CITY OF PINOLE

SEWER FLOW MONITORING & INFLOW/INFILTRATION STUDY

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Abbreviations, Acronyms, Units of Measure, and Terms and Definitions used in this Report

Table i. Abbreviations

Abbreviation	Term
ADWF	average dry weather flow
C. of	City of…
CO	carbon monoxide
COOP	Cooperative Observer Program
d/D	depth/diameter ratio
gpd	gallons per day
FM	flow monitor
GWI	groundwater infiltration
H_2S	hydrogen sulfide
IDM	inch diameter-miles
I/I	inflow and infiltration
LEL	lower explosive limit
LS	lift station
mgd	million gallons per day
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OSHA	U.S. Department of Labor, Occupational Safety and Health Administration
PPE	personal protective equipment
Q	flow rate
RDI	rainfall-dependent infiltration
QA/QC	quality assurance/quality control
RRI	rainfall-responsive infiltration
RG	rain gauge
SSO	sanitary sewer overflow
WEF	Water Environment Federation
WRCC	Western Regional Climate Center

Table ii. Terms and Definitions

Term	Definition
Average dry weather flow (ADWF)	Average flow rate or pattern from days without noticeable inflow or infiltration response. ADWF usage patterns for weekdays and weekends differ and must be computed separately. ADWF can be expressed as a numeric average or as a curve showing the variation in flow over a day. ADWF includes the influence of normal groundwater infiltration (not related to a rain event).
Basin	Sanitary sewer collection system upstream of a given location (often a flow meter), including all pipelines, inlets, and appurtenances. Also refers to the ground surface area near and enclosed by pipelines. A basin may refer to the entire collection system upstream from a flow meter or exclude separately monitored basins upstream.
Depth/diameter (*d/D*) ratio	Depth of water in a pipe as a fraction of the pipe's diameter. A measure of fullness of the pipe used in capacity analysis.
Infiltration and inflow	Infiltration and inflow (I/I) rates are calculated by subtracting the ADWF flow curve from the instantaneous flow measurements taken during and after a storm event. Flow in excess of the baseline consists of inflow, rainfall-responsive infiltration, and rainfall-dependent infiltration. **Total I/I** is the total sum in gallons of additional flow attributable to a storm event.
Infiltration, *groundwater*	Groundwater infiltration (**GWI**) is groundwater that enters the collection system through pipe defects. GWI depends on the depth of the groundwater table above the pipelines as well as the percentage of the system that is submerged. The variation of groundwater levels and subsequent groundwater infiltration rates is seasonal by nature. On a day-to-day basis, groundwater infiltration rates are relatively steady and will not fluctuate greatly.
Infiltration, *rainfall-dependent*	Rainfall-dependent infiltration (**RDI**) is similar to groundwater infiltration but occurs as a result of storm water. The storm water percolates into the soil, submerges more of the pipe system, and enters through pipe defects. RDI is the slowest component of storm-related infiltration and inflow, beginning gradually and often lasting 24 hours or longer. The response time depends on the soil permeability and saturation levels.
Infiltration, *rainfall-responsive*	Rainfall-responsive infiltration (**RRI**) is storm water that enters the collection system through pipe defects, but normally in sewers constructed close to the ground surface such as private laterals. RRI is independent of the groundwater table and reaches defective sewers by way of the pipe trench in which the sewer is constructed; particularly if the pipe is placed in impermeable soil and bedded and backfilled with a granular material. In this case, the pipe trench serves as a conduit similar to a French drain, conveying storm drainage to defective joints and other openings in the system.
Inflow	**Inflow** is defined as water discharged into the sewer system, including private sewer laterals, from **direct** connections such as downspouts, yard and area drains, holes in manhole covers, cross-connections from storm drains, or catch basins. Inflow creates a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows. Overflows are often attributable to high inflow rates.
Normalization	To run an "apples-to-apples" comparison amongst different basins, calculated metrics must be **normalized**. Individual basins will have different runoff areas, pipe lengths and sanitary flows. There are three common methods of normalization. Depending on the information available, one or all methods can be applied to a given project:

Term	Definition
	• Pipe Length: The metric is divided by the length of pipe in the upstream basin expressed in units of inch-diameter-mile (IDM). • Basin Area: The metric is divided by the estimated drainage area of the basin in acres. • ADWF: The metric is divided by the average dry weather sanitary flow (ADWF).
Normalization, *inflow*	The peak I/I flow rate is used to quantify inflow. Although the instantaneous flow monitoring data will typically show an inflow peak, the inflow response is measured from the I/I flow rate (in excess of baseline flow). This removes the effect of sanitary flow variations and measures only the I/I response: • Pipe Length: The peak I/I flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). • Basin Area: The peak I/I flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. • ADWF: The peak I/I flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *GWI*	The estimated GWI rates are compared to acceptable GWI rates, as defined by the Water Environment Federation, and are used to identify basins with high GWI: • Pipe Length: The GWI flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). • Basin Area: The GWI flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. • ADWF: The GWI flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *RDI*	The estimated RDI rates at a period 24 hours or more after the conclusion of a storm event are used to identify basins with high RDI: • Pipe Length: The RDI flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). • Basin Area: The RDI flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. • ADWF: The RDI flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *total I/I*	The estimated totalized I/I in gallons attributable to a particular storm event is used to identify basins with high total I/I. Because this is a totalized value rather than a rate and can be attributable solely to an individual storm event, the volume of the storm event is also taken into consideration. This allows for a comparison not only between basins but also between storm events: • Pipe Length: Total gallons of I/I is divided by the length of pipe (IDM) in the upstream basin and the rainfall total (inches) of the storm event. The result is expressed in gallons per IDM per inch-rain.

Term	Definition
	• Basin Area (R-Value): Total gallons of I/I is divided by total gallons of rainfall water that fell within the acreage of the basin area. This is a ratio and is expressed as a percentage. R-Value is described as "the percentage of rainfall that enters the collection system." Systems with R-Values less than 5%[1] are often considered to be performing well. • ADWF: Total gallons of I/I is divided by the ADWF and the rainfall total of the storm event. The result is expressed in million gallons per MGD of ADWF per inch of rain.
Peaking factor	Ratio of peak measured flow to average dry weather flow. This ratio expresses the degree of fluctuation in flow rate over the monitoring period and is used in capacity analysis.
Surcharge	When the flow level is higher than the crown of the pipe, then the pipeline is said to be in a **surcharged** condition. The pipeline is surcharged when the *d/D* ratio is greater than 1.0.
Weekend/weekday ratio	The ratio of weekend ADWFs to weekday ADWFs. In residential areas, this ratio is typically slightly higher than 1.0. In business districts, depending on the type of service, this ratio can be significantly less than 1.0.

[1] Keefe, P.N. "Test Basins for I/I Reduction and SSO Elimination." 1998 WEF Wet Weather Specialty Conference, Cleveland.

ES EXECUTIVE SUMMARY

Scope and Purpose

V&A Consulting Engineers, Inc. (V&A) has completed sanitary sewer flow monitoring with inflow and infiltration (I/I) analysis within the City of Pinole (City). Flow monitoring was performed over a period of approximately 3.5 months from December 13, 2013 to April 1, 2014 at 16 open-channel flow monitoring sites. The purpose of this study was to identify smaller basins within Area Five and Area Six having the highest rates of I/I.

To the extent possible given the time constraints of a single wet weather season and the unpredictable nature regarding the duration and intensity of storm events, V&A attempted to analyze early season rain events, make a decision on areas with high I/I, and then relocate flow meters within the same wet weather season. Relocations between rainfall events intended to further narrow the search for areas of high I/I with an ultimate goal of identifying possible CIP projects in support of the City's budgeted pipe lining and replacement program.

During the course of Phase 1 of this study, V&A installed 14 flow meters and 2 volumetric meters focused within Area Five and Area Six, dividing these areas into 16 sub-basins. For Phase 2, V&A removed ten Phase 1 meters and redistributed them amongst Basins 3, 5 and 6. A final rain event allowed for a third phase of this study, in which V&A removed seven Phase 1 and 2 meters and reinstalled them within sub-basins 3.1, 5.2, 6.3 and 6.5.

The contents of this deliverable summarize the results of the three aforementioned flow monitoring and I/I phases of this study. Additionally, V&A was asked to analyze and comment on the following items, which are included in this report as additional Appendices:

- **Flow Split between M6.0A and M6:** As a part of Phase 3, the City asked that the flow split between Sites M6.0A and M6.3 be monitored and analyzed during average dry weather and peak wet weather flow conditions.
- **Allocation of Inflow within the Perimeter of the Treatment Plant:** Rain that falls within the perimeter of the treatment plant flows directly into the treatment facility as waste; henceforth, there is an associated cost of treatment. The City asked V&A to determine the volume of inflow that falls within the footprint of the treatment facility.
- **Treatment Plant Influent Meter:** The City has two methods available to measure incoming flows from the City of Pinole. The City requested that V&A analyze the accuracy and determine which method is preferred for flow data reliability. This analysis was important for purposes of billing between the Cities of Pinole and Hercules. V&A dedicated a flow meter to measure the flow into the treatment plant for comparison to the City meter; the results are presented within this deliverable as a Technical Memorandum.

Disclaimer

The following flow monitoring, capacity and I/I results and analyses do not replace a full dynamic hydraulic model. A dynamic model developed by a master planning engineering firm would determine capacity on a node-to-node basis and would be based on pipe slopes of the individual pipe segments within the local collection system. The following data and the interpretation of these data should be used at the discretion of the City Engineer.

Flow Monitoring and Capacity Results

Table ES-1 summarizes the peak recorded flows, levels, *d/D* ratios, and peaking factors per site during the flow monitoring period. Sites that surcharged and sites with peaking factors greater than 10.0 have been shaded in RED. Capacity analysis data is presented on a site-by-site basis and represents the hydraulic conditions only at the point site locations. Hydraulic conditions in other areas of the collection system will differ.

Table ES-1. Capacity Analysis Summary

Monitoring Site	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (inches)	Peak Level (inches)	d/D Ratio	Surcharge Level (feet)
Phase 1							
Site M1	0.71	3.50	4.9	15	8.5	0.57	-
Site M2	1.11	7.20	6.5	30	45.5	1.52	1.3
Site M3	0.07	0.71	10.7	n/a	n/a	n/a	-
Site M4	0.13	0.47	3.7	n/a	n/a	n/a	-
Site M5	0.02	0.65	33.9	7.25	10.7	1.53	0.3
Site M6	0.18	1.10	6.2	10	82.3	8.23	6.0
Site M7	0.36	2.02	5.6	15	11.8	0.78	-
Site M8	0.007	0.03	5.0	7.75	1.3	0.17	-
Site M9	0.004	0.30	67.5	6	2.7	0.45	-
Site M10	0.09	0.41	4.8	8	11.4	1.43	0.3
Site M11	0.02	0.53	30.6	10	51.6	5.16	3.5
Site M12[2]	0.003	n/a	n/a	8	51.6	6.45	3.6
Site M13	0.06	0.21	3.8	6	1.7	0.28	-
Site M14	0.04	0.32	7.7	8	9.3	1.16	0.1
Site M15	0.02	0.21	14.1	6	2.6	0.44	-
Site M16	0.09	0.62	7.2	11.5	37.2	3.23	2.1

[2] Site M12 failed during Storm Event 1; the manhole was surcharged for an extended time period, flooding the flow logging computer. Enough data was recovered to establish an average dry weather flow but not enough for a proper capacity and I/I analysis. This site and other sites that comprise the 'Old Henry Road' basin are the subject of a future project.

Monitoring Site	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (inches)	Peak Level (inches)	d/D Ratio	Surcharge Level (feet)
Phase 2							
Site M3.1	0.03	0.58	18.3	6	3.3	0.41	-
Site M3.2	0.01	0.08	7.3	6	3.2	0.40	-
Site M5.1	0.02	0.15	6.5	8	7.6	0.95	-
Site M5.2	0.01	0.31	27.6	8	6.1	0.77	-
Site M5.3	0.02	0.10	4.5	6	2.1	0.35	-
Site M6.1	0.01	0.12	10.4	6	7.2	1.20	0.1
Site M6.2	0.02	0.04	2.3	8	1.9	0.23	-
Site M6.3	0.16	0.72	4.4	8	5.1	0.64	-
Site M6.4	0.08	0.51	6.1	8	6.2	0.78	-
Site M6.5	0.01	0.12	13.5	8	3.0	0.37	-
Phase 3							
Site M3.1A	0.009	0.15	15.4	6	5.9	0.98	-
Site M3.1B	0.006	0.10	16.7	6	2.0	0.34	-
Site M5.2A	0.009	0.11	12.0	6	3.2	0.53	-
Site M6.0A	0.057	1.09	19.0	10	7.2	0.72	-
Site M6.3A	0.005	0.30	61.5	6	3.2	0.53	-
Site M6.3B	0.004	0.06	16.1	8	1.3	0.16	-
Site M6.5A	0.003	0.03	11.1	7.75	1.3	0.17	-
Site M6.5B	0.003	0.04	11.8	7.75	1.1	0.14	-

The following capacity analysis results are noted:

- **Peaking Factor:** Several sites had peaking factors greater than 10. Larger peaking factors are expected given that the study analyzes basins previously identified as having high I/I rates.
- **d/D Ratio:** Nine of the flow monitoring sites (Sites M2, M5, M6, M10, M11, M12, M14, M16 and M6.1) reached surcharge conditions.
- **Sanitary Sewer Overflow Potential:** Given the level of surcharging seen during Storm Event 1, the manholes at Site 6, Site 11/12 and Site 16 have the potential for a sanitary sewer overflow (SSO) during a larger rainfall event. Site 6 has historical precedence for SSO discharging during large rainfall events.

Inflow and Infiltration Analysis Results

Preface

Per discussions with the City, V&A prioritized I/I evaluations on the comparative analysis of the Peak I/I rate, traditionally associated with inflow. Inflow sources transport rain water *directly* into the sewer system; the corresponding inflow rates are tied closely to the intensity of the storm. This component of RDI/I often causes a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows. Figure ES-1 illustrates the I/I response curve for Basin 3 during Phase 1 as it related to peak I/I rate.

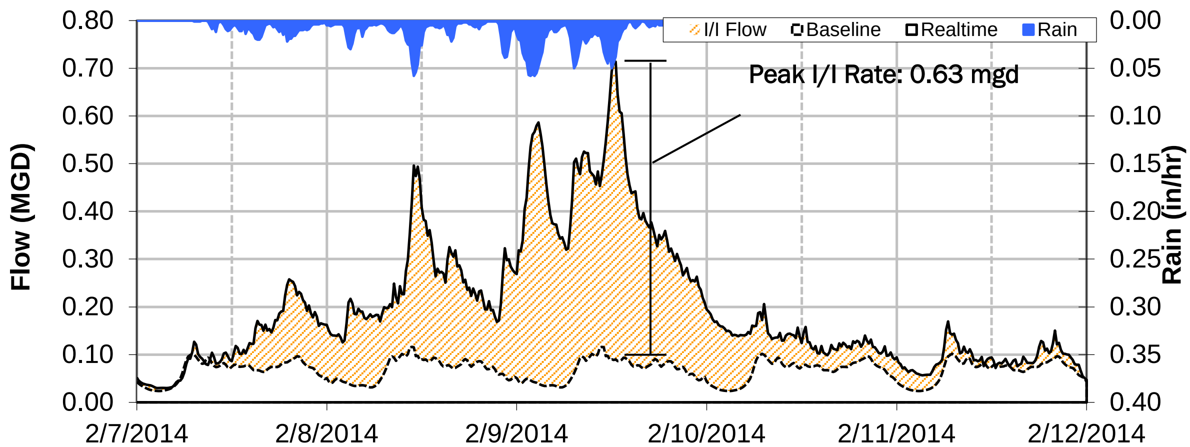


Figure ES-1. I/I Isolation Curve, Basin 3 (Inflow Measurement)

V&A analyzed the I/I isolation curves for all sites and all phases of this study to try to determine the areas of the City collection system that had the highest peak I/I rates.

Phase 1 (Large Basin) Results

The results of the Phase 1 flow monitoring and I/I analyses for the larger basins are shown as follows:

- **Basin 3:** The City cited historical data and field observations regarding known I/I issues within Basin 3.
- **Basin 5:** V&A recommended investigating Basin 5 due to the high peak I/I ratios and high combined I/I totals.
- **Basin 6:** There is a known capacity issue one manhole upstream from the Basin 6 monitoring location.
- **Basin 8:** This is a newer area of the City and this area had minimal I/I contribution.
- **Basin 9:** The flow meter was not in an ideal location for monitoring. The consensus was that the response for Basin 9 was real and considerable but the magnitude may not be correct due to metering conditions.

- **Basin 11:** This location had significant peak I/I rates and combined I/I totals.
- **Basin 12:** The metering manhole for this basin surcharged with evidence that the surcharge was close to an SSO.
- **Basins 15/16:** Both basins were noted for generally high I/I rates and total I/I contribution.
- **Old Henry Road:** The City cited the age of the sewer system along Old Henry Road and noted this correlation to the high I/I rates within Basins 9, 11 and 12.

Final group conclusions were as follows:

- Focus additional phases of monitoring within Basins 3, 5 and 6.
    - The focus of the study moving forward would be to spend the remainder of the 2014 wet weather season identifying smaller high I/I mini-basins within this region for possible future CIP work.
    - Identifying areas of I/I reduction may help to solve two problems within the City: (1) severe flows observed in Basin 3 (San Pablo Pump Station), and (2) capacity issues observed at the manhole at the intersection of Pinon Avenue and Bay View Farm Road.
- Make note of the 'Old Henry Road' Basins as a future candidate for a focused flow monitoring and I/I study.

Figure ES-2 illustrates the Phase 1 inflow rankings for the larger basins.

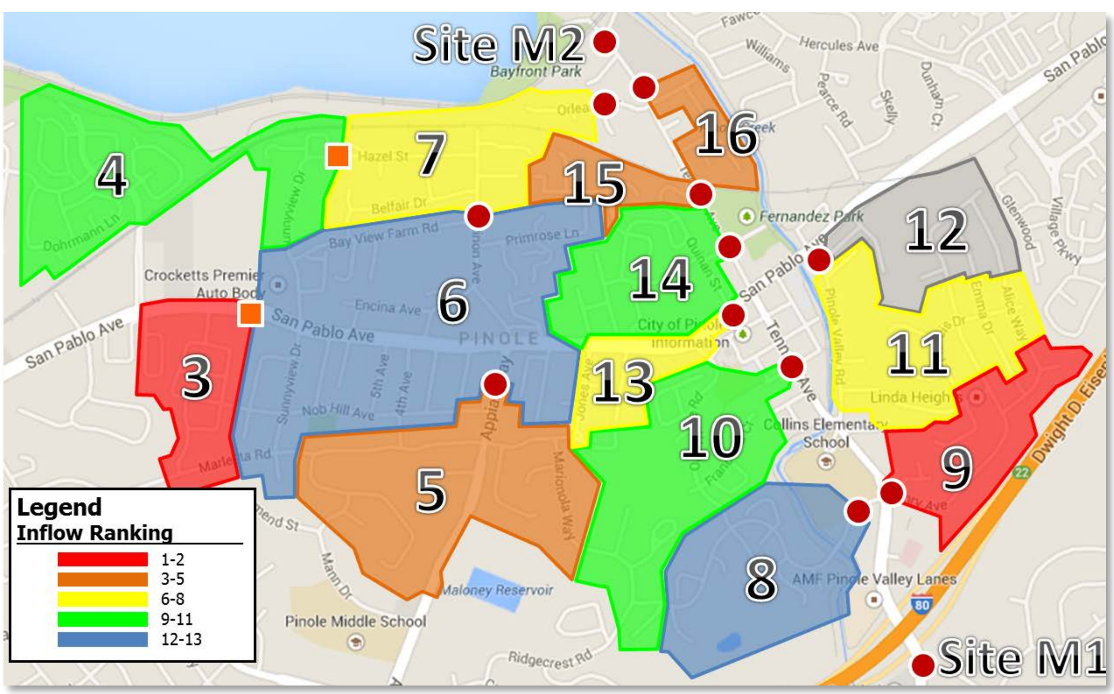


Figure ES-2. Phase 1 Inflow Temperature Map

Phases 2 and 3 Focused Sub-Basin Results

Additional phases of flow monitoring and I/I analysis were focused within Basins 3, 5 and 6. Through focused flow monitoring on a very small basis, V&A was able to find 'hot-spot' locations within Basins 3, 5 and 6 that were contributing a significant percentage of the peak. Figure ES-3 illustrates the hot-spot areas within Basins 3, 5 and 6.

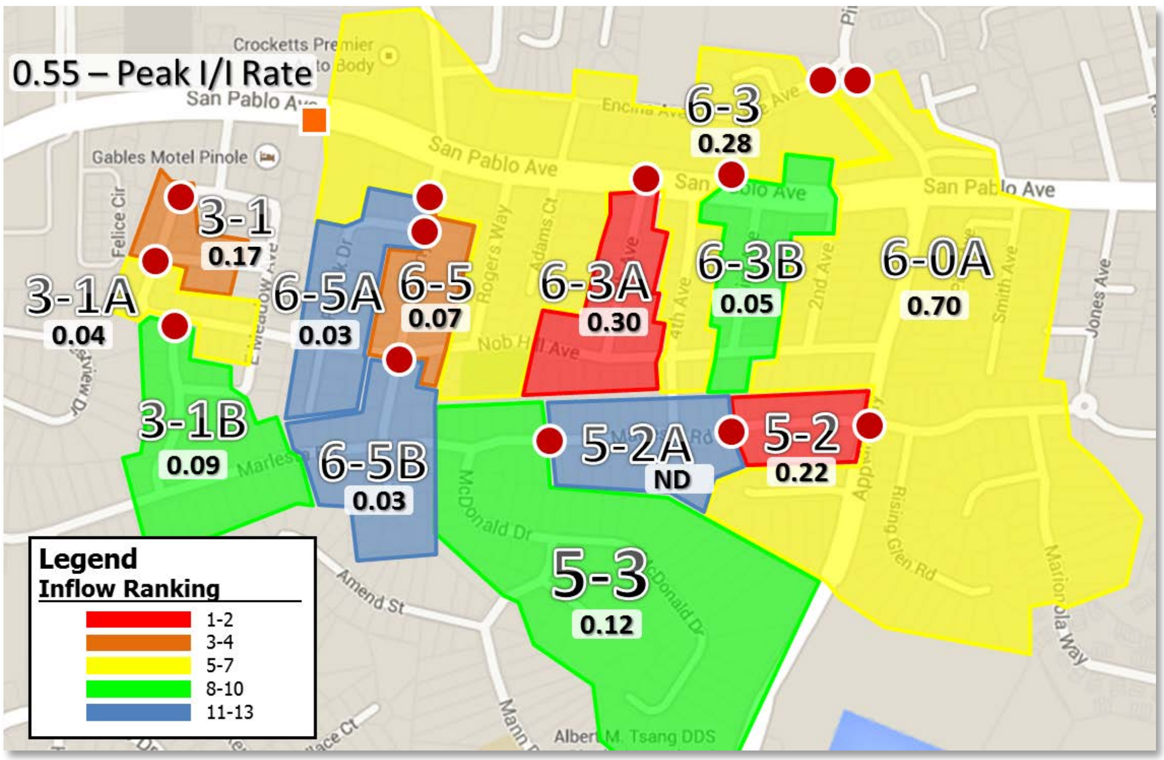


Figure ES-3. Phase 3 Inflow Analysis Temperature Map

Recommendations

V&A advises that future I/I reduction plans consider the following recommendations:

1. **Potential CIP Projects for I/I Mitigation and Reduction**
   a. The City should conduct I/I mitigation and reduction measures in the following mini-basins:
      i. Basin 3-1
      ii. Basin 3-1A
      iii. Basin 5-2
      iv. Basin 6-3A
      v. Basin 6-5
   b. For I/I reduction, V&A recommends rehabilitation of the sewer mains, laterals and side sewers.
      i. The most comprehensive study on the percent of I/I reduction has been conducted by King County, *Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report*. This study confirmed the popular theory that over 50% of infiltration and inflow enters from private lateral connections. The report also makes the following recommendations for I/I mitigation:
         (a) CCTV work is best performed during a rainfall event after groundwater levels have begun to rise, allowing visual confirmation of specific I/I entry points, including determining the source of potential lateral I/I source. A generally consistent deficiency was observed with regards to the joint conditions in the laterals and side sewers.
         (b) Rehabilitation of sewer mains, manholes, laterals and side sewers results in approximately 80% reduction of I/I.
2. **Future I/I Identification – Continued Sub-Basin Flow Monitoring and I/I Analysis:** V&A recommends that the City continue to locate and mitigate potential sources of I/I. Already identified as known contributing sub-basins with high volumes of I/I are Basins 9, 11, 12, 14 and 15. It is possible that a study similar to this study may identify CIP projects that can significantly reduce the overall I/I within the City collection system.
3. **Other I/I Investigation Methods:** Other potential I/I investigation methods include the following:
   a. Smoke testing
   b. Night-time reconnaissance work to (1) investigate and determine direct point sources of inflow, and (2) determine the areas and pipe reaches responsible for high levels of infiltration contribution.
4. **I/I Reduction Cost Effectiveness Analysis:** The City should conduct a study to determine which is more cost-effective: (1) locating the sources of inflow/infiltration and systematically rehabilitating or replacing the faulty pipelines; or (2) continued treatment of the additional rainfall dependent I/I flow.

1.0 INTRODUCTION

1.1 Scope and Purpose

V&A Consulting Engineers, Inc. (V&A) was retained by the City of Pinole (City) to conduct sanitary sewer flow monitoring and inflow/infiltration (I/I) analysis within the City of Pinole (City). Flow monitoring occurred over a 3.5-month period from December 13, 2013 to April 1, 2014. Two basins within the collection system (Area Five "The Meadows" and Area Six "Old Town") had already been identified by the City as having high rates of RDI/I. The purpose of this study was to identify smaller basins within Area Five and Area Six having the highest rates of I/I.

To the extent possible given the time constraints of a single wet weather season and the unpredictable nature regarding the duration and intensity of storm events, V&A would attempt to relocate flow meters within the wet weather season. Relocations between rainfall events could further narrow the search for areas of high I/I with an ultimate goal of identifying possible CIP projects in support of the City's budgeted pipe lining and replacement program. The outline of the strategies for the I/I investigation is shown as follows:

- **Phase 1 – Initial Sub-Basins:** V&A installed 14 flow meters and 2 volumetric meters focused within Area Five and Area Six, dividing these areas into 16 sub-basins.
    - **Mid-Project, Post-Rainfall I/I Analysis:** After the first usable rainfall event, V&A analyzed the flow data for relative I/I contribution and comparison amongst the sub-basins.
    - **Quick Decisions:** V&A conveyed the I/I results to the City, making recommendations for targeted investigation of the highest ranking I/I sub-basins.
    - **Maneuverable Metering:** V&A removed the meters from the sub-basins with lower RDI/I rates and relocated them into the sub-basins with the higher RDI/I rates, dividing the original sub-basins into mini-basins.
- **Phase 2 – Focused Sub-Basins:** The same process from Phase 1 was repeated for Phase 2, focusing the search within the sub-basins with the greatest I/I contribution.
- **Phase 3 – Focused Mini-Basins:** The rain events of the 2013/2014 season were sufficient to conduct a third phase of flow monitoring and I/I analysis.

Additionally, V&A was asked to analyze and comment on the following items:

- **Flow Split between M6.0A and M6:** As a part of Phase 3, the City asked that the flow split between Sites M6.0A and M6.3 be monitored and analyzed during average dry weather and peak wet weather flow conditions.

- **Allocation of Inflow within the Perimeter of the Treatment Plant:** Rain that falls within the perimeter of the treatment plant flows directly into the treatment facility as waste; henceforth, there is an associated cost of treatment. The City asked V&A to determine the volume of inflow that falls within the footprint of the treatment facility.
- **Treatment Plant Influent Meter:** The City has two methods available to measure incoming flows from the City of Pinole. The City requested that V&A analyze the accuracy and determine which method is preferred for flow data reliability. This analysis was important for purposes of billing between the Cities of Pinole and Hercules. V&A dedicated a flow meter to measuring the flow into the treatment plant for comparison to the City meter; the results are presented within this deliverable as a Technical Memorandum.

These additional analyses are included in this report as *Appendix A, Appendix B and Appendix C*.

1.2 Flow Monitoring Sites

Flow monitoring sites are the locations where the flow monitors were placed. Flow monitoring site data may include the flows of one or many drainage basins. Capacity and flow rate information is presented on a site-by-site basis. The flow monitoring sites for the three phases are listed in Table 1-1, Table 1-2 and Table 1-3 and illustrated in Figure 1-1, Figure 1-2 and Figure 1-3. Detailed descriptions of the individual flow monitoring sites are included in *Appendix A*.

Table 1-1. Phase 1 Flow Monitoring Sites

Monitoring Site	Pipe Size (inches)	Location
Site M1	15	Pinole Valley Rd., just south of Highway 80
Site M2	30	Tennant Ave., just outside WWTP
Site M3	n/a	San Pablo Ave., west of Sunnyview Dr.
Site M4	n/a	In easement at west end of Hazel St.
Site M5	7.25	Appian Way, south of San Pablo Ave.
Site M6	10	Pinon Ave., north of Bay View Farm Rd.
Site M7	15	Intersection of Orleans Dr. and Zoe Ct.
Site M8	7.75	Henry Ave., west of Pinole Valley Rd.
Site M9	6	Intersection of Henry Ave. and Pinole Valley Rd.
Site M10	8	Intersection of Tennant Ave. and Prune St.
Site M11	10	Intersection of Pinole Valley Rd. and Rafaela St.
Site M12	8	Intersection of Pinole Valley Rd. and Rafaela St.
Site M13	6	San Pablo Ave. just west of Quinan St.
Site M14	8	Intersection of Tennant Ave. and Park St.
Site M15	6	Tennant Ave., south of train tracks, west of Fernandez Park
Site M16	11.5	Tennant Ave. north of Orleans Dr.

Table 1-2. Phase 2 Flow Monitoring Sites

Monitoring Site	Pipe Size (inches)	Location
Site M2	30	Tennant Ave., just outside WWTP
Site M3	n/a	San Pablo Ave., west of Sunnyview Dr.
Site M4	n/a	In easement at west end of Hazel St.
Site M6	10	Pinon Ave., north of Bay View Farm Rd.
Site M7	15	Intersection of Orleans Dr. and Zoe Ct.
Site M3.1	6	830 Meadows Ave.
Site M3.2	6	830 Meadows Ave.
Site M5.1	8	Intersection of Appian Way and Marlesta Rd.
Site M5.2	8	Intersection of Appian Way and Marlesta Rd.
Site M5.3	6	1171 Marlesta Rd.
Site M6.1	6	Just west of intersection of Bay View Farm Rd. and Pinon Ave.
Site M6.2	8	Intersection of Pinon Ave. and Primrose Ln.
Site M6.3	8	Roble Ave., west of Pinon Ave.
Site M6.4	8	Intersection of San Pablo Ave. and Rogers Way
Site M6.5	8	747 Sunnyview Dr.

Table 1-3. Phase 3 Flow Monitoring Sites

Monitoring Site	Pipe Size (inches)	Location
Site M2	30	Tennant Ave., just outside WWTP
Site M3	n/a	San Pablo Ave., west of Sunnyview Dr.
Site M4	n/a	In easement at west end of Hazel St.
Site M6	10	Pinon Ave., north of Bay View Farm Rd.
Site M3.1	6	830 Meadows Ave.
Site M5.2	8	Intersection of Appian Way and Marlesta Rd.
Site M5.3	6	1171 Marlesta Rd.
Site M6.3	8	Roble Ave., west of Pinon Ave.
Site M6.5	8	747 Sunnyview Dr.
Site M3.1A	6	Intersection of Meadow Ave. and Betty Ave.
Site M3.1B	6	Intersection of Meadow Ave. and Nob Hill Ave.
Site M5.2A	6	1367 Marlesta Rd.
Site M6.0A	10	Intersection of Roble Ave. and Pinon Ave.
Site M6.3A	6	Intersection of San Pablo Ave. and 5th Ave.
Site M6.3B	8	Intersection of San Pablo Ave. and Roble Ave.
Site M6.5A	7.75	Intersection of Sunnyview Dr. and Patrick Dr.
Site M6.5B	7.75	Intersection of Sunnyview Dr. and Nob Hill Ave.

Figure 1-1. Phase 1 Flow Monitoring Site Map

Figure 1-2. Phase 2 Flow Monitoring Site Map

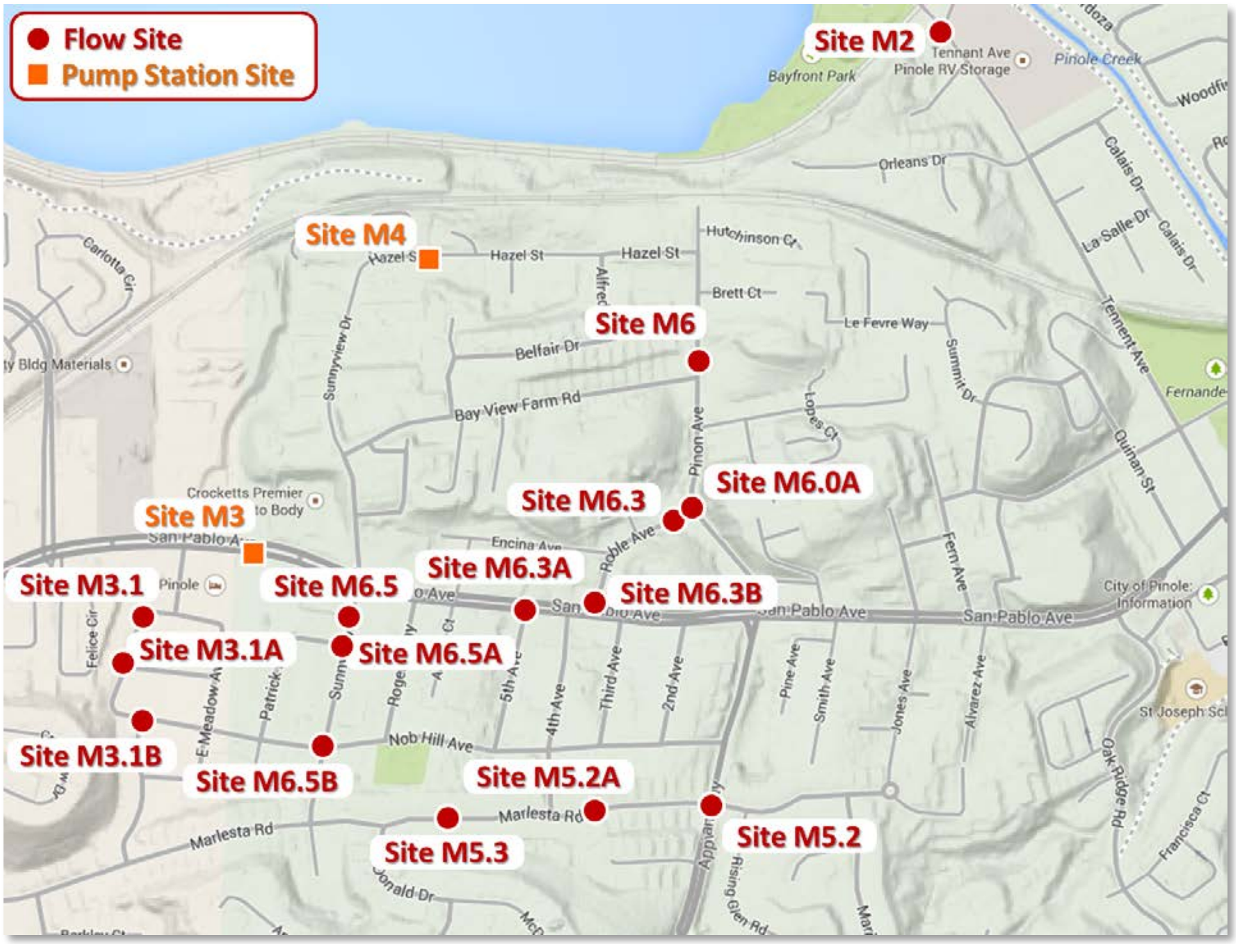


Figure 1-3. Phase 3 Flow Monitoring Site Map

1.3 Flow Monitoring Basins

Flow monitoring basins are localized areas of a sanitary sewer collection system upstream of a given location (often a flow meter), including all pipelines, inlets, and appurtenances. The basin refers to the ground surface area near and enclosed by the pipelines. A basin may refer to the entire collection system upstream from a flow meter or may exclude separately monitored basins upstream.

To isolate a flow monitoring basin, an addition or subtraction of flows may be required[3]. Site M1 was not used as a basin because it served to measure the flow coming into the area of interest. Site M2 was not isolated as a basin because it would have required subtracting the flow from 11 other sites.

I/I analysis in this report will be conducted on a basin-by-basin basis. Table 1-4 lists the basins and sub-basins that were isolated[4] and utilized for I/I analysis and Figure 1-4, Figure 1-5 and Figure 1-6 illustrate the basins utilized for I/I analysis.

Table 1-4. List of Flow Monitoring Basins

Sub-Basin	Area (acres)	Pipe Length (IDM)	Basin Flow Calculation
Phase 1			
Basin M3	40	5.09	$Q_{M3(Basin)} = Q_{M3(Site)}$
Basin M4	58	12.91	$Q_{M4(Basin)} = Q_{M4(Site)}$
Basin M5	71	10.32	$Q_{M5(Basin)} = Q_{M5(Site)}$
Basin M6	130	13.01	$Q_{M6(Basin)} = Q_{M6(Site)} - Q_{M5(Site)} - Q_{M3(Site)}$
Basin M7	41	11.88	$Q_{M7(Basin)} = Q_{M7(Site)} - Q_{M6(Site)} - Q_{M4(Site)}$
Basin M8	53	6.35	$Q_{M8(Basin)} = Q_{M8(Site)}$
Basin M9	28	4.99	$Q_{M9(Basin)} = Q_{M9(Site)}$
Basin M10	62	11.87	$Q_{M10(Basin)} = Q_{M10(Site)}$
Basin M11	52	10.48	$Q_{M11(Basin)} = Q_{M11(Site)}$
Basin M12	31	4.47	$Q_{M12(Basin)} = Q_{M12(Site)}$
Basin M13	17	3.20	$Q_{M13(Basin)} = Q_{M13(Site)}$
Basin M14	37	6.33	$Q_{M14(Basin)} = Q_{M14(Site)}$
Basin M15	16	3.65	$Q_{M15(Basin)} = Q_{M15(Site)}$
Basin M16	12	4.78	$Q_{M16(Basin)} = Q_{M16(Site)}$

[3] There is error inherent in flow monitoring. Adding and subtracting flows increases error on an additive basis. For example, if Site A has error ±10% and Site B has error ±10%, then the resulting flow when subtracting Site A from Site B would be ±20%.

[4] There may be locations with cross-connections between trunk sewers or overflow bypass sewers to help equalize basins and prevent sanitary sewer overflows during peak rain events. However, unless the inter-basin connections are plugged, the behavior of flows may not be known with certainty. The basin isolation equations shown are per the best of V&A's knowledge.

Sub-Basin	Area (acres)	Pipe Length (IDM)	Basin Flow Calculation
Phase 2			
Basin M3.1	16	2.07	$Q_{M3.1(Basin)} = Q_{M3.1(Site)}$
Basin M3.2	6	1.14	$Q_{M3.2(Basin)} = Q_{M3.2(Site)}$
Basin M5.1	23	3.34	$Q_{M5.1(Basin)} = Q_{M5.1(Site)} - Q_{M5.3(Site)}$
Basin M5.2	9	1.34	$Q_{M5.2(Basin)} = Q_{M5.2(Site)}$
Basin M5.3	29	3.25	$Q_{M5.3(Basin)} = Q_{M5.3(Site)}$
Basin M6.1	13	2.41	$Q_{M6.1(Basin)} = Q_{M6.1(Site)}$
Basin M6.2	13	3.32	$Q_{M6.2(Basin)} = Q_{M6.2(Site)}$
Basin M6.3	40	2.69	$Q_{M6.3(Basin)} = Q_{M6.3(Site)} - Q_{M6.4(Site)}$
Basin M6.4	13	1.07	$Q_{M6.4(Basin)} = Q_{M6.4(Site)} - Q_{M6.5(Site)}$
Basin M6.5	17	3.50	$Q_{M6.5(Basin)} = Q_{M6.5(Site)}$
Phase 3			
Basin M3.1	3.1	0.69	$Q_{M3.1(Basin)} = Q_{M3.1(Site)} - Q_{M3.1A(Site)}$
Basin M3.1A	2.4	0.67	$Q_{M3.1A(Basin)} = Q_{M3.1A(Site)} - Q_{M3.1B(Site)}$
Basin M3.1B	10.1	1.83	$Q_{M3.1B(Basin)} = Q_{M3.1B(Site)}$
Basin M5.2	3.6	0.75	$Q_{M5.2(Basin)} = Q_{M5.2(Site)} - Q_{M5.2A(Site)}$
Basin M5.2A	5.6	0.69	$Q_{M5.2A(Basin)} = Q_{M5.2A(Site)} - Q_{M5.3(Site)}$
Basin M5.3	28.9	3.42	$Q_{M5.3(Basin)} = Q_{M5.3(Site)}$
Basin M6.0A	55.1	10.14	$Q_{M6.0A(Basin)} = Q_{M6.0A(Site)} - Q_{M5.2(Site)}$
Basin M6.3	36.4	5.38	$Q_{M6.3(Basin)} = Q_{M6.3(Site)} - Q_{M6.3A(Site)} - Q_{M6.3B(Site)}$
Basin M6.3A	7.6	0.97	$Q_{M6.3A(Basin)} = Q_{M6.3A(Site)}$
Basin M6.3B	5.9	1.39	$Q_{M6.3B(Basin)} = Q_{M6.3B(Site)}$
Basin M6.5	3.4	0.85	$Q_{M6.5(Basin)} = Q_{M6.5(Site)} - Q_{M6.5A(Site)} - Q_{M6.5B(Site)}$
Basin M6.5A	6.4	1.36	$Q_{M6.5ABasin)} = Q_{M6.5A(Site)}$
Basin M6.5B	7.3	1.32	$Q_{M6.5B(Basin)} = Q_{M6.5B(Site)}$

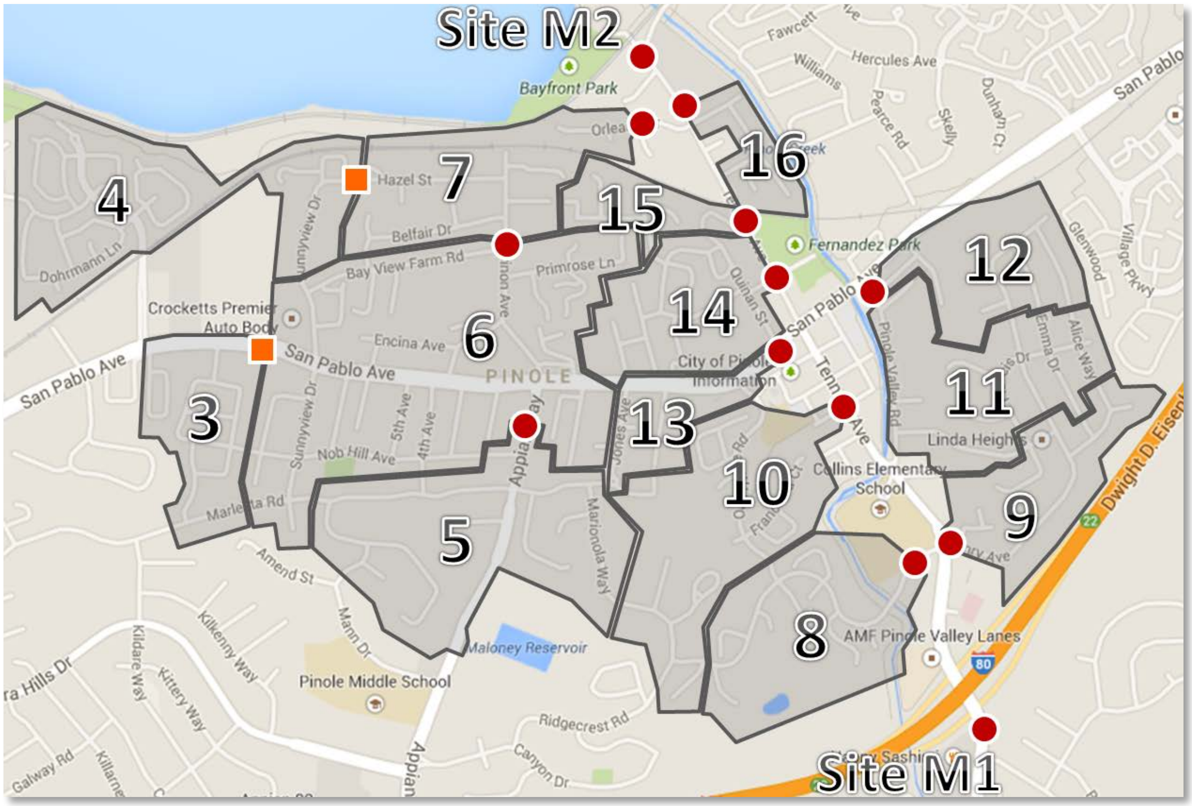


Figure 1-4. Phase 1 Flow Monitoring Basins Map

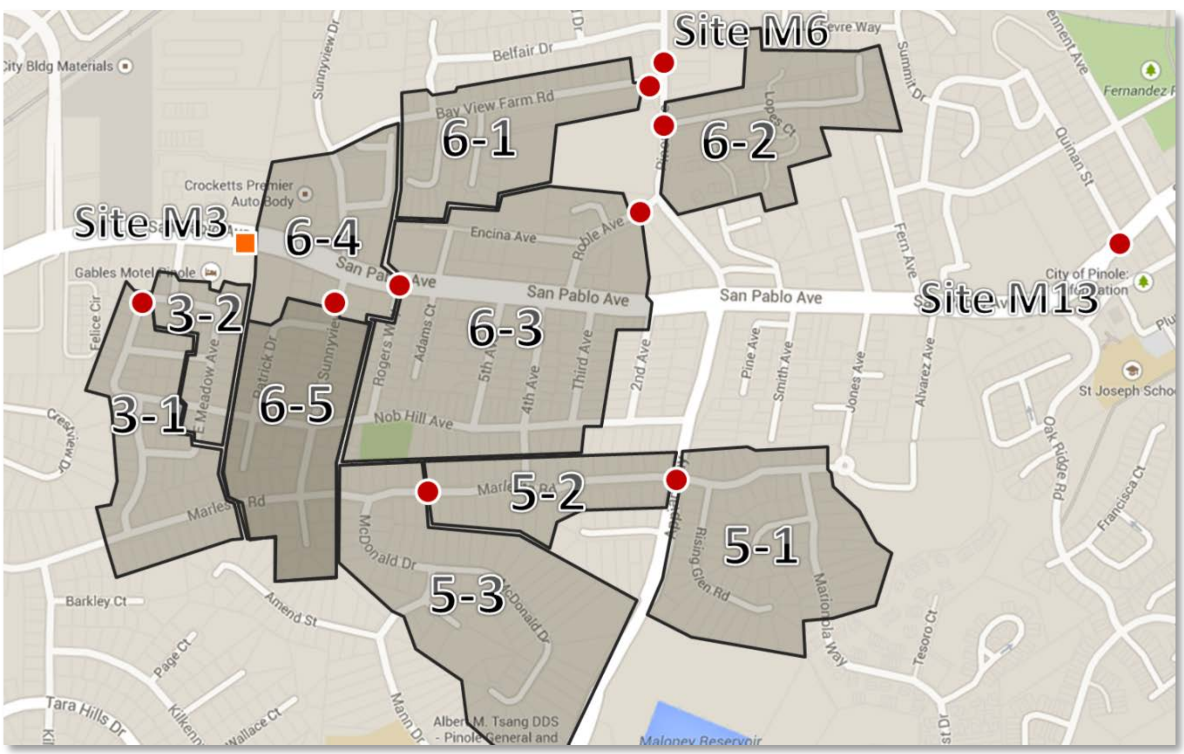


Figure 1-5. Phase 2 Flow Monitoring Basins Map

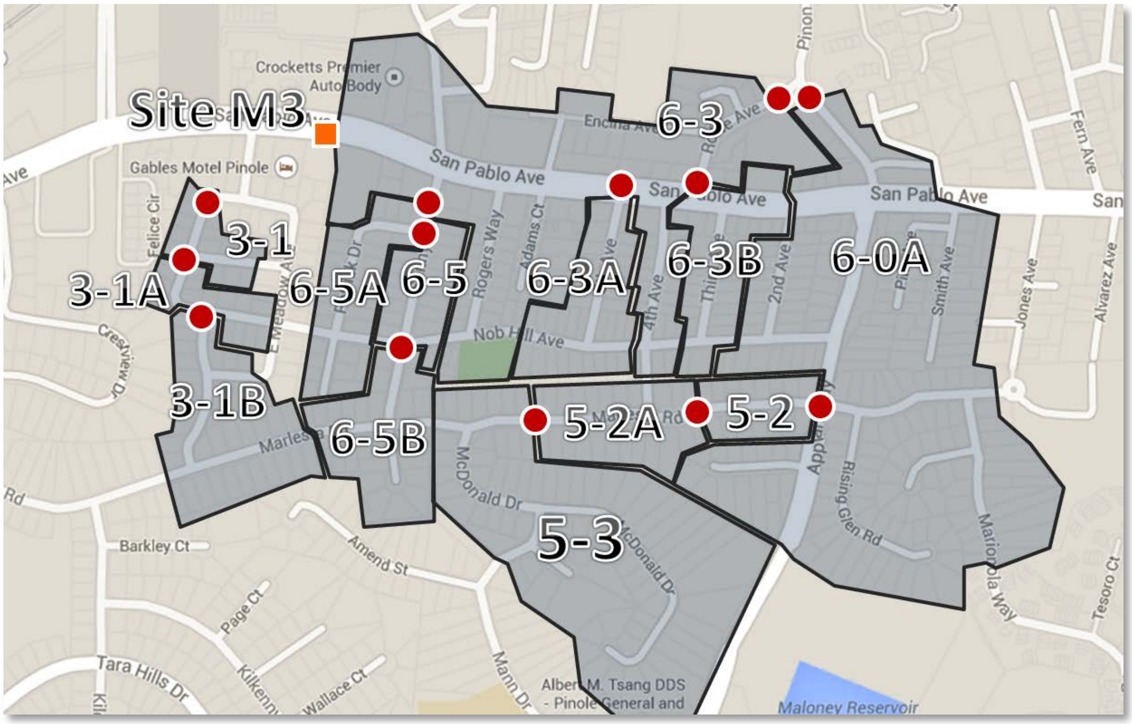


Figure 1-6. Phase 3 Flow Monitoring Basins Map

2.0 METHODS AND PROCEDURES

2.1 Confined Space Entry

A confined space entry (Photo 2-1) is defined as any space large enough and so configured that a person can bodily enter and perform assigned work, has limited or restricted means for entry or exit, and is not designed for continuous employee occupancy. In general, the atmosphere must be constantly monitored for sufficient levels of oxygen (19.5% to 23.5%), and the absence of hydrogen sulfide (H_2S) gas, carbon monoxide (CO) gas, and lower explosive limit (LEL) levels. A typical confined space entry crew has members with U.S. Department of Labor, Occupational Safety & Health Administration-defined (OSHA-defined) responsibilities of "entrant," "attendant," and "supervisor." The entrant is the individual performing the work. He or she is equipped with the appropriate level of personal protective equipment (PPE) needed to perform the job safely, including a personal four-gas monitor (Photo 2-2). If it is not possible to maintain line-of-sight with the entrant, then more entrants are required until line-of-sight can be maintained. The attendant is responsible for maintaining contact with the entrants to monitor the atmosphere using another four-gas monitor and maintaining records of all entrants. The supervisor is responsible for developing the safe work plan prior to entering.

Photo 2-1. Confined Space Entry

Photo 2-2. Typical Personal Four-Gas Monitor

2.2 Flow Meter Installation

A combination of Isco 2150 area-velocity meters and Hach Flo-Dar meters were installed by V&A in the sewer lines in Table 1-1, Table 1-2 and Table 1-3. Continuous depth and velocity readings were recorded by the flow meters on 5-minute intervals.

Isco 2150 meters use submerged sensors with a pressure transducer to collect depth readings and an ultrasonic Doppler sensor to determine the average fluid velocity. The ultrasonic sensor emits high-frequency sound waves, which are reflected by air bubbles and suspended particles in the flow. The sensor receives the reflected signal and determines the Doppler frequency shift, which indicates the estimated average flow velocity. The sensor is typically mounted at a manhole inlet to take advantage of smoother upstream flow conditions. Figure 2-1 shows a typical installation for a flow meter with a submerged sensor.

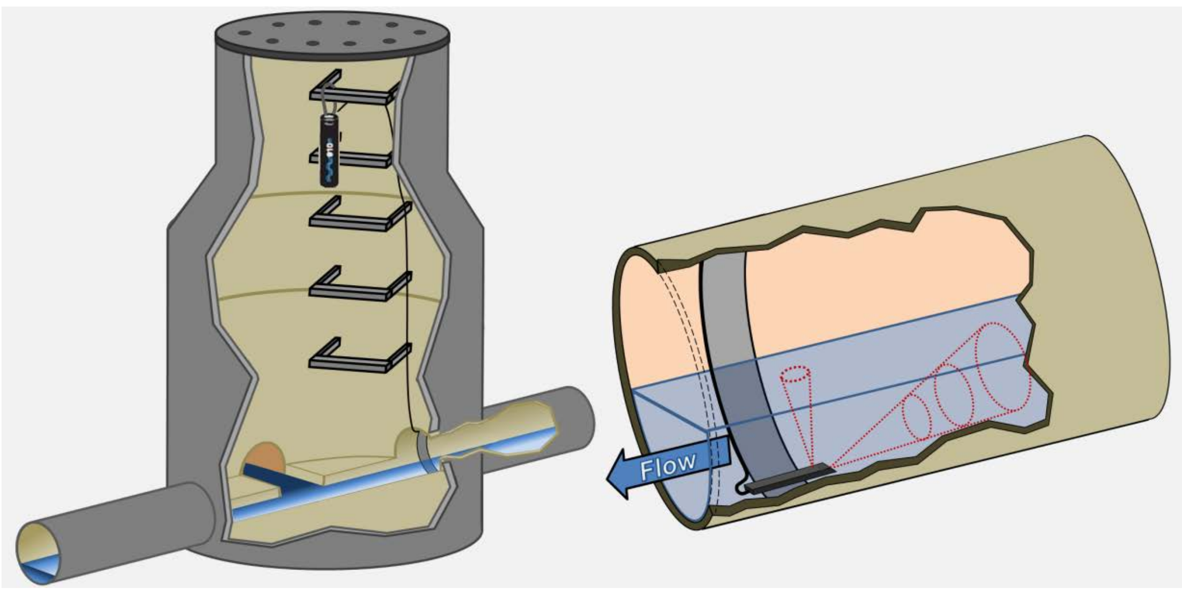


Figure 2-1. Typical Installation for Flow Meter with Submerged Sensor

The pipe diameter was verified in order to accurately calculate the flow cross-section. In-situ manual (hand) level and velocity measurements were taken and compared to simultaneous level and velocity readings from the flow meters to ensure proper calibration and accuracy. This determination of the level offset is required because of variations in individual flow meters, position of the sensor upon installation, thickness of the mounting band and other factors.

During the in-situ calibrations, the technician/engineer reports the actual depth of the flow to the invert of the pipe (d_A) while the flow meter reports the depth of water to the sensor (d_S). The difference between these is the offset. These sets of measurements are taken at least three times during installation and removal of the flow meters and during mid-project calibrations. The various sets of measurements are used to track the data quality. During site visits, observations of sediment are noted. If sediment is present, several depth of sediment readings (S) are taken and the type of sediment encountered (sandy, rocky, pebbly) is noted.

Most area-velocity meters employ a forward-looking ultrasonic Doppler sensor that does not record velocity if covered by sediment. To mitigate this, the sensor may be offset to a position where sediment is less likely to affect the sensor. It is important to take multiple sediment readings in multiple locations; sediment tends to settle in waves, which affects the accuracy of the sediment measurement if not accounted for.

Figure 2-2 illustrates a sensor offset for sediment, and the level measurements recorded during an in situ calibration. Figure 2-3 illustrates sediment wave pattern settlement commonly observed in sewer lines.

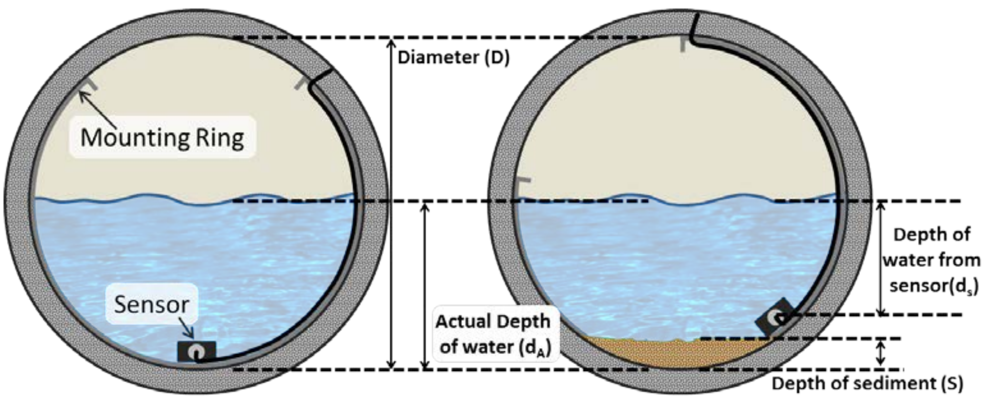


Figure 2-2. Sensor Offset due to Sediment

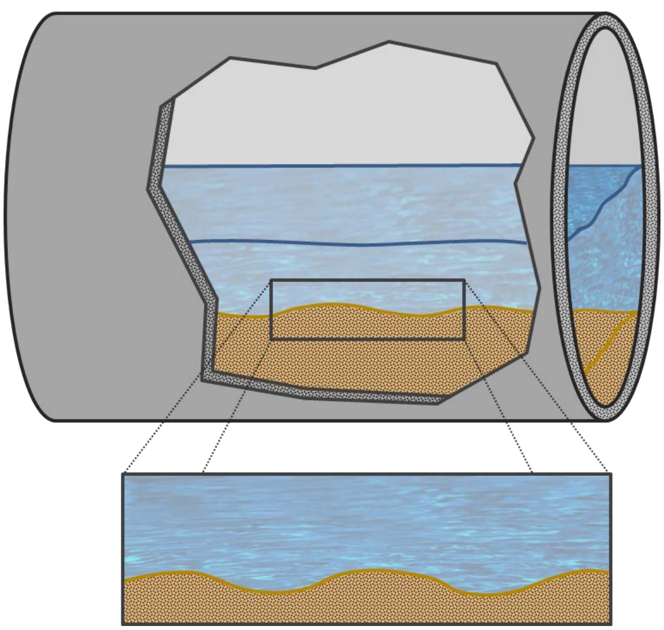


Figure 2-3. The Settling of Sediment in Pipelines

A Flo-Dar flow meter is a non-contact flow meter that uses radar to measure velocity and a down-looking ultrasonic sensor to measure depth. Figure 2-4 illustrates a typical Flo-Dar installation.

Figure 2-4. Typical Flo-Dar Flow Meter Installation

2.3 Flow Calculation

Data retrieved from each flow meter was placed into a spreadsheet program for analysis. Data analysis includes data comparison to field calibration measurements, as well as necessary geometric adjustments as required for sediment (sediment reduces the pipe's wetted cross-sectional area available to carry flow). Area-velocity flow metering uses the continuity equation,

$$Q = v \cdot A = v \cdot (A_T - A_S)$$

where Q : volume flow rate
v: average velocity as determined by the ultrasonic sensor
A: cross-sectional area available to carry flow
A_T: total cross-sectional area with both wastewater and sediment
A_S: cross-sectional area of sediment.

For circular pipe,

$$A_T = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right]-\left[\left(\frac{D}{2}-d_W\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right)\right]$$

$$A_S = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right]-\left[\left(\frac{D}{2}-d_S\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right)\right]$$

where d_W: distance between wastewater surface level and pipe invert
d_S: depth of sediment
D: pipe diameter

2.4 Average Dry Weather Flow Determination

Weekday and weekend flow patterns differ and must be separated when determining average dry weather flows. Days least affected by rainfall were used to estimate weekend and weekday average flows. The overall average dry weather flow (ADWF) was calculated per the following equation:

$$ADWF = \left(ADWF_{Mon-Fri} \times \frac{5}{7} \right) + \left(ADWF_{Sat-Sun} \times \frac{2}{7} \right)$$

Figure 2-5 illustrates the varying flow patterns within a typical dry week.

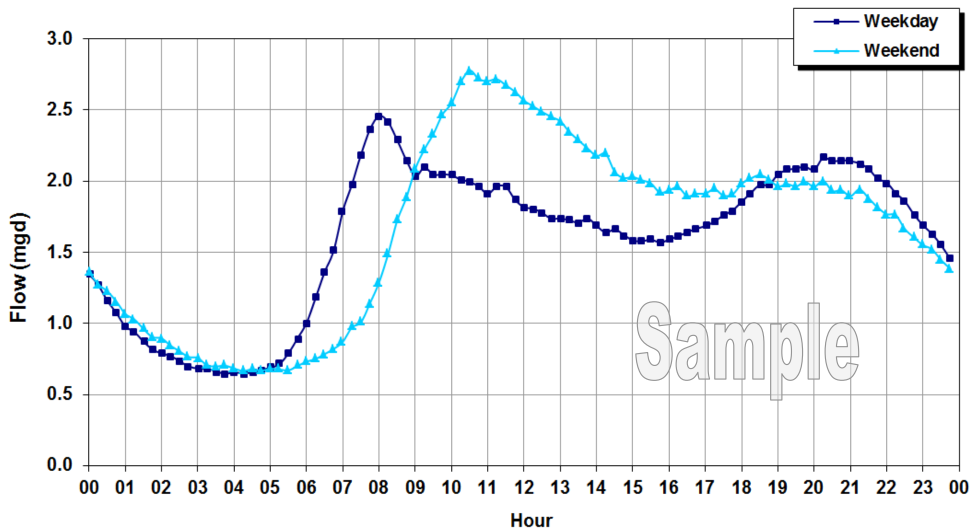


Figure 2-5. Sample ADWF Diurnal Flow Patterns

2.5 Pipeline Capacity Analysis Methods

Peak measured flows and peak flow depths are important factors to consider when evaluating the capacity of the collection system. The peak flows and flow levels reported are from the peak measurements taken across the entirety of the flow monitoring period and may or may not correspond to a simultaneous event for all sites.

