified by the CCTV inspections within Subbasins 8 and 11 if needed.
3. Further investigate Basin 10 to confirm or identify whether or not additional collection system piping contributes to Basin 10. Further investigation to confirm field conditions is recommended.

2.0 BACKGROUND AND HISTORY

2.1 Location

The Town of Yorktown is located in Westchester County, New York (refer to Figure 1 for a project location map). The Town owns a NYSDEC permitted WWTP which serves residential and commercial customers within the Town (SPDES Permit No. NY0026743). The WWTP and wastewater collection system infrastructure, which includes 16 pump stations, 3,462 manholes, and approximately 124 miles of sanitary sewer collection pipes owned and operated by the Town. The Peekskill Sewer District is comprised of approximately 320,000 linear-feet of gravity sewer, 1,750 manholes, and 30,000 linear-feet of forcemain which discharges to Westchester County owned Peekskill WWTP.

The Peekskill sewage collection system is comprised of approximately 320,000 linear-feet of collection system piping that could be divided into 12 individual "basins". Pipe sizes in the system range from 6-inch to 36-inch. Age of the collection system piping varies. Flow from each of the basins is collected together into a 36-inch (owned by Westchester County) pipe which discharges to the Peekskill WWTP. Figure 3 provides an overview of the Peekskill Sewer District owned and operated by the Town of Yorktown, and the basins within the collection system.

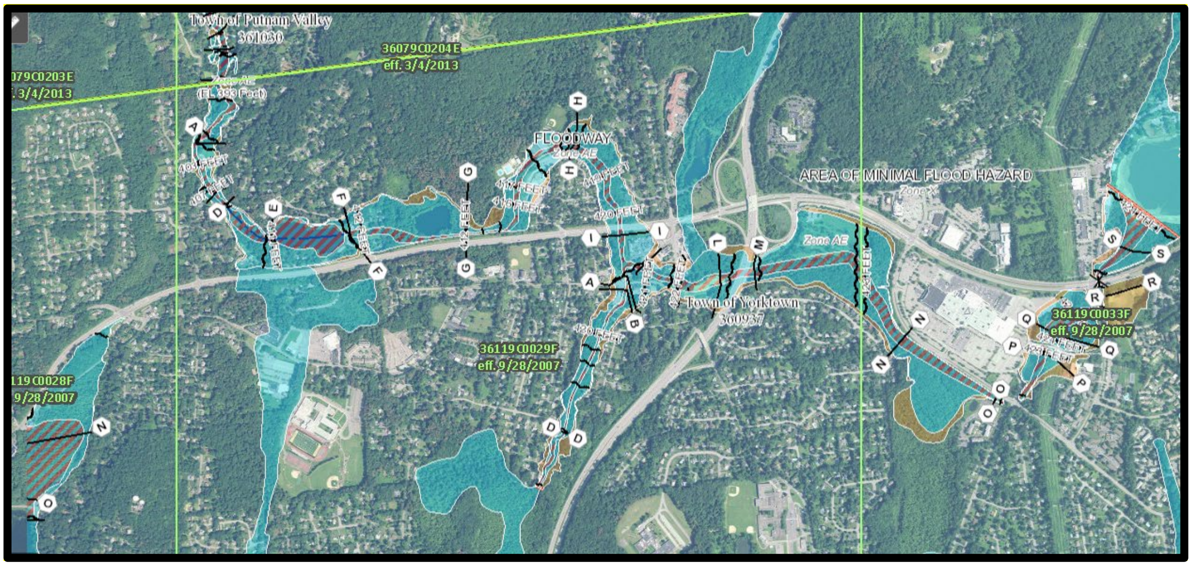
2.2 Environmental Resources Present

A desktop analysis of environmental resources was performed for the Peekskill Sewer District. A review of the NYSDEC Environmental Resource Mapper indicated that there are some National Wetland Inventory (NWI) or NYSDEC jurisdictional wetlands within the limits of the Peekskill Sewer District in the Town of Yorktown. The wetland mapper indicated that state-listed threatened and endangered species are not present in the proximity of the Peekskill Sewer District. A preliminary review of the U.S. Fish and Wildlife Service (FWS) IPaC Resource List indicates that there are endangered species expected in the area including the Indiana bat and bog turtle. Additionally, several migratory birds may use this area as a breeding habitat. Although these State and Federally listed wetlands and species may be present in the vicinity, the nature of the project is maintenance of existing infrastructure that does not provide a quality habitat.

2.3 Floodplains

Portions of the project located are located within the 100-year flood zone according to the FEMA FIRM obtained for the Town of Yorktown (Community Panel Number 36079C 0028F, 36079C 0029F, 36119C 0033F, 36119C 0036F).

Several 100 year floodplains exist within along Shrub Oak Brook, Mohegan Lake, and the Mohegan Outlet . There are several pipes located along and within the flood plain.



3.0 OWNERSHIP AND SERVICE AREA

3.1 Population Trends

According to the U.S. Census data from the past two decades (2000-2019), the Town's population has remained relatively constant. Population in 2000, 2010, and 2019 are 36,318, 36,081, and 36,269, respectively. The population is expected to stay relatively consistent. Significant increases or decreases in population could account for changes in the collection system capacity. However, as noted above, the population within the Town has remained consistent for the past two decades.

4.0 EXISTING CONDITIONS

4.1 Collection System

The Town of Yorktown is in the process of updating data on their existing collection system infrastructure as some records have been lost throughout the years. The Town's Geographical Information System (GIS), in conjunction with the sewer system record drawings, were reviewed to provide a map of the existing infrastructure within the Town for the purposes of this study.

Prior to the beginning of this project, the Town created an electronic map of the Town's sanitary sewer infrastructure via GIS. As part of this project, this map was evaluated for accuracy and completeness. It was found that the electronic map was incomplete. For example, pipe diameters were not included in the GIS mapping of the collection system. Record drawings were reviewed to gain a better understanding of the collection system. However, record drawings were not available for some areas of the collection system and some of the records have been lost throughout the years. The Town continues to develop the GIS system and identify the discrepancies through field investigations such as field investigations to determine pipe diameters.

The current map of the Town's sanitary sewer system was evaluated based on flow paths and partitioned into 12 basins. A basin is the designation given to a series of interconnected sewers within the system that collect and convey wastewater to a common manhole. Refer to Figure 3 for a map displaying the 12 basins within the Village.

4.2 Flow Monitoring

ADS was contracted to install flow monitoring devices at the common manholes for each of the 12 basins, 8 groundwater monitors, and 1 rain gauge located on the roof of the Curry Street Pump Station. For the installation of the flow monitoring devices, a crew of two ADS employees, one Town employee, and one EDR project manager were onsite to ensure the flow meters were installed at the correct locations and to make determinations based on field conditions at the time of installation.

Installation of flow monitoring equipment typically proceeds in four steps. First, the site is investigated for safety and to determine physical condition and hydraulic suitability for the flow monitoring equipment. Second, the equipment is physically installed at the selected location. Third, the monitor is tested to assure proper operation of the velocity and depth of flow sensors and verify that the monitor clock is operational and synchronized to the master computer clock. Fourth, the depth and velocity sensors are confirmed and line confirmations are performed.

In pipes 42-inches or less (all the pipes in the Town), the sensors are mounted on expandable stainless steel rings, inserted at least a foot upstream into the influent pipes, and tightened against the inside walls of the pipe. Influent pipe installations reduce the influence of turbulence and backwater often caused by changes in channel geometry in manholes.

4.2.1 Basin 1

The flow meter for Basin 1 (Figure 4) was installed in an 8-inch diameter pipe located adjacent to Route 6 across from Mohegan Lake Volkswagen. See Figure 3 for the location of Basin 1 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 1 is included in Table 4-1 below.

Table 4-1. Observed Flow Conditions Basin 1

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	4.1	1.56	0.19
Minimum	1.2	0.15	0.01
Maximum	7.75	5.36	1.05

4.2.2 Basin 2

The flow meter for Basin 2 (Figure 5) was installed in an 8-inch diameter pipe located on the western side of Lakeland High School. See Figure 3 for the location of Basin 2 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 2 is included in Table 4-2 below.

Table 4-2. Observed Flow Conditions Basin 2

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	2.61	1.20	0.08
Minimum	1.16	0.15	0.01
Maximum	6.05	3.24	0.54

4.2.3 Basin 3

The flow meter for Basin 3 (Figure 6) was installed in a 10-inch diameter pipe located on Mill Street north of Route 6. See Figure 3 for the location of Basin 3 meter. This meter was slated to be installed in a different location and was relocated to accommodate capturing the residential flow from the adjacent development. Installation of this meter proceeded as expected. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 3 is included in Table 4-3 below.

Table 4-3. Observed Flow Conditions Basin 3

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	0.6	2.55	0.02
Minimum	0.23	1.49	0.004
Maximum	1.01	3.97	0.065

4.2.4 Basin 4

The flow meter for Basin 4 (Figure 7) was installed in an 12-inch diameter pipe located behind a private residence on Artis Road. See Figure 3 for the location of Basin 4 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. All flow from Basin 11 and 12 flows to Basin 4 so Basins 11 and 12 were included as part of Basin 4 for all analysis of the meter data. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 4 is included in Table 4-4 below.

Table 4-4. Observed Flow Conditions Basin 4

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	3.79	2.84	0.40
Minimum	2.09	1.56	0.09
Maximum	6.88	4.03	1.21

4.2.5 Basin 5

The flow meter for Basin 5 (Figure 8) was installed in an 12-inch diameter pipe located along Lee Boulevard off the southwestern portion of Jefferson Valley Mall. See Figure 3 for the location of Basin 5 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. Basin 5 contributes to the flow observed in Basin 10 and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 5 is included in Table 4-5 below.

Table 4-5. Observed Flow Conditions Basin 5

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	1.78	2.60	0.13
Minimum	0.90	1.64	0.03
Maximum	4.06	3.25	0.48

4.2.6 Basin 6

The flow meter for Basin 6 (Figure 9) was installed in an 12-inch diameter pipe located in the parking lot of the townhomes located on Strang Boulevard adjacent to the intersection of Strang Boulevard and Lee Boulevard (adjacent to meter 9). See Figure 3 for the location of Basin 6 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. Basin 6 contributes to the flow observed in Basin 10 and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 6 is included in Table 4-6 below.

Table 4-6. Observed Flow Conditions Basin 6

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	2.57	2.04	0.13
Minimum	1.52	0.72	0.012
Maximum	4.90	3.73	0.636

4.2.7 Basin 7

The flow meter for Basin 7 (Figure 10) was installed in an 8-inch diameter pipe located on Hill Boulevard adjacent to the intersection of Hill Boulevard and Village Road South. See Figure 3 for the location of Basin 7 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. Basin 7 contributes to the flow observed in Basin 10 and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 7 is included in Table 4-7 below.

Table 4-7. Observed Flow Conditions Basin 7

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	2.16	3.23	0.16
Minimum	1.79	1.89	0.072
Maximum	6.87	6.15	0.682

4.2.8 Basin 8

The flow meter for Basin 8 (Figure 11) was installed in an 8-inch diameter pipe located in the woods off of Smith Road. See Figure 3 for the location of Basin 8 meter. This is the location chosen for the meter to be installed based on the basin mapping. The meter was slated to be installed north of the clearing but the intended manhole could not be field located. Basin 8 contributes to the flow observed in Basin 7 (and ultimately 10) and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 8 is included in Table 4-8 below.

Table 4-8. Observed Flow Conditions Basin 8

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	1.82	3.29	0.13
Minimum	1.01	1.68	0.03
Maximum	6.44	5.12	0.76

4.2.9 Basin 9

The flow meter for Basin 9 (Figure 12) was installed in a 16-inch diameter pipe located in the parking lot of the townhomes located on Strang Boulevard adjacent to the intersection of Strang Boulevard and Lee Boulevard (adjacent to meter 6). See Figure 3 for the location of Basin 9 meter. This meter was originally slated to be installed at the manhole at the intersection of Lee Boulevard and Shrub Oak Brook but during the installation it was found that this manhole was not suitable for installation due to turbulent flows. Basin 9 contributes to the flow observed in Basin 10 and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 9 is included in Table 4-9 below.

Table 4-9. Observed Flow Conditions Basin 9

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	3.50	1.86	0.28
Minimum	2.02	1.08	0.08
Maximum	5.65	2.80	0.76

4.2.10 Basin 10

The flow meter for Basin 10 (Figure 13) was installed in a 30-inch diameter pipe located behind a private residence on Artis Road. See Figure 3 for the location of Basin 10 meter. This meter was originally slated to be installed in the manhole at the intersection of Old Yorktown Road and Barger Street and was field located in order to capture flow from a residential development north of Route 6. The Basin 10 meter was installed in a main interceptor sewer owned by Westchester County and received contributing flow from Basins 5, 6, 7, 8 and 9 which were included in the evaluation.

The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 10 is included in Table 4-10 below.

Table 4-10. Observed Flow Conditions Basin 10

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	6.85	1.33	0.67
Minimum	4.04	0.40	0.16
Maximum	12.6	1.94	2.18

4.2.11 Basin 11

The flow meter for Basin 11 (Figure 14) was installed in an 12-inch diameter pipe north of the Hunterbrook Pump Station. See Figure 3 for the location of Basin 11 meter. This is the location chosen for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. Basin 11 contributes to the flow observed in Basin 4 since the Hunterbook Pump Station discharges to gravity sewer within Basin 4 and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 11 is included in Table 4-11 below.

Table 4-11. Observed Flow Conditions Basin 11

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	2.27	2.71	0.19
Minimum	1.82	0.40	0.10
Maximum	11.5	4.83	1.44

4.2.12 Basin 12

The flow meter for Basin 12 (Figure 15) was installed in an 8-inch diameter pipe northeast of the Hunterbrook Pump Station. See Figure 3 for the location of Basin 12 meter. This is the location field located for the meter to be installed based on the basin mapping. Installation of this meter proceeded as expected. Basin 12 contributes to the flow observed in Basin 4 since the Hunterbook Pump Station discharges to gravity sewer within Basin 4 and was included in the evaluation. The installation reports, including photos of the installation conditions and brief description, is included in Appendix A and a summary of the observed flow conditions for Basin 12 is included in Table 4-12 below.

Table 4-12. Observed Flow Conditions Basin 12

Item	Depth (in)	Velocity (ft/s)	Quantity (mgd)
Average	4.64	0.80	0.09
Minimum	2.56	0.18	0.01
Maximum	9.96	2.75	0.43

5.0 SYSTEM ANALYSIS AND EVALUATION

The purpose of this report was to complete initial investigations to assist with identifying the basins within the collection system where the most severe issues exist and, based on the data, provide recommendations for next steps to further pinpoint the sources on inflow and infiltration. The initial investigations included identifying the individual collection system basins as noted above and then completing a limited flow monitoring program.

5.1 Flow Monitoring

The first to determine the significance of inflow and infiltration within the existing system was to utilize flow monitoring equipment to record flows during normal periods and rain events from each of the system's 12 basins. Flow monitoring was conducted at 12 locations by ADS between May 13, 2020 and July 26, 2020.

The planned approach was to install flow meters at the common manhole within each of the 12 basins to monitor flow from each of the designated basins. Field modifications to three of the metering locations were made based on collection area and turbulent flow in the original manhole locations. Turbulent flow is primarily caused in manholes where multiple sewers connect. The locations of the flow meters are shown in Figure 2.

A rain gauge monitor was installed on the roof of the Curry Street Pump Station and measured rain quantities over the entire monitoring period. There were six storms in the period that recorded 0.5-inches or more of total rainfall over the course of a 24 hour period. Table 5-1 lists the rainfall event and equivalent rainfall return frequency.

Table 5-1. Rainfall Events

Date	Rainfall Total (in.)	Rainfall Return Frequency
May 15, 2020	1.05	2.8 month
June 11, 2020	0.81	1.2 year
June 27, 2020	0.97	1.9 month
July 8, 2020	0.63	1.7 month

July 10-11, 2020	2.98	1.6 year
July 23, 2020	0.63	1.5 year

The monitoring equipment was installed to help identify areas that experience excessive amounts of infiltration and inflow which can compromise collection system capacity. ADS field crews performed operation and maintenance activities throughout the period with no significant loss of data. This effort included manual field checks to ensure equipment was accurately measuring flows and rainfall.

At the conclusion of the monitoring period, ADS removed the equipment and performed a quality review of flow monitoring and raw data to ensure consistency and validate the recorded data. The data was further analyzed to separate flows into dry days and wet days. From this data, Average Dry Day Flow (ADDF) (not influenced by prior rainfall) and Rainfall Dependent Inflow and Infiltration (RDII) were developed to identify issues within the collection system and for each system basin.

5.2 Basin Sizes and Lengths

A common tool used to assist with the analysis of data is to calculate the volume of dry day flow in gallons per linear-foot in each basin (gallons per day per linear-foot). The figure helps with understanding the magnitude of flows within a basin. It was originally believed that infiltration in sewer pipes was a surface phenomenon and that ground water entered a pipe uniformly around the circumference. When comparing infiltration among basins, infiltration rates were normalized by gallons per day per linear foot to prevent the worst basins from being merely the sewers with the greatest surface area. This form of the analysis is an industry acceptable equivalent to alternative methods of comparing basins (inch-diameter miles) when a complete data set of the collection system is not available. Table 5-2 lists the sewer lengths for each basin.

Table 5-2. Basin Sewer Lengths

Basin/Basin Meter	Length of Piping (Feet)
1	25,023
2	36,305
3	9,532
4	33,574
5	35,856
6	28,476
7	16,974
8	23,516
9	37,718

10	20,309
11	23,024
12	27,109

As one approach to analyzing the data, the volume of dry day flow from the basin is divided by the length of sewer, generating a value in gallons per day per linear foot (LF) of public sanitary sewer. In addition, the basin size has value in interpreting the severity of the RDII. Large basins will generally exhibit RDII severity close to the system-wide average and a small basin will exhibit RDII severity much higher or much lower than the system average.

5.3 Average Dry Day Flow (ADDF)

Average Dry Day Flow (ADDF) at each metering location is used in two ways. The first is that the shape of an ADDF hydrograph is used to estimate what portion of the ADDF is wastewater production (WW) and what portion is base infiltration (BI). The second is that the ADDF is subtracted from the flow measured during a storm and the difference is RDII.

Dry day flows were obtained by identifying days that were not influenced by previous rainfall and that have a regular diurnal (daily) pattern. Typically, weekday and weekend diurnal patterns are different and therefore are averaged separately. The selected days were averaged to generate separate weekday and weekend diurnal patterns.

It is noted that Meter 10 includes flows from Meters 5, 6, 7, 8 and 9 and Meter 4 includes flows from Meters 11 and 12. Net flows for a basin are obtained by subtracting out any upstream basin flows. It is noted that Meter 10 recorded wastewater flows higher than anticipated based on the linear-feet of pipe within the basin area, available mapping, and information. Further investigation to confirm field conditions is recommended. For all other meters, the gross flow recorded flow by the meter equals the net flow.

Next, base infiltration was estimated using an industry accepted empirical formula utilizing minimum and average day recorded flows. A standard prescribed by the U.S. Environmental Protection Agency (EPA) for excessive BI is 4,000 gallons per day per inch diameter mile (gpdim) (EPA, 2014)[(1)]. For this analysis, inch diameter of metered pipes was not available so comparisons were completed using length of pipe for each basin. A threshold value of 5 gallons per day per linear-foot of pipe. The 5 gpd/ft threshold is a rough equivalent to the EPA guidance.

(1) Guide for Estimating Infiltration and Inflow, U.S. Environmental Protection Agency. June 2014.

Table 5-3 displays the estimated net base infiltration, net wastewater, and net average in mgd for each basin. This method of estimating BI is based on traditional residential diurnal flow patterns and it is not uncommon for mathematical inconsistencies to occur between basins. Basins that have upstream flows that contribute more BI than the net at the downstream meter will be shown as an *. This occurs at meters 10, 9 and 7 which have upstream areas contributing more BI than the downstream. For those locations listed with an asterisk, it is assumed the BI values are not significant to investigate further.

Net wastewater flow volumes listed in Table 5-3 were also compared against typical standards for the type of land use within the basins. Average dry day flows are typically in the range of 2 to 5 gal/day/linear foot for medium density residential areas. As shown in the Table 5-3, the net estimated wastewater volumes fall within this range with the exception of Basin 10 which is believed to have contributing wastewater flow from unidentified sources.

Table 5-3. ADDF and Base Infiltration(1)

Basin/Basin Meter	Net Average Day Dry Flow (ADDF) (gal/day/ft of pipe)	Net Estimated Wastewater Volume (gal/day/ft of pipe)	Net Estimated Base Infiltration (gal/day/ft of pipe)	Base Infiltration Percentage (Net BI/Net Avg)(2)	Base Infiltration Exceeds Equivalent Standards?
1	6.6	4.0	2.6	39%	No
2	2.1	1.3	0.8	37%	No
3	0.86	0.62	0.24	27%	No
4	2.1	1.4	0.7	33%	No
5	3.4	2.2	1.3	36%	No
6	4.3	3.0	1.3	31%	No
7	0.81	0.81	*	N/A	No
8	7.7	4.1	3.6	46%	Yes
9	0.34	0.34	*	N/A	No
10	10.4	10.4	*	N/A	No
11	8.0	2.9	5.1	64%	Yes
12	3.0	2.0	1.0	34	No

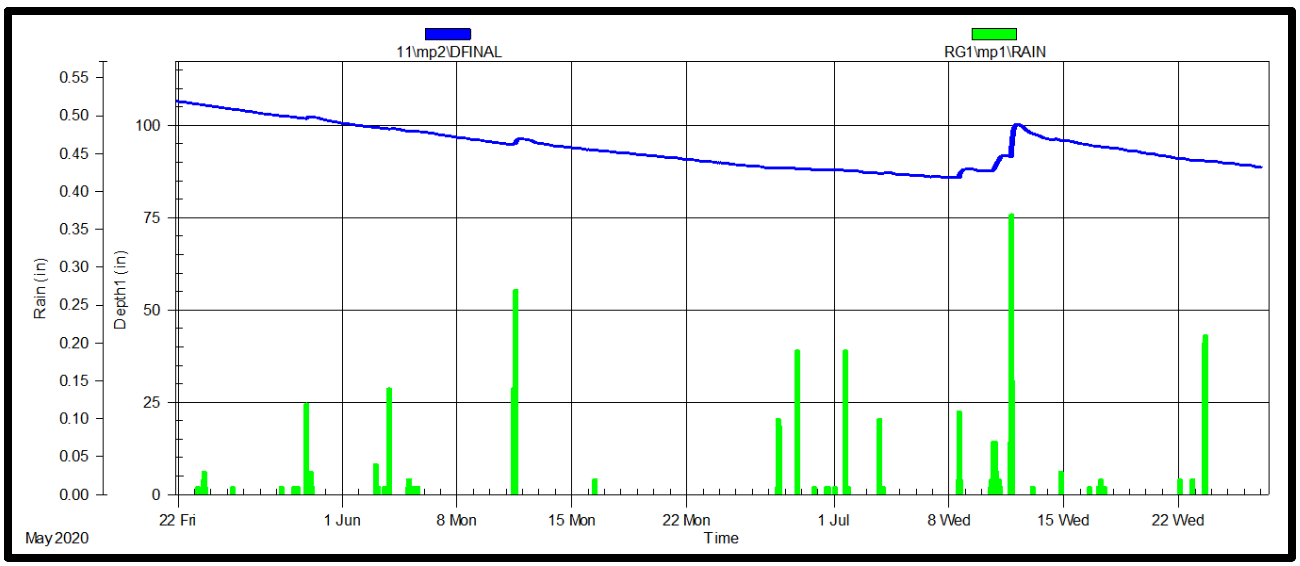
(1)Values rounded
(2)Base infiltration is considered excessive if the percentage of BI to the net average is near or above 50%

Since the ratio of net estimated base infiltration versus ADDF approaches or exceeds 50% in Basins 8 and 11 and their base infiltration approaches or exceeds 5.0 gallons/day/linear-foot of pipe they are considered to have excessive infiltration and are recommended for further evaluation.

5.4 Groundwater

There were eight groundwater gauges (piezometers) installed at flow meter locations throughout the flow monitoring period. The number of gauges was reduced from 12 to 8 due to the proximity of flowmeter locations so a single gauge could account for two/three flowmeters. For example, flow Meter Nos. 4 and 10 were installed in the same manhole; as such, a single groundwater gauge was utilized.

Groundwater gauges are installed near the influent sewer pipe spring line and calibrated to match the invert of the influent pipe. The data is then compared to the same timeframe as the flow monitoring to highlight the change in groundwater levels and potential impacts on base infiltration of the collection system. For example, at Basin 11 the data shows groundwater well above the sewer pipe and gradually decreasing throughout the monitoring period, except when significant storms occur. See diagram below.



5.5 Rainfall

There were six rain events during the study period that produced over 0.5-inches of total rainfall. Of these six events, the four largest were selected to utilize in developing RDII volumes. Based on the measured data and National Weather Service standards with respect to rainfall events for the area, the four selected storms were not of unusual severity. From a return frequency standpoint, no single event exceeded a two year frequency storm. Recorded flow data on the days of the storm events was then compared against the average dry day flows to determine the RDII volumes.

The RDII volumes in gallons per day per linear foot per inch of rain (gpd/LF/inch of rain) are presented in Table 5-4.

Table 5-4. Rainfall Dependent Inflow Infiltration (RDII)(1)

Storm Event	May 15, 2020	June 11, 2020	July 10, 2020	July 23, 2020
1	2.7	1.8	1.4	1.8
2	1.0	0.5	0.9	0.6
3	0.4	0.3	0.1	0.8
4	1.3	0.9	0.9	0.1
5	0.4	0.5	0.9	0.7
6	1.6	1.2	1.8	1.1
7	0.8	0.5	0.3	1.0
8	1.1	2.2	1.7	1.0
9	1.0	0.4	0.4	0.4
10	1.9	4.6	2.0	3.4
11	1.3	1.9	1.7	0.9
12	0.9	0.9	0.8	0.6

(1)Values rounded.

There are no formal established thresholds for identifying a basin with 'severe' RDII, but generally basins classified by a Gal/LF/Inch of Rain in the range of 0 to 10 Gal/LF/In are in the minimal category, 10 to 15 Gal/LF/Inch are in the marginal category, and greater than 15 Gal/LF/Inch are in the severe category.

The threshold values are generally higher in the winter season when vegetation is dormant and in long soaking events that cause the ground to be saturated. For example, if data are collected solely in the winter, the marginal category might be 15 to 20 Gal/LF/In. These values are generally lower for flows measured during periods of low antecedent moisture.

The calculated values in the above parameters are utilized to compare against the generally accepted thresholds. As seen in Table 5-4, there were no instances where values were greater than 15 Gal/LF/Inch. Therefore, all of the monitoring basins are determined to have minimal severity of RDII.

6.0 RECOMMENDED NEXT STEPS

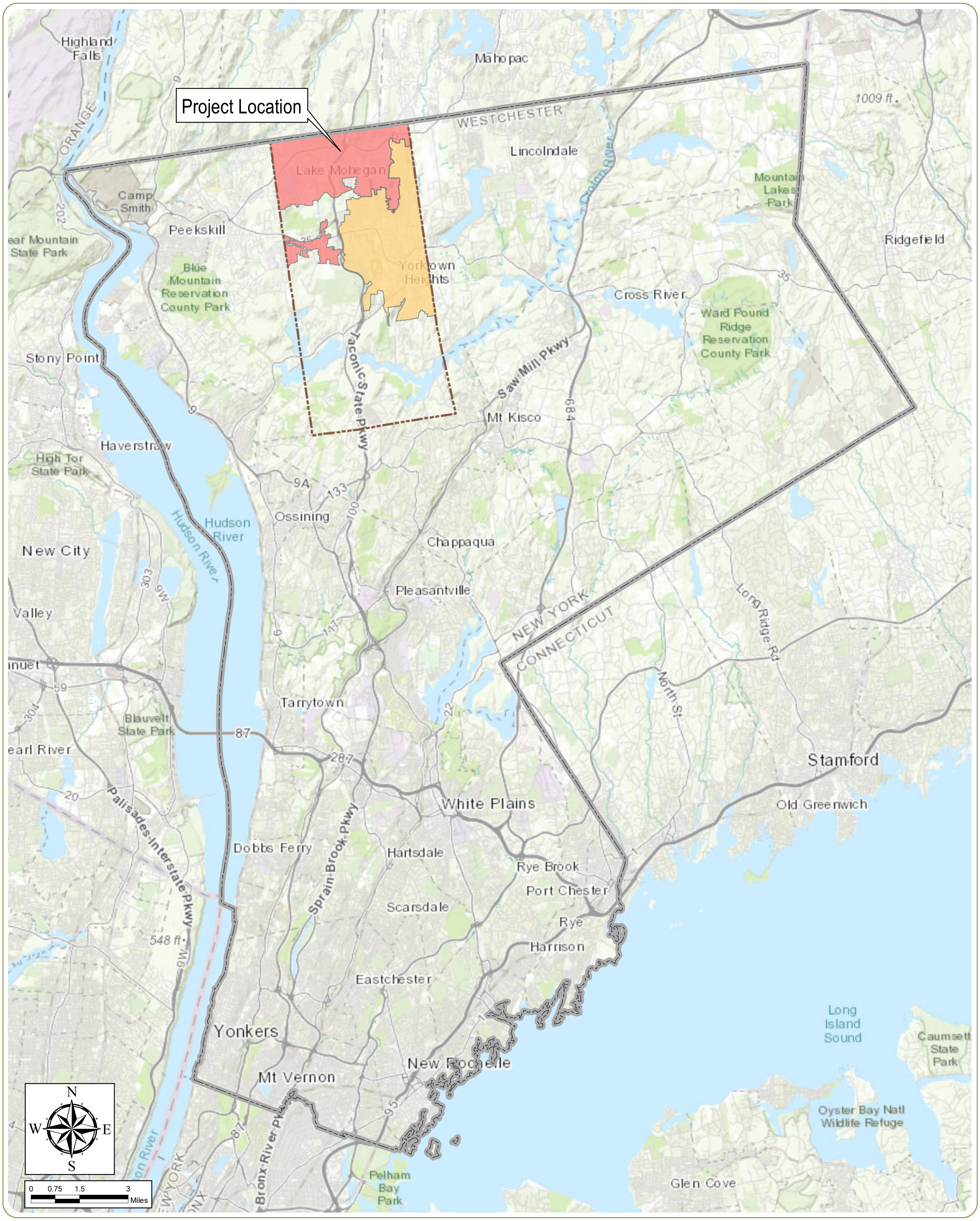
Data collected during the flow metering program indicates the following:

1. Base infiltration for Subbasins 8 and 11 exceeded equivalent EPA standards.
2. Based on the calculated wastewater flow results, it appears Basin 10 includes additional unidentified contributing sewers of wastewater flow.

Based on this data, recommendations for next steps to better identify the root causes of the system issues are as follows:

1. Complete cleaning, close circuit tv inspection (CCTV) in Subbasins 8 and 11.
2. Based on the results of cleaning and CCTV inspections, perform smoke and/or dye testing of areas to identify inflow sources that could not be verified by the CCTV inspections within Subbasins 8 and 11 if needed.
3. Further investigate Basin 10 to confirm or identify whether or not additional collection system piping contributes to Basin 10. Further investigation to confirm field conditions is recommended.

FIGURES



Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 1: Location Map

Notes: 1. Basemap: ESRI ArcGIS Online "World Topographic Map" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

- Peekskill Sewer District
- Hallocks Mill Sewer District
- Town of Yorktown
- Westchester County

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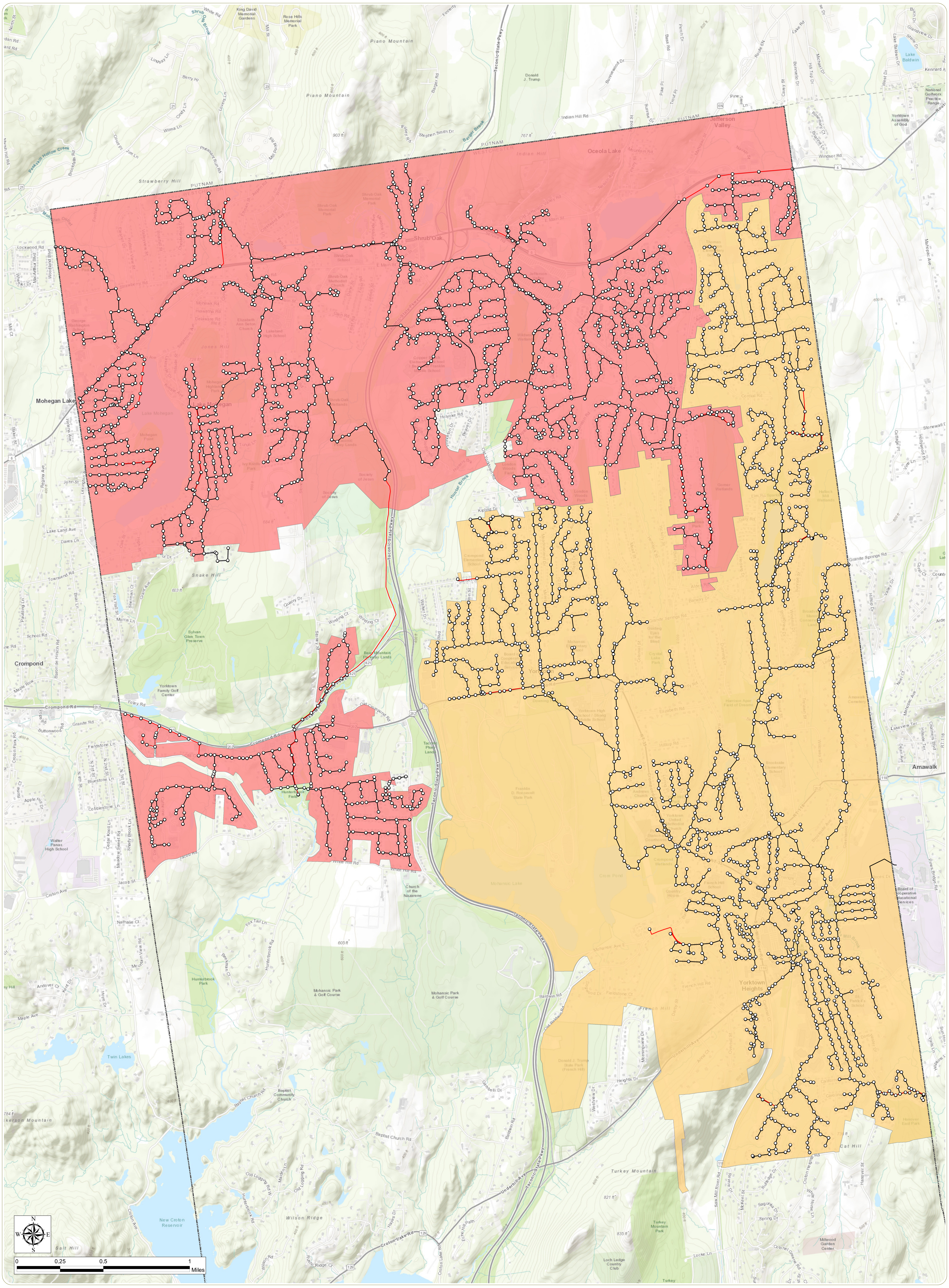

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 2: Sewer Collection System Map

- Manhole
- Sewer Force Main
- Sewer Main
- Town of Yorktown
- Peekskill Sewer District
- Hallocks Mill Sewer District

Notes: 1. Basemap: ESRI ArcGIS Online "World Topographic Map" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

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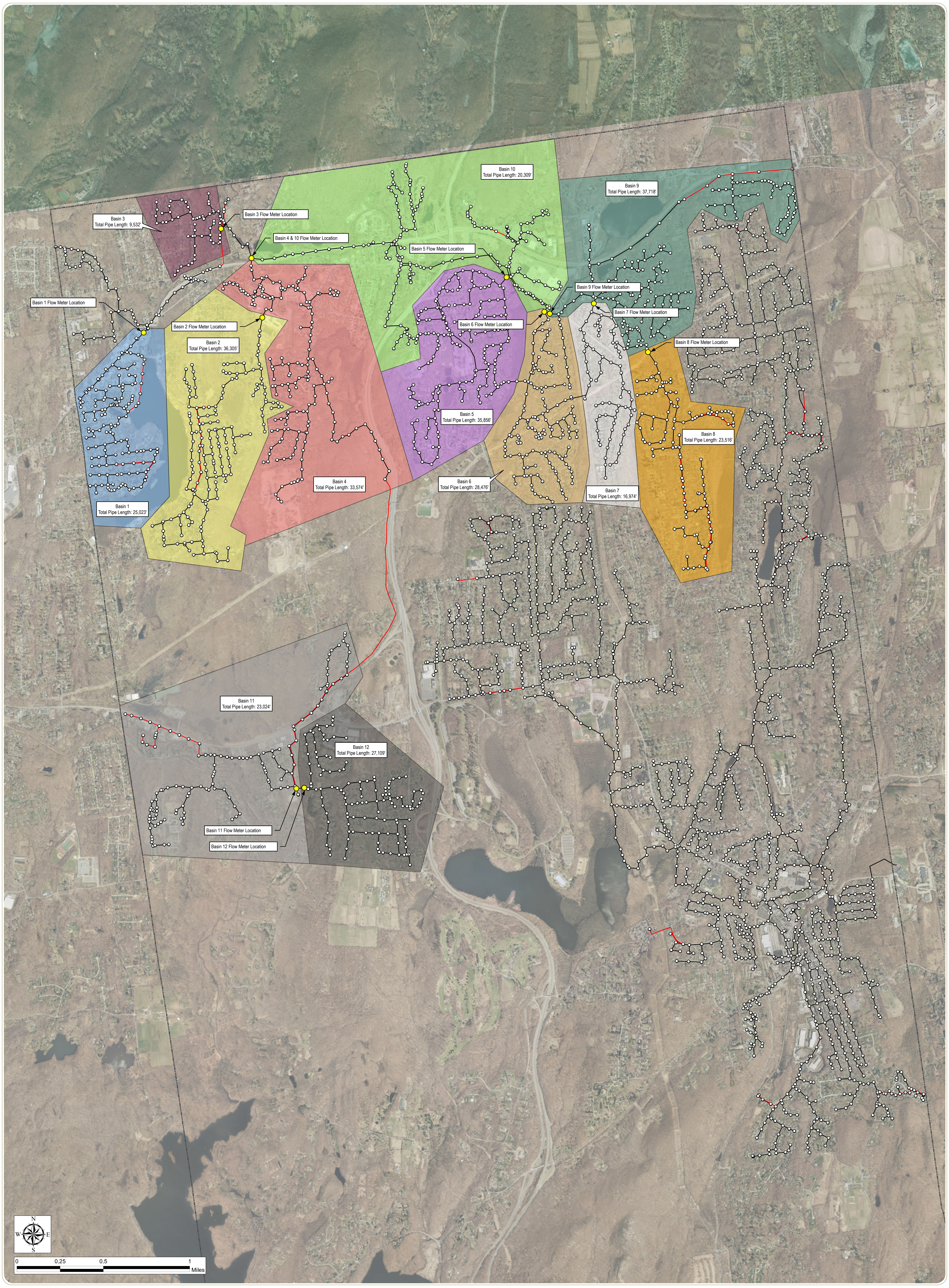

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 2: Peekskill Sewer District - Basin Location Map

- Flow Meter
- Manhole
- Sewer Force Main
- Sewer Main
- Town of Yorktown

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

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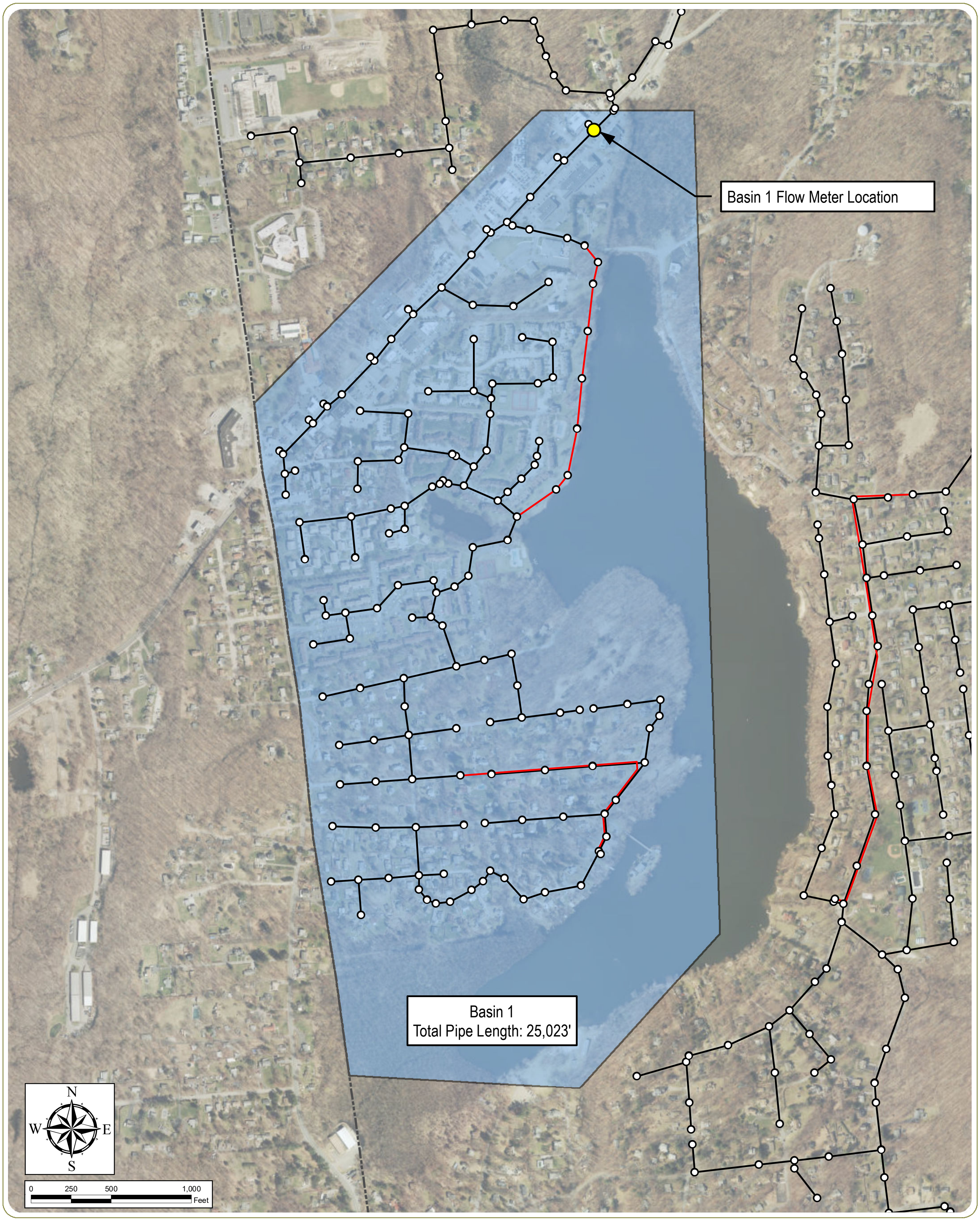


Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

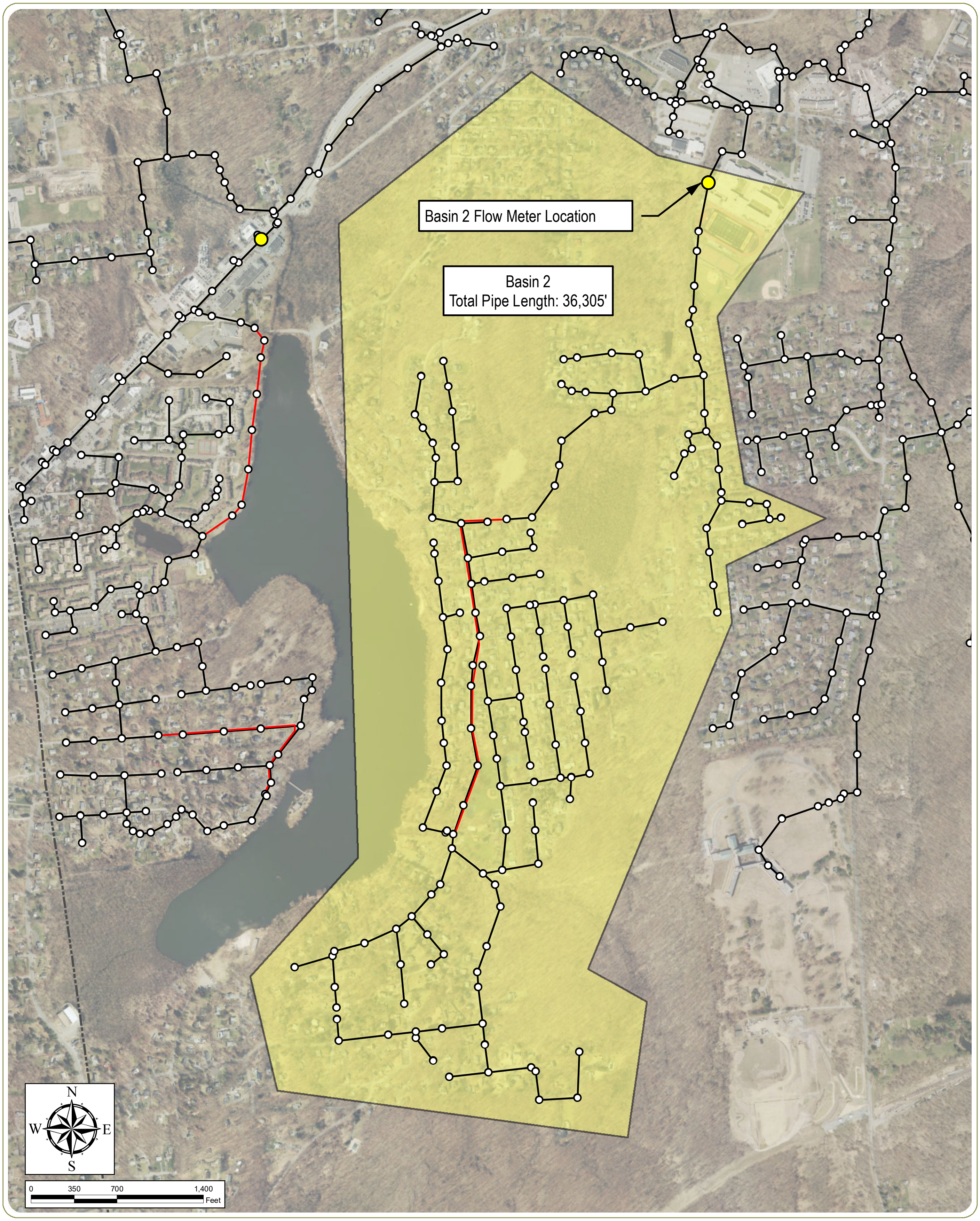
Figure 4: Basin 1

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 1
Town of Yorktown

edr

www.edrdpc.com



Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 5: Basin 2

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

- Flow Meter
- Manhole
- Sewer Force Main
- Sewer Main
- Basin 2
- Town of Yorktown

edr

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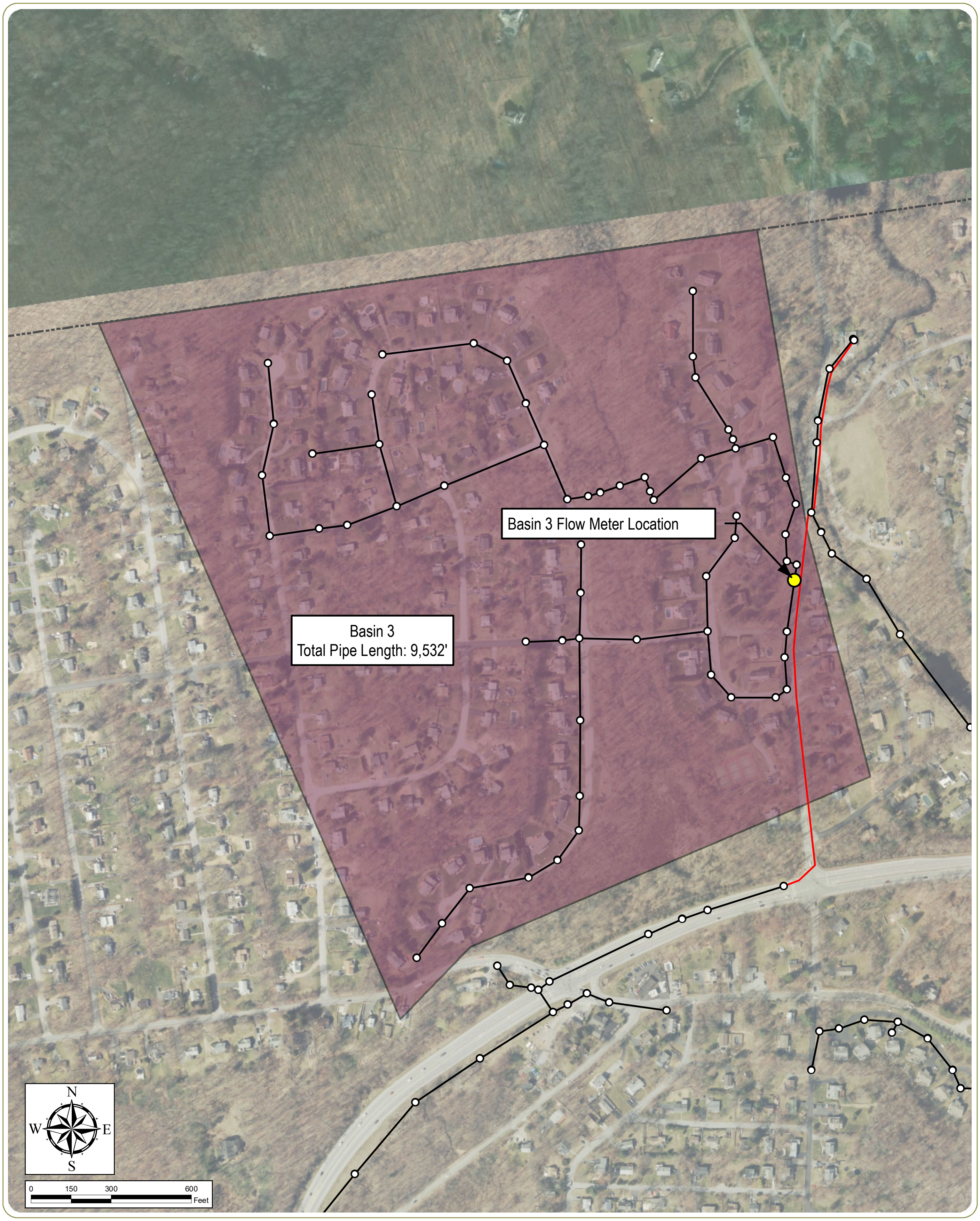

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 6: Basin 3

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 3
Town of Yorktown

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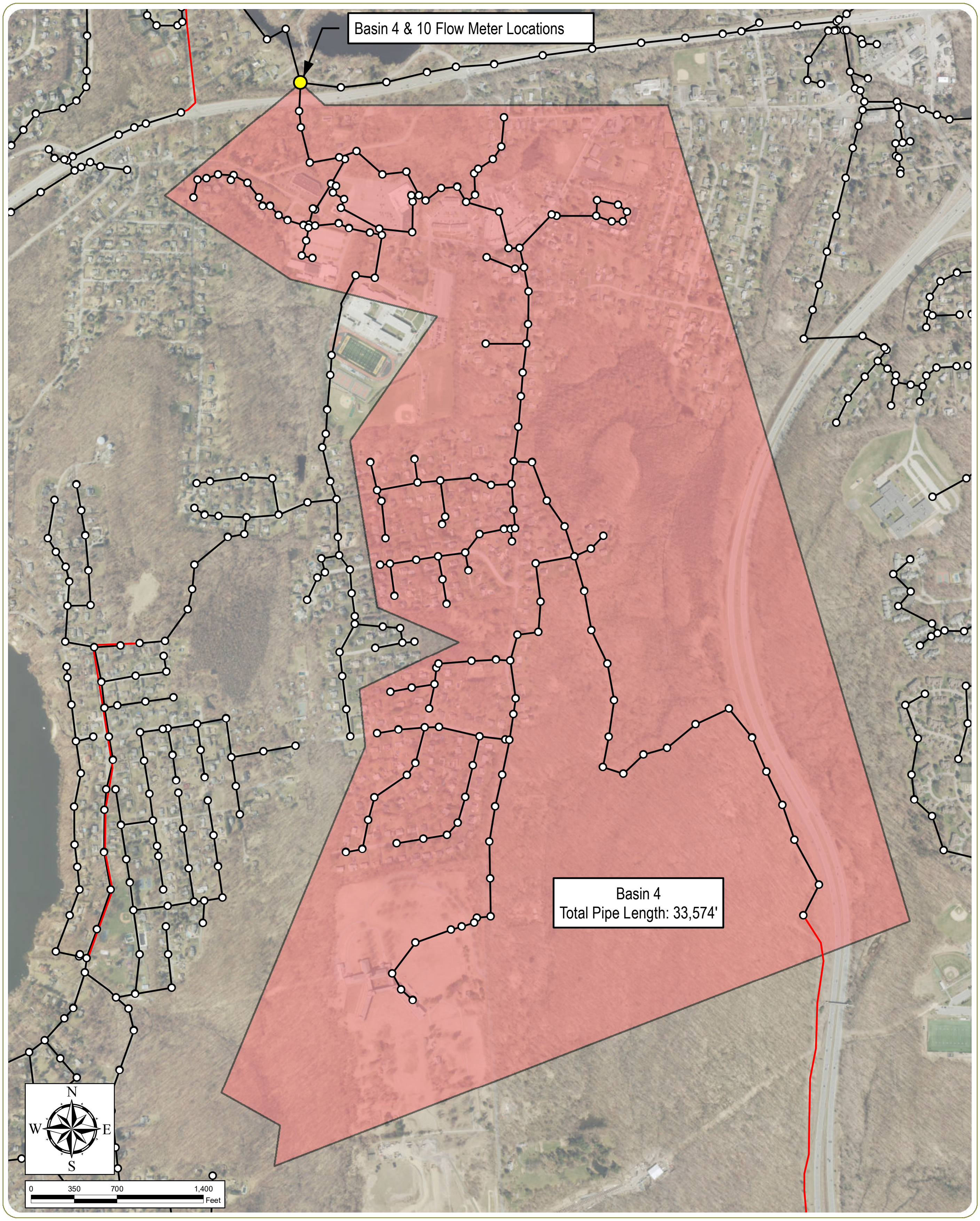

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 7: Basin 4

- Flow Meter
- Manhole
- Sewer Force Main
- Sewer Main
- Basin 4
- Town of Yorktown

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

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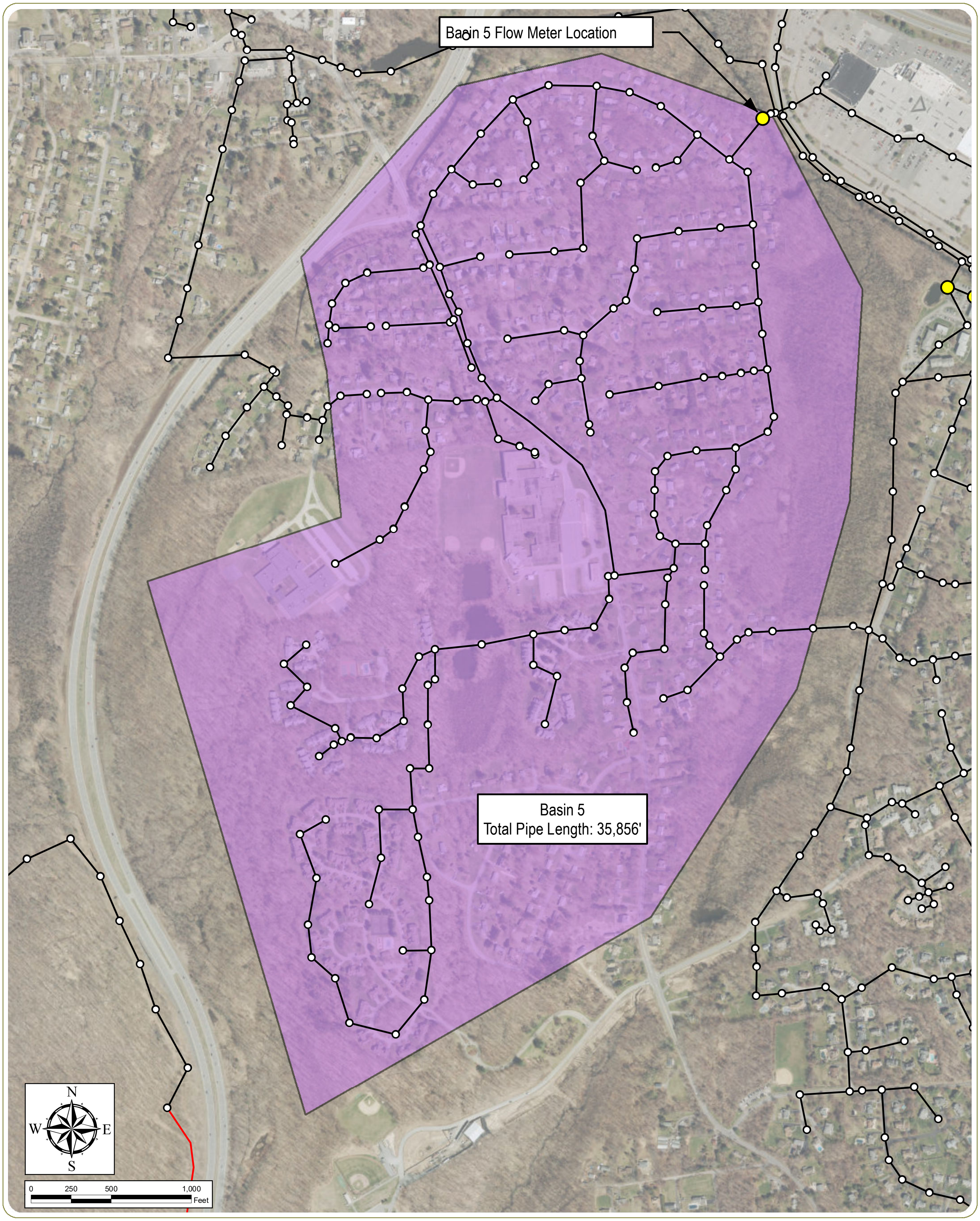

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 8: Basin 5

- Flow Meter
- Manhole
- Sewer Force Main
- Sewer Main
- Basin 5
- Town of Yorktown

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

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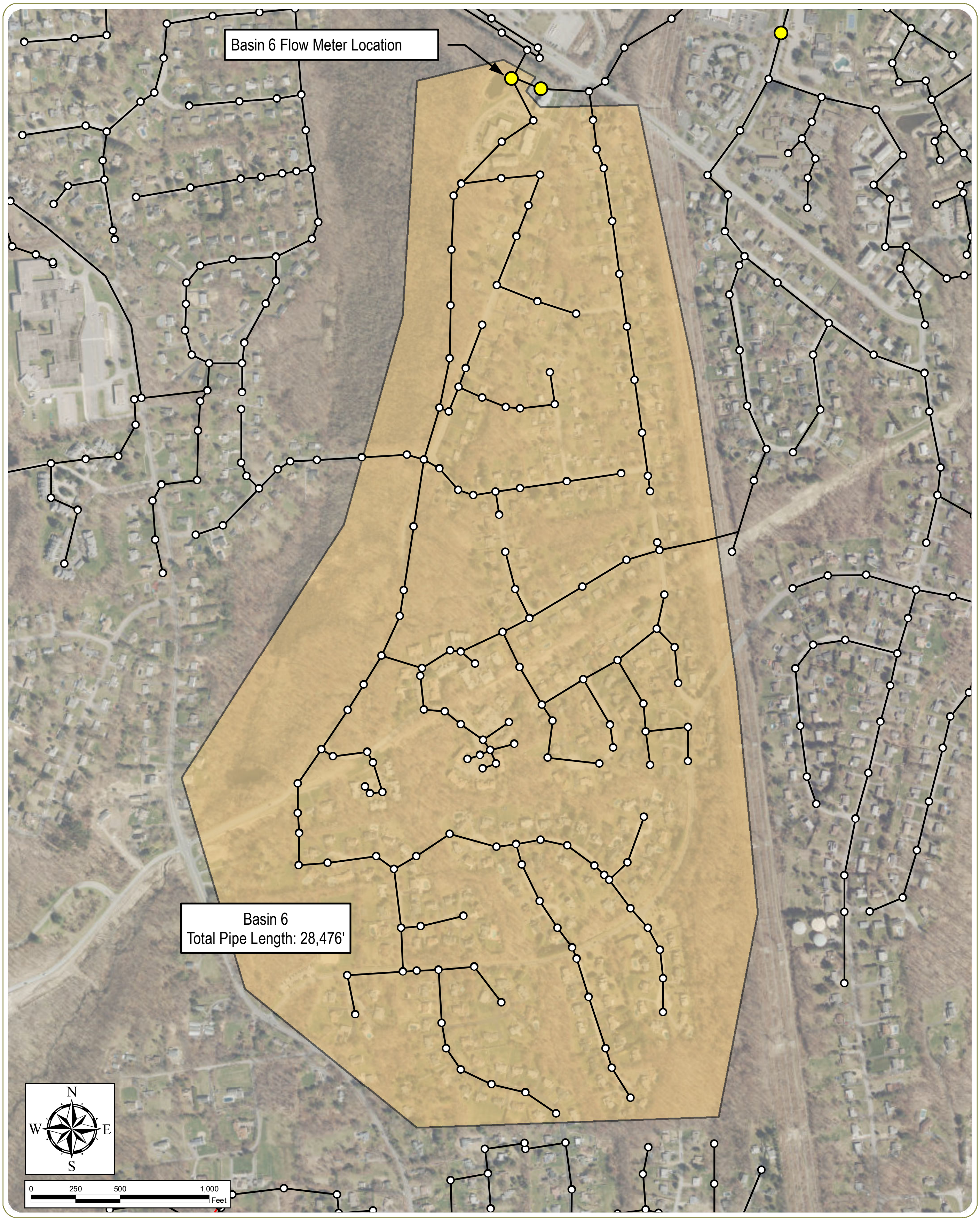

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 9: Basin 6

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 6
Town of Yorktown

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

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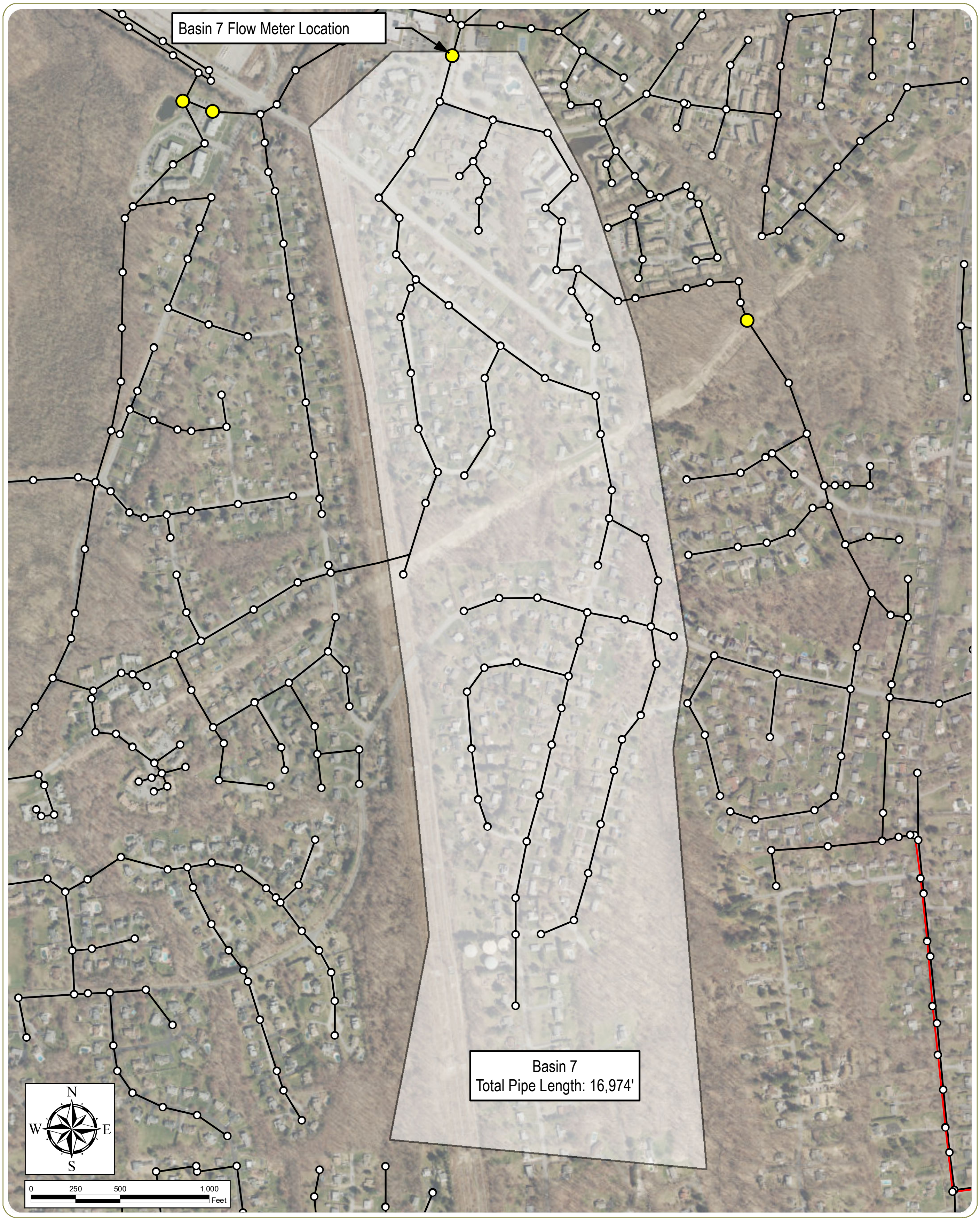

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 10: Basin 7

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

edr

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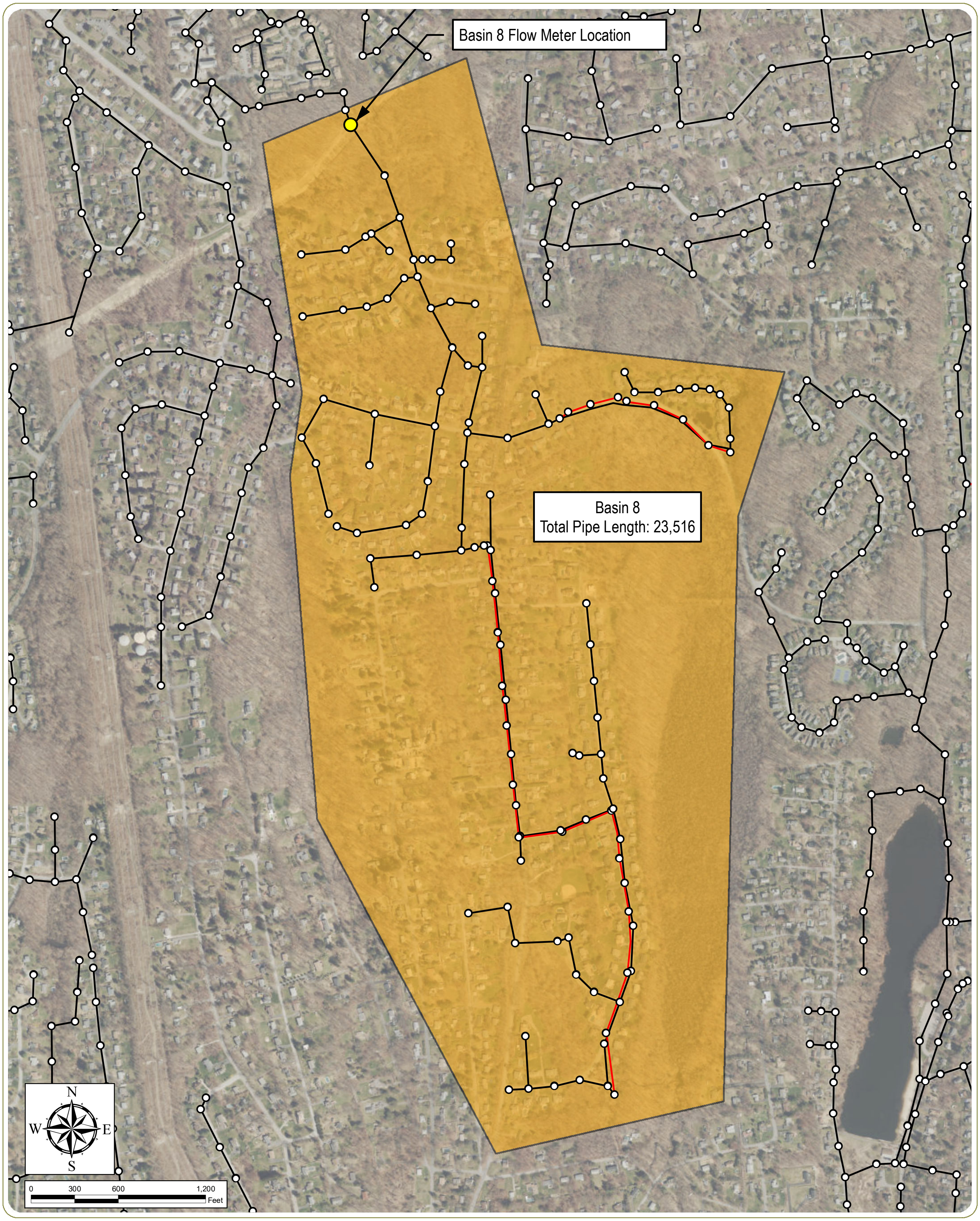


Yorktown Inflow and Infiltration Study

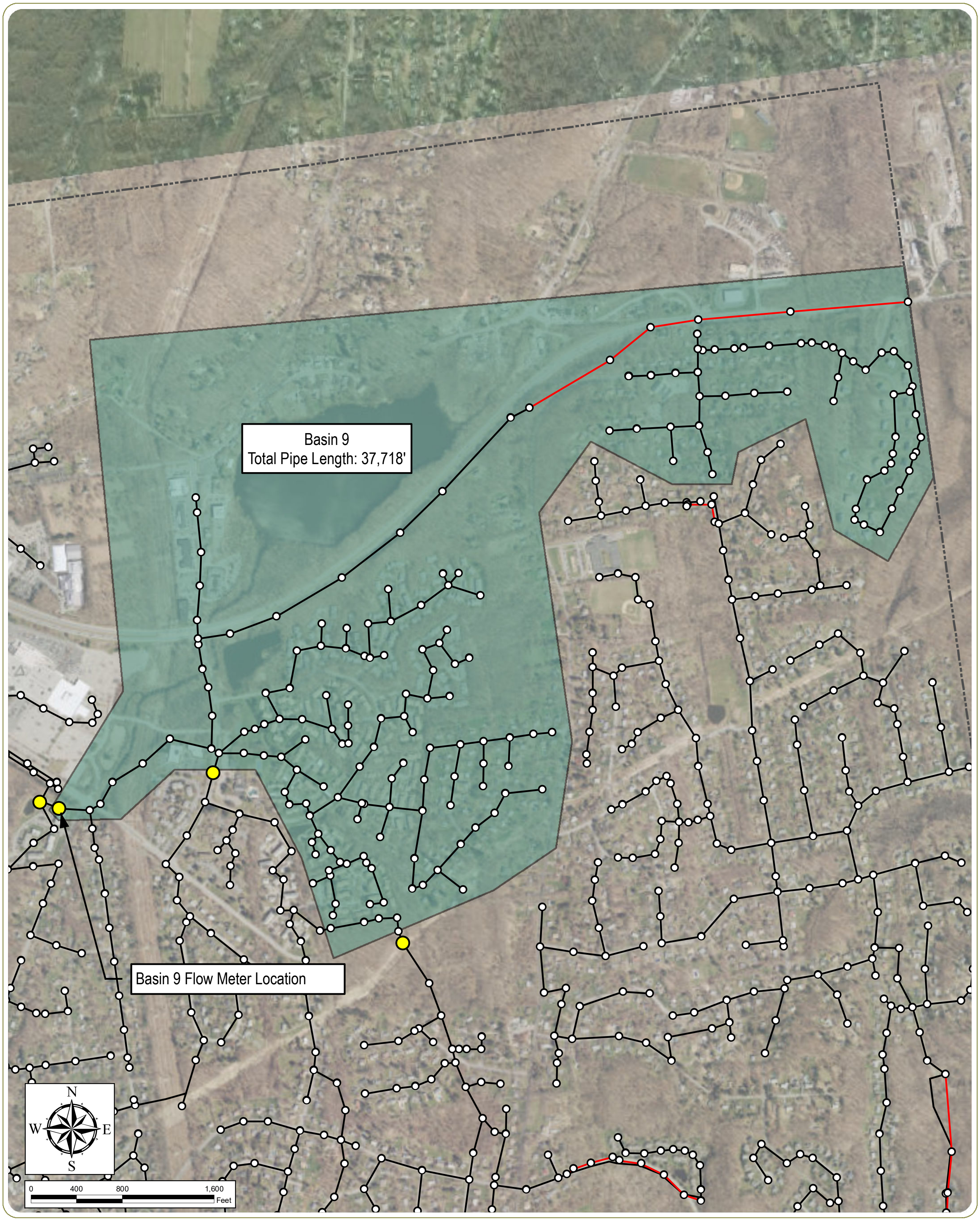
Town of Yorktown, Westchester County, New York

Figure 11: Basin 8

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 8
Town of Yorktown

edr
www.edrdpc.com



Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

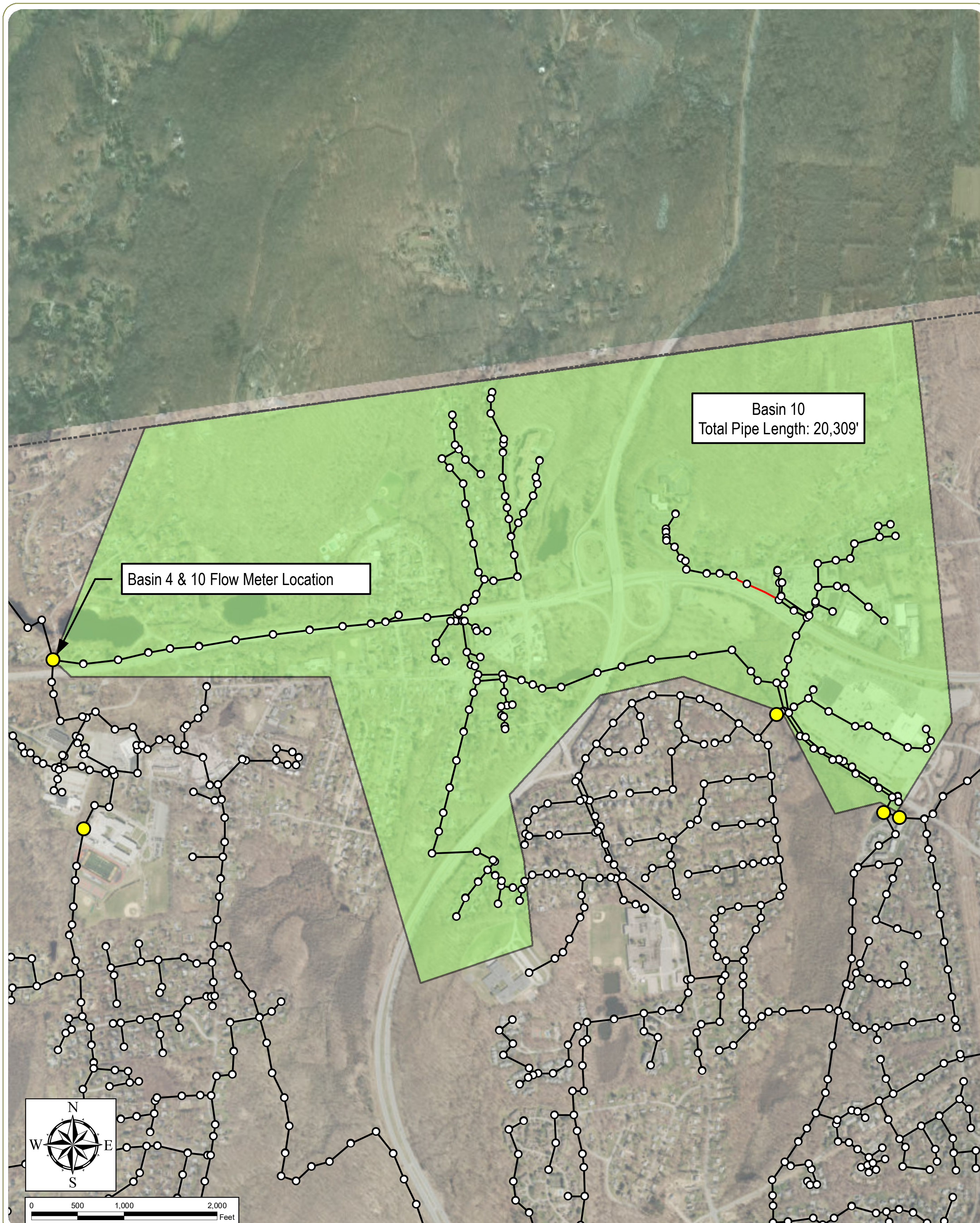
Figure 12: Basin 9

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 9
Town of Yorktown

edr

www.edrdpc.com



Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 13: Basin 10

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

- Flow Meter
- Manhole
- Sewer Force Main
- Sewer Main
- Basin 10
- Town of Yorktown

edr

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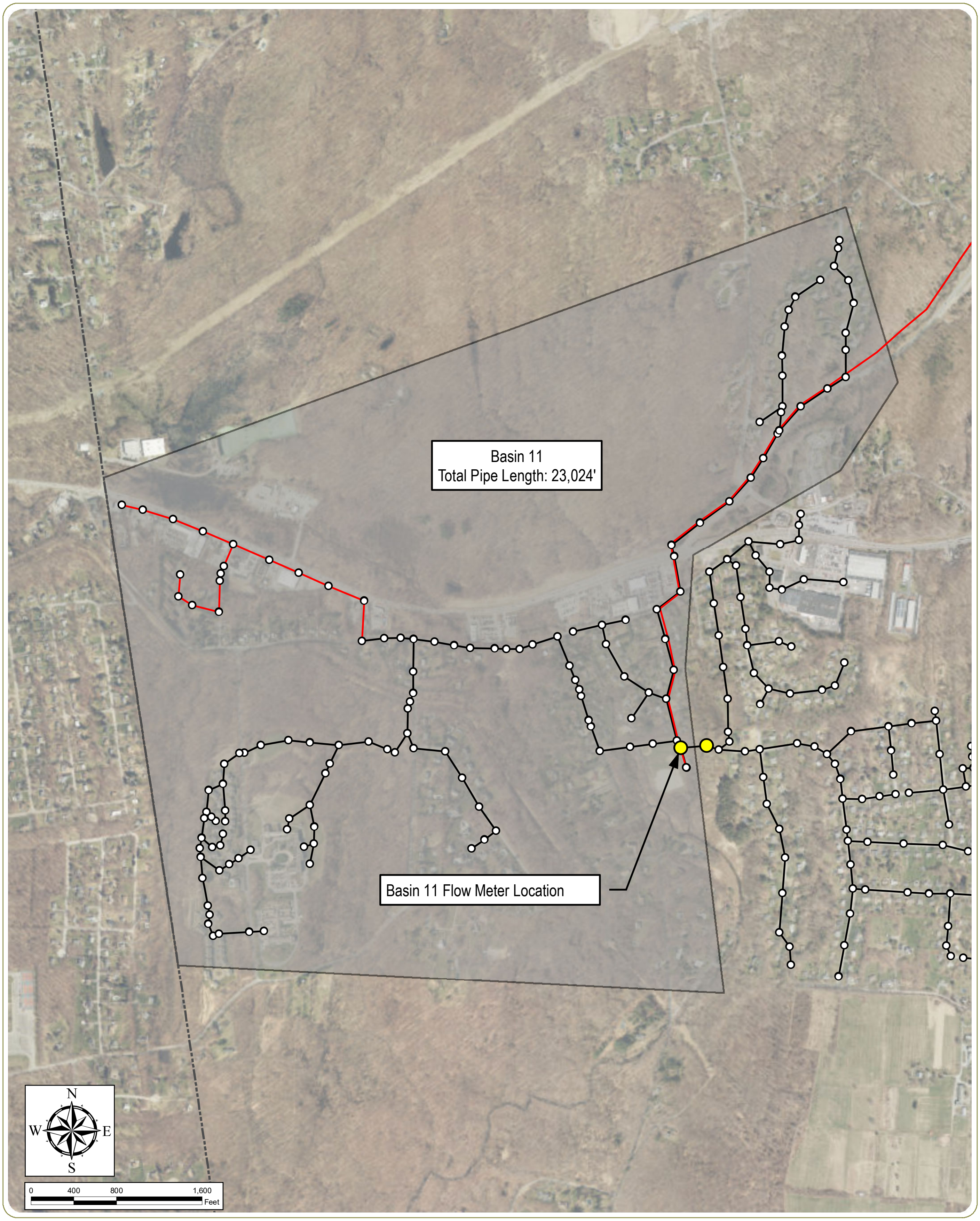

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 14: Basin 11

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 11
Town of Yorktown

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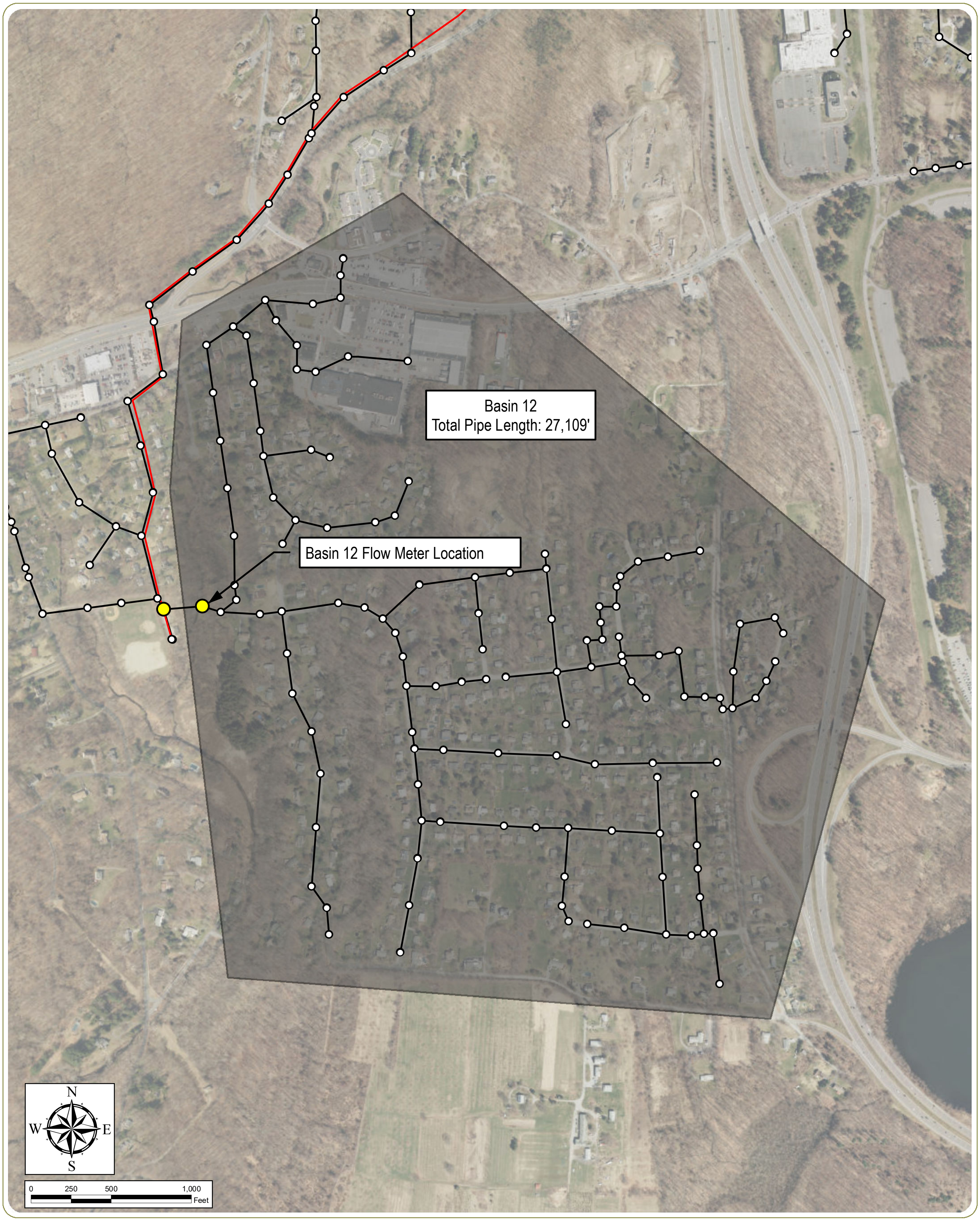

Yorktown Inflow and Infiltration Study

Town of Yorktown, Westchester County, New York

Figure 15: Basin 12

Notes: 1. Basemap: ESRI ArcGIS Online "World Imagery" map service. **2.** This map was generated in ArcMap on August 17, 2020. **3.** This is a color graphic. Reproduction in grayscale may misrepresent the data.

Flow Meter
Manhole
Sewer Force Main
Sewer Main
Basin 12
Town of Yorktown

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APPENDICES

APPENDIX A

Flowmeter Installation Reports

Yorktown TFM 2020

Flow Monitoring Site Installation Report

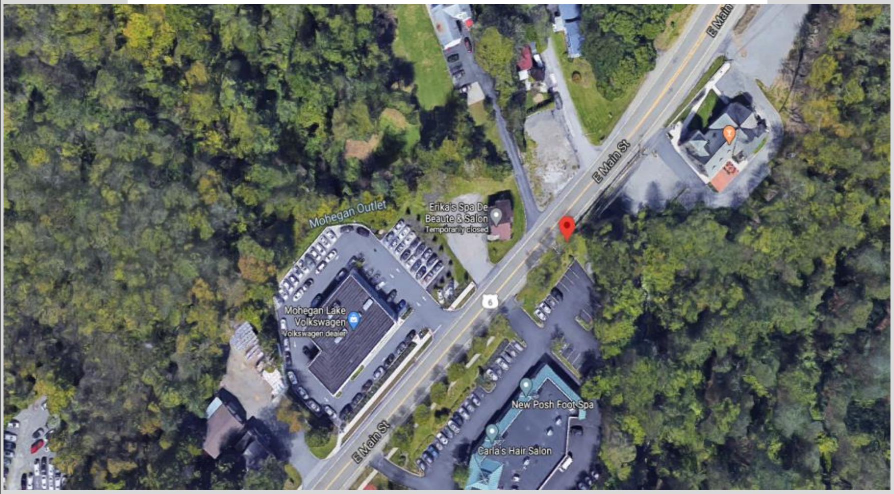
ADS ENVIRONMENTAL SERVICES®

Site I.D.