The following capacity analysis terms are defined as follows:

- **Peaking Factor:** Peaking factor is defined as the peak measured flow divided by the ADWF. A peaking factor threshold value of 3.0 is commonly used for sanitary sewer design of new pipe; however, it is noted that this value is variable and subject to attenuation and the size of the upstream collector area. The City should follow its own standards and criteria when examining peaking factors.
- **d/D Ratio:** The d/D ratio is the peak measured depth of flow (d) divided by the pipe diameter (D). Standards for d/D ratio vary agency to agency, but typically range between d/D ≤ 0.5 and d/D ≤ 0.75. The d/D ratio for each site was computed based on the maximum depth of flow for the flow monitoring study.

2.6 Inflow/Infiltration Analysis Methods

Inflow and infiltration (I/I) consists of stormwater and groundwater that enter the sewer system through pipe defects and improper storm drainage connections and is defined as follows.

2.6.1 Definition and Typical Sources

- **Inflow:** Storm water inflow is defined as water discharged into the sewer system, including private sewer laterals, from direct connections such as downspouts, yard and area drains, holes in manhole covers, cross-connections with storm drains, or catch basins.
- **Infiltration:** Infiltration is defined as water entering the sanitary sewer system through defects in pipes, pipe joints, and manhole walls, which may include cracks, offset joints, root intrusion points, and broken pipes.

Figure 2-6 illustrates the possible sources and components of I/I.

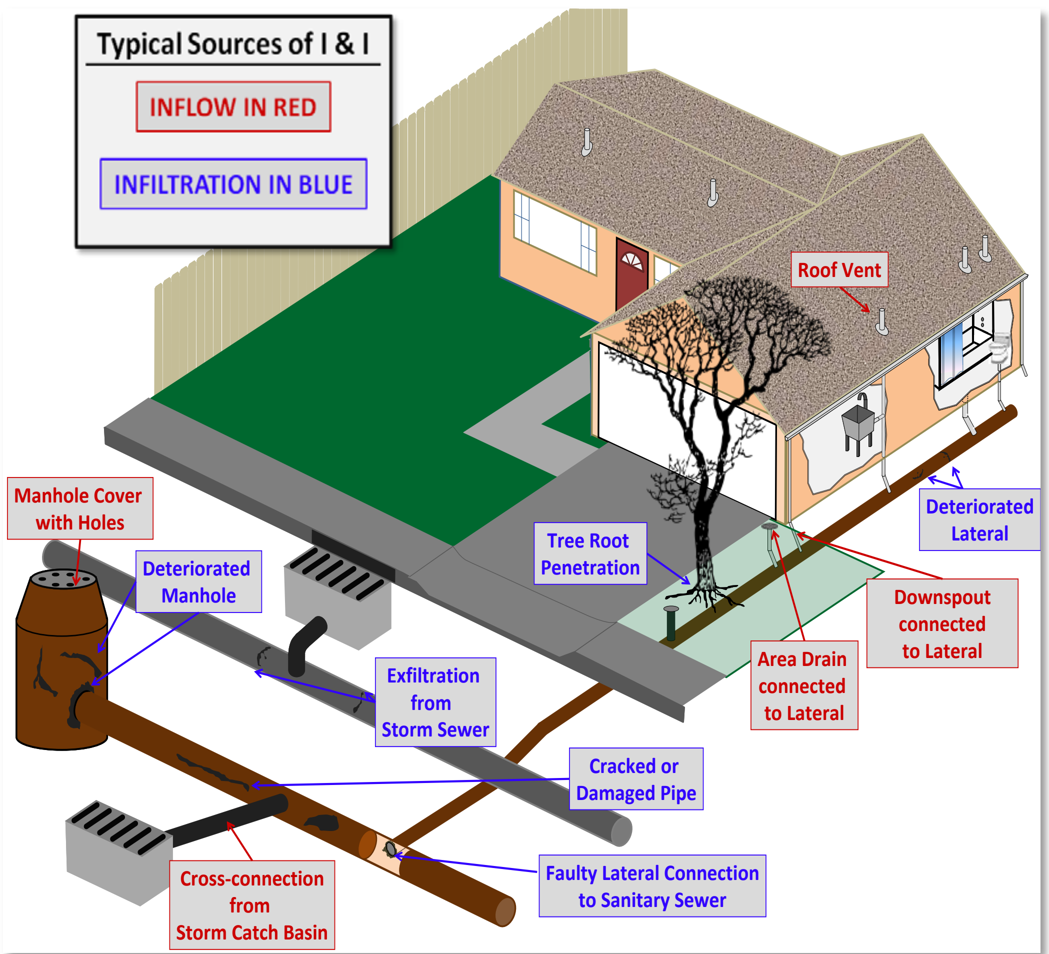


Figure 2-6. Typical Sources of Infiltration and Inflow

2.6.2 Infiltration Components

Infiltration can be further subdivided into the following components:

- **Rainfall-Dependent Infiltration:** This component occurs as a result of storm water and enters the sewer system through pipe defects, as with GWI. The storm water first percolates directly into the soil and then migrates to an infiltration point. Typically, the time of concentration for rainfall-dependent infiltration (RDI) may be 24 hours or longer, but this depends on the soil permeability and saturation levels.
- **Groundwater Infiltration:** Groundwater infiltration (GWI) depends on the depth of the groundwater table above the pipelines as well as the percentage of the system submerged. The variation of groundwater levels and subsequent GWI rates are seasonal by nature. On a day-to-day basis, GWI rates are relatively steady and will not fluctuate greatly.
- **Rainfall-Responsive Infiltration** is storm water that enters the collection system indirectly through pipe defects, but normally in sewers constructed close to the ground surface such as private laterals. Rainfall-responsive infiltration (RRI) is independent of the groundwater table and reaches defective sewers via the pipe trench in which the sewer is constructed, particularly if the pipe is placed in impermeable soil and bedded and backfilled with a granular material. In this case, the pipe trench serves as a conduit similar to a French drain, conveying storm drainage to defective joints and other openings in the system. This type of infiltration can have a quick response and graphically can look very similar to inflow.

2.6.3 Impact and Cost of Source Detection and Removal

- **Inflow:**
  - **Impact:** This component of I/I creates a peak flow problem in the sewer system and may dictate the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows. Because the response and magnitude of inflow is tied closely to the intensity of the storm event, short-term peak flows may result in surcharging and overflows within a collection system. Severe inflow can result in sewage dilution, which may upset the biological process (secondary treatment) at the treatment facility.
  - **Cost of Source Identification and Removal:** Inflow locations are usually less difficult to find and less expensive to correct than infiltration sources. These sources include direct and indirect cross-connections with storm drainage systems, roof downspouts, and various types of surface drains. Generally, the costs to identify and remove sources of inflow are low compared to potential benefits to public health and safety or the costs of building new facilities to convey and treat the resulting peak flows.
- **Infiltration:**
  - **Impact:** Infiltration typically creates long-term annual volumetric problems. The major impact is the cost of pumping and treating the additional volume of water, and of paying for treatment (for municipalities that are billed strictly on flow volume).
  - **Cost of Source Detection and Removal:** Infiltration sources are usually harder to find and more expensive to correct than inflow sources. Infiltration sources include defects in deteriorated sewer pipes or manholes that may be widespread throughout a sanitary sewer system.

2.6.4 Graphical Identification of Inflow and Infiltration

Inflow is usually recognized graphically by large-magnitude, short-duration spikes immediately following a rain event. Infiltration is often recognized graphically by a gradual increase in flow after a wet-weather event. The increased flow typically sustains for a period after rainfall has stopped and then gradually drops off as soils become less saturated and as groundwater levels recede to normal levels. Real-time flows were plotted against average dry weather flow (ADWF) to analyze the I/I response to rainfall events. Figure 2-7 illustrates a sample of how this analysis is conducted and some of the measurements that are used to distinguish I/I. Similar graphs were generated for the individual flow monitoring sites and can be found in *Appendix A*.

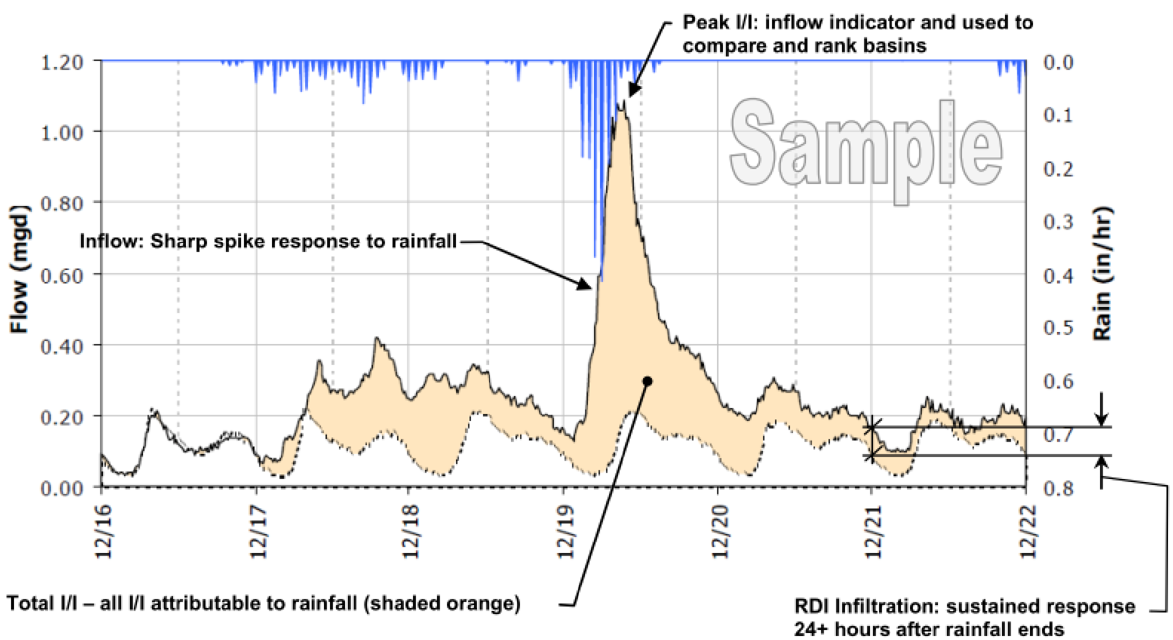


Figure 2-7. Sample Infiltration and Inflow Isolation Graph

2.6.5 Analysis Methods

After differentiating I/I flows from ADWF flows, various calculations can be made to determine which I/I component (inflow or infiltration) is more prevalent at a particular site and to compare the relative magnitudes of the I/I components between drainage basins and between storm events. Inflow or infiltration components are typically normalized in up to three ways:

- **per-IDM:** Inflow or infiltration rates are divided by length of pipe within the drainage basin, expressed in units of inch-diameter-mile (IDM) (miles of pipeline multiplied by the diameter of the pipeline in inches). Final units are gallons per day (gpd) per IDM.
- **per-ACRE:** Inflow or infiltration rates are divided by the acreage of the drainage basin. Final units are gallons per day (gpd) per ACRE.
- **per-ADWF:** Inflow or infiltration rates are divided by the ADWF that was measured and established within the drainage basin. This is a ratio. The number is unitless, but can be thought of in the same light as a Peaking Factor.

The infiltration and inflow indicators were normalized by all three methods for this report per the following weighting system:

I/I Analysis Method	Weight
per-IDM	50%
per-ACRE	20%
per-ADWF	30%

The per-IDM method was given the highest weight because capital improvement projects concerning rehabilitation or replacement of sanitary sewer pipelines are most commonly bid based on the length of pipe. Note: inflow is subject to the effects of attenuation, explained in the following section.

2.7 Flow Attenuation

Flow attenuation in a sewer collection system is the natural process of the reduction of the peak flow rate through redistribution of the same volume of flow over a longer period of time. This occurs as a result of friction (resistance), internal storage and diffusion along the sewer pipes. Fluids are constantly working towards equilibrium. For example, a volume of fluid poured into a static vessel with no outside turbulence will eventually stabilize to a static state, with a smooth fluid surface without peaks and valleys. Attenuation within a sanitary sewer collection system is based upon this concept. A flow profile with a strong peak will tend to stabilize towards equilibrium, as shown in Figure 2-8.

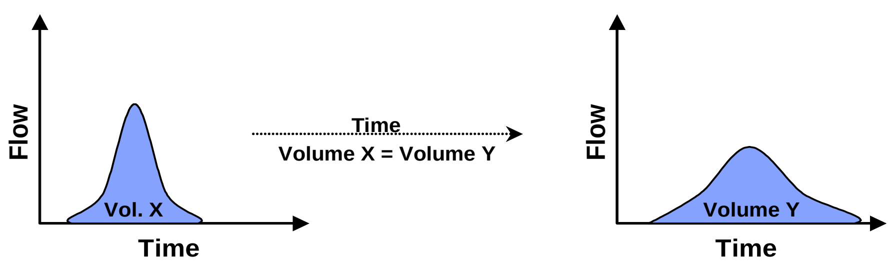


Figure 2-8. Attenuation Illustration

Within a sanitary sewer collection system, each individual basin will have a specific flow profile. As the flows from the basins combine within the trunk sewer lines, the peaks from each basin will (a) not necessarily coincide at the same time, and (b) due to the length and time of travel through the trunk sewers, peak flows will attenuate prior to reaching the treatment facility. The sum of the peak flows of the individual basins within a collection system will usually be greater than the peak flows observed at the treatment facility.

3.0 RAINFALL RESULTS

3.1 Rainfall Data

There were sufficient rainfall events over the flow monitoring period that could be used to conduct multiple sets of infiltration and inflow analysis, allowing for relocation of flow meters and isolation of multiple drainage basins. V&A utilized rain data publically available through the National Weather Service (NWS) Cooperative Observer Program (COOP). While V&A performed QA/QC analysis to ensure, to the extent possible, the quality of the rainfall data, it is noted that V&A had no direct control over those gauges.

Table 3-1 shows the precipitation for the notable rainfall events measured from the four rain gauges. Figure 3-1 illustrates the rain events over the monitoring period (average of all rain gauges shown). Figure 3-2 shows the rainfall accumulation during the monitoring period, as well as the historical average rainfall[5] in Pinole at the approximate study centroid during this project duration.

The cumulative precipitation at the four rain gauges ranged from 52% to 85% of the historical precipitation for the time period shown.

Table 3-1. Rainfall Events Summary

Rainfall	RG North (inches)	RG East (inches)	RG South (inches)	RG West (inches)
Event 1: February 2, 2014 – February 10, 2014	3.75	5.47	4.76	3.00
Event 2: February 26, 2014 – March 6, 2014	2.34	2.48	2.55	1.28
Event 3: March 26, 2014 – April 1, 2014	2.45	3.17	3.09	2.46
Total over Monitoring Period:	*8.69*	*11.28*	*10.55*	*6.84*

[5] Historical data taken from the WRCC (Station 45378 in Martinez, CA and Station 47414 in Richmond, CA): http://www.wrcc.dri.edu/summary/climsmnca.html

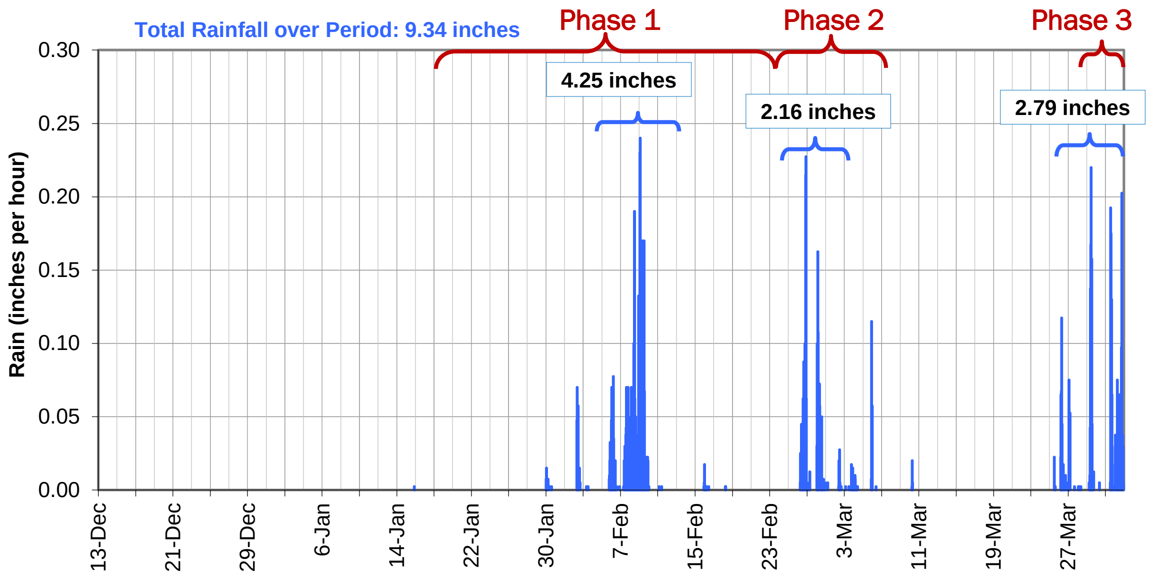


Figure 3-1. Rainfall Distribution over Flow Monitoring Period (Avg. of Four Rain Gauges)

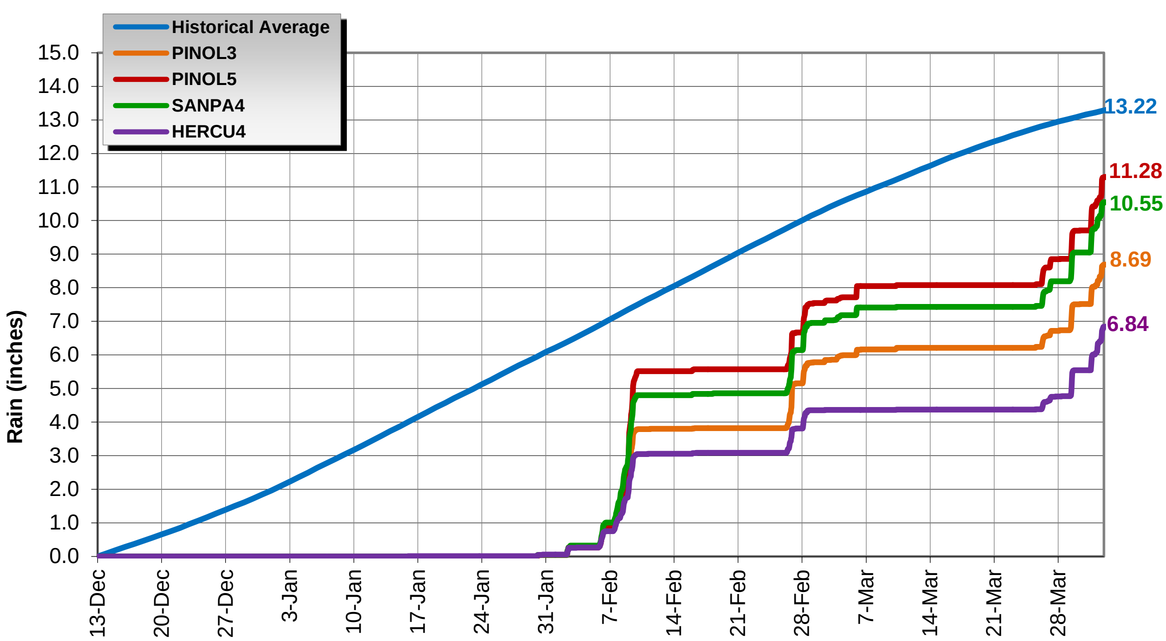


Figure 3-2. Rainfall Accumulation Plot

3.2 Regional Rainfall Event Classification

It is important to classify the relative size of a major storm event that occurs over the course of a flow-monitoring period[6]. Rainfall events are classified by intensity and duration. Based on historical data, frequency contour maps for storm events of given intensity and duration have been developed by the National Oceanic and Atmospheric Administration (NOAA) for Northern California (Figure 3-3).

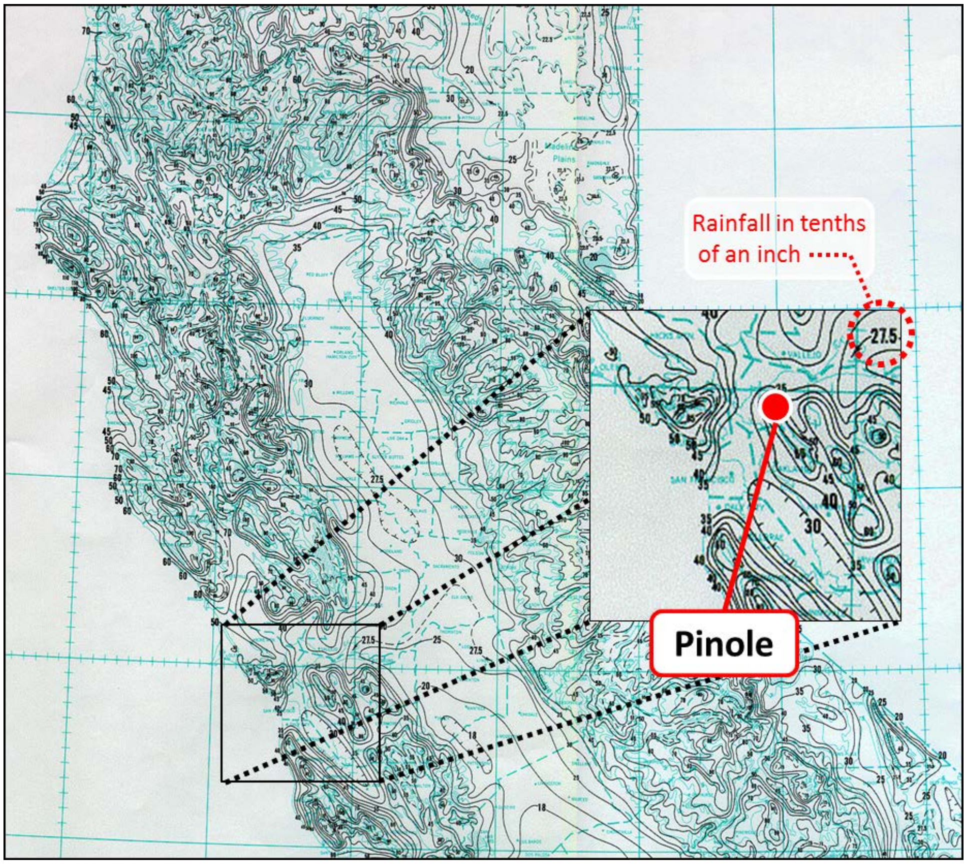


Figure 3-3. NOAA Northern California Rainfall Frequency Map, Isopluvials of 10-year 24-hour precipitation in inches

For example, the NOAA *Rainfall Frequency Atlas*[7] classifies a 10-year, 24-hour storm event at the PINOL5 rain gauge location as 3.75 inches. This means that in any given year, at this specific location, there is a 10% chance that 3.75 inches of rain will fall in any 24-hour period.

From the NOAA frequency maps, for a specific latitude and longitude, the rainfall densities for period durations ranging from 1 hour to 24 hours are known for rain events ranging from 1-year to 100-year intensities. These were plotted to develop a rain event frequency map specific to each rainfall monitoring site. Superimposing the peak-measured densities for the rainfall events on the rain event

[6] Sanitary sewers are often designed to withstand I/I contribution to sanitary flows for specific-sized "design" storm events.
[7] NOAA Western U.S. Precipitation Frequency Maps Atlas 14, 1973: http://www.wrcc.dri.edu/pcpnfreq.html

frequency plot determines the classification of the rainfall event. Figure 3-4 depicts the classification curves for the rainfall events for the SANPA4 rain gauge. Table 3-2 lists the intensity of the various storm events for each rain gauge.

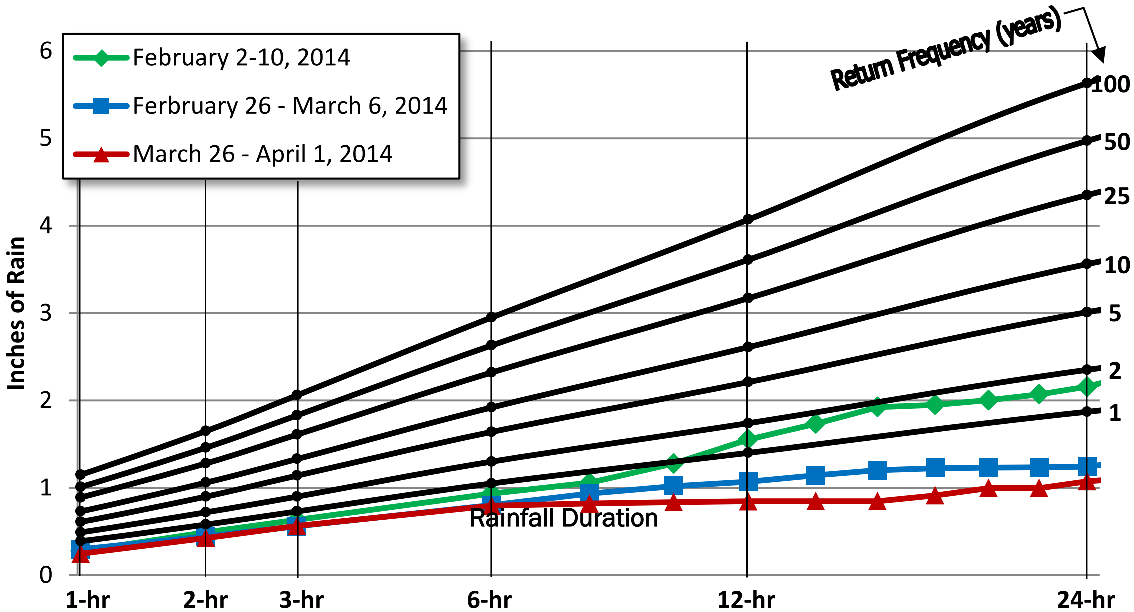


Figure 3-4. Storm Event Classification at SANPA4

Table 3-2. Rainfall Frequency Return Summary

Rainfall Event	PINOL3 (in)	PINOL5 (in)	SANPA4 (in)	HERCU4 (in)
Event 1: February 2 – February 10, 2014	< 1 year	4 year, 24 hour	1+ year, 24 hour	< 1 year
Event 2: February 26 – March 6, 2014	< 1 year	< 1 year	< 1 year	< 1 year
Event 3: March 26 – April 1, 2014	< 1 year	< 1 year	< 1 year	< 1 year

3.3 Rainfall Summary

- Though the total rainfall for the entirety of the 2013/2014 rainfall season was generally low, Storm Event 1 provided sufficient rainfall to conduct a solid I/I analysis of the flow monitoring data gathered for Phase 1.
- Event 1 was classified as greater than a 1-year, 24-hour event for some rain gauges in the region. Event 1 also increased the soil saturation levels so that future rainfall events (Events 2 and 3) were effective for I/I analysis of the flow monitoring data collected for Phase 2 and Phase 3.

4.0 Flow Monitoring Results

4.1 Average Dry Weather Flows

ADWF flows were established during dry days within the flow monitoring period when RDI had the least impact on the flow rates. Table 4-1 summarizes the ADWF flow data measured during this study. Figure 4-1, Figure 4-2 and Figure 4-3 show flow schematic diagrams of the ADWF and flow levels for the flow monitoring sites, all phases.

Table 4-1. Average Dry Weather Flow Summary

Monitoring Site	Weekday ADWF (mgd)	Weekend ADWF (mgd)	Overall ADWF (mgd)
Phase 1			
Site M1	0.70	0.76	0.71
Site M2	1.11	1.10	1.11
Site M3	0.07	0.07	0.07
Site M4	0.13	0.14	0.13
Site M5	0.02	0.02	0.02
Site M6	0.17	0.19	0.18
Site M7	0.36	0.38	0.36
Site M8	0.007	0.006	0.007
Site M9	0.004	0.005	0.004
Site M10	0.08	0.09	0.09
Site M11	0.02	0.02	0.02
Site M12	0.003	0.003	0.003
Site M13	0.06	0.06	0.06
Site M14	0.04	0.04	0.04
Site M15	0.01	0.02	0.02
Site M16	0.08	0.09	0.09
Phase 2			
Site M3.1	0.035	0.025	0.032
Site M3.2	0.011	0.011	0.011
Site M5.1	0.022	0.026	0.023
Site M5.2	0.011	0.013	0.011
Site M5.3	0.022	0.023	0.022
Site M6.1	0.010	0.014	0.011

Monitoring Site	Weekday ADWF (mgd)	Weekend ADWF (mgd)	Overall ADWF (mgd)
Site M6.2	0.015	0.018	0.016
Site M6.3	0.171	0.140	0.163
Site M6.4	0.076	0.103	0.084
Site M6.5	0.008	0.011	0.009
Phase 3			
Site M3.1A	0.009	0.010	0.009
Site M3.1B	0.006	0.006	0.006
Site M5.2A	0.009	0.010	0.009
Site M6.0A	0.056	0.061	0.057
Site M6.3A	0.005	0.005	0.005
Site M6.3B	0.003	0.004	0.004
Site M6.5A	0.003	0.003	0.003
Site M6.5B	0.003	0.004	0.003

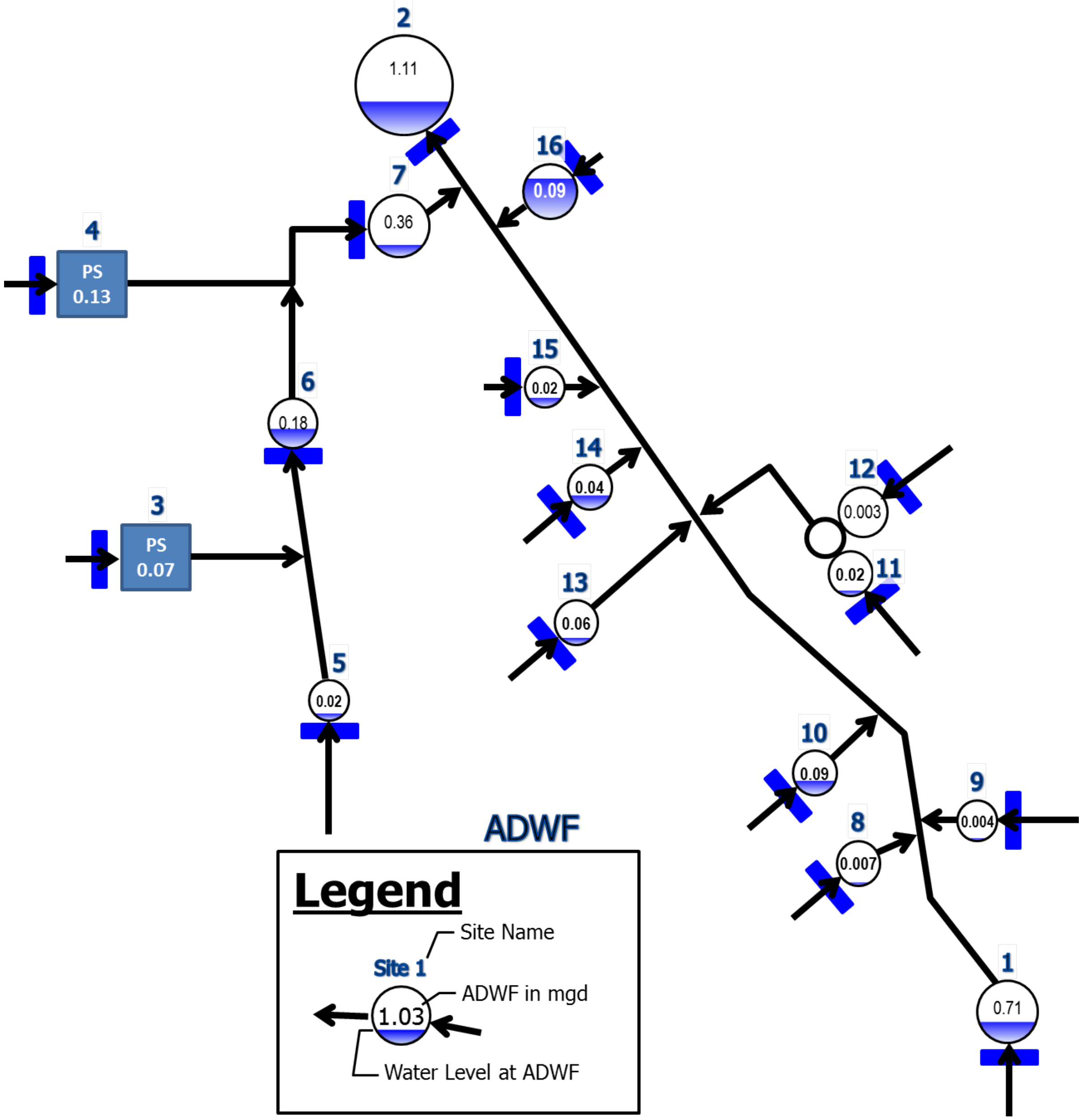


Figure 4-1. Average Dry Weather Flow Schematic (Phase 1)

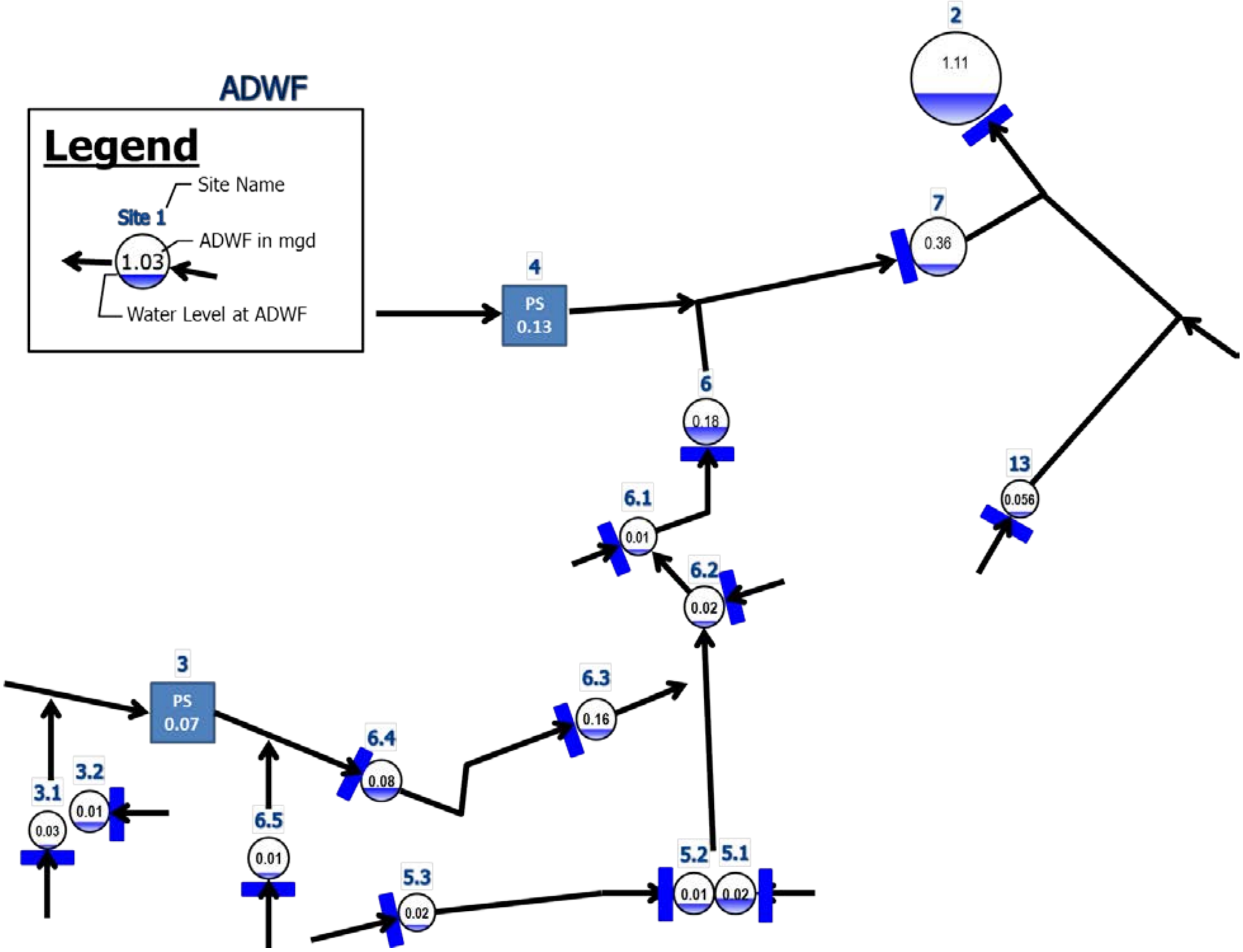


Figure 4-2. Average Dry Weather Flow Schematic (Phase 2)

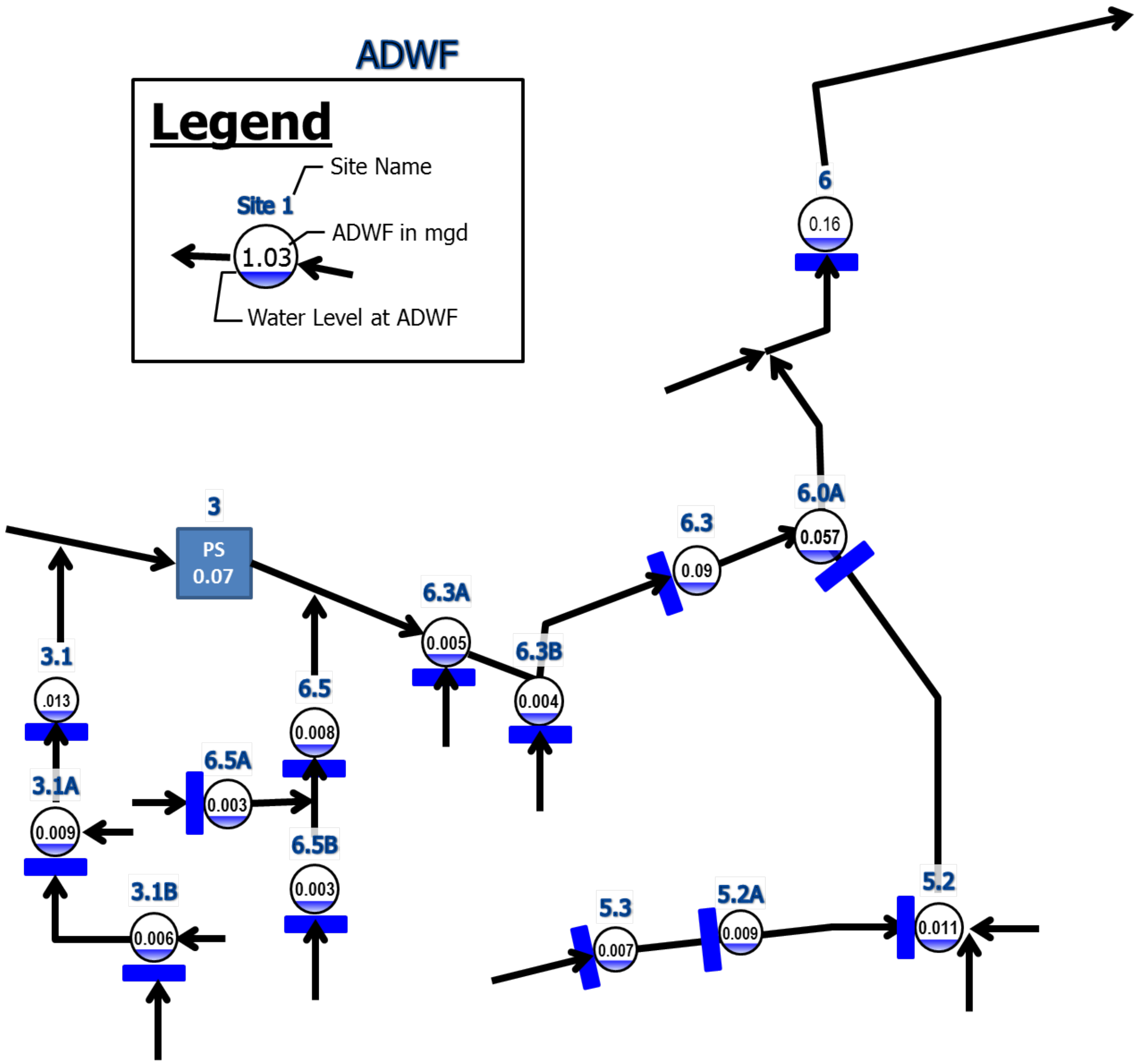


Figure 4-3. Average Dry Weather Flow Schematic (Phase 3)

4.2 Peak Measured Flows and Pipeline Capacity Analysis

Capacity analysis data is presented on a site-by-site basis and represents the hydraulic conditions only at the point site locations. Hydraulic conditions in other areas of the collection system will differ. Due to the relocation of flow meters and different flow data capture periods, the peak flows and peak levels should not necessarily be directly compared to each other. The period of meter installation are coded per the following scheme:

Scheme	Install Period
A	1/17/2014 – 2/25/2014
B	1/17/2014 – 3/28/2014
C	1/17/2014 – 4/1/2014
D	2/25/2014 – 3/28/2014
E	2/25/2014 – 4/1/2014
F	3/28/2014 – 4/1/2014

Table 4-2 summarizes the peak recorded flows, levels, *d/D* ratios, and peaking factors per site during the flow monitoring period. Sites that surcharged and sites with peaking factors greater than 10.0 have been shaded in RED. Figure 4-4, Figure 4-5 and Figure 4-6 show bar graphs of the capacity results for all phases. Figure 4-7, Figure 4-8 and Figure 4-9 show schematic diagrams of the peak measured flows with peak flow levels for all phases of the flow monitoring.

Table 4-2. Capacity Analysis Summary

Monitoring Site	Install Period Scheme	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (inches)	Peak Level (inches)	d/D Ratio	Surcharge Level (feet)
Phase 1								
Site M1	A	0.71	3.50	4.9	15	8.5	0.57	-
Site M2	C	1.11	7.20	6.5	30	45.5	1.52	1.3
Site M3	C	0.07	0.71	10.7	n/a	n/a	n/a	-
Site M4	C	0.13	0.47	3.7	n/a	n/a	n/a	-
Site M5	A	0.02	0.65	33.9	7.25	10.7	1.53	0.3
Site M6	C	0.18	1.10	6.2	10	82.3	8.23	6.0
Site M7	B	0.36	2.02	5.6	15	11.8	0.78	-
Site M8	A	0.007	0.03	5.0	7.75	1.3	0.17	-
Site M9	A	0.004	0.30	67.5	6	2.7	0.45	-
Site M10	A	0.09	0.41	4.8	8	11.4	1.43	0.3
Site M11	A	0.02	0.53	30.6	10	51.6	5.16	3.5
Site M12[8]	A	0.003	n/a	n/a	8	51.6	6.45	3.6

[8] Site M12 failed during Storm Event 1; the manhole was surcharged for an extended time period, flooding the flow logging computer. Enough data was recovered to establish an average dry weather flow but not enough for a proper capacity and I/I analysis. This site and other sites that comprise the 'Old Henry Road' basin are the subject of a future project.

Monitoring Site	Install Period Scheme	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	Diameter (inches)	Peak Level (inches)	d/D Ratio	Surcharge Level (feet)
Site M13	B	0.06	0.21	3.8	6	1.7	0.28	-
Site M14	A	0.04	0.32	7.7	8	9.3	1.16	0.1
Site M15	A	0.02	0.21	14.1	6	2.6	0.44	-
Site M16	A	0.09	0.62	7.2	11.5	37.2	3.23	2.1
Phase 2								
Site M3.1	E	0.03	0.58	18.3	6	3.3	0.41	-
Site M3.2	D	0.01	0.08	7.3	6	3.2	0.40	-
Site M5.1	D	0.02	0.15	6.5	8	7.6	0.95	-
Site M5.2	E	0.01	0.31	27.6	8	6.1	0.77	-
Site M5.3	E	0.02	0.10	4.5	6	2.1	0.35	-
Site M6.1	D	0.01	0.12	10.4	6	7.2	1.20	0.1
Site M6.2	D	0.02	0.04	2.3	8	1.9	0.23	-
Site M6.3	E	0.16	0.72	4.4	8	5.1	0.64	-
Site M6.4	D	0.08	0.51	6.1	8	6.2	0.78	-
Site M6.5	E	0.01	0.12	13.5	8	3.0	0.37	-
Phase 3								
Site M3.1A	F	0.009	0.15	15.4	6	5.9	0.98	-
Site M3.1B	F	0.006	0.10	16.7	6	2.0	0.34	-
Site M5.2A	F	0.009	0.11	12.0	6	3.2	0.53	-
Site M6.0A	F	0.057	1.09	19.0	10	7.2	0.72	-
Site M6.3A	F	0.005	0.30	61.5	6	3.2	0.53	-
Site M6.3B	F	0.004	0.06	16.1	8	1.3	0.16	-
Site M6.5A	F	0.003	0.03	11.1	7.75	1.3	0.17	-
Site M6.5B	F	0.003	0.04	11.8	7.75	1.1	0.14	-

The following capacity analysis results are noted:

- **Peaking Factor:** Several sites had peaking factors greater than 10. Larger peaking factors are expected given that the study analyzes basins previously identified as having I/I rates.
- **d/D Ratio:** Nine of the flow monitoring sites (Sites M2, M5, M6, M10, M11, M12, M14, M16 and M6.1) reached surcharge conditions.
- **Sanitary Sewer Overflow Potential:** Given the level of surcharging seen during Storm Event 1, the manholes at Site 6, Site 11/12 and Site 16 have the potential for a sanitary sewer overflow (SSO) during a larger rainfall event. Site 6 has historical precedence for SSO discharging during large rainfall events.
- These capacity results do not replace a full hydraulic model which would determine capacity on a node-to-node basis and would be based on pipe slopes of the individual pipe segments within the local collection system.

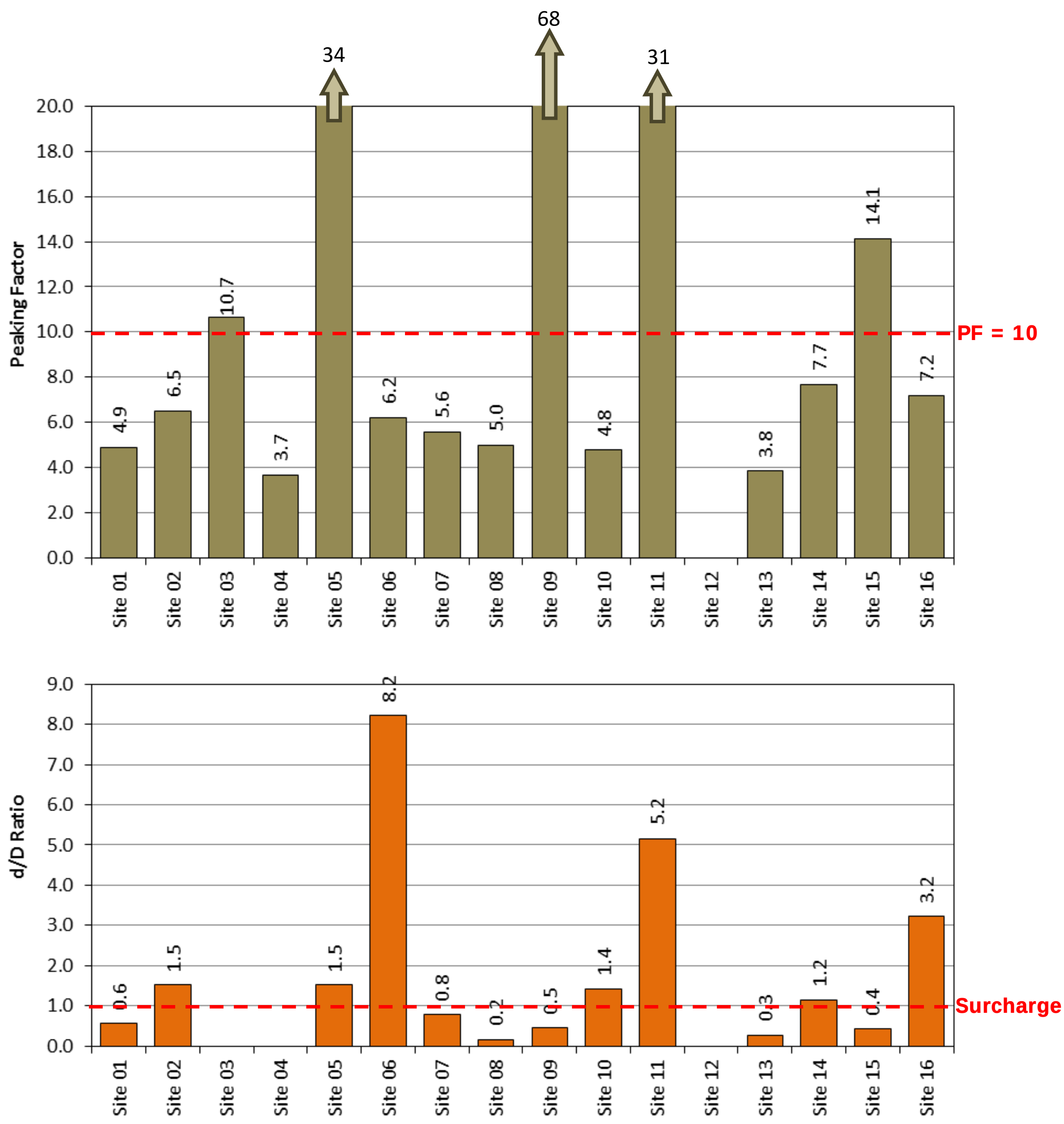
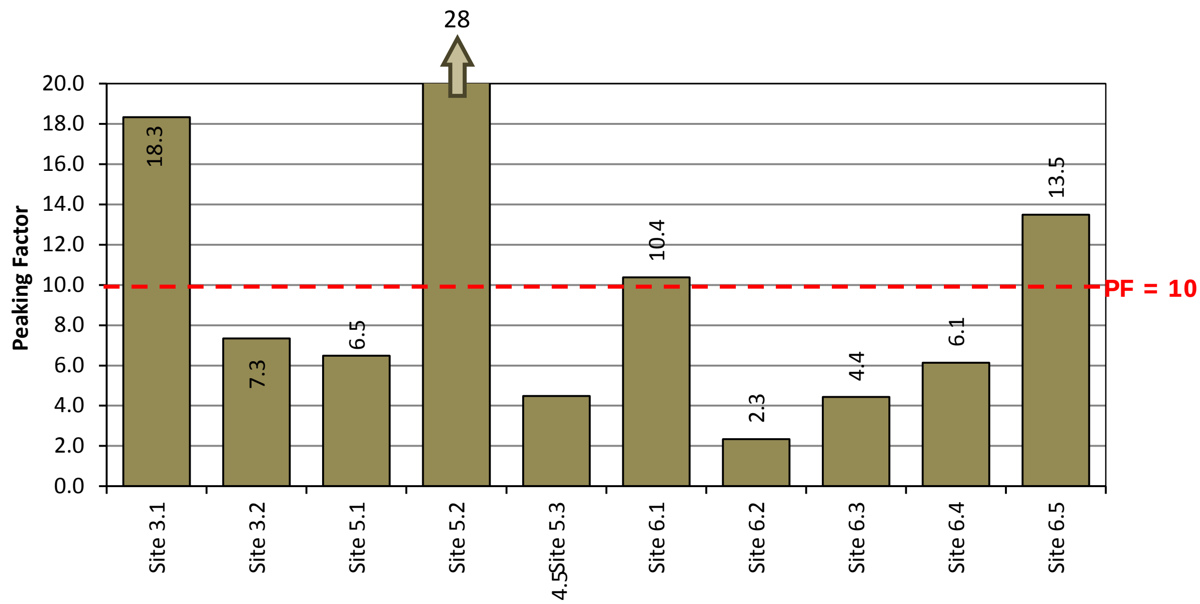


Figure 4-4. Phase 1 Capacity Summary: Peaking Factors and d/D Ratios



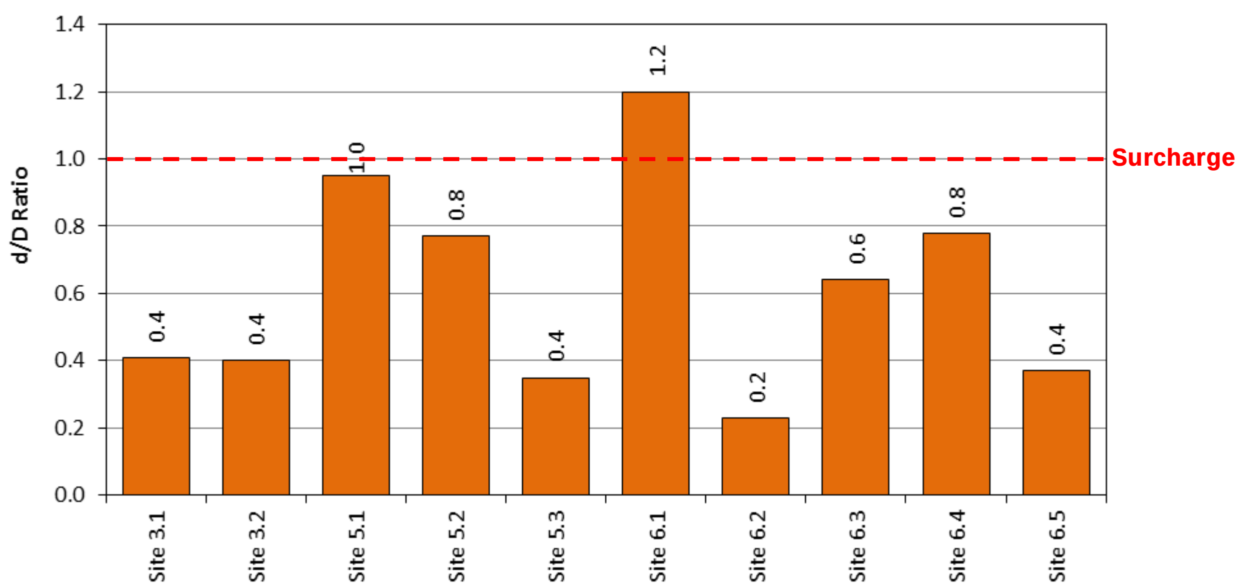


Figure 4-5. Phase 2 Capacity Summary: Peaking Factors and d/D Ratios

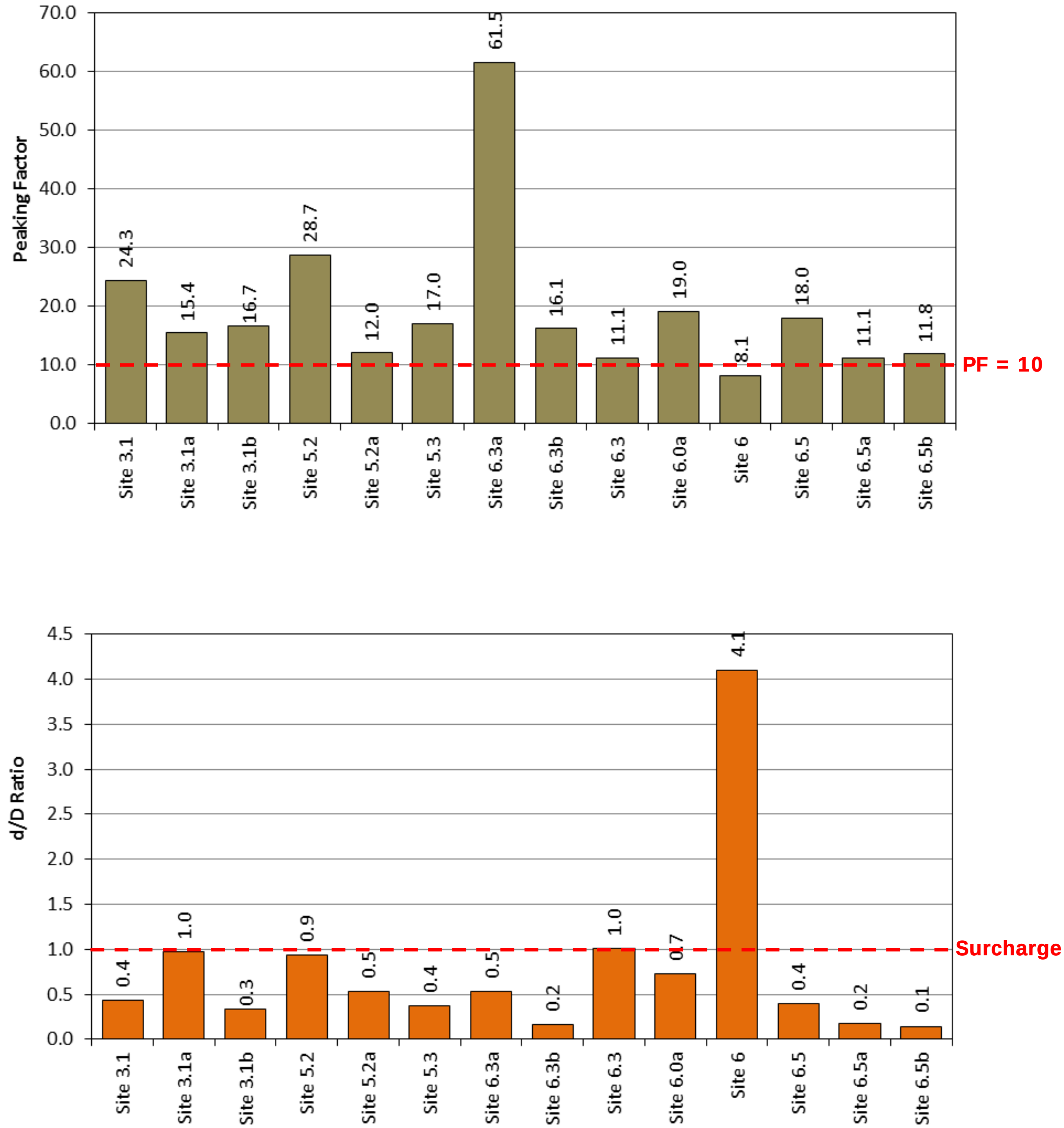


Figure 4-6. Phase 3 Capacity Summary: Peaking Factors and d/D Ratios

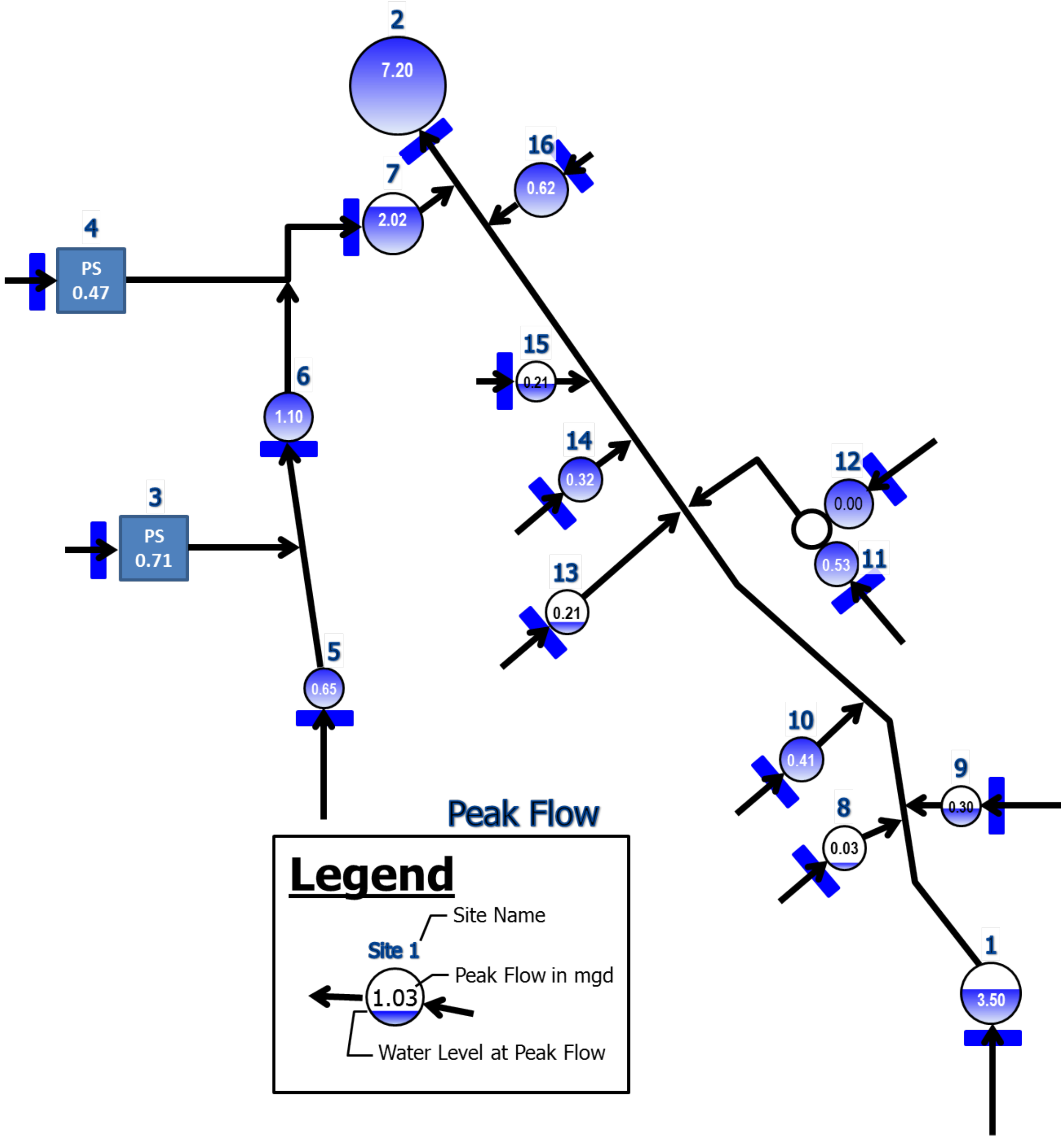


Figure 4-7. Peak Measured Flow Schematic (Phase 1)

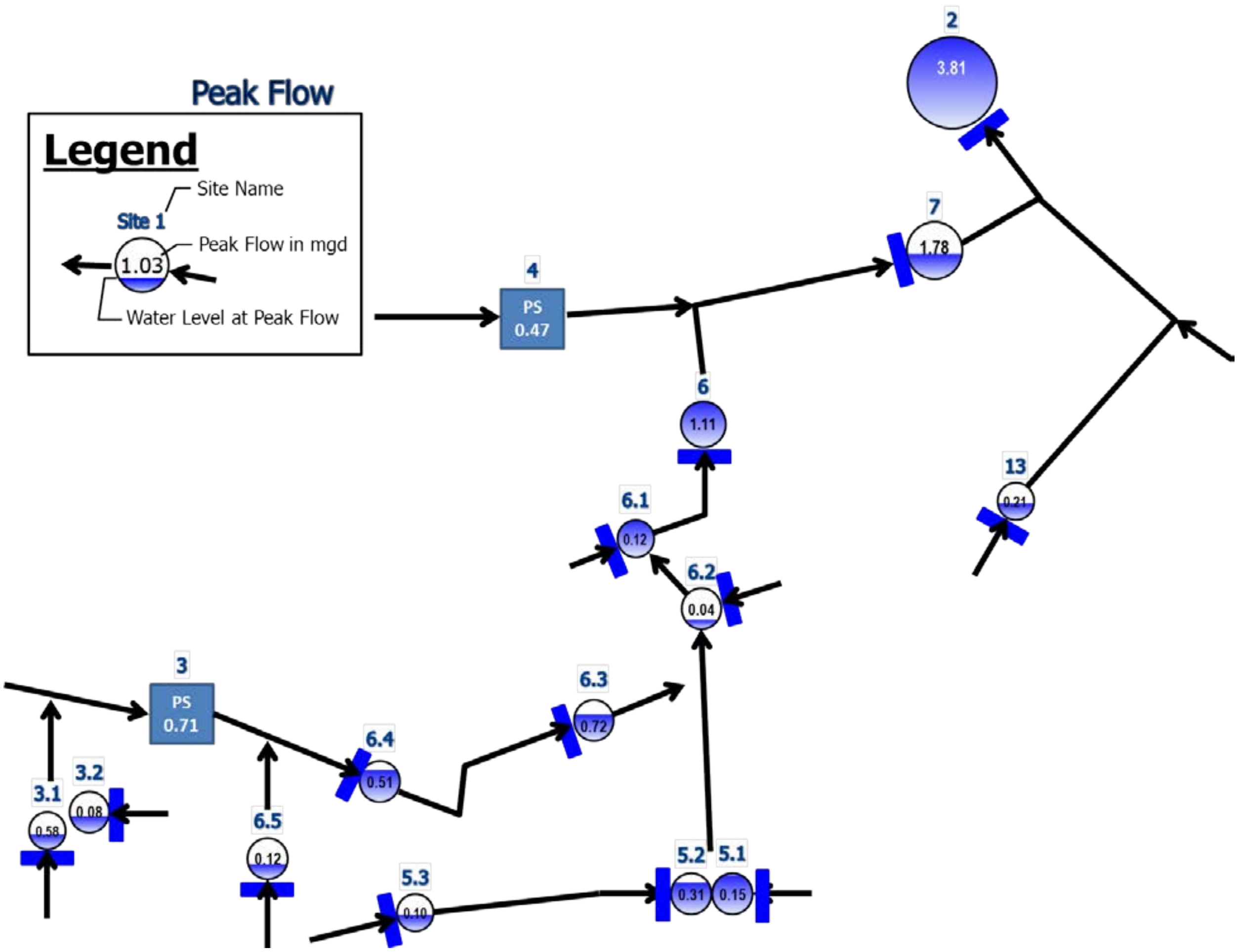


Figure 4-8. Peak Measured Flow Schematic (Phase 2)

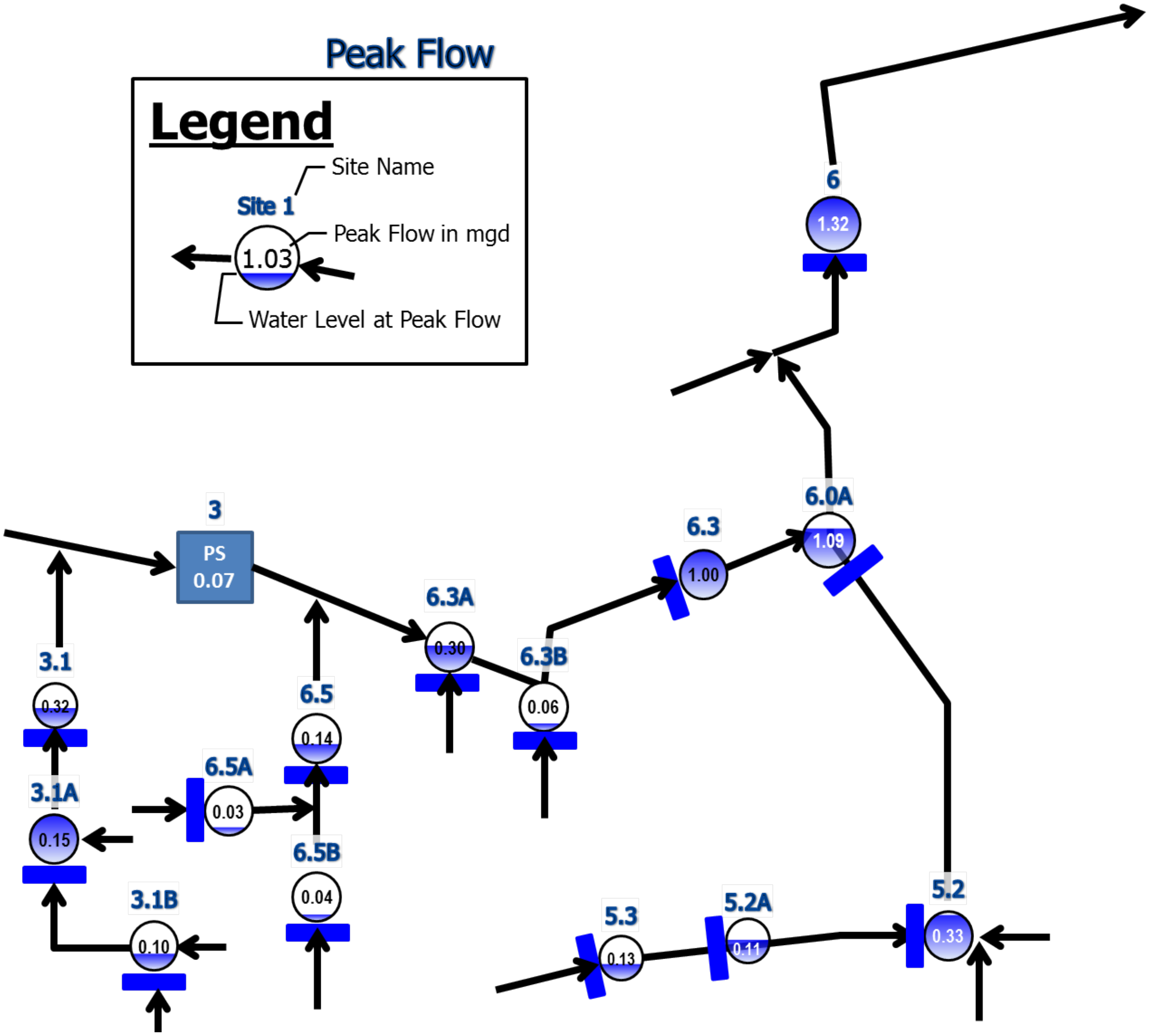


Figure 4-9. Peak Measured Flow Schematic (Phase 3)

5.0 Phase 1 I/I Results

5.1 Preface

The original 16 flow monitoring basins were illustrated in Figure 1-4. The following items are noted regarding the early-season analysis:

- Results are presented on a basin-by-basin basis (not a site-by-site basis).
- Results are for the original 15 basins only (Basin 12 excluded).
- Results presented to the City during the early-season were considered preliminary and based upon the information known at the time of presentation.
- Results presented in the following pages of analyses have been updated from the initial presentation to reflect final data and results; values may be different from the initial presentation; however, the conclusions and recommendations are the same.