1

Site Address / Location:	1719 Rt 6 In grass behind guardrail	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive, park at end of stip mall lot	Pipe Size (H x W)	Pipe Shape
		7.75 x 7.75"	Circular

Manhole #	System Characteristics
	Commercial
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
Tuesday, May 12, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:30:00 AM	7.75 x 7.75"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
6.25	1.5
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.33	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:

Fast, steady flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
14'	Single
Manhole Material:	Manhole Condition:
Concrete	Fair
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
PVC	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

GWG P.O. = 12" 41.324096,-73.851810

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

Yorktown TFM 2020

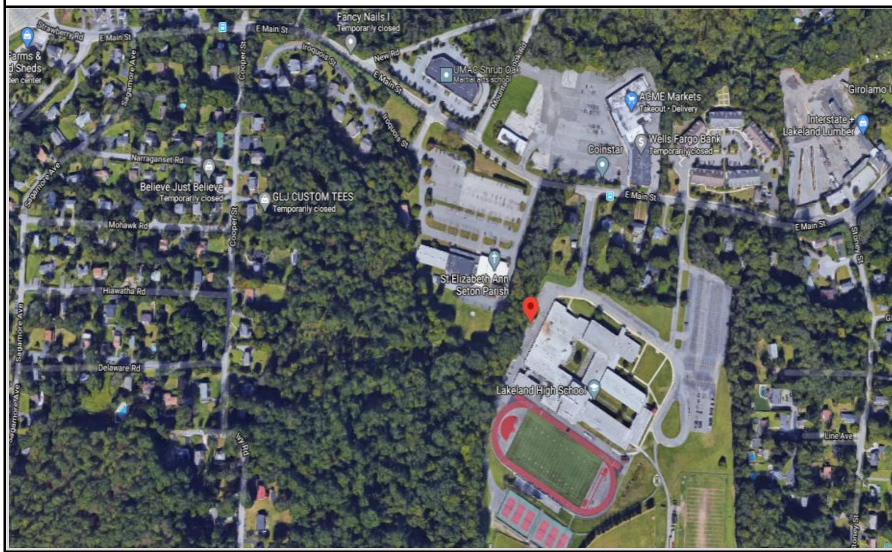
Flow Monitoring
Site Installation Report

Site I.D.

2

Site Address / Location:	Lakeland H. S. Side lot
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
8.0 x 8.0"	Circular



Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Tuesday, May 12, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:30:00 PM	8.0 x 8.0"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.25	5.75
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.18	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:
Fast, steady flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
4.5'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Cast Iron Pipe	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.325542 Lon-73.838301

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

Yorktown TFM 2020

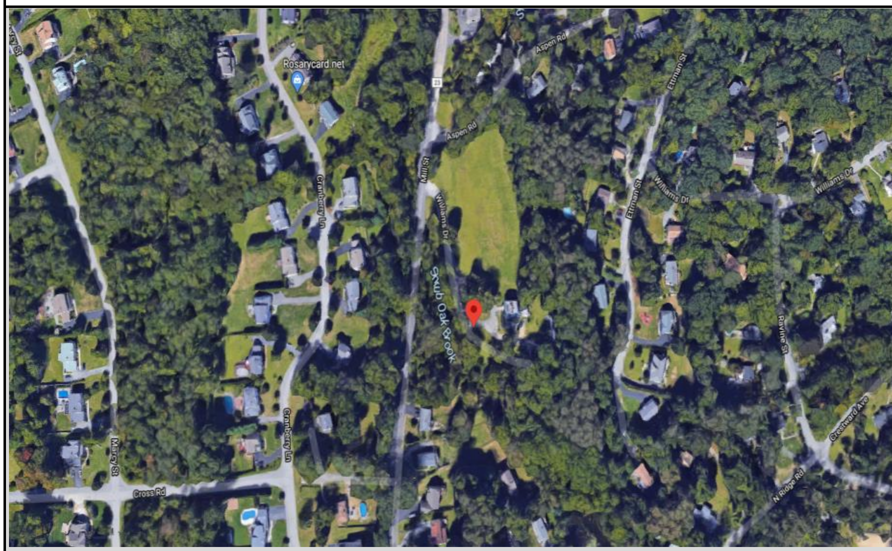
Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

Site I.D.

3

Site Address / Location:	Mill St. In grass behind guardrail near Williams Dr.	Monitor Series: TRITON+	Location Type: Temporary
Site Access:	Drive/Walk	Pipe Size (H x W): 9.75 x 9.75"	Pipe Shape: Circular



Manhole #	System Characteristics
	Residential
Access	**Traffic**
Drive	None

Installation Information

Installation Date:	Installation Type:
Wednesday, May 13, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
Surface Combo (CS5-V2)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
9:00:00 AM	9.75 x 9.75"
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
0.5	9.25
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.38"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
3.18	0
Silt (in)	**Silt Type**
0	N/A

Hydraulic Comments:
Fast, steady flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
13'	Single
Manhole Material:	**Manhole Condition:**
Concrete	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
24	36
Manhole Cover	**Manhole Frame**
Vented	Normal
Active Drop Connections	**Air Quality:**
No	20.9, 0, 0
Pipe Material	**Pipe Condition:**
Cast Iron Pipe	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.333183 Lon-73.842230 GWG P.O. = 25"

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

Yorktown TFM 2020

Flow Monitoring
Site Installation Report

Site I.D.

4

Site Address / Location:	1345 Artis Rd	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive/Walk	Pipe Size (H x W)	Pipe Shape
		12.0 x 12.0"	Circular

Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Tuesday, May 12, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
1:30:00 PM	12.0 x 12.0"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4	8
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.21	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:
Fast, steady flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
11'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Cast Iron Pipe	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.330272 Lon-73.839633 GWG P.O. = 33"

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

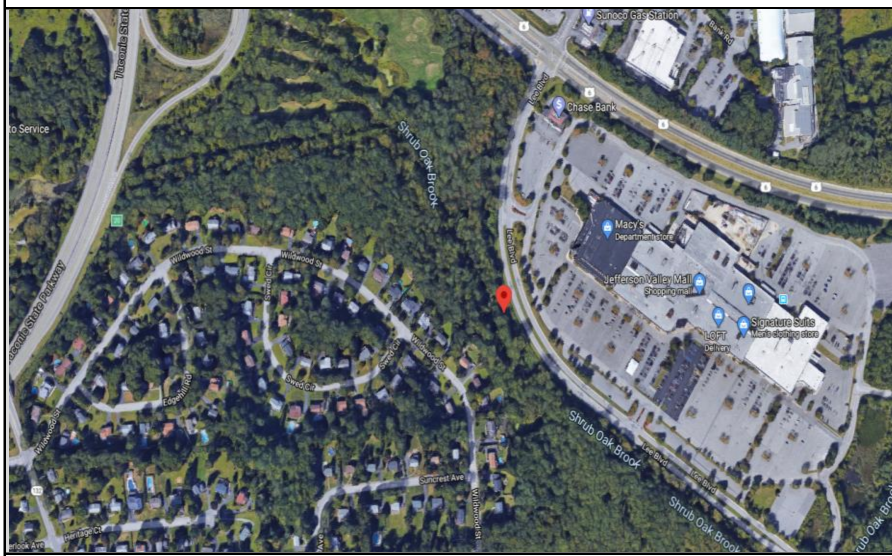
Yorktown TFM 2020

Flow Monitoring
Site Installation Report

Site I.D.

5

Site Address / Location:	651 Lee Blvd. across from Macy's	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive/Walk	Pipe Size (H x W)	Pipe Shape
		12.0 x 12.0"	Circular



Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Wednesday, May 13, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:00:00 PM	12.0 x 12.0"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2	10
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.98	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:
Fast, steady flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
14'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
PVC	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.328422 Lon-73.811066 GWG P.O. = 10" D/S installation

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

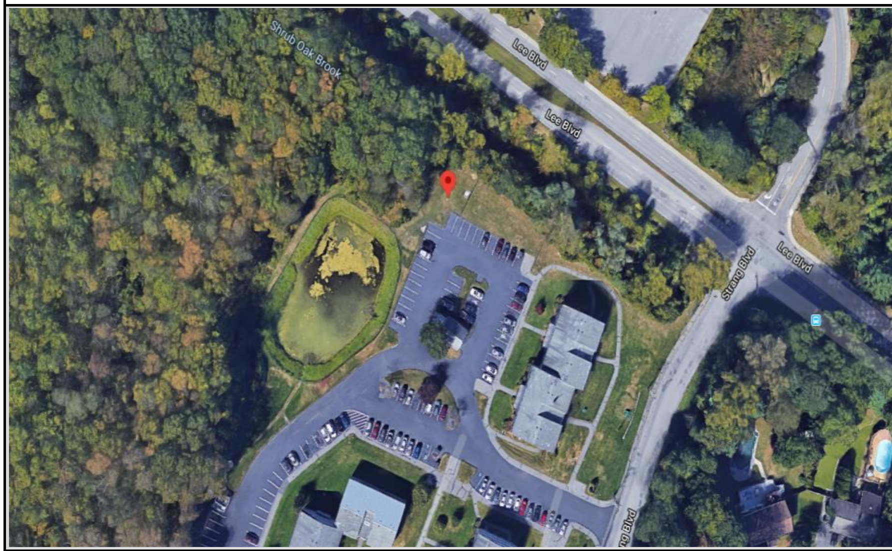
Yorktown TFM 2020

Flow Monitoring
Site Installation Report

Site I.D.

6

Site Address / Location:	In grass, Rt rear corner Jefferson Woods Apts.	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive/Walk	Pipe Size (H x W)	Pipe Shape
		12.25 x 12.25	Circular



Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	None

Installation Information

Installation Date:	Installation Type:
Thursday, May 14, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:20:00 AM	12.25 x 12.25
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
3	9.25
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.75	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:

Moderately fast flow, bend has no effect

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
12'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Cast Iron Pipe	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

41.325182,-73.806601 GWG P.O. = 12"

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

Yorktown TFM 2020

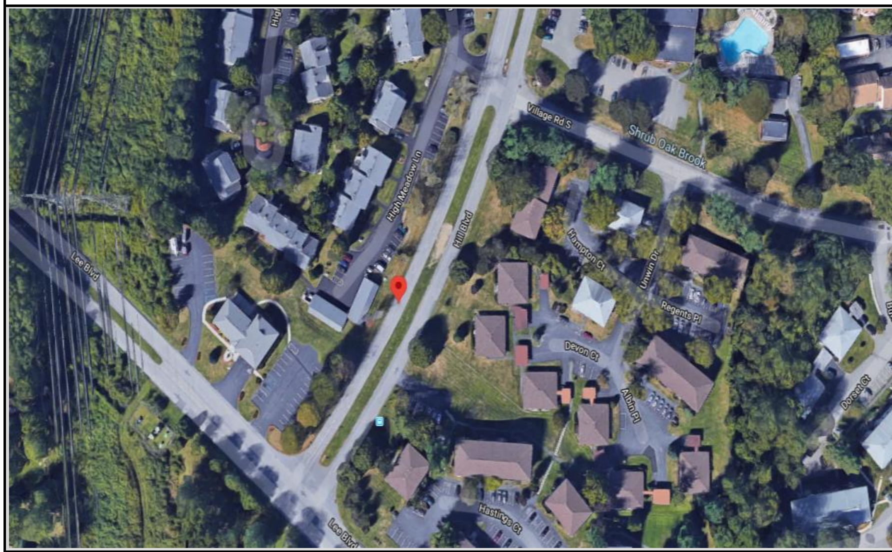
Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

Site I.D.

7

Site Address / Location:	19 A & B Hill Blvd.	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive	Pipe Size (H x W)	Pipe Shape
		7.75 x 7.75"	Circular



Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	Light

Installation Information

Installation Date:	Installation Type:
Wednesday, May 13, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Surface Combo (CS5-V2)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:20:00 AM	7.75 x 7.75"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
0.5	7.25
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.38	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:

Fast flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
9'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Concrete	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

41.324712,-73.802526 GWG P.O. = 8"

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

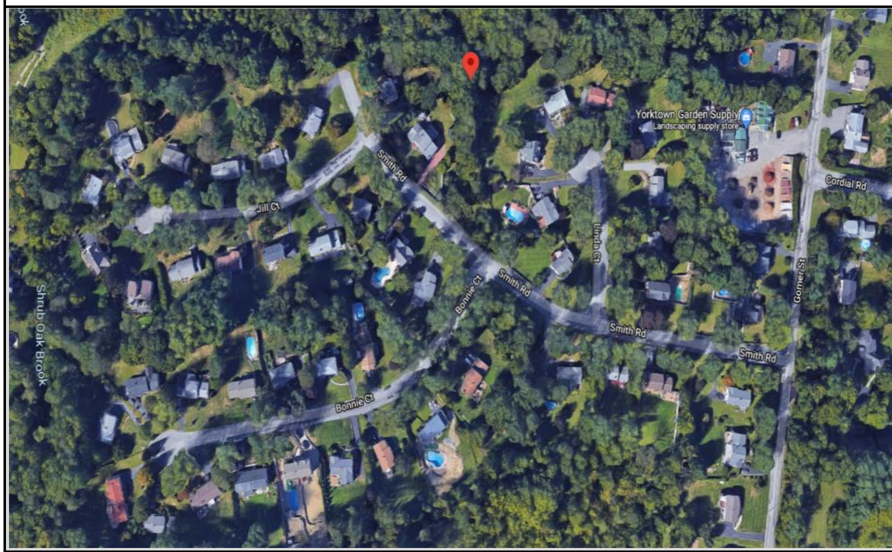
Yorktown TFM 2020

Flow Monitoring
Site Installation Report

Site I.D.

8

Site Address / Location:	420 Smith Rd (Jill Ct)	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive/Walk	Pipe Size (H x W)	Pipe Shape
		8.0 x 8.0"	Circular



Manhole #	System Characteristics
	Residential
Access	Traffic
Walk (Wooded)	None

Installation Information

Installation Date:	Installation Type:
Wednesday, May 13, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Surface Combo (CS5-V2)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:00:00 AM	8.0 x 8.0"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2	7.25
Downlooker Physical Offset (in)	Measurement Confidence (in)
	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.02	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:

Fast even flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
4.5'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Concrete	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.320397 Lon-73.794270 GWG P.O. = 10"

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

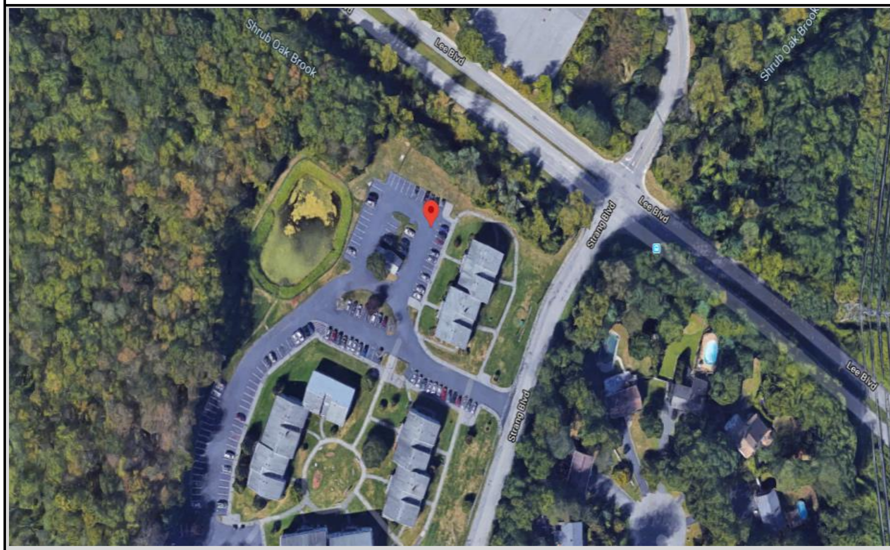
Yorktown TFM 2020

Flow Monitoring Site Installation Report

Site I.D.

9

Site Address / Location:	Parking lot of 3601 Strang Blvd. Jefferson Woods Apts.	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive	Pipe Size (H x W)	Pipe Shape
		16.0 x 16.0"	Circular



Manhole #	System Characteristics
	Residential
Access	**Traffic**
Drive	None

Installation Information

Installation Date:	Installation Type:
Thursday, May 14, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
9:45:00 AM	16.0 x 16.0"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4	12
Downlooker Physical Offset (in)	Measurement Confidence (in)
	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.36	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:

Moderately fast flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
11'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Concrete	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

41.325159,-73.806642

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

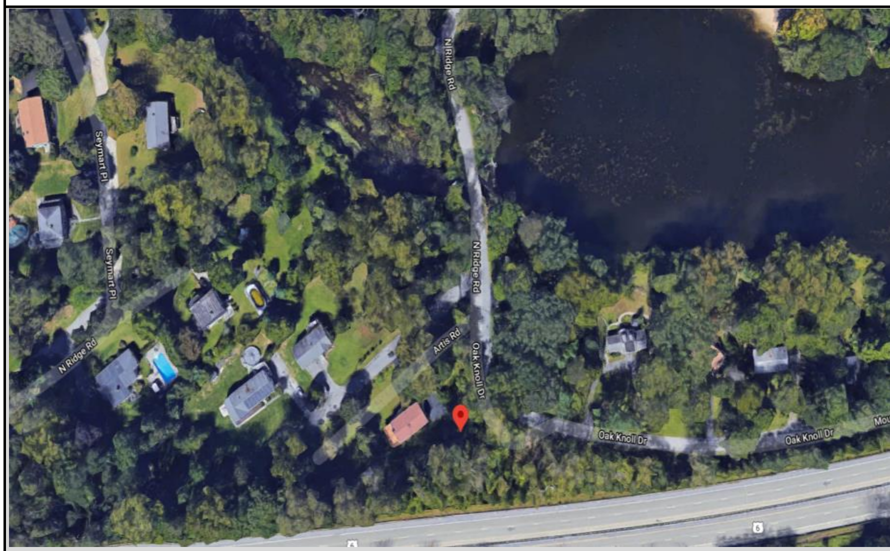
Yorktown TFM 2020

Flow Monitoring
Site Installation Report

Site I.D.

10

Site Address / Location:	1345 Artis Rd	Monitor Series TRITON+	Location Type Temporary
Site Access:	Drive/Walk	Pipe Size (H x W) 30.0 x 30.0"	Pipe Shape Circular



Manhole #	System Characteristics
	Other
Access	**Traffic**
Drive	None

Installation Information

Installation Date:	Installation Type:
Tuesday, May 12, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
1:30:00 PM	30.0 x 30.0"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
8	22
Downlooker Physical Offset (in)	Measurement Confidence (in)
	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.55	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:
Moderately smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
11'	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
Yes, Inside	20.9, 0, 0
Pipe Material	Pipe Condition:
Cast Iron Pipe	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.330272 Lon-73.839633 Metering interceptor line

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

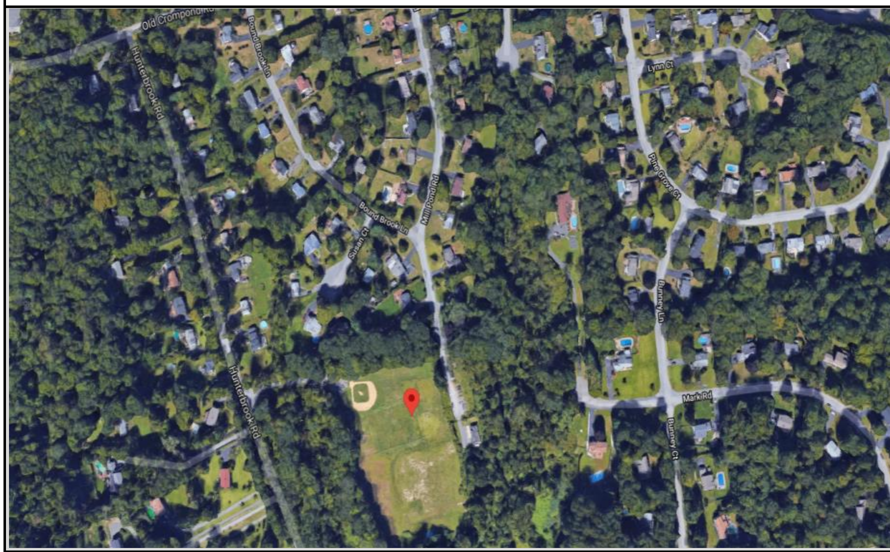
Yorktown TFM 2020

Flow Monitoring
Site Installation Report

Site I.D.

11

Site Address / Location:	2413 Mill Pond Rd Just U/S of P/S	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive/Walk	Pipe Size (H x W)	Pipe Shape
		12.25 x 12.25"	Circular



Manhole #	System Characteristics
	Other
Access	Traffic
Drive	None

Topside / Area

Installation Information

Installation Date:	Installation Type:
Tuesday, May 12, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
9:00:00 AM	12.25 x 12.25"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.38	9.88
Downlooker Physical Offset (in)	Measurement Confidence (in)
	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.17	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:
Moderately smooth flow

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
14	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
Yes, Outside	20.9, 0, 0
Pipe Material	Pipe Condition:
Cast Iron Pipe	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.285552 Lon-73.835687 GWG P.O. = 14"

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

Yorktown TFM 2020

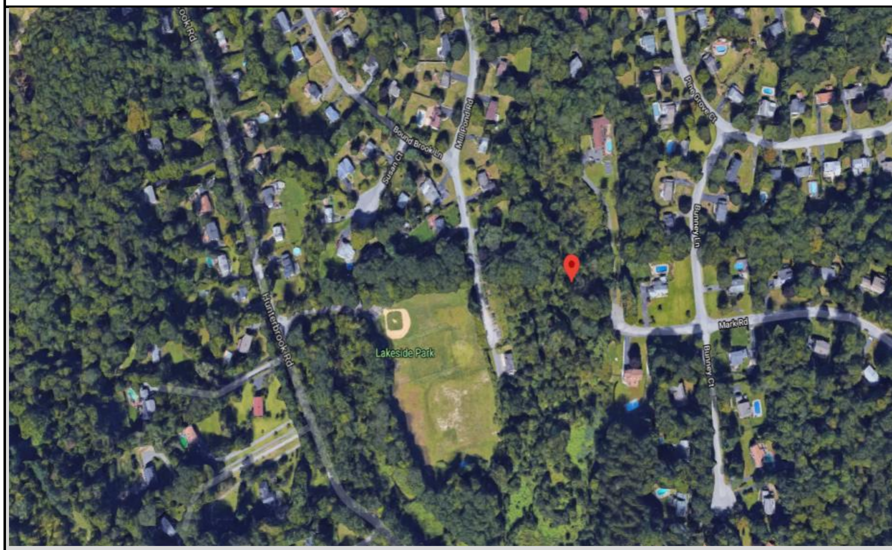
Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

Site I.D.

12

Site Address / Location:	In woods at end of Theresa Ct.	Monitor Series	Location Type
		TRITON+	Temporary
Site Access:	Drive/Walk	Pipe Size (H x W)	Pipe Shape
		7.0 x 6.38"	Elliptical



Manhole #	System Characteristics
	Other
Access	Traffic
Walk (Wooded)	None

Installation Information

Installation Date:	Installation Type:
Tuesday, May 12, 2020	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:00:00 AM	7.0 x 6.38"
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.5	2.5
Downlooker Physical Offset (in)	Measurement Confidence (in)
	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.59	0
Silt (in)	Silt Type
0	N/A

Hydraulic Comments:

Configuration of trough lends itself to frequent ragging/back-ups

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
12	Single
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
24	36
Manhole Cover	Manhole Frame
Vented	Normal
Active Drop Connections	Air Quality:
No	20.9, 0, 0
Pipe Material	Pipe Condition:
Cast Iron Pipe	Fair

Communication Information:

Communication Type	Antenna Location
Wireless	Grass (buried)

Additional Site Info. / Comments:

Lat 41.286046 Lon-73.834069

ADS Project Name:	Yorktown EDR TFM 2020
ADS Project Number:	32561.11.325

APPENDIX B

Rainfall Derived Inflow and Infiltration Report

FLOWVIEW™

UNDERGROUND INTELLIGENCE®
FOR ENHANCED COLLECTION SYSTEM PERFORMANCE

ADS ENVIRONMENTAL SERVICES®

Yorktown, NY

Rainfall Derived Inflow and Infiltration Report

May - July 2020

Contents

Definitions

Average Dry Day Flow (ADDF) - The average of several qualified Dry Days.

Basin – a designation given to a series of interconnected sewers within a sanitary sewer system that collect and convey wastewater to a common manhole or pump station. The size and geographic extent of a given basin are system specific. Basin designations are established to provide a consistent nomenclature for system components to facilitate effective planning, operation, and maintenance.

Base Infiltration (BI) – Component of ADDF comprised of groundwater, potable water leaks, springs and tidal intrusion. BI is relatively steady over days and weeks.

Dry Day – Day not influenced by prior rainfall. To qualify as a Dry Day, cumulative rainfall must be less than 0.10” for the prior one day, 0.50” for the prior three days, and 1.00” for the prior five days.

Gallons per Day Inch Diameter Mile (GPDIM) – Dry weather flow that is normalized by the basin pipe size and length.

Gross flows – Flow measured by a meter.

Inflow – Fast response flow component of RDII that enters a sanitary sewer system from direct connections including, but not limited to, building downspouts, clean-outs, foundation drains, sump pumps, basement and area drains, and cross connections with storm sewer systems.

Infiltration – Slow response flow component of RDII; water that enters a sanitary sewer system from the ground through defective system components including, but not limited to, defective sewers, manholes, service connections, or other system appurtenances. Infiltration is primarily dependent upon groundwater elevations but may also be influenced by storm events and leaking water mains.

Net flows – Flow measured by a meter minus Gross flow(s) from any upstream meter(s).

Rainfall Dependent Inflow and Infiltration (RDII) – Extraneous flow that enters a collection system following a precipitation event. It includes Inflow and Infiltration. Base Infiltration is removed from the calculation of RDII.

Rainfall Return Frequency – From rainfall measurements, for every year of record, determine the annual maximum rainfall intensity for specific durations (or the annual maximum rainfall depth over the specific durations). Common durations for design applications are: 5-min, 10-min, 15-min, 30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr

Peaking Factor (PF) – a ratio of maximum flow rate to average flow rate. Peaking factors are often calculated to describe both dry weather and wet weather periods, where maximum flow rates are compared to average dry weather flow rates. In this study, peaking factors are computed using hourly average data.

Wastewater (WW) – Component of ADDF comprised of sanitary flow from buildings and industrial discharge.

Wet period – Time of year when groundwater and soil moisture is high due to winter/spring precipitation.

Introduction

In May 2020, ADS Environmental Services (ADS) performed sewer flow monitoring for Environmental Design and Research (EDR) in the Yorktown, NY collection system. Flow monitoring at twelve (12) locations determined by EDR began on 13 May 2020 and concluded on 26 July 2020. A rain gauge was installed at a pump station near 3770 Curry St. and recorded six (6) storms greater than 0.50". The monitoring points were selected to identify areas that experience excessive amounts of infiltration and inflow, which can compromise collection system performance and increase operating costs. ADS field crews performed operation and maintenance activities throughout the period with no significant loss of data. This effort includes manual field checks to ensure equipment was accurately measuring flows and rainfall.

At the conclusion of the monitoring period, ADS removed the equipment and performed QA/QC checks on the data set to ensure consistency and valid data were reported. ADS further analyzed the data through their Sliicer program, which is a tool to help separate flows into dry days and wet days and determine volume of inflow and infiltration for each basin. This report utilizes the outputs from the Sliicer program and includes all data collected in MS Excel, field installation reports and industry standard graphs (hydrograph and scattergraph) of collected data.

1.0 – Analysis Steps to Achieve Wet Weather Performance

The following sections address the Dry Day and the RDII (Rainfall Dependent Infiltration and Inflow) analysis. These steps include determining the basin size and performing a quality check on the wastewater produced by each basin. Rainfall data are examined and RDII is calculated.

1.1 - Basin Size

Basin boundaries were drawn in ArcMap software to generally follow the neighborhood or natural boundaries.
The length (ft.) of sewer pipes for each basin was provided to ADS by EDR. The reason to keep track of basin footage is two-fold. The first use is a QA/QC step to test the magnitude of wastewater generated. The volume of dry day flow from the basin is divided by the length of sewer, generating a value in gallons per day per linear foot (LF) of public sanitary sewer. This analysis is discussed on the page 7. If there are upstream meters, the basin size is the area between the meter, also called the Net basin size. For this monitoring project the basin sizes (flow meters) in Linear Feet are listed in Table 1.

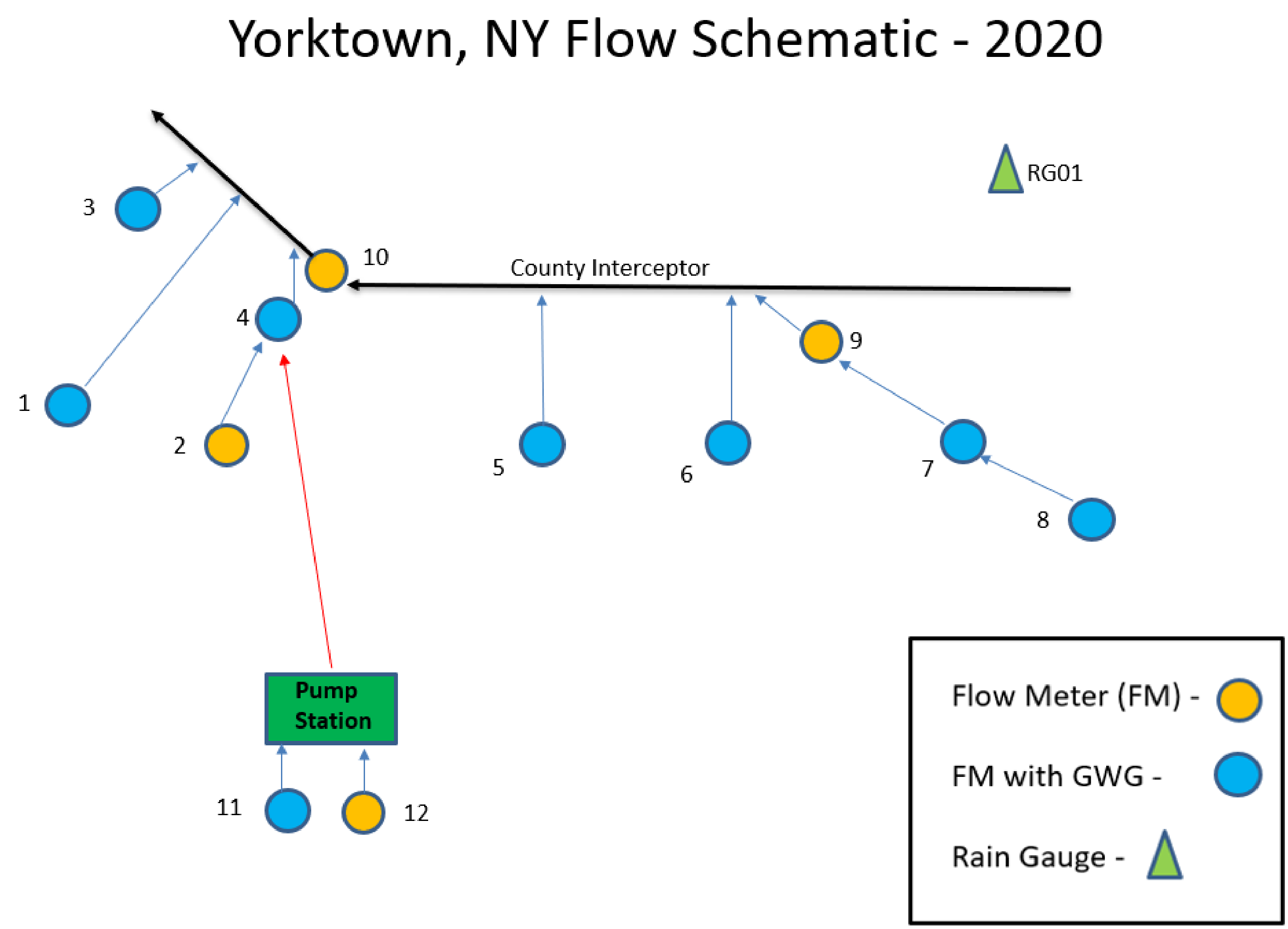
Table 1

Basin	LF of Pipe
1	28,544
2	33,514
3	21,149
4	31,542
5	35,512
6	26,715
7	18,487
8	16,847
9	23,891
10	14,842
11	22,000
12	23,500

Secondly, the basin size has value in interpreting RDII severity. Large basins (> 30,000 lf) will exhibit RDII severity close to the system-wide average and a small basin (<10,000 lf) will exhibit RDII severity much higher or much lower than the system average. Smaller basins optimize the identification of poor performing areas of the collection system and minimize the cost of sewer system evaluation studies (SSES) by focusing ongoing activities like smoke testing, manhole inspections and CCTV inspection.

Figure 1 is a schematic of the monitoring area showing flows as measured by ADS meters. Blue circles indicate flow meters that also had a groundwater gauge monitor attached. Orange circles are flow meters. Some meters measure flow that includes upstream basins; meter 10, 4, 9, 7, and 11. ADS will use the term Gross flow when upstream areas are included, and Net flows will subtract out any upstream basin flows.

Figure 1



1.2 – Average Dry Day Flow (ADDF)

One of the first steps in conducting an RDII analysis is to determine Average Dry Day Flow (ADDF) at each metering location and this information is used in two ways. The first is that the ADDF is subtracted from the flow measured during a storm and the difference is RDII. The second is that the shape of the ADDF hydrograph is used to estimate what portion of the ADDF is wastewater production (WW) and what portion is base infiltration (BI).

Dry day flows are obtained by identifying days that are not influenced by previous rainfall and that have a regular diurnal (daily) pattern. In nearly all cases weekday and weekend diurnal patterns are different and consequently are averaged separately. The selected days are averaged to generate separate weekday and weekend diurnal patterns.

For each meter the ADDF is decomposed into the two components of Wastewater Production (WW) and Base Infiltration (BI) as shown in Figure 2 for Meter 8. The estimated Base Infiltration (BI) is based on the shape of the weekday ADDF hydrograph and is shown as the red horizontal line at 0.06 mgd. The average dry day flow of 0.13 mgd is shown at the orange horizontal line. The percent of weekday Base Infiltration at this site is 46% base infiltration (0.06mgd / 0.13mgd).

Figure 2

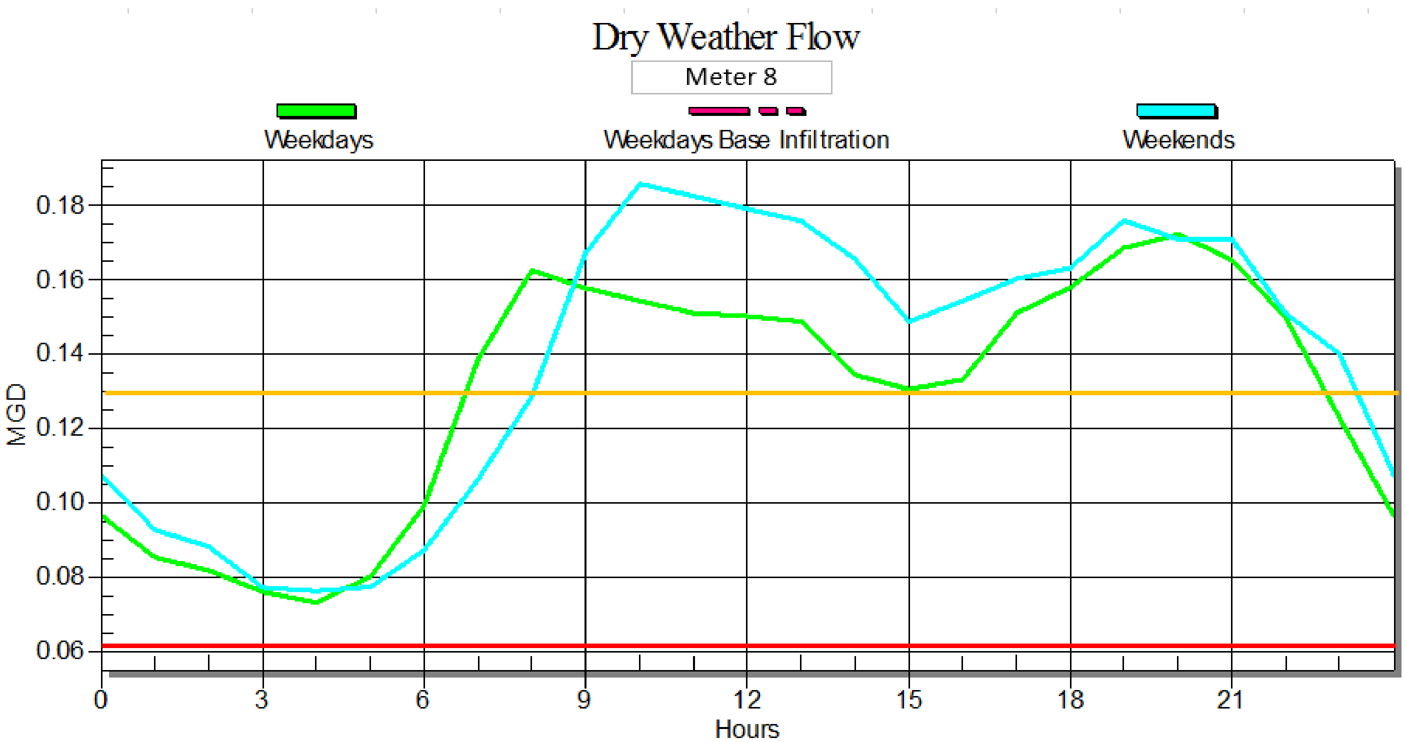


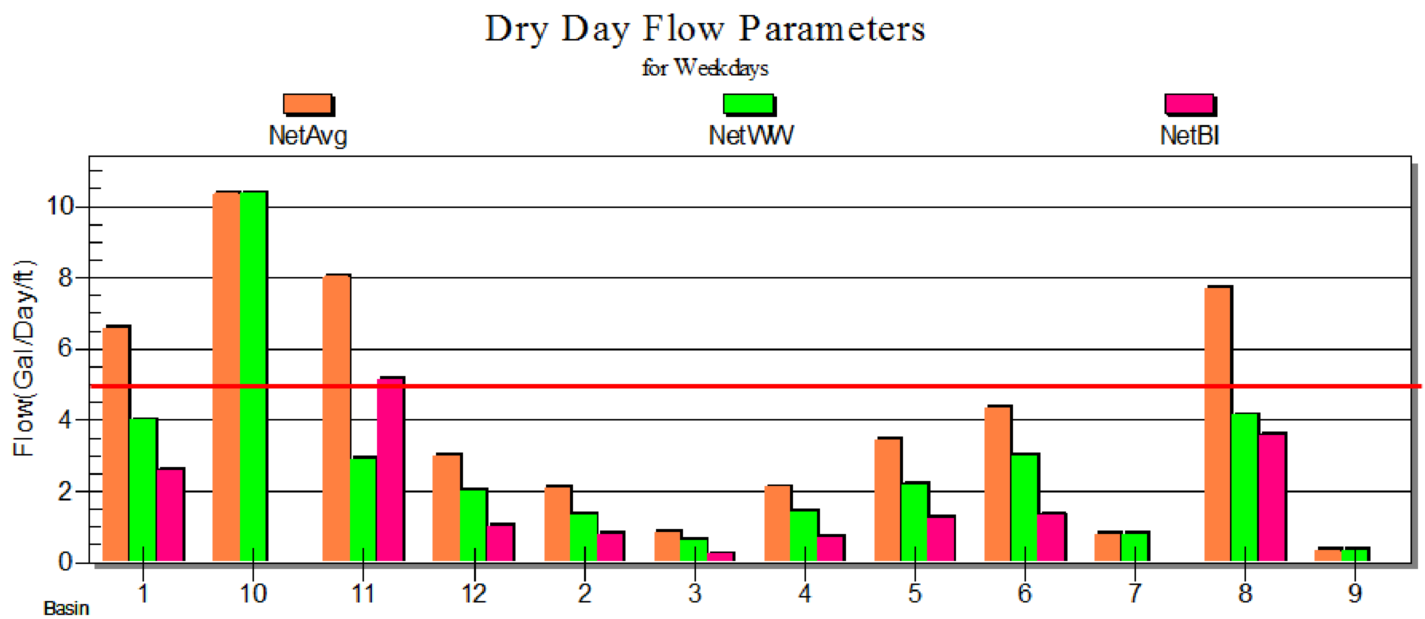
Figure 3 is a graphic of the values for the ADDF and the two components, Wastewater production and Base Infiltration. Base Infiltration exceeds 50% of ADDF in basin 11. A standard prescribed by the U.S. Environmental Protection Agency (EPA) for excessive Base Infiltration is 4,000 gallons per day per inch diameter mile (gpdim) (EPA, 2014). For this analysis, inch diameter of metered pipes was not available, so comparisons were completed using length of pipe for each basin. ADS used a threshold value of 5 gpd/ft to Figure 3 and Table 2 highlighting basins with infiltration values that are cost effective to inspect further. The 5 gpd/ft threshold is a rough equivalent to the EPA guidance

This display shows the concept of base infiltration (BI) and how it is estimated. Over the years, ADS developed an empirical equation to estimate wastewater production (WWP) based on the measured average daily flow (ADF) and minimum daily flows (MDF).

For this analysis, ADS used the Stevens/Schutzbach method (below), based on the MDF and the ratio MDF/AFD (Mitchell et al., 2007). This formula has been in use since 1999 and peer reviewed by numerous agencies and last reviewed in 2012 by the Water Environment Research Foundation (WREF) on the NYC DEP CSO Pilot Project (Water Environment Research Foundation, 2015).

$$\text{Base Infiltration} = \frac{0.4 * MDF}{1- 0.6\ (MDF/ADF) \wedge ADF\ 0.7}$$

Figure 3



Basin	1	10	11	12	2	3	4	5	6	7	8	9
NetAvg	6.590	10.366	8.031	3.004	2.108	0.855	2.115	3.439	4.324	0.810	7.706	0.338
NetWW	4.001	10.366	2.884	1.994	1.330	0.620	1.423	2.187	2.999	0.810	4.134	0.338
NetBI	2.589		5.147	1.010	0.778	0.235	0.693	1.252	1.325		3.572	

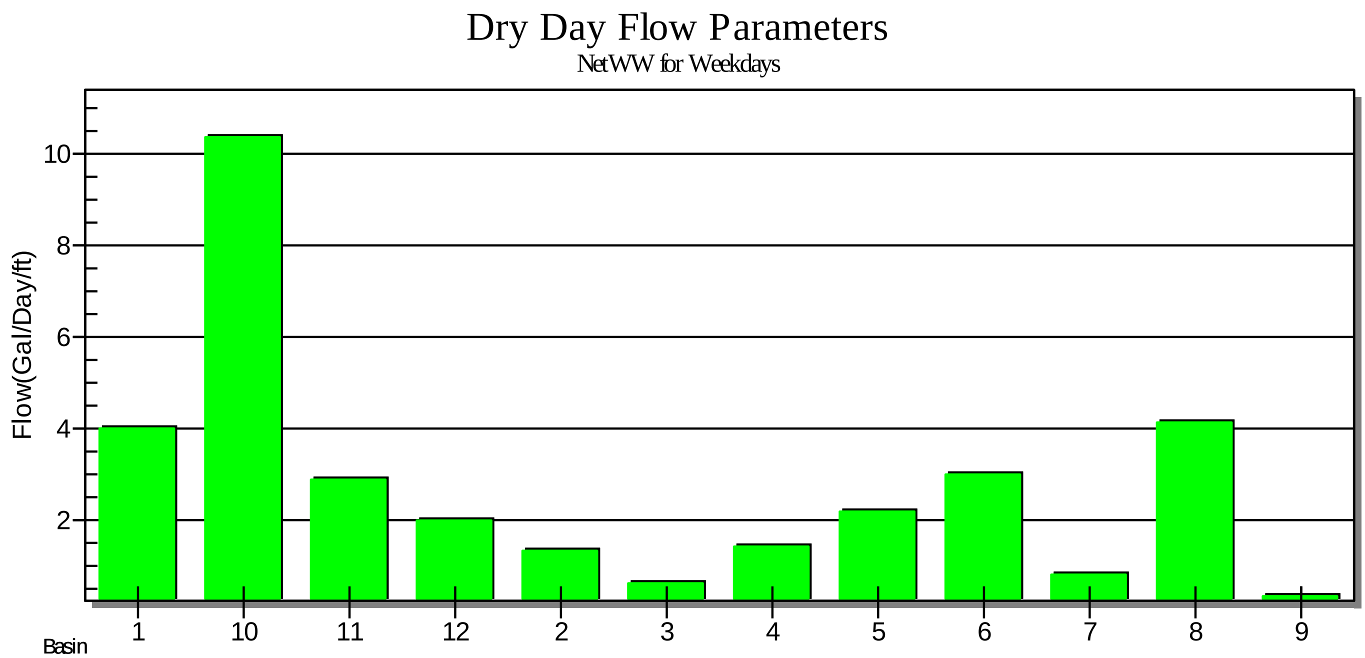
Table 2 displays the estimated net base infiltration, net wastewater and net average in MGD for each basin. This method of estimating Base Infiltration is based on traditional residential diurnal flow patterns and it is not uncommon for mathematical inconsistencies to occur between basins. Basins that have upstream flows that contribute more base infiltration than the net at the downstream meter will be shown as an *. This occurs at meters 10, 9 and 7 which have upstream areas contributing more BI than the downstream. For those locations listed with an asterisk, it is assumed the BI values are not significant to investigate further.

Table 2

Dry Day Weekdays (Gal/day/ft of pipe)				
Meter	**Net Avg**	**Net WW**	**Net BI**	**% Base Infil**
1	6.59	4.001	2.589	39%
2	2.108	1.33	0.778	37%
3	0.855	0.62	0.235	27%
4	2.115	1.423	0.693	33%
5	3.439	2.187	1.252	36%
6	4.324	2.999	1.325	31%
7	0.81	0.81	*	N/A
8	7.706	4.134	3.572	46%
9	0.338	0.338	*	N/A
10	10.366	10.366	*	N/A
11	8.031	2.884	5.147	64%
12	3.004	1.994	1.01	34%

The subtraction of upstream meters produces a Net flow and the Net ADDF is normalized by the length of sewer in each basin to obtain an apples-to-apples comparison. Figure 4 shows those values expressed in GPD/LF of public sewer. The net wastewater values (Net WW) are a function of land use with ADDF in medium-density residential basins typically being in the range of 2 to 5 gpd/LF. Low density residential areas can produce less than 2 gpd/lf and high density residential (apartments) and business districts can be in the range of 7 to 10 gpd/LF.

Figure 4



Basin	1	10	11	12	2	3	4	5	6	7	8	9
NetWW	4.001	10.366	2.884	1.994	1.330	0.620	1.423	2.187	2.999	0.810	4.134	0.338

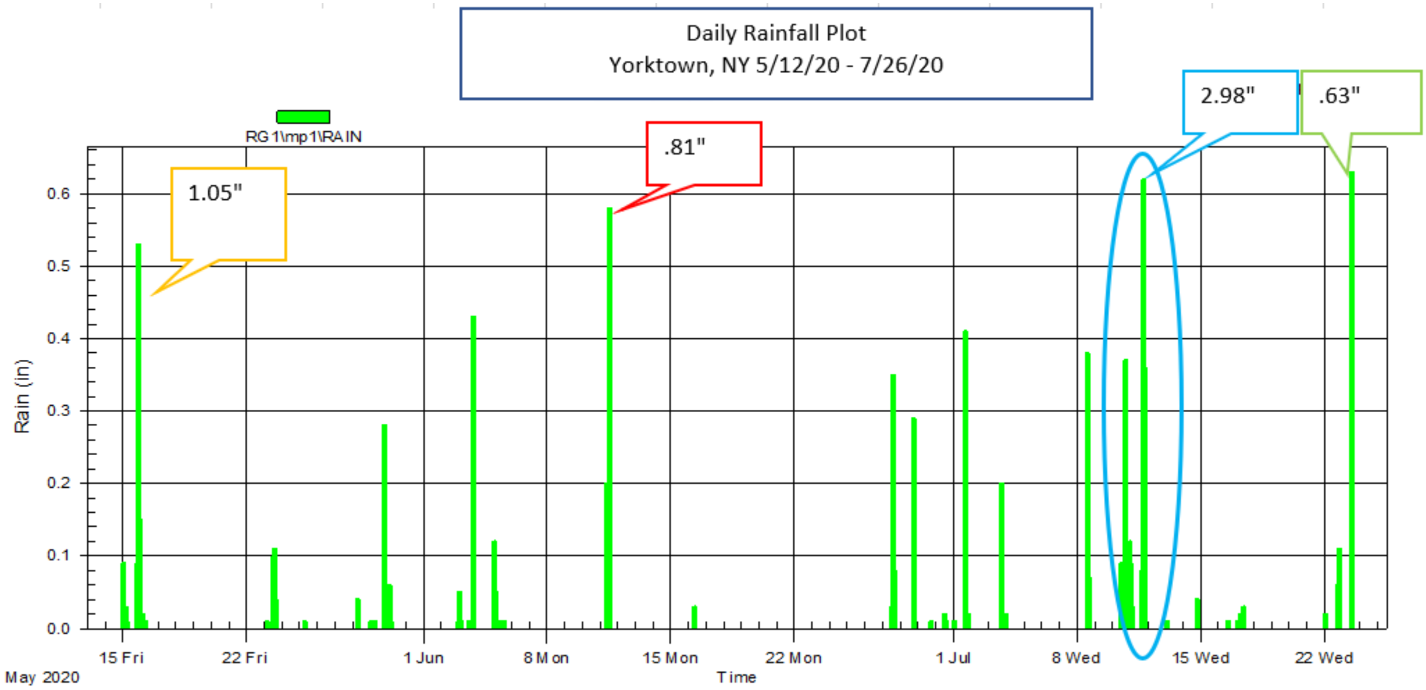
This plot serves as a quality control step. Basins that are out of the typical ranges for a specific land use will likely have meter inaccuracies, incorrect flow schematics or incorrect length of sewer pipe used for calculation. Using the typical land use values, it appears all locations except basin 10 are within typical values for low or medium density land use.

Meter 10 appears to be higher than expected from map and local reconnaissance by ADS field crews. Additional map review should be conducted to ensure proper pipe connectivity and footage are in use. The numbers as shown in figure 4 would indicate that additional flows from outside the basin 10 area are being measured by the meter, but not included in the upstream footage of sewer pipe.

1.3 - Rainfall Analysis

Figure 5 below displays the daily hyetograph of rainfall measured during the monitoring period. The significant storms analyzed further are highlighted and color coded to match table 3 summary below.

Figure 5



The rainfall analysis looks at the total rainfall recorded by the rain gauge for each storm and at the maximum return frequency for each storm. There were six (6) storms that exceeded a total of 0.5 inches. Table 3 lists the measured rainfall for those storms. The storms highlighted were the most significant during the study period and further analyzed for RDII response.

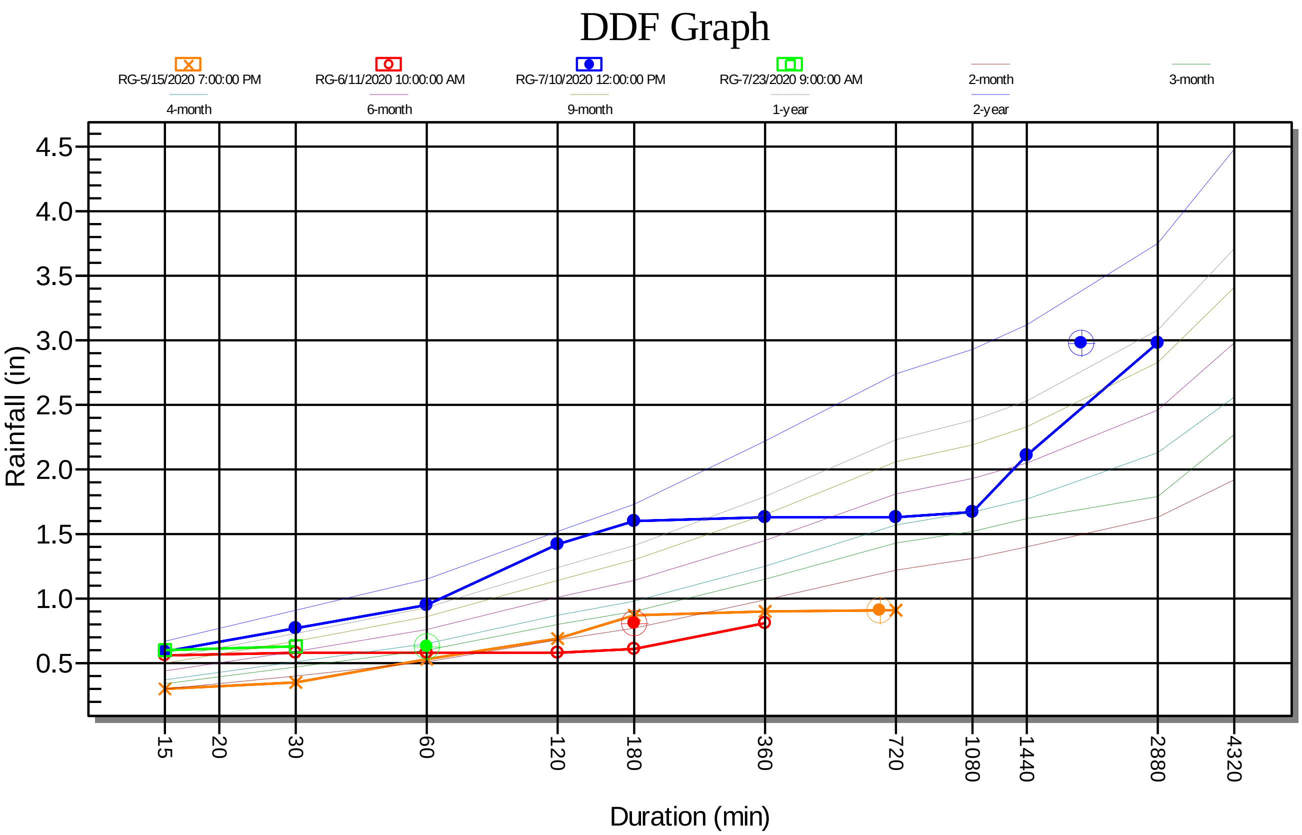
Table 3 also displays the maximum return frequency utilizing National Weather Service (NWS) Atlas 14 maps, corresponding duration and total rainfall for each storm event. The explanation for how these values are determined follows on the next page.

Table 3

Storm	Event Total (in.)	Rainfall return freq.
5/15/2020	1.05	2.8-mo
6/11/2020	0.81	1.2-yr
6/27/2020	0.97	1.9-mo
7/8/2020	0.63	1.7-mo
7/10 - 7/11/2020	2.98	1.6-yr
7/23/2020	0.63	1.5-yr

A Depth Duration Frequency (DDF) analysis determines the maximum return frequency and corresponding duration for each RG and each storm. The analysis is displayed graphically in Figure 6. The standard National Weather Service storm durations are plotted on the X-axis and depth of rain is on the Y-axis. The dashed lines are the historical values in the area and developed from several years of weather data. Plotted as examples are the DDF values for four (4) storms recorded by the RG rain gauge on 15 May 2020, 11 June 2020, 10-11 July 2020, and 23 July 2020. No rain event measured during the study exceeded a return frequency of two years shown by the dashed dark grey line.

Figure 6



It is easy to look at Figure 6 with a time scale on the bottom and conclude that this traces the storm history, but it is showing the maximum rainfall depth for each of the time durations. For example, the peak 180-minute rainfall depth can occur at the beginning, middle or end of the storm. This view looks at duration periods of 15 minutes and longer. The actual duration of each rain event and the corresponding rainfall are shown with a circled symbol. For the monitoring period, the highest peak return frequencies were slightly less than a two (2) year storms measured for events (10-11 July 2020). The remaining storms are relatively small in magnitude. This type of analysis is helpful for determining peak rainfall intensity and the impact on the collection system performance.

1.4 - RDII Analysis

The Rainfall Dependent Infiltration Inflow (RDII) is based on Net flows. Figure 7 below details the process for the storm on 10 July 2020. The hydrograph shows the measured flow from meter 1 in blue, the Dry Day flow expected in green (weekdays) and cyan (weekends), the RDII flow in gold (difference between measured and expected flow). The RDII volumes are used to determine RDII severity. This analysis was performed for each site and storm event. Graphical representation is provided in the appendices.

Figure 7

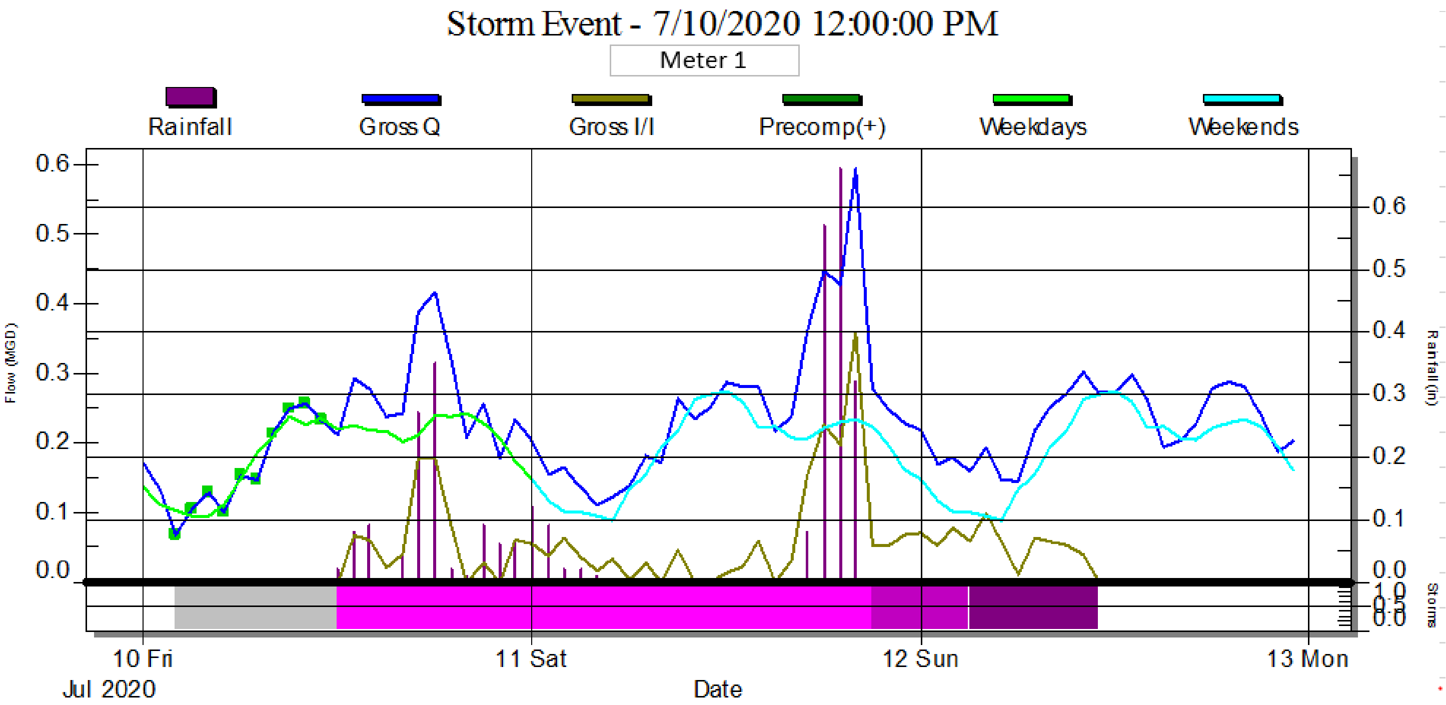
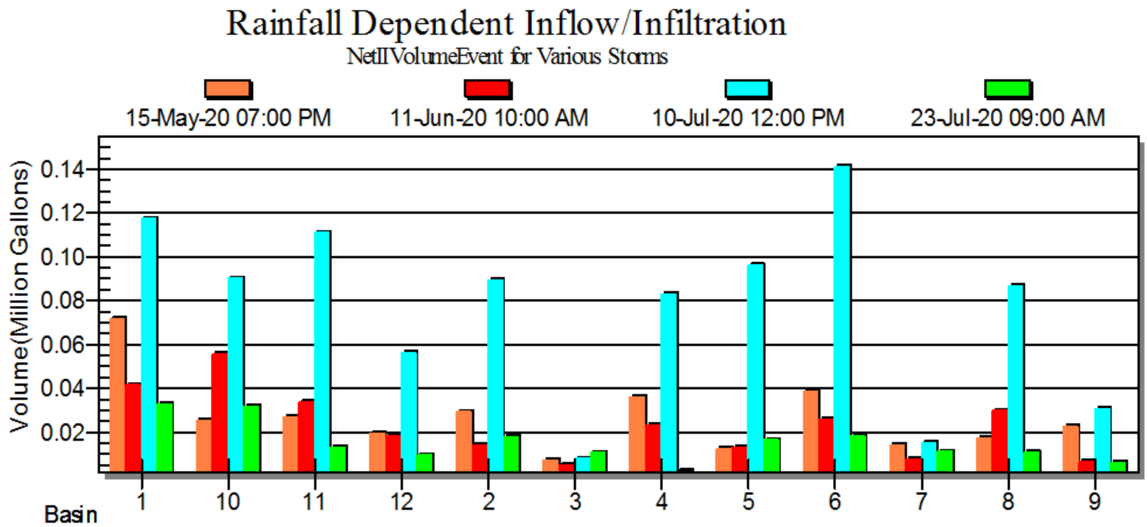


Figure 8 below displays the Net RDII volumes in MGD for the four (4) significant storms. The values are not normalized and will show larger basins have greater RDII.

Figure 8



Basin	1	10	11	12	2	3	4	5	6	7	8	9
15-May-20 07:00 PM	0.071	0.025	0.027	0.019	0.029	0.007	0.036	0.012	0.039	0.014	0.017	0.023
11-Jun-20 10:00 AM	0.042	0.056	0.034	0.018	0.014	0.005	0.023	0.013	0.026	0.008	0.030	0.007
10-Jul-20 12:00 PM	0.117	0.090	0.111	0.056	0.089	0.008	0.083	0.096	0.141	0.015	0.087	0.031
23-Jul-20 09:00 AM	0.033	0.032	0.013	0.009	0.018	0.011	0.002	0.016	0.018	0.011	0.011	0.006

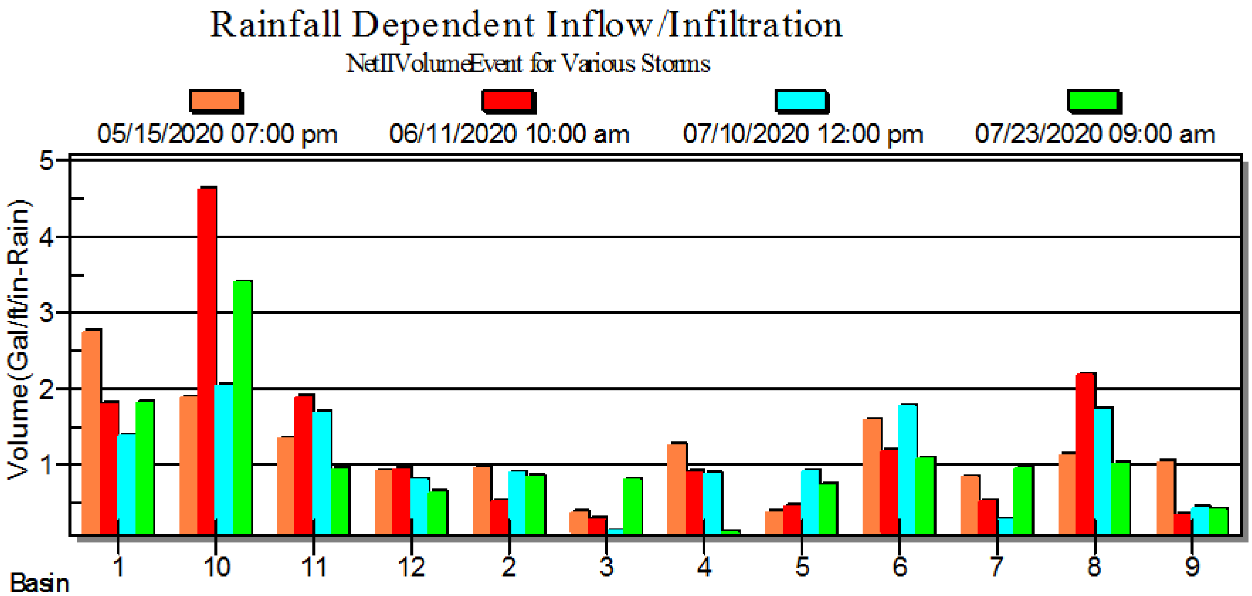
1.5 – RDII Severity of Basins

There are not formal thresholds for identifying a basin with ‘severe’ RDII, but over 45 years and over 400 similar flow studies, ADS has developed a general rule of thumb for basin severity. The RDII is classified by Gal/LF/Inch of Rain and ranges of 0 to 10 Gal/LF/In are in the minimal category, 10 to 15 Gal/LF/In are in the marginal category and greater than 15 Gal/LF/In are in the severe category.

The threshold values are generally higher in the winter season when vegetation is dormant and in long soaking events that cause the ground to be saturated. So, for example if data are collected solely in the winter, the marginal category might be 15 to 20 Gal/LF/In. These values are generally lower for flows measured during periods of low antecedent moisture.

Figure 9 below shows normalized measurements of RDII severity for the storms highlighted in Table 3. All monitored basins are in the minimal severity of RDII. It should be noted that there were minimal wet weather events that tested the system and groundwater was relatively low as foliage was present prior to meter installation. Results for basin 10 should be reviewed with the understanding that upstream basin footage may not reflect the actual amount of wastewater entering the system. Variation in RDII responses for basins is due to antecedent rainfall so wetter conditions prior to a storm will typically show greater response.

Figure 9

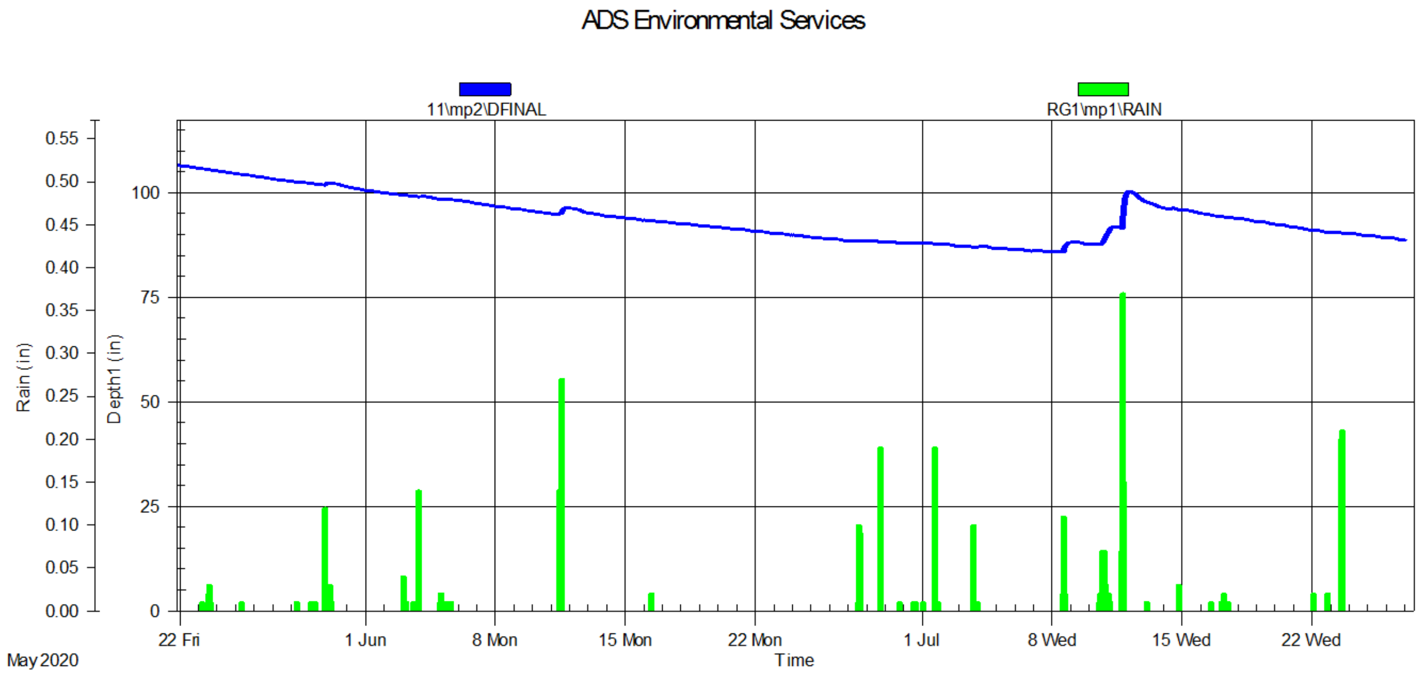


Basin	1	10	11	12	2	3	4	5	6	7	8	9
05/15/2020 07:00 pm	2.752	1.880	1.337	0.910	0.960	0.373	1.257	0.383	1.587	0.838	1.127	1.036
06/11/2020 10:00 am	1.797	4.621	1.889	0.942	0.519	0.286	0.899	0.452	1.182	0.516	2.176	0.339
07/10/2020 12:00 pm	1.379	2.038	1.690	0.802	0.895	0.126	0.883	0.909	1.772	0.272	1.724	0.431
07/23/2020 09:00 am	1.820	3.395	0.938	0.638	0.844	0.797	0.108	0.733	1.074	0.953	1.011	0.405

1.6 Groundwater Monitoring

In addition to monitoring wastewater flows, ADS installed groundwater gauges (piezometers) at eight locations. Figure 1 highlights the flow meters that included groundwater monitoring. Groundwater gauges are installed near the influent sewer pipe spring line and calibrated to match the invert of the influent pipe. Below in figure 10 is a plot of meter 11 groundwater and rainfall. The graph is zoomed into the same time frame as the flow monitoring study to highlight the change in groundwater levels and potential impacts on base infiltration of the collection system. The data shows groundwater well above the sewer pipe and gradually decreasing throughout the monitoring period, except when significant storms occur. All groundwater data is in the appendices and shown as meter number with a 2, denoting the second data channel. Example 11(2).

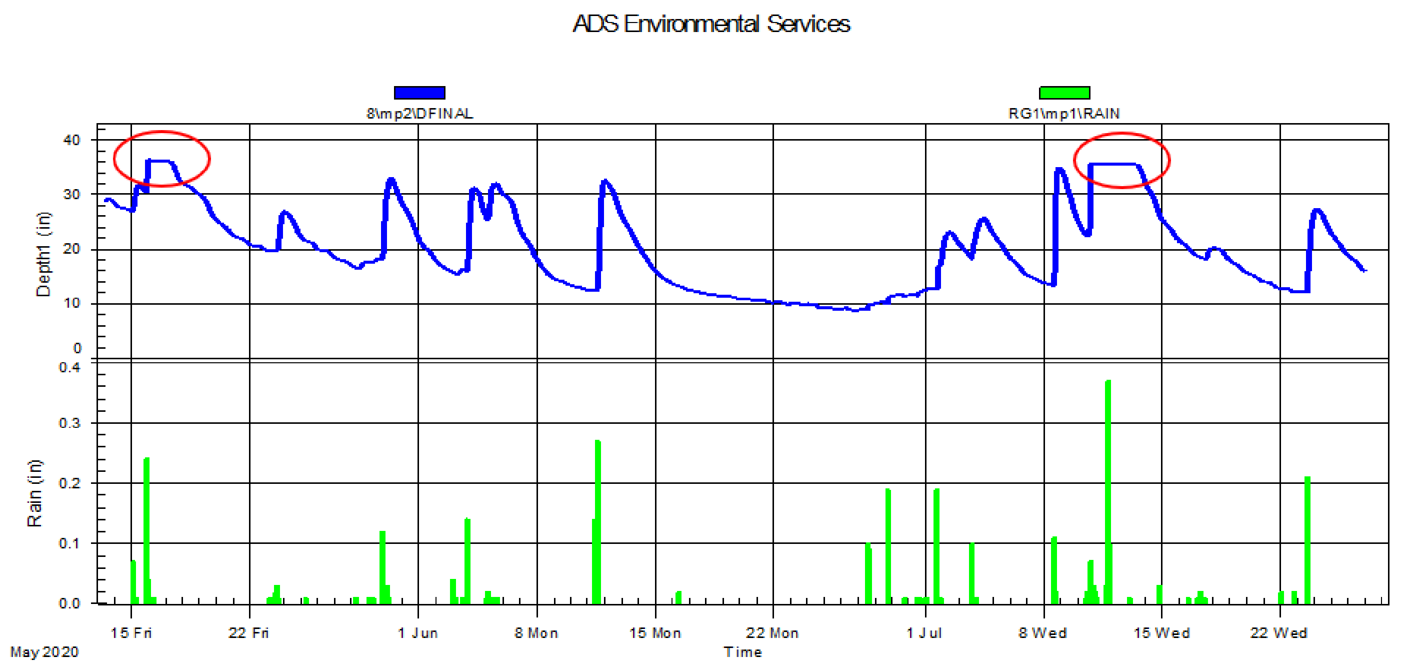
Figure 10


ADS Environmental Services
11\mp2\DFINAL
RG1\mp1\RAIN
Rain (in)
Depth1 (in)
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
100
75
50
25
0
22 Fri
1 Jun
8 Mon
15 Mon
22 Mon
1 Jul
8 Wed
15 Wed
22 Wed
May 2020
Time

2.0 – Observations

1. Meters 1 and 12 measured flow depths greater than the pipe crowns (surcharged) during the study, indicating that either there is insufficient capacity to carry flows or there is a pump station downstream restricting flow. Meter 12 is upstream of a pump station and meter 1 is upstream of the County Interceptor that during wet weather may operate at an elevation that restricts the gravity flow from meter 1. In both locations (1 and 12) these surcharges occurred during wet weather.
2. Meter 11 is upstream of the same pump station as meter 12 and meter 11 operated in backwater condition during wet weather. The pump station operation should be reviewed to ensure full capacity during storm events.
3. Base infiltration (BI) appears to be a source of extraneous flow in basins 8 and 11 and would be the priority for further SSES activity.
4. Groundwater at meter 8 indicates rapid increase/decrease in levels surrounding rain events. Below Figure 11 highlights the unique data. ADS crews noted that this meter location was in a wetland that is regulated by a culvert which appears to be relieving the area of extraneous water. Two periods were noted with red circles when the groundwater level reached the manhole rim. Occasional inspection of the drainage culvert should occur during wet weather to minimize water infiltration into the sewer.

Figure 11



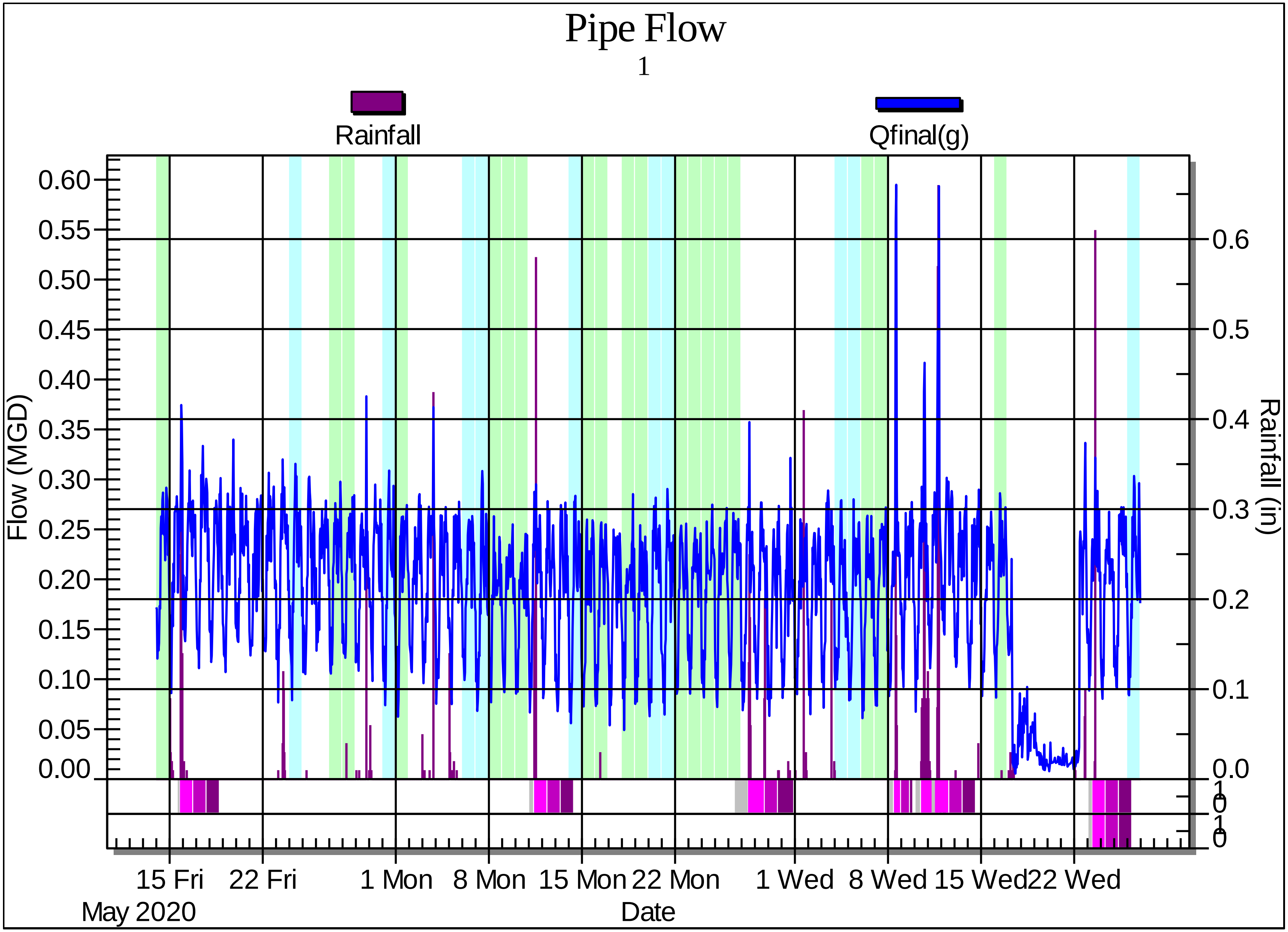
References

EPA. (2014). *Guide for Estimating Infiltration and Inflow, June 2014*. 7. https://www3.epa.gov/region1/sso/pdfs/Guide4EstimatingInfiltrationInflow.pdf

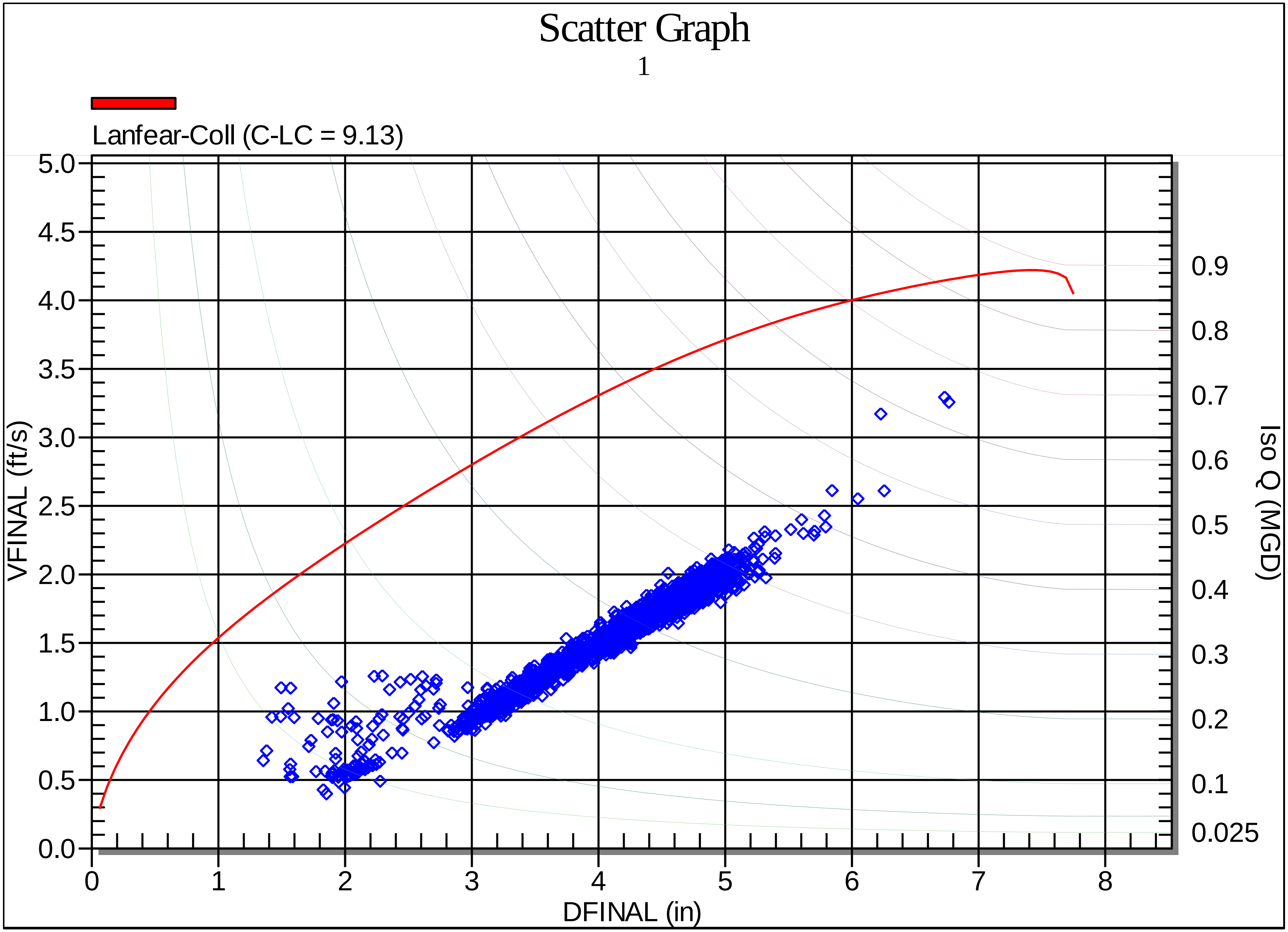
Mitchell, P. S., Stevens, P. L., & Nazaroff, A. (2007). QUANTIFYING BASE INFILTRATION IN SEWERS: A Comparison of Methods and a Simple Empirical Solution. *Proceedings of the Water Environment Federation*, *2007*(4), 219–238. https://doi.org/10.2175/193864707787974805

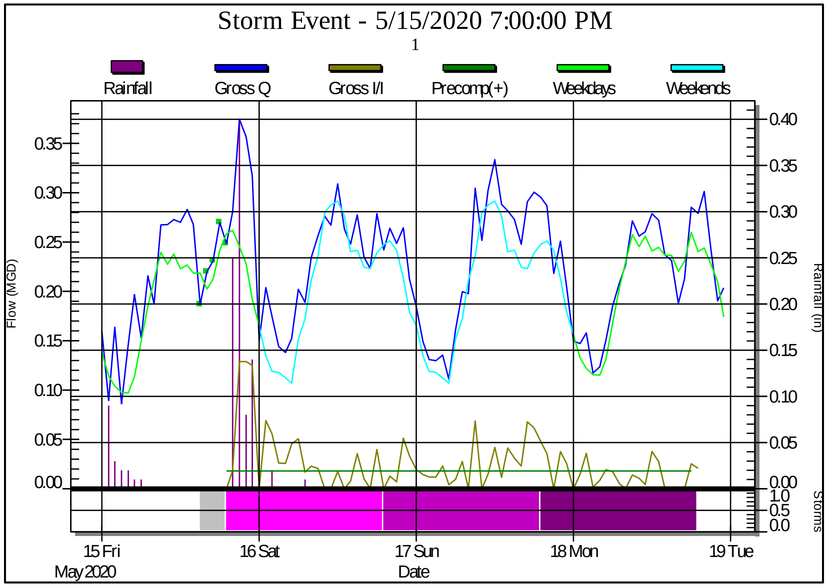
Water Environment Research Foundation. (2015, May). *WERF2P13 NYCDEP CSO.pdf*. NYCDEP CSO Metering Pilot Study. http://mcwrs.org/Documents/WERF2P13%20%20NYCDEP%20CSO.pdf

Appendices

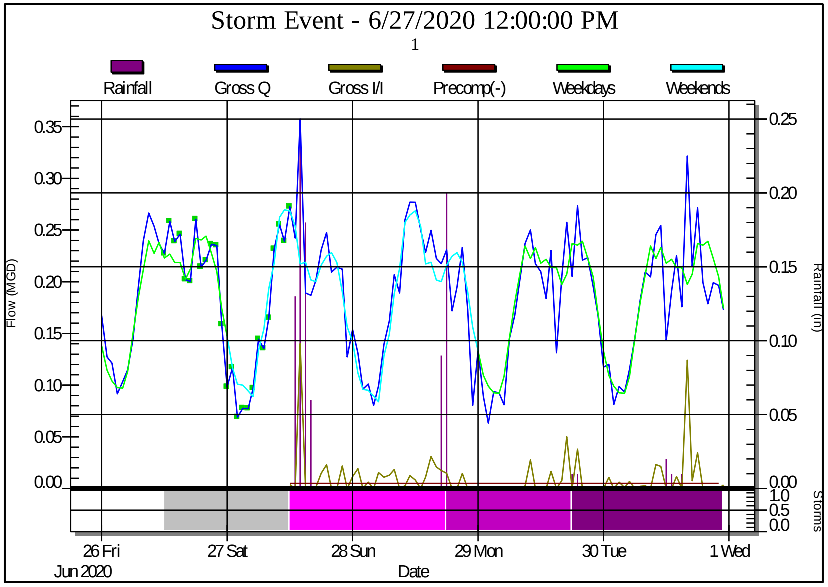


Pipe Flow
1
Rainfall
Qfinal(g)
Flow (MGD)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