5.2 Inflow Analysis

Inflow sources transport rain water *directly* into the sewer system; the corresponding inflow rates are tied closely to the intensity of the storm. This component of RDI/I often causes a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows.

Figure 5-1 illustrates the I/I response curve for Basin 3 and Storm Event 1 as it relates to peak I/I rate.

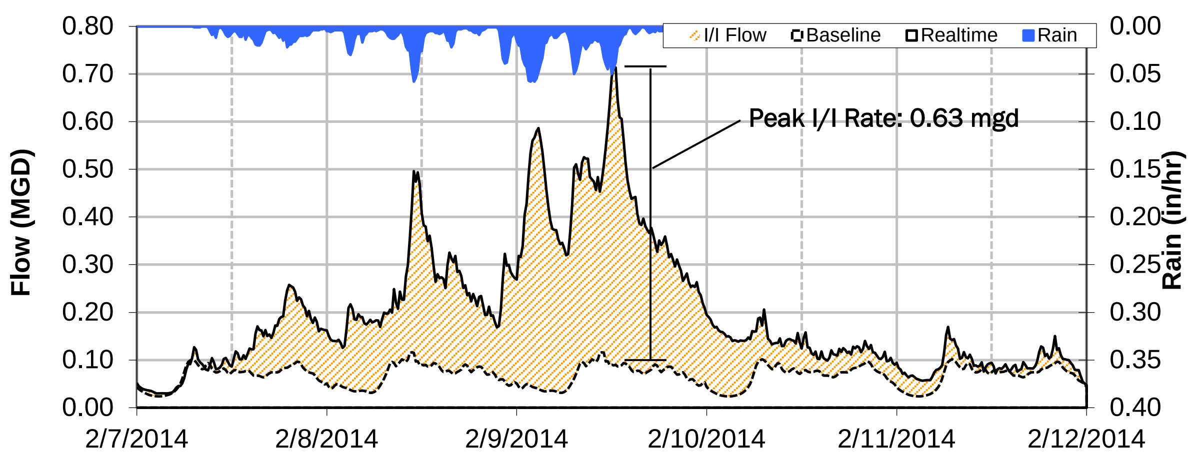


Figure 5-1. I/I Isolation Curve, Basin 3 (Inflow Measurement)

Table 5-1 summarizes the peak measured I/I flows and inflow analysis results for the Phase 1 basins for Storm Event 1 (refer to the *Methods* section for more information on inflow analysis methods). The peak I/I rate was normalized by three different methods: length of pipe (IDM), basin area (acres) and sewerage contribution (ADWF). Basins that ranked in the top 5 have been color coded red. Figure 5-2 illustrates a temperature map summary of the inflow analysis results per basin.

Table 5-1. Inflow Analysis Summary, Large Basins

Basin	ADWF (mgd)	Peak I/I Rate (mgd)	Peak I/I per IDM (gpd/IDM)	Peak I/I per ACRE (gpd/AC)	Peak I/I per ADWF Ratio	Inflow Ranking
Basin 3	0.067	0.63	123,000	15,700	9.34	1
Basin 4	0.129	0.28	22,000	4,800	2.16	11
Basin 5	0.019	0.64	62,000	9,000	33.50	4
Basin 6	0.090	0.14	11,000	1,100	1.57	13
Basin 7	0.058	0.66	56,000	16,100	11.34	6
Basin 8	0.007	0.02	3,000	400	3.06	12
Basin 9	0.004	0.30	60,000	10,700	67.75	2
Basin 10	0.085	0.26	22,000	4,200	3.05	10
Basin 11	0.017	0.51	49,000	9,800	29.38	7
Basin 13	0.056	0.16	50,000	9,400	2.86	8
Basin 14	0.042	0.30	47,000	8,100	7.17	9
Basin 15	0.015	0.21	58,000	13,100	13.91	5
Basin 16	0.086	0.58	121,000	48,300	6.78	3

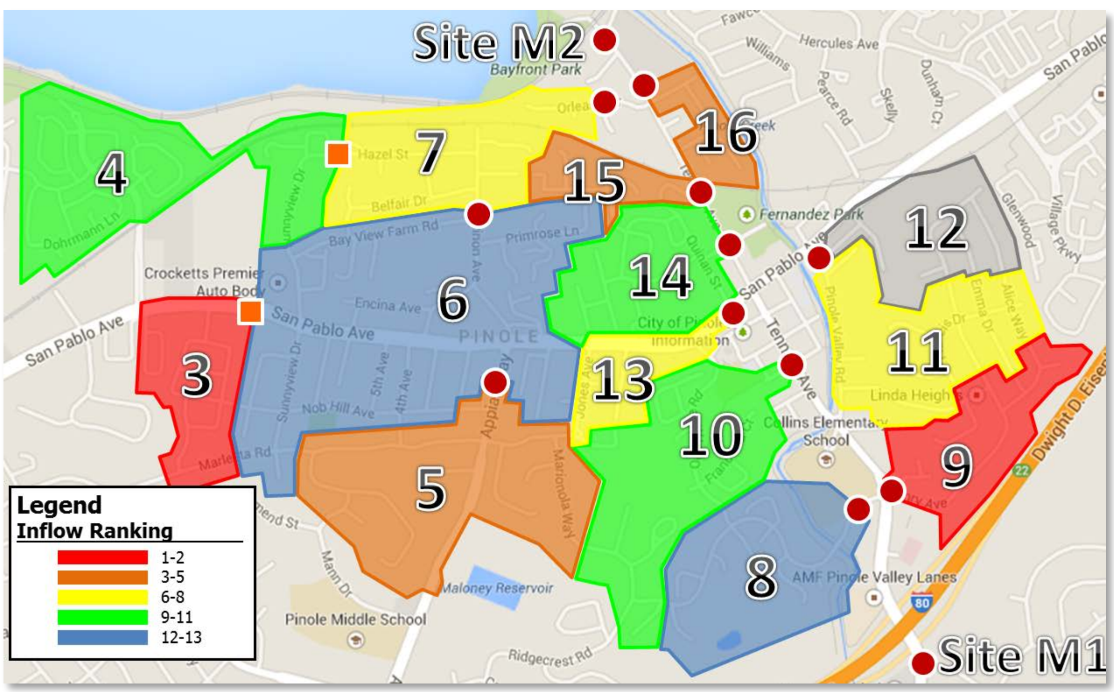


Figure 5-2. Phase 1 Inflow Temperature Map

5.3 Combined I/I Analysis

Combined I/I analysis considers the totalized volume (in gallons) of both inflow and rainfall-dependent infiltration over the course of a storm event. For example, the total volume of infiltration and inflow into Basin 3 for the February 7 - 12, 2014 storm event calculated out to 670,000 gallons (hatched area below in Figure 5-3).

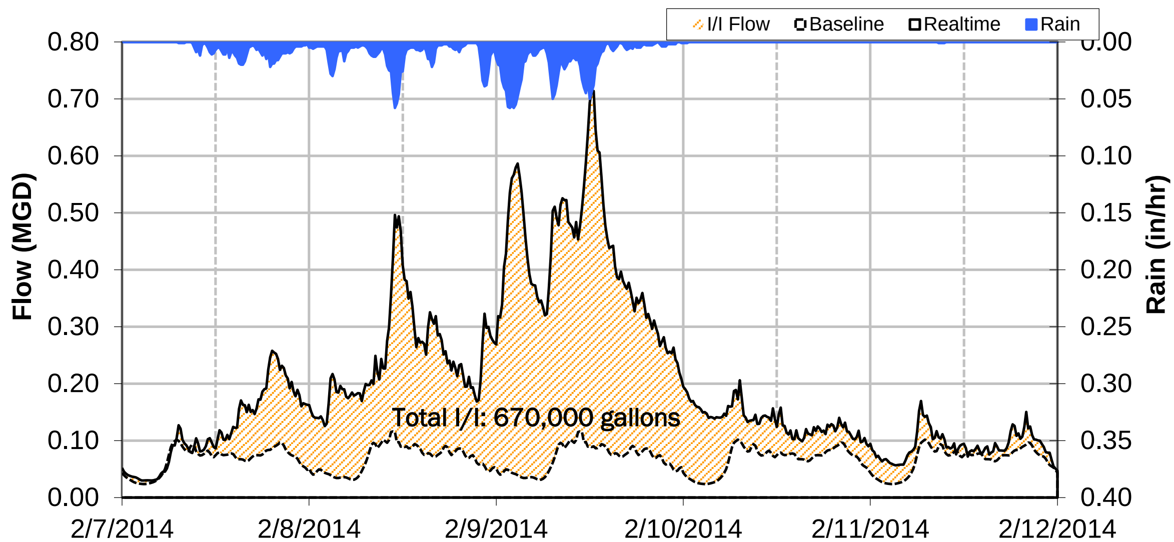


Figure 5-3. I/I Isolation Curve, Basin 3 (Combined I/I Measurement)

Table 5-2 summarizes the combined I/I analysis results for the large basins. Figure 5-4 illustrates a temperature map of the basin rankings for combined I/I.

Table 5-2. Combined I/I Analysis Summary, Large Basins

Basin	ADWF (mgd)	Total I/I (gallons)	Total I/I per IDM	R-Value (per Acre)	Total I/I per ADWF	Combined I/I Ranking
Basin 3	0.067	670,000	109,000	19.0%	3.07	5
Basin 4	0.129	355,000	8,000	6.9%	0.85	11
Basin 5	0.019	570,000	17,000	9.1%	9.17	4
Basin 6	0.090	560,000	27,000	4.9%	1.90	9
Basin 7	0.058	200,000	5,000	5.5%	1.05	10
Basin 8	0.007	1,000	0	0.0%	0.05	13
Basin 9	0.004	76,000	5,000	3.1%	5.27	7
Basin 10	0.085	291,000	8,000	5.3%	1.05	12
Basin 11	0.017	594,000	17,000	12.9%	10.51	1
Basin 13	0.056	214,000	21,000	14.2%	1.18	8
Basin 14	0.042	412,000	20,000	12.6%	3.02	6
Basin 15	0.015	205,000	17,000	14.5%	4.17	3
Basin 16	0.086	858,000	55,000	80.9%	3.08	2

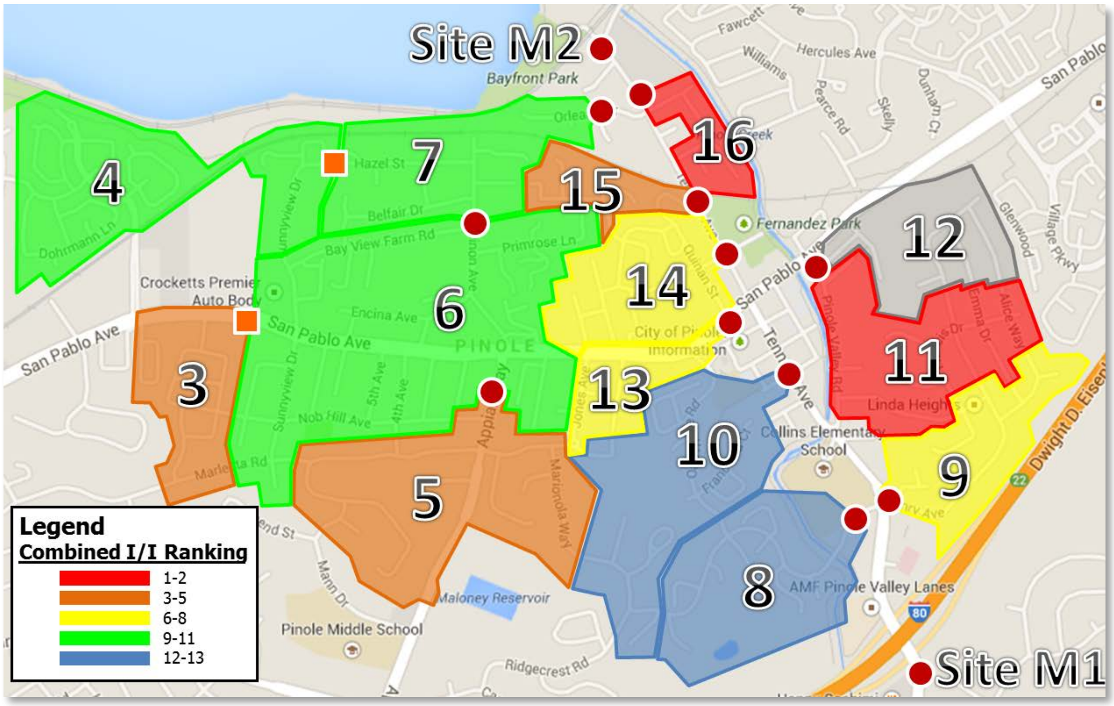


Figure 5-4. Phase 1 Combined I/I Temperature Map

5.4 Phase 1 Summary

On February 20, 2014, V&A met with the City to discuss the Phase 1 findings. At the time of the discussion, peak I/I to ADWF ratios and total combined I/I contribution were main topics of discussion, presented in the format of I/I response curves per each monitoring site (similar to Figure 5-1). The following bullet items highlight important topics of discussion between V&A and the City:

- **Basin 3:** The City cited historical data and field observations regarding known I/I issues within Basin 3.
- **Basin 5:** V&A recommended investigating Basin 5 due to the high peak I/I ratios and high combined I/I totals.
- **Basin 6:** There is a known capacity issue one manhole upstream from the Basin 6 monitoring location.
- **Basin 8:** This is a newer area of the City and this area had minimal I/I contribution.
- **Basin 9:** The flow meter was not in an ideal location for monitoring. The consensus was that the response for Basin 9 was real and considerable but the magnitude may not be correct due to metering conditions.
- **Basin 11:** This location had significant peak I/I rates and combined I/I totals.

- **Basin 12:** The metering manhole for this basin surcharged with evidence that the surcharge was close to an SSO.
- **Basins 15/16:** Both basins were noted for generally high I/I rates and total I/I contribution.
- **Old Henry Road:** The City cited the age of the sewer system along Old Henry Road and noted this correlation to the high I/I rates within Basins 9, 11 and 12.

5.4.1 Conclusions

Final group conclusions were as follows:

- Focus the Phase 2 monitoring within Basins 3, 5 and 6.
  - The focus of the study moving forward would be to spend the remainder of the 2014 wet weather season identifying smaller high I/I mini-basins within this region for possible future CIP work.
  - Identifying areas of I/I reduction may help to solve two problems within the City: (1) severe flows observed in Basin 3 (San Pablo Pump Station), and (2) capacity issues observed at the manhole at the intersection of Pinon Avenue and Bay View Farm Road.
- Make note of the 'Old Henry Road' Basins as future candidates for a focused flow monitoring and I/I study.

5.4.2 Actions

Future actions for Phase 2 included the following:

- Remove ten flow meters from the following sites: M1, M5, M8 – M16.
- Utilize the ten available flow meters to further analyze and gather data on the high I/I basins as follows:
  - Basin 3: Sub-divide into two basins (3.1 and 3.2) and perform Phase 2 flow monitoring.
  - Basin 5: Sub-divide into three basins (5.1, 5.2 and 5.3) and perform Phase 2 flow monitoring.
  - Basin 6: Sub-divide into five basins (6.1, 6.2, 6.3, 6.4 and 6.5) and perform Phase 2 flow monitoring.

6.0 PHASE 2 I/I RESULTS

6.1 Preface

The Phase 2 flow monitoring occurred from February 26, 2014 through March 6, 2014. The ten flow monitoring sub-basins designated for the Phase 2 analysis are illustrated in Figure 1-5. The following items are noted regarding the early-season analysis:

- Results are presented on a basin-by-basin basis (not a site-by-site basis).
- Results are for the ten Phase 2 basins only.
- Results presented to the City during Phase 2 were considered preliminary and based upon the information known at the time of presentation.
- Results presented in the following pages of analyses have been updated from initial presentation to reflect final data and results. The values presented in this report will differ from the initial presentation; however, the conclusions and recommendations are the same.

6.2 I/I Summary of Results

V&A performed flow monitoring and I/I analysis similar to Phase 1. Figure 6-1 shows the I/I response curve for Basin 3.1.

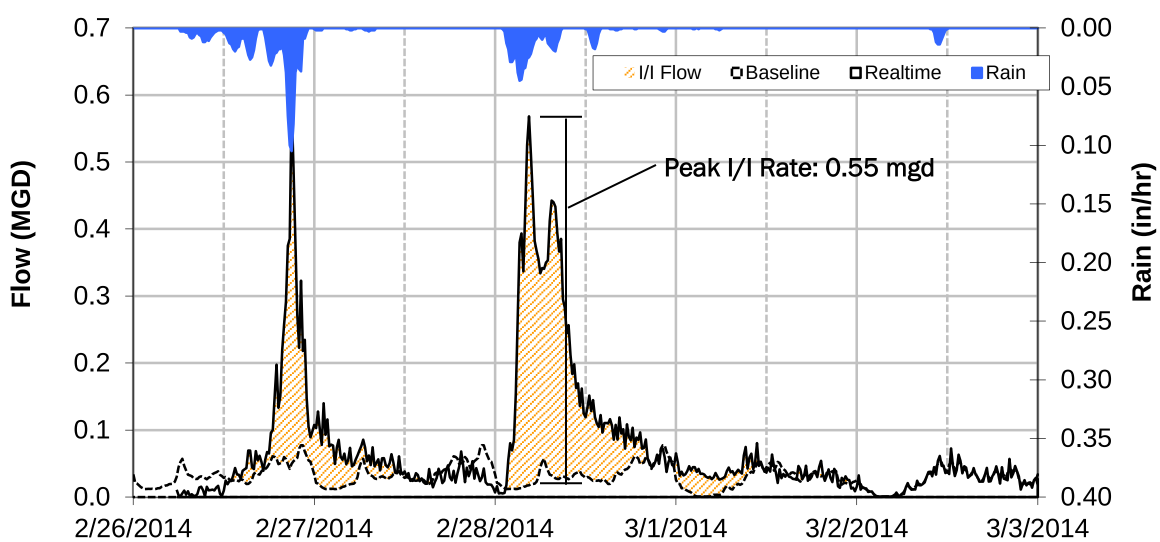


Figure 6-1. Peak I/I Rate, Basin 3.1 (Event 2)

Table 6-1 summarizes the peak measured I/I flows and inflow analysis results for the Phase 2 basins for Storm Event 2. Basins that ranked in the top 5 have been color coded red. Figure 6-2 illustrates a temperature map summary of the inflow analysis results per basin.

Table 6-1. Phase 2 Inflow Analysis Summary

Basin	ADWF (mgd)	Peak I/I Rate (mgd)	Peak I/I per IDM (gpd/IDM)	Peak I/I per ACRE (gpd/AC)	Peak I/I per ADWF Ratio	Inflow Ranking
Basin 3.1	0.032	0.55	265,700	34,400	17.3	2
Basin 3.2	0.011	0.06	52,600	10,000	5.7	5
Basin 5.1	0.023	0.12	35,900	5,200	5.2	6
Basin 5.2	0.011	0.23	171,600	25,600	20.9	1
Basin 5.3	0.022	0.08	24,600	2,800	3.6	8
Basin 6.1	0.011	0.10	41,500	7,700	8.9	4
Basin 6.2	0.016	0.03	9,000	2,300	1.9	9
Basin 6.3	0.079	0.04	14,900	1,000	0.5	10
Basin 6.4	0.008	0.03	28,000	2,300	3.7	7
Basin 6.5	0.009	0.11	31,400	6,500	12.6	3

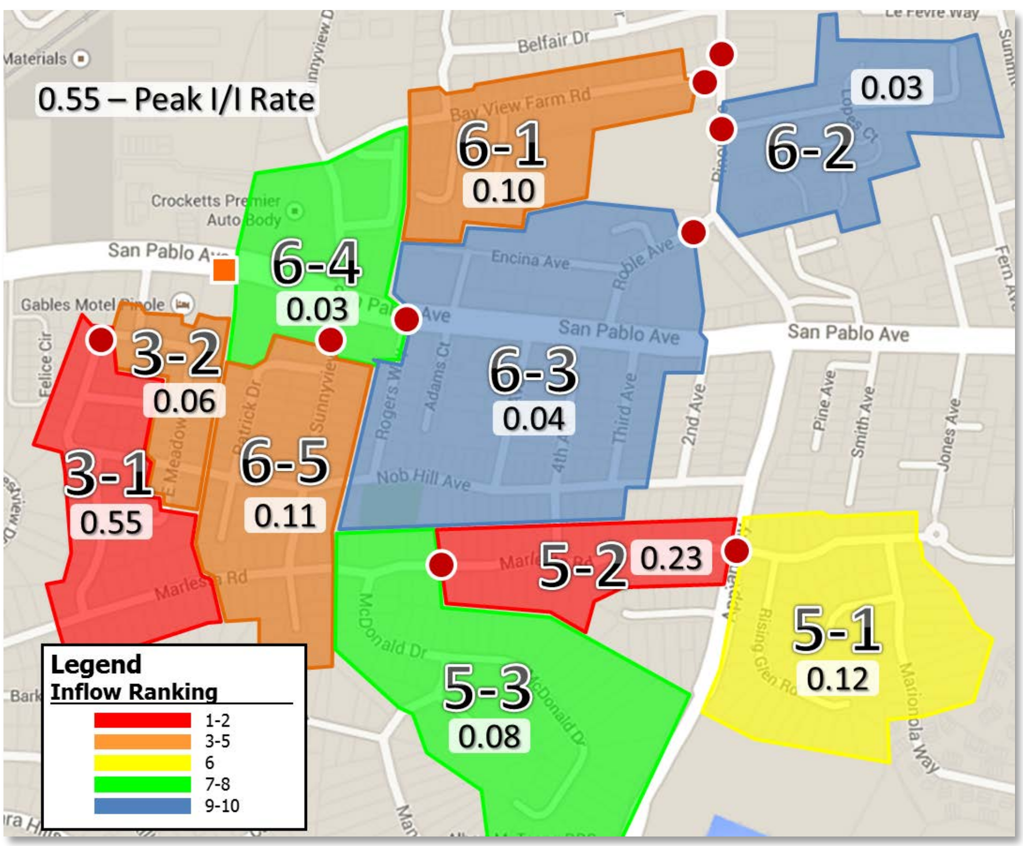


Figure 6-2. Phase 2 Inflow Analysis Temperature Map

6.3 Phase 2 Summary

On March 18, 2014, V&A met with the City to discuss the Phase 2 findings. At the time of the discussion, the measured peak I/I rates were the main topics of discussion, presented in the format of I/I response curves per each monitoring site. The following bullet items highlight important topics of discussion between V&A and the City:

- **Basin 3.1/Basin 3.2:** Basin 3.1 had significantly more peak I/I than Basin 3.2. Basin 3.1 had 0.55 mgd of peak I/I flow occurring within only approximately 2,700 lineal feet of pipe.
  - Rehabilitating the 2,700 lineal feet of pipe is a realistic CIP project that can have significant impact at the treatment plant. For Storm Event 2, at the treatment plant, there was approximately 2.47 mgd of peak I/I. Though not a perfect comparison due to attenuation and holding times within the collection system, 0.55 mgd peak inflow from Basin 3.1 is approximately 22% of the 2.47 mgd peak inflow measured from the City of Pinole for Storm Event 2.
- **Basin 5.2** and **Basin 6.5** also had high peak I/I rates.
- The City was interested in obtaining the percentage volume of flow contribution at the intersection of Roble Avenue and Appian Way where two main sewers combine.
- **Basin 6.3:** The City was interested in directly monitoring flows in the numbered streets if possible (2nd Avenue to 5th Avenue).

6.3.1 Recommendations

Final group recommendations were as follows:

- Focus the Phase 3 monitoring within Basins 3.1, 5.2 and 6.5 for focused I/I analysis.
- Monitor the Roble/Appian junction and capture the sewerage basins for Third Avenue and 5th Avenue.

6.3.2 Actions

- Remove seven flow meters from the following sites: M3.2, M5.1, M6.1, M6.2, M6.4, M7 and M13.
- Utilize the seven available flow meters plus one extra meter to further analyze and gather data on the high I/I basins as follows:
  - **Basin 3.1:** Sub-divide into three basins (3.1, 3.1A, 3.1B) for Phase 3 flow monitoring.
  - **Basin 5.2:** Sub-divide into three basins (5.2, 5.2A and 5-3) for Phase 3 flow monitoring.
  - **Basin 6.3:** Sub-divide into three basins (6.3, 6.3A and 6.3B) for Phase 3 flow monitoring.
  - **Basin 6.5:** Sub-divide into three basins (6.5, 6.5A and 6.5B) for Phase 3 flow monitoring.

7.0 Phase 3 I/I Results

7.1 Preface

The 13 flow monitoring sub-basins designated after the Phase 2 analysis are illustrated in Figure 1-6. The following items are noted regarding the early-season analysis:

- Results are presented on a basin-by-basin basis (not a site-by-site basis).
- Results are for the 13 Phase 3 basins only.
- Results presented to the City during Phase 3 were considered preliminary and based upon the information known at the time of presentation.
- Results presented in the following pages of analyses have been updated from the initial presentation to reflect final data and results. The results may differ from the initial presentation; however, the conclusions and recommendations are the same.

7.2 I/I Summary of Results

V&A performed flow monitoring and I/I analysis similar to Phase 1 and Phase 2. Figure 7-1 shows the I/I response curve for Basin 3.1A

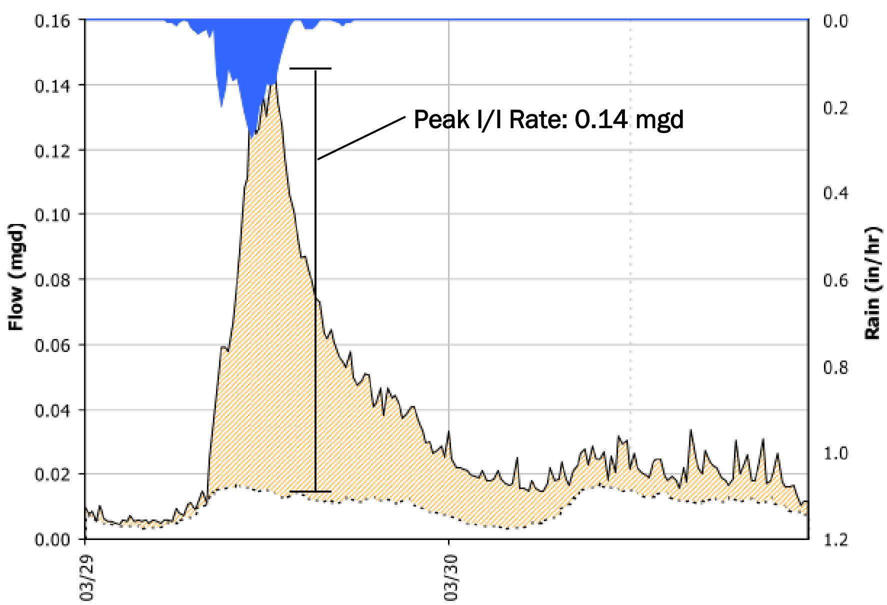


Figure 7-1. Peak I/I Rate, Basin 3.1A (Event 3)

Table 7-1 summarizes the peak measured I/I flows and inflow analysis results for the Phase 3 basins for Storm Event 3. Basins that ranked in the top 5 have been color coded red. Figure 7-2 illustrates a temperature map summary of the inflow analysis results per basin.

Table 7-1. Phase 3 Inflow Analysis Summary

Basin	ADWF (mgd)	Peak I/I Rate (mgd)	Peak I/I per IDM (gpd/IDM)	Peak I/I per ACRE (gpd/AC)	Peak I/I per ADWF Ratio	Inflow Ranking
Basin M3.1	0.0036	0.168	243,600	54,200	46.6	3
Basin M3.1A	0.0038	0.044	66,000	18,400	11.7	7
Basin M3.1B	0.0057	0.087	47,700	8,600	15.2	8
Basin M5.2	0.0025	0.220	292,700	61,000	89.3	1
Basin M5.2A	0.0016	0.000	0	0	0	13
Basin M5.3	0.0074	0.115	33,500	4,000	15.6	10
Basin M6.0A	0.0459	0.703	69,300	12,700	15.3	6
Basin M6.3	0.0146	0.283	52,500	7,800	19.4	5
Basin M6.3A	0.0049	0.295	304,100	38,800	60.0	2
Basin M6.3B	0.0036	0.052	37,600	8,800	14.5	9
Basin M6.5	0.0016	0.068	80,600	20,100	41.8	4
Basin M6.5A	0.0029	0.028	20,400	4,300	9.4	12
Basin M6.5B	0.0033	0.034	25,800	4,700	10.4	11

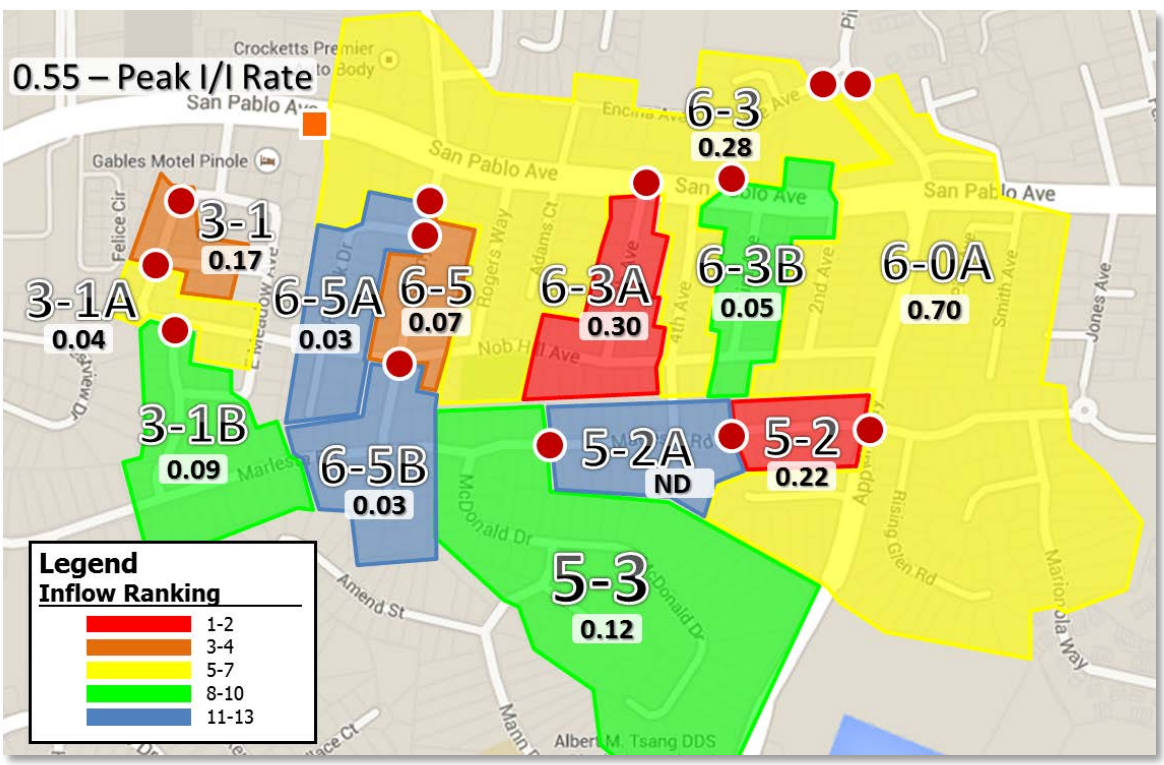


Figure 7-2. Phase 3 Inflow Analysis Temperature Map

7.3 Phase 3 Summary

On April 15, 2014, V&A met with the City to discuss the Phase 3 findings. The following bullet items highlight important topics of discussion between V&A and the City:

- **Basin 3.1:** Basin 3.1 had previously been broken into three parts in order to refine the potential location for the high rates of inflow.
  - The high rates of inflow were once more confirmed in Basin 3.1. Basin 3.1 had the highest rate of inflow amongst the three Basin 3.1 meters (3.1, 3.1A and 3.1B)
- **Basin 5.2:** Previously, Basin 5.2 had very high rates of inflow for a relatively small service area. This basin was divided approximately in half to further refine the problem area.
  - Of the two sub-basins (5.2 and 5.2A), Basin 5.2 had the vast majority of I/I.
- **Basin 6.5:** During Phase 2, Basin 6.5 was one of the two highest ranked basins. This was divided into three sub-basins (6.5, 6.5A and 6.5B).
  - Basin 6.5 had the highest rate of inflow
- **Basin 6.3A:** The rate of inflow observed in Basin 6.3A was higher than expected.

8.0 RECOMMENDATIONS

V&A advises that future I/I reduction plans consider the following recommendations:

1. **Potential CIP Projects for I/I Mitigation and Reduction**
   a. The City should conduct I/I mitigation and reduction measures in the following mini-basins:
      i. Basin 3-1
      ii. Basin 3-1A
      iii. Basin 5-2
      iv. Basin 6-3A
      v. Basin 6-5

   b. For I/I reduction, V&A recommends rehabilitation of the sewer mains, laterals and side sewers.
      i. The most comprehensive study on the percent of I/I reduction has been conducted by King County, *Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report*. This study confirmed the popular theory that over 50% of infiltration and inflow enters from private lateral connections. The report also makes the following recommendations for I/I mitigation:
         (a) CCTV work is best performed during a rainfall event after groundwater levels have begun to rise, allowing visual confirmation of specific I/I entry points, including determining the source of potential lateral I/I source. A generally consistent deficiency was observed with regards to the joint conditions in the laterals and side sewers.
         (b) Rehabilitation of sewer mains, manholes, laterals and side sewers results in approximately 80% reduction of I/I.
2. **Future I/I Identification – Continued Sub-Basin Flow Monitoring and I/I Analysis:** V&A recommends that the City continue to locate and mitigate potential sources of I/I. Already identified as known contributing sub-basins with high volumes of I/I are Basins 9, 11, 12, 14 and 15. It is possible that a study similar to this study may identify CIP projects that can significantly reduce the overall I/I within the City collection system.
3. **Other I/I Investigation Methods:** Potential other I/I investigation methods include the following:
   a. Smoke testing
   b. Night-time reconnaissance work to (1) investigate and determine direct point sources of inflow, and (2) determine the areas and pipe reaches responsible for high levels of infiltration contribution.
4. **I/I Reduction Cost Effectiveness Analysis:** The City should conduct a study to determine which is more cost-effective: (1) locating the sources of inflow/infiltration and systematically rehabilitating or replacing the faulty pipelines; or (2) continued treatment of the additional rainfall dependent I/I flow.

Appendix A. Additional Analysis Request: Flow Split between M6.0A and M6.3

A.1 Flow Split between M6.0A and M6

As a part of Phase 3, the City asked that the flow split between Sites M6.0A and M6.3 be monitored. Site M6.0A monitored a 10-inch line running southwest along Pinon Ave that gathers flow from Basin 5 (Phase 1) as well as the area near the intersection of Appian Way and San Pablo Ave. Site M6.3 monitors an 8-inch line that gathers flow from Basin 3, Basin 6.5, Basin 6.4 and Basin 6.3. The flows from these two sites eventually travel through Site M6.

The average and peak flow splits for the two sites are illustrated in Figure A-1 and Figure A-2.

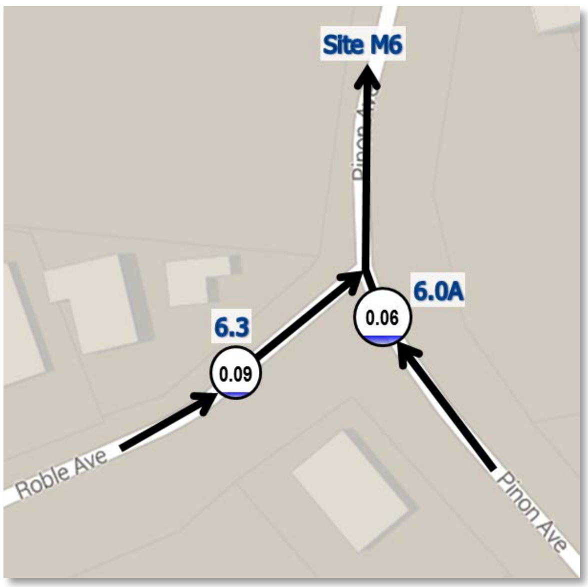


Figure A-1. ADWF Split for Site M6.3 and M6.0A

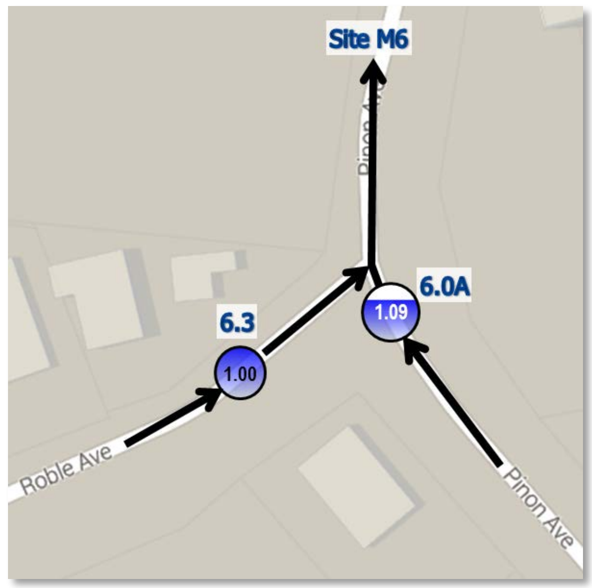


Figure A-2. Peak Flow Split for Site M6.3 and M6.0A

The split in flows between the two lines was approximately 40% for Site M6.0A and 60% for Site M6.3 for Average Dry Weather Flow.

The split in flows between the two lines was approximately 52% for Site M6.0A and 48% for Site M6.3 for Peak Flow during Storm Event 3.

Appendix B. Additional Analysis Request: Treatment Plant Inflow Contribution

B.1 Treatment Plant Inflow Contribution

The City of Pinole shares ownership of the Wastewater Treatment Plant with the City of Hercules. One aspect that is currently not addressed between the cities is the cost of treating the rainfall that falls on the footprint of the treatment plant itself.

The footprint of the treatment plant (Figure B-3) is approximately 228,300 ft^2 (5.28 acres). This equates to 142,300 gallons per inch of rain that falls. The City of Pinole averages approximately 20.25 inches of rain per year. With the drainage on the treatment plant property, the majority of this rainfall would flow into the treatment process. In total, this results in approximately 2,880,000 gallons of rainfall that is treated by the treatment facility each year.

Figure B-3. Footprint of City of Pinole Wastewater Treatment Plant

Appendix C. Additional Analysis Request: Comparison of Sanitary Sewer Flows from City of Pinole, City of Hercules, and the Pinole/ Hercules Wastewater Treatment Plant

This request was processed and submitted as a separate Technical Memorandum, but included within Appendix C as follows.

TECHNICAL MEMORANDUM

COMPARISON OF SANITARY SEWER FLOWS FROM CITY OF PINOLE, CITY OF HERCULES, AND THE PINOLE/HERCULES WASTEWATER TREATMENT PLANT

Prepared for: Dean Allison, P.E., City of Pinole

Prepared by: Kevin Krajewski, P.E., V&A Consulting Engineers

Reviewed by: Oliver Pohl, P.E., V&A Consulting Engineers
Glenn Willson, P.E., V&A Consulting Engineers

V&A

Date: February 23, 2015

V&A Project No.: 13-0276

1.0 INTRODUCTION

The Pinole/Hercules Wastewater Treatment Plant treats sanitary sewage flow from both the City of Pinole and the City of Hercules. Presently, the Hercules flows are measured directly through a Parshall flume located at the treatment plant. Pinole flows are measured using two methods:

- **Method 1:** Indirect measurement by subtracting the Hercules flows from the totalized treatment plant effluent flows, monitored at an effluent weir structure. This method has traditionally been the primary method for determining flows from the City of Pinole.
- **Method 2:** Direct measurement using a Hach FloDar flow meter located on the 30-inch line on Tennant Avenue as it enters into the treatment facility. This 30-inch line captures the entirety of the sanitary sewer waste from the City of Pinole collection system.

V&A Consulting Engineers (V&A) was retained by the City of Pinole (City) to compare both methods of flow calculation to temporary flow monitoring conducted on the 30-inch line on Tennent Avenue, just east of the railroad tracks, approximately 240 feet upstream from the City Influent Meter. The 30-inch line captures the entirety of the sanitary sewer waste from the City of Pinole collection system.

Flows from the Influent, Hercules and Effluent meters were provided by the City. V&A was provided two different types of data sets from the influent (FloDar) meter:

- **Data Set 1:** The City provided 15-minute interval data for the Influent flow meter from November 1 through December 10, 2014.
- **Data Set 2:** V&A accessed the flow meter directly and was able to retrieve five days of 1-minute interval data from January 18 to 23, 2015.

These data sets were analyzed separately and for different purposes that will be outlined later in this report.

V&A was initially retained by the City to perform sanitary sewer flow monitoring during the 2013/2014 wet weather season as part of the City's efforts to reduce inflow and infiltration (I/I) within the City collection system. Through the 2014 summer months, V&A maintained the flow meter that was already installed on Tennent Avenue. This work was performed under the same contract as the 2013/2014 Flow Monitoring and I/I Analysis work.

Figure 1-1 illustrates a map of the treatment plant and the Pinole and Hercules trunk sewer lines.

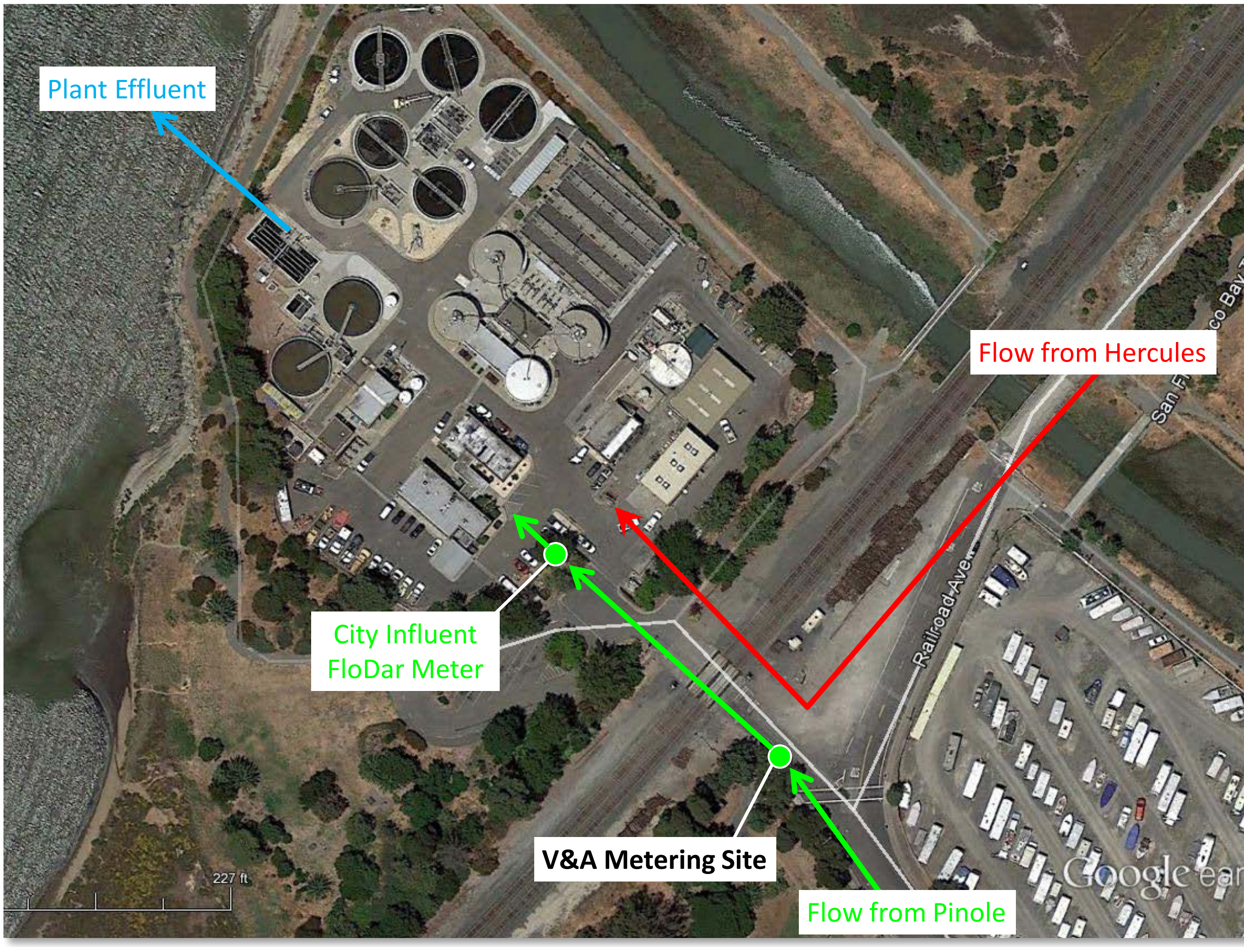


Figure 1-1. Map of Pinole/Hercules Treatment Plant, Contributing Flows

2.0 METHOD 1 ANALYSIS (EFFLUENT LESS HERCULES)

2.1 Review of Validity of City Data for Analysis

The City provided 15-minute interval data for the Hercules Parshall flume and for the treatment plant effluent from June 14, 2014 to September 25, 2014. V&A performed a cursory QA/QC on the data provided. The data from June 14 through July 20, 2014 appeared to have been reported correctly and is considered as valid data sets for comparison. From July 21, 2014 forward, there were only a few valid data points for each data set per day, resulting in several "flat-lines" or repeated values in the data sets, illustrated in Figure 2-1.

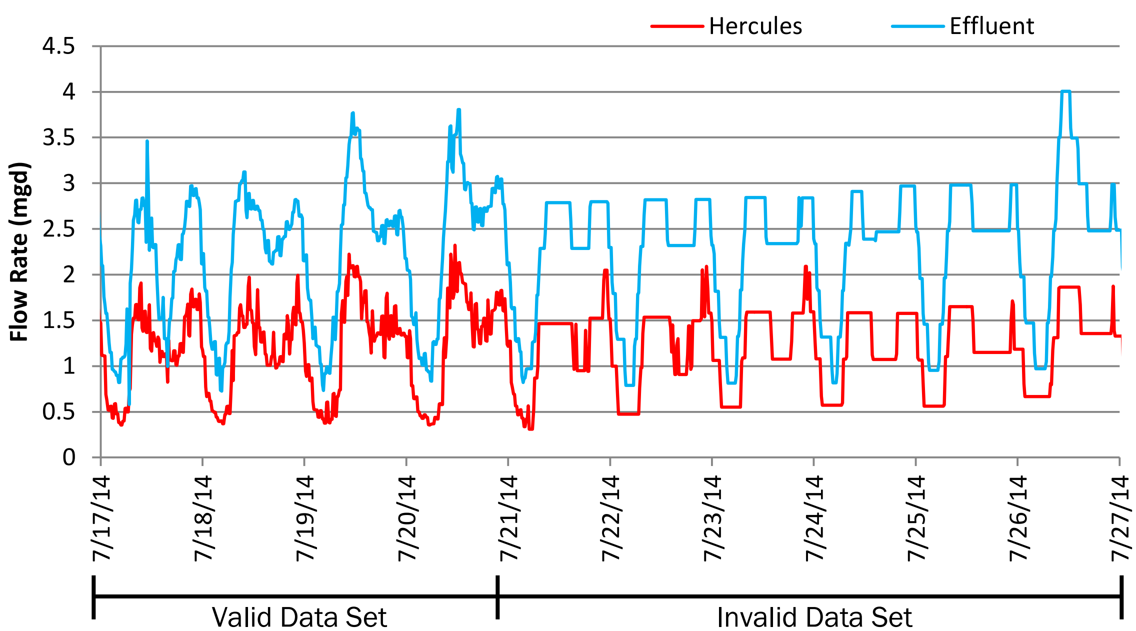


Figure 2-1. Hercules and Effluent Flow Data, 7/17/2014 – 7/27/2014

For Method 1 Flows, the data from July 21 forward was not considered valid for comparison for the purposes of this study.

2.2 Micro Analysis

V&A first looked at the data at the 15-minute data interval level. Though the City does not report totalized flows at this interval level; however, analyzing the data on a micro level may lend confidence or provide valuable information as to the operational viability of the metering methods currently in use. Figure 2-2 shows a graph of the flow monitoring data sets evaluated for this study. The purple line labeled "Pinole+Hercules" is simply a sum of the directly monitored values for Pinole and Hercules and is intended to be shown as a direct comparison to the Effluent data.

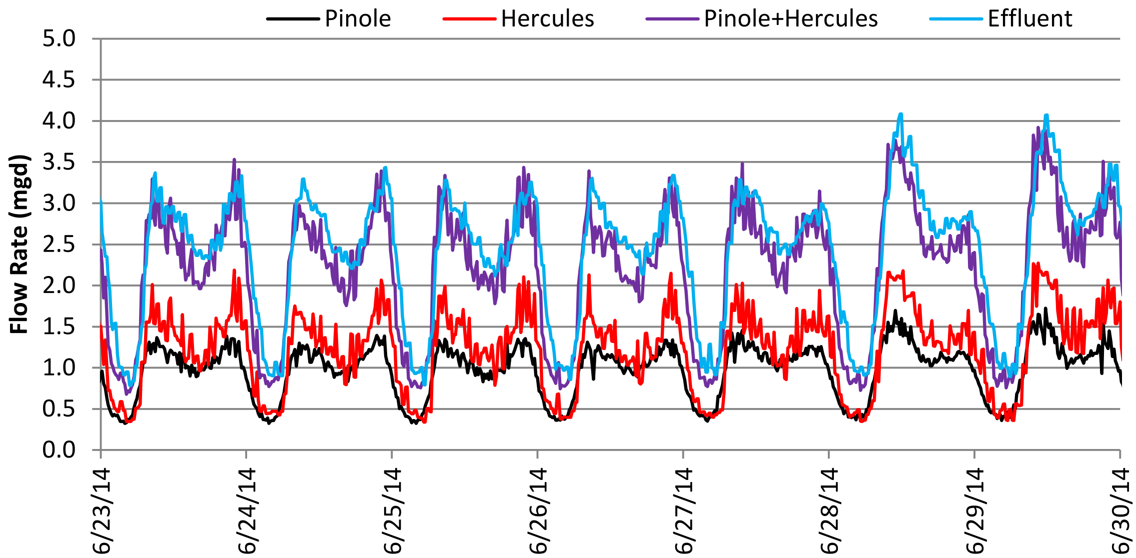


Figure 2-2. Hercules and Effluent Flow Data, 6/23/2014 – 6/30/2014

It is noted that the Effluent flows undergo some degree of attenuation; there is detention time in between the influent and effluent stages of the treatment process. The following items are noted: analysis:

- The Effluent flow data and the sum of the directly monitored data sets ("Pinole + Hercules") match each other well in terms of magnitude and range.
- When operating correctly, the diurnal curves and trends of the flow data from the Hercules Parshall flume and the Effluent Weir appear to provide solid and repeatable data.

2.3 Macro Analysis

Flow data was analyzed on a day-by-day basis to determine the estimated difference in the calculated flow for Pinole (present method -- Effluent less Hercules) versus the measured flows per the V&A flow monitoring conducted on the 30-inch trunk sewer on Tennent Avenue. Table 2-1 shows the daily flow comparison of the daily calculated flows versus the measured City flows.

Table 2-1. Comparison of Average Daily Flow Rates (Method 1)

Date	Effluent (mgd)	Hercules (mgd)	Method 1 Pinole Flows (Effl – Herc) (mgd)	Pinole Measured (mgd)	% Difference
6/18/2014	2.32	1.17	1.15	0.97	19%
6/19/2014	2.34	1.18	1.16	0.97	19%
6/20/2014	2.39	1.18	1.21	0.98	22%
6/21/2014	2.49	1.30	1.19	0.99	20%
6/22/2014	2.50	1.34	1.16	1.01	14%
6/23/2014	2.37	1.21	1.16	0.96	20%
6/24/2014	2.36	1.19	1.18	0.94	25%
6/25/2014	2.32	1.20	1.12	0.94	19%
6/26/2014	2.33	1.15	1.19	0.94	26%
6/27/2014	2.40	1.20	1.21	1.00	21%
6/28/2014	2.51	1.26	1.25	1.01	24%
6/29/2014	2.59	1.34	1.25	1.02	22%
6/30/2014	2.42	1.21	1.21	0.97	24%
7/1/2014	2.32	1.15	1.17	0.95	23%
7/2/2014	2.30	1.15	1.15	0.97	19%
7/3/2014	2.28	1.16	1.12	0.96	17%
7/4/2014	2.37	1.23	1.15	0.97	18%
7/5/2014	2.32	1.20	1.12	0.99	12%
7/6/2014	2.40	1.26	1.14	1.04	10%
7/7/2014	2.29	1.18	1.11	1.03	8%
7/8/2014	2.27	1.15	1.12	1.02	9%
7/9/2014	2.28	1.18	1.10	1.00	10%
7/10/2014	2.20	1.15	1.05	0.98	7%
7/11/2014	2.24	1.12	1.12	1.00	13%
7/12/2014	2.39	1.27	1.12	1.02	9%
7/13/2014	2.44	1.29	1.15	1.05	10%
7/14/2014	2.33	1.21	1.12	1.03	8%
7/15/2014	2.35	1.18	1.17	0.99	18%
7/16/2014	2.41	1.18	1.22	1.01	21%
7/17/2014	2.02	1.15	0.87	0.98	-11%
7/18/2014	2.22	1.13	1.09	1.00	9%
7/19/2014	2.31	1.24	1.07	1.00	7%
7/20/2014	2.37	1.26	1.11	1.04	7%
Average:	**2.35**	**1.20**	**1.14**	**0.99**	**15.2%**

Note: V&A has no knowledge of the accuracy of the flow data from Hercules and the plant. It is also noted that the industry standard for open-channel flow monitoring is expected to have an accuracy of approximately ±5%.

Method 1 Flow Measurement Summary

Using the Method 1 determination of the City of Pinole flows, the flows for Pinole are over-reported by approximately 15.2%.

3.0 METHOD 2, DATA SET 1

3.1 Review of Validity of City Data for Analysis

Similar to the data sets provided for the Hercules and Effluent flows of the previous section, the data set had many repeated values and flat-lines, illustrated in Figure 3-1.