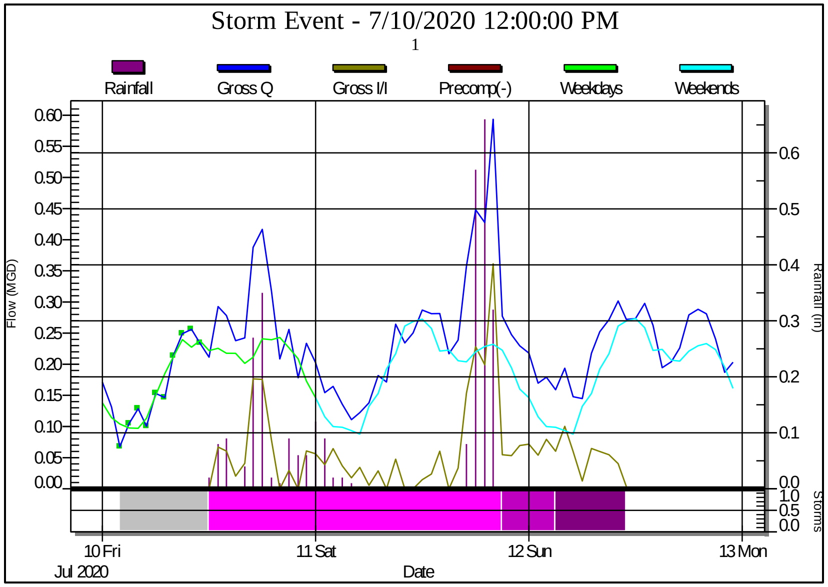

Scatter Graph
1
Lanfear-Coll (C-LC = 9.13)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
1
2
3
4
5
6
7
8
0.025
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9



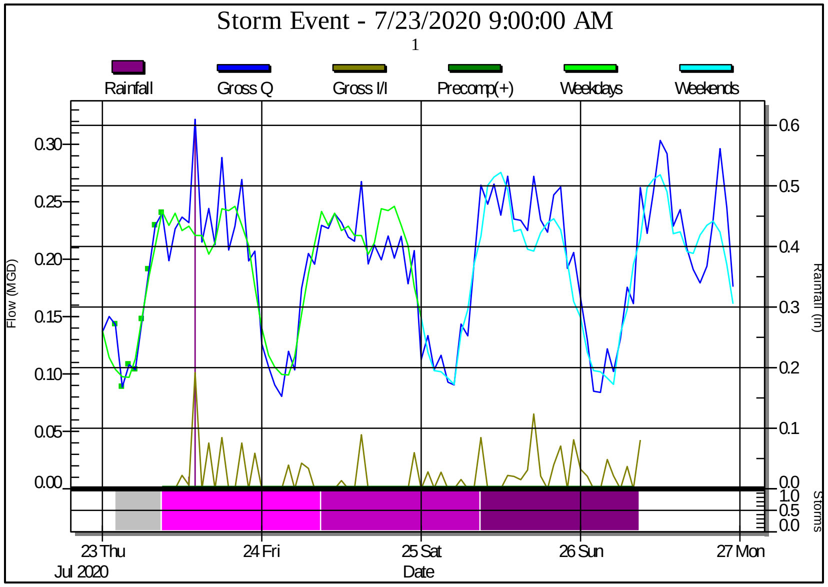
Storm Event - 5/15/2020 7:00:00 PM
1
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date



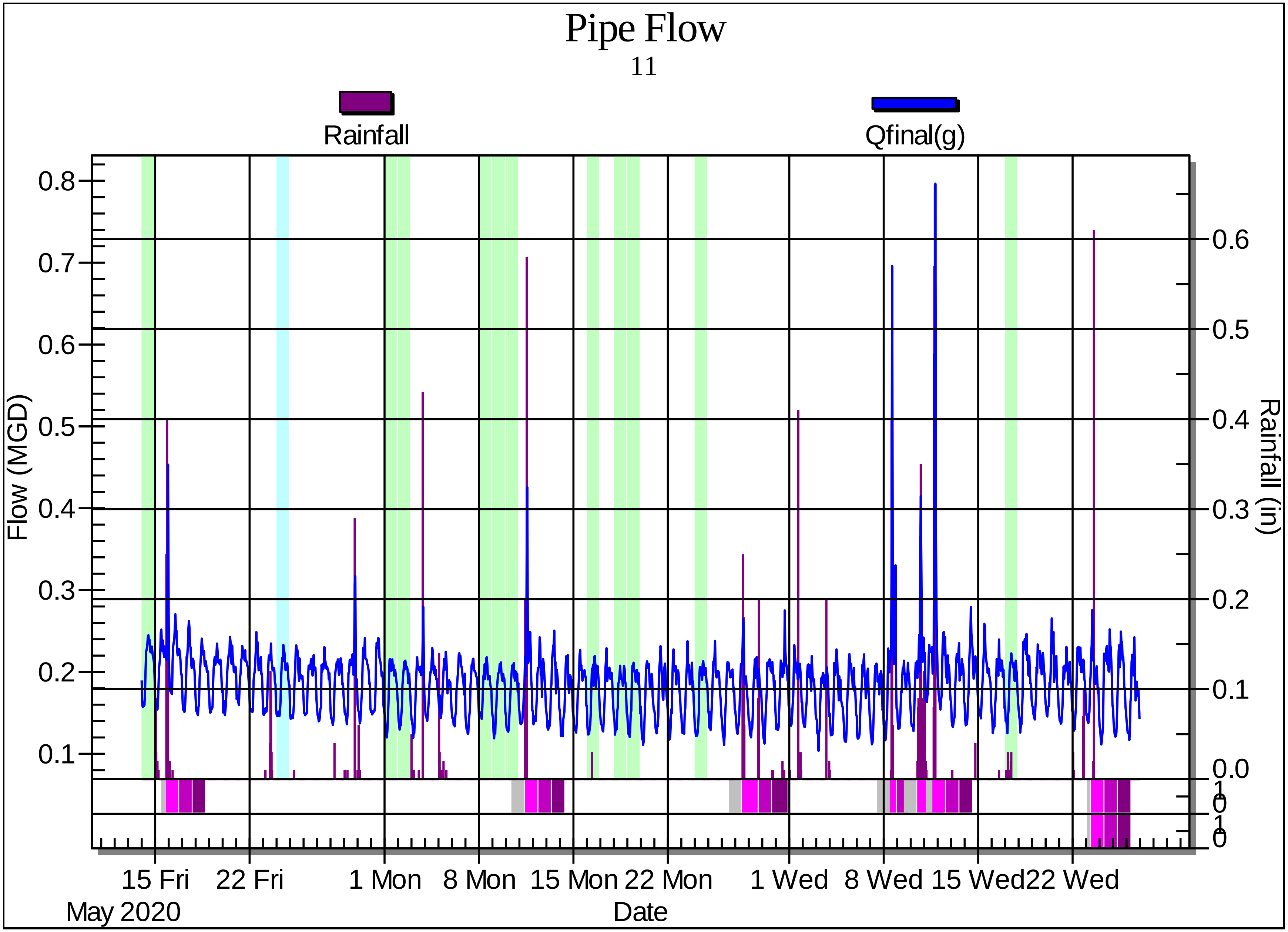
Storm Event - 6/27/2020 12:00:00 PM
1
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date



Storm Event - 7/10/2020 12:00:00 PM
1
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date



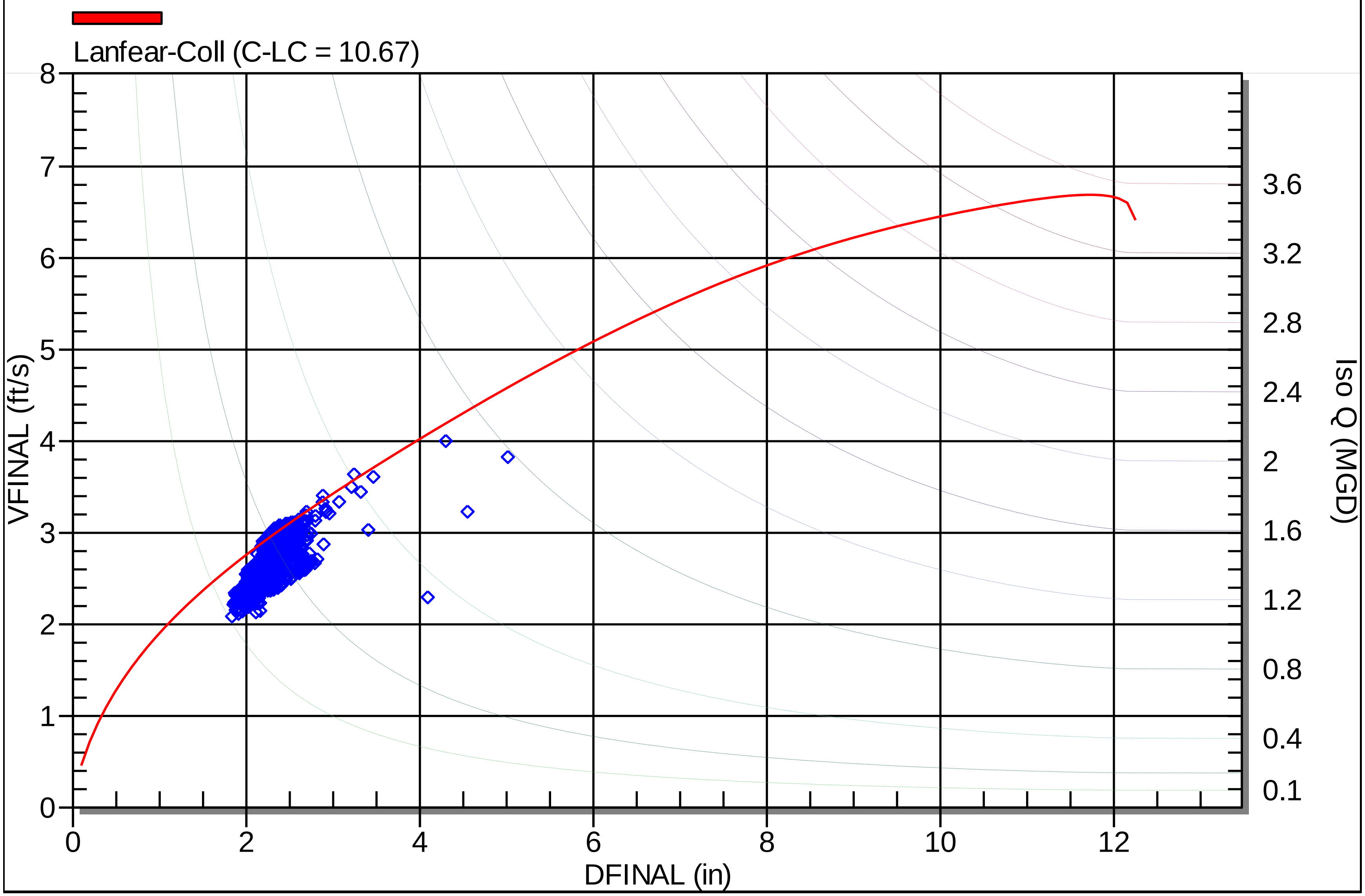
Storm Event - 7/23/2020 9:00:00 AM
1
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

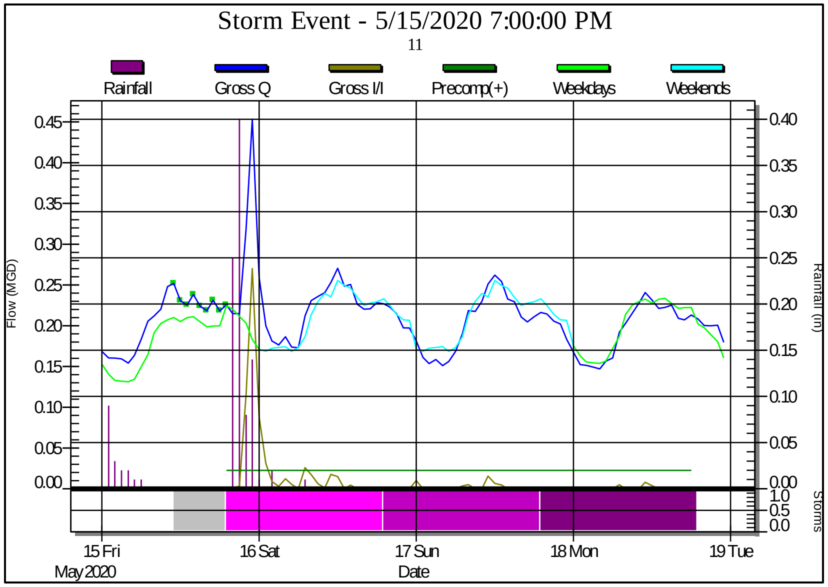


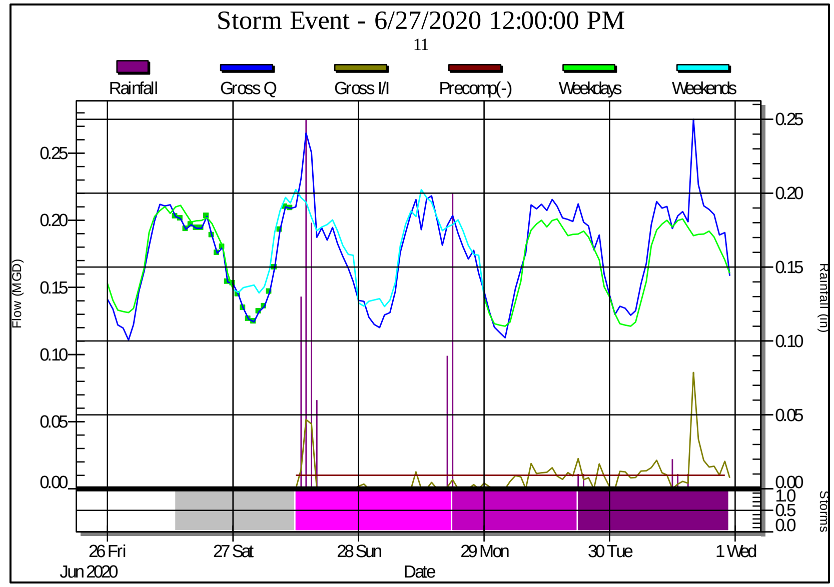
Pipe Flow
11
Rainfall
Qfinal(g)
Flow (MGD)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

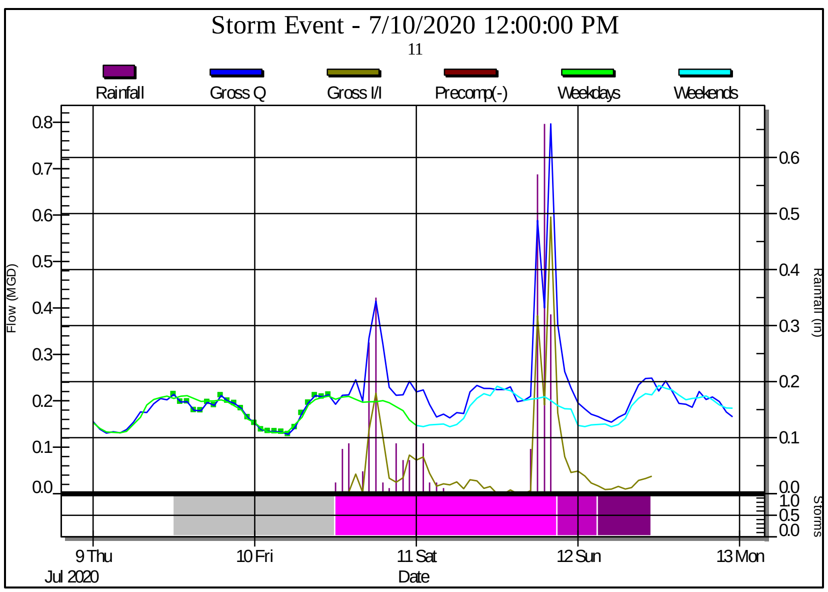
Scatter Graph

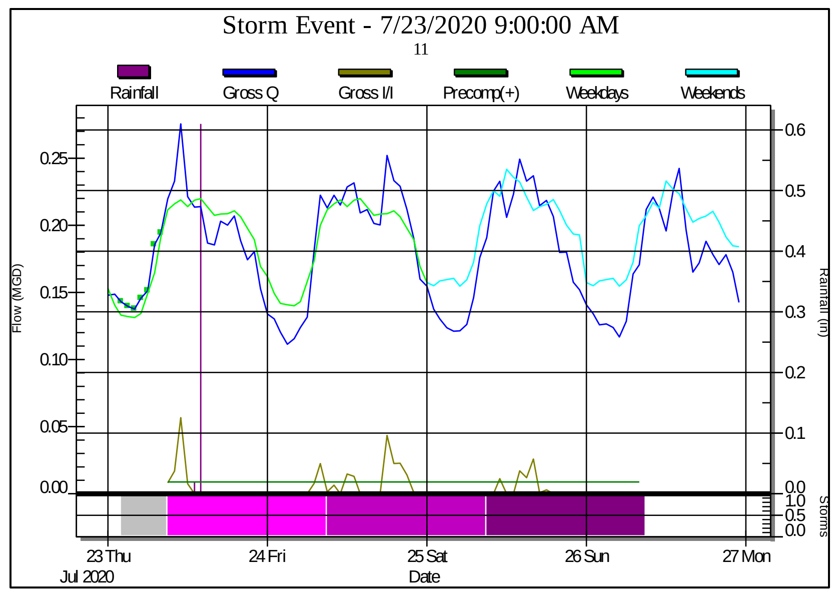
11

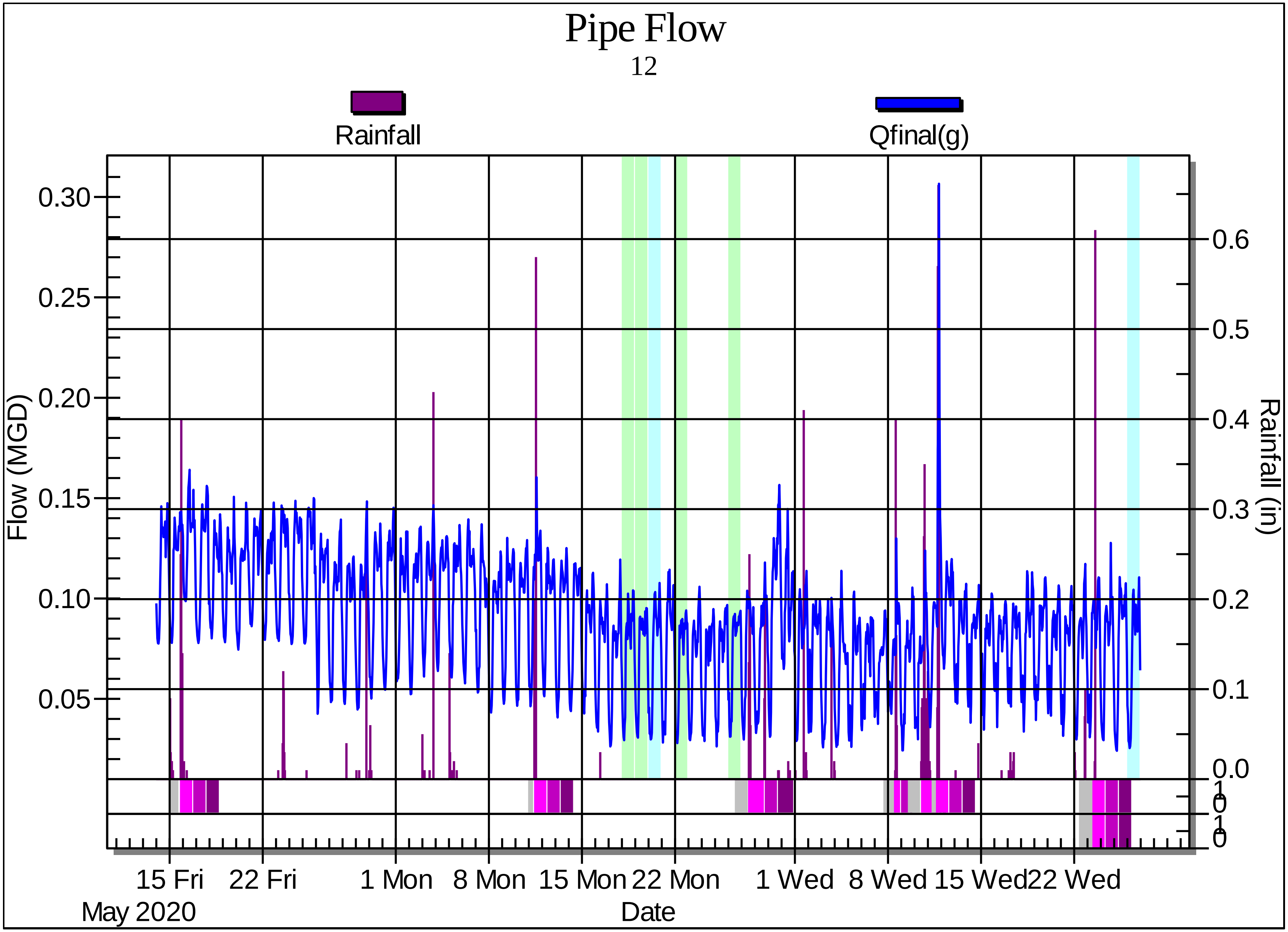



Storm Event - 5/15/2020 7:00:00 PM
11
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date

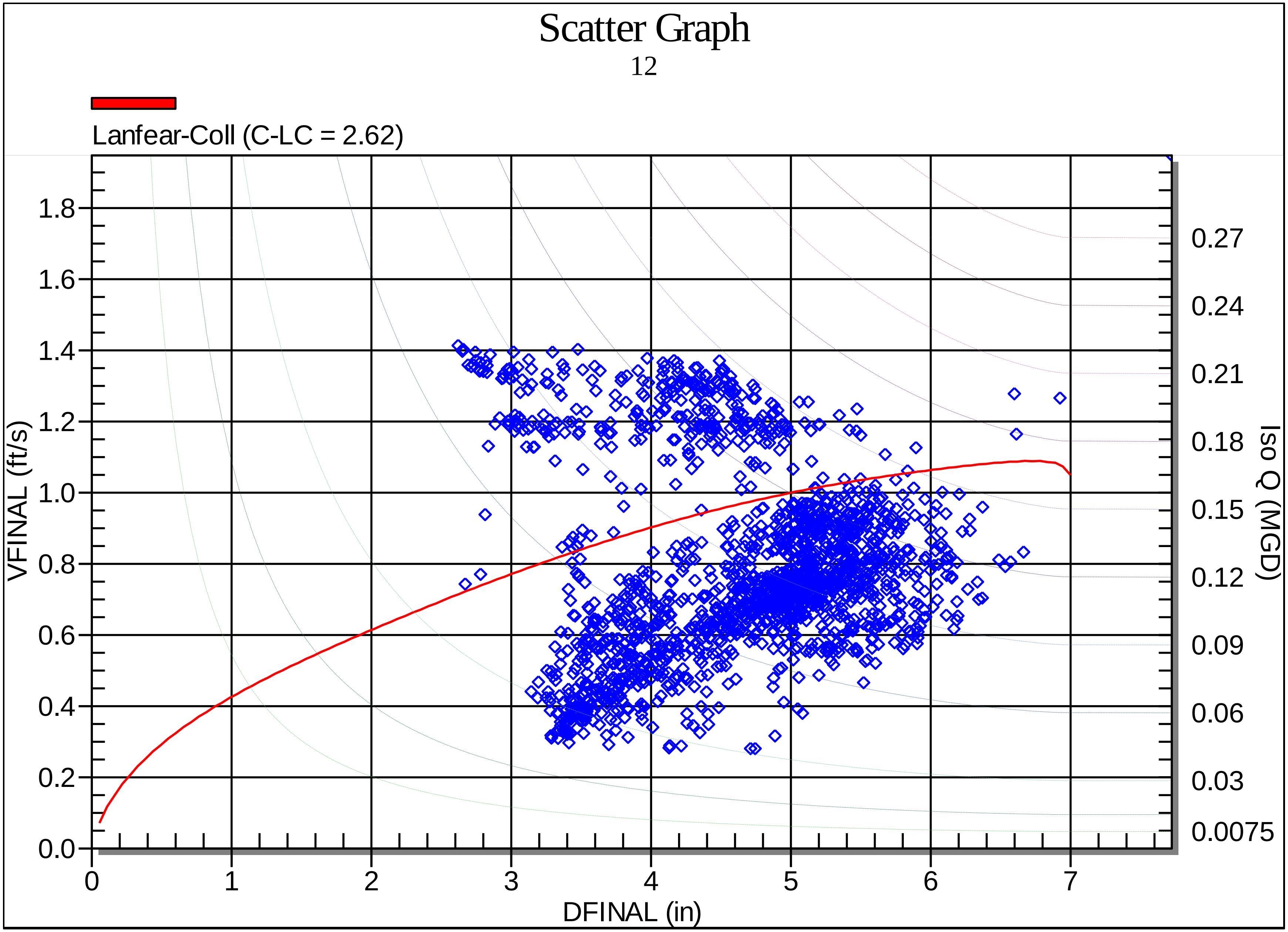

Storm Event - 6/27/2020 12:00:00 PM
11
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date

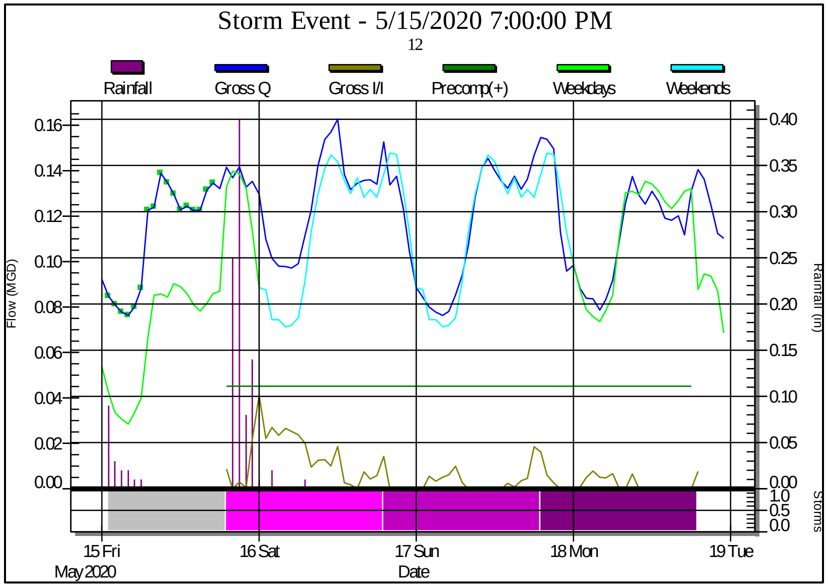

Storm Event - 7/10/2020 12:00:00 PM
11
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

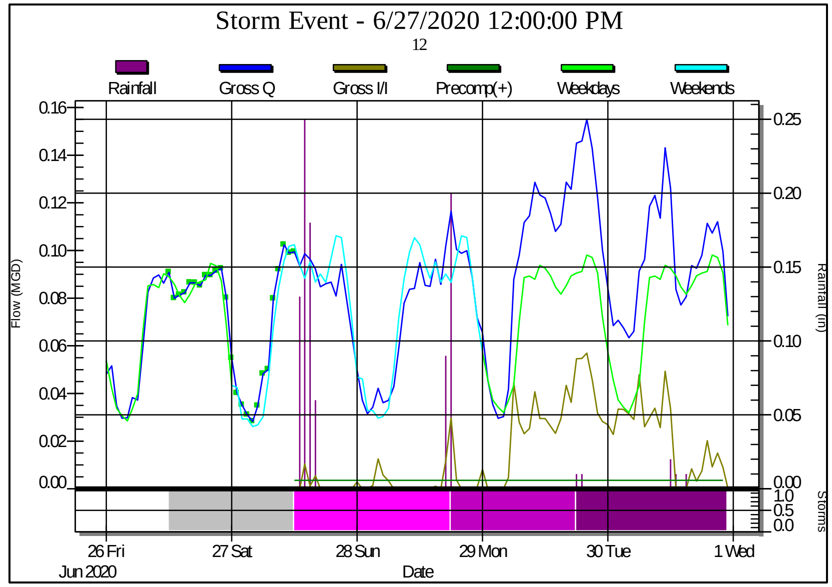

Storm Event - 7/23/2020 9:00:00 AM
11
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

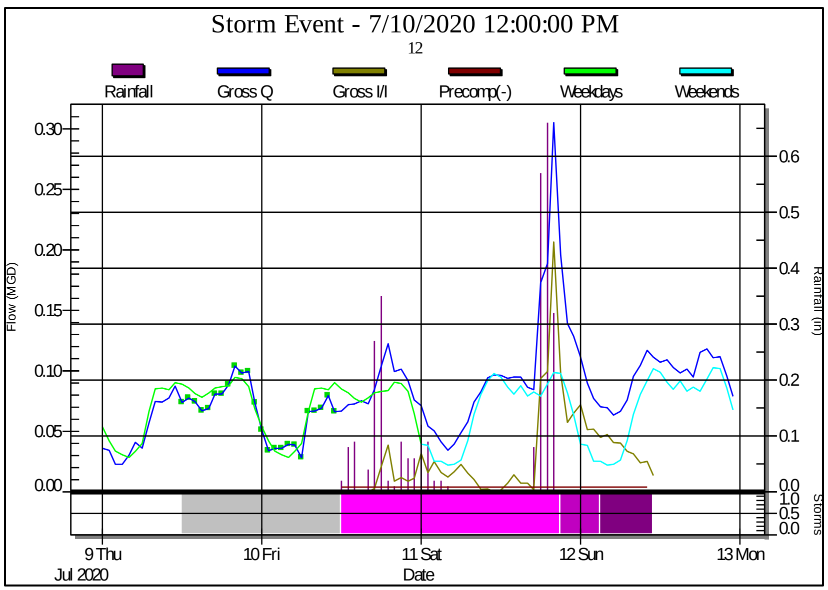


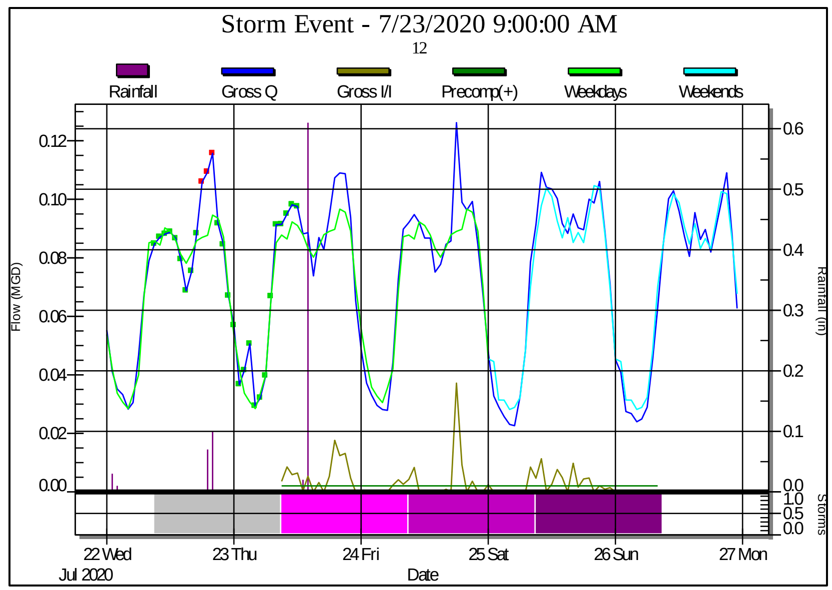
Pipe Flow
12
Rainfall
Qfinal(g)
Flow (MGD)
0.30
0.25
0.20
0.15
0.10
0.05
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

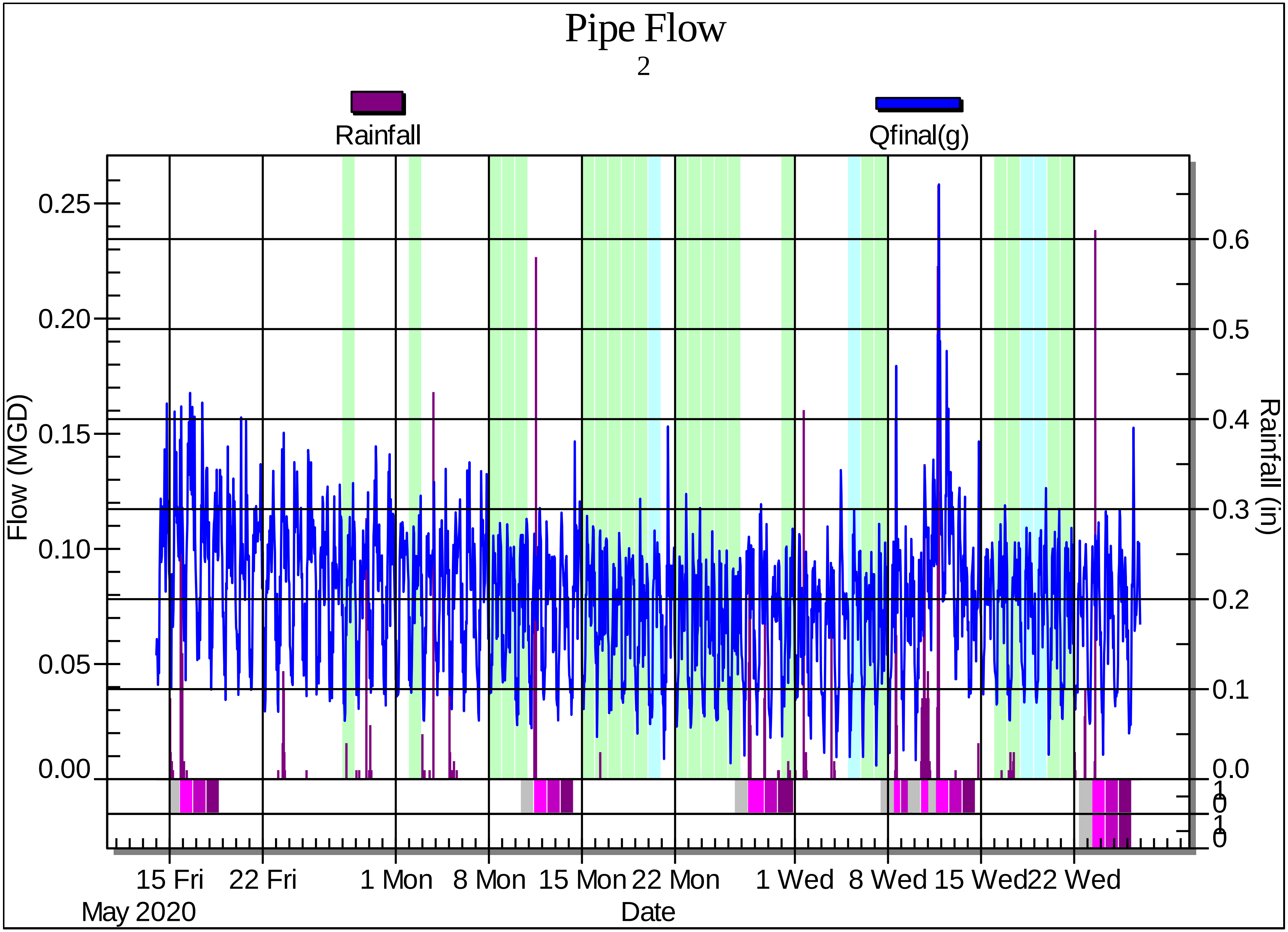

Scatter Graph
12
Lanfear-Coll (C-LC = 2.62)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0
1
2
3
4
5
6
7
0.0075
0.03
0.06
0.09
0.12
0.15
0.18
0.21
0.24
0.27


Storm Event - 5/15/2020 7:00:00 PM
12
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date

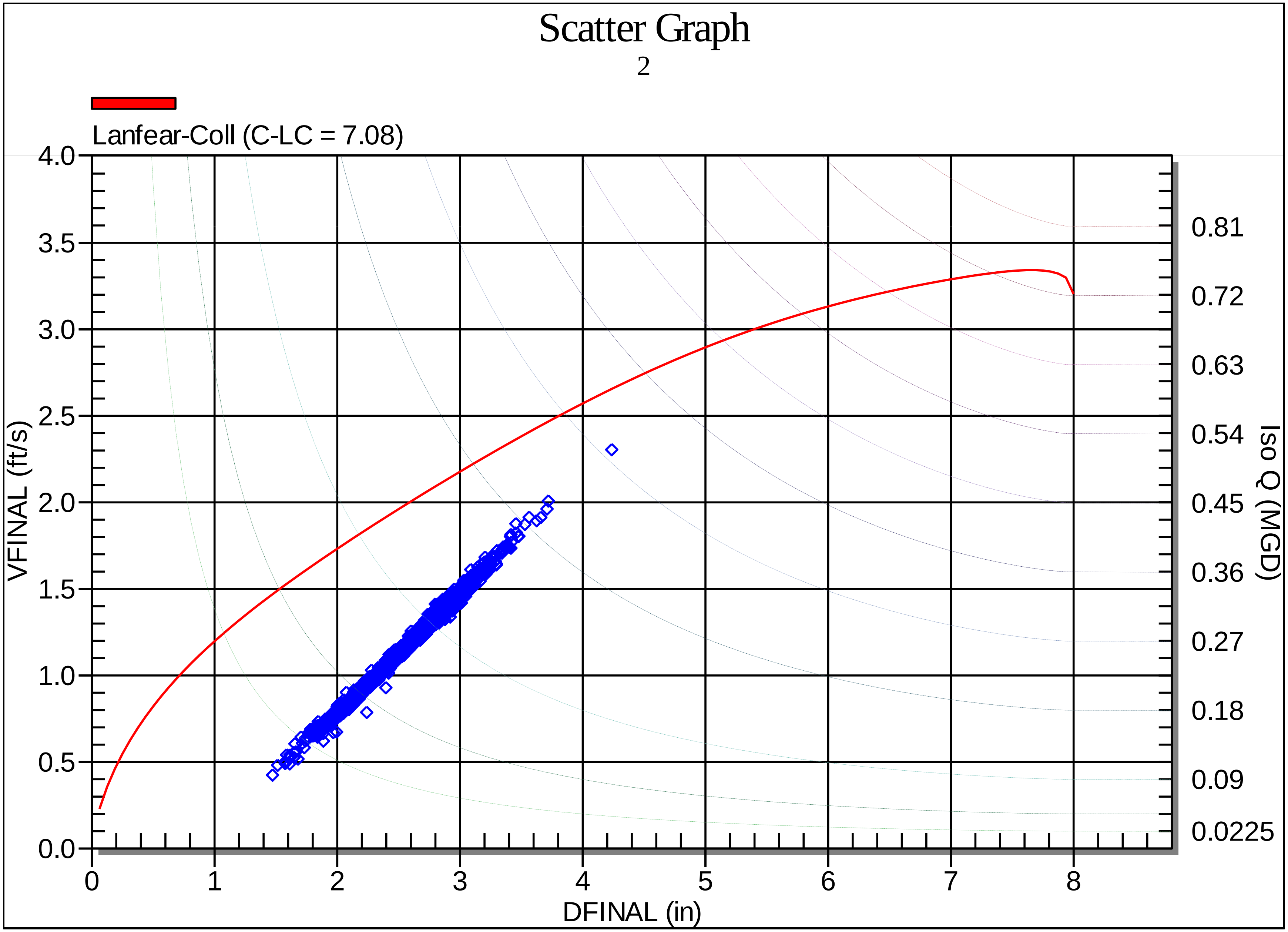

Storm Event - 6/27/2020 12:00:00 PM
12
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date


Storm Event - 7/10/2020 12:00:00 PM
12
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

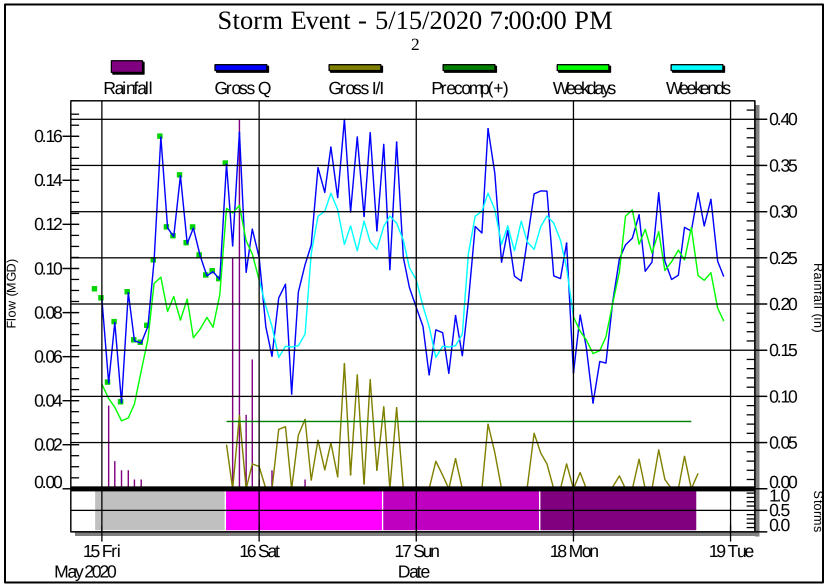

Storm Event - 7/23/2020 9:00:00 AM
12
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

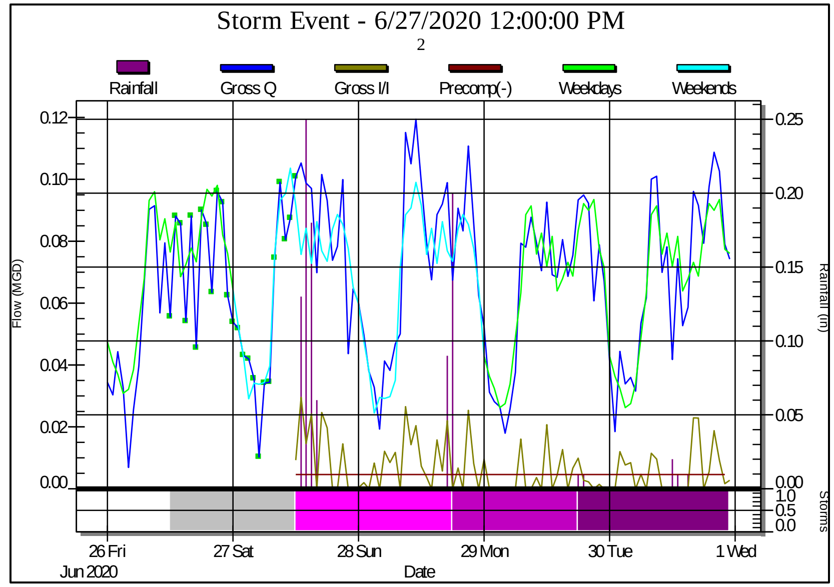


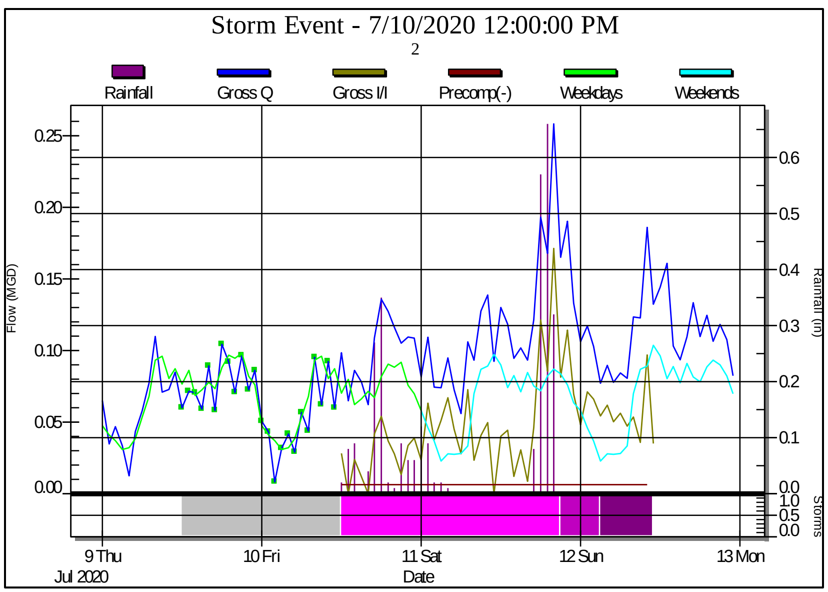
Pipe Flow
2
Rainfall
Qfinal(g)
Flow (MGD)
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

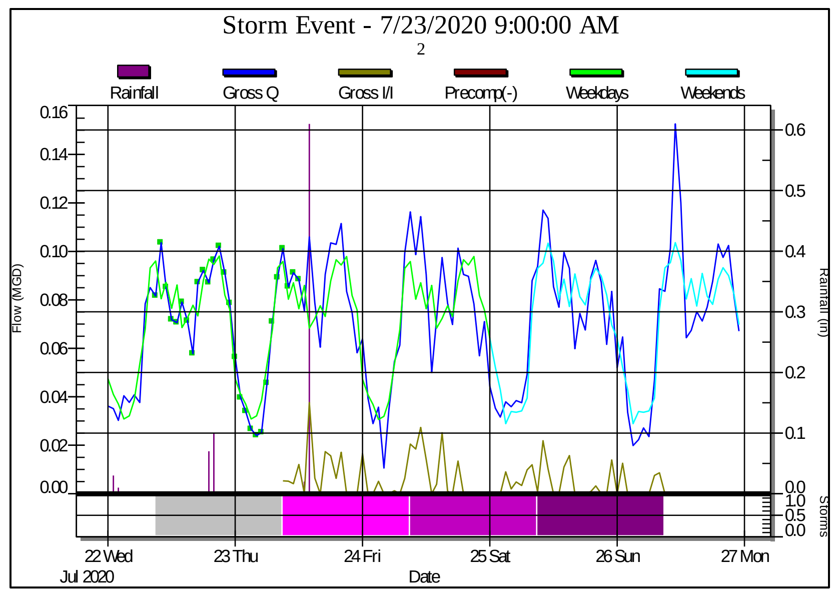


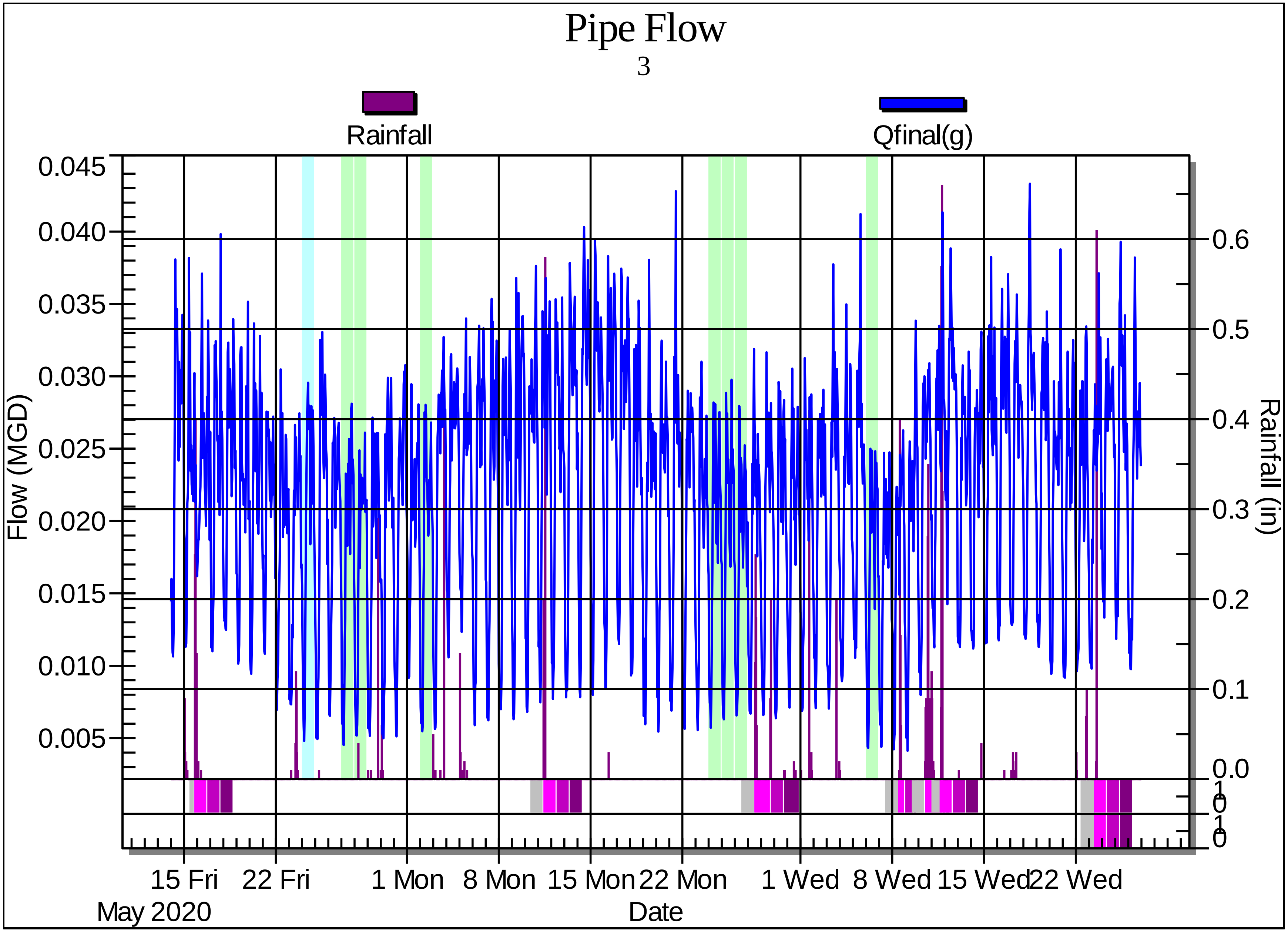
Scatter Graph
2
Lanfear-Coll (C-LC = 7.08)
VFINAL (ft/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
5
6
7
8
DFINAL (in)
Iso Q (MGD)
0.81
0.72
0.63
0.54
0.45
0.36
0.27
0.18
0.09
0.0225


Storm Event - 5/15/2020 7:00:00 PM
2
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Rainfall (in)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Storms
1.0
0.5
0.0
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date


Storm Event - 6/27/2020 12:00:00 PM
2
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Rainfall (in)
0.25
0.20
0.15
0.10
0.05
0.00
Storms
1.0
0.5
0.0
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date


Storm Event - 7/10/2020 12:00:00 PM
2
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Storms
1.0
0.5
0.0
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

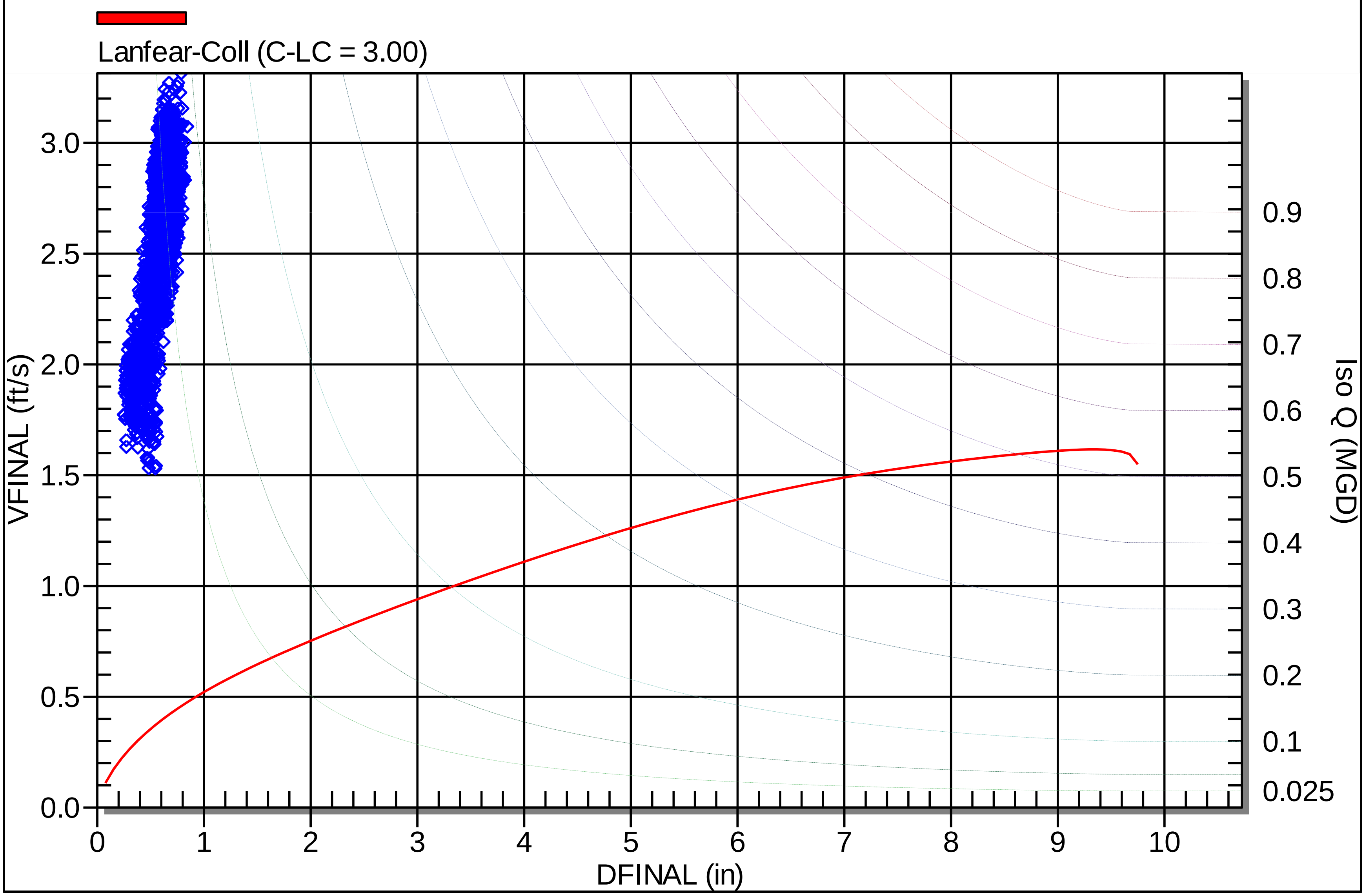

Storm Event - 7/23/2020 9:00:00 AM
2
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Storms
1.0
0.5
0.0
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

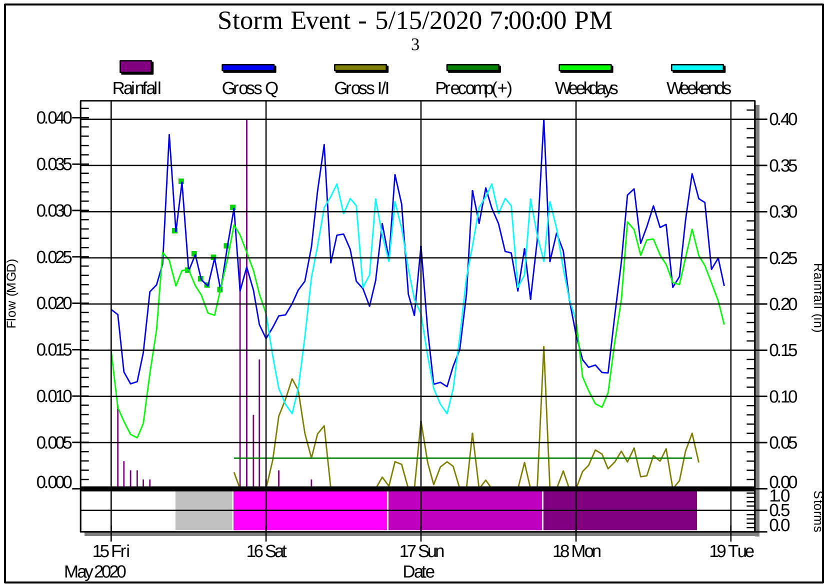


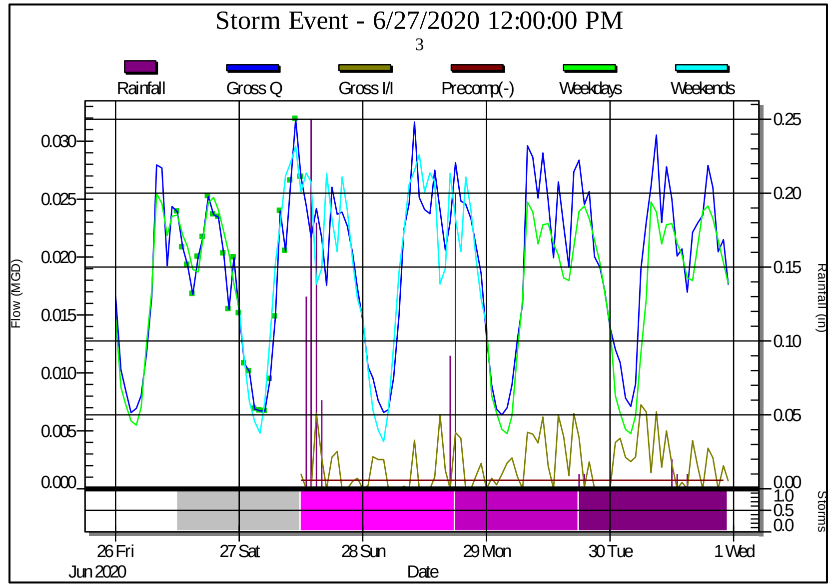
Pipe Flow
3
Rainfall
Qfinal(g)
Flow (MGD)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

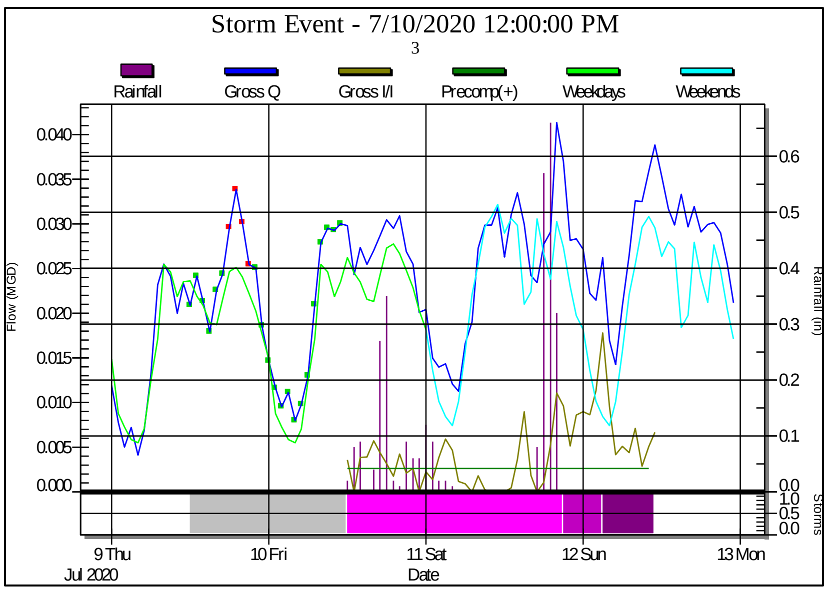
Scatter Graph

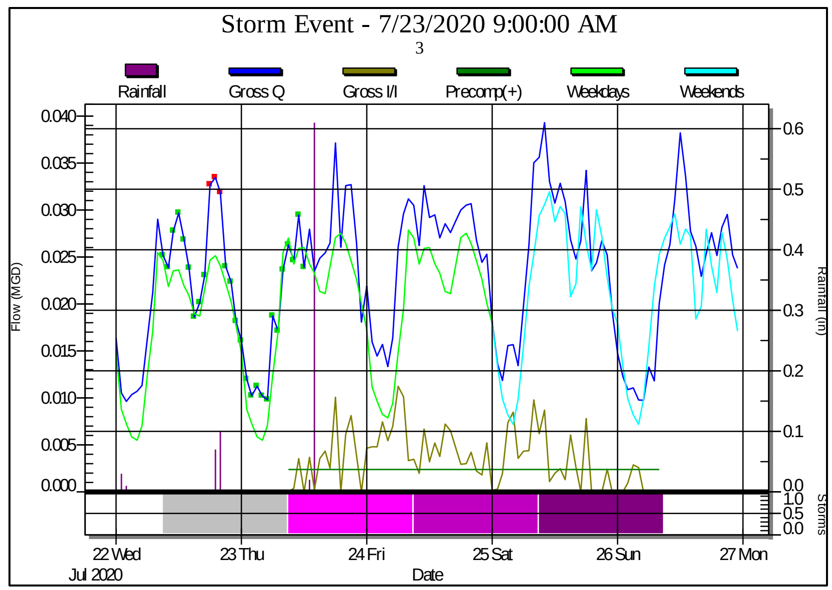
3

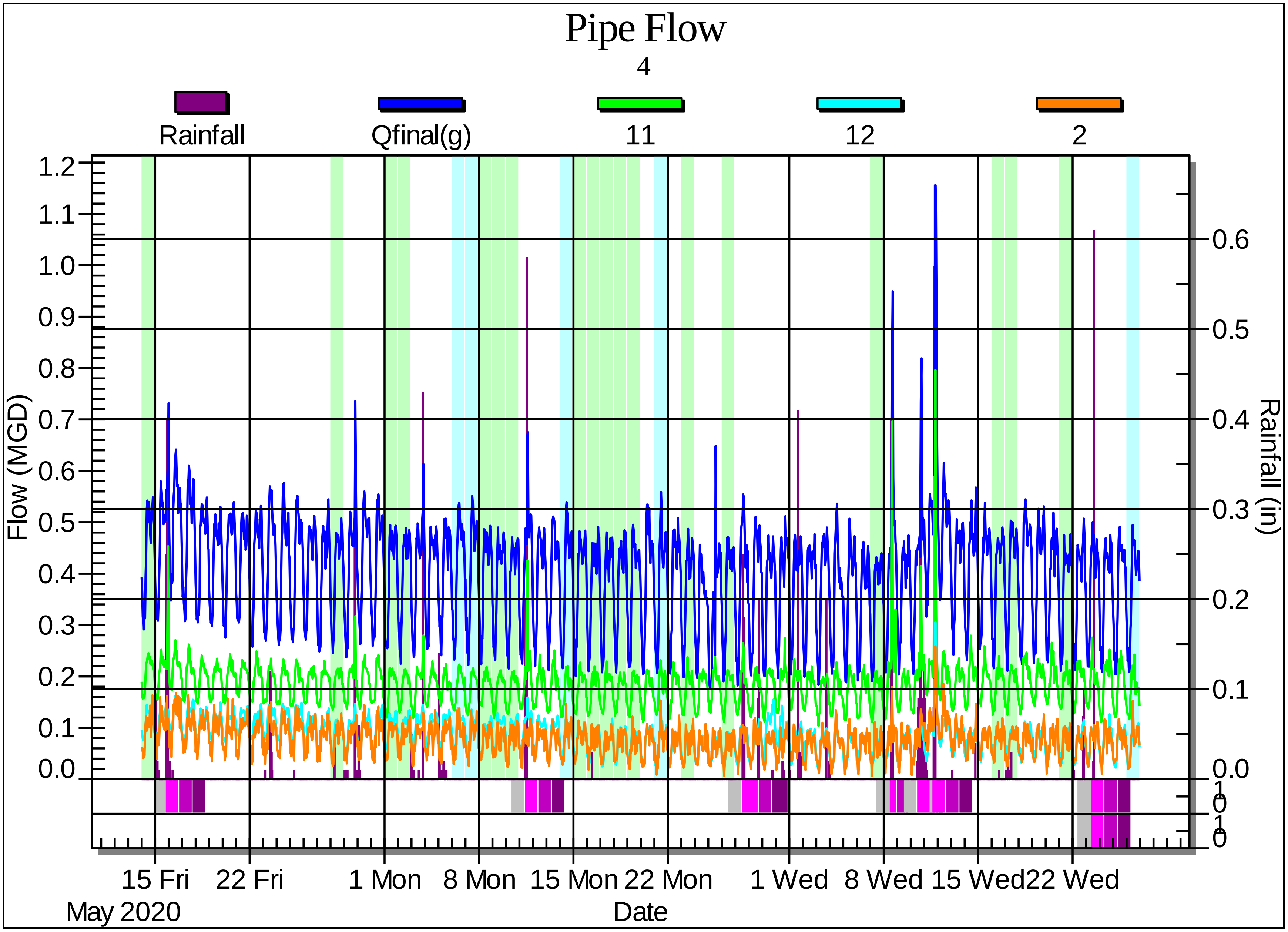



Storm Event - 5/15/2020 7:00:00 PM
3
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Rainfall (in)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Storms
1.0
0.5
0.0
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date

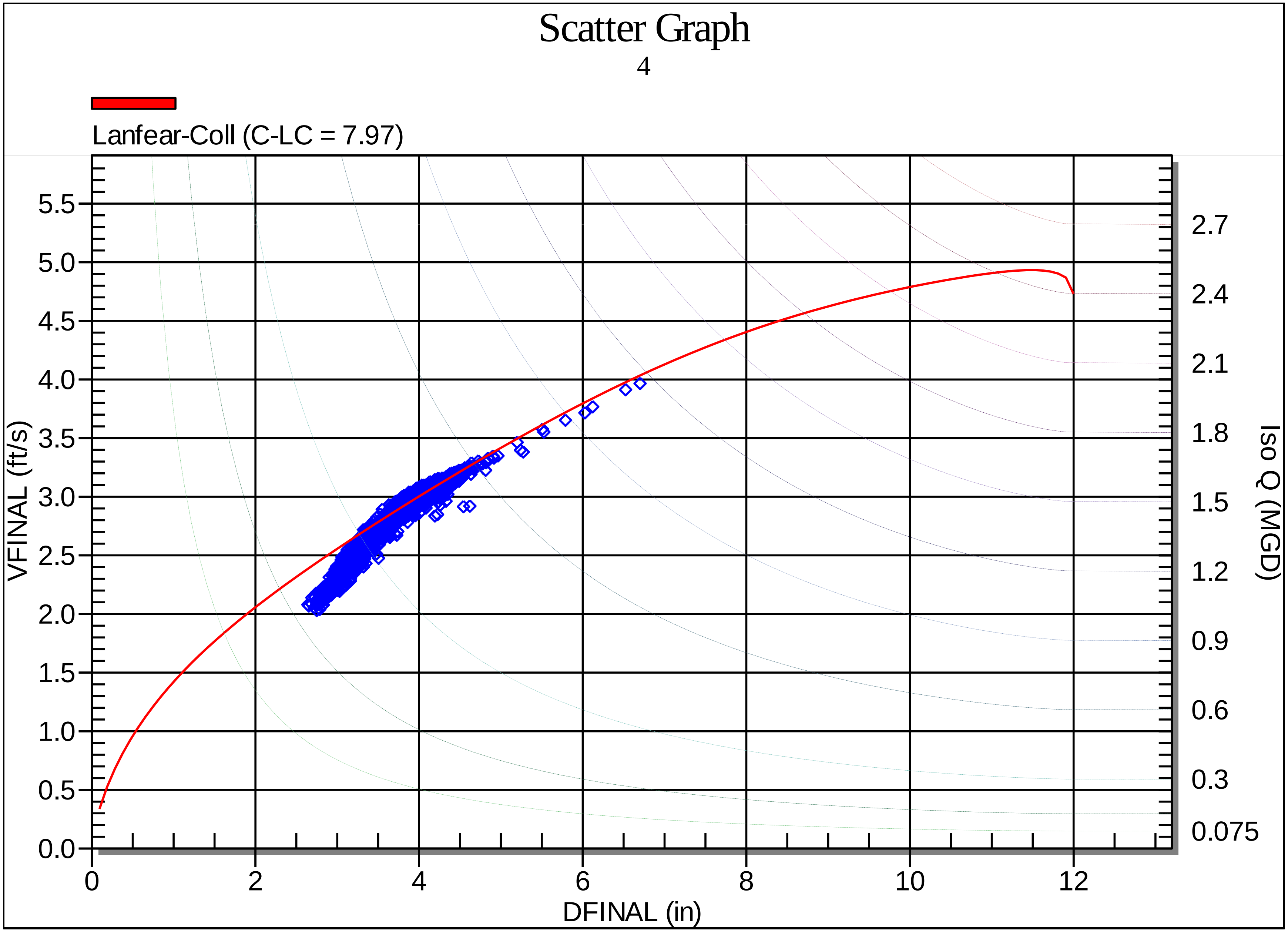

Storm Event - 6/27/2020 12:00:00 PM
3
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Rainfall (in)
0.25
0.20
0.15
0.10
0.05
0.00
Storms
1.0
0.5
0.0
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date

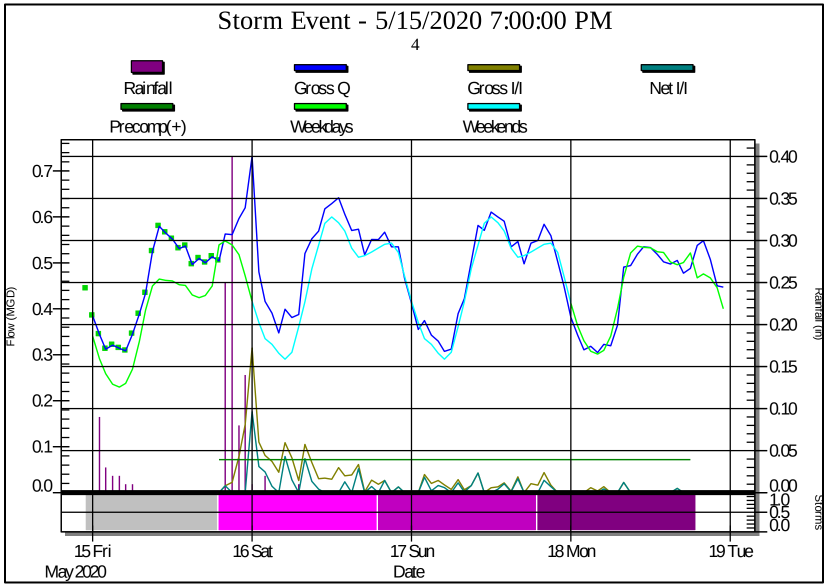

Storm Event - 7/10/2020 12:00:00 PM
3
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Storms
1.0
0.5
0.0
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

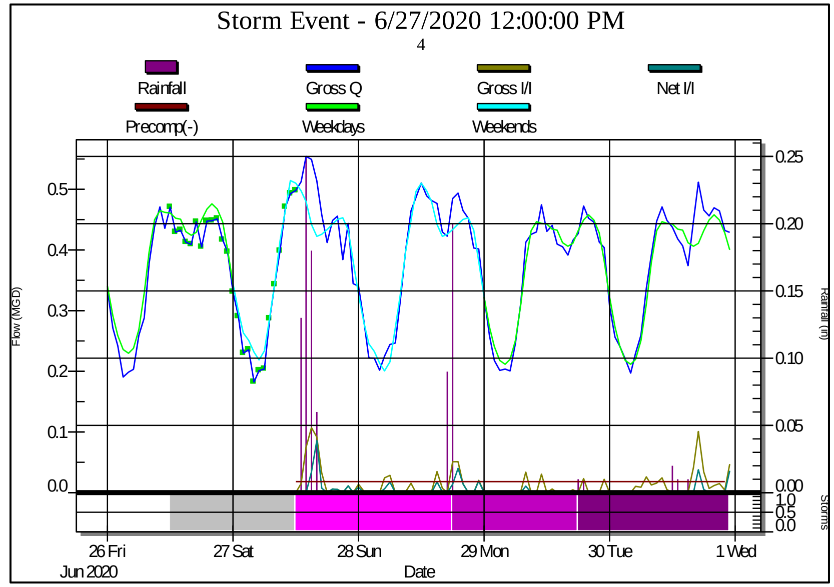

Storm Event - 7/23/2020 9:00:00 AM
3
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Storms
1.0
0.5
0.0
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

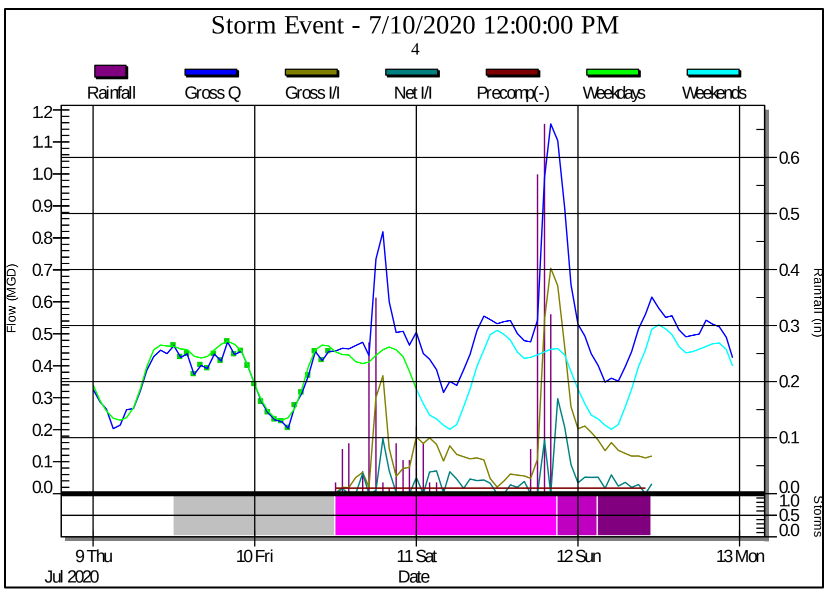


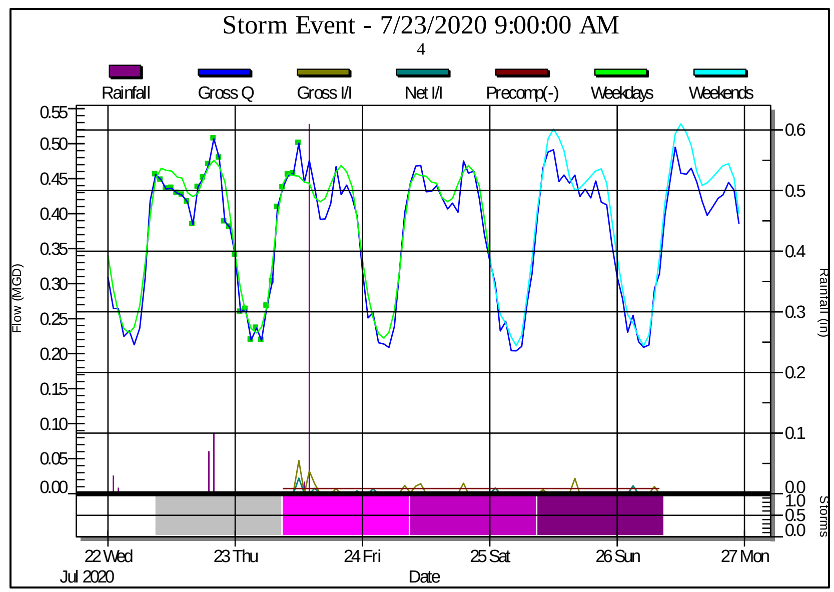
Pipe Flow
4
Rainfall
Qfinal(g)
11
12
2
Flow (MGD)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

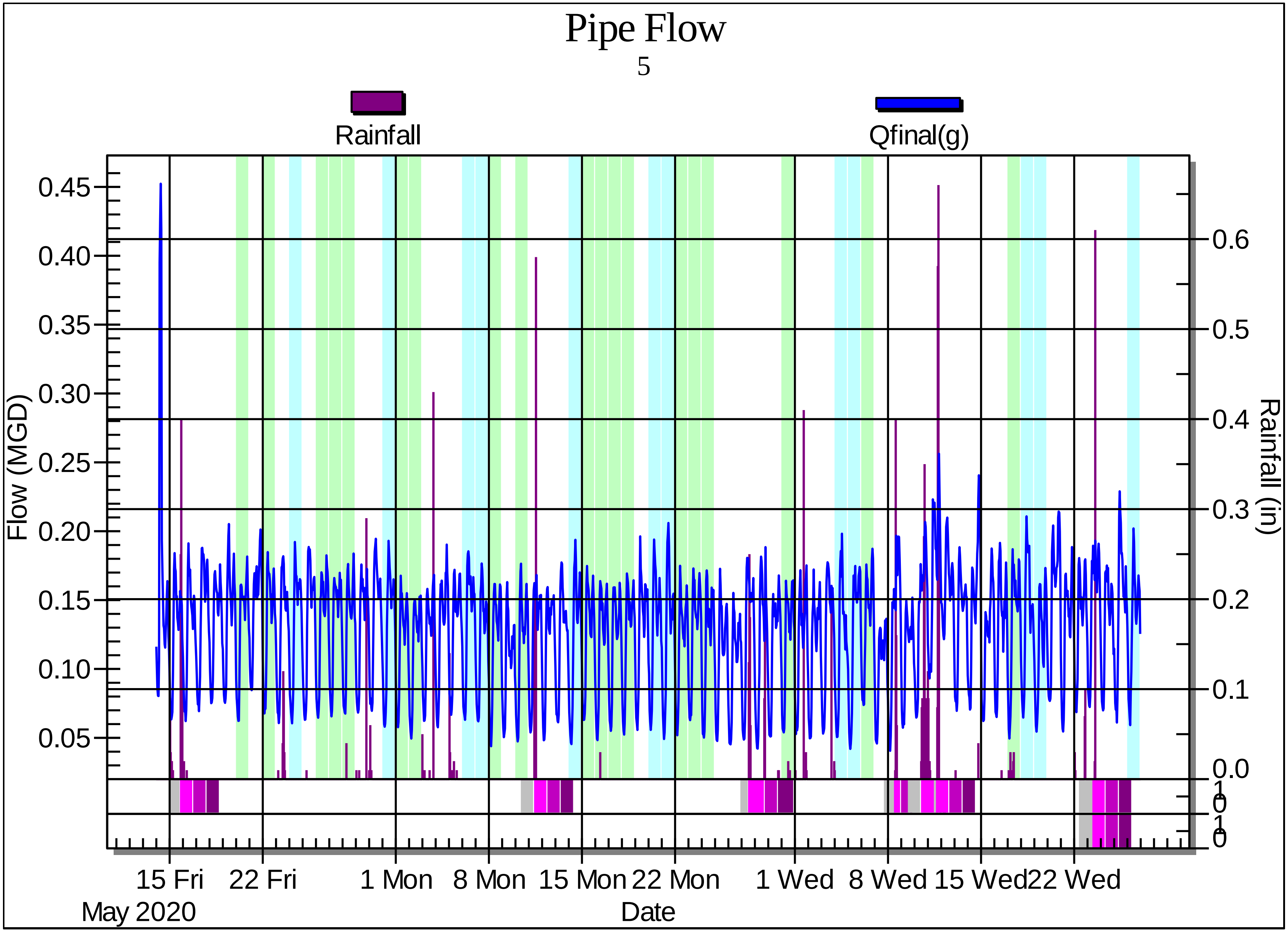

Scatter Graph
4
Lanfear-Coll (C-LC = 7.97)
VFINAL (ft/s)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
DFINAL (in)
Iso Q (MGD)
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.075


Storm Event - 5/15/2020 7:00:00 PM
4
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date

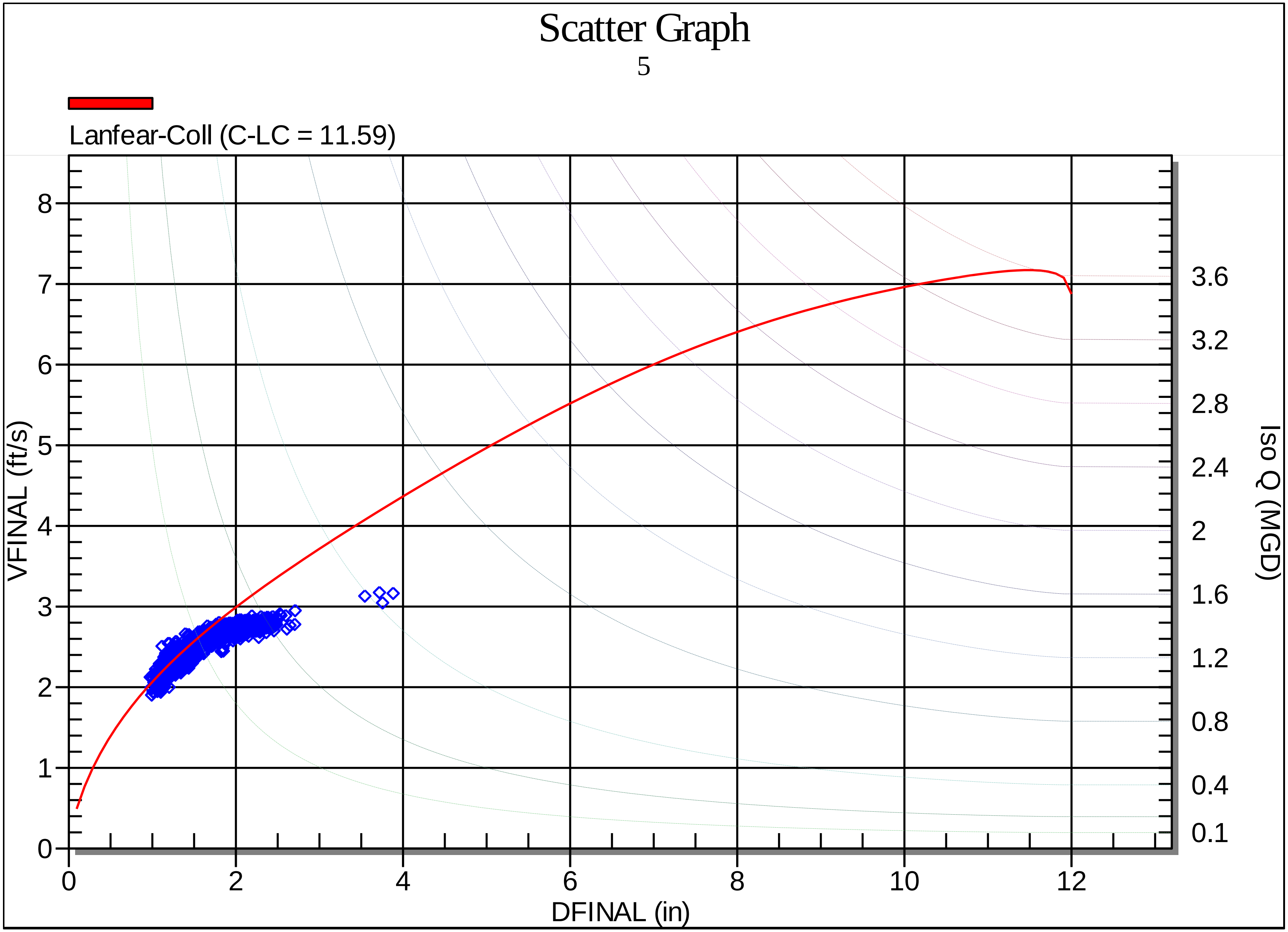

Storm Event - 6/27/2020 12:00:00 PM
4
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date

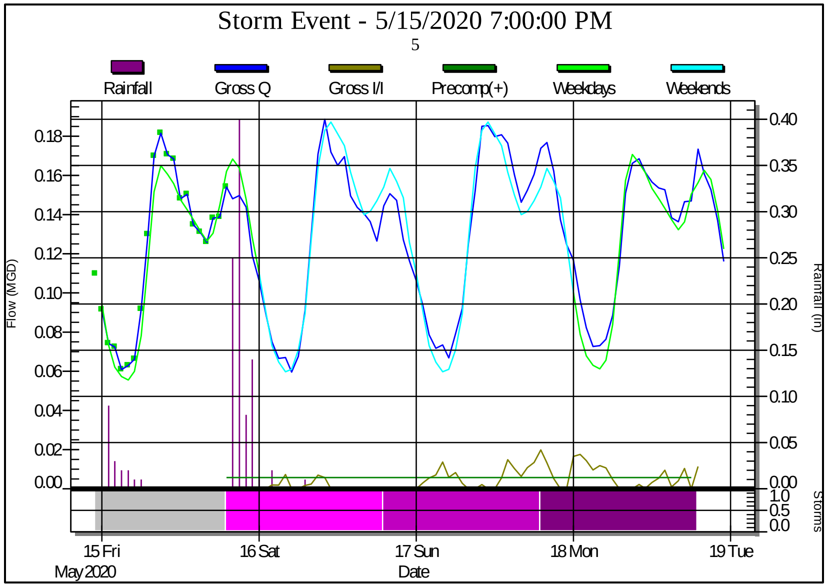
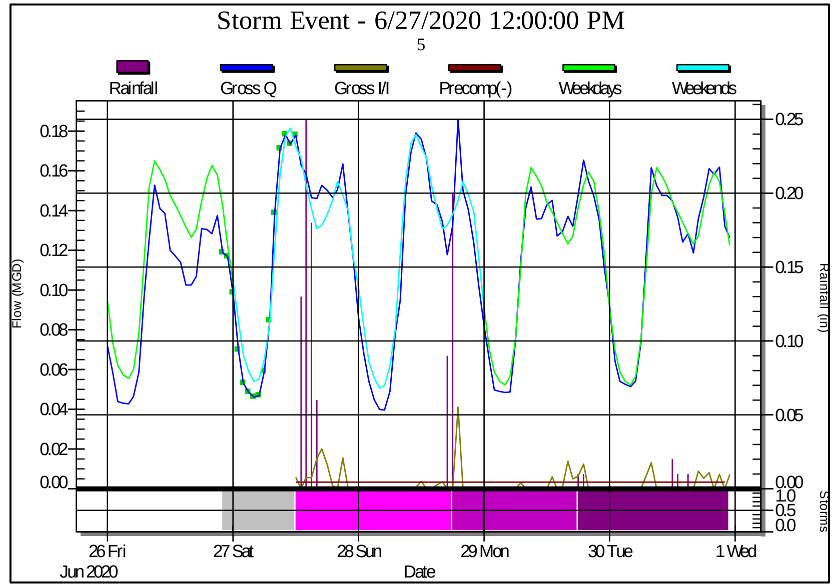
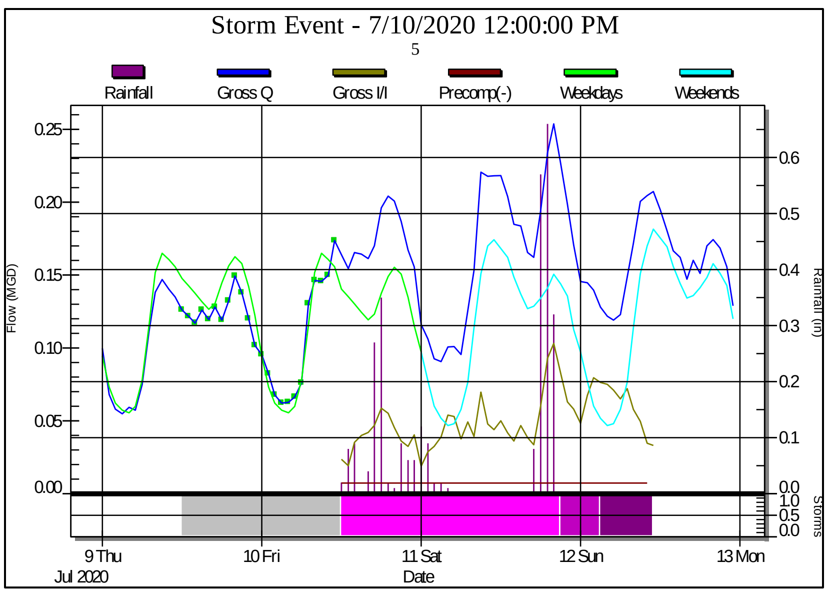
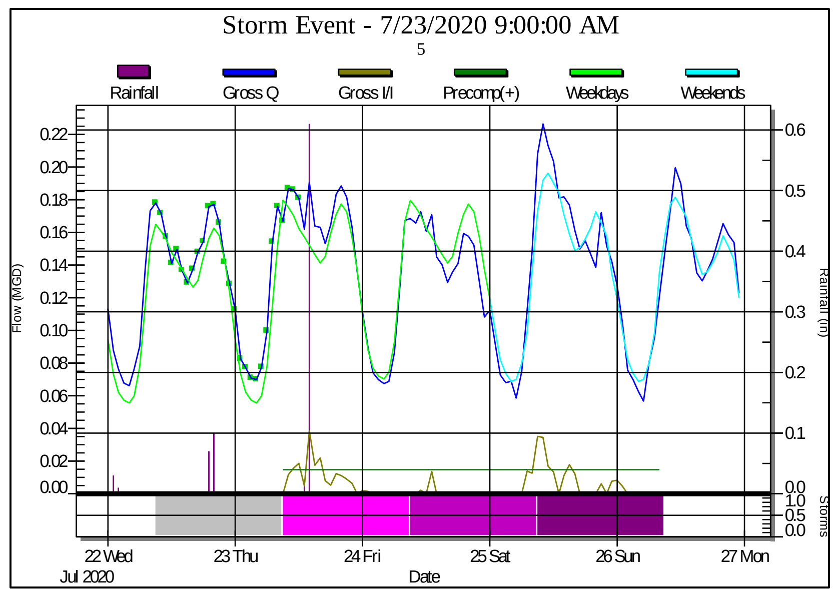