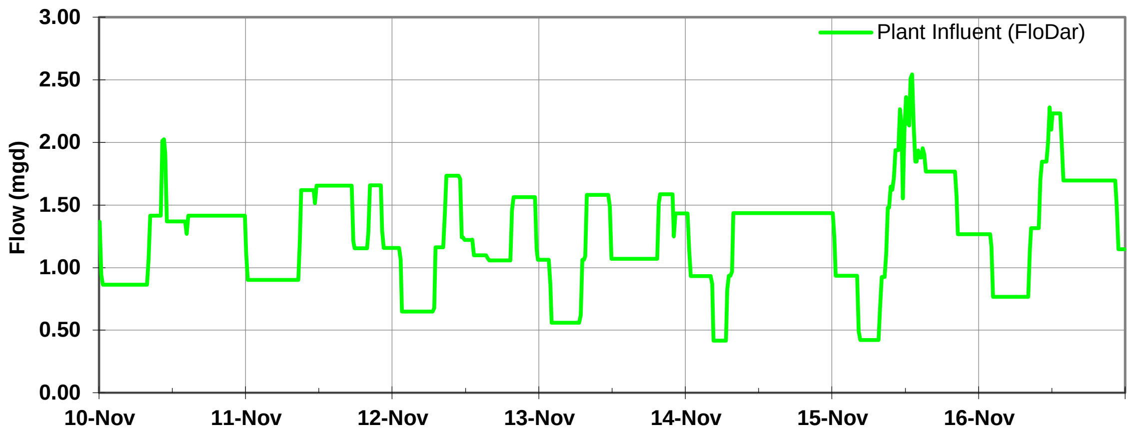


Figure 3-1. Pinole Influent Data, 11/10/2014 – 11/17/2014

Given that the repeated values occurred with all data sets, and occurred for the same date/time stamps for concurrent data sets of different meters, it is believed the repeated values are not an indication of meter failure, but an indication of data storage error within the City SCADA system.

For the purposes of the Method 2, Data Set 1 analysis, V&A assumed that non-repeated data points were valid at the time of the date/time stamp, but that repeated values were not valid data points. Figure 3-2 illustrates an example of valid data points for analysis and direct comparison to the V&A temporary flow meter.

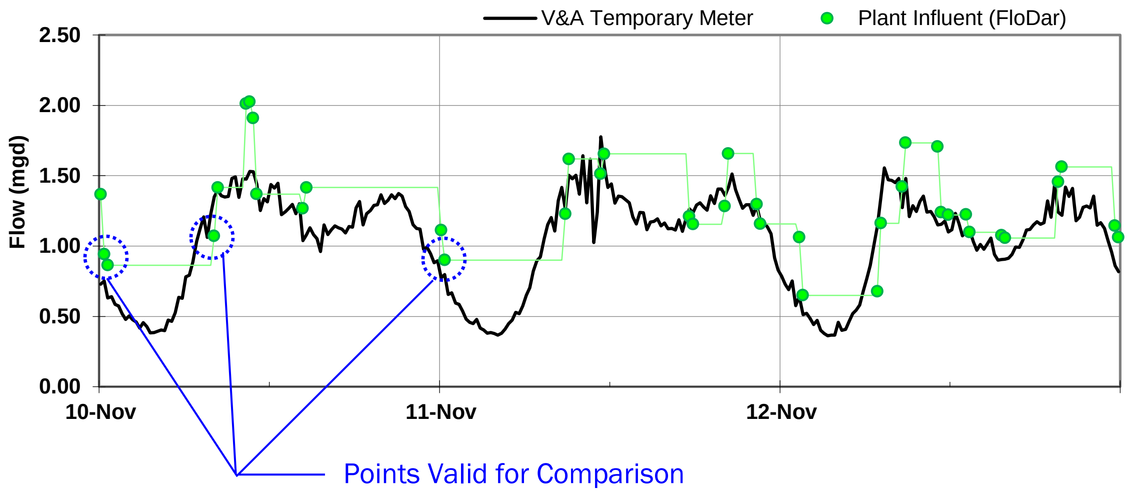
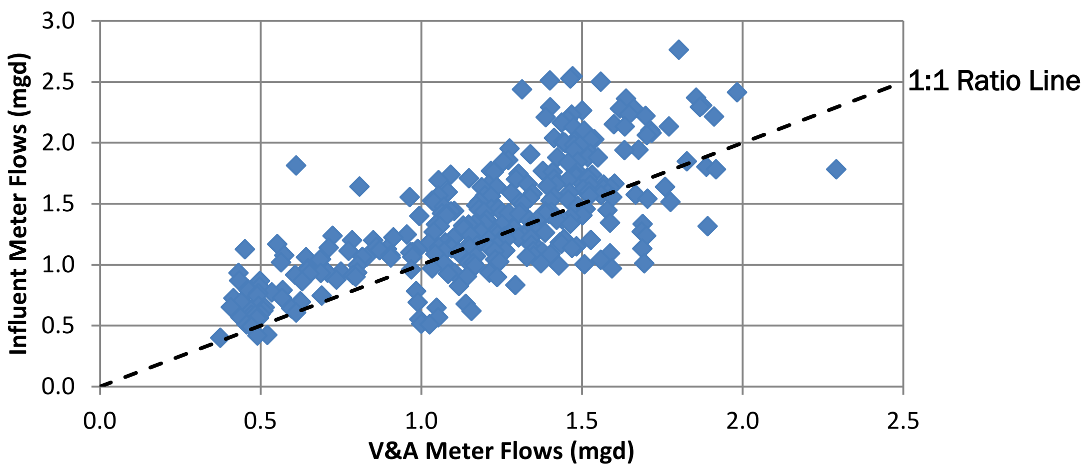


Figure 3-2. Pinole Influent Data, 11/10/2014 – 11/13/2014, Example of Valid Points

3.2 Method 2, Data Set 1 Analysis

From Data Set 1 (November 1 through December 10, 2014), there were 316 valid data points from the plant influent meter that could be directly compared to the V&A temporary flow meter. Figure 3-3 shows a scatter plot comparison of the Influent Meter to the V&A Meter.



Average of Valid Influent Meter Flow Values:	**1.361**	**mgd**
Average of Like V&A Meter Flow Values:	**1.195**	**mgd**
Percent Difference:	**13.9%**	

Figure 3-3. Pinole Influent Data Comparison of All Valid Points

<u>Method 2 Flow Measurement Summary (Data Set 1)</u>

Using the Method 2 determination of the City of Pinole flows, the flows for Pinole are over-reported by approximately 13.9%.

4.0 METHOD 2, DATA SET 2

Data Set 2 was 1-minute interval data accessed directly from the flow meter and thus did not have the “repeated-value” issue noted in previous sections. This data set was utilized to better analyze the sensor measurements of the FloDar flow meter and perhaps lend information to understand why the values in Data Set 1 were over-reported.

4.1 Method 2, Data Set 2 Analysis

Figure 4-1 illustrates hydrographs of the 1-minute level, velocity and flow data measured by the FloDar meter from January 18 through 23, 2015.

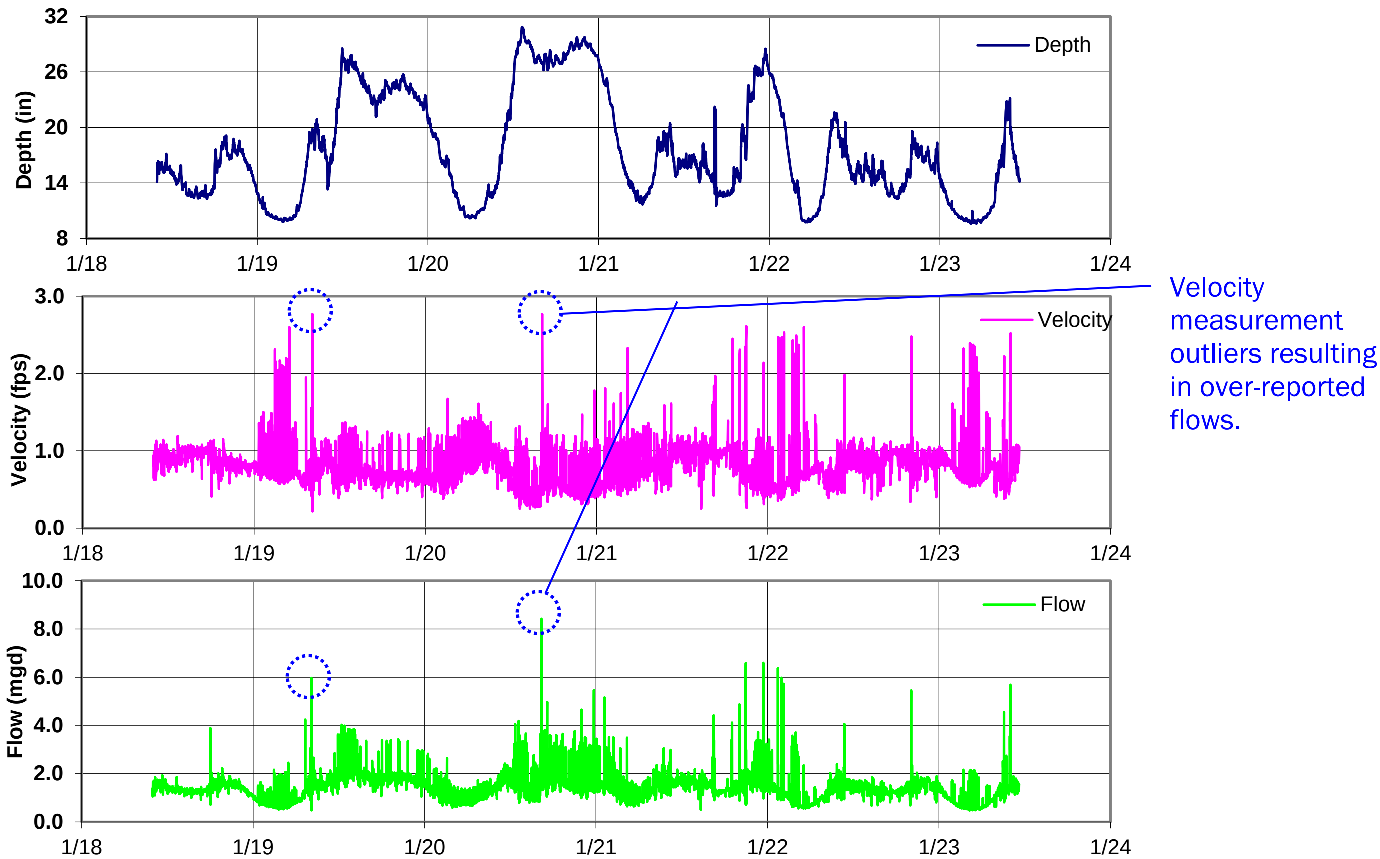
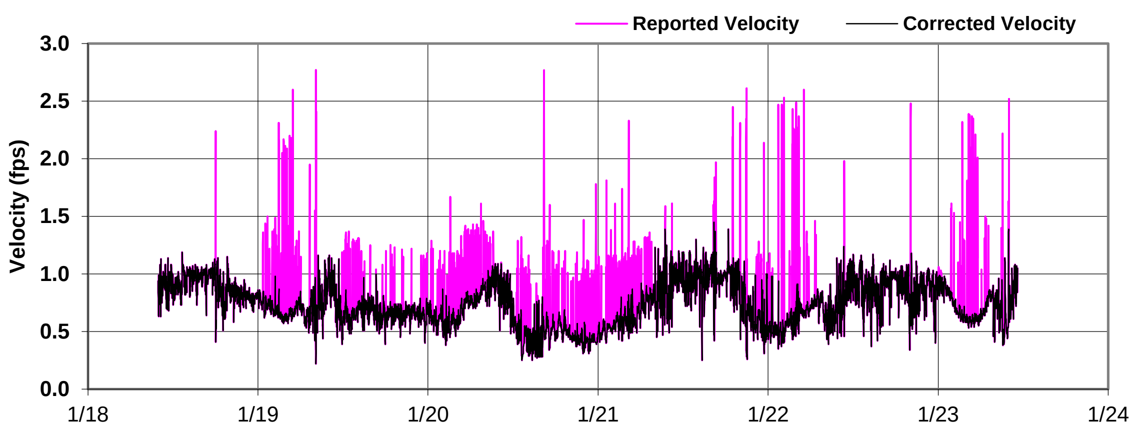


Figure 4-1. Pinole Influent Level, Velocity and Flow Data

Velocity Outliers

There are several velocity point outliers that, based on the hydraulic conditions at the treatment plant, are known to be incorrect and over-reported. This is not an uncommon occurrence with flow monitoring equipment. The FloDar meter measures surface velocity of the flow stream; excessive floating debris or bubbles or foam on the flow surface could cause this issue.

For this data set, V&A went through the exercise of correcting the velocity values to determine the overall effect of these outliers on the flow data. Figure 4-2 illustrates the corrected velocity measurements.



Average of Reported Velocity Measurements:	**0.794 fps**
Average of Like V&A Meter Flow Values:	**0.733 fps**
Percent Difference:	**9.1%**

Figure 4-2. Pinole Influent Velocity Measurements, Reported and Corrected

Flow Calculation and Sediment

The flow calculation programmed into the FloDar meter did not consider the volume of sediment within the pipe channel. The cross-sectional area filled with sediment is not available for conveyance of waste stream flow. It is known that this particular trunk sewer has a sediment issue. Assuming no sediment would result in the over-reporting of flow values.

The exact level of sediment at the Influent Meter location was not known. The sediment at the V&A Meter approximately 240 feet upstream from the Influent Meter manhole measured approximately 2 inches. For Data Set 2, assuming 2 inches of sediment in the pipe channel would result in a 5.7% reduction of flow.

Data Set 2 Analysis Summary

If the velocity outliers were corrected and 2 inches of sediment was accounted for in the pipeline, the overall impact on the flows reported by the FloDar would be approximately 14.8%. This number corresponds well with the percentage difference in flows analyzed in Data Set 1 (13.9%).

5.0 DISCUSSION

The following discussion items are presented for review by the City:

- **Primary Devices vs. Flow Meters:** Primary devices, flumes and weirs, traditionally have been a popular and reliable method to measure flows in permanent installations. The main limitations of these methods is that there are constraints on where such devices can be installed and once installed, moving them to a different location is difficult. Primary devices are less reliant on technology because one of the parameters used to calculate flow is removed from the equation as a variable.
- **Method 1 (Effluent less Hercules):** Using the Method 1 determination of the City of Pinole flows, the flows for Pinole are over-reported by approximately 15.2%.
    - The flow monitoring methods used presently to determine the Hercules flows and the Effluent flows appear to be repeatable.
- **Method 2 (Influent meter direct measurement):** The influent meter was over-reporting flows by approximately 13.9% per comparison of valid data points within Data Set 1 and the V&A temporary meter.
    - Detailed analysis of the 1-minute level and velocity data reported from the FloDar meter indicates that there are likely two causes for this over-reporting:
        - **Cause #1:** There are velocity outliers reported by the FloDar that cause the velocity to be over-reported. For the five days of data analyzed, these outliers caused the flows to be over-reported by 9.1%.
        - **Cause #2:** There are known sediment issues in the pipeline where the influent meter is located. The FloDar meter was not programmed to account for sediment when calculating flow. The exact level of sediment in that manhole was not known at the time of this report. If one assumes 2 inches of sediment as measured 240 feet upstream from the influent meter, then the net effect of accounting for the sediment would be a reduction of flow of approximately 5.7% (Data Set 2).
- **Preferred Method:** Given the known sediment issues at the influent meter location, and also given the repeatability and sustainability of the Primary Device used at the Effluent Meter location, Method 1 would be considered the preferred method for determining the City of Pinole flows generated from the collection system on a mass flow basis.
    - Note: Instantaneous flows from the City of Pinole cannot be determined due to attenuation and hold times through the treatment process.

Appendix D. Flow Monitoring Sites Data, Graphs, Information: Phase 1

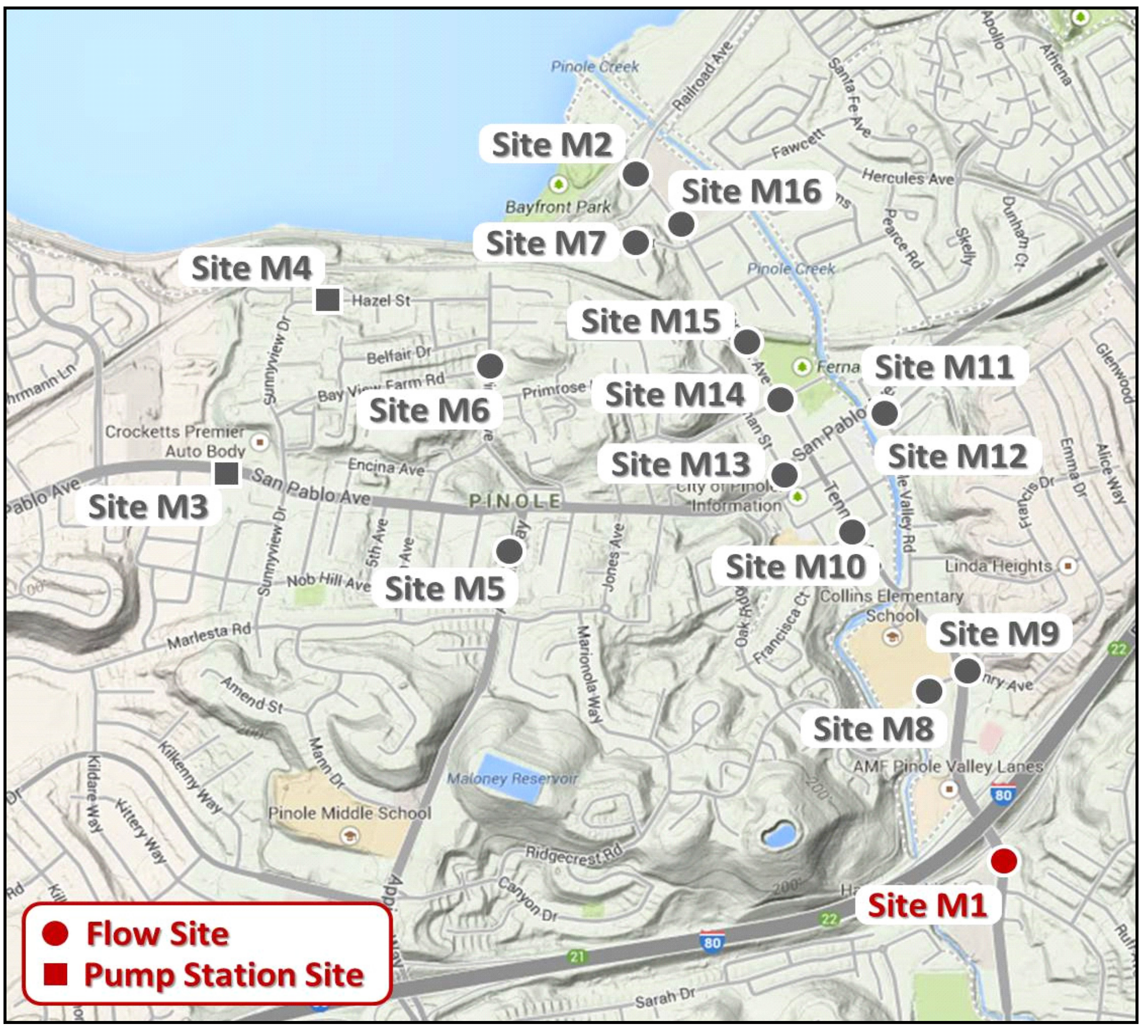
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M1

Location: Pinole Valley Rd., just south of Highway 80

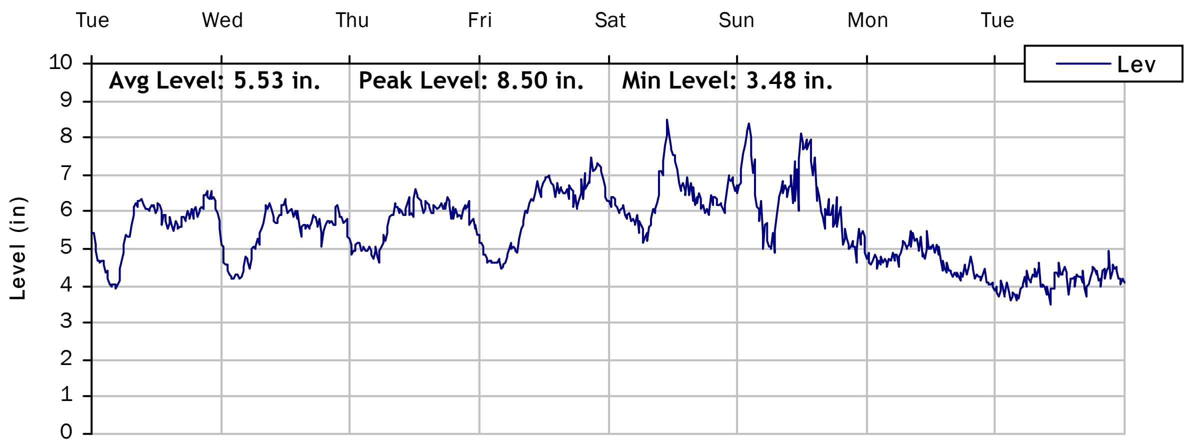
Data Summary Report

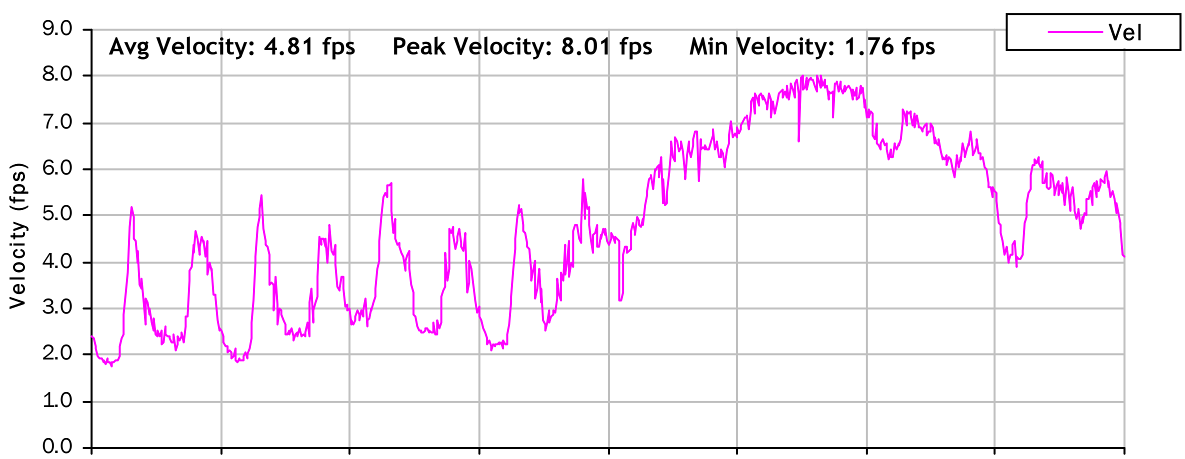


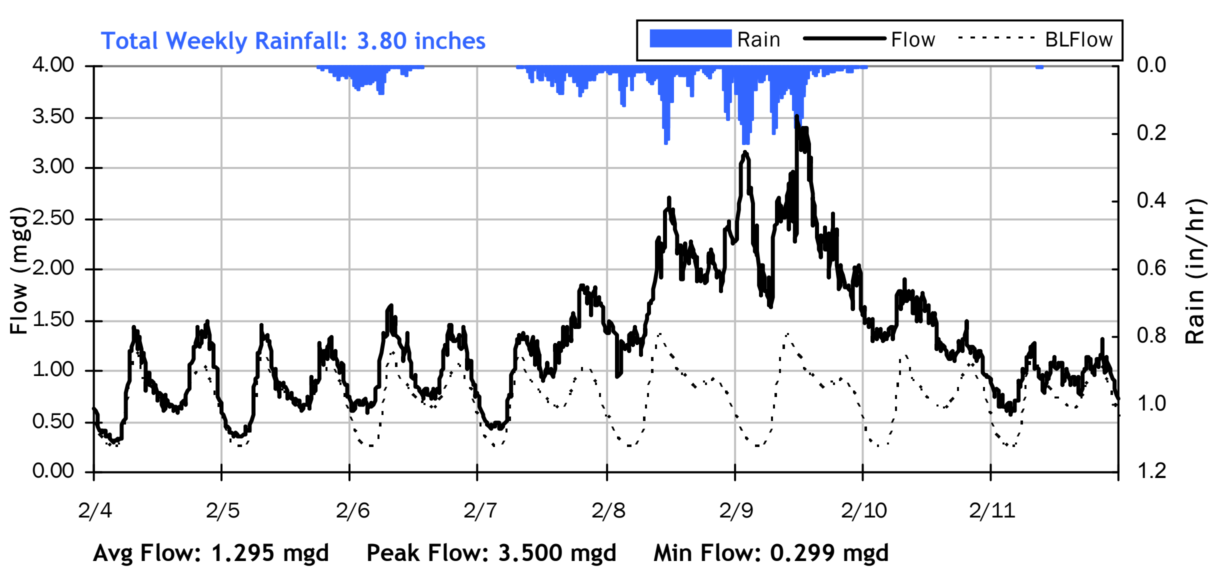
Vicinity Map: Site M1

SITE M1

Weekly Level, Velocity and Flow Hydrographs

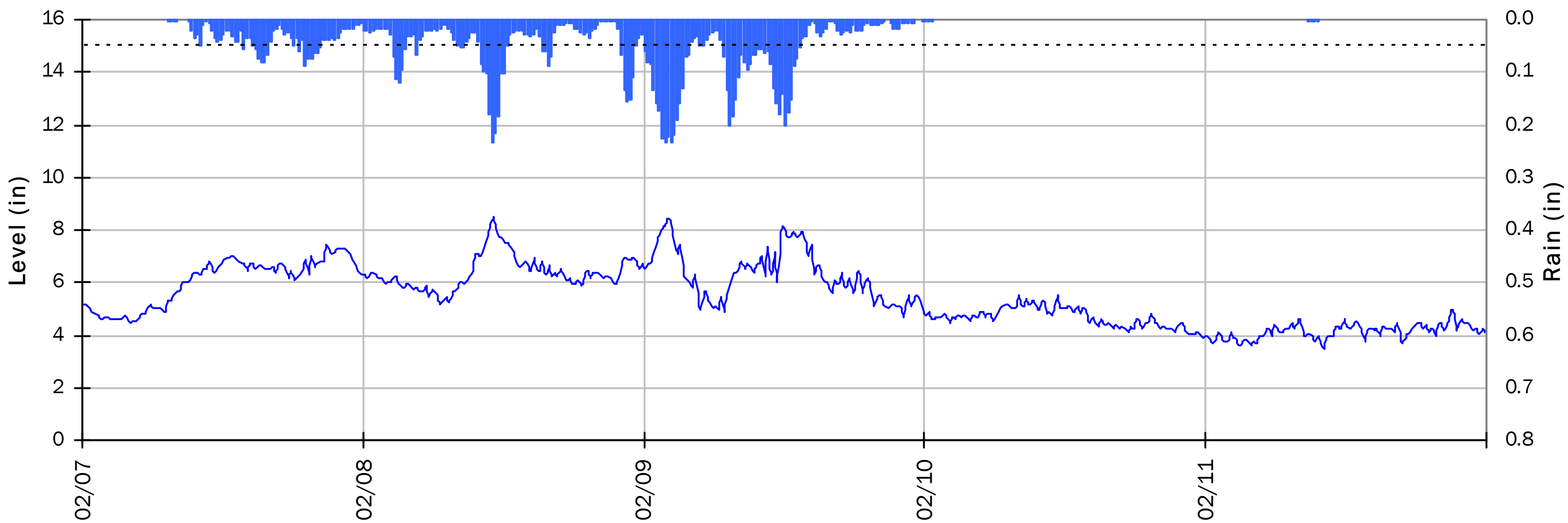


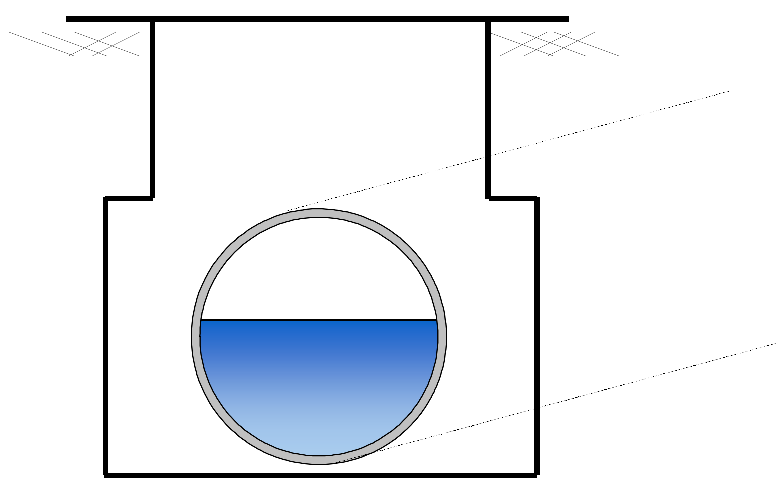




SITE M1
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



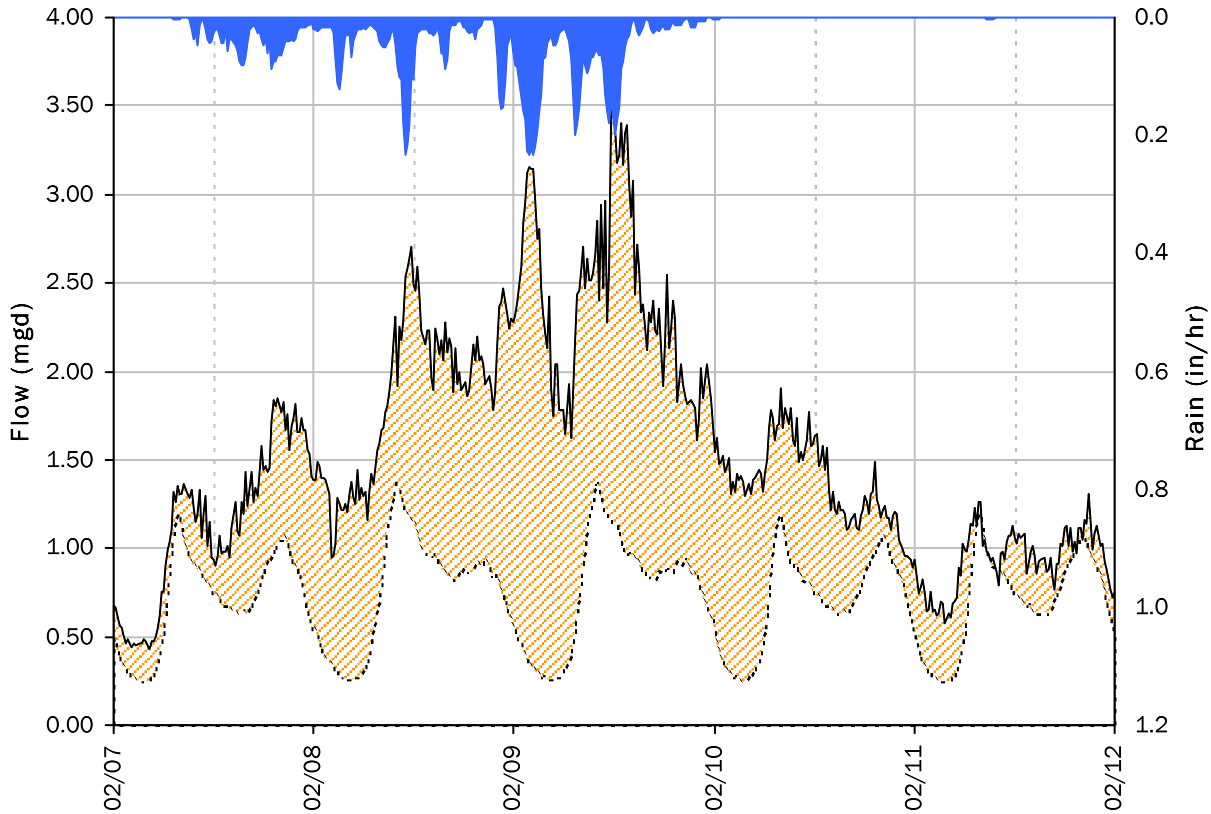


Pipe Diameter:	15	*inches*
Peak Measured Level:	8.5	*inches*
Peak d/D Ratio:	0.57	

SITE M1
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 3.50 *mgd*
PF: 4.90

Peak Level: 8.50 *in*
d/D Ratio: 0.57

Inflow / Infiltration

Peak I/I Rate: 2.83 *mgd*
Total I/I: 4,093,000 *gallons*

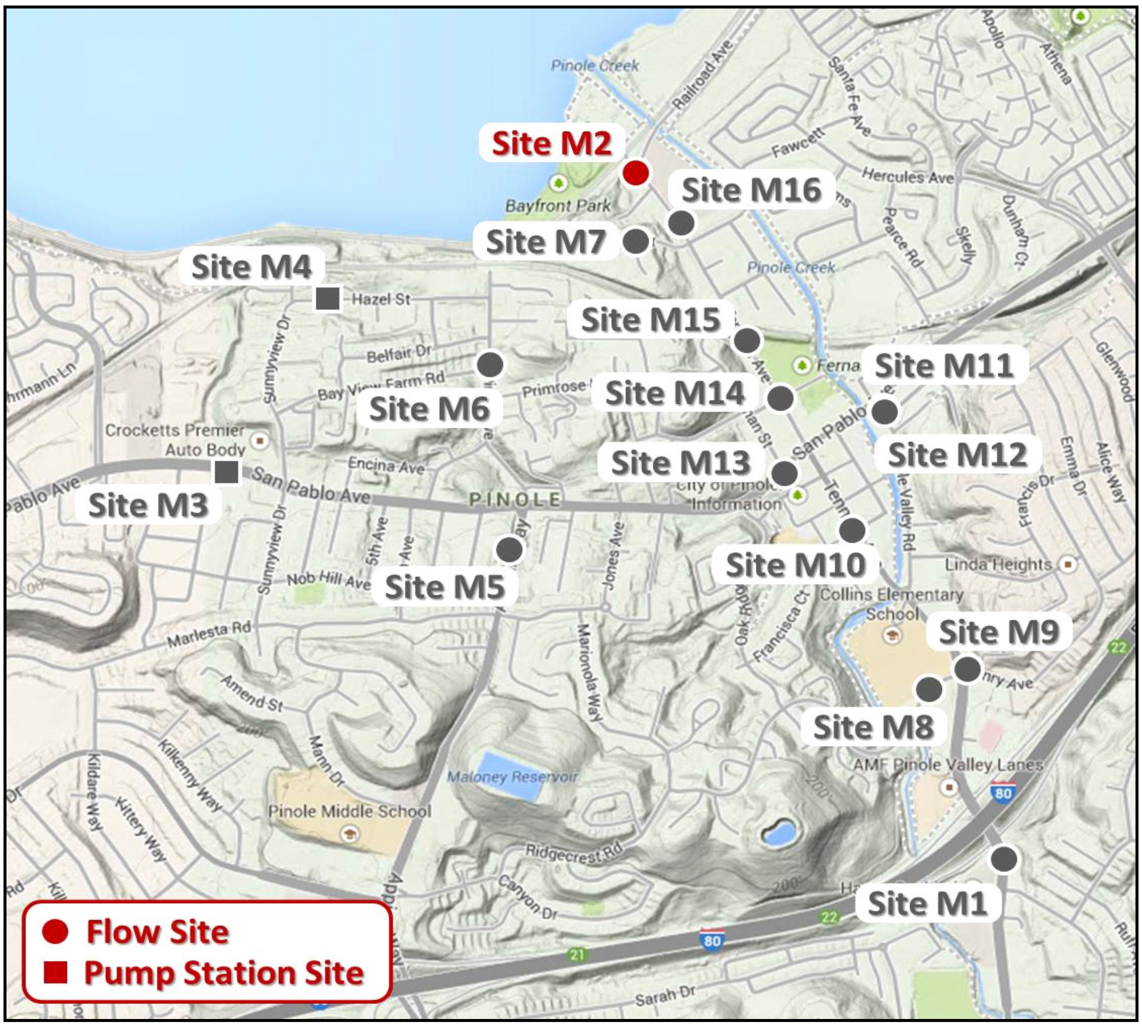
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M2

Location: Tennant Ave., just outside WWTP

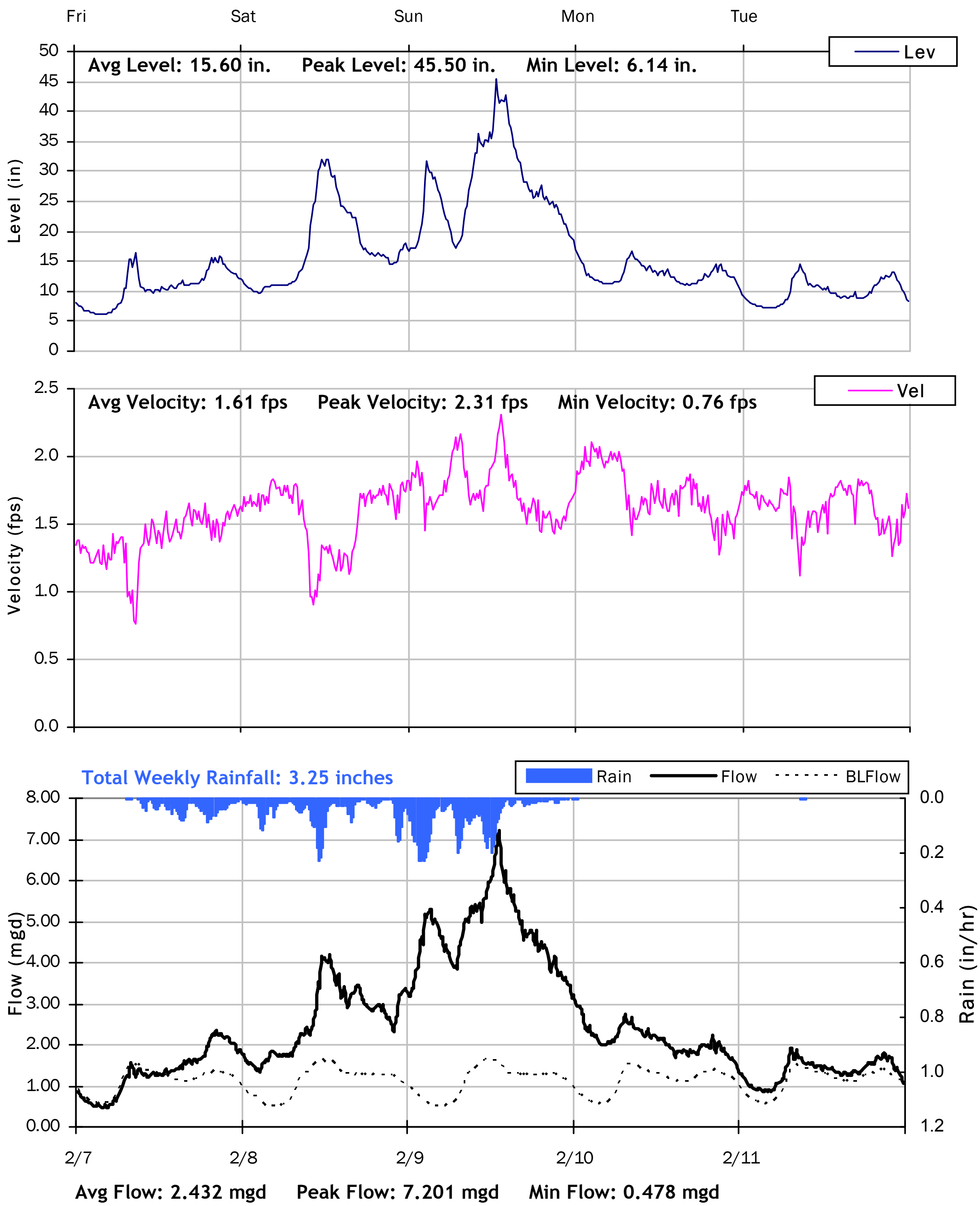
Data Summary Report



Vicinity Map: Site M2

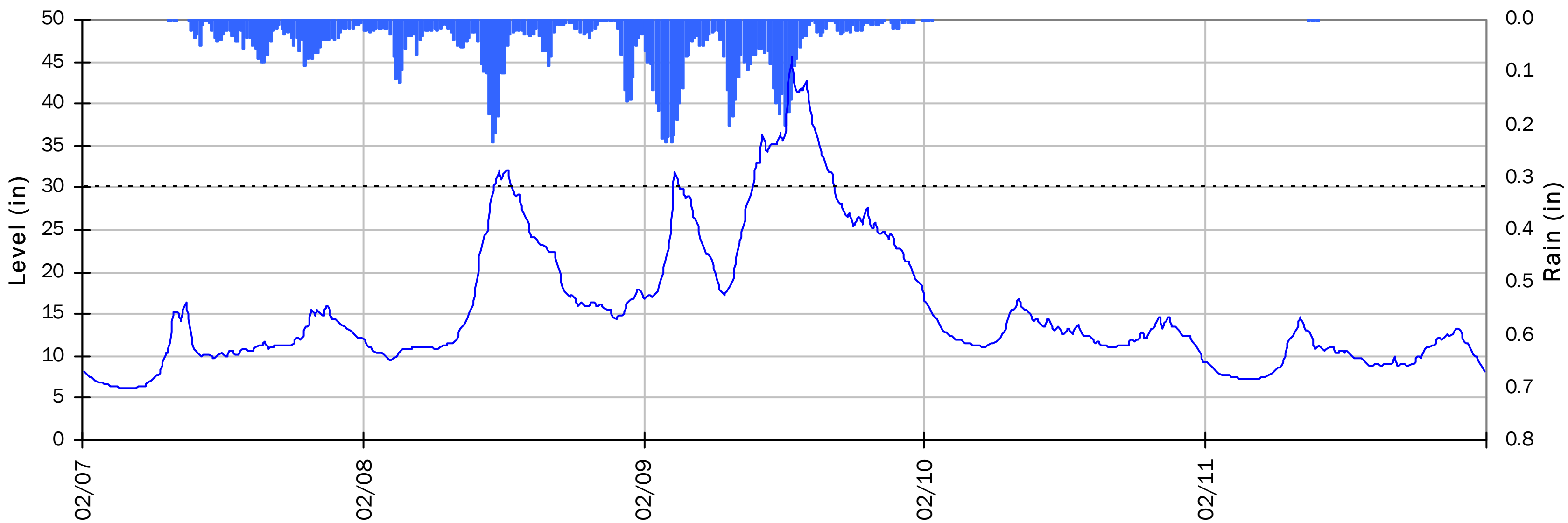
SITE M2

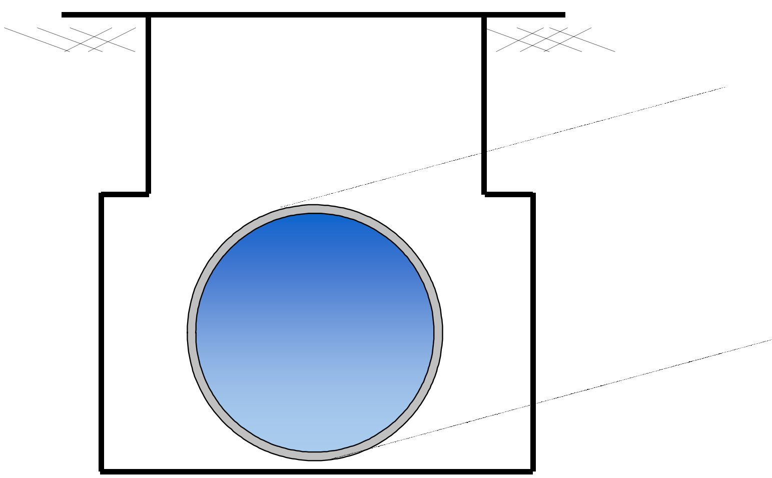
Weekly Level, Velocity and Flow Hydrographs



SITE M2
Site Capacity and Surcharge Summary

<u>Realtime Flow Levels with Rainfall Data over Monitoring Period</u>





Pipe Diameter: 30 *inches*

Peak Measured Level: 45.5 *inches*

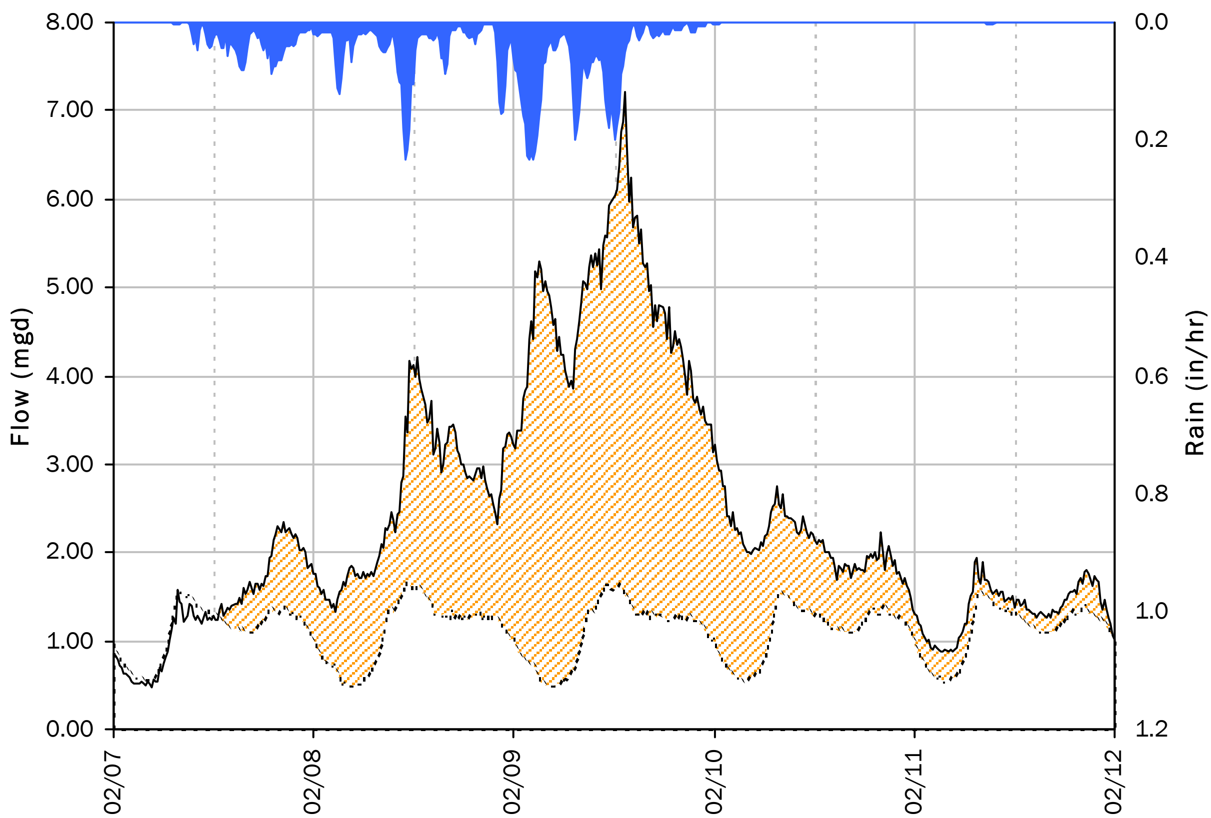
Peak d/D Ratio: 1.52

Surcharged 15.5 inches over crown

SITE M2
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow:	7.20 *mgd*
PF:	6.50
Peak Level:	45.50 *in*
d/D Ratio:	1.52

Inflow / Infiltration

Peak I/I Rate:	5.70 *mgd*
Total I/I:	6,623,000 *gallons*

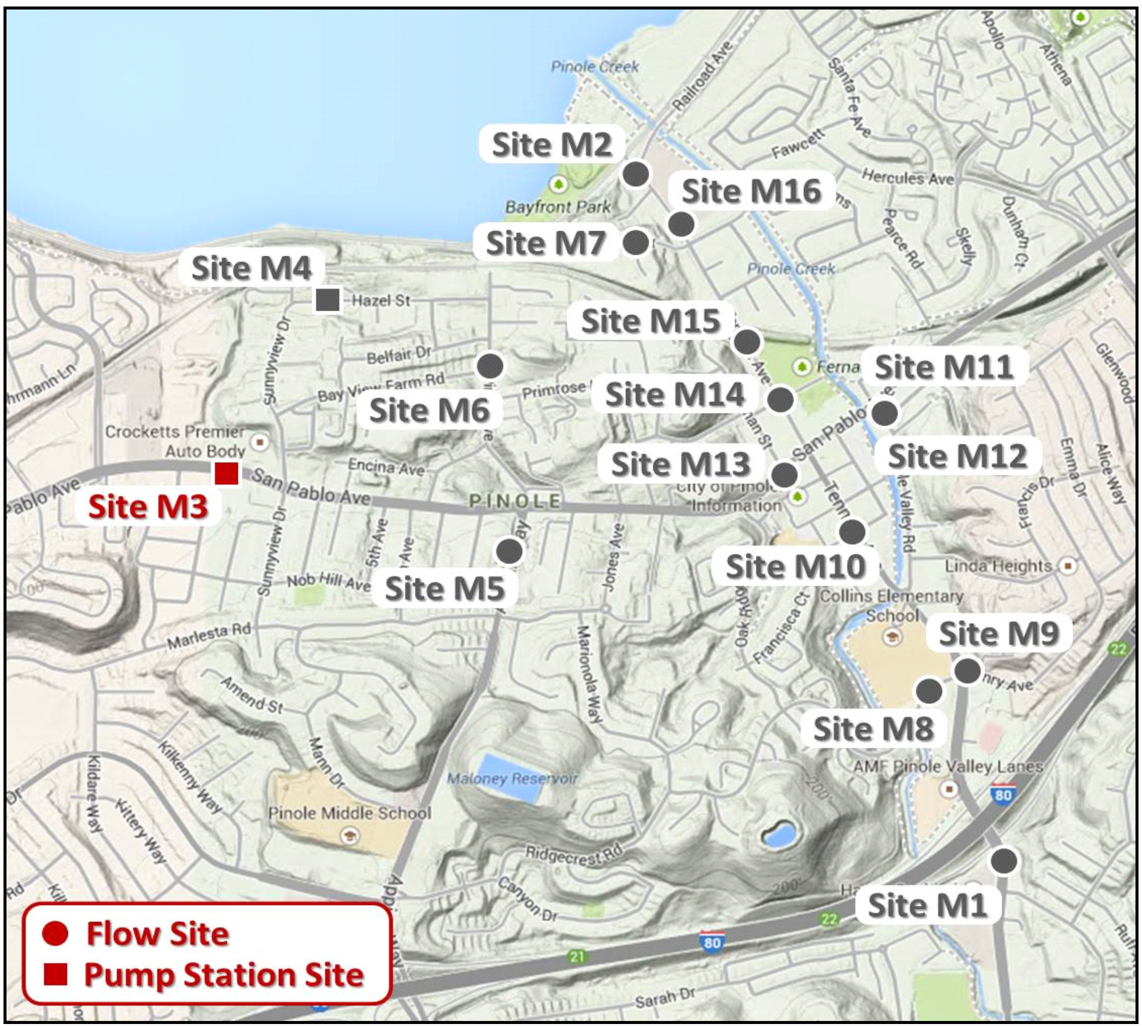
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M3

Location: San Pablo Ave., west of Sunnyview Dr.

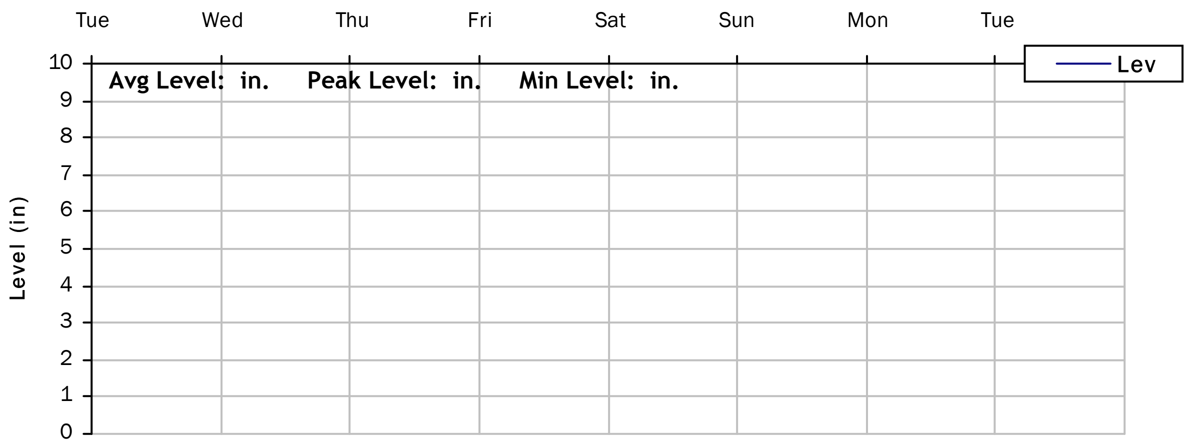
Data Summary Report

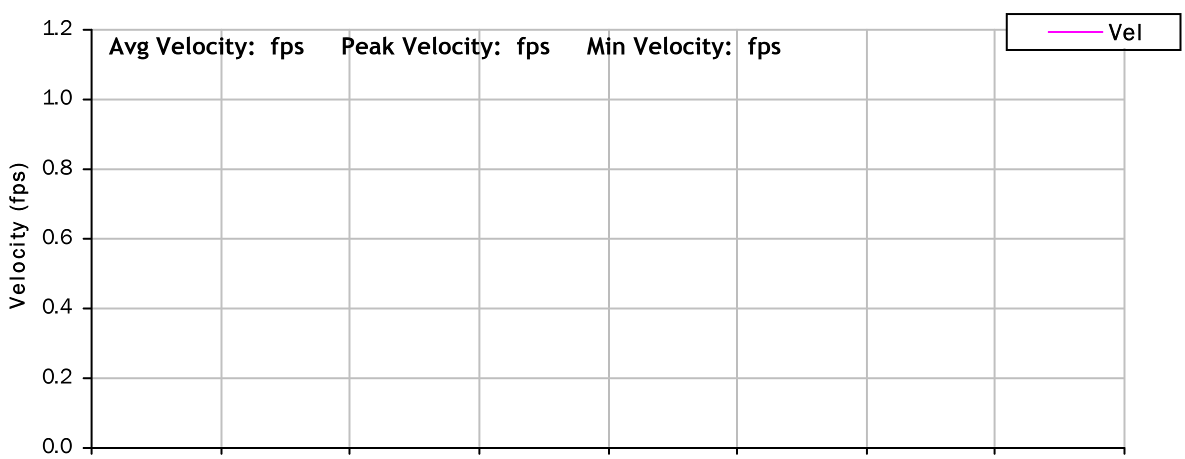


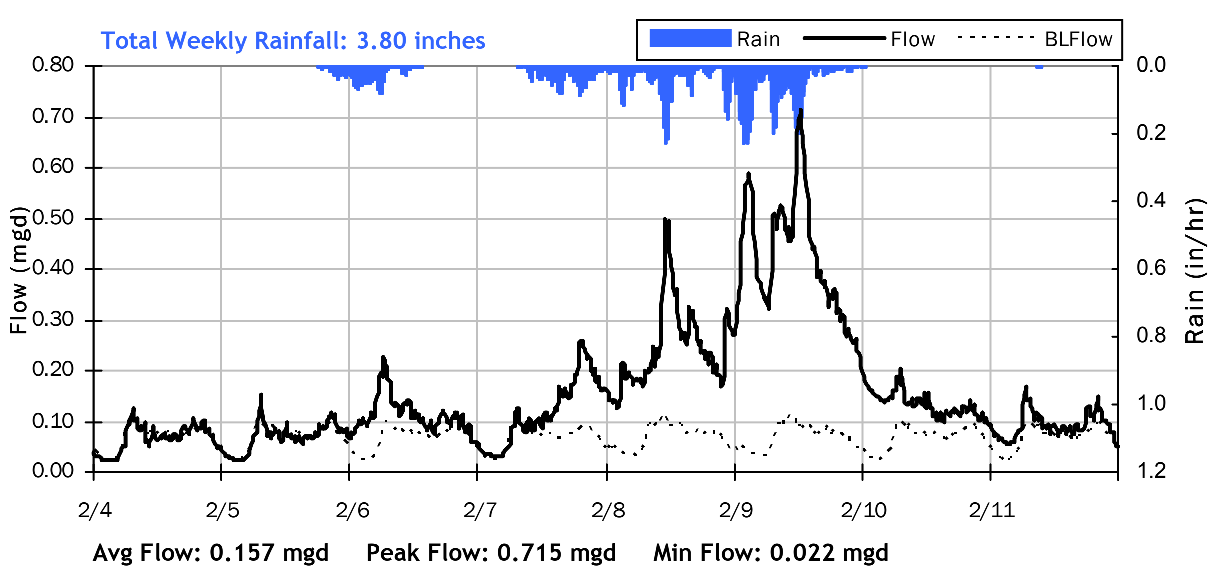
Vicinity Map: Site M3

SITE M3

Weekly Level, Velocity and Flow Hydrographs

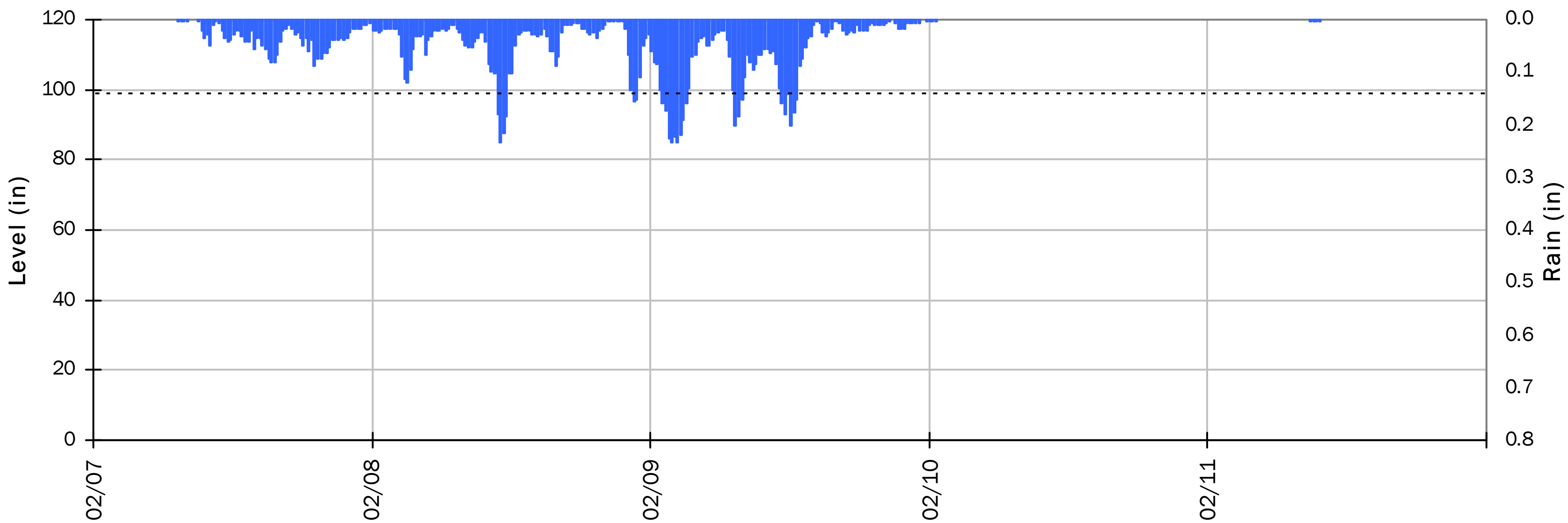


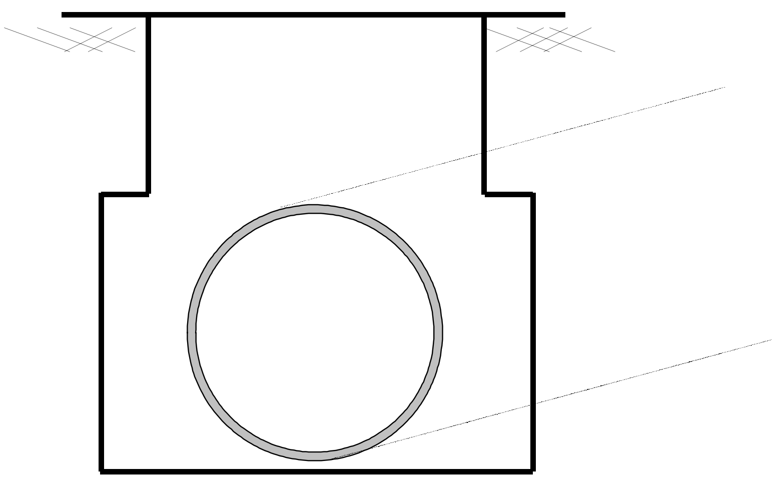




SITE M3
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



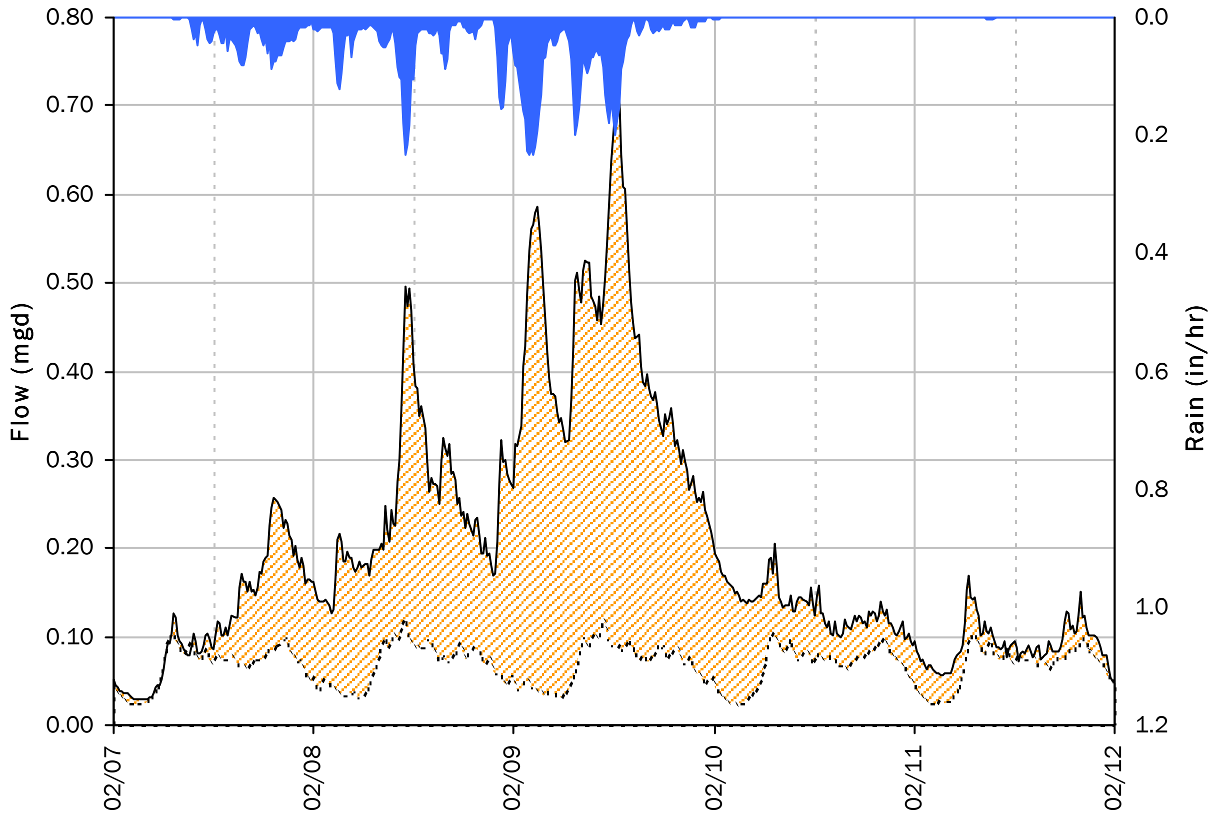


Pipe Diameter:	99	*inches*
Peak Measured Level:		*inches*
Peak d/D Ratio:		

SITE M3
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.71 *mgd*
PF: 10.66

Peak Level: *in*
d/D Ratio:

Inflow / Infiltration

Peak I/I Rate: 0.63 *mgd*
Total I/I: 670,000 *gallons*

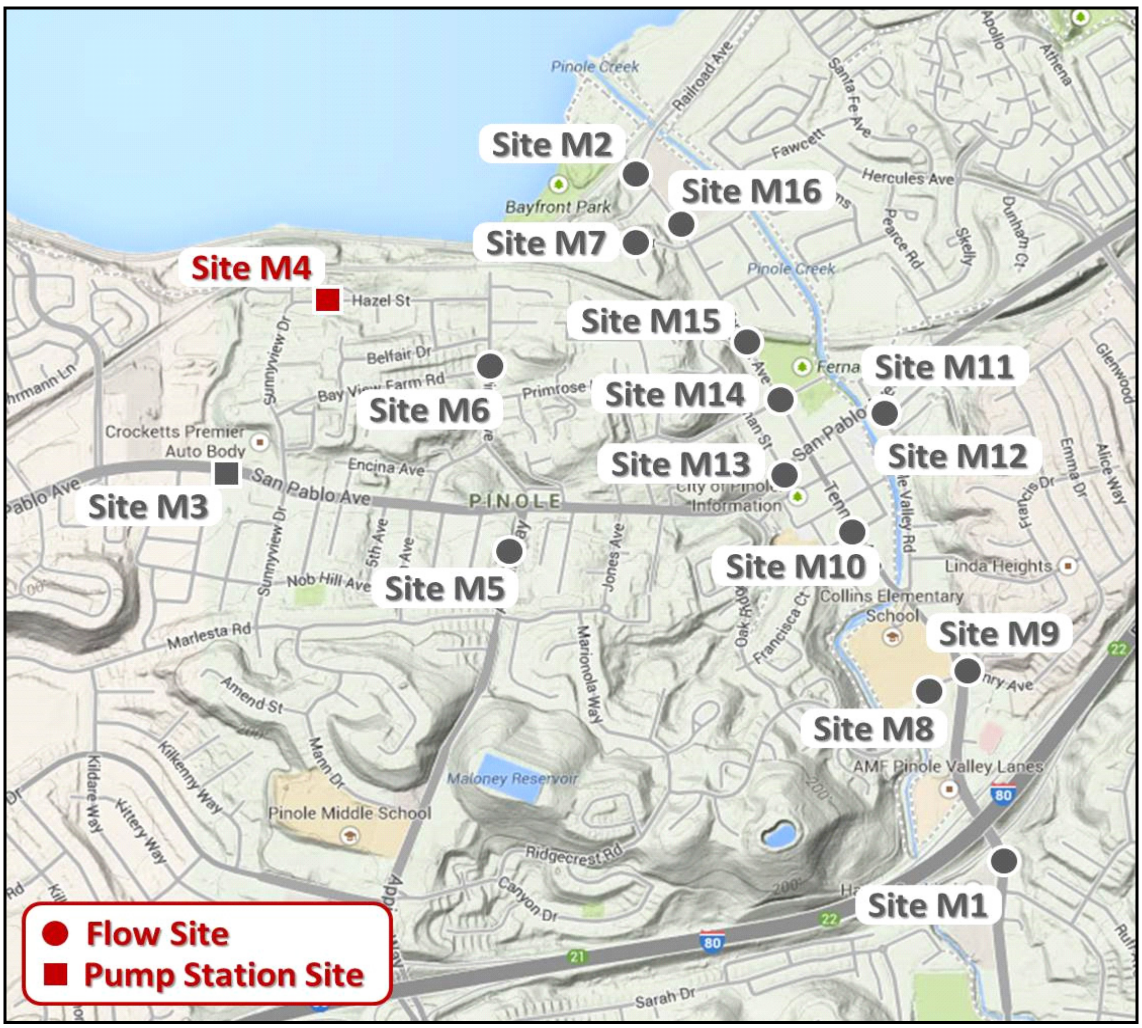
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M4

Location: In easement at west end of Hazel St.

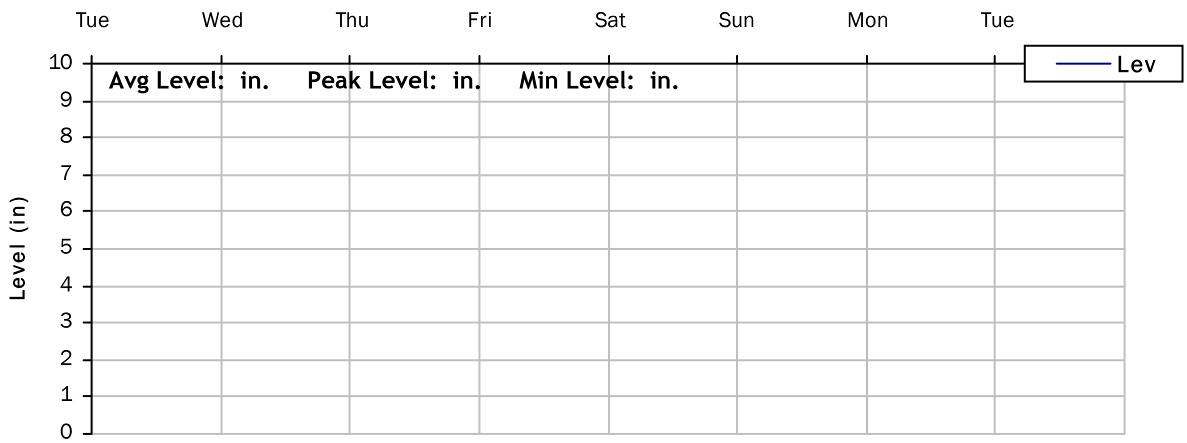
Data Summary Report

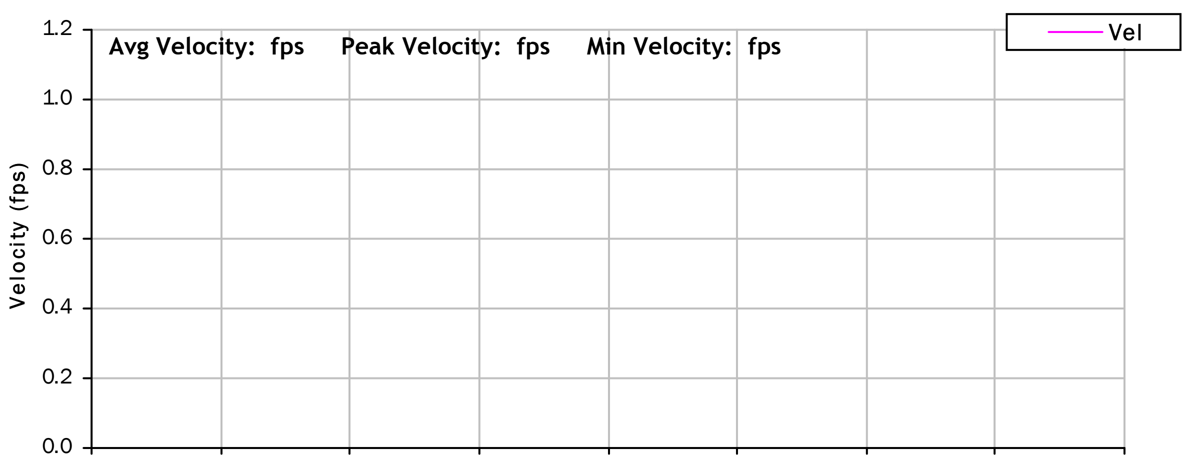


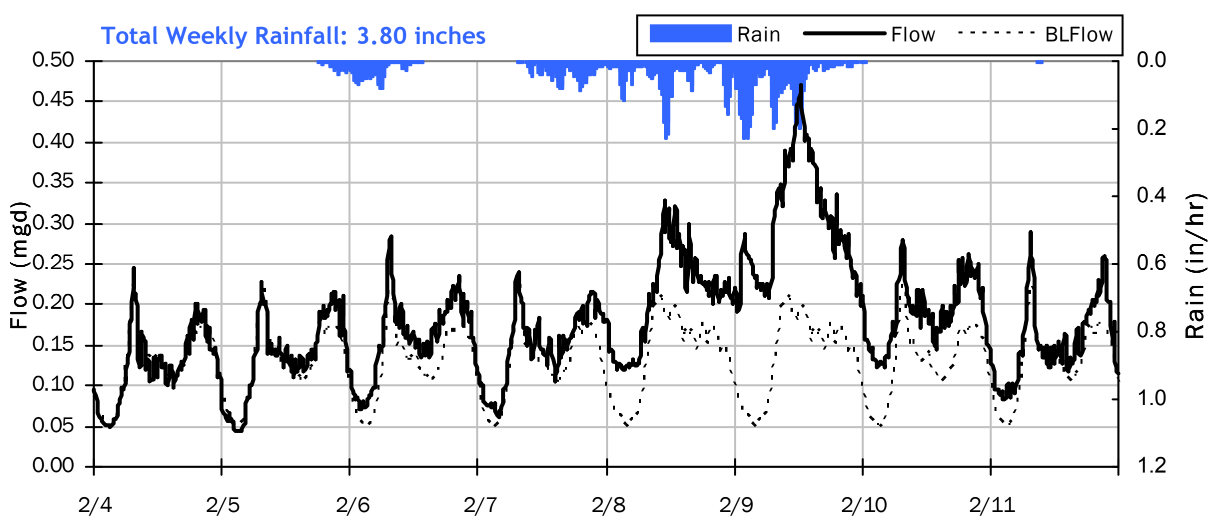
Vicinity Map: Site M4

SITE M4

Weekly Level, Velocity and Flow Hydrographs



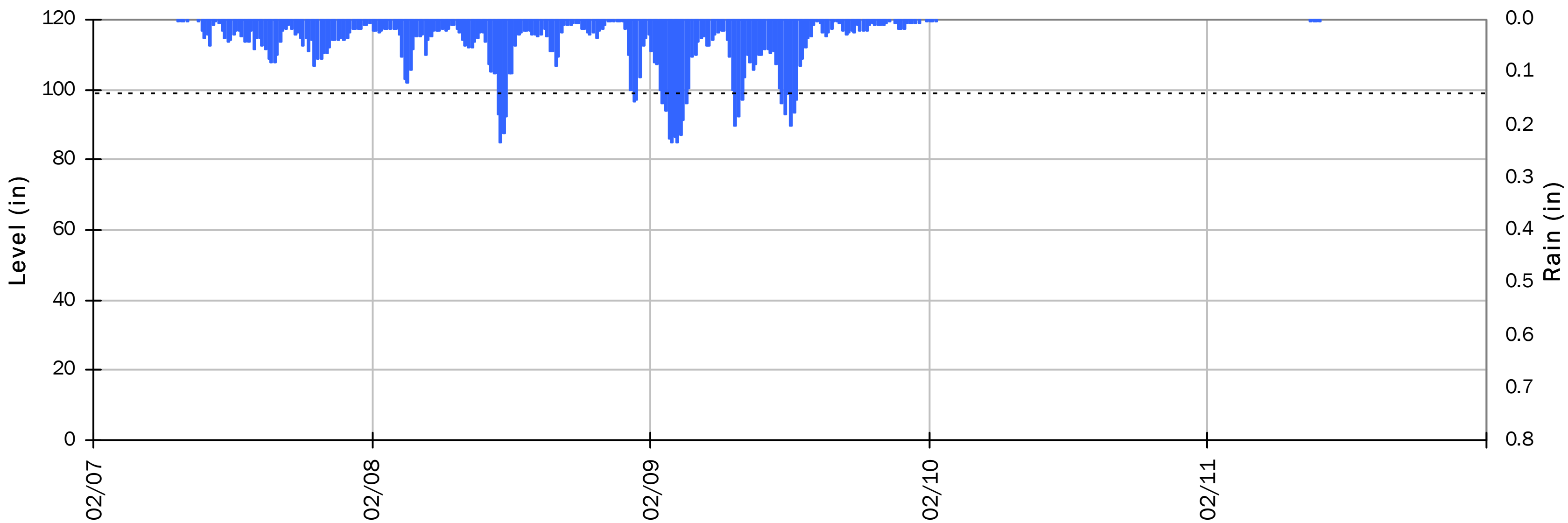


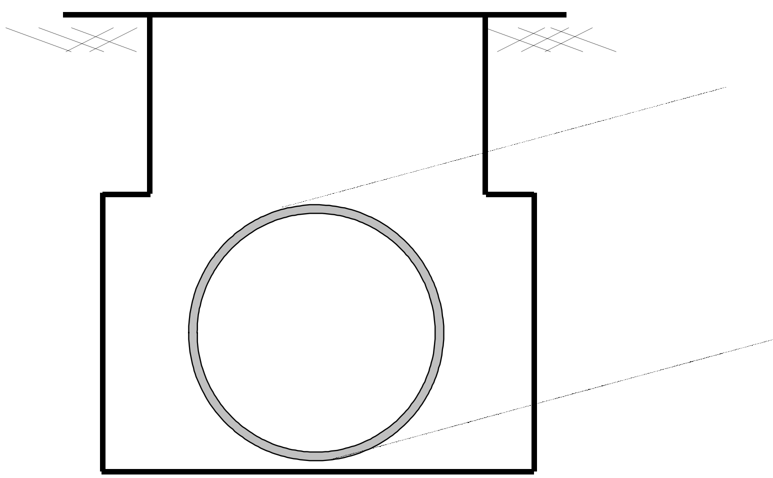


Avg Flow: 0.178 mgd   Peak Flow: 0.470 mgd   Min Flow: 0.044 mgd

SITE M4
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



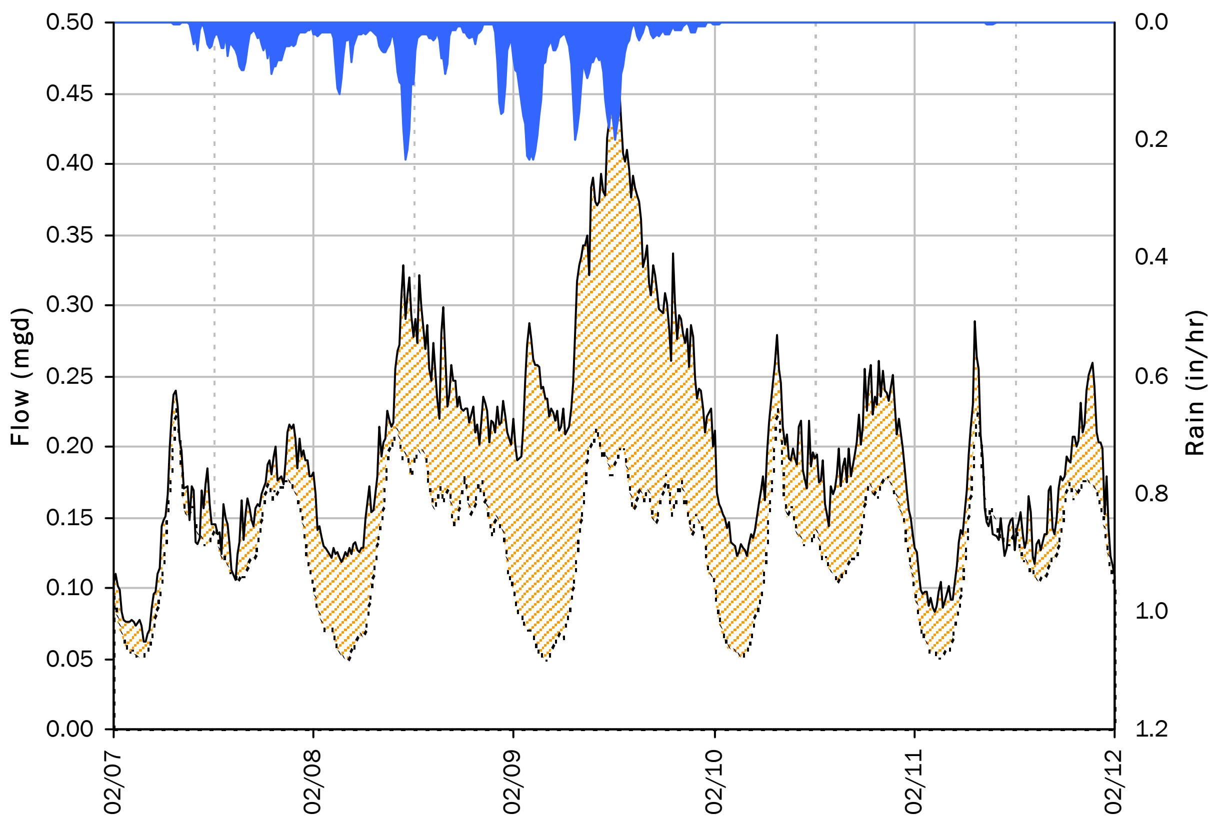


Pipe Diameter:	99	*inches*
Peak Measured Level:		*inches*
Peak d/D Ratio:		

SITE M4
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.47 *mgd*
PF: 3.66

Peak Level: *in*
d/D Ratio:

Inflow / Infiltration

Peak I/I Rate: 0.28 *mgd*
Total I/I: 355,000 *gallons*

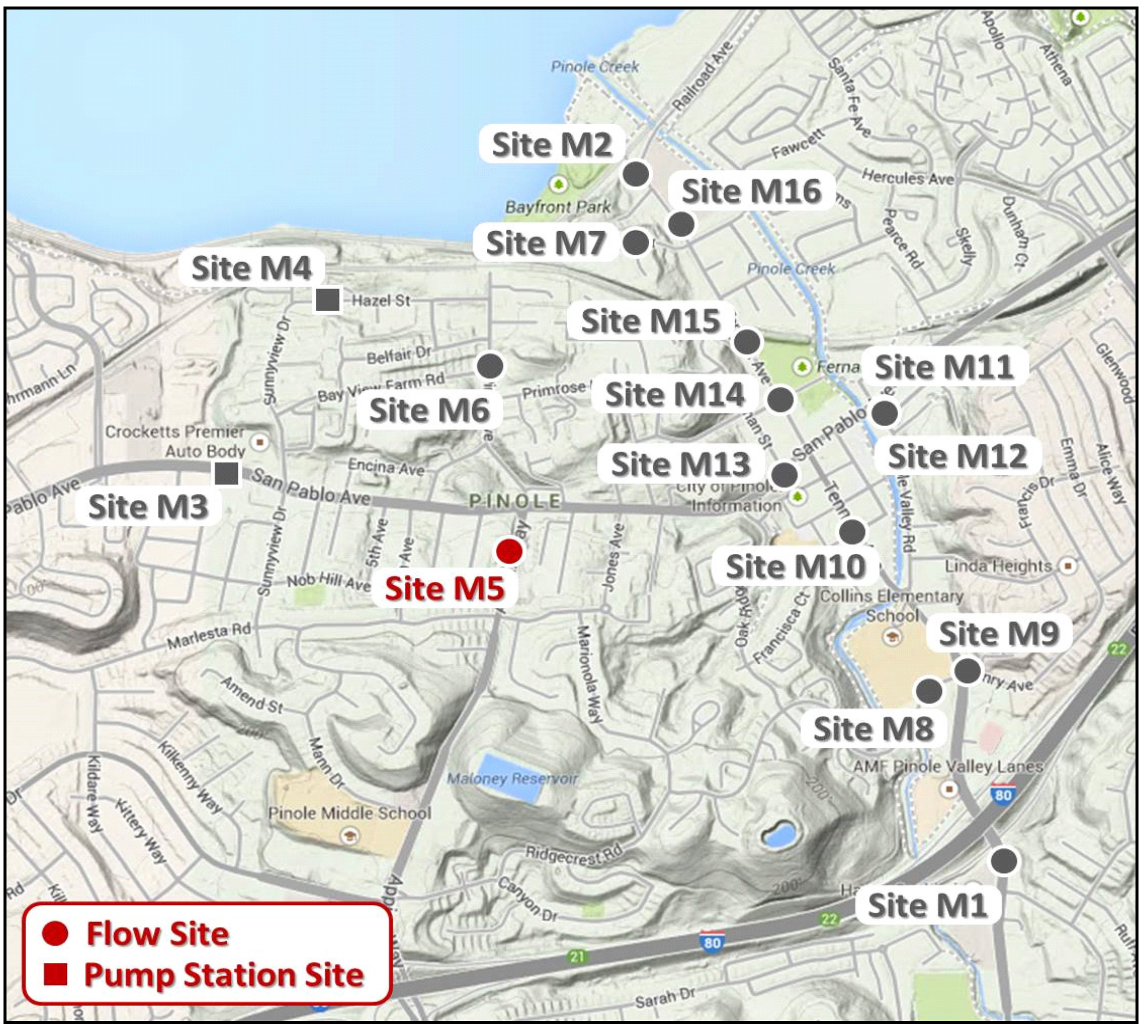
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M5

Location: Appian Way, south of San Pablo Ave.

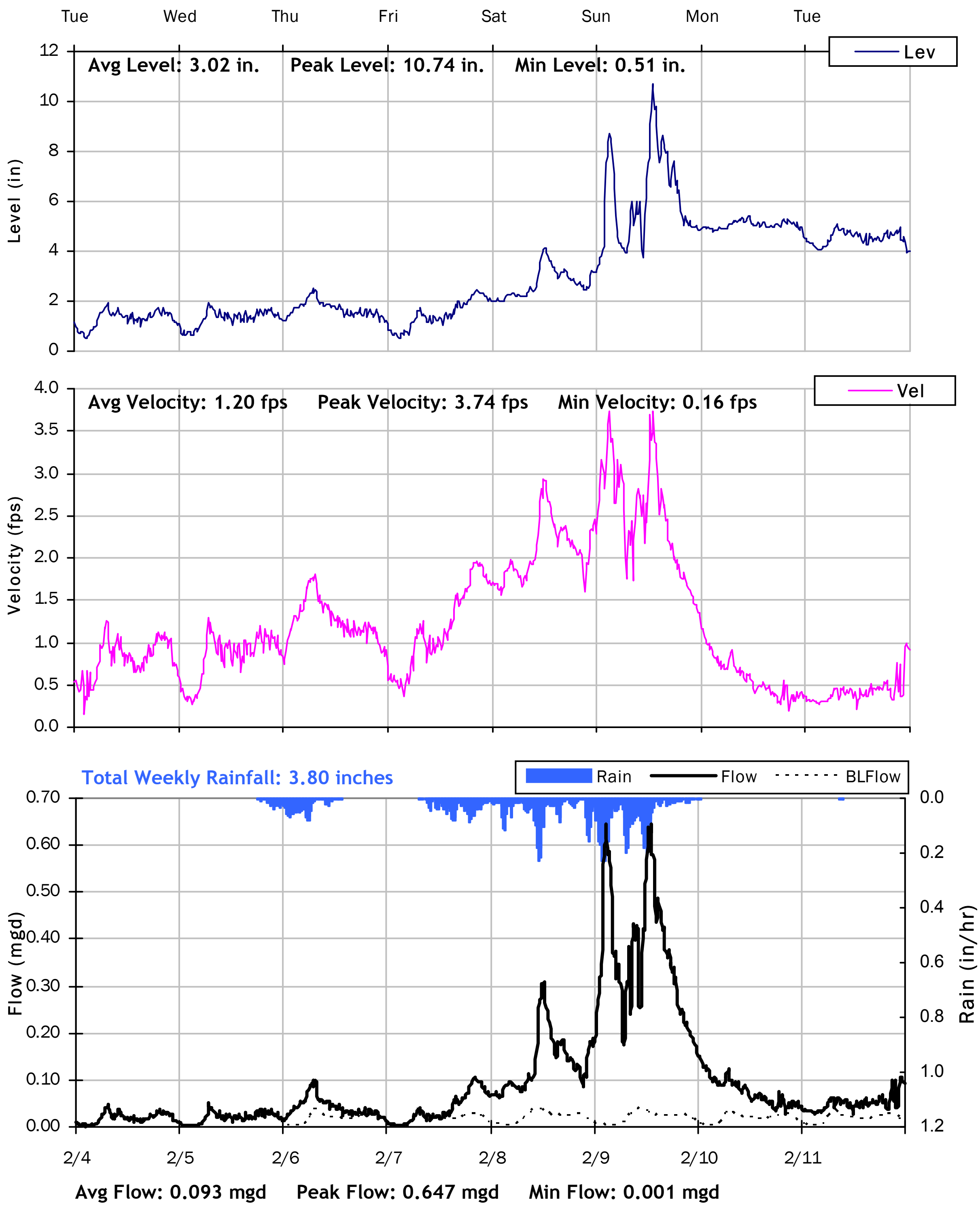
Data Summary Report



Vicinity Map: Site M5

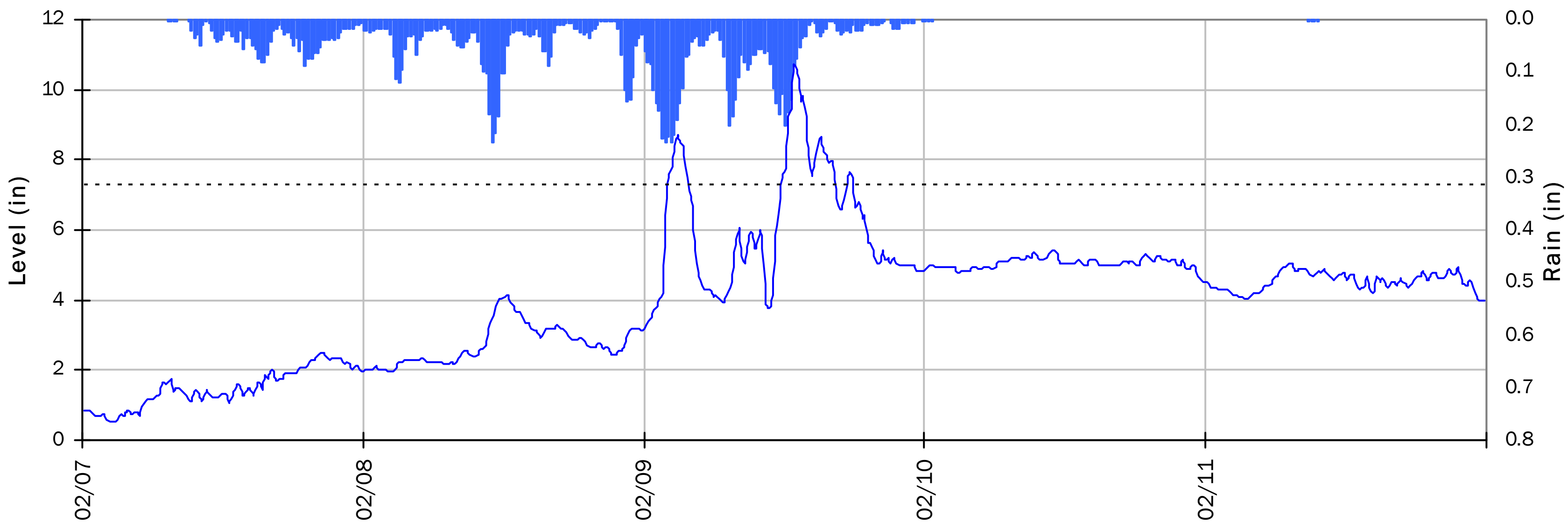
SITE M5

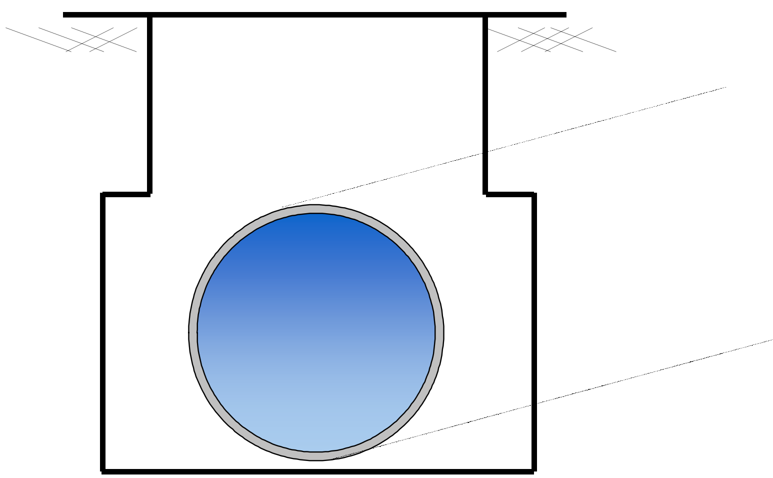
Weekly Level, Velocity and Flow Hydrographs



SITE M5
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





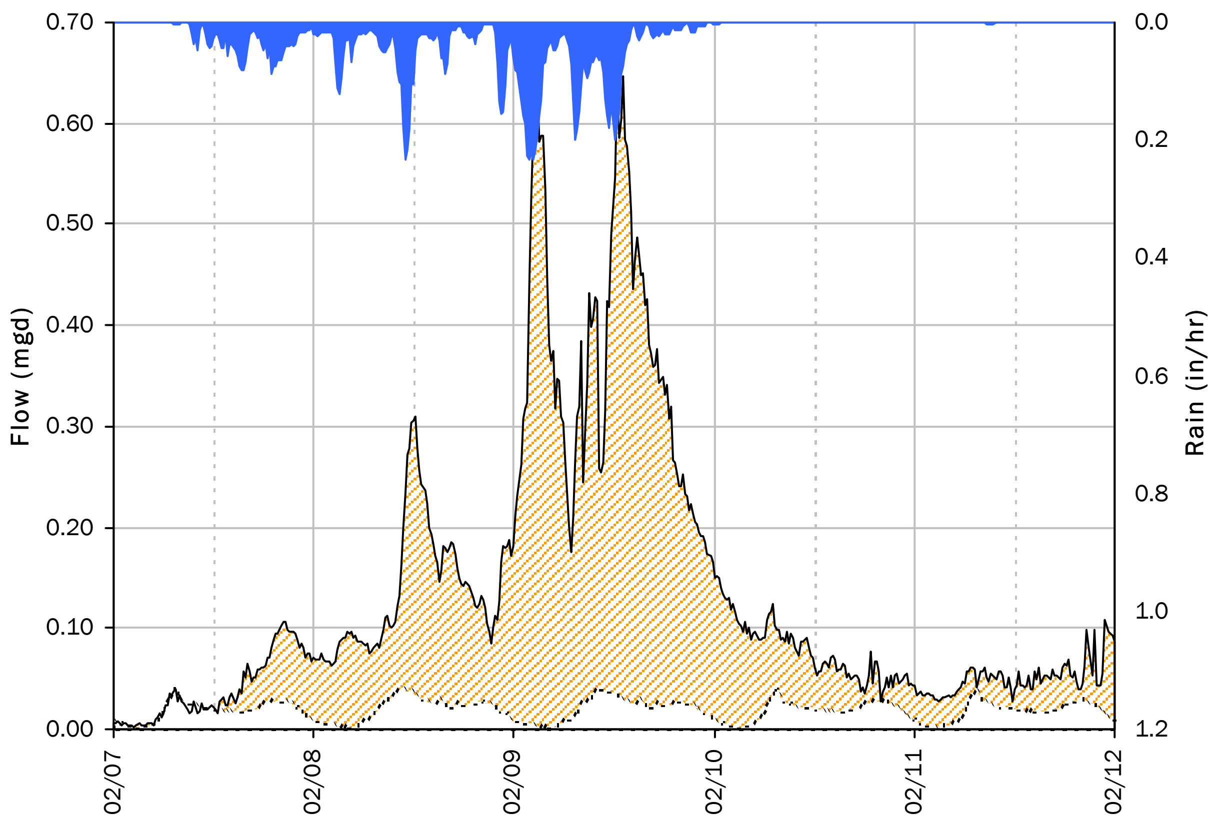
Pipe Diameter:	7.25	*inches*
Peak Measured Level:	10.7	*inches*
Peak d/D Ratio:	1.48	

Surcharged 3.5 inches over crown

SITE M5
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.65 *mgd*
PF: 33.85

Peak Level: 10.74 *in*
d/D Ratio: 1.48

Inflow / Infiltration

Peak I/I Rate: 0.64 *mgd*
Total I/I: 570,000 *gallons*

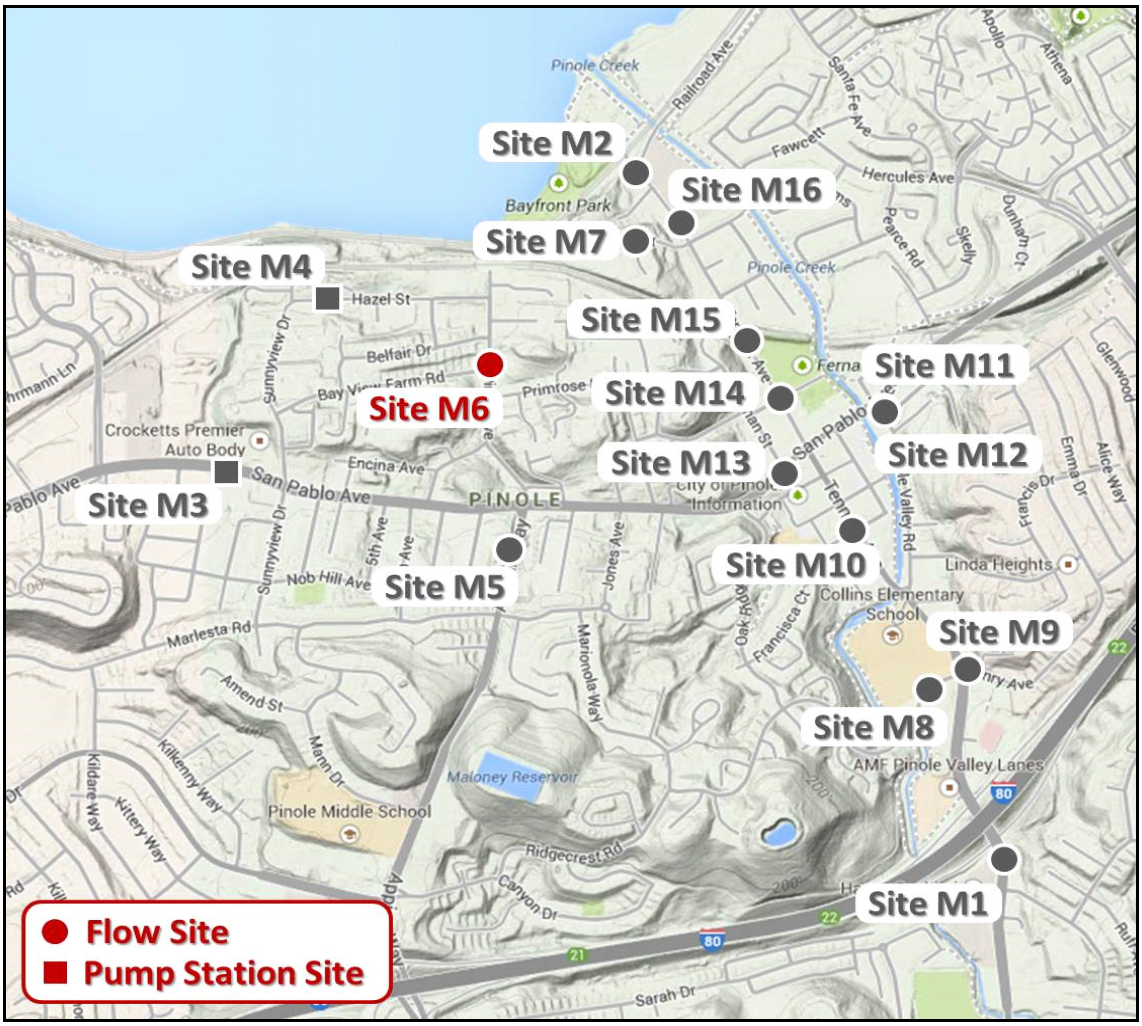
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M6

Location: Pinon Ave., north of Bay View Farm Rd.

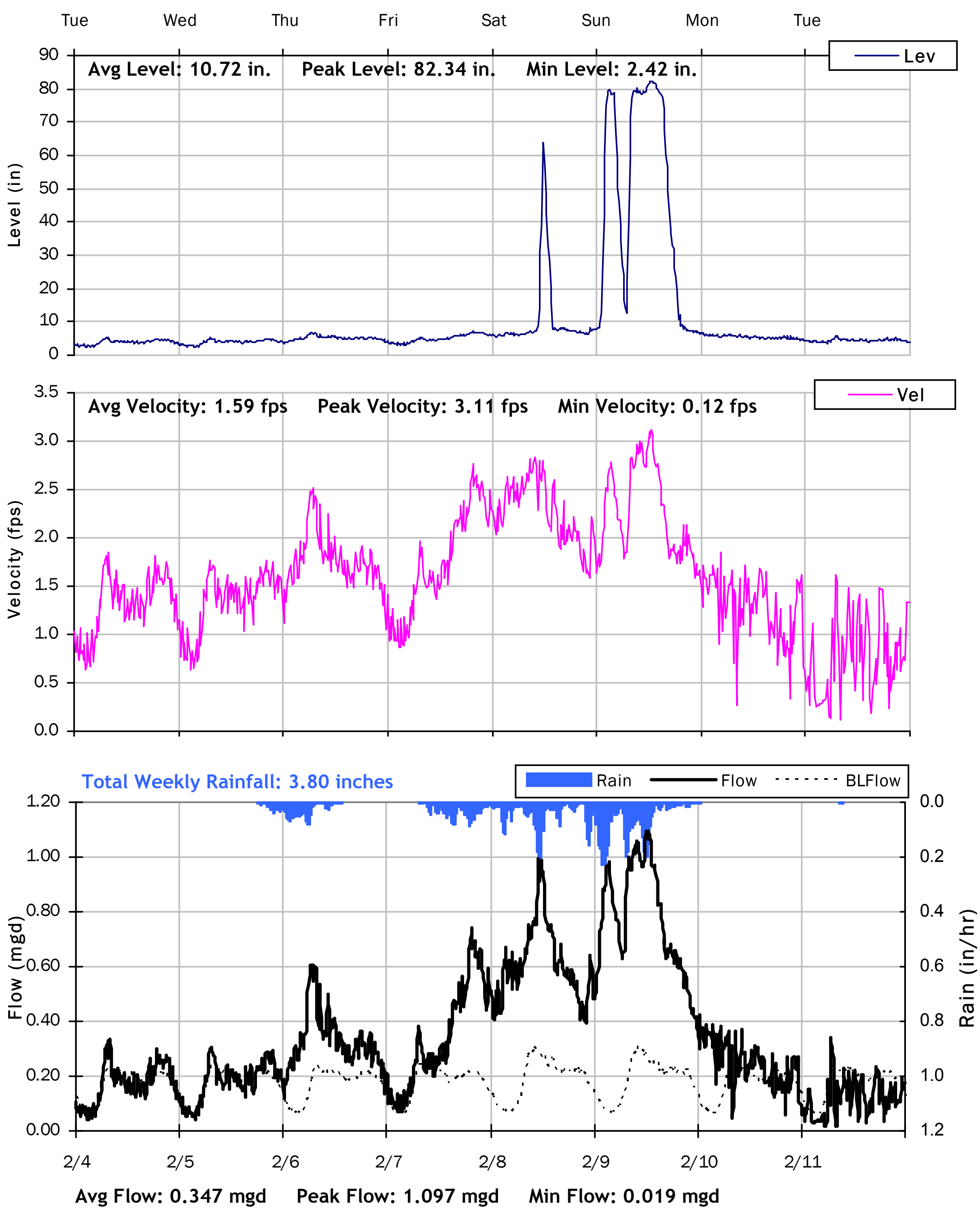
Data Summary Report



Vicinity Map: Site M6

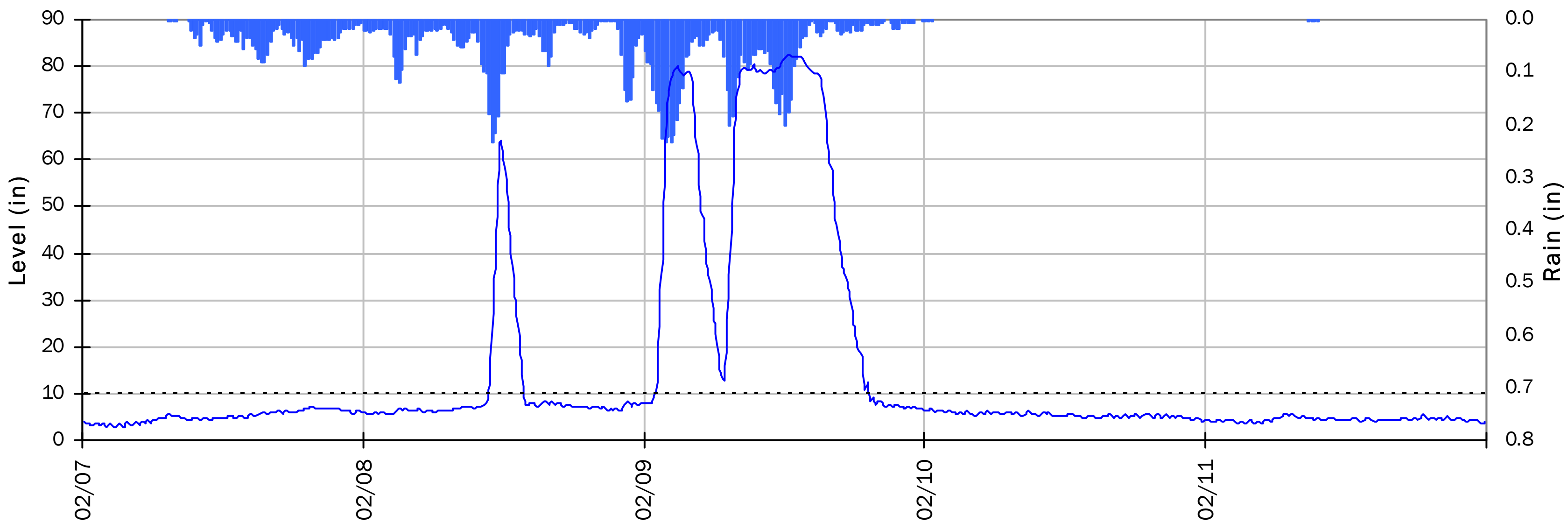
SITE M6

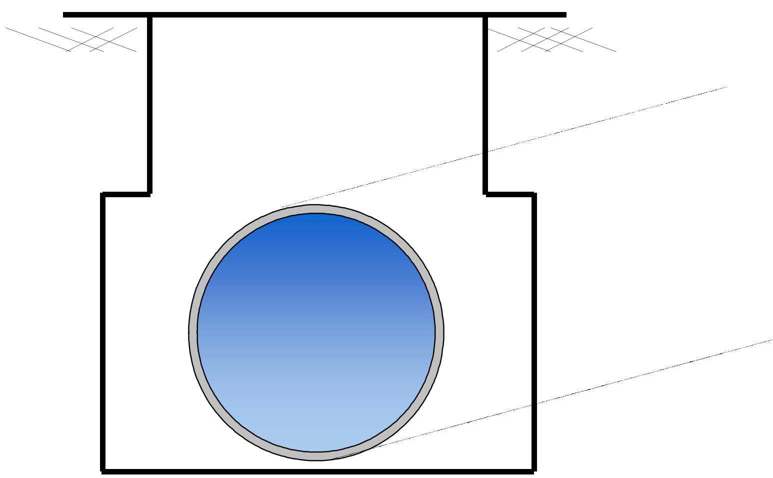
Weekly Level, Velocity and Flow Hydrographs



SITE M6
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





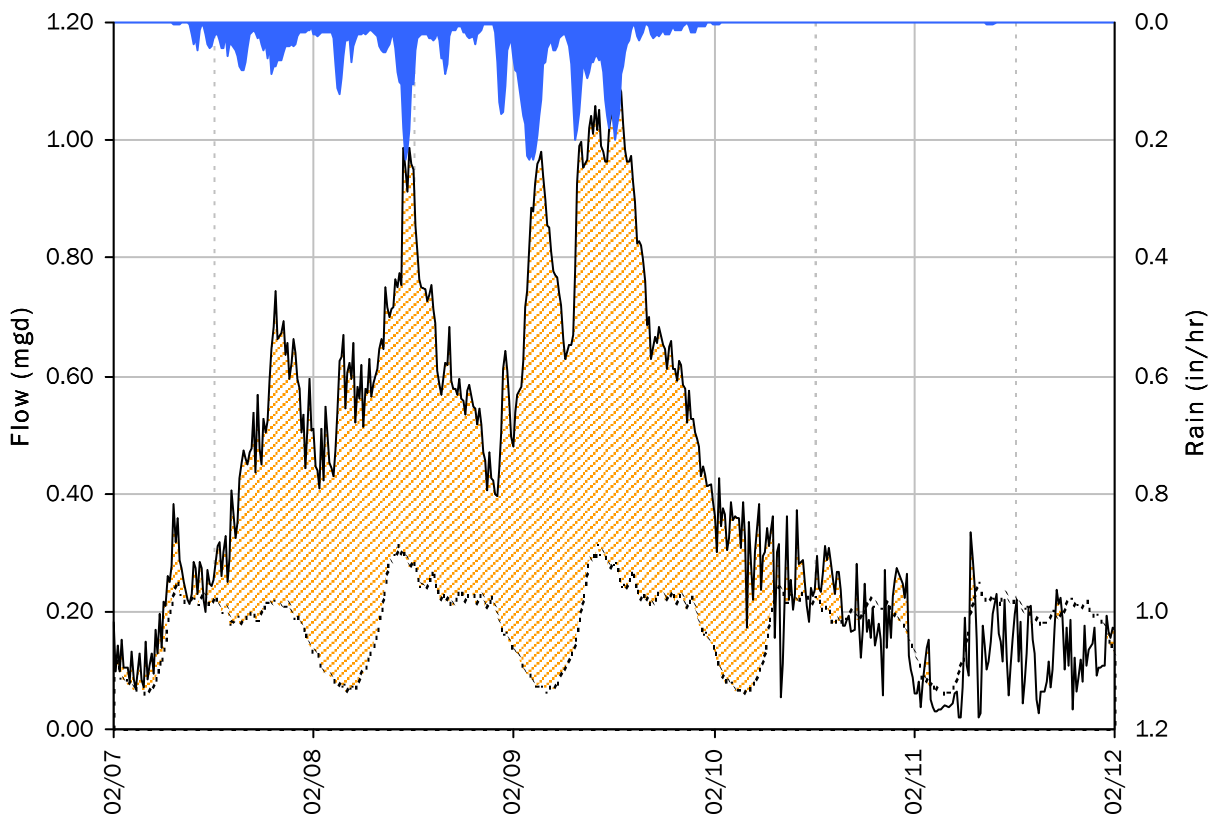
Pipe Diameter:	10	*inches*
Peak Measured Level:	82.3	*inches*
Peak d/D Ratio:	8.23	

Surcharged 72.3 inches over crown

SITE M6
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 1.10 *mgd*
PF: 6.21

Peak Level: 82.34 *in*
d/D Ratio: 8.23

Inflow / Infiltration

Peak I/I Rate: 0.91 *mgd*
Total I/I: 1,202,000 *gallons*

City of Pinole

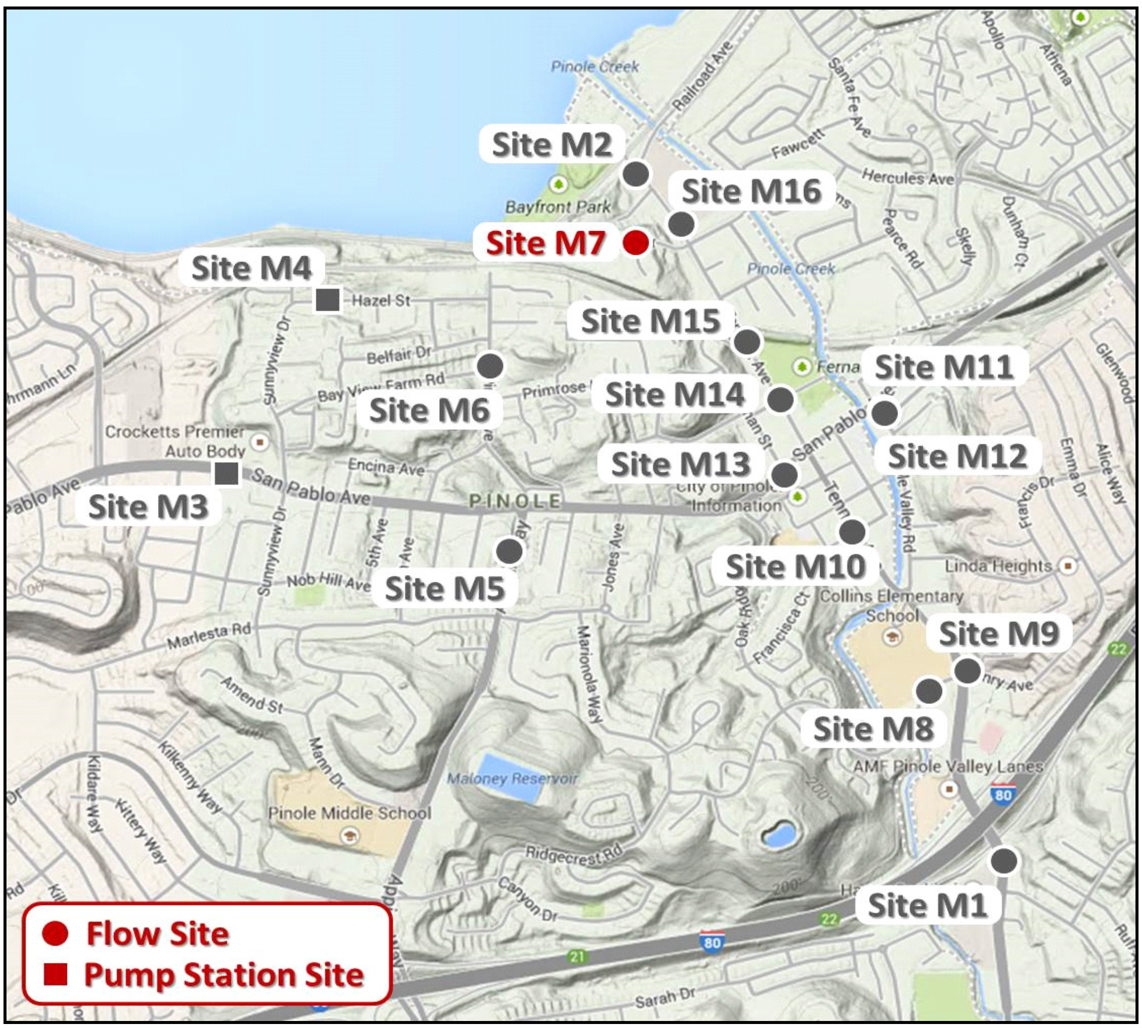
Sanitary Sewer Flow Monitoring

Temporary Monitoring: February 2014

Monitoring Site: Site M7

Location: Intersection of Orleans Dr. and Zoe Ct.

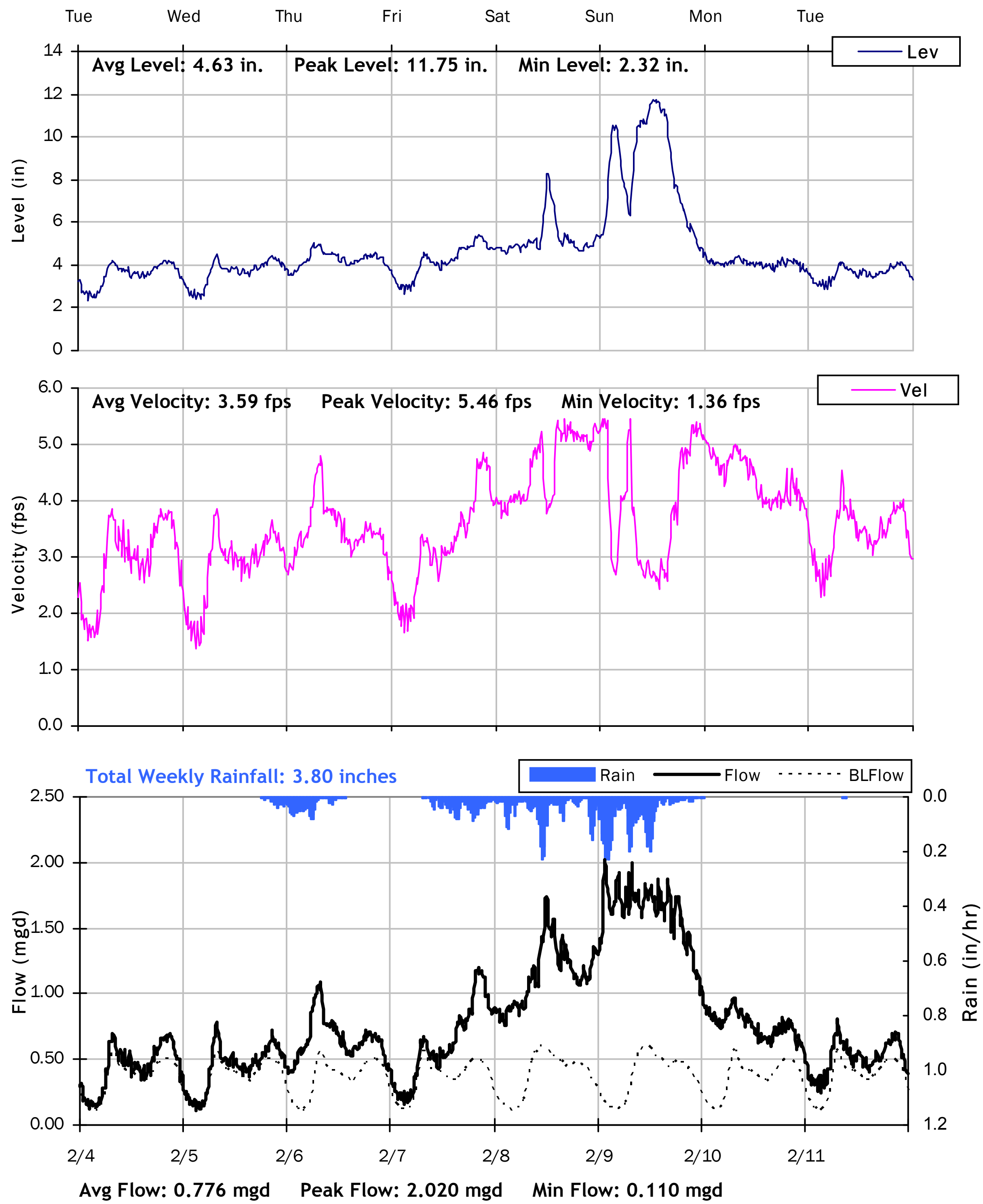
Data Summary Report



Vicinity Map: Site M7

SITE M7

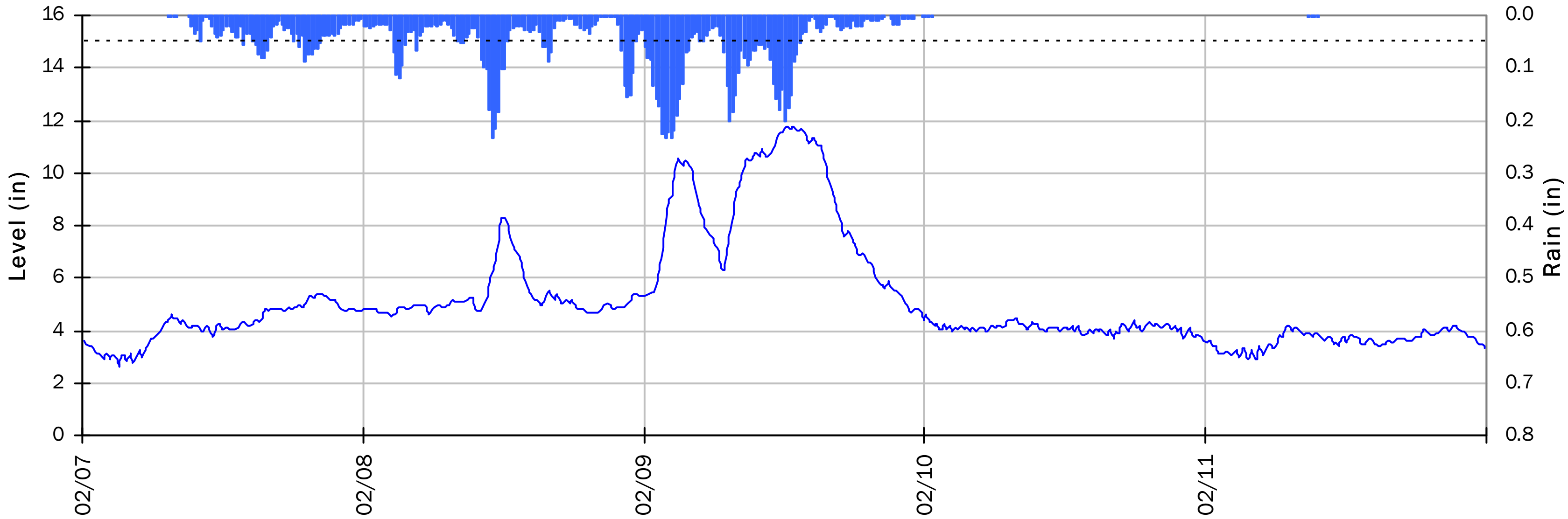
Weekly Level, Velocity and Flow Hydrographs

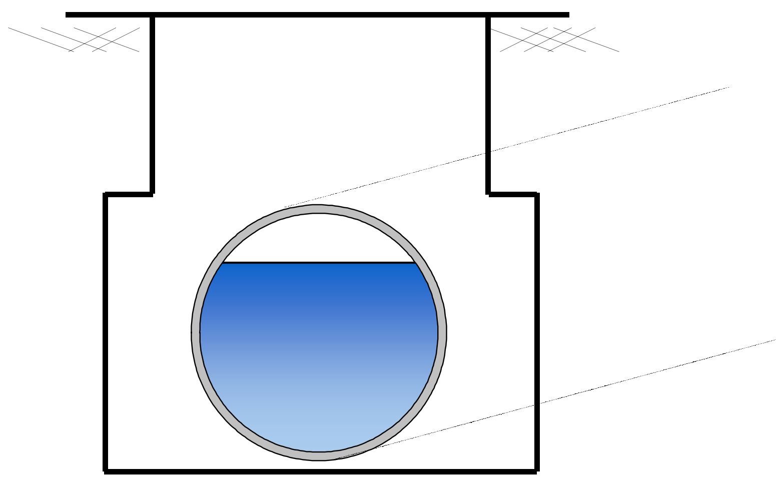


SITE M7

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



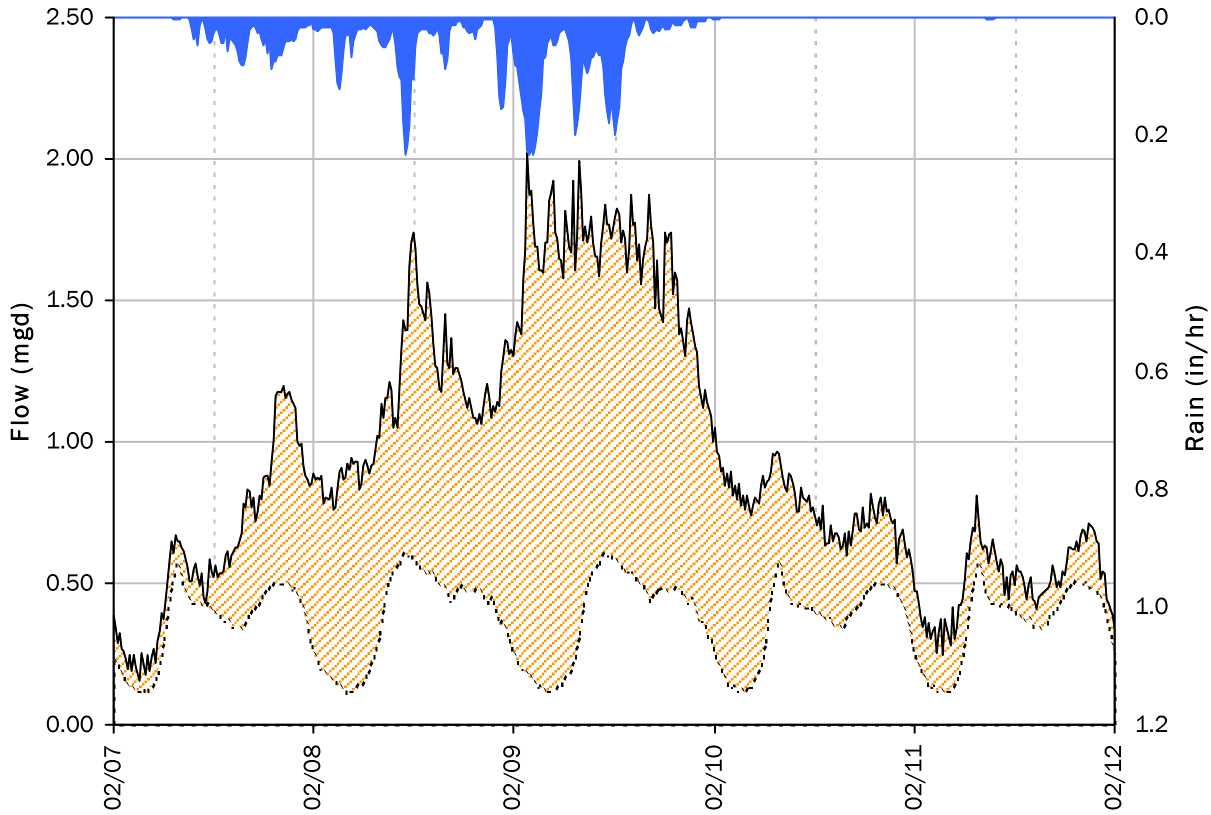


Pipe Diameter:	15	*inches*
Peak Measured Level:	11.8	*inches*
Peak d/D Ratio:	0.78	

SITE M7
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 2.02 *mgd*
PF: 5.56

Peak Level: 11.75 *in*
d/D Ratio: 0.78

Inflow / Infiltration

Peak I/I Rate: 1.85 *mgd*
Total I/I: 2,841,000 *gallons*

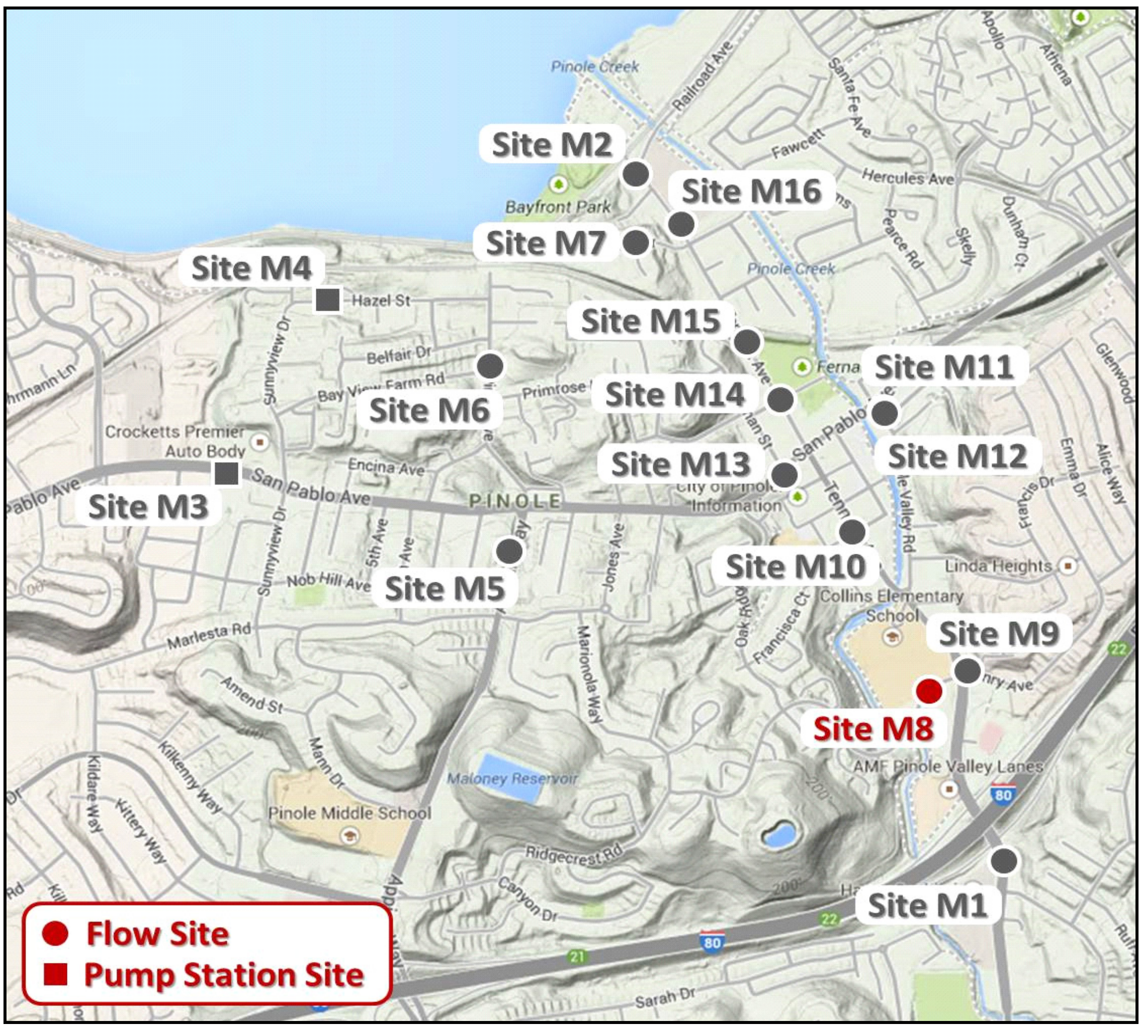
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M8

Location: Henry Ave., west of Pinole Valley Rd.