Storm Event - 7/10/2020 12:00:00 PM
4
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

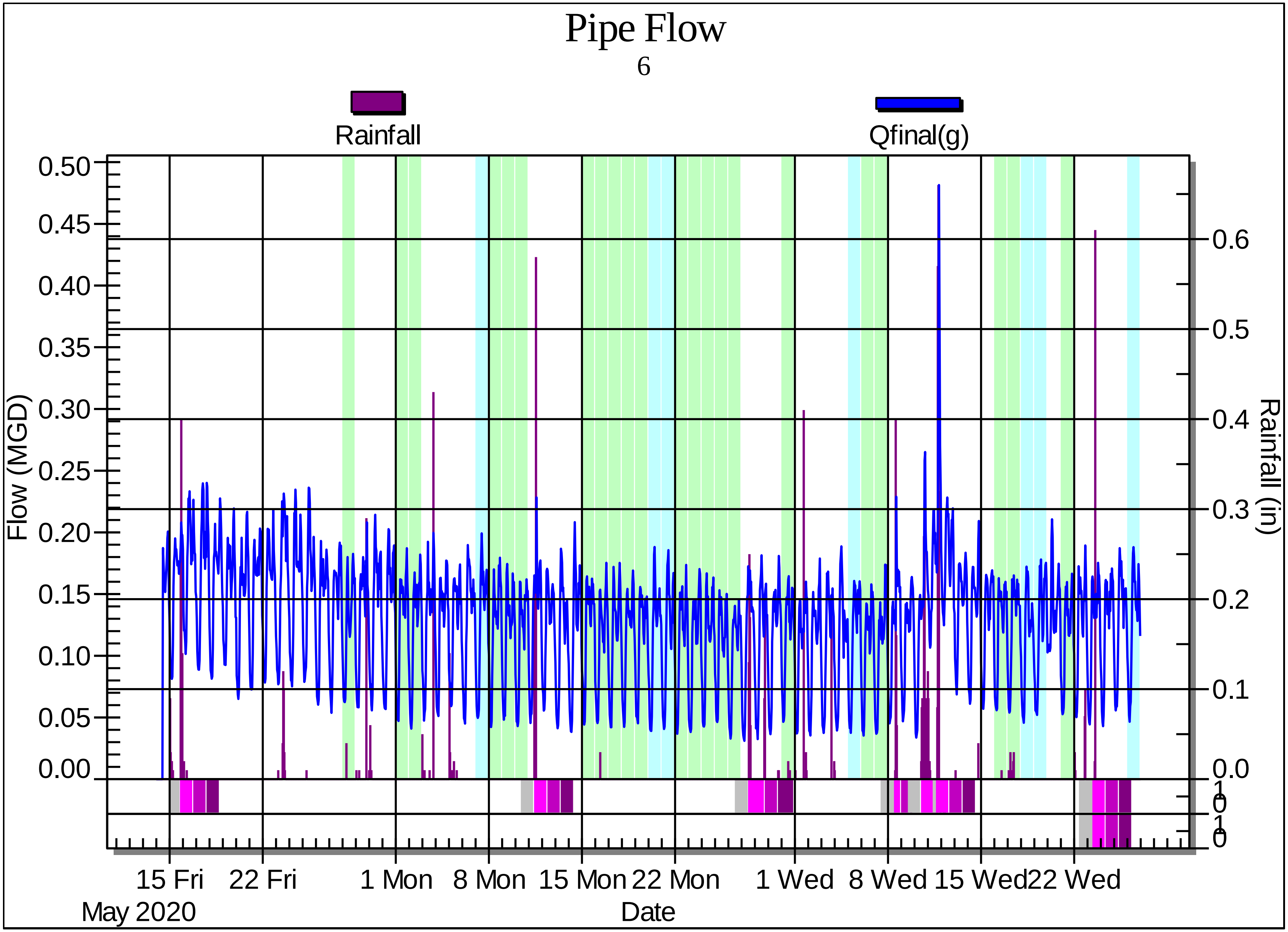

Storm Event - 7/23/2020 9:00:00 AM
4
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date



Pipe Flow
5
Rainfall
Qfinal(g)
Flow (MGD)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date


Scatter Graph
5
Lanfear-Coll (C-LC = 11.59)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
0.1
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6

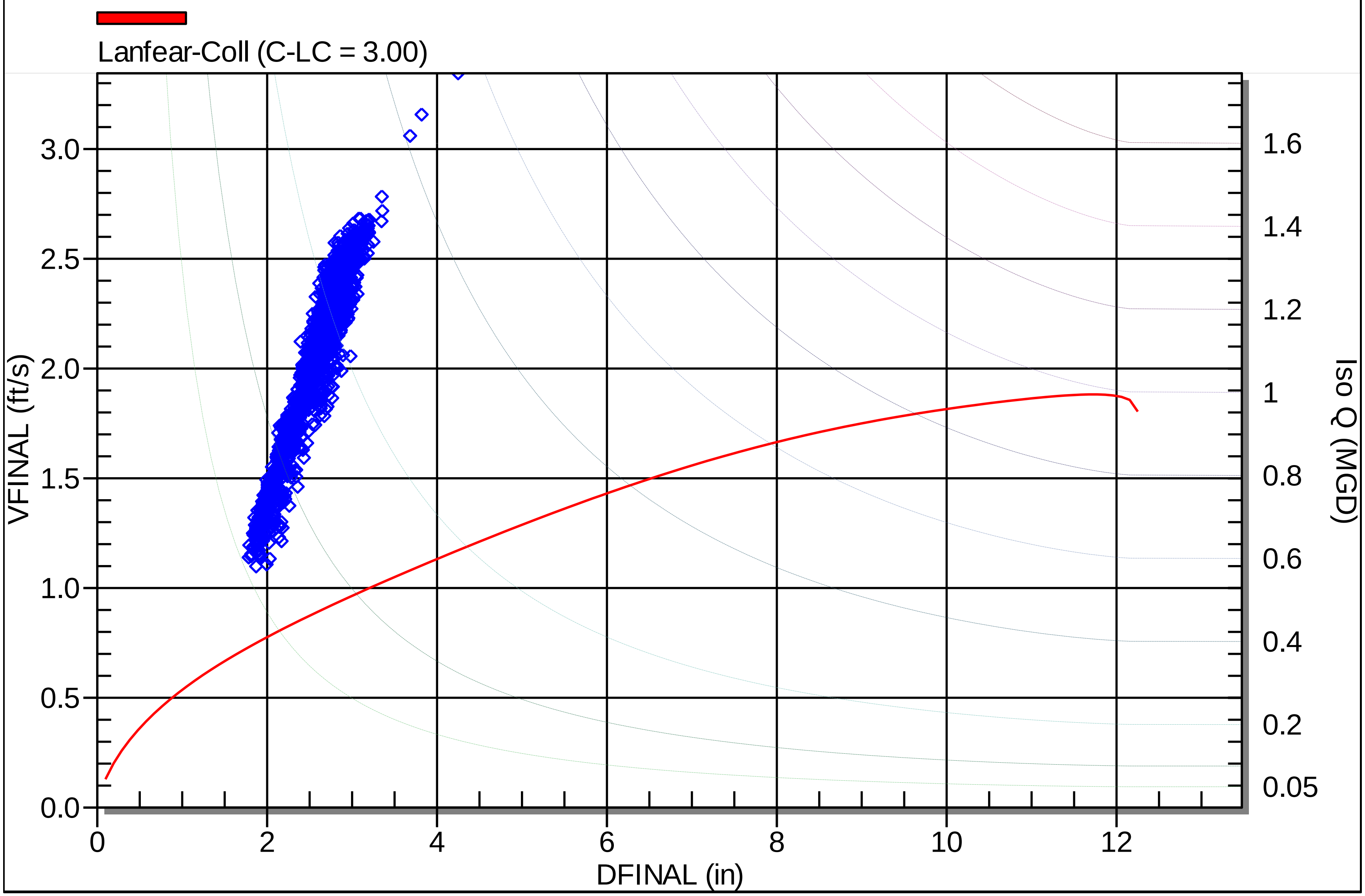

Storm Event - 5/15/2020 7:00:00 PM
5
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Storms
0.0
0.5
1.0
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date

Storm Event - 6/27/2020 12:00:00 PM
5
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
Rainfall (in)
0.00
0.05
0.10
0.15
0.20
0.25
Storms
0.0
0.5
1.0
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date

Storm Event - 7/10/2020 12:00:00 PM
5
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
0.00
0.05
0.10
0.15
0.20
0.25
Rainfall (in)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Storms
0.0
0.5
1.0
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

Storm Event - 7/23/2020 9:00:00 AM
5
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
Rainfall (in)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Storms
0.0
0.5
1.0
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

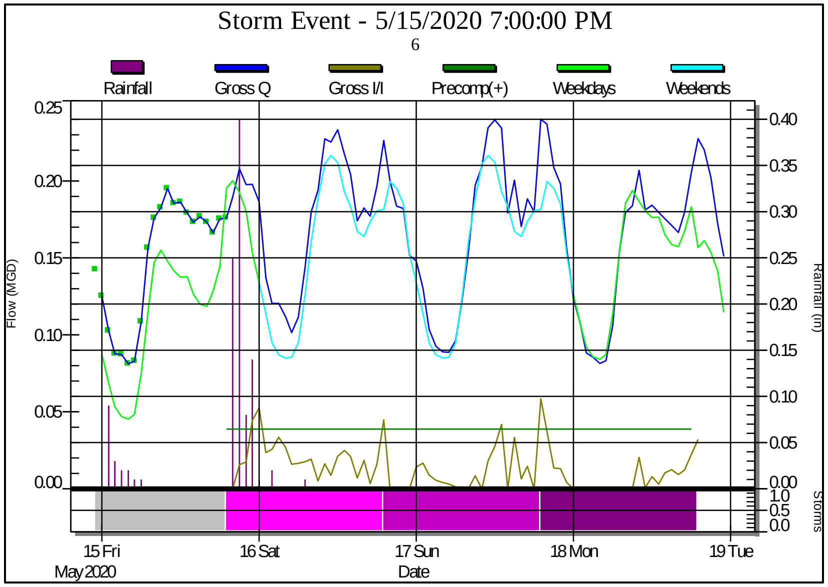


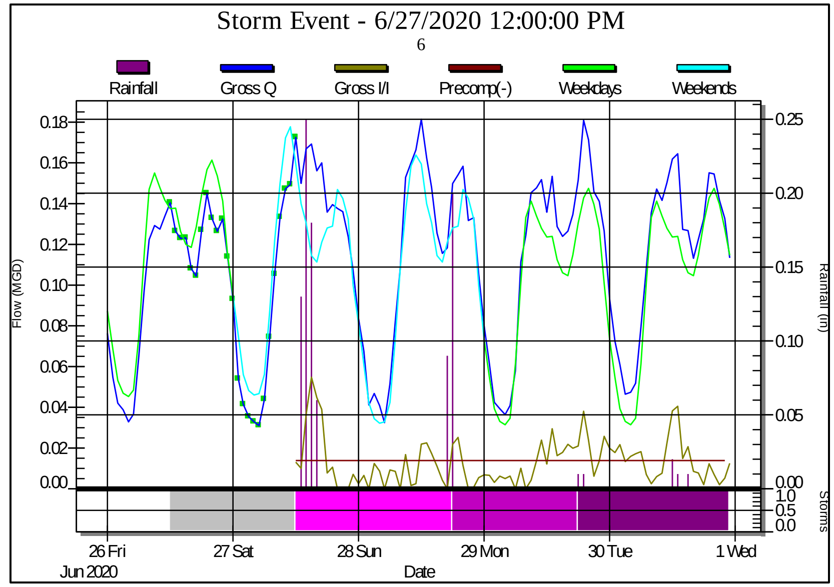
Pipe Flow
6
Rainfall
Qfinal(g)
Flow (MGD)
Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

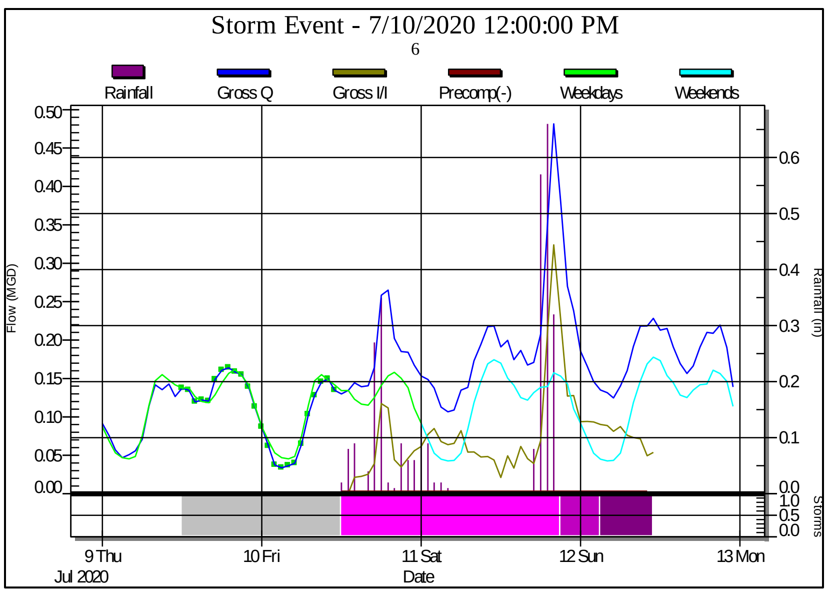
Scatter Graph

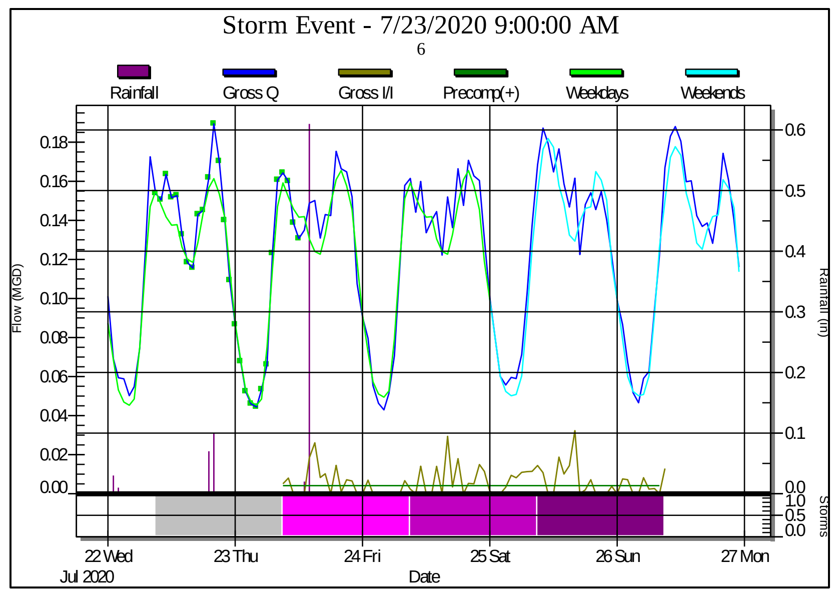
6

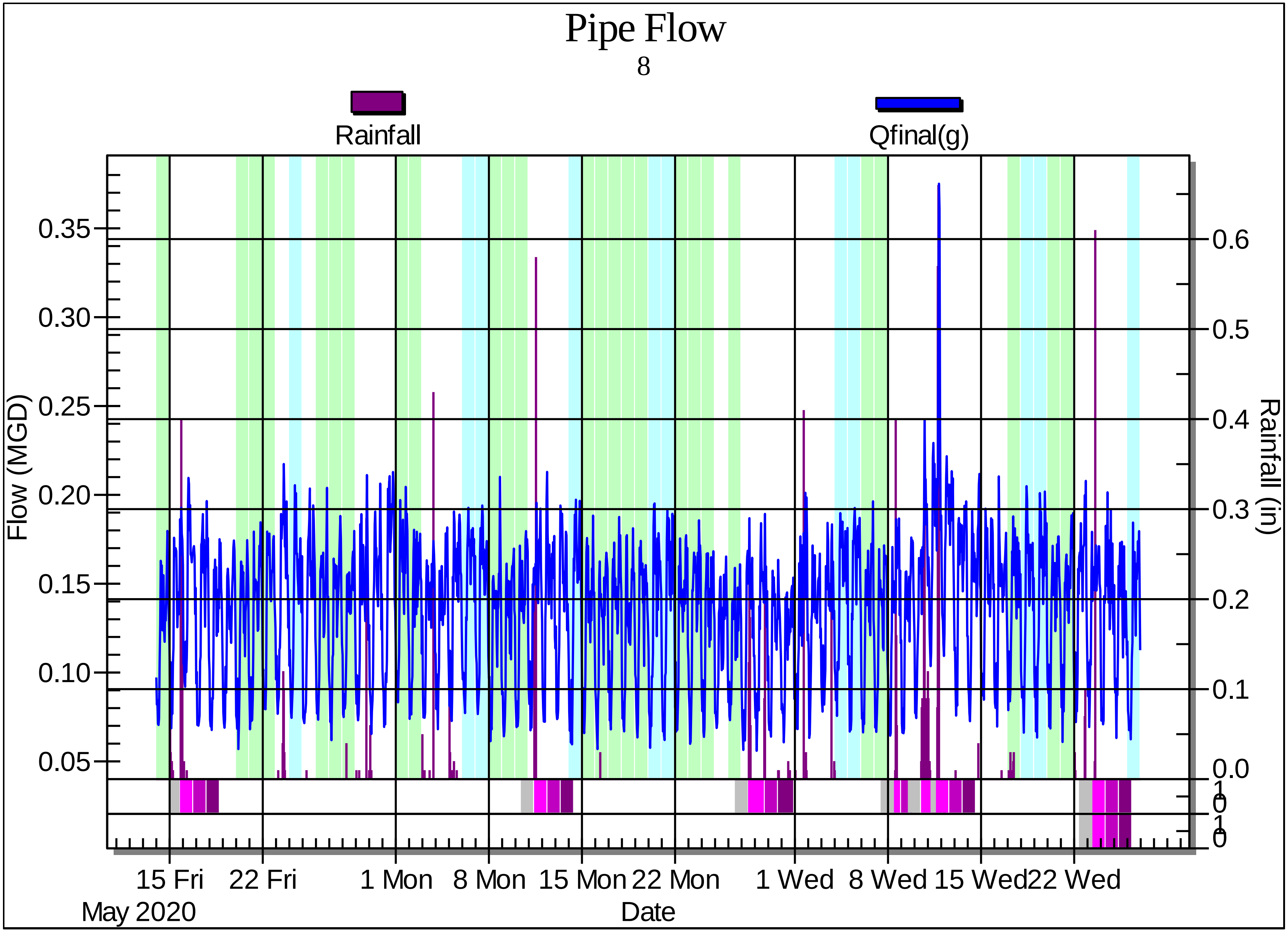



Storm Event - 5/15/2020 7:00:00 PM
6
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
May 2020
16 Sat
17 Sun
18 Mon
19 Tue
Date

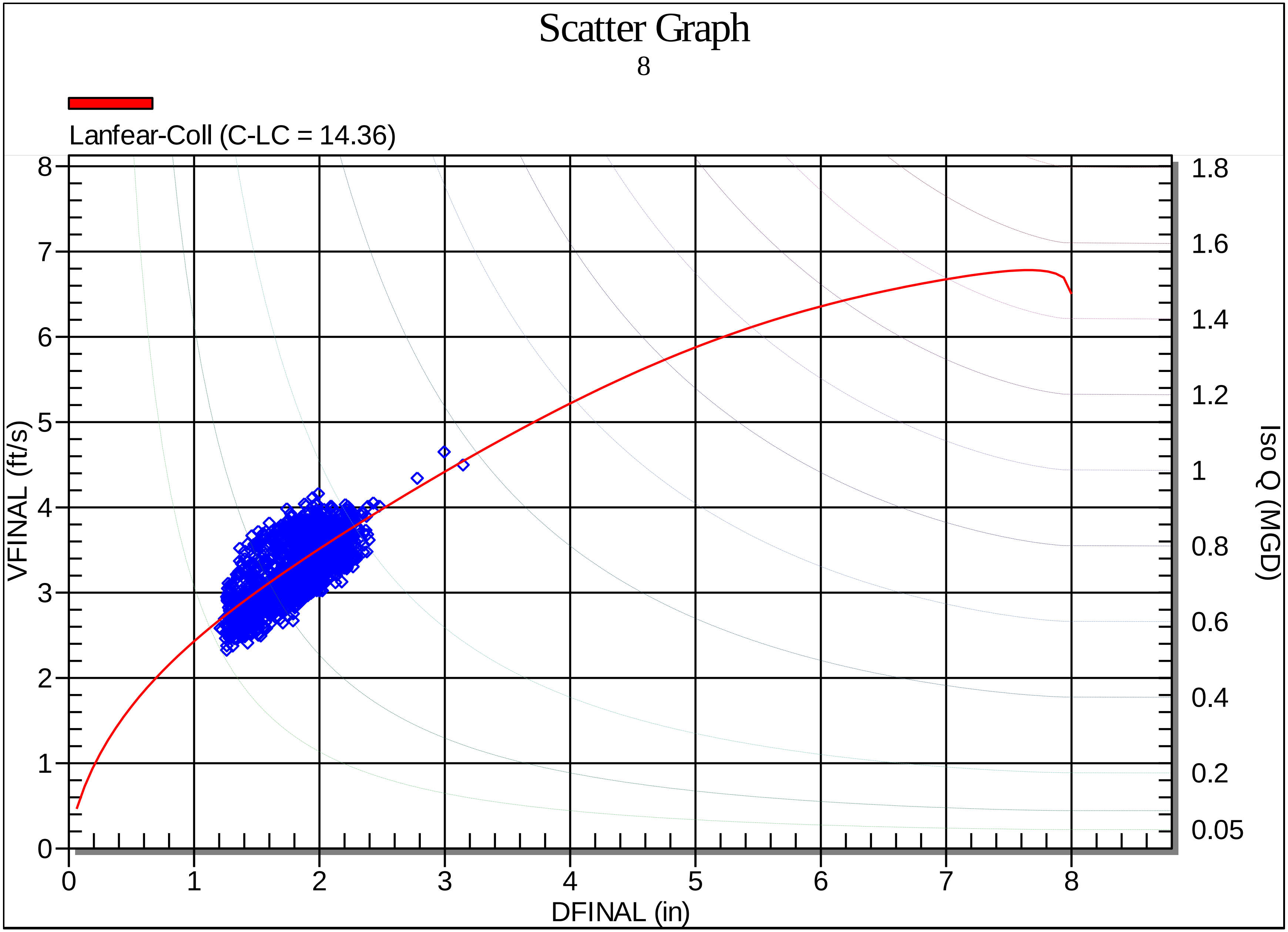

Storm Event - 6/27/2020 12:00:00 PM
6
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
Jun 2020
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Date

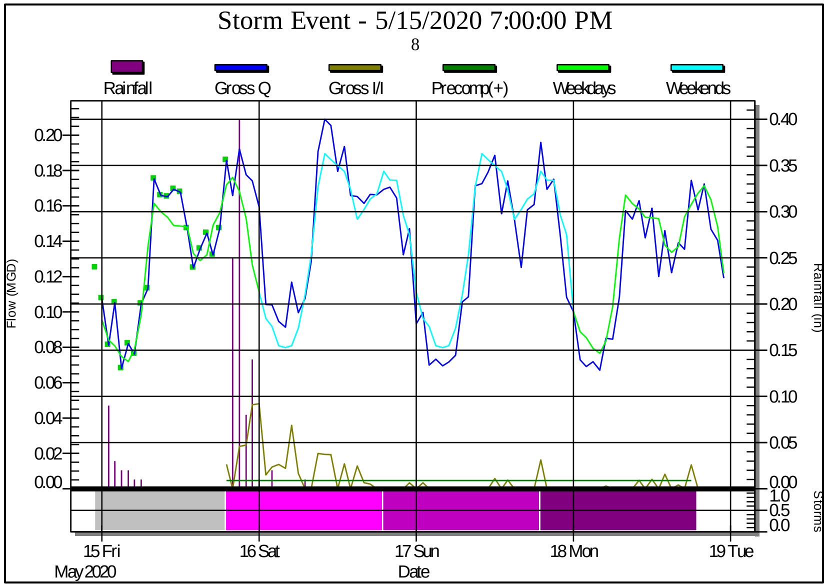

Storm Event - 7/10/2020 12:00:00 PM
6
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
Jul 2020
10 Fri
11 Sat
12 Sun
13 Mon
Date

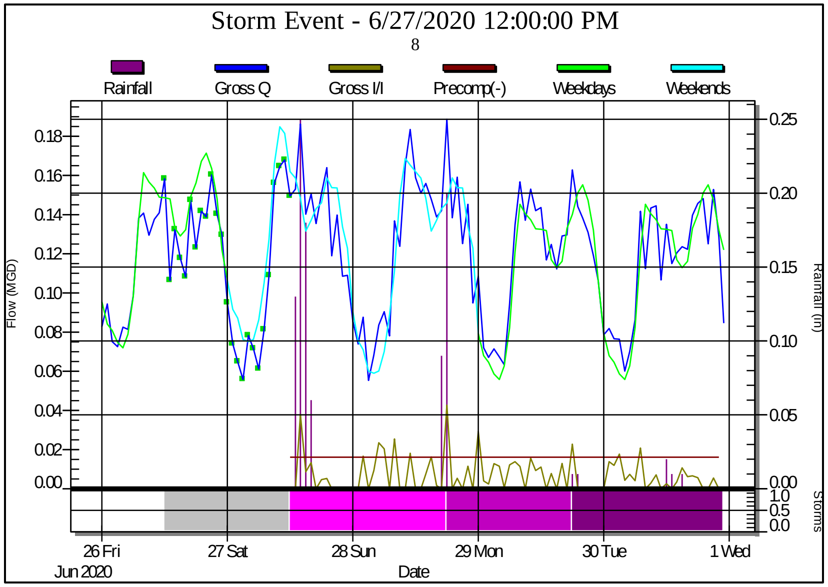

Storm Event - 7/23/2020 9:00:00 AM
6
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
22 Wed
Jul 2020
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Date

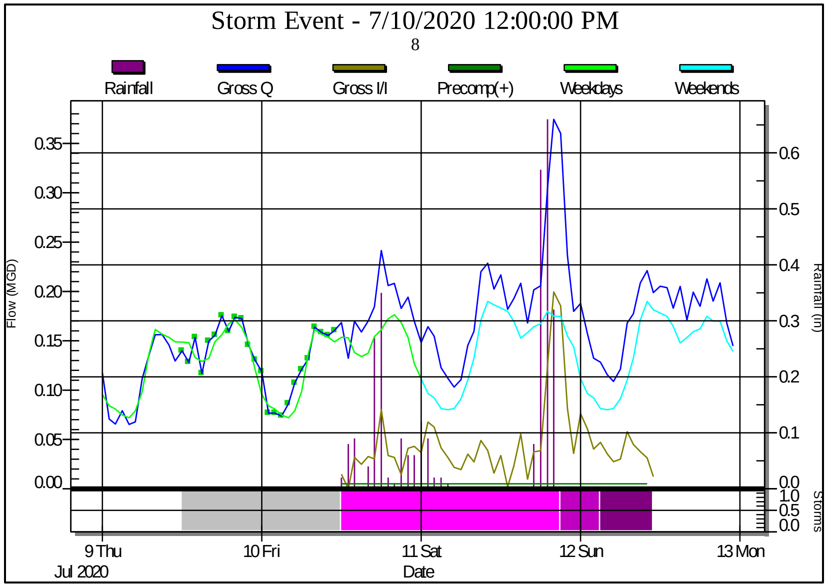


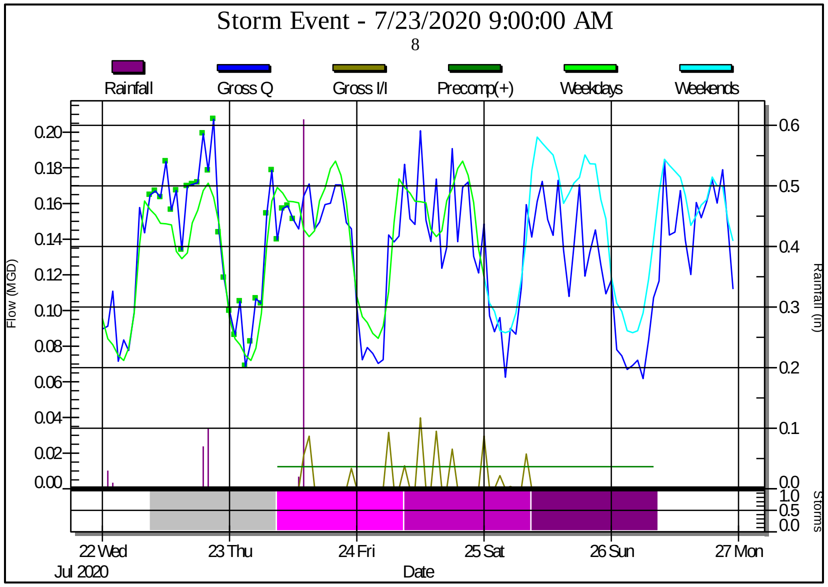
Pipe Flow
8
Rainfall
Qfinal(g)
Flow (MGD)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

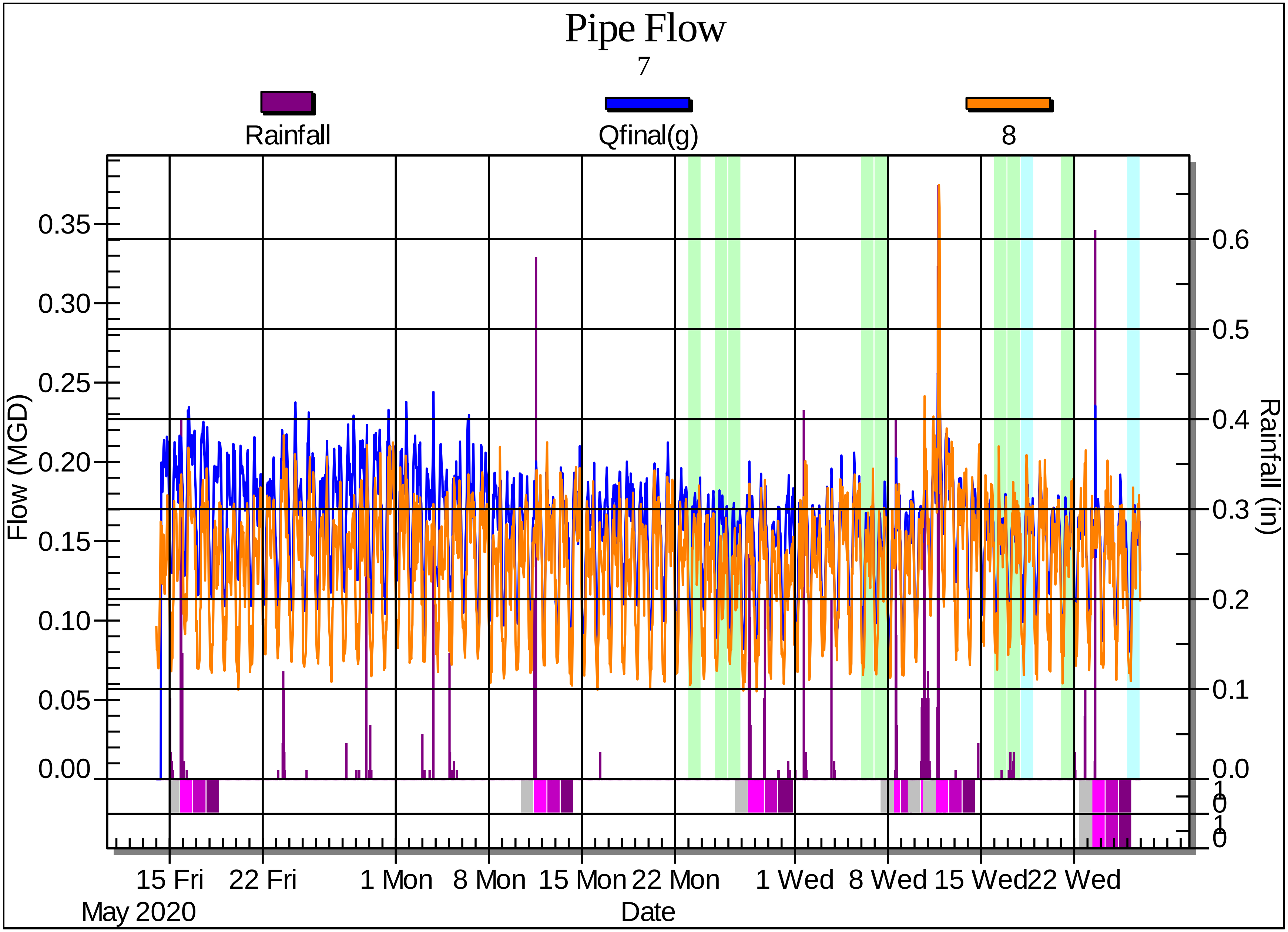

Scatter Graph
8
Lanfear-Coll (C-LC = 14.36)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)
0
1
2
3
4
5
6
7
8
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0.05


Storm Event - 5/15/2020 7:00:00 PM
8
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date

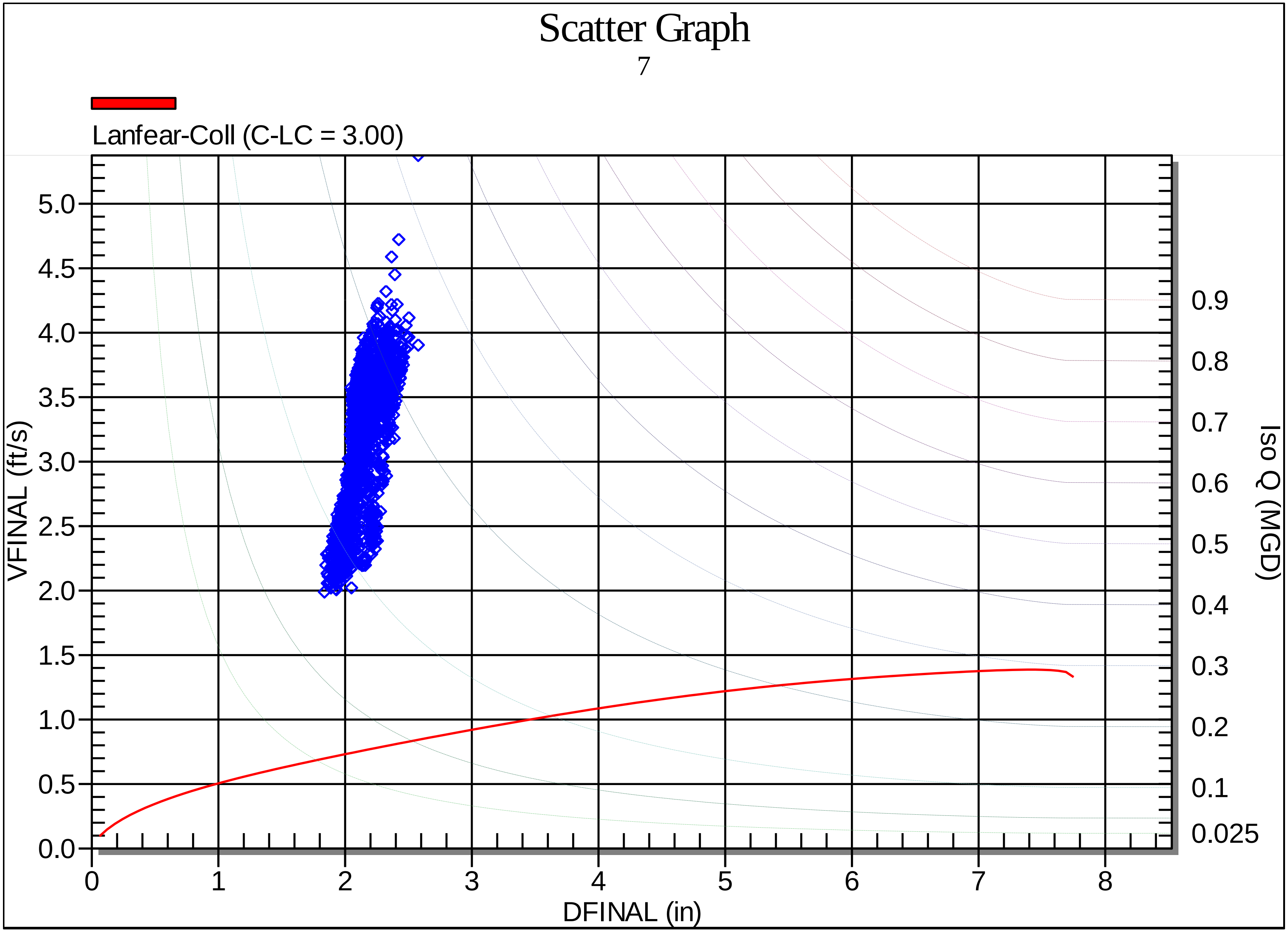

Storm Event - 6/27/2020 12:00:00 PM
8
Rainfall
Gross Q
Gross I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date


Storm Event - 7/10/2020 12:00:00 PM
8
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

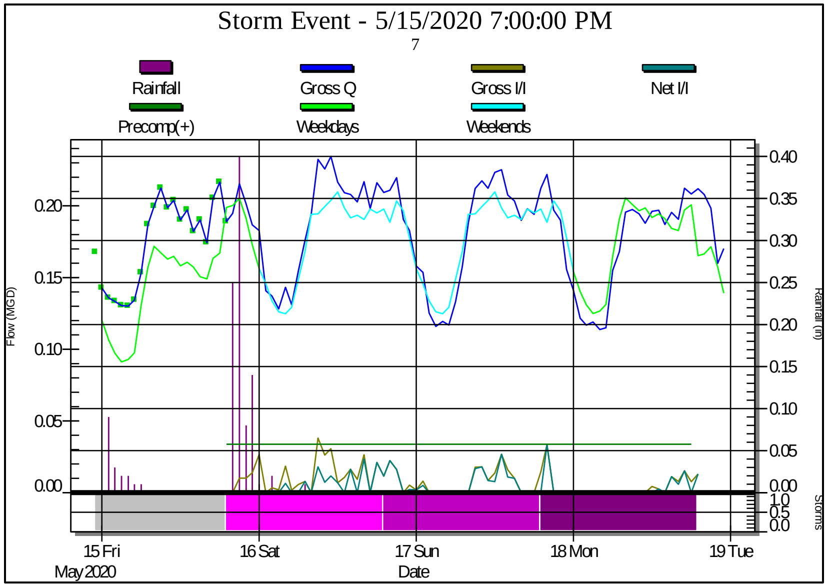

Storm Event - 7/23/2020 9:00:00 AM
8
Rainfall
Gross Q
Gross I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date



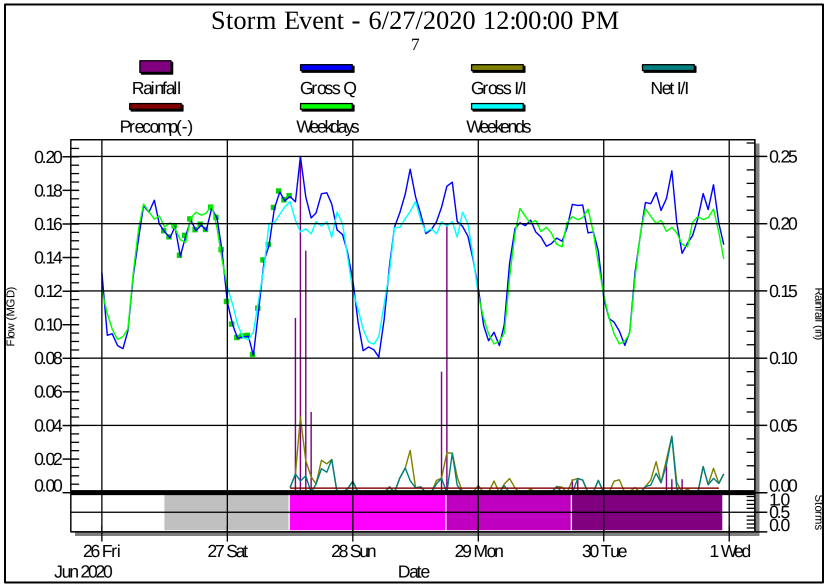
Pipe Flow
7
Rainfall
Qfinal(g)
8
Flow (MGD)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date



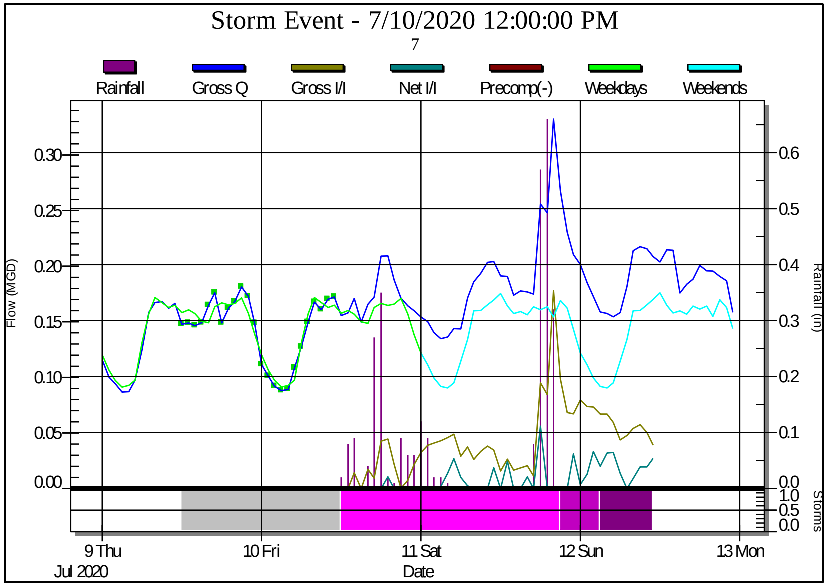
Scatter Graph
7
Lanfear-Coll (C-LC = 3.00)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
5
6
7
8
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.025