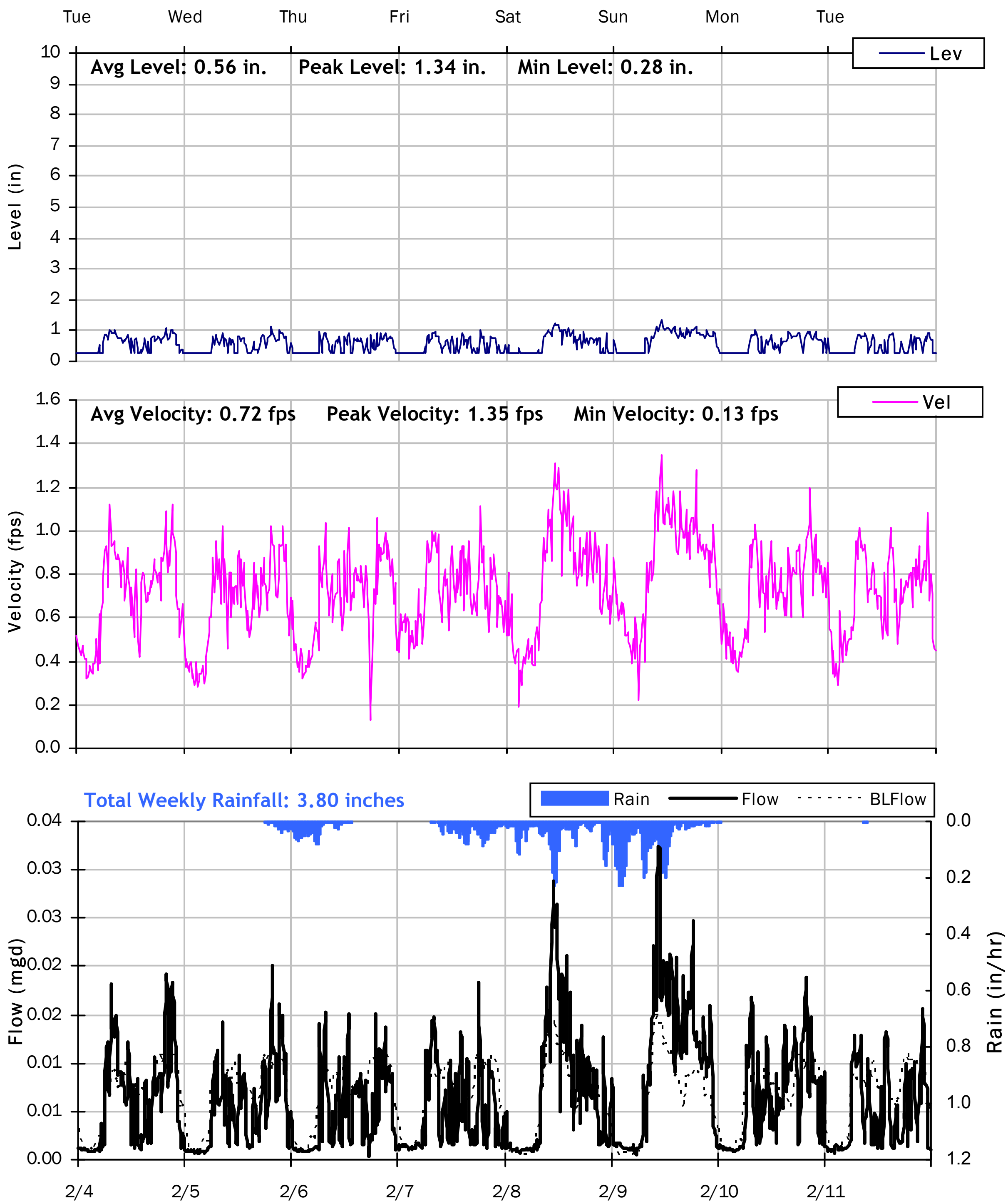
Data Summary Report



Vicinity Map: Site M8

SITE M8

Weekly Level, Velocity and Flow Hydrographs

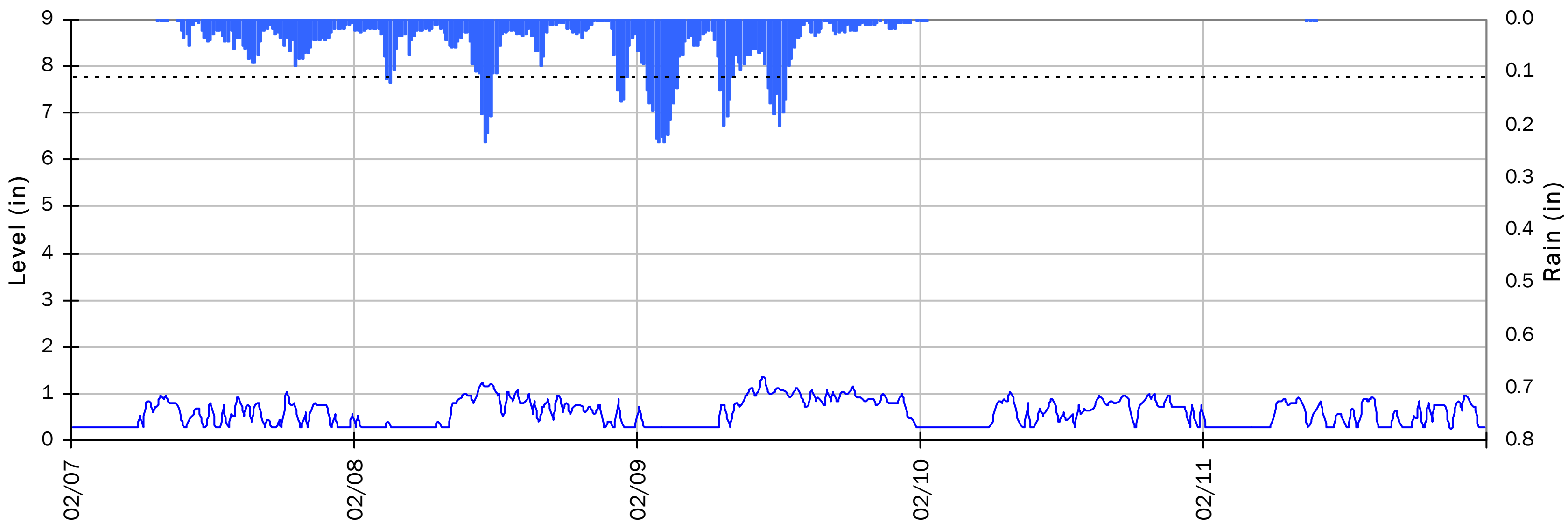


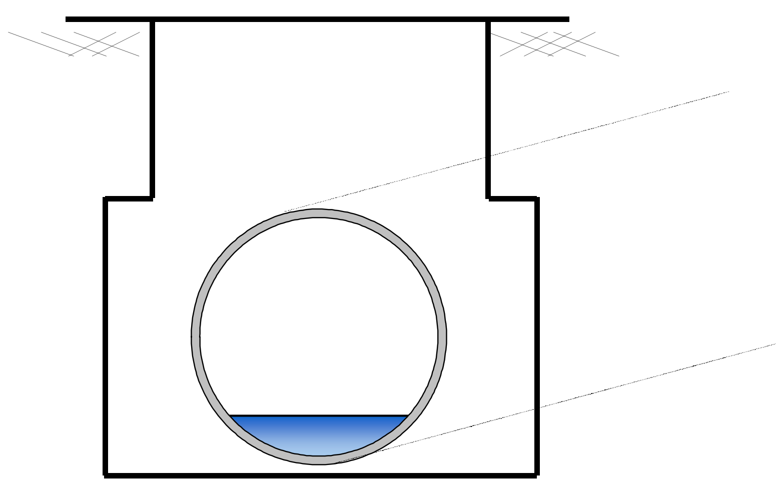
Avg Flow: 0.006 mgd **Peak Flow: 0.032 mgd** **Min Flow: 0.000 mgd**

SITE M8

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



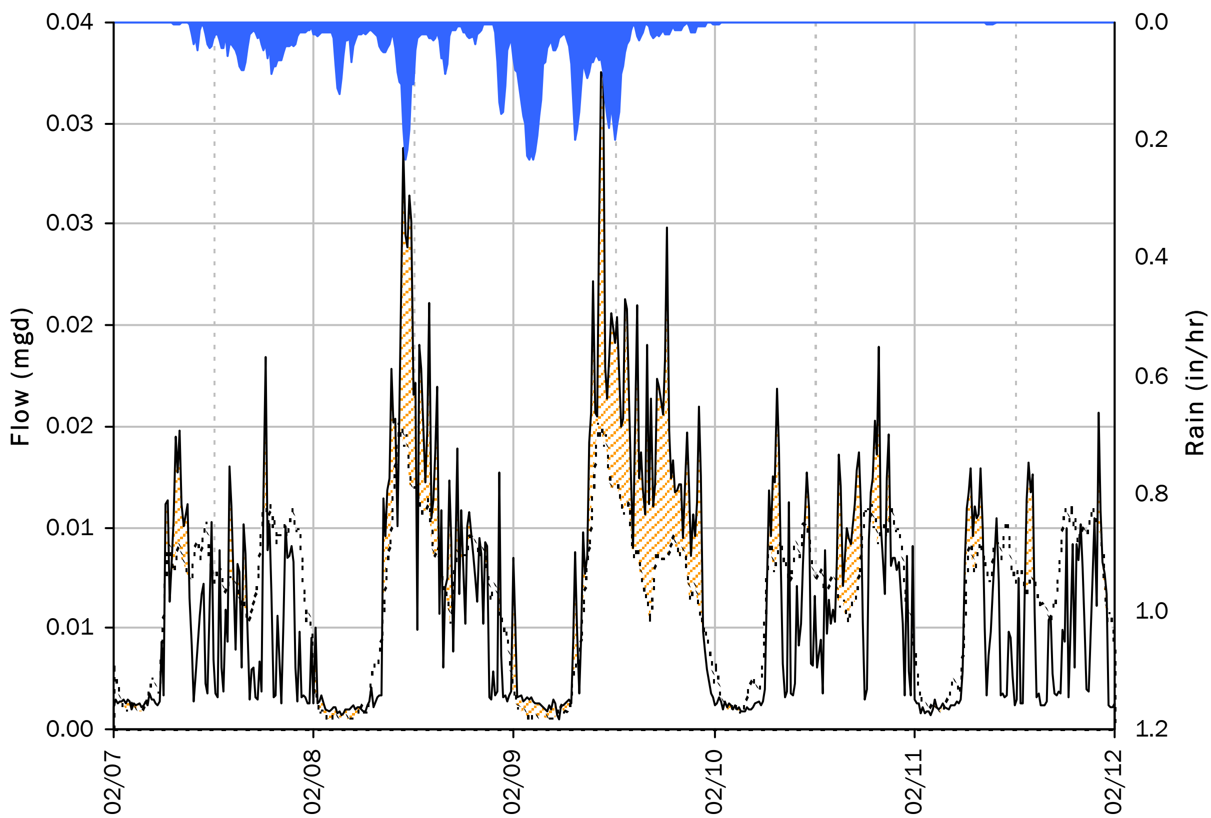


Pipe Diameter:	7.75	*inches*
Peak Measured Level:	1.34	*inches*
Peak d/D Ratio:	0.17	

SITE M8
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow:	0.03 *mgd*
PF:	4.98
Peak Level:	1.34 *in*
d/D Ratio:	0.17

Inflow / Infiltration

Peak I/I Rate:	0.02 *mgd*
Total I/I:	1,000 *gallons*

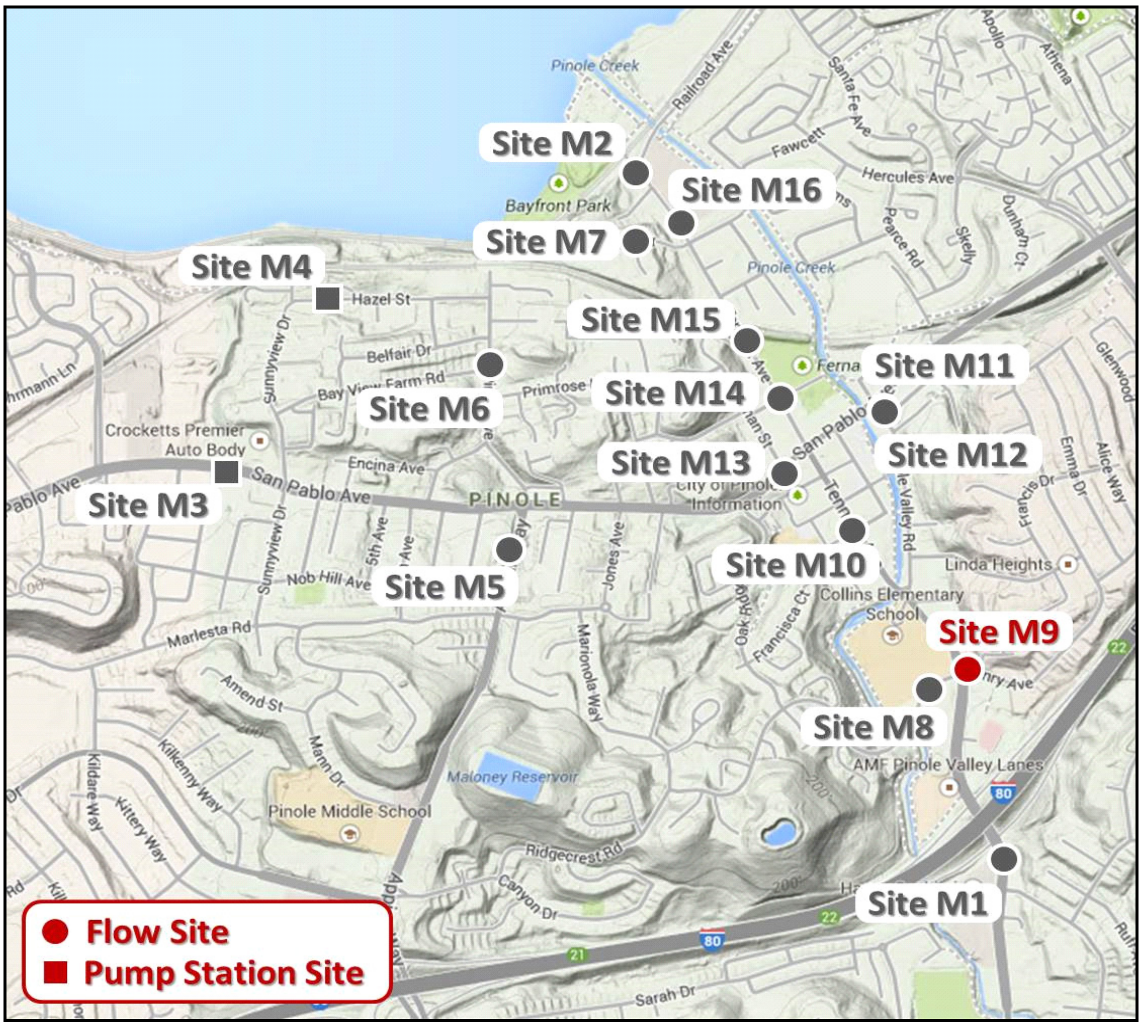
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M9

Location: Intersection of Henry Ave. and Pinole Valley Rd.

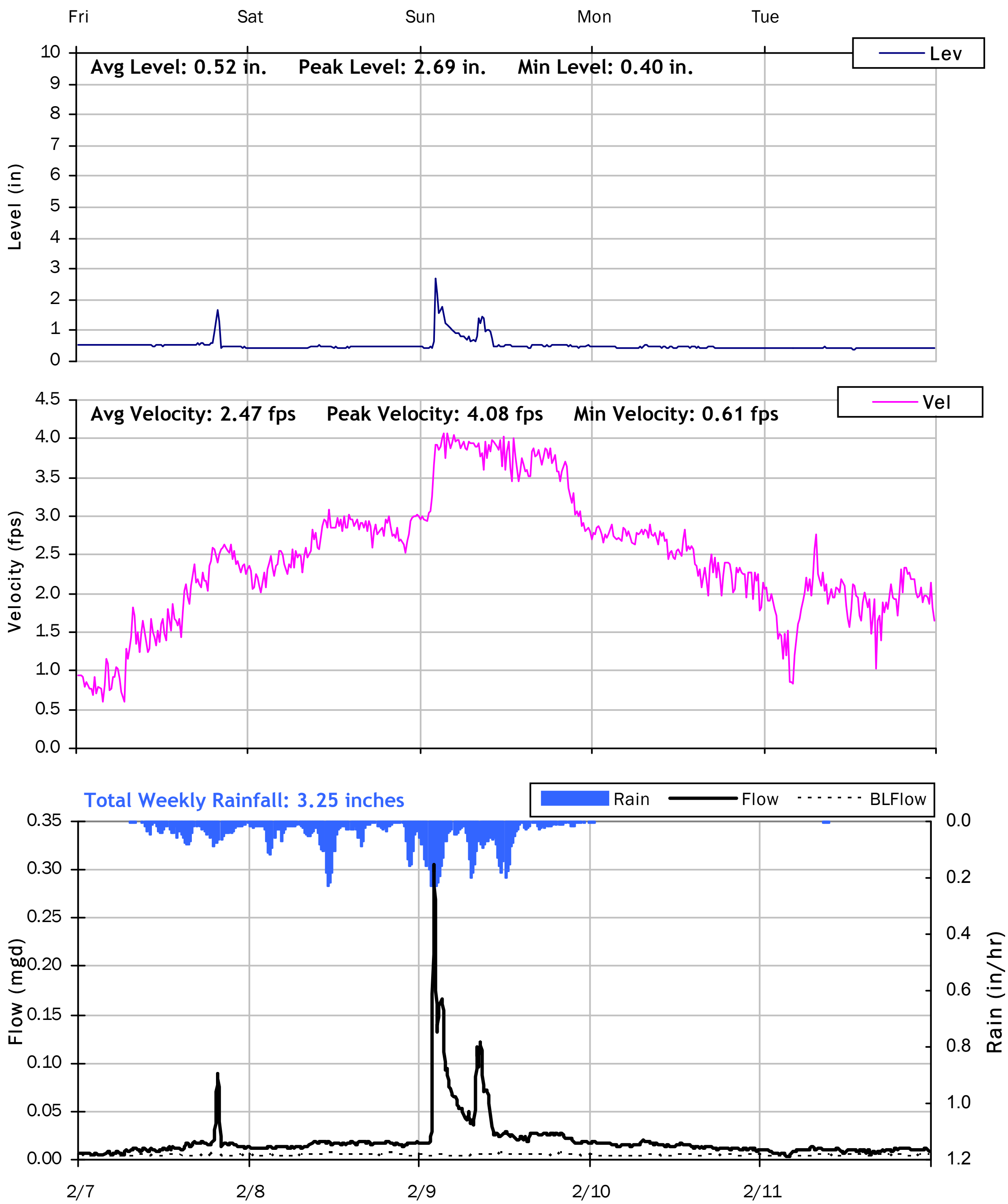
Data Summary Report



Vicinity Map: Site M9

SITE M9

Weekly Level, Velocity and Flow Hydrographs

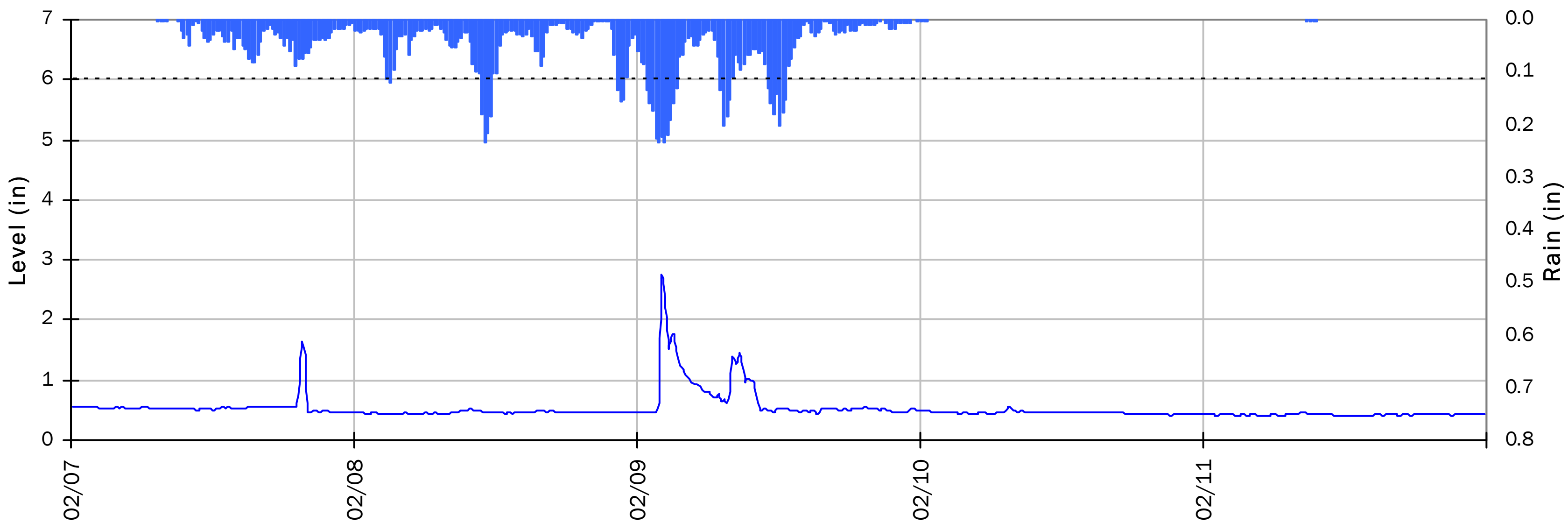


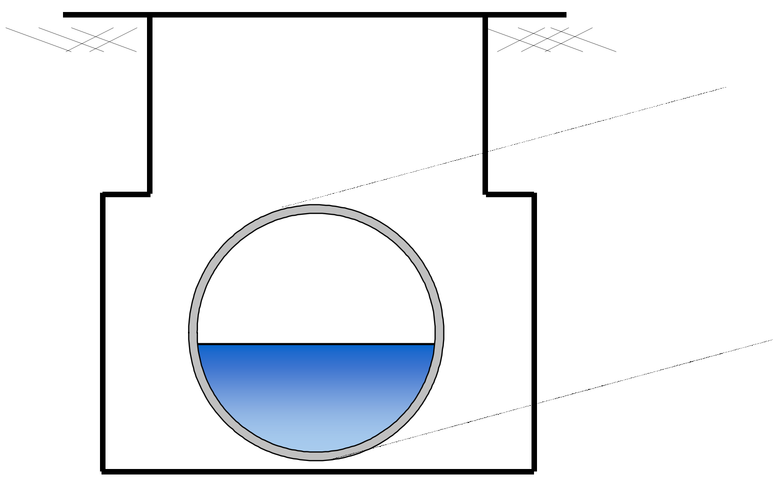
Avg Flow: 0.020 mgd **Peak Flow: 0.299 mgd** **Min Flow: 0.004 mgd**

SITE M9

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



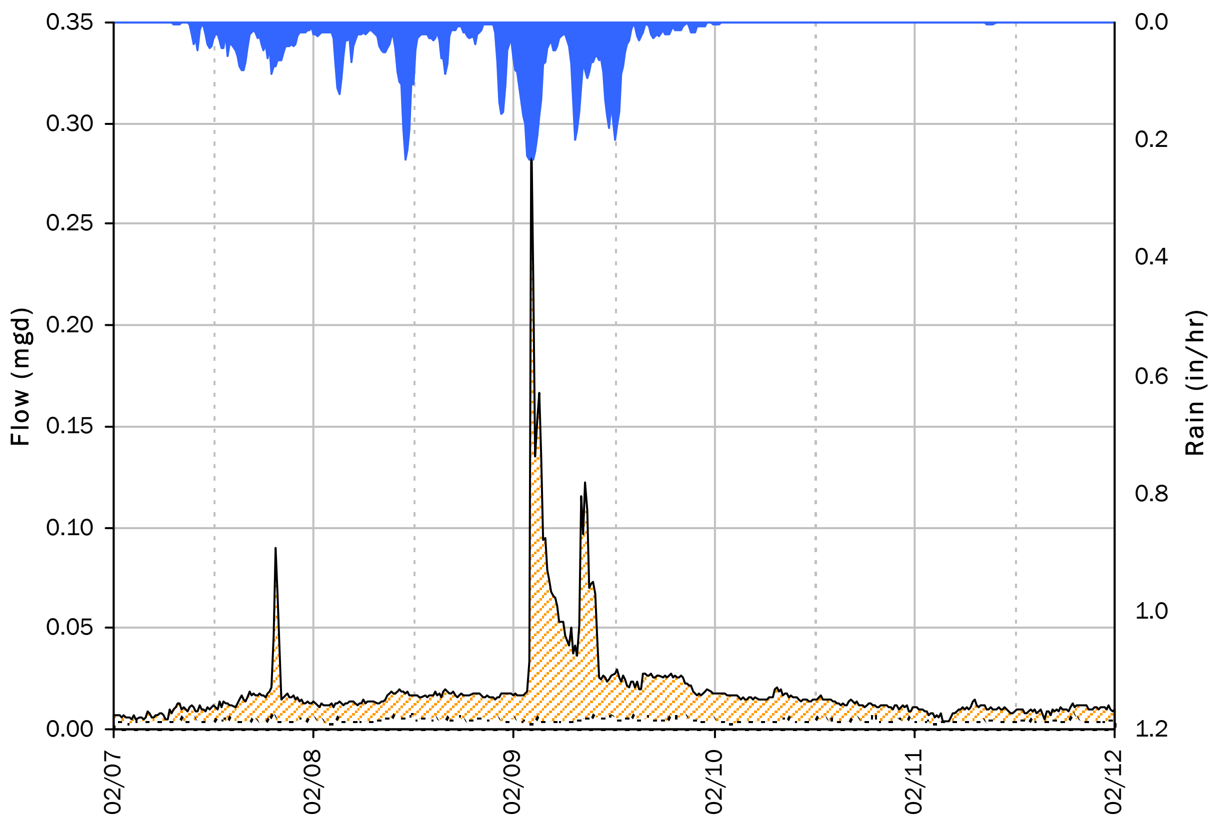


Pipe Diameter:	6	*inches*
Peak Measured Level:	2.69	*inches*
Peak d/D Ratio:	0.45	

SITE M9
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.30 *mgd*
PF: 67.45

Peak Level: 2.69 *in*
d/D Ratio: 0.45

Inflow / Infiltration

Peak I/I Rate: 0.30 *mgd*
Total I/I: 76,000 *gallons*

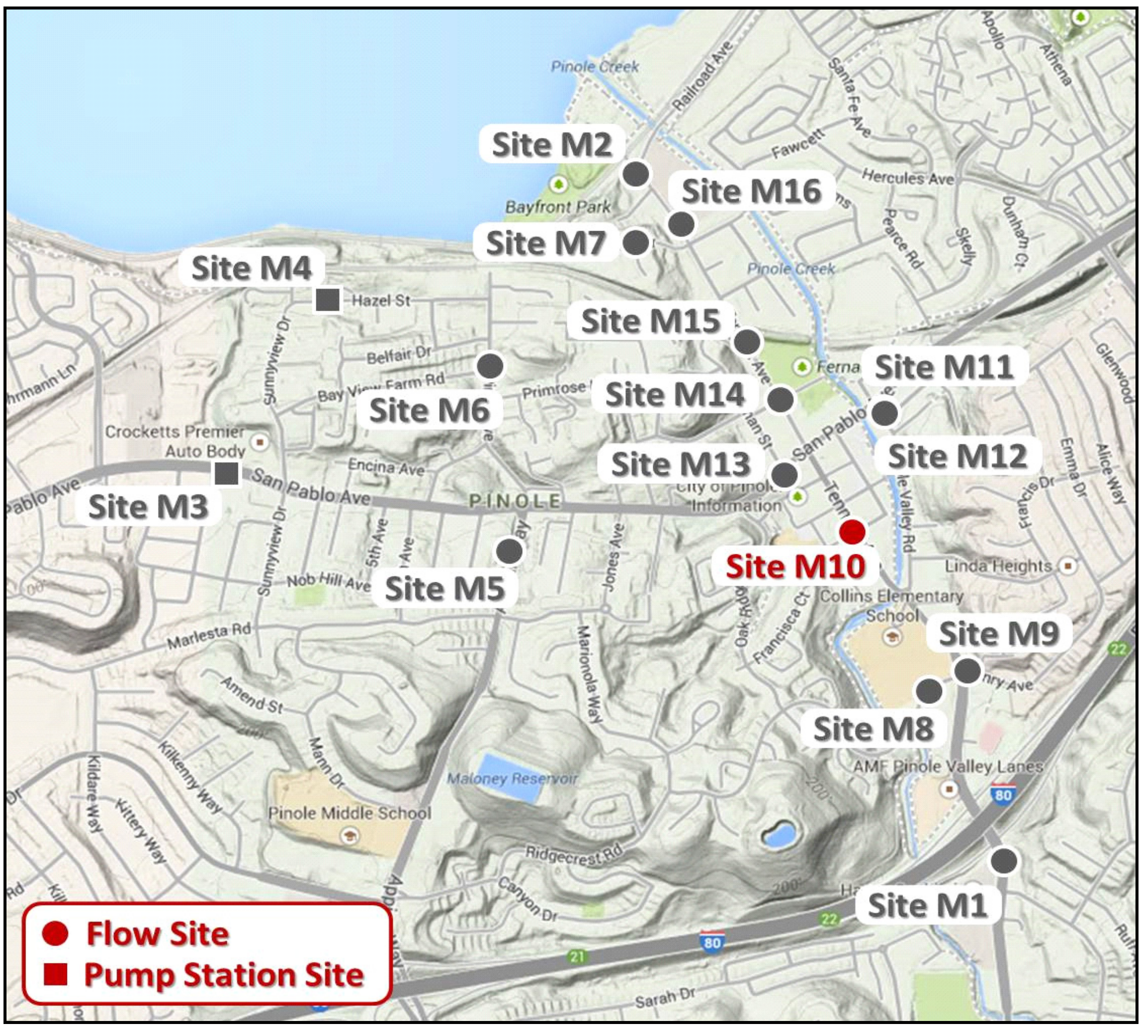
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M10

Location: Intersection of Tennant Ave. and Prune St.

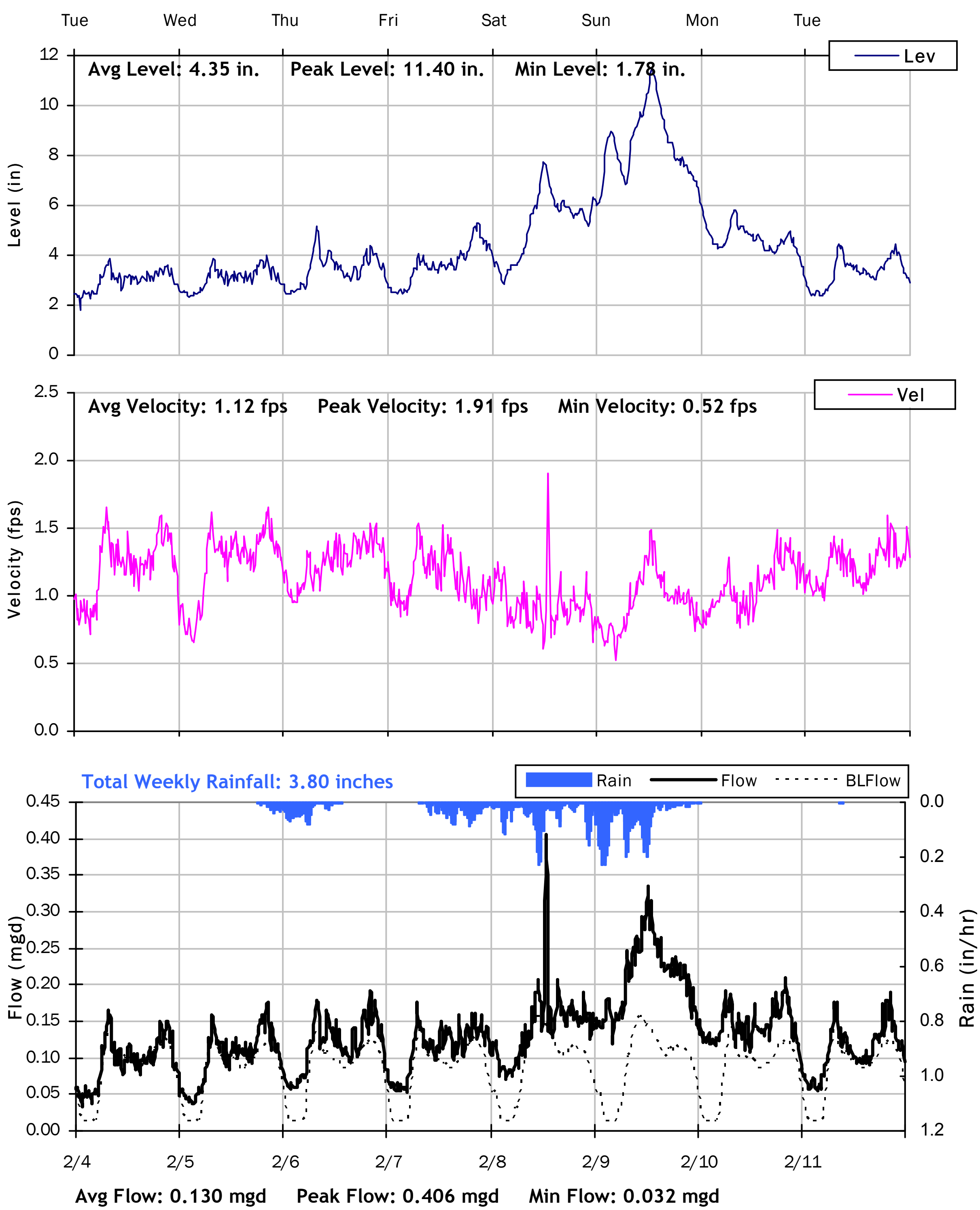
Data Summary Report



Vicinity Map: Site M10

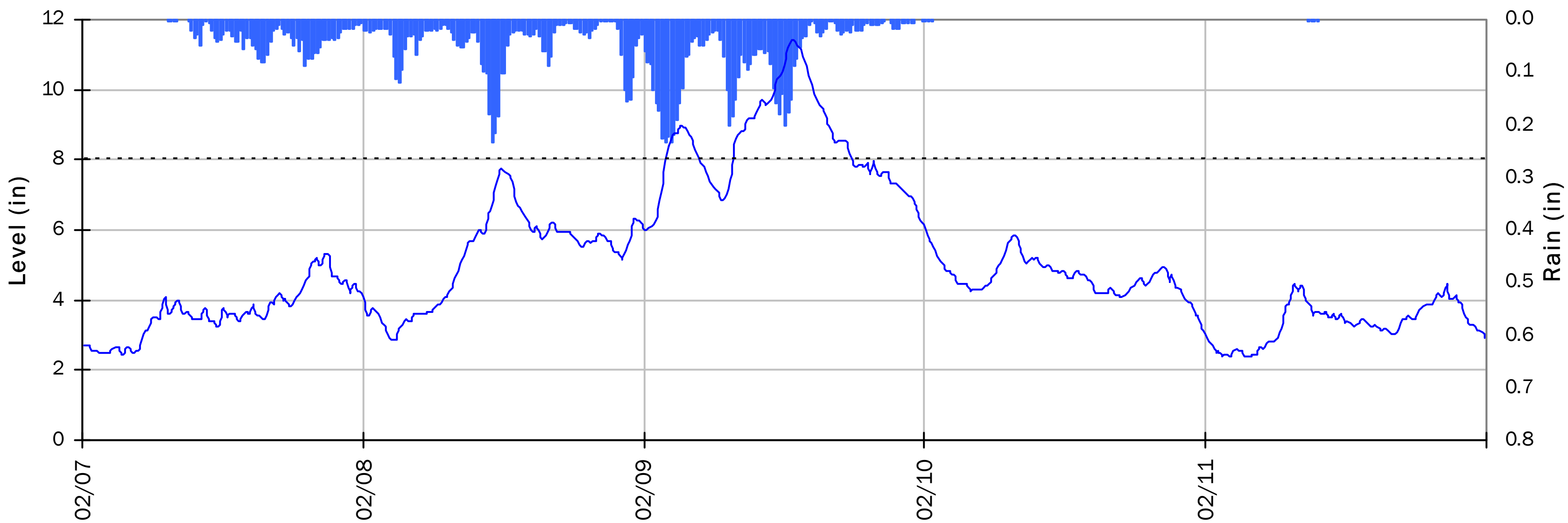
SITE M10

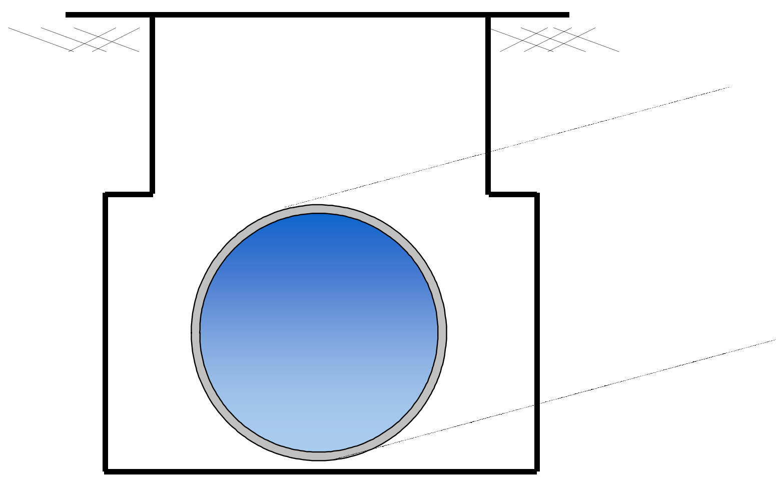
Weekly Level, Velocity and Flow Hydrographs



SITE M10
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





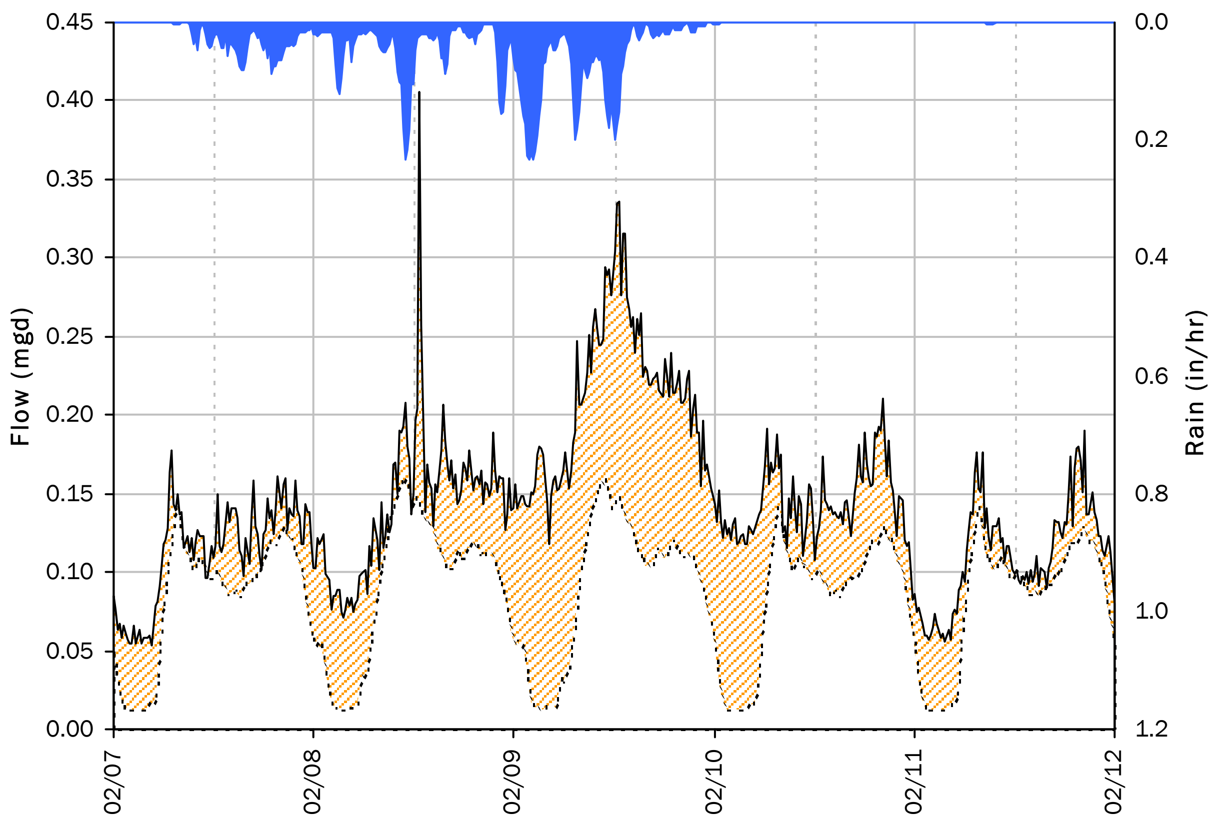
Pipe Diameter:	8	*inches*
Peak Measured Level:	11.4	*inches*
Peak d/D Ratio:	1.43	

Surcharged 3.4 inches over crown

SITE M10
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.41 *mgd*
PF: 4.76

Peak Level: 11.40 *in*
d/D Ratio: 1.43

Inflow / Infiltration

Peak I/I Rate: 0.26 *mgd*
Total I/I: 291,000 *gallons*

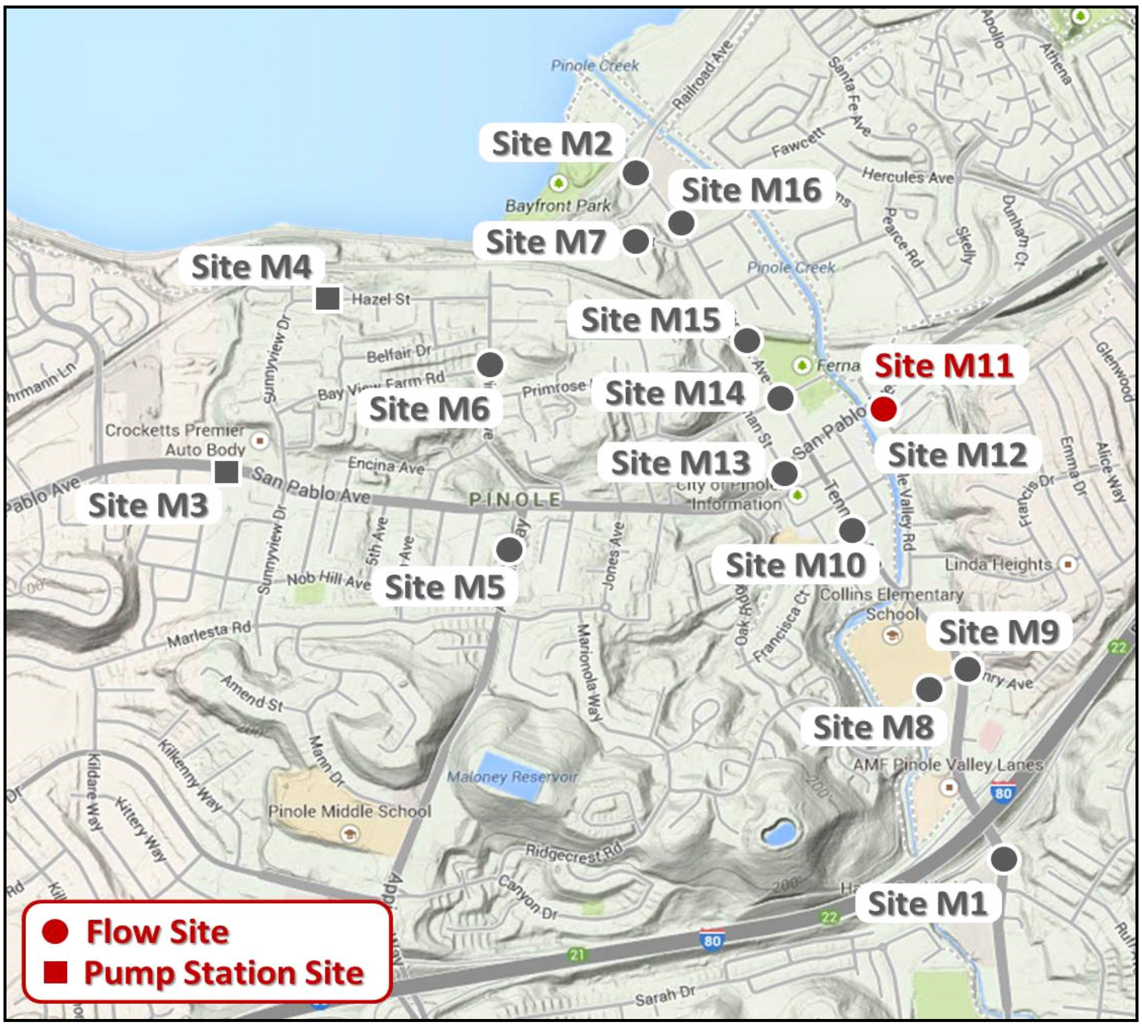
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M11

Location: Intersection of Pinole Valley Rd. and Rafaela St.

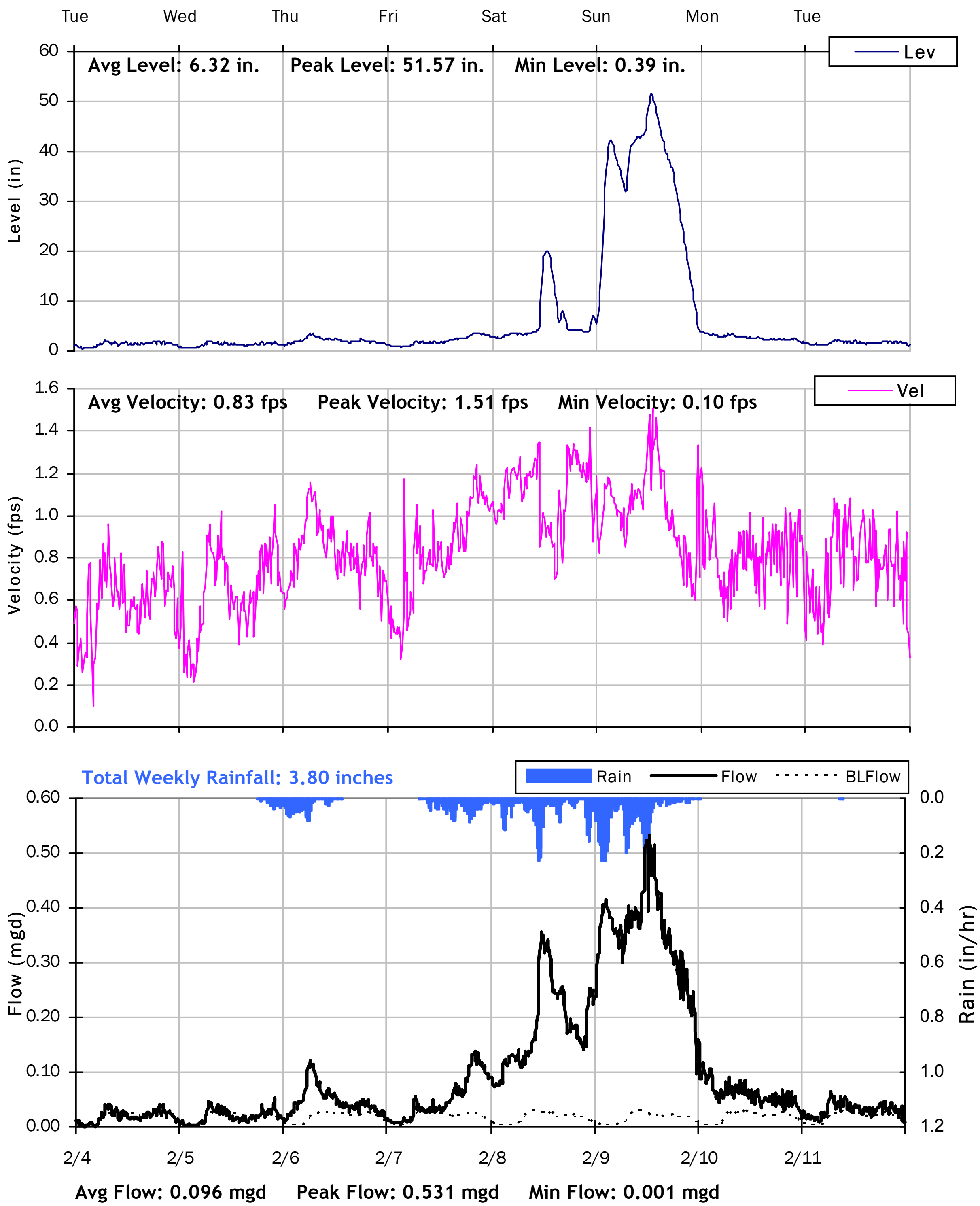
Data Summary Report



Vicinity Map: Site M11

SITE M11

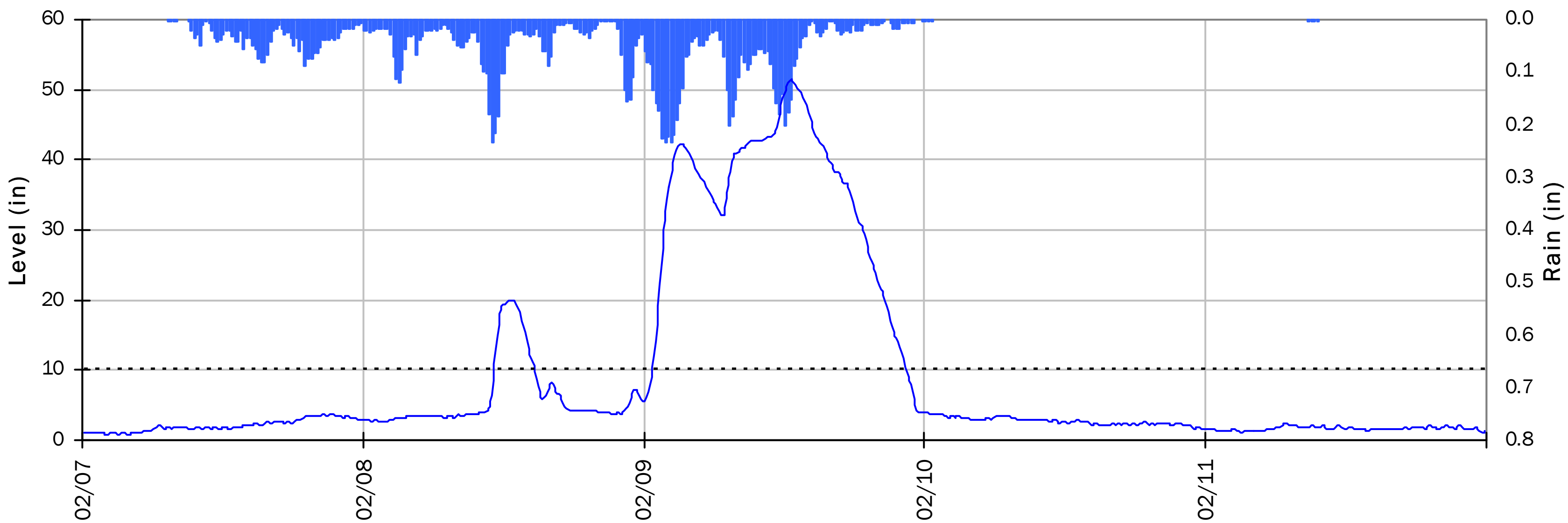
Weekly Level, Velocity and Flow Hydrographs

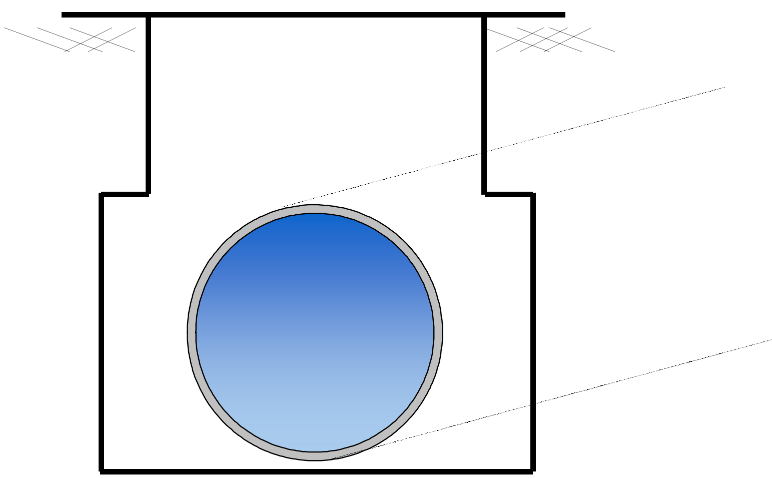


SITE M11

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





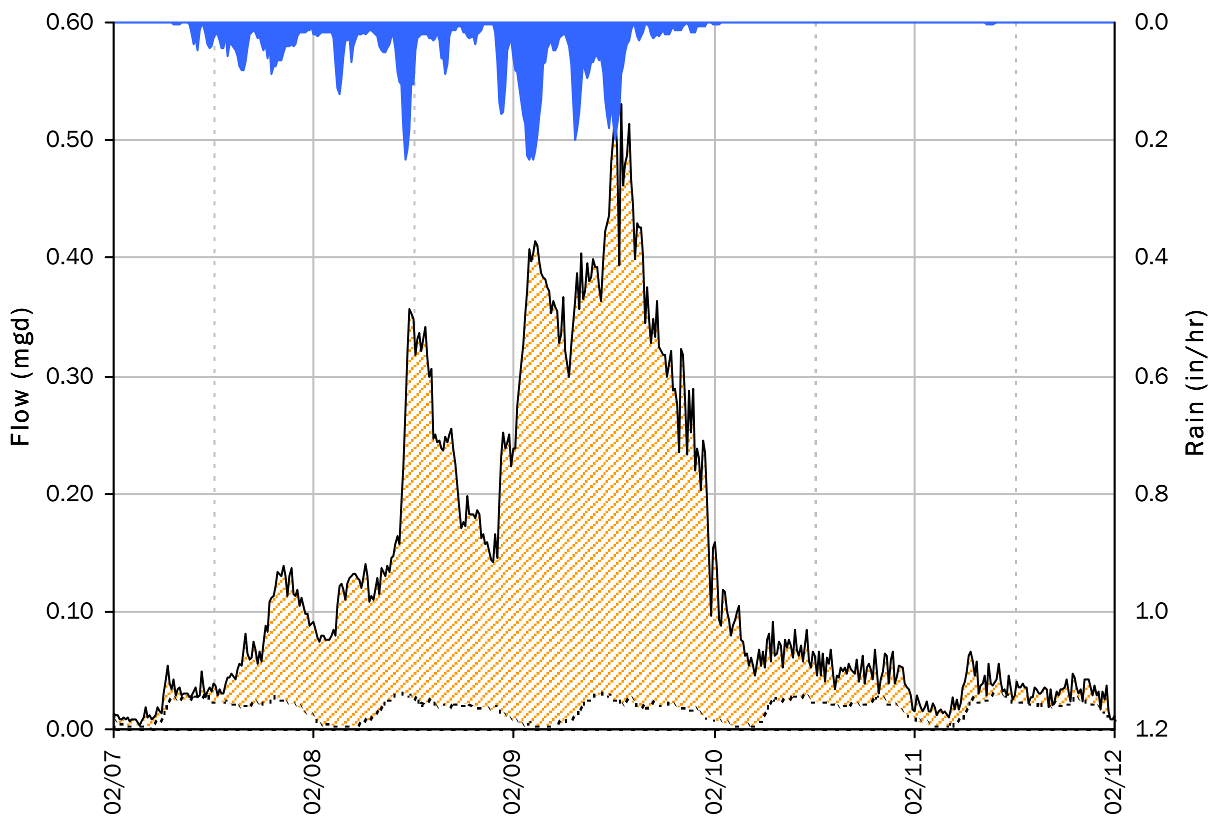
Pipe Diameter:	10	*inches*
Peak Measured Level:	51.6	*inches*
Peak d/D Ratio:	5.16	

Surcharged 41.6 inches over crown

SITE M11
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.53 *mgd*
PF: 30.59

Peak Level: 51.57 *in*
d/D Ratio: 5.16

Inflow / Infiltration

Peak I/I Rate: 0.51 *mgd*
Total I/I: 594,000 *gallons*

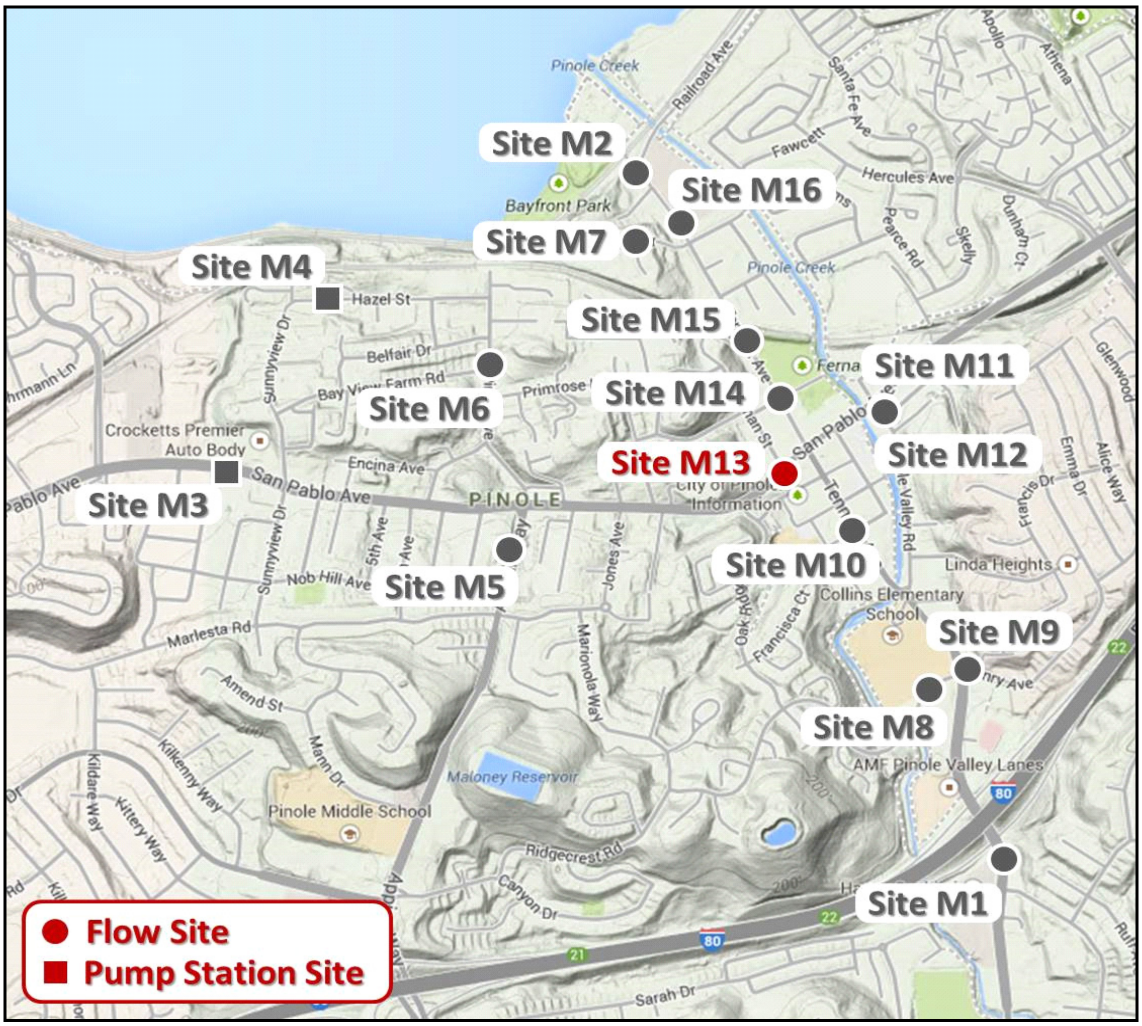
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M13

Location: San Pablo Ave. just west of Quinan St.

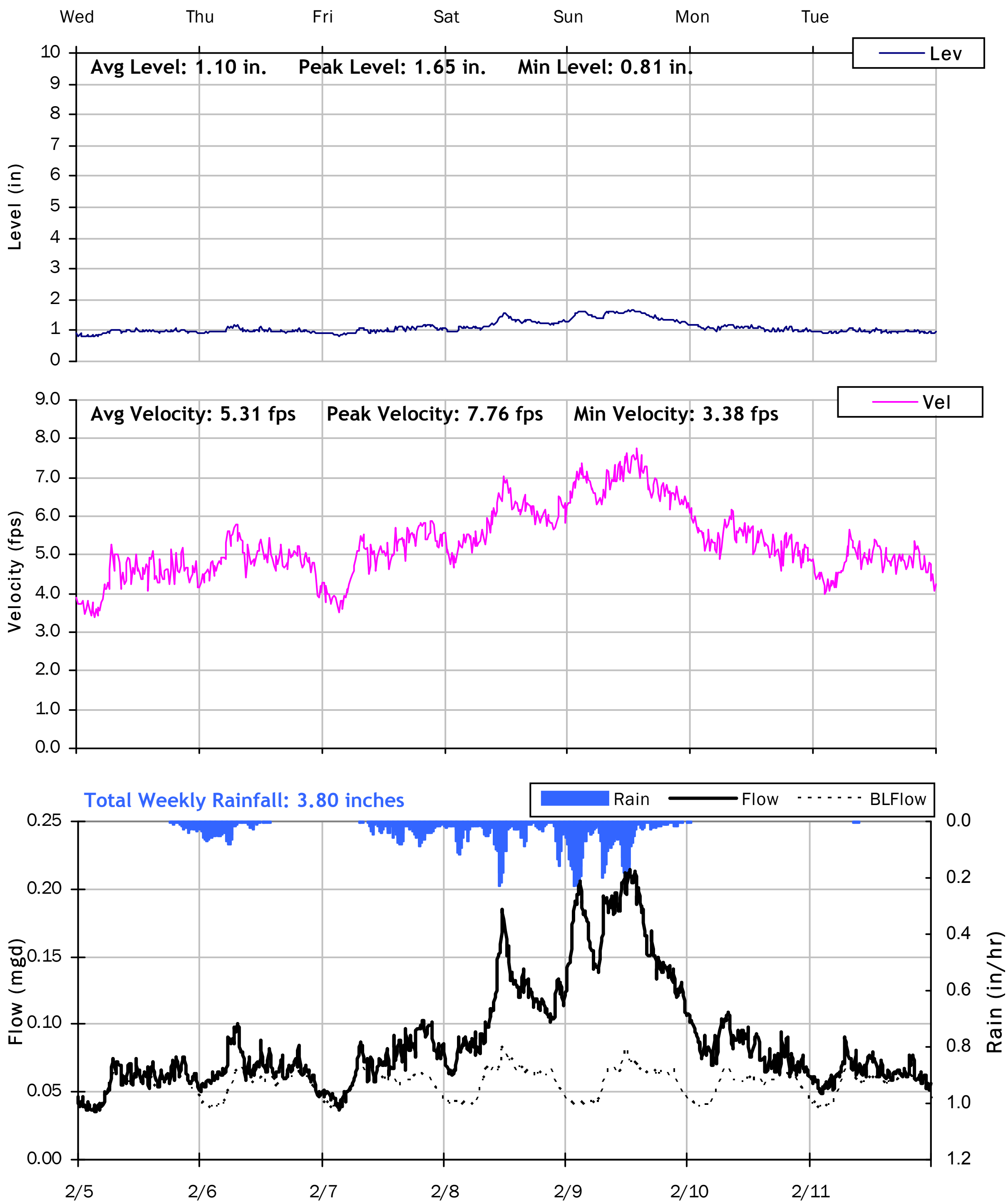
Data Summary Report



Vicinity Map: Site M13

SITE M13

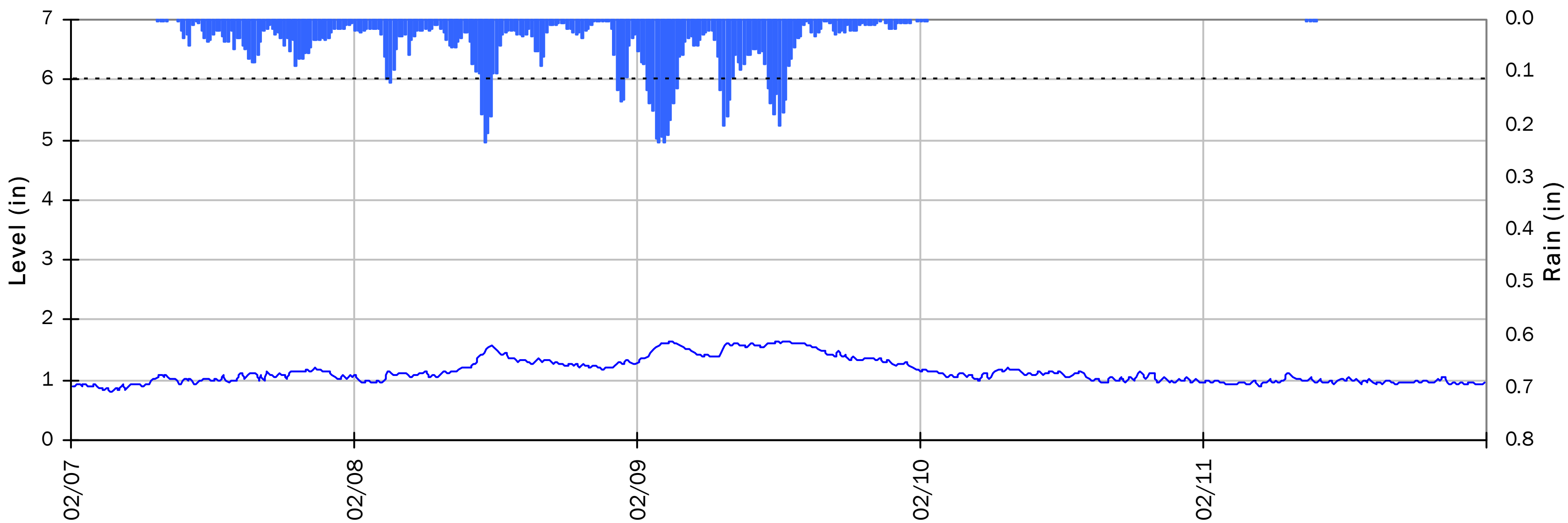
Weekly Level, Velocity and Flow Hydrographs

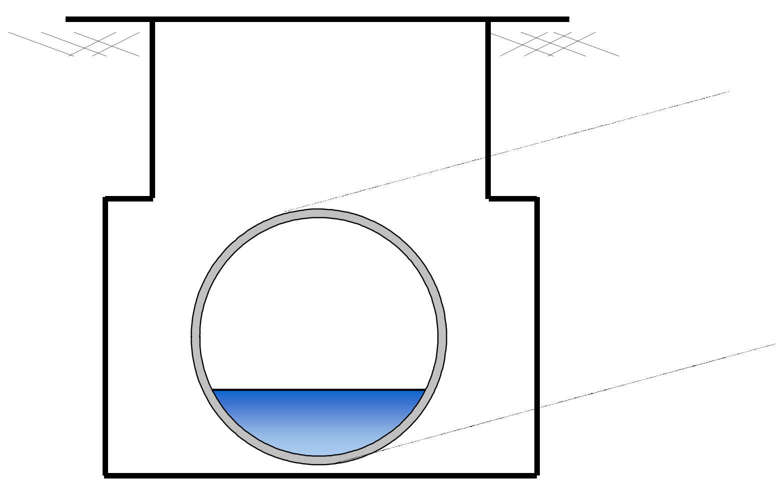


Avg Flow: 0.089 mgd **Peak Flow: 0.215 mgd** **Min Flow: 0.036 mgd**

SITE M13
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



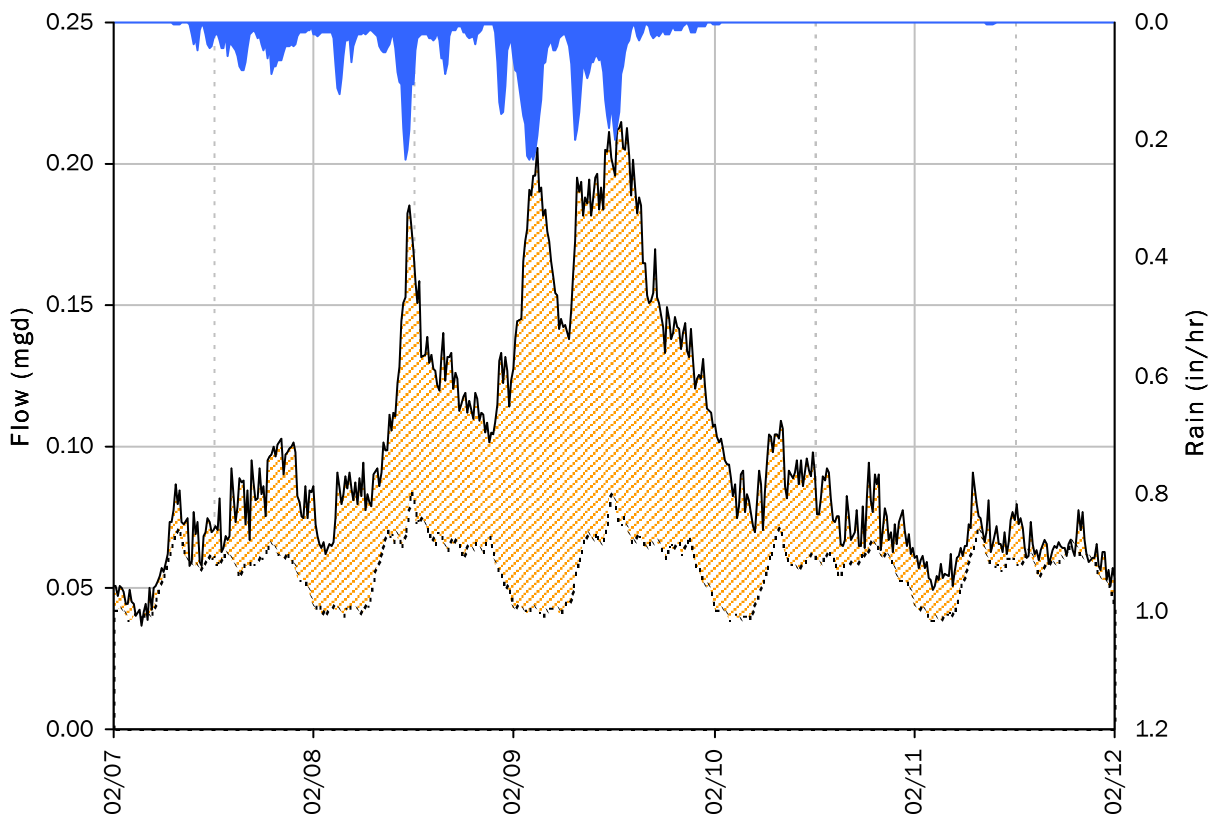


Pipe Diameter:	6	*inches*
Peak Measured Level:	1.65	*inches*
Peak d/D Ratio:	0.28	

SITE M13
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.21 *mgd*
PF: 3.84

Peak Level: 1.65 *in*
d/D Ratio: 0.28

Inflow / Infiltration

Peak I/I Rate: 0.16 *mgd*
Total I/I: 214,000 *gallons*

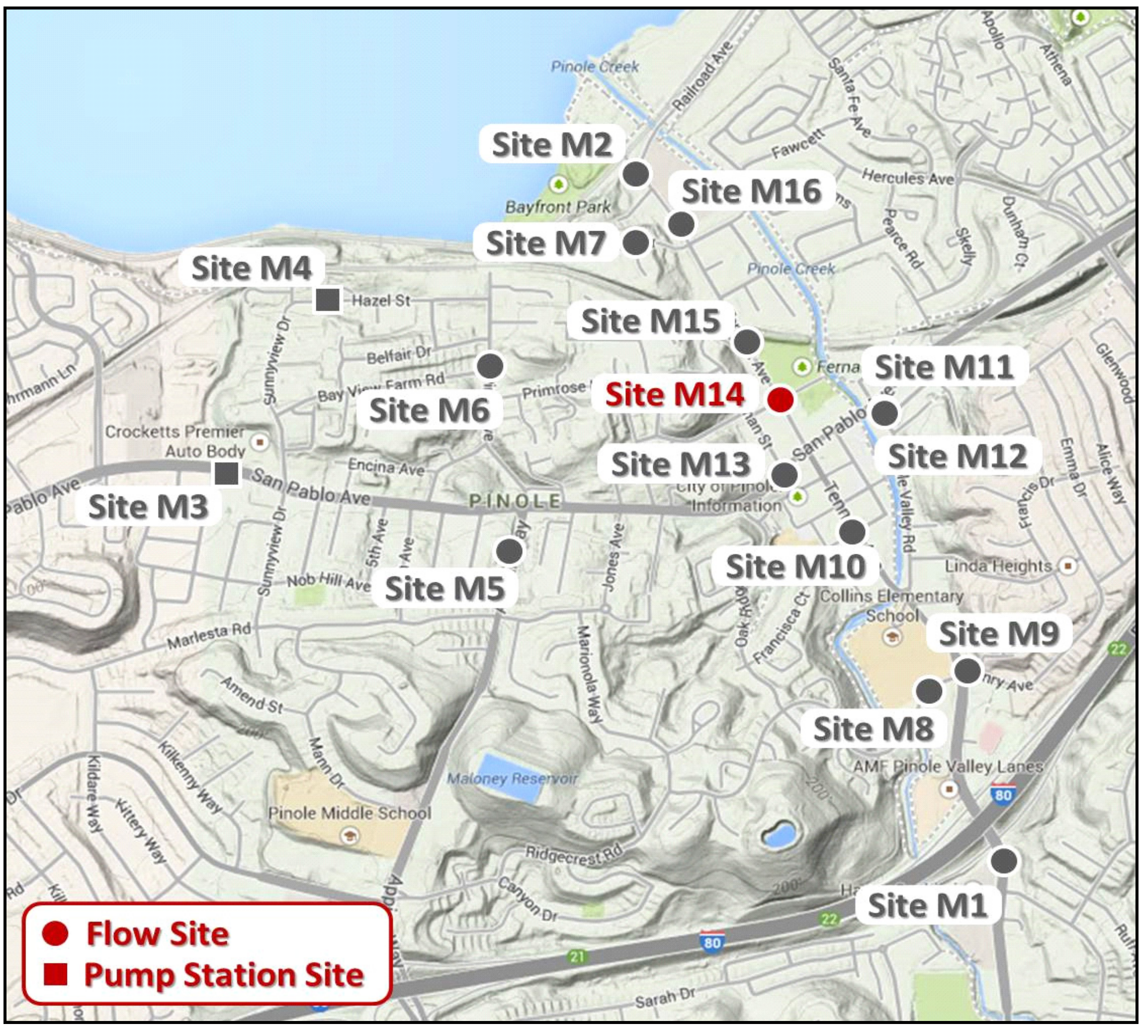
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M14

Location: Intersection of Tennant Ave. and Park St.

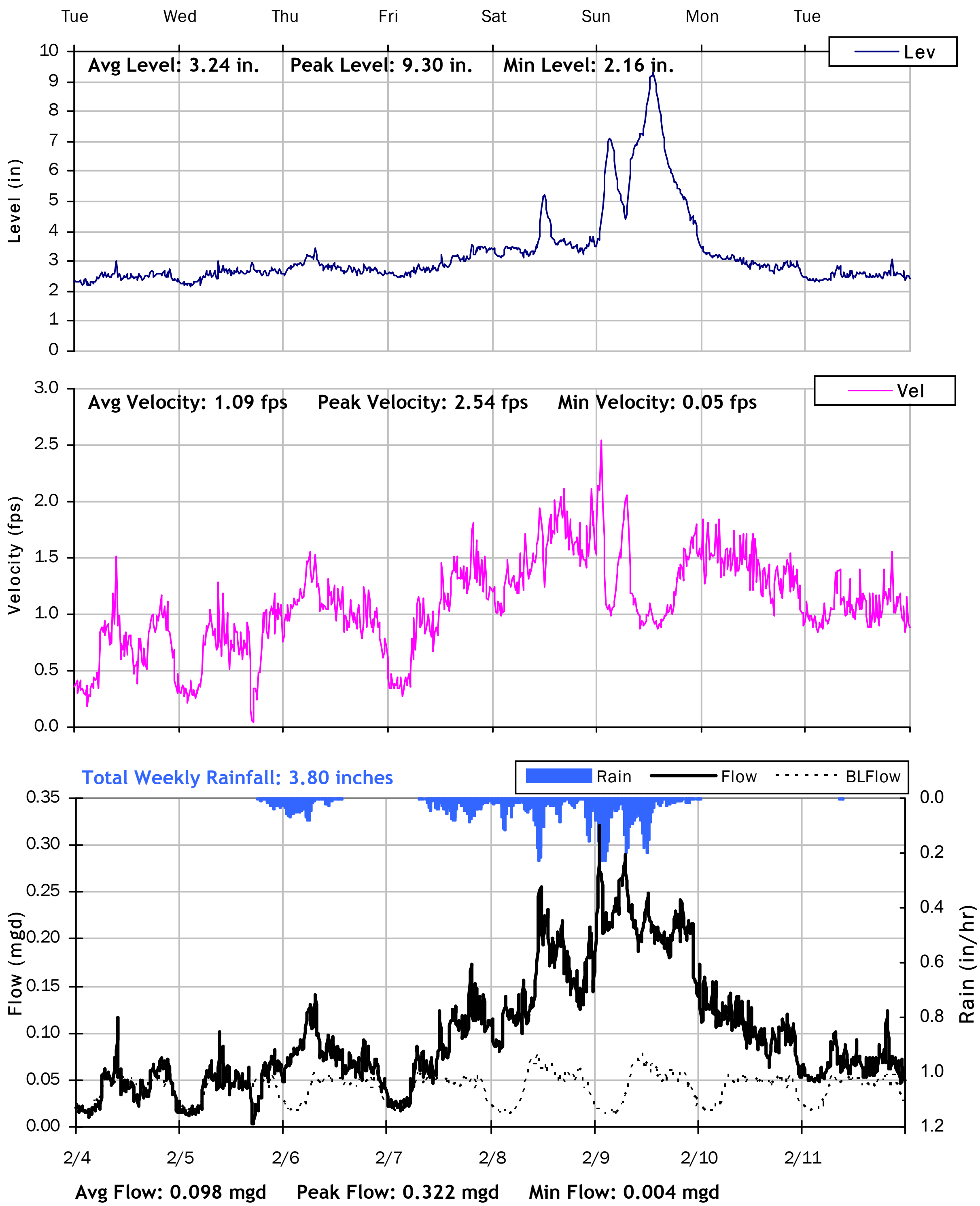
Data Summary Report



Vicinity Map: Site M14

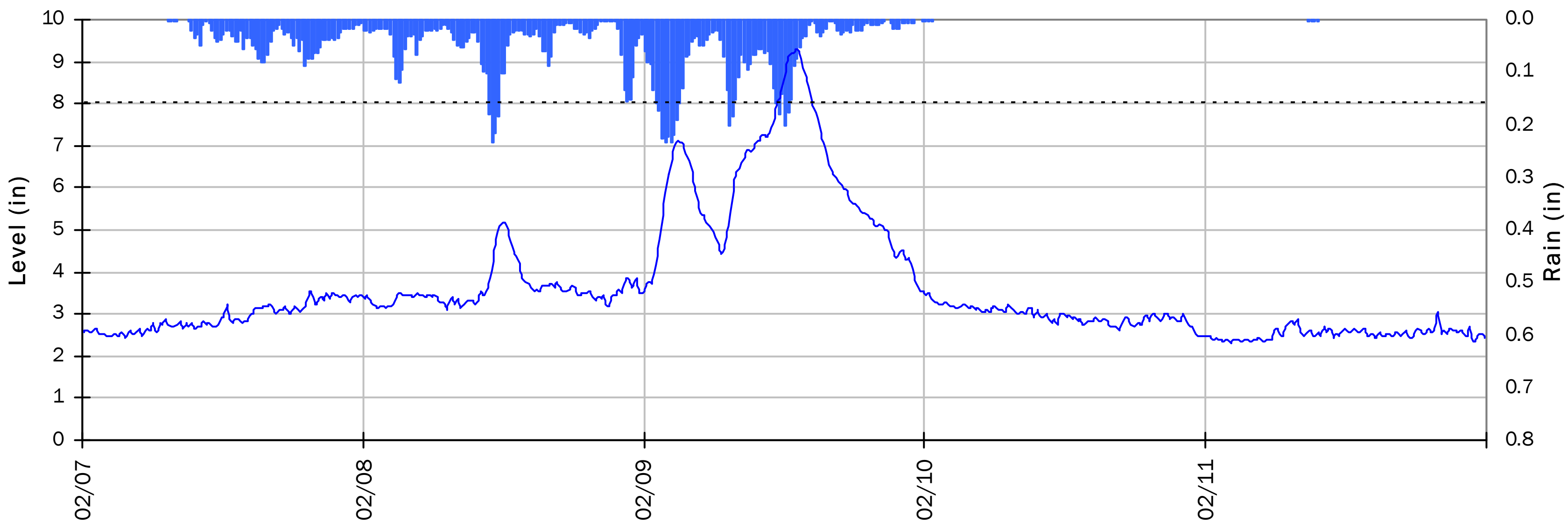
SITE M14

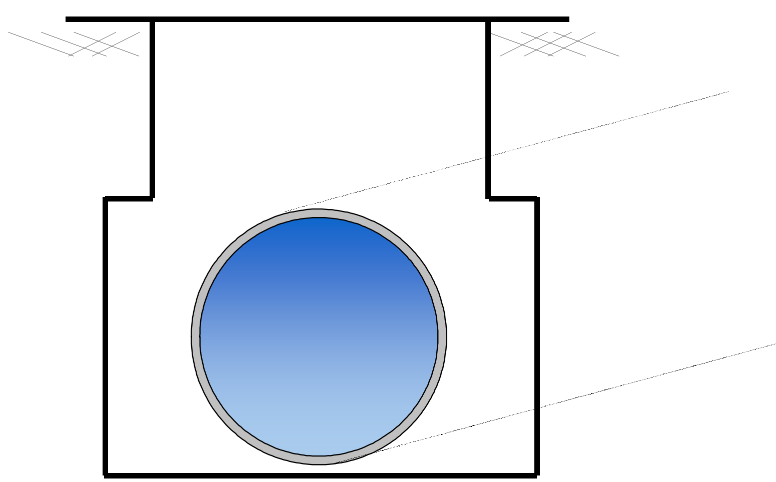
Weekly Level, Velocity and Flow Hydrographs



SITE M14
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





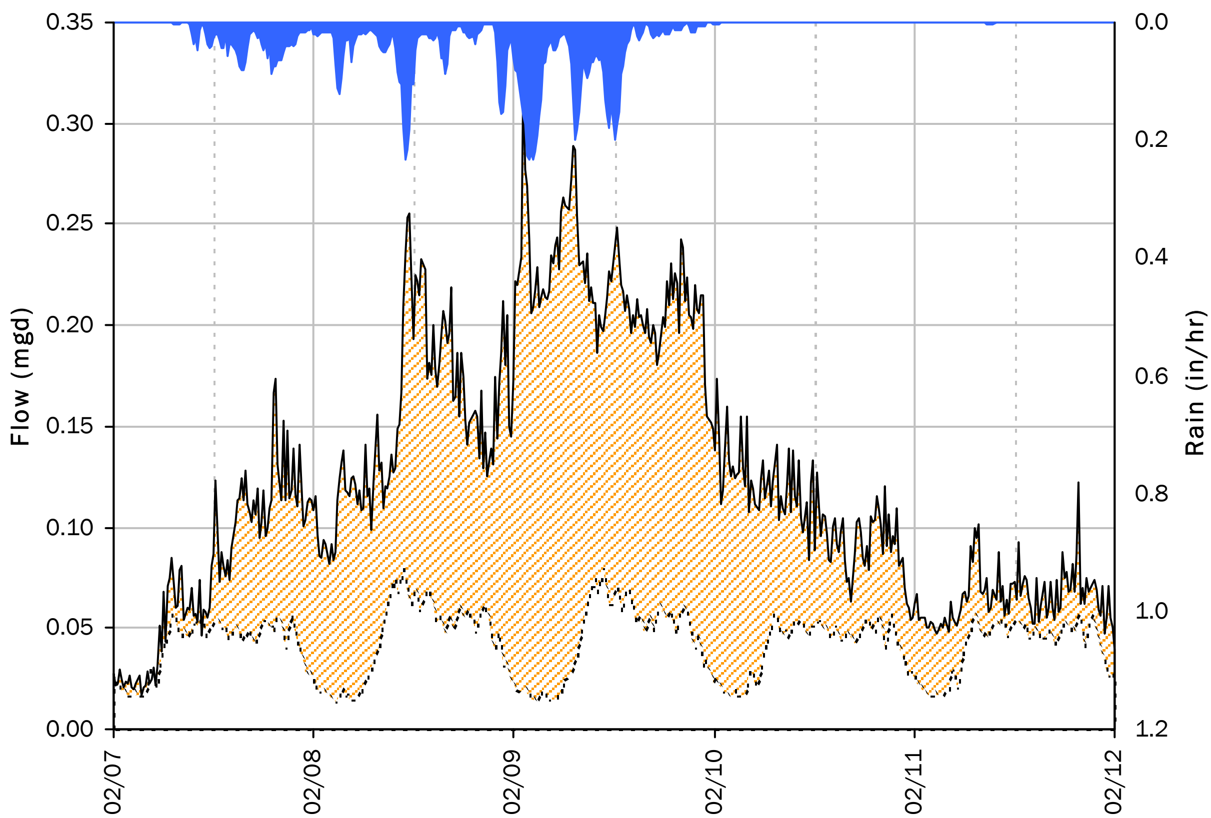
Pipe Diameter:	8	*inches*
Peak Measured Level:	9.3	*inches*
Peak d/D Ratio:	1.16	

Surcharged 1.3 inches over crown

SITE M14
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow:	0.32 *mgd*
PF:	7.68
Peak Level:	9.30 *in*
d/D Ratio:	1.16

Inflow / Infiltration

Peak I/I Rate:	0.30 *mgd*
Total I/I:	412,000 *gallons*

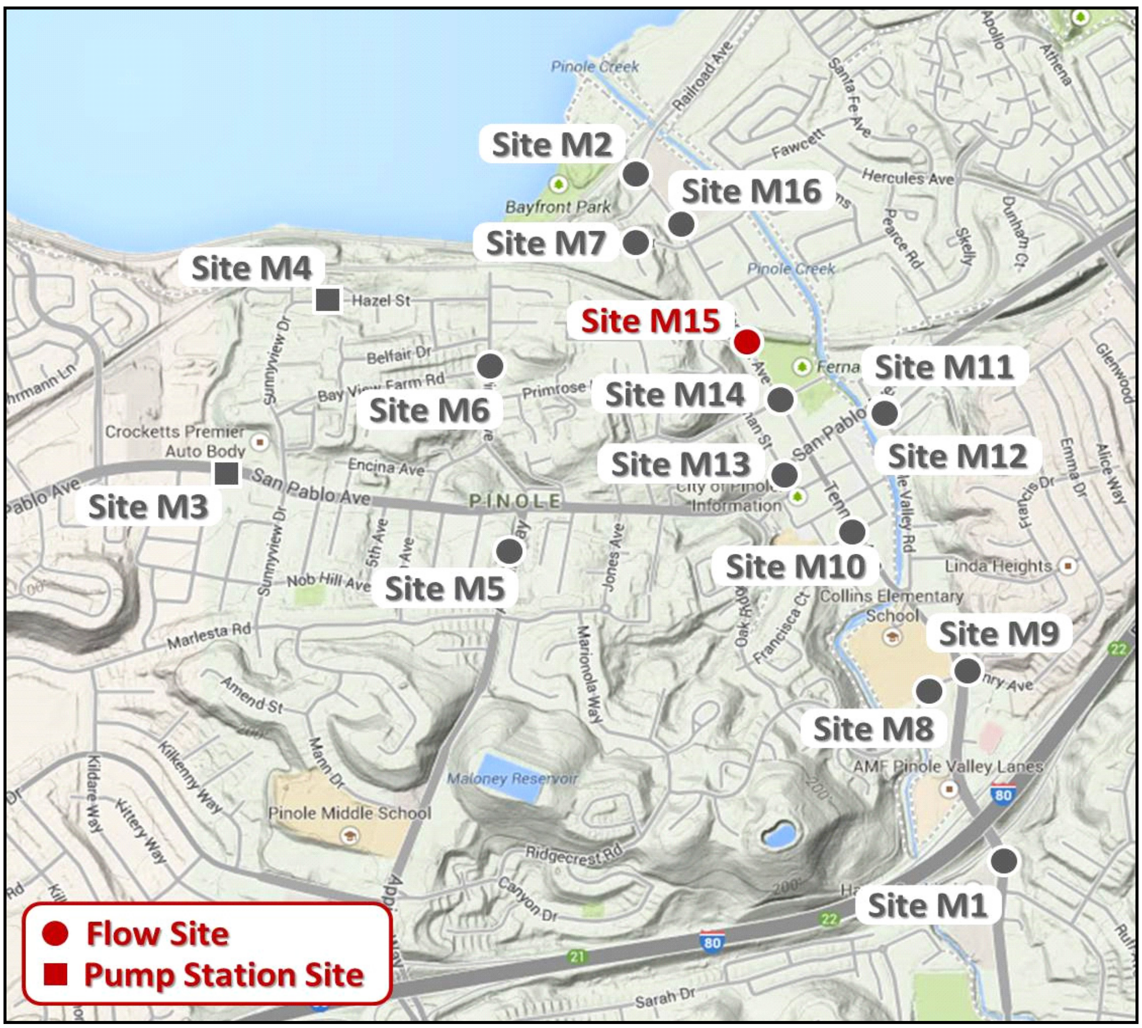
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M15

Location: Tennant Ave., south of train tracks, west of Fernandez Park

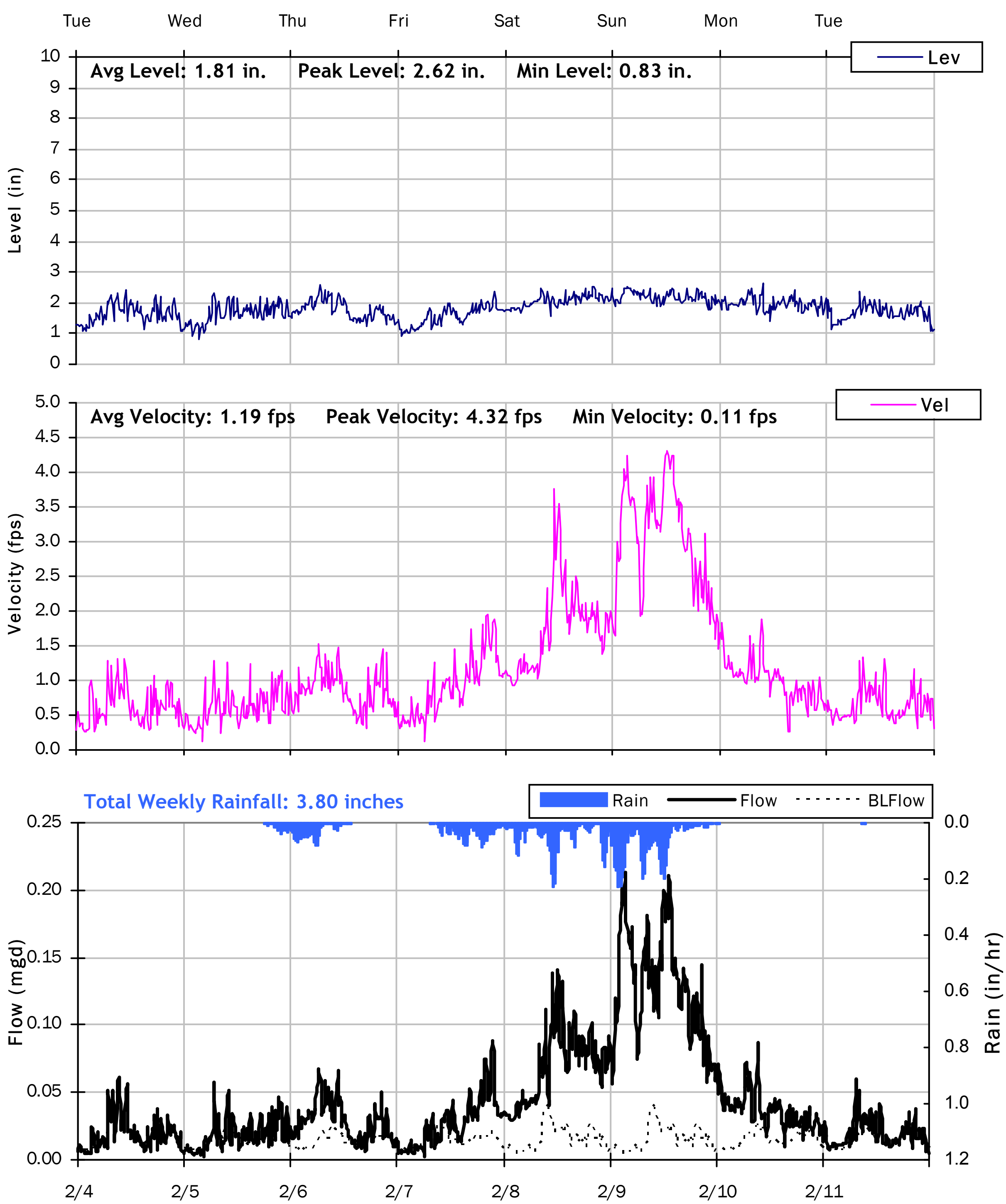
Data Summary Report



Vicinity Map: Site M15

SITE M15

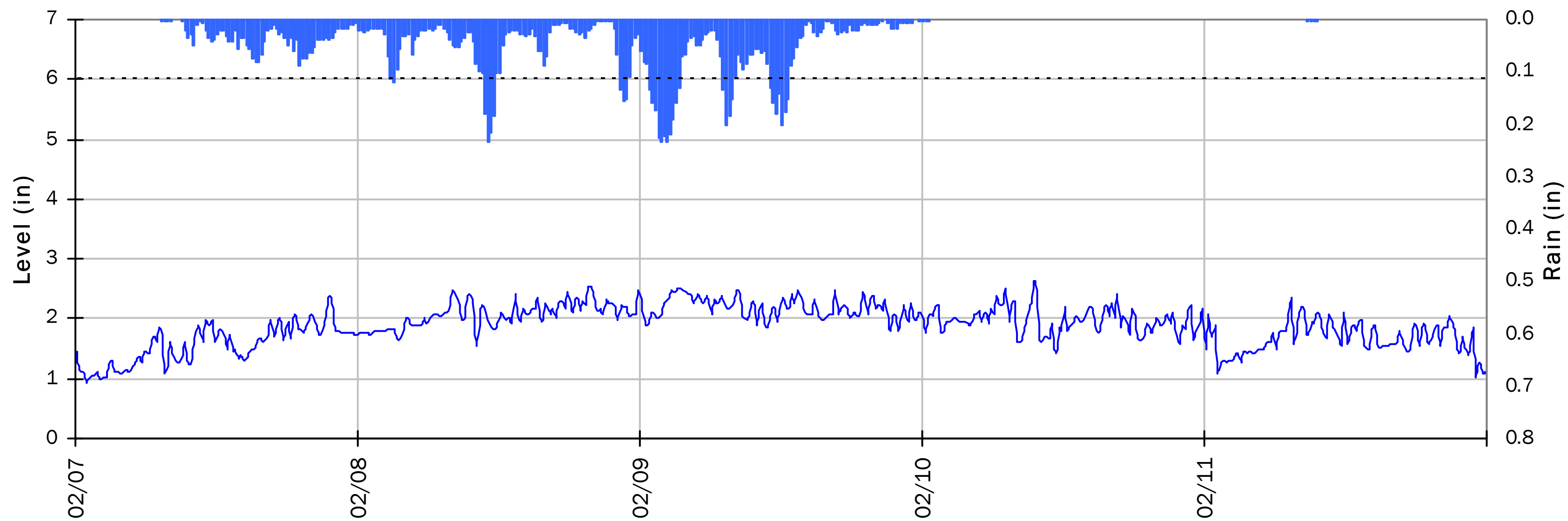
Weekly Level, Velocity and Flow Hydrographs

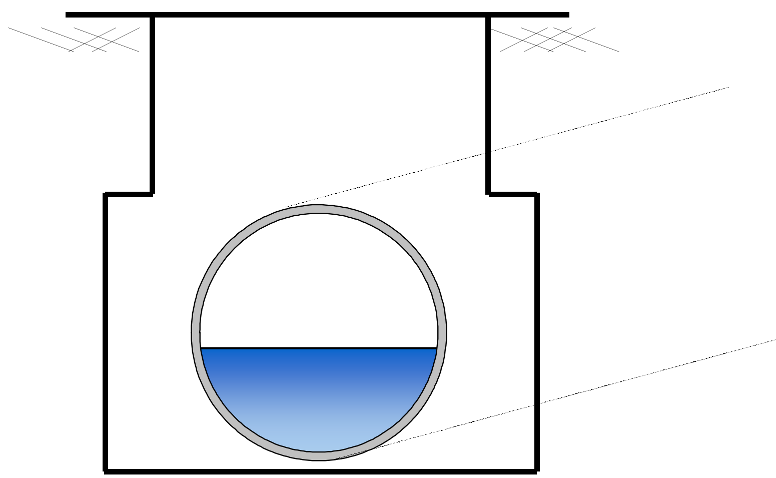


Avg Flow: 0.043 mgd **Peak Flow: 0.214 mgd** **Min Flow: 0.002 mgd**

SITE M15
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



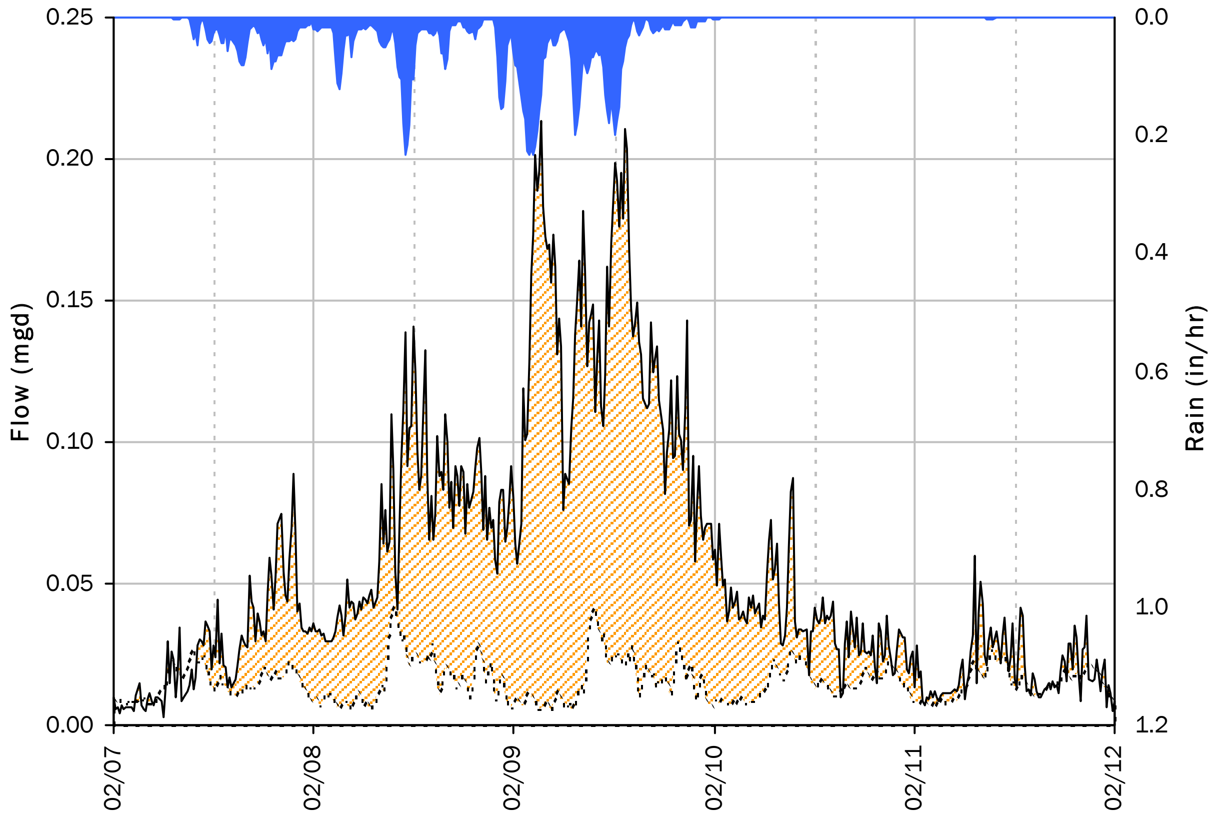


Pipe Diameter:	6	*inches*
Peak Measured Level:	2.62	*inches*
Peak d/D Ratio:	0.44	

SITE M15
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow: 0.21 *mgd*
PF: 14.14

Peak Level: 2.62 *in*
d/D Ratio: 0.44

Inflow / Infiltration

Peak I/I Rate: 0.21 *mgd*
Total I/I: 205,000 *gallons*

City of Pinole

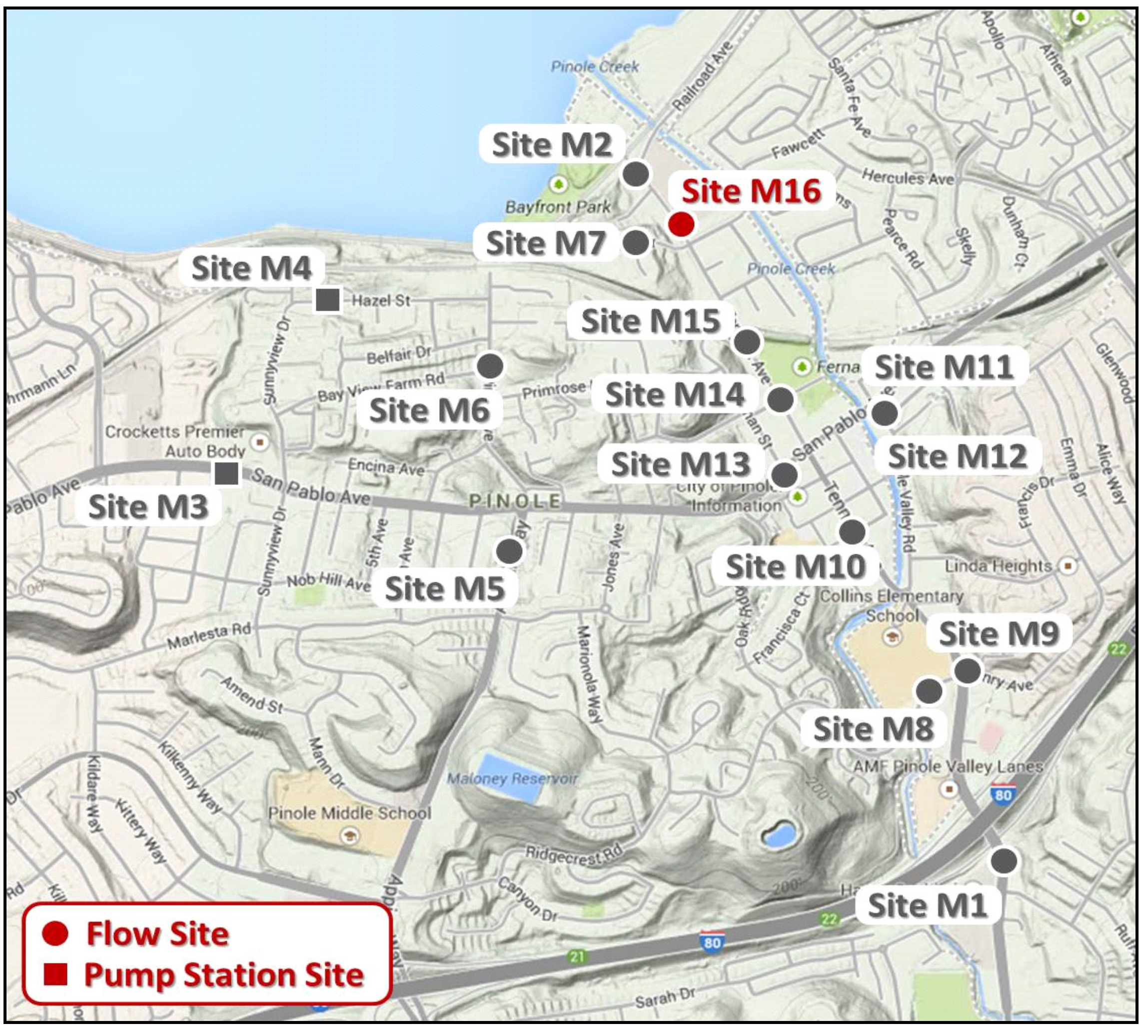
Sanitary Sewer Flow Monitoring

Temporary Monitoring: February 2014

Monitoring Site: Site M16

Location: Tennant Ave. north of Orleans Dr.

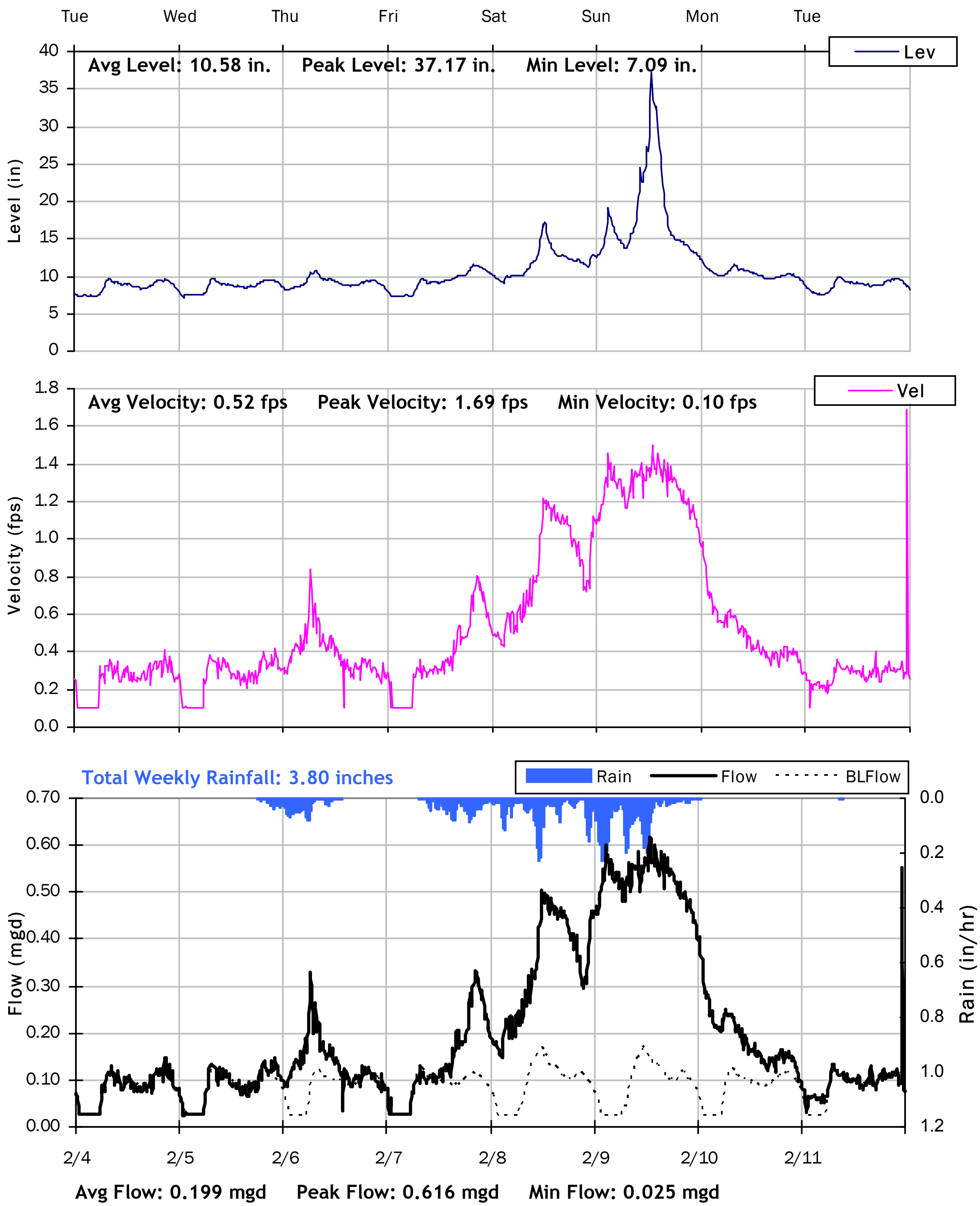
Data Summary Report



Vicinity Map: Site M16

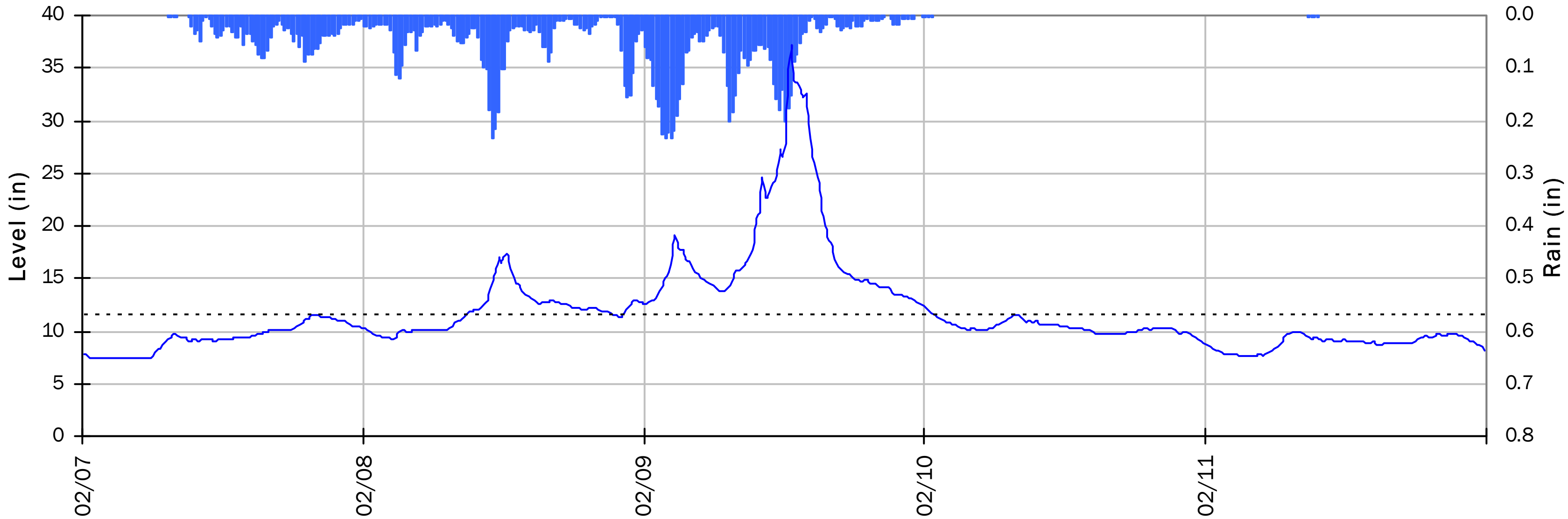
SITE M16

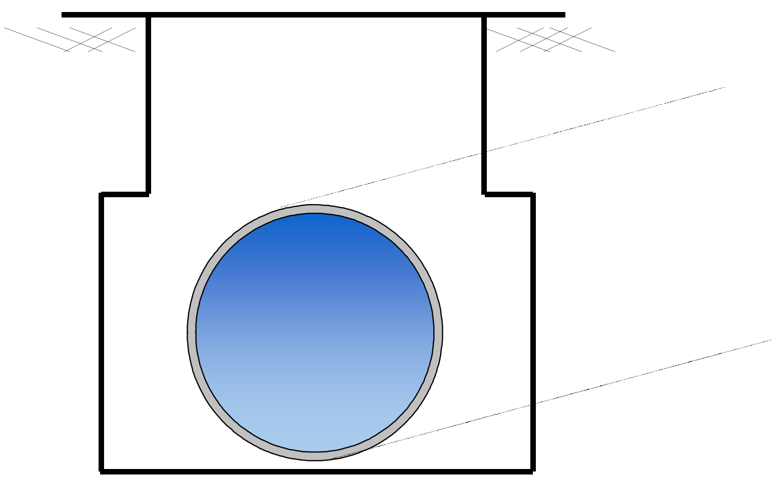
Weekly Level, Velocity and Flow Hydrographs



SITE M16
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





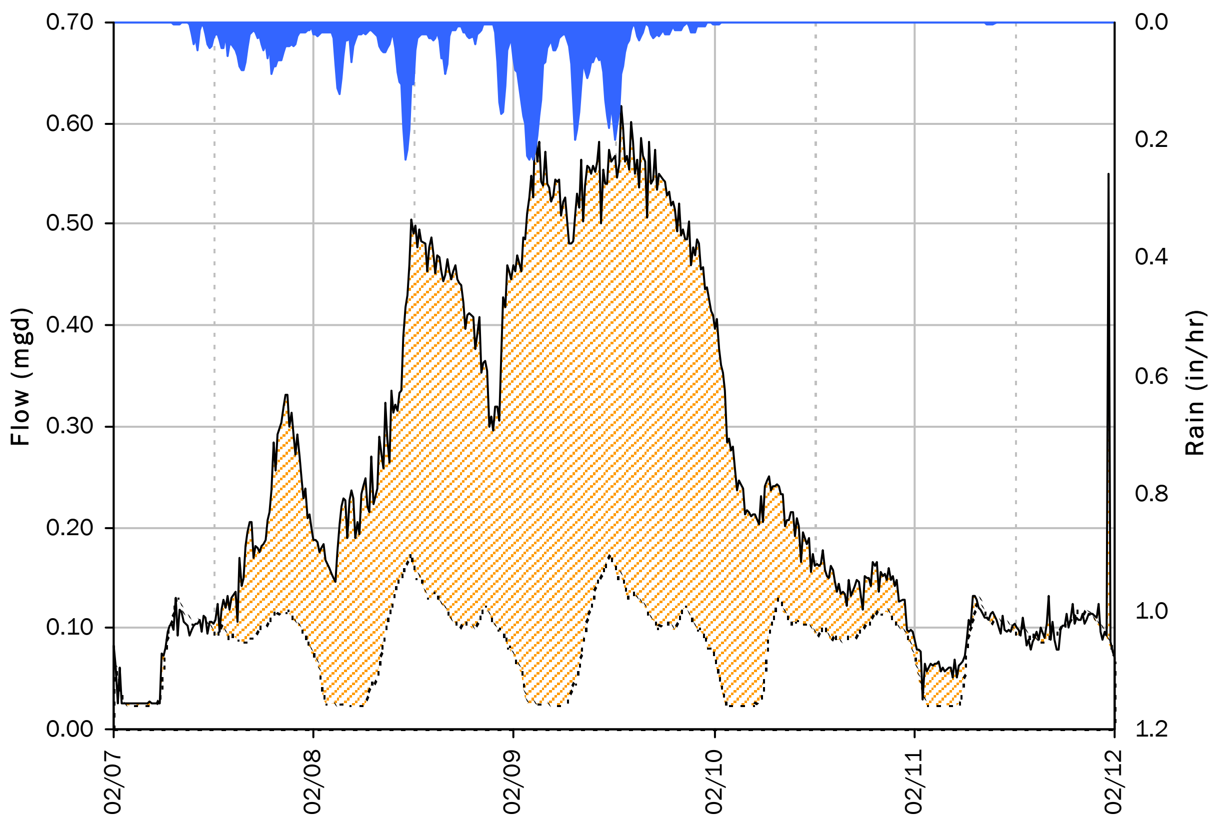
Pipe Diameter:	11.5	*inches*
Peak Measured Level:	37.2	*inches*
Peak d/D Ratio:	3.23	

Surcharged 25.7 inches over crown

SITE M16
I/I Summary: Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 1 Detail Graph



Storm Event I/I Analysis (Rain = 3.25 inches)

Capacity

Peak Flow:	0.62 *mgd*
PF:	7.20
Peak Level:	37.17 *in*
d/D Ratio:	3.23

Inflow / Infiltration

Peak I/I Rate:	0.58 *mgd*
Total I/I:	858,000 *gallons*

Appendix E. Flow Monitoring Sites Data, Graphs, Information: Phase 2

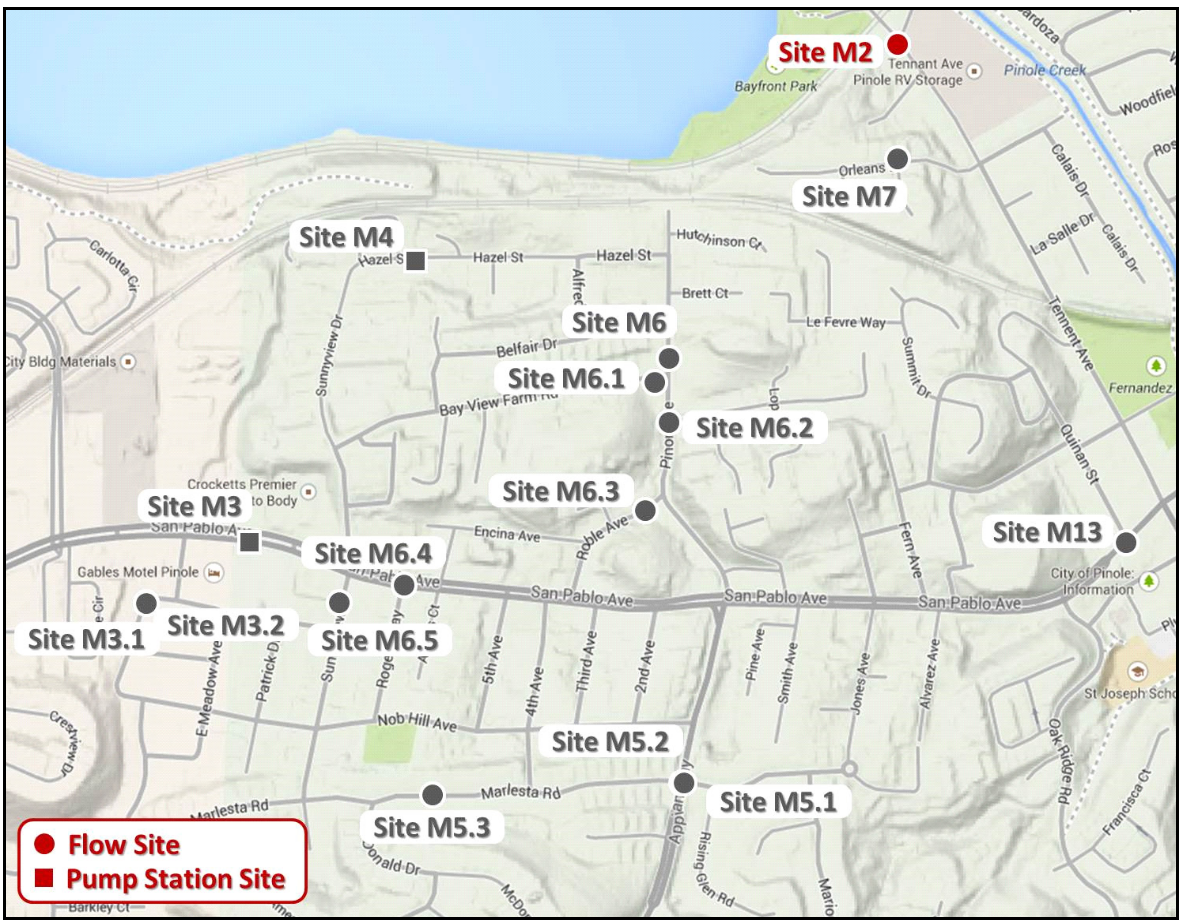
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M2