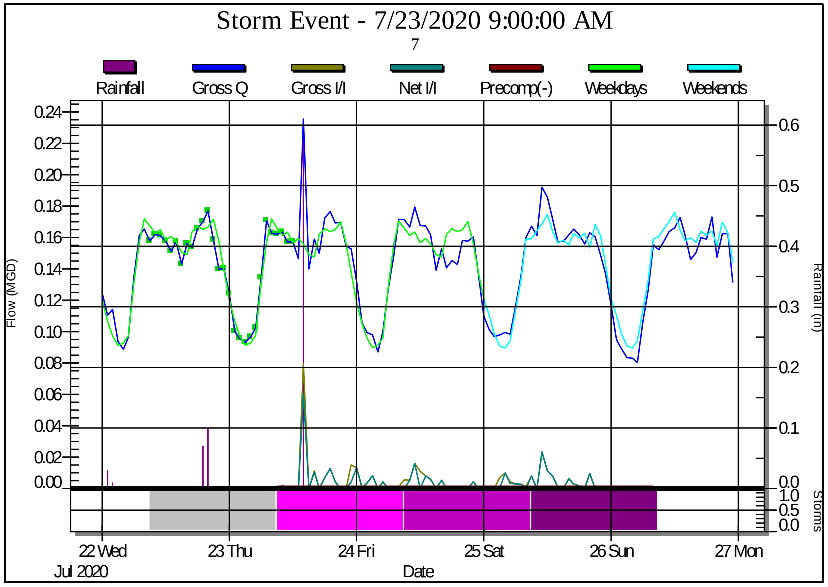
Storm Event - 5/15/2020 7:00:00 PM
7
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
May 2020
16 Sat
17 Sun
18 Mon
19 Tue
Date



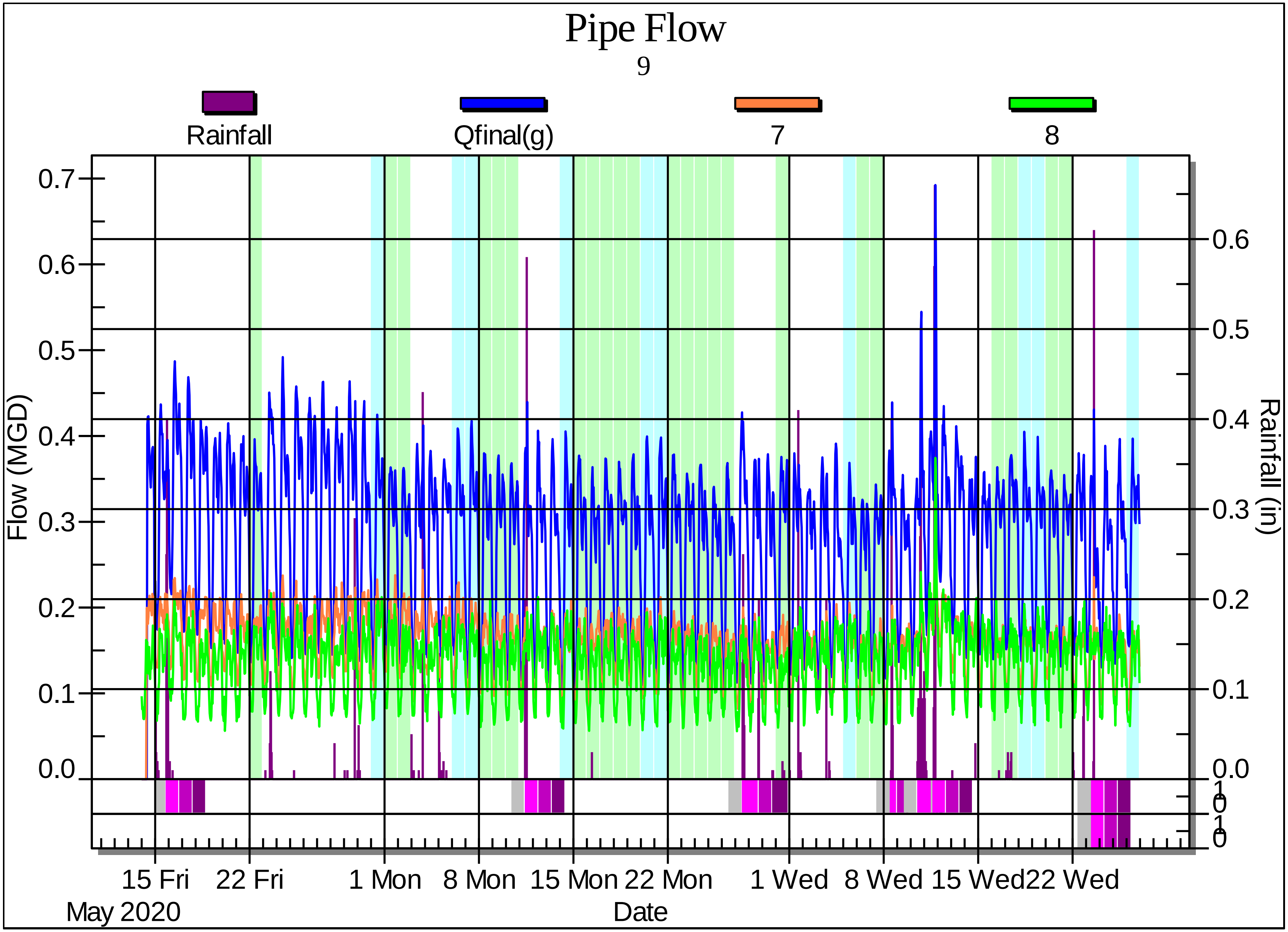
Storm Event - 6/27/2020 12:00:00 PM
7
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
Jun 2020
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Date



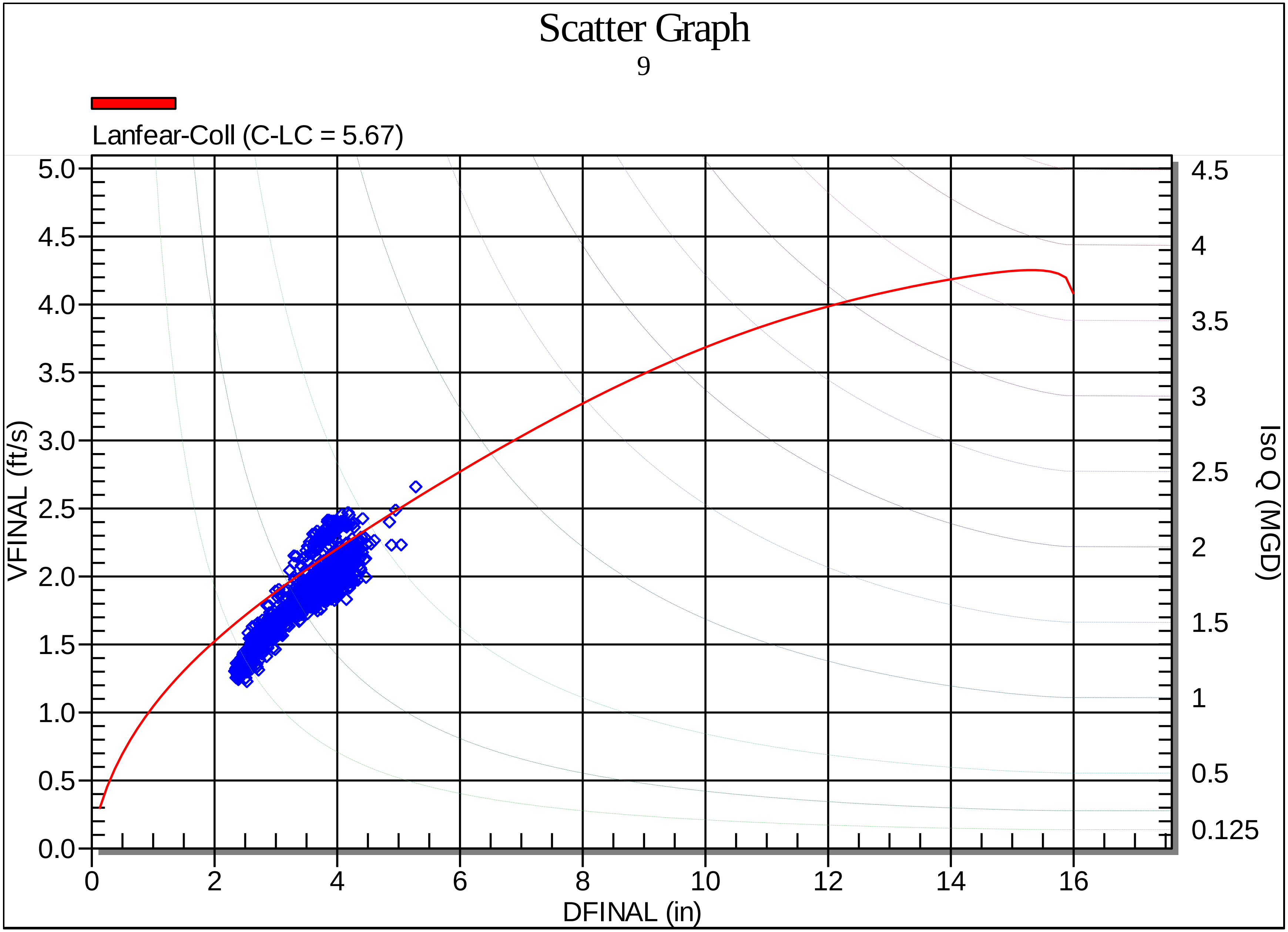
Storm Event - 7/10/2020 12:00:00 PM
7
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
Jul 2020
10 Fri
11 Sat
12 Sun
13 Mon
Date

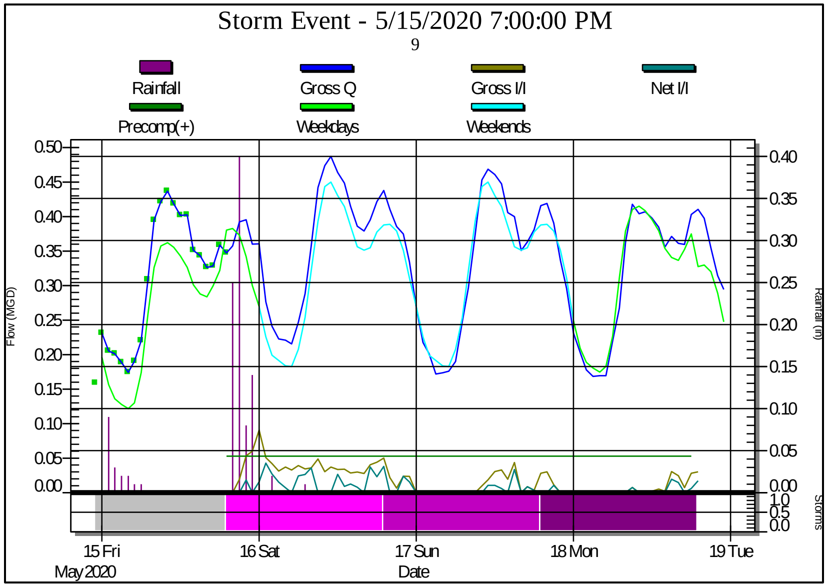


Storm Event - 7/23/2020 9:00:00 AM
7
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
22 Wed
Jul 2020
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Date

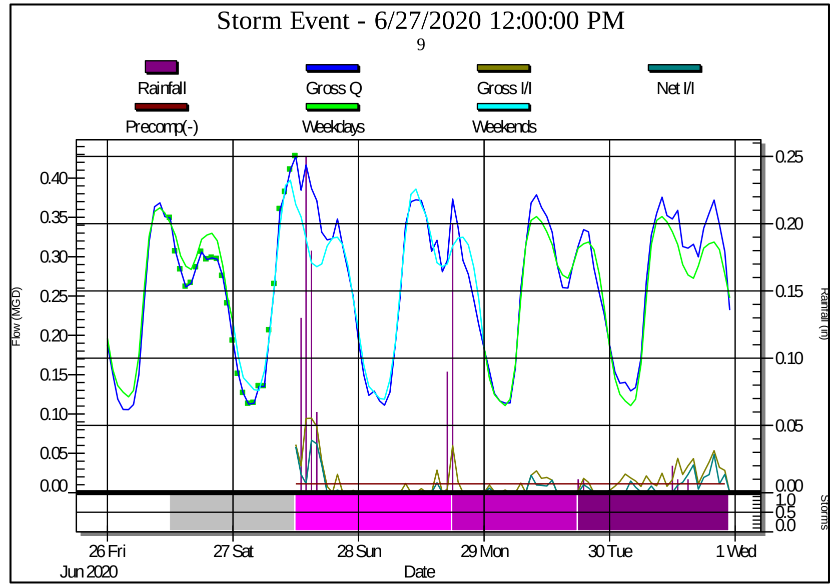


Pipe Flow
9
Rainfall
Qfinal(g)
7
8
Flow (MGD)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Rainfall (in)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
0
1
0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date

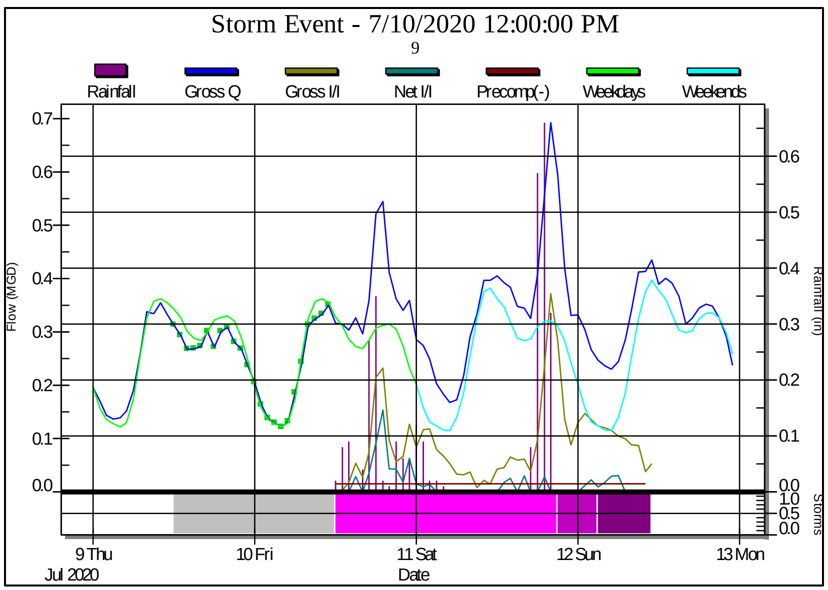

Scatter Graph
9
Lanfear-Coll (C-LC = 5.67)
VFINAL (ft/s)
DFINAL (in)
Iso Q (MGD)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14
16
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0.125



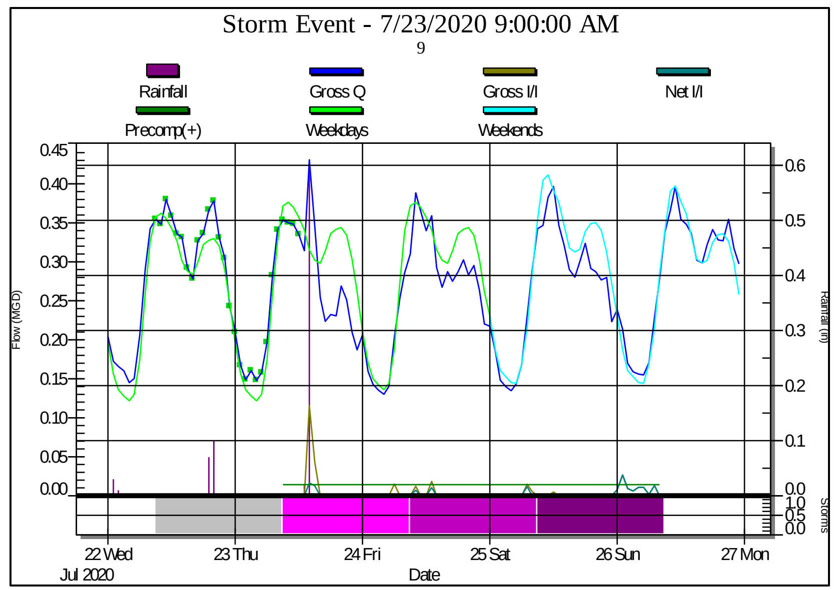
Storm Event - 5/15/2020 7:00:00 PM
9
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date



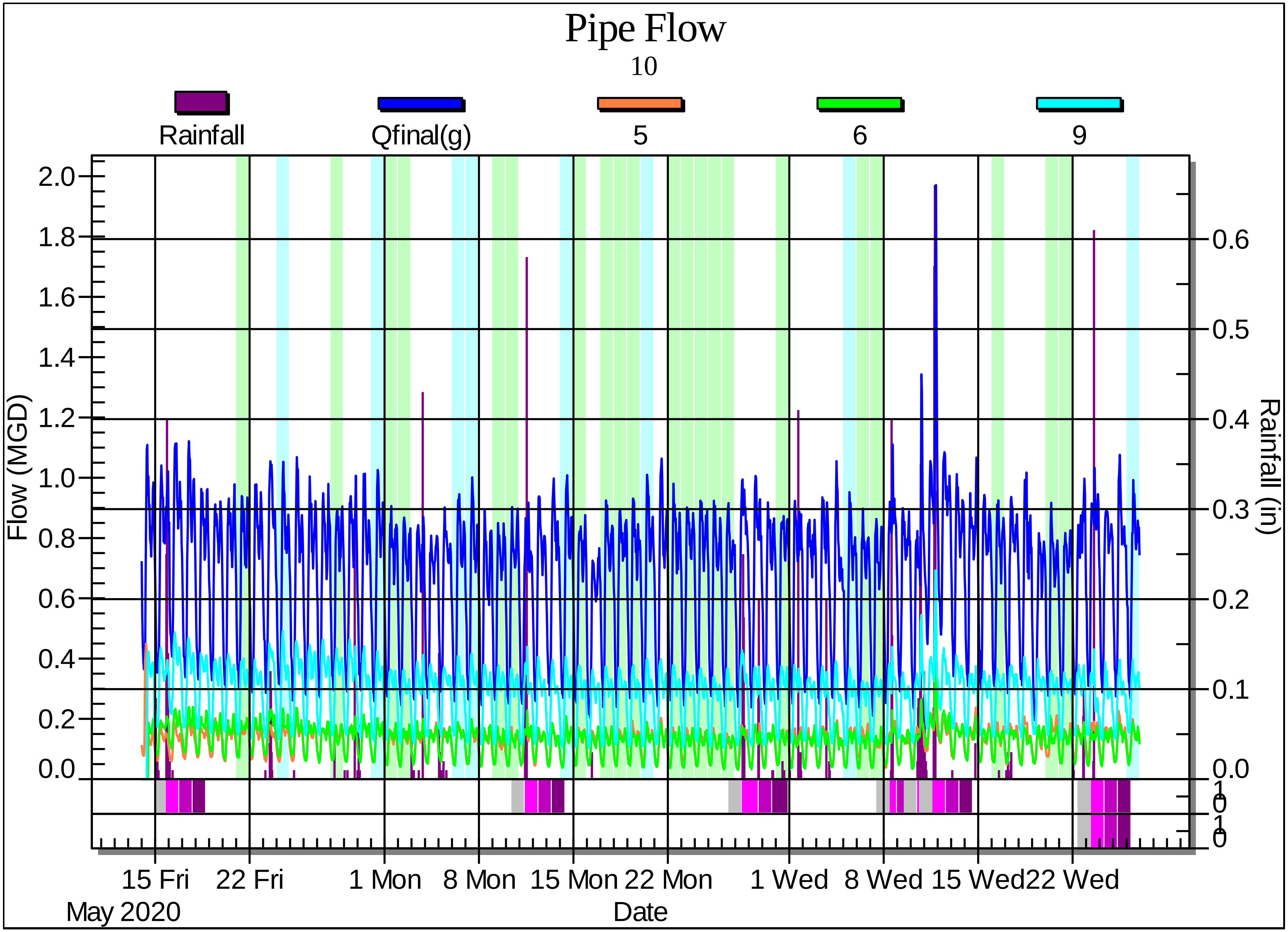
Storm Event - 6/27/2020 12:00:00 PM
9
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date

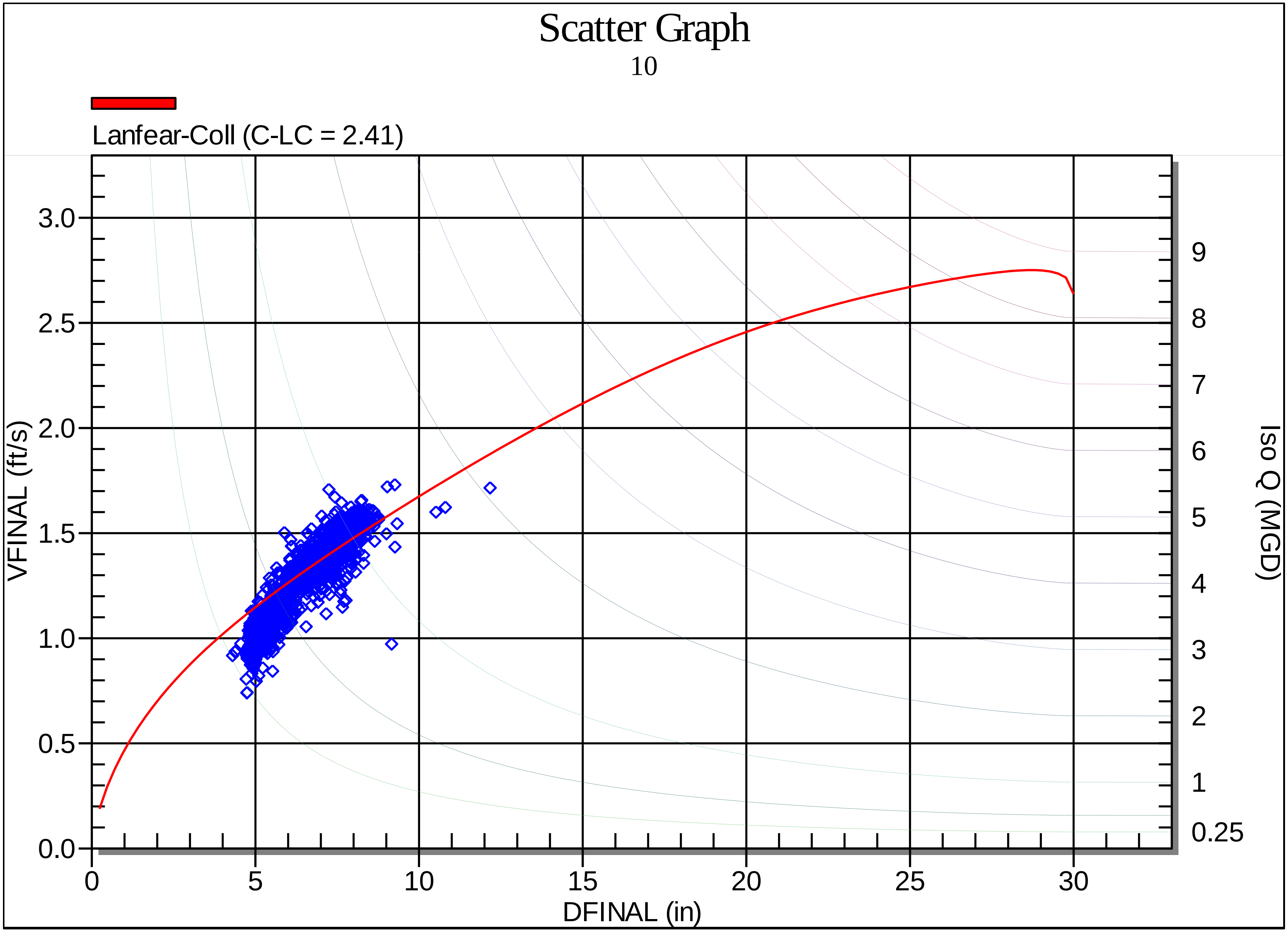


Storm Event - 7/10/2020 12:00:00 PM
9
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
9 Thu
10 Fri
11 Sat
12 Sun
13 Mon
Jul 2020
Date

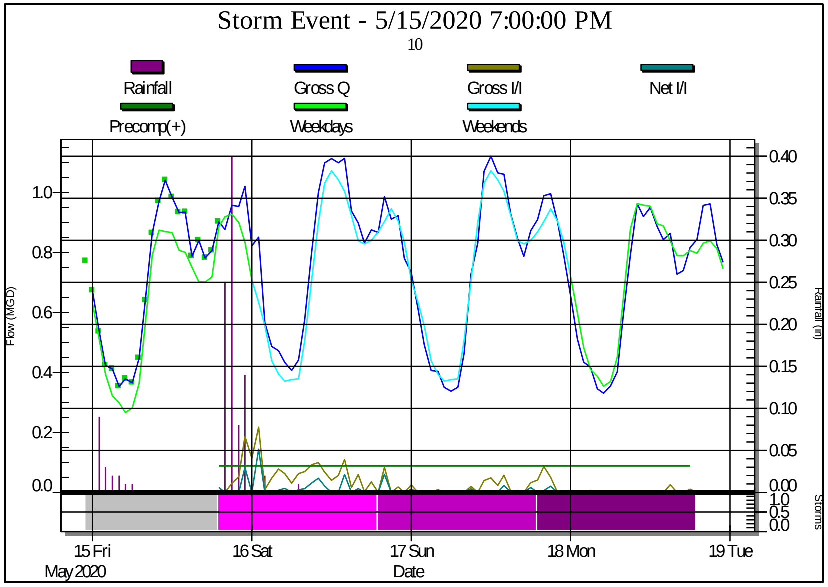


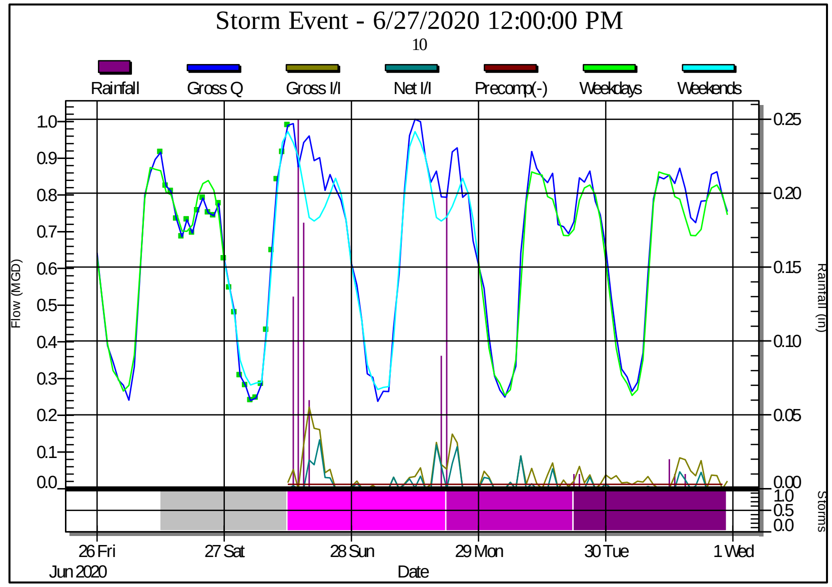
Storm Event - 7/23/2020 9:00:00 AM
9
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date


Pipe Flow
10
Rainfall
Qfinal(g)
5
6
9
Flow (MGD)
Rainfall (in)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.6
0.5
0.4
0.3
0.2
0.1
0.0
15 Fri
22 Fri
1 Mon
8 Mon
15 Mon
22 Mon
1 Wed
8 Wed
15 Wed
22 Wed
May 2020
Date



Scatter Graph
10
Lanfear-Coll (C-LC = 2.41)
VFINAL (ft/s)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
DFINAL (in)
9
8
7
6
5
4
3
2
1
0.25
Iso Q (MGD)


Storm Event - 5/15/2020 7:00:00 PM
10
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
0.0
0.2
0.4
0.6
0.8
1.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1.0
0.5
0.0
15 Fri
16 Sat
17 Sun
18 Mon
19 Tue
May 2020
Date


Storm Event - 6/27/2020 12:00:00 PM
10
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0.00
0.05
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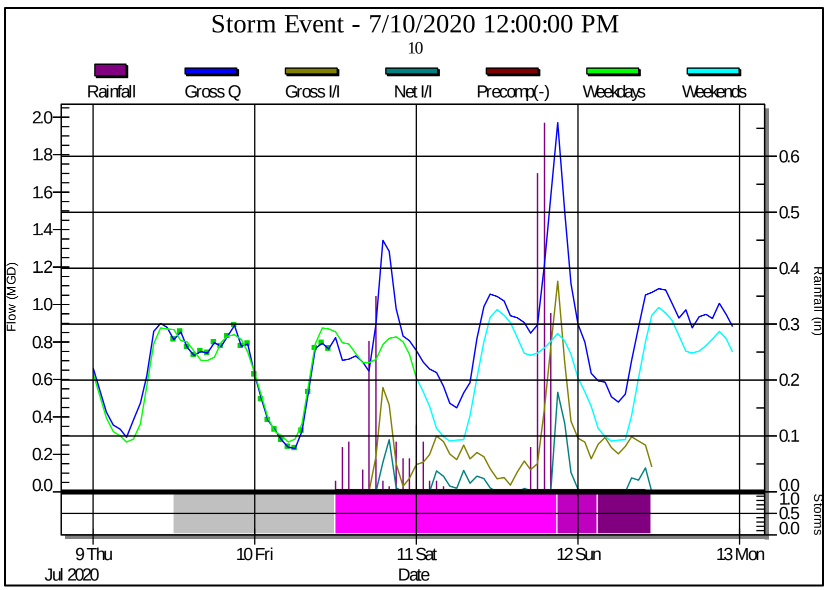
26 Fri
27 Sat
28 Sun
29 Mon
30 Tue
1 Wed
Jun 2020
Date


Storm Event - 7/10/2020 12:00:00 PM
10
Rainfall
Gross Q
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Net I/I
Precomp(-)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
0.0
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9 Thu
10 Fri
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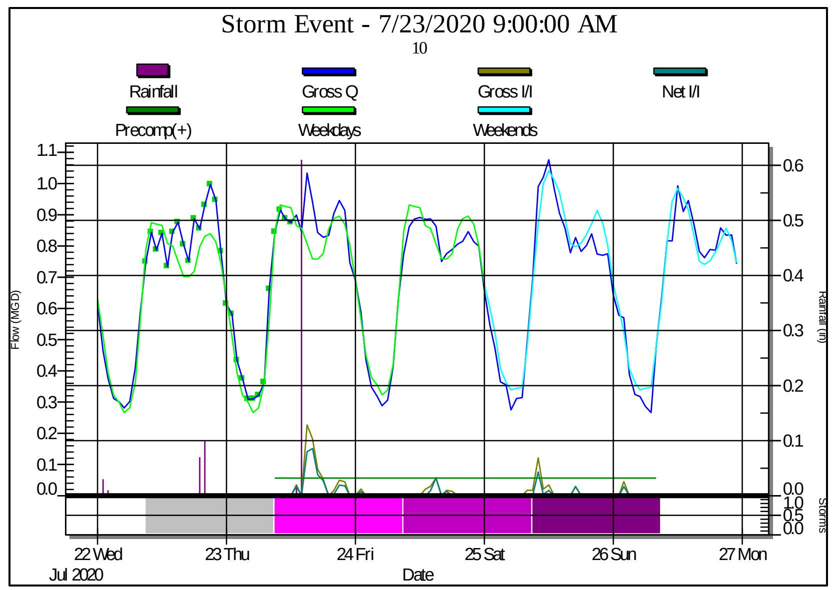
13 Mon
Jul 2020
Date


Storm Event - 7/23/2020 9:00:00 AM
10
Rainfall
Gross Q
Gross I/I
Net I/I
Precomp(+)
Weekdays
Weekends
Flow (MGD)
Rainfall (in)
Storms
0.0
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22 Wed
23 Thu
24 Fri
25 Sat
26 Sun
27 Mon
Jul 2020
Date

HARDWARE

ADS TRITON+™

The new ***ADS TRITON+™*** is a "Fit-for-Purpose" open channel flow monitor for use in sanitary, combined, and storm sewers. It is designed to be the most versatile flow monitoring system available for wastewater collection applications. It supports single pipe or dual pipe flow measurement installations and is certified to the highest level of Intrinsic Safety.

ADS TRITON+

This multiple technology flow monitor will power almost every available sensor technology that is used in wastewater applications today. It is the most versatile and cost-effective, multiple-technology flow monitor on the market. The ***TRITON+*** includes three multiple technology sensor options: a Peak Combo Sensor, a Surface Combo Sensor, and an Ultrasonic Level Sensor (see inside for technology and specifications). This array of monitoring technologies provides for unmatched flexibility in a fully integrated, fit-for-purpose monitoring platform.

The ***TRITON+*** platform adapts to a wide range of customer applications and budgets. It can be configured as an economical single sensor monitor or dual sensor monitor. It offers a longer battery life and fewer parts for a more reliable system. This provides a lower purchase price and a lower ownership cost over the life of the monitor. The ***TRITON+*** has the lowest operational cost per data sample of any Intrinsically Safe flow monitor available.

About ADS

A leading technology and service provider, ADS Environmental Services® has established the industry standard for open channel flow monitoring and has the only ETV-verified flow monitoring technology for wastewater collection systems. These battery-powered monitors are specially designed to operate with reliability, durability, and accuracy in sewer environments.

TRITON+ Features

- Versatile performance that is easy to install and operate
- Two sensor ports supporting 3 interchangeable sensors providing up to 6 sensor readings at a time
- Single or dual pipe/monitoring point measurement capabilities
- Multi-carrier cellular or serial communication to help optimize coverage and cost
- Industry-leading battery life with a 3G/4G UMTS/HSPA+ wireless connection providing up to 15 months at the standard 15-minute sample rate (*varies with sensor configuration*)
- External power and Modbus network connectivity option available with an ADS External Power and Communications Unit (ExPAC) and a 9-36 VDC power supply
- Analog and digital I/O expansion (4-20 mA and dry contacts) available with an ADS External I/O unit (XIO)
- Modbus protocols enabling RTUs to help simplify SCADA system integration
- Supports the delivery of CSV files to an FTP site at user-defined intervals
- Supports actuation of a water quality sampler for flow proportional or level-based operation
- Monitor-Level Intelligence (MLI®) enables the ***TRITON+*** to effectively operate over a wide range of hydraulic conditions
- Superior noise reduction design for maximizing acoustic signal detection from depth and velocity sensors
- Five software packages for accessing flow information: Q*start*™ (configuration and activation); Profile® (data collection, analysis, and reporting); IntelliServe® (web-based alarming); Sliicer.com® (I/I analysis); and FlowView Portal® (online data presentation and reporting)
- Intrinsically-Safe (IS) certification by IECEx for use in Zone 0/Class I, Division 1, Groups C & D, ATEX Zone 0, and CSA Class I, Zone 0, IIB
- Thick, seamless, high-impact, ABS plastic canister with aluminum end cap (meets IP68 standard)
- Innovative circuit board dome-enclosure protects and limits exposure of electronics when opening the canister to change the battery

To Learn more, visit www.adsenv.com/TRITON+

ADS ENVIRONMENTAL SERVICES®
A Division of ADS LLC

Multiple Technology Sensors

The ***TRITON+*** features three depths and two velocities with three sensor options. Each sensor provides multiple technologies for continuous running of comparisons.

Peak Combo Sensor

Dimensions: 6.76 inches (172 mm) long x 1.23 inches (31 mm) wide x 0.83 inches (21 mm) high

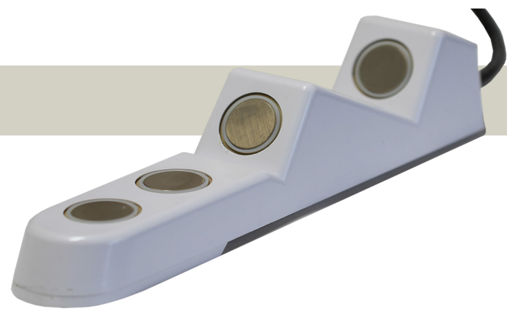
This versatile and economical sensor includes three measurement technologies in a single housing: ADS-patented continuous wave peak velocity, uplooking ultrasonic depth, and pressure depth.

Continuous Wave Velocity
Range: -30 feet per second (-9.1 m/s) to +30 ft/sec (9.1 m/s)
Resolution: 0.01 feet per second (0.003 m/s)
Accuracy: +/- 0.2 feet per second (0.06 m/s) or 4% of actual peak velocity (whichever is greater) in flow velocities between -5 and 20 ft/sec (-1.52 and 6.10 m/s)

Uplooking Ultrasonic Depth
Performs with rotation of up to 15 degrees from the center of the invert; up to 30 degrees rotation with Silt Mount Adapter
Operating Range: 1.0 inch (25 mm) to 5 feet (152 cm)
Resolution: 0.01 inches (0.254 mm)
Accuracy: 0.5% of reading or 0.125 inches (3.2 mm), whichever is greater

Pressure Depth
Range: 0-5 PSI up to 11.5 feet (3.5 m); 0-15 PSI up to 34.5 feet (10.5 m); or 0-30 PSI up to 69 feet (21.0 m)
Accuracy: +/-1.0% of full scale
Resolution: 0.01 inches (0.25 mm)

Surface Combo Sensor



Dimensions: 10.61 inches (269 mm) long x 2.03 inches (52 mm) wide x 2.45 inches (62 mm) high

This revolutionary new sensor features four technologies including surface velocity, ultrasonic depth, surcharge continuous wave velocity, and pressure depth.

Surface Velocity *
Minimum air range: 3 inches (76 mm) from the bottom of the rear, descended portion of the sensor
Maximum air range: 42 inches (107 cm)
Range: 1.00 to 15 feet per second (0.30 to 4.57 m/s)
Resolution: 0.01 feet per second (0.003 m/s)
Accuracy: +/-0.25 feet per second (0.08 m/s) or 5% of actual reading (whichever is greater) in flow velocities between 1.00 and 15 ft/sec (0.30 and 4.57 m/s)

** The flow conditions existing in some applications may prevent the surface velocity technology from being used.*

Ultrasonic Depth
(*Does not require electronic offsets*)
Minimum dead band: 1.0 inches (25.4 mm) from the face of the sensor or 5% of the maximum range, whichever is greater
Maximum operating air range: 10 feet (3.05 m)
Resolution: 0.01 inches (0.25 mm)
Accuracy: +/- 0.125 inches (3.2 mm) with 0.0 inches (0 mm) drift, compensating for variations in air temperature

Surcharge Continuous Wave Velocity (*Under submerged conditions, this technology provides the same accuracy and range as* **Continuous Wave Velocity** *for Peak Combo Sensors*)

Surcharge Pressure Depth (*Under submerged conditions, this technology provides the same accuracy and range as* **Pressure Depth** *for Peak Combo Sensors*)

Ultrasonic Level Sensor

Dimensions: 10.61 inches (269 mm) long x 2.03 inches (52 mm) wide x 2.45 inches (62 mm) high

This non-intrusive, zero-drift sensing method results in a stable, accurate, and reliable flow depth calculation. Two independent ultrasonic transducers allow for independent cross-checking.

Ultrasonic Depth (*See* **Ultrasonic Depth** *Specifications Above*)

TRITON+ Specifications

Connectors
U.S. Military specification MIL-C 26482 series 1, for environmental sealing, with gold-plated contacts

Communications
- Hepta band UMTS/HSPA+ cellular wireless modem
- Direct connection to PC using an ADS USB serial cable

Monitor Interfaces
- Supports simultaneous interfaces with up to two combo sensors
- Supports optional Analog and Digital I/O with ADS XIO: two 4-20 mA inputs and outputs, two switch inputs and two relay outputs

Power
Internal - Battery life with a cellular modem:
- Over 15 months at a 15-minute sample rate*
- Over 6 months at a 5-minute sample rate*

External - Optional external power available with ADS External Power and Communications Unit (ExPAC) with an ADS- or customer-supplied 9-36 Volt DC power supply

** Rate based on collecting data once a day and varies according to sensor configuration and operating temperature*

Operating and Storage Temperature
-4 degrees to 140 degrees F (-20 degrees to 60 degrees C)

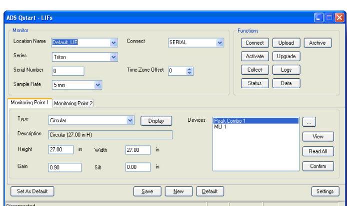
Connectivity
- Modbus ASCII: Wireless; Wired using ExPac
- Modbus RTU: Wireless; Wired using ExPac
- Modbus TCP: Wireless only

Intrinsic Safety Certification
- Certified under the ATEX European Intrinsic Safety standards for Zone 0 rated hazardous areas
- Certified under IECEx (International Electro technical Commission Explosion Proof) Intrinsic Safety standards for use in Zone 0/Class I, Division 1, Groups C&D rated hazardous areas
- CSA Certified to CLASS 2258 03 - Process Control Equipment, Intrinsically Safe and Non-Incendive Systems - For Hazardous Locations, Ex ia IIB T3 (152 degrees C)

Other Certifications/Compliances
- FCC Part 15 and Part 68 compliant
- ROHS (lead-free) compliant
- Carries the EU CE mark
- Canada IC CS-03 compliant

ISO 9001 Registered Company sira CERTIFICATION UKAS MANAGEMENT SYSTEMS 011
Certificate No: 940056

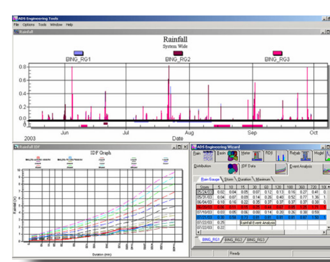
ADS Flow Monitoring Software



Q*start* is desktop software providing field crews with a simple, easy-to-use tool for quickly activating and configuring ADS flow monitors. Q*start* enables the user to collect and review the monitor's depth and velocity data in hydrograph and tabular views simultaneously.

FlowView Portal is web-hosted software providing robust report delivery, enabling the user to manage data, customize reports, and select viewing parameters. FlowView Portal has a virtually unlimited database for storing and accessing historical data, using data for comparison and trend analysis purposes, and sharing information electronically.

IntelliServe is web-hosted software providing real-time operational intelligence on the status of flow activity throughout the wastewater collection system. IntelliServe utilizes dynamic (or smart) alarming to inform clients about the occurrence of rain events, flow performance abnormalities, and data anomalies at the flow monitoring locations.



Sliicer.com is web-hosted software providing a powerful set of engineering tools designed for both the consulting and municipal engineer. Sliicer.com's inflow and infiltration tools examine wastewater collection system dry and wet weather flow data and provide rigorous performance measurements in one-tenth the time of other analysis tools.

Profile is desktop software providing the industry's best data analysis tools, from basic flow monitoring data to complex hydraulic analysis. Profile is intuitive software that saves time and improves data quality by compiling project data into one location for analysis and reporting.

FLOW MONITORING APPLICATIONS

- Billing
- Inflow/Infiltration
- Model Calibration
- Combined Sewer Overflows (CSOs)
- Stormwater Monitoring
- Capacity Analysis
- Spill Notification