Location: Tennant Ave., just outside WWTP

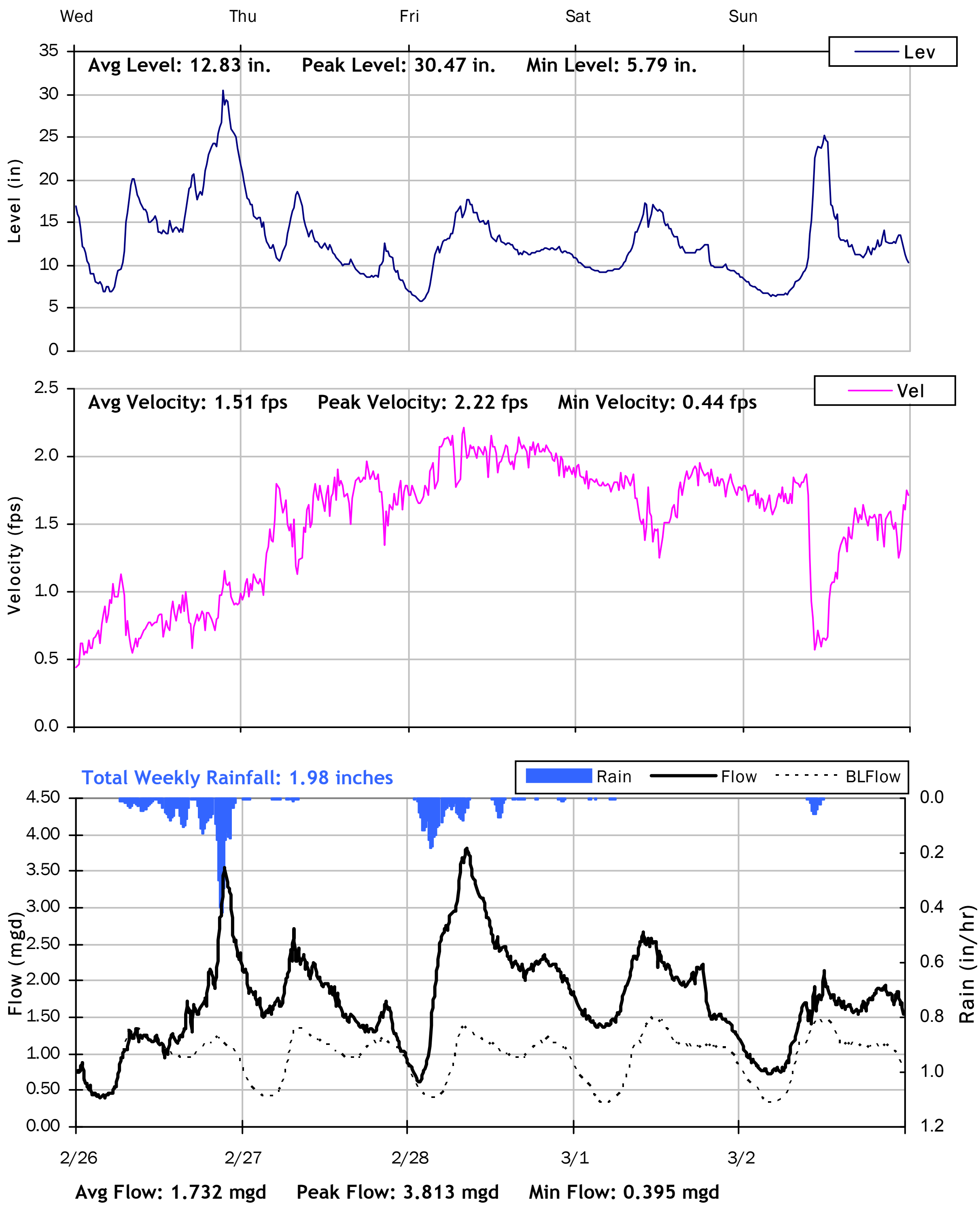
Data Summary Report



Vicinity Map: Site M2

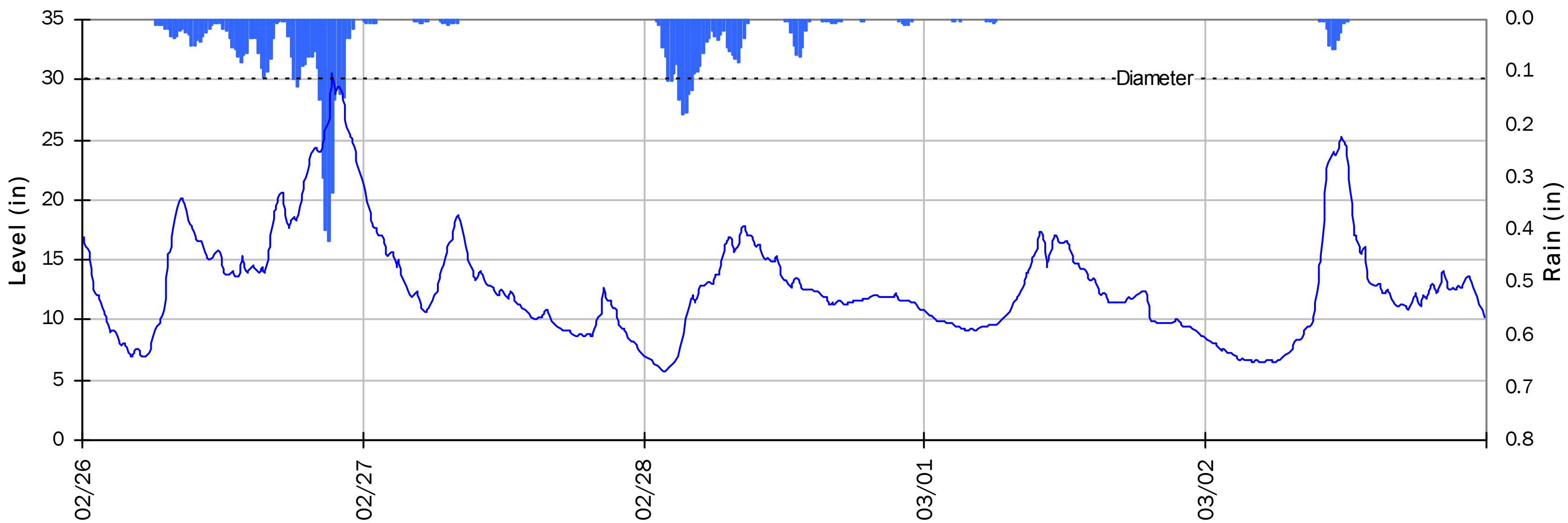
SITE M2

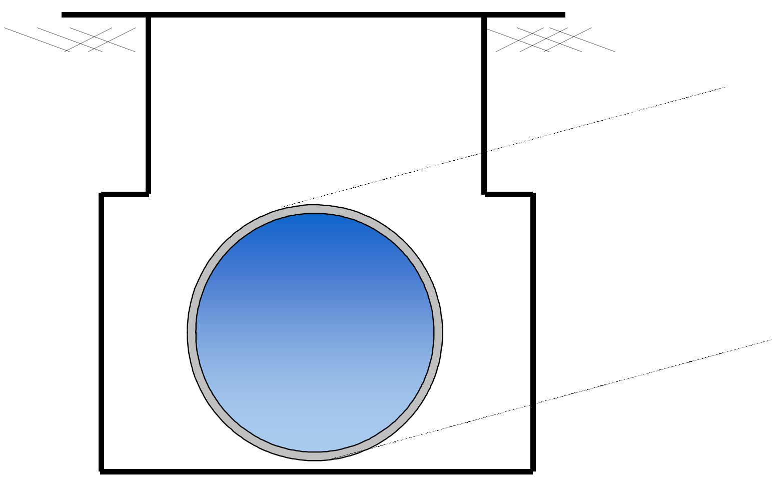
Weekly Level, Velocity and Flow Hydrographs



SITE M2
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





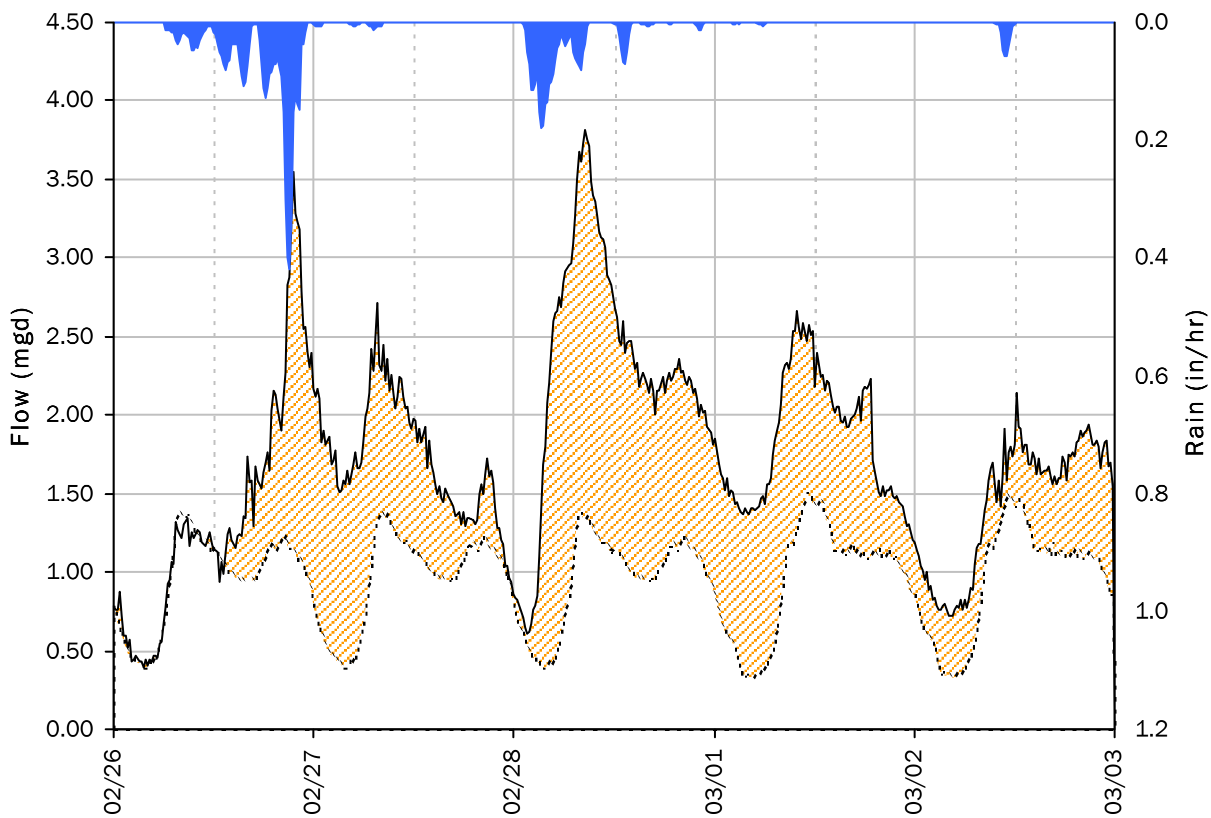
Pipe Diameter:	30	*inches*
Peak Measured Level:	30.5	*inches*
Peak d/D Ratio:	1.02	

Surcharged 0.5 inches over crown

SITE M2
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 3.81 *mgd*
PF: 4.02

Peak Level: 30.47 *in*
d/D Ratio: 1.02

Inflow / Infiltration

Peak I/I Rate: 2.47 *mgd*
Total I/I: 3,432,000 *gallons*

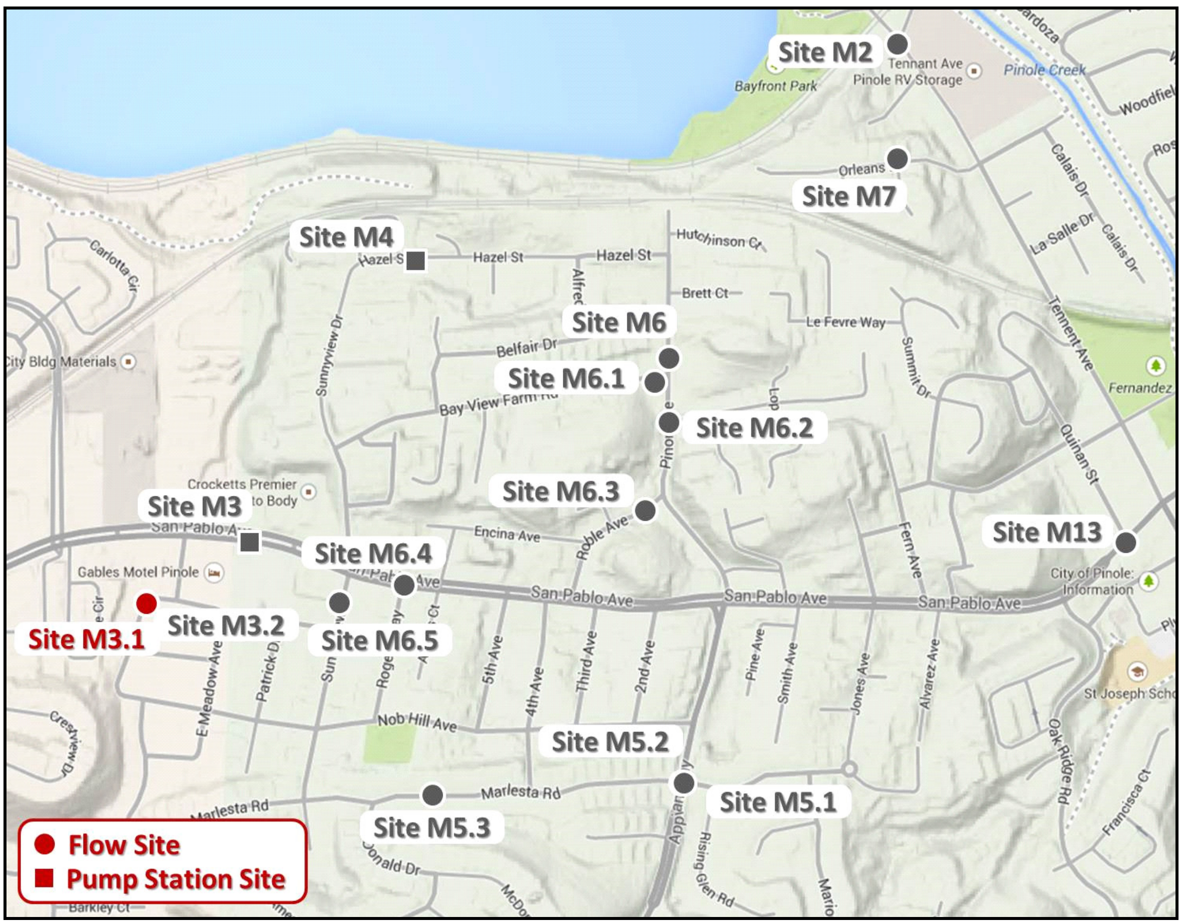
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M3.1

Location: 830 Meadows Ave.

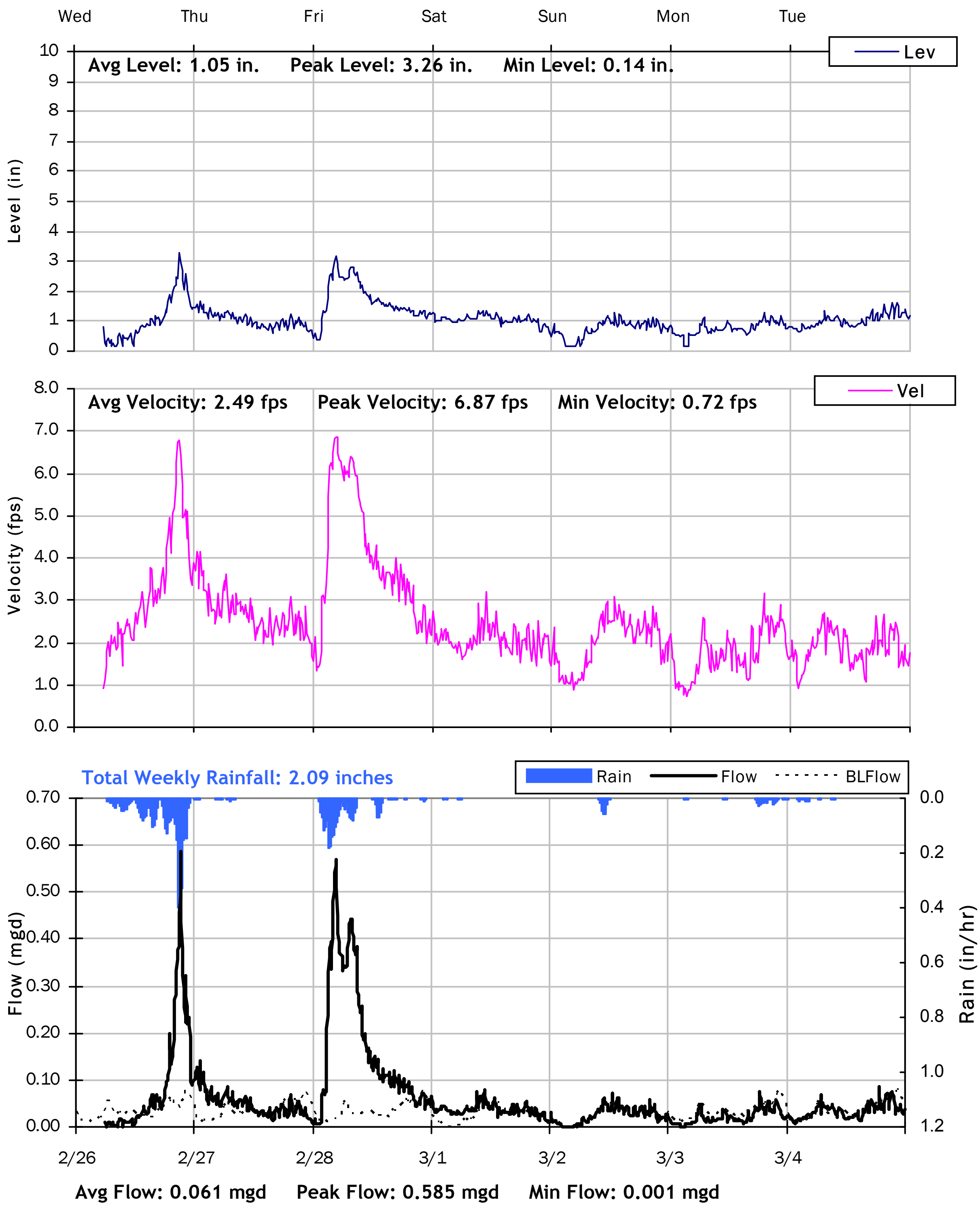
Data Summary Report



Vicinity Map: Site M3.1

SITE M3.1

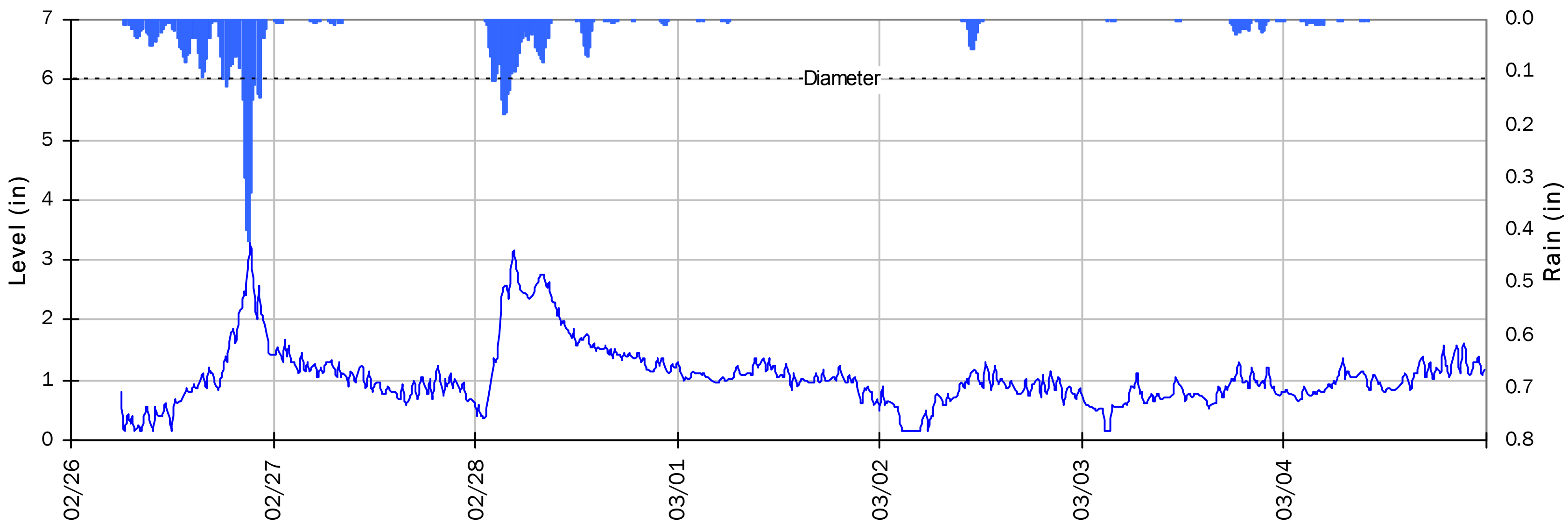
Weekly Level, Velocity and Flow Hydrographs

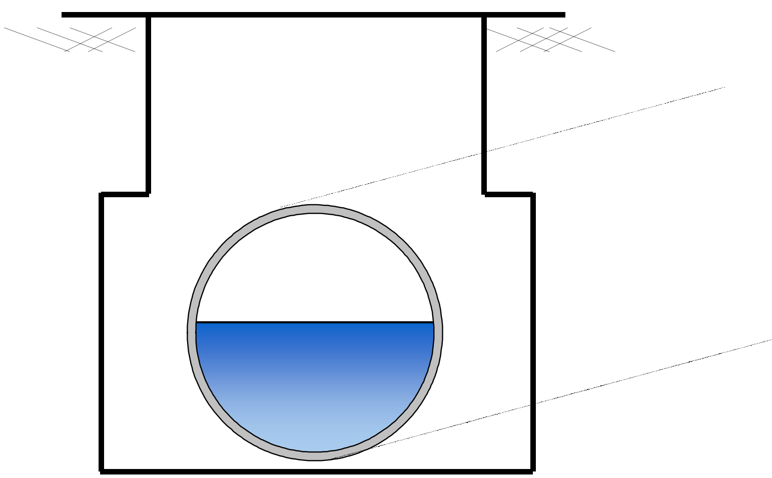


SITE M3.1

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



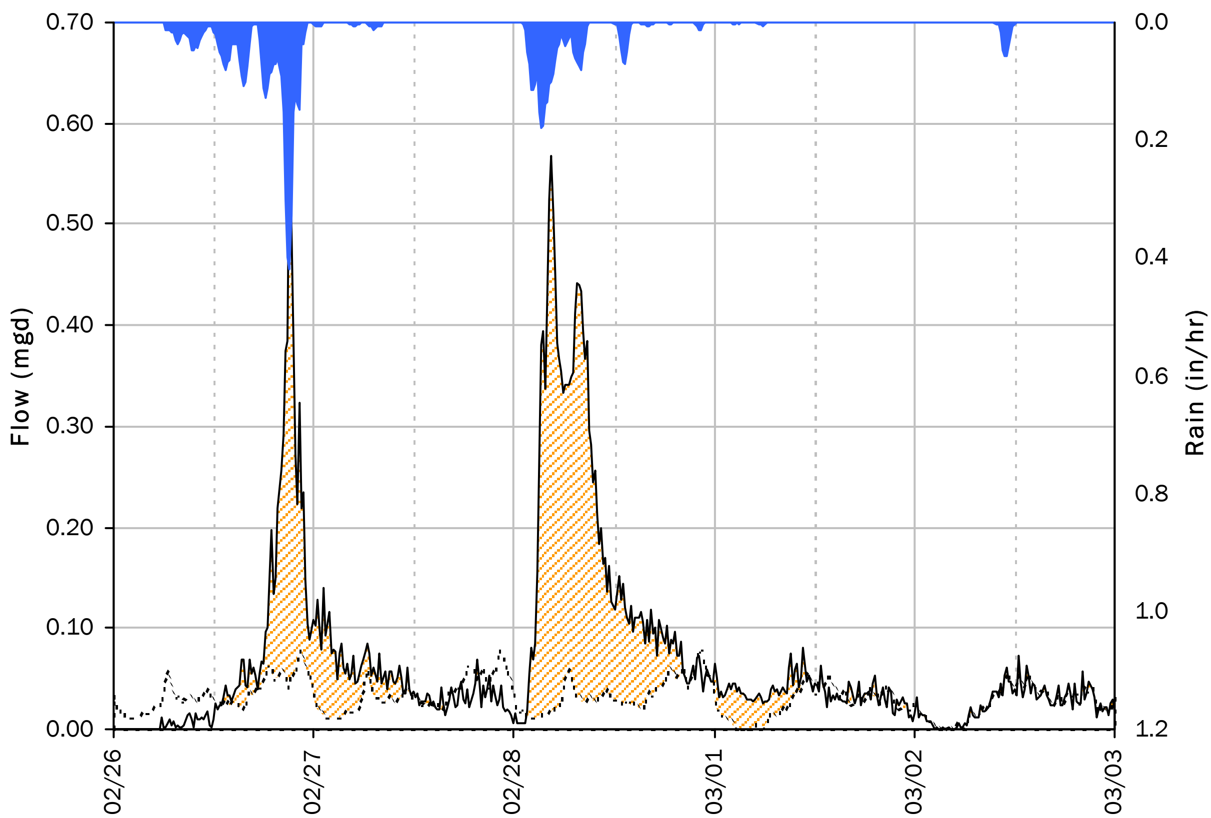


Pipe Diameter:	6	*inches*
Peak Measured Level:	3.26	*inches*
Peak d/D Ratio:	0.54	

SITE M3.1
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.58 *mgd*
PF: 18.34

Peak Level: 3.26 *in*
d/D Ratio: 0.54

Inflow / Infiltration

Peak I/I Rate: 0.55 *mgd*
Total I/I: 213,000 *gallons*

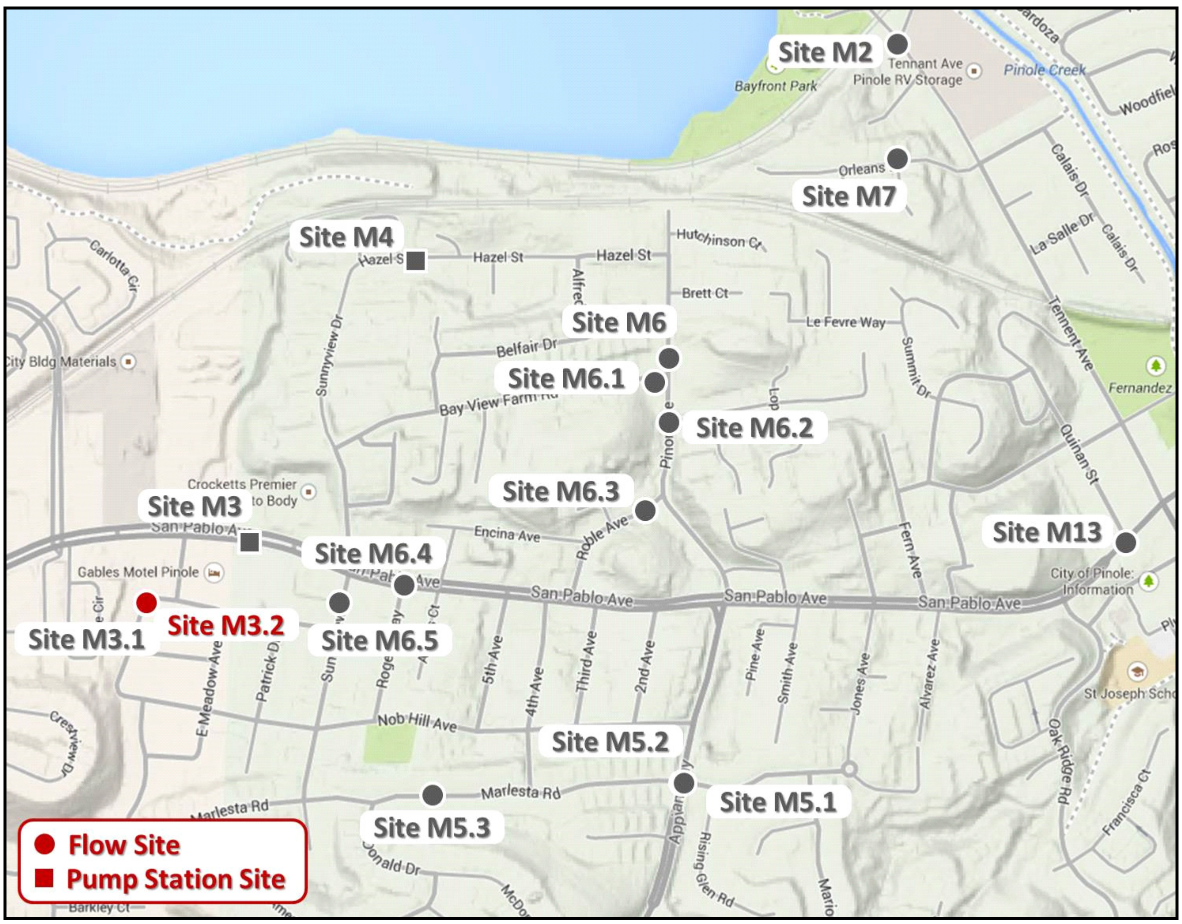
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M3.2

Location: 830 Meadows Ave.

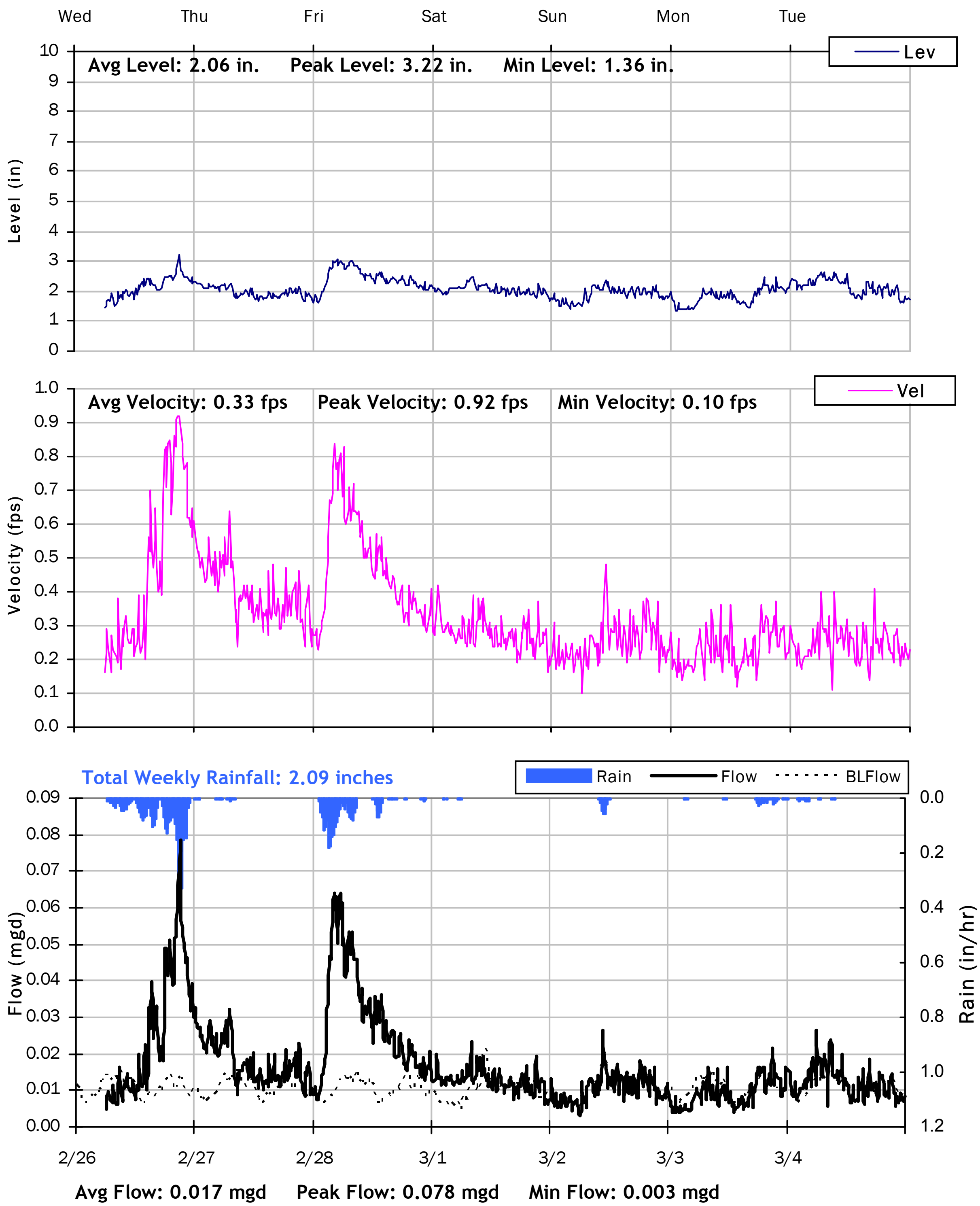
Data Summary Report



Vicinity Map: Site M3.2

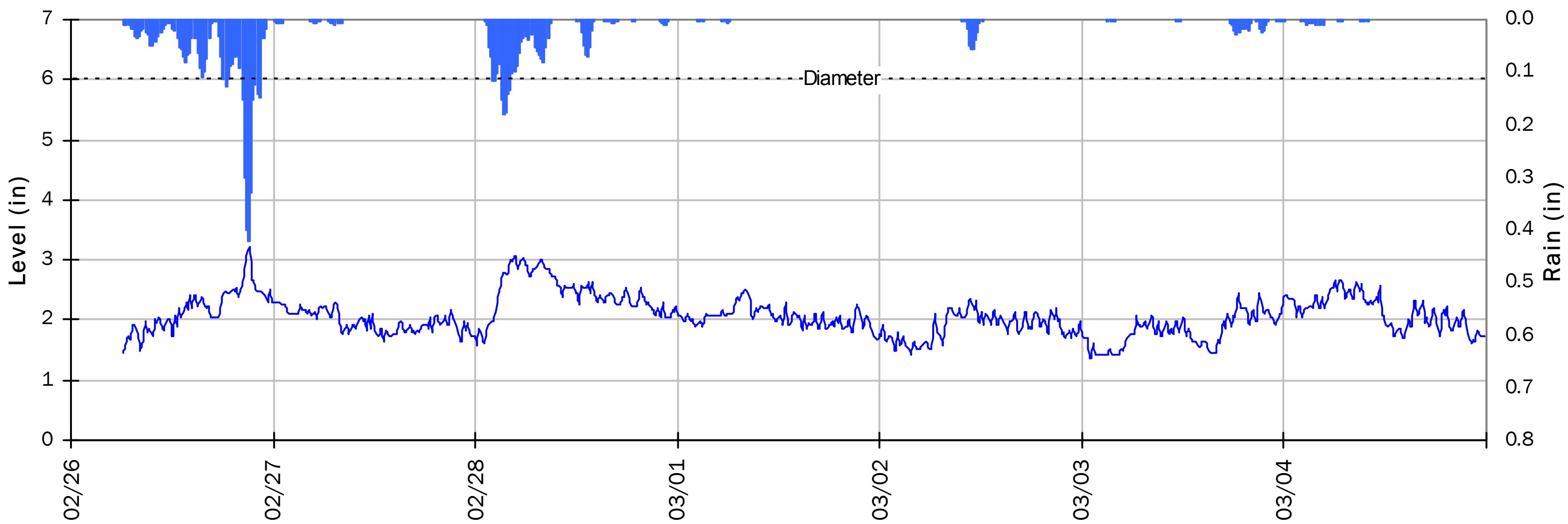
SITE M3.2

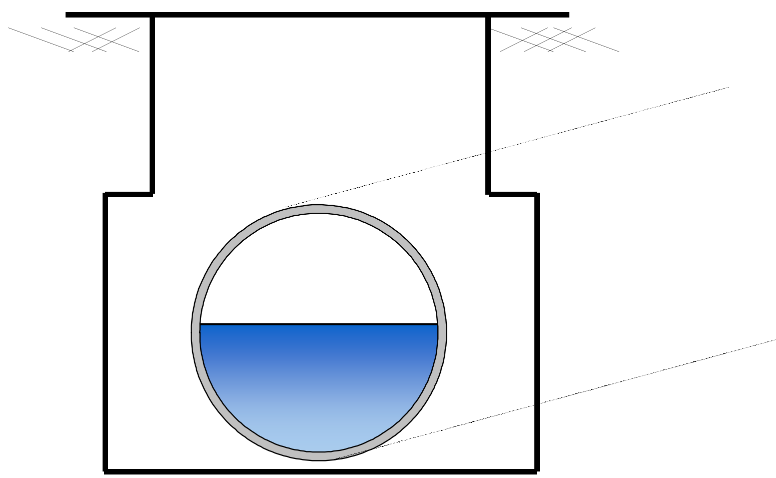
Weekly Level, Velocity and Flow Hydrographs



SITE M3.2
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



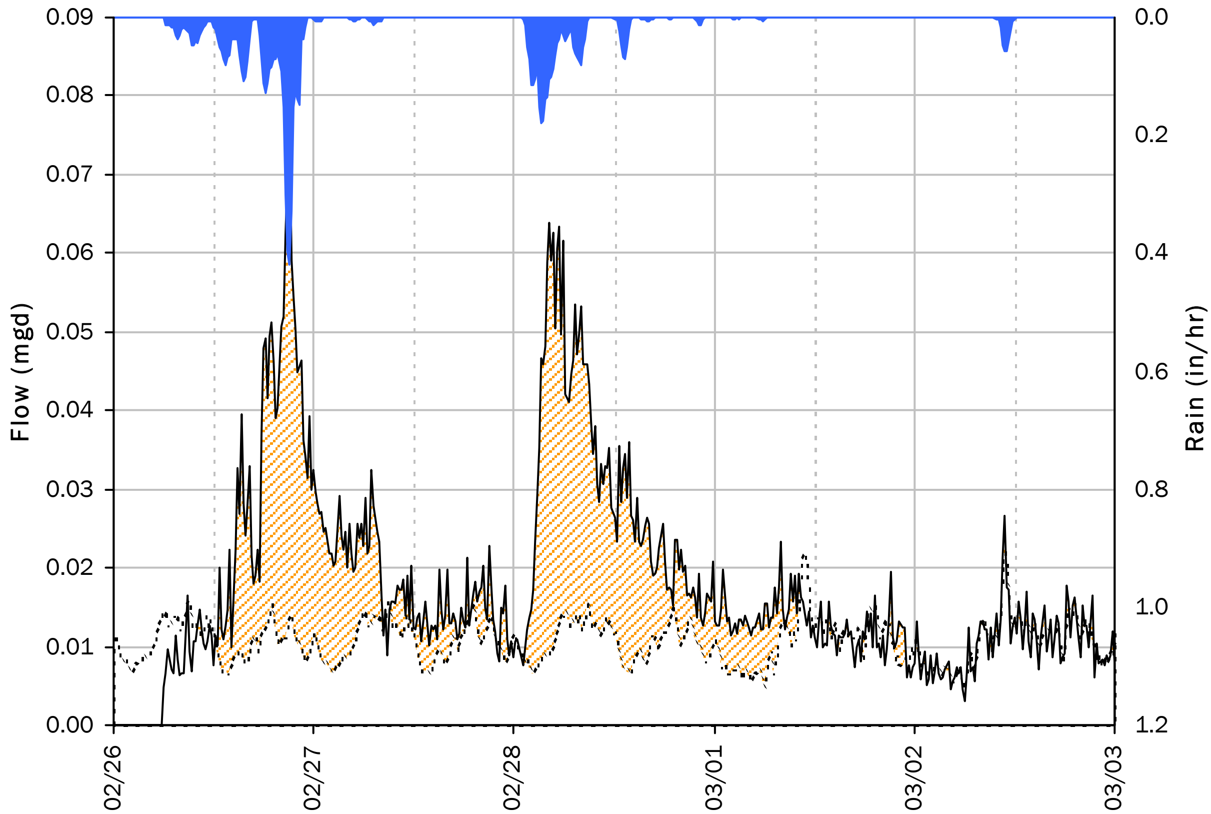


Pipe Diameter:	6	*inches*
Peak Measured Level:	3.22	*inches*
Peak d/D Ratio:	0.54	

SITE M3.2
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow:	0.08 *mgd*
PF:	7.34
Peak Level:	3.22 *in*
d/D Ratio:	0.54

Inflow / Infiltration

Peak I/I Rate:	0.06 *mgd*
Total I/I:	41,000 *gallons*

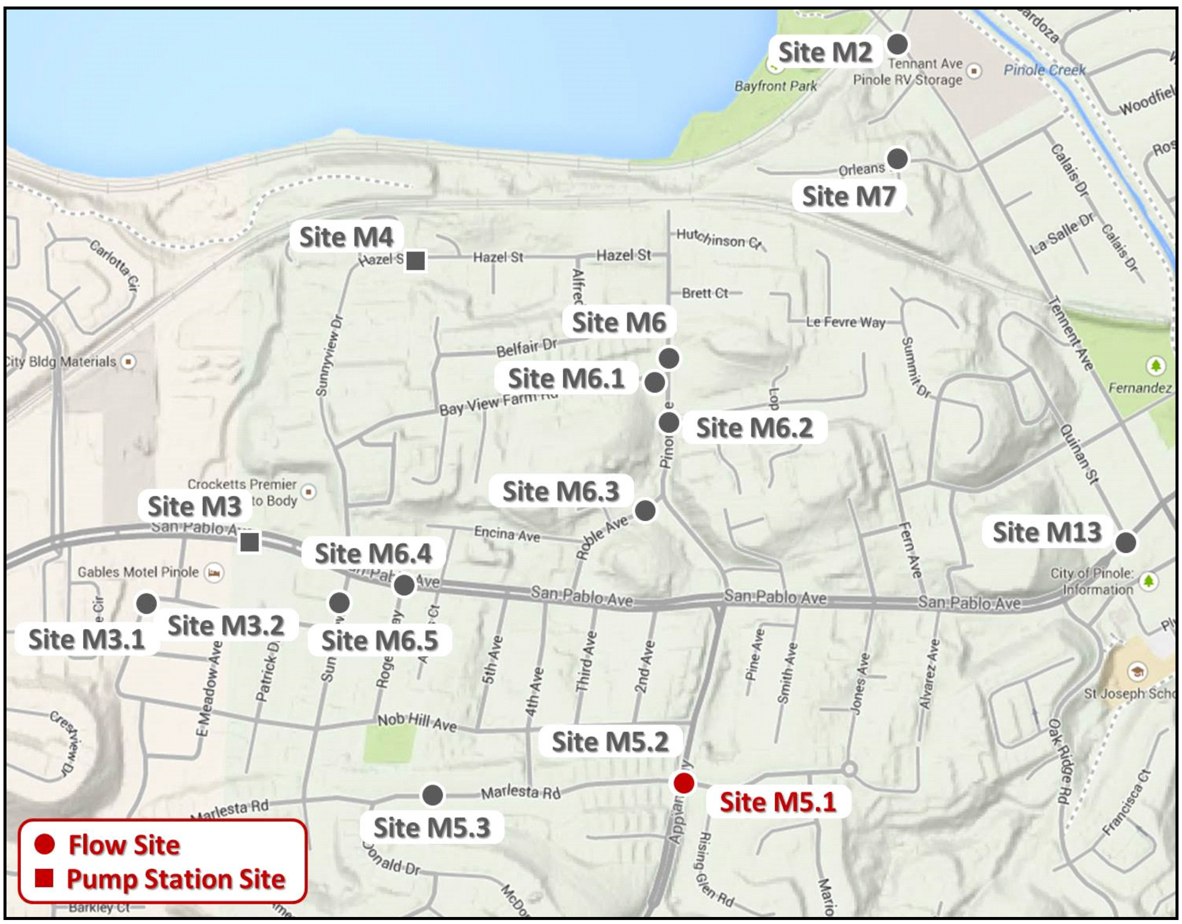
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M5.1

Location: Intersection of Appian Way and Marlesta Rd.

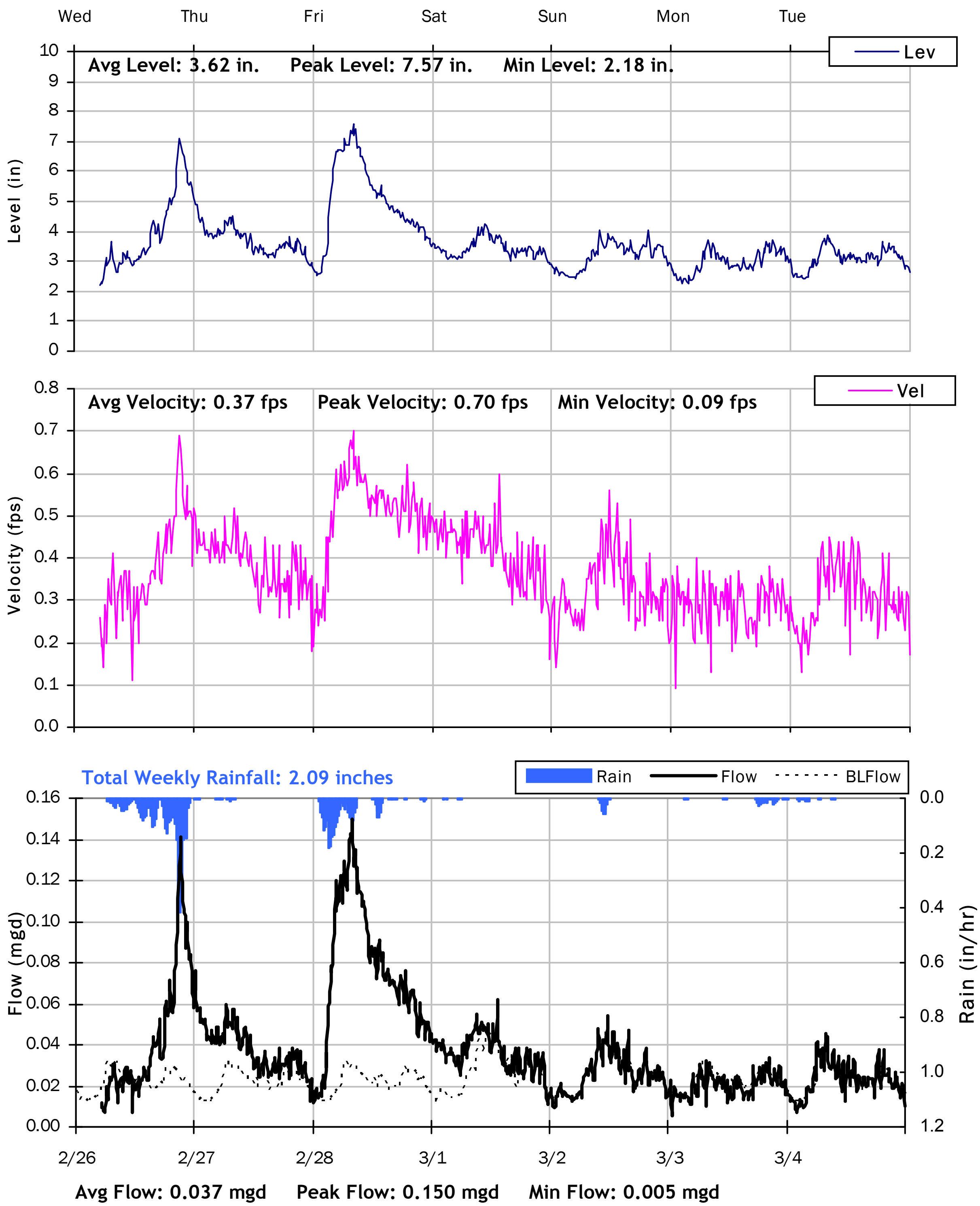
Data Summary Report



Vicinity Map: Site M5.1

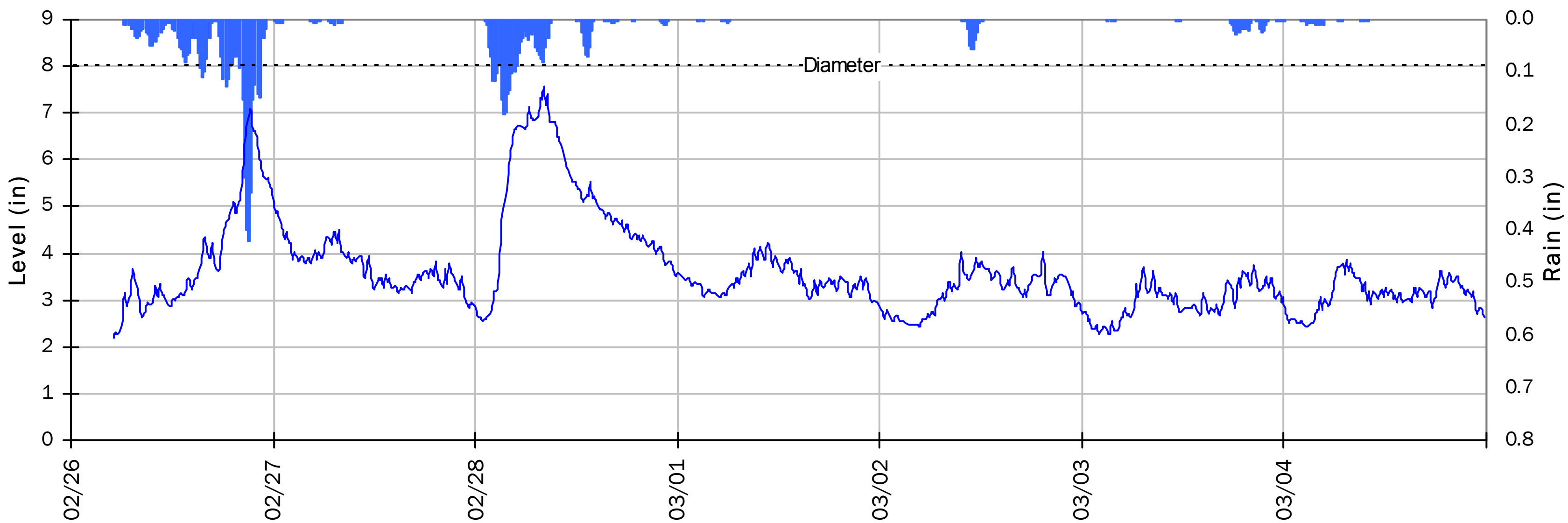
SITE M5.1

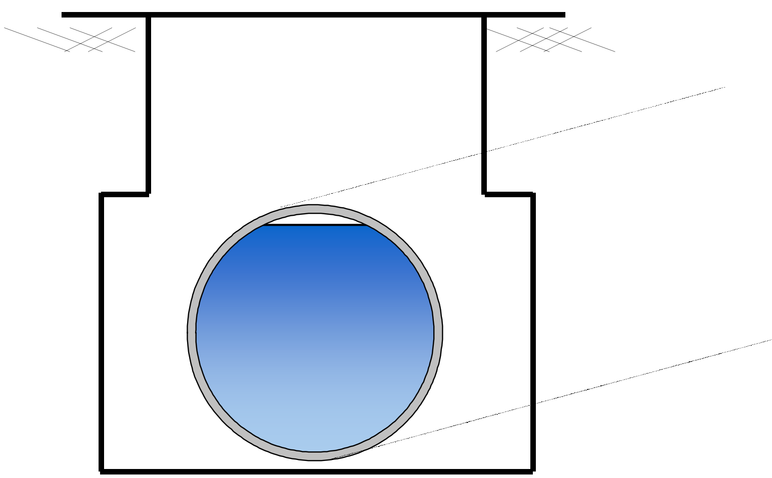
Weekly Level, Velocity and Flow Hydrographs



SITE M5.1
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



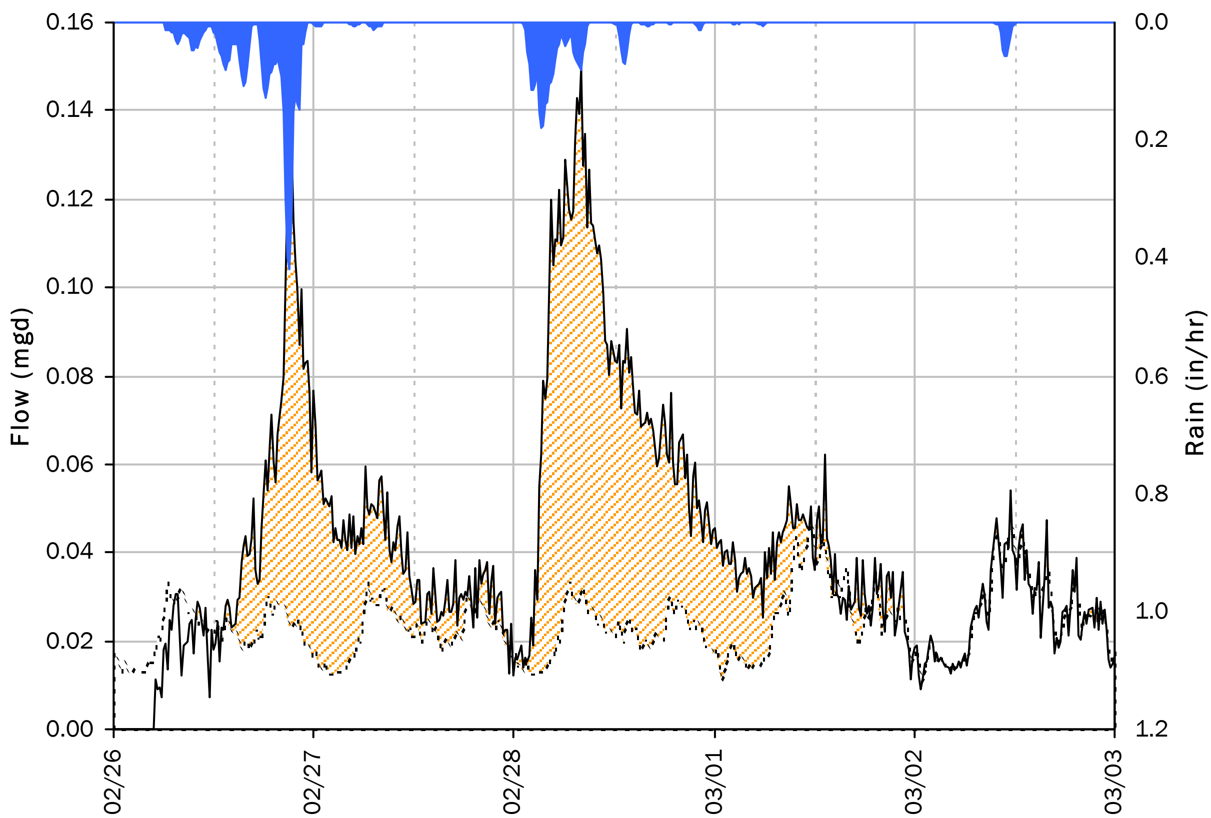


Pipe Diameter:	8	*inches*
Peak Measured Level:	7.57	*inches*
Peak d/D Ratio:	0.95	

SITE M5.1
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.15 *mgd*
PF: 6.49

Peak Level: 7.57 *in*
d/D Ratio: 0.95

Inflow / Infiltration

Peak I/I Rate: 0.12 *mgd*
Total I/I: 98,000 *gallons*

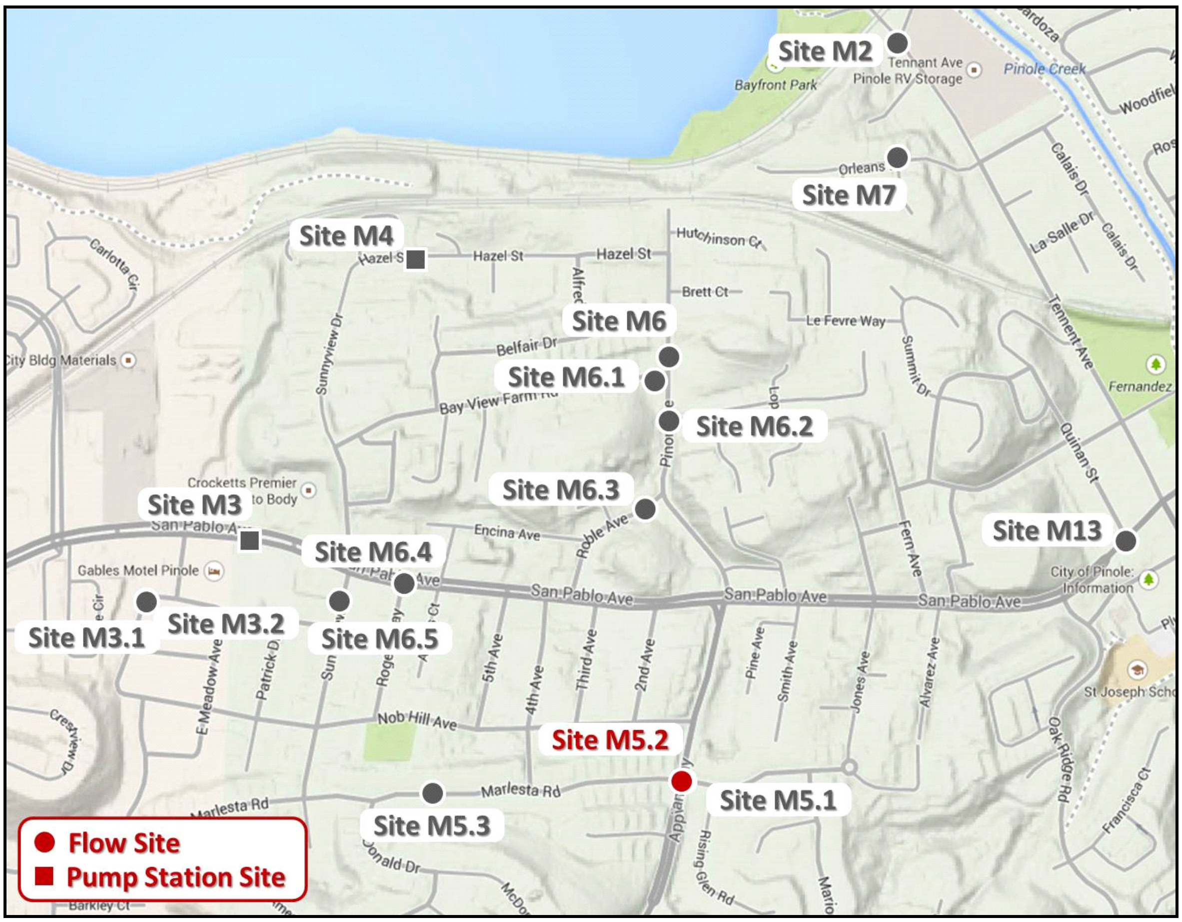
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M5.2

Location: Intersection of Appian Way and Marlesta Rd.

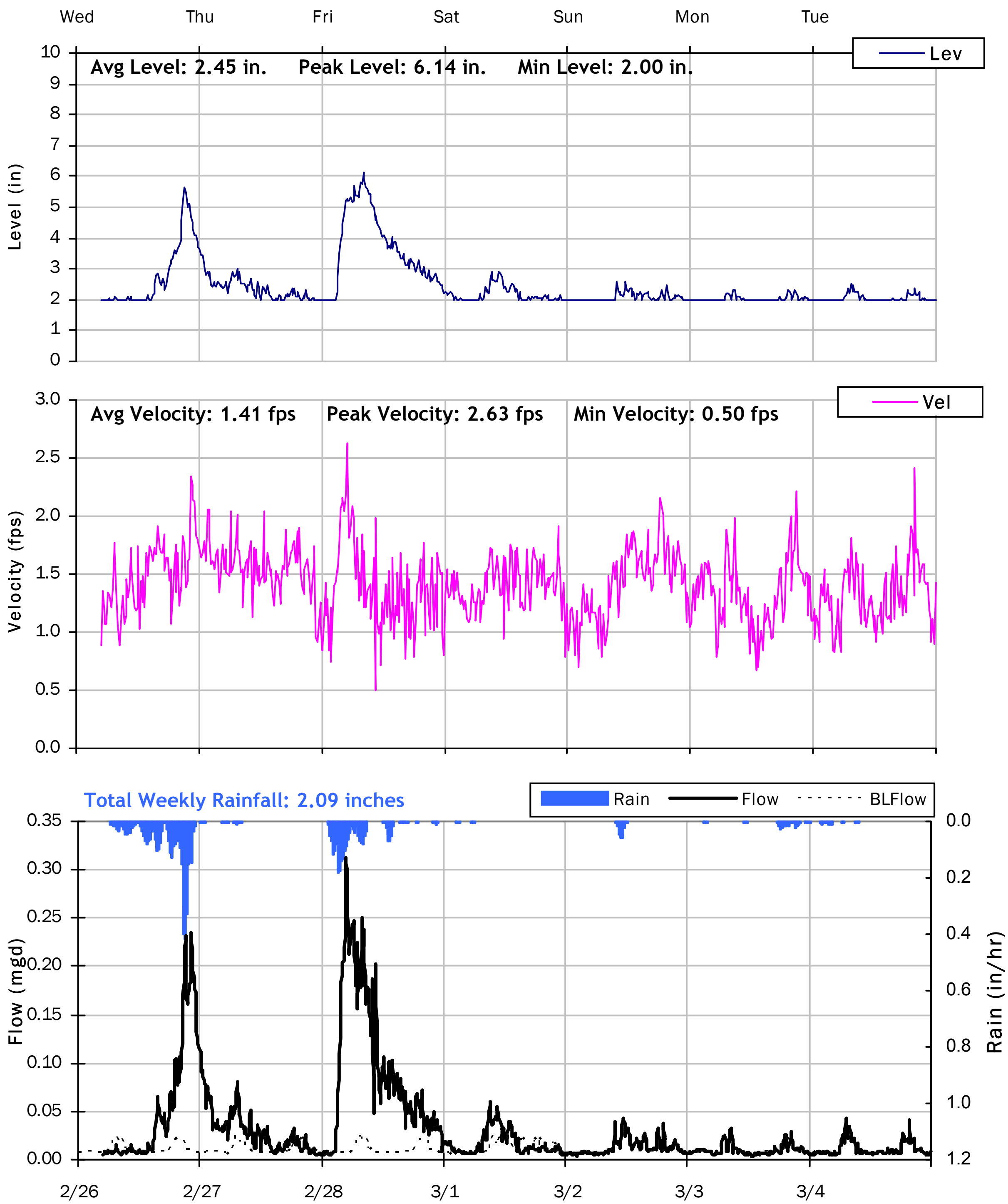
Data Summary Report



Vicinity Map: Site M5.2

SITE M5.2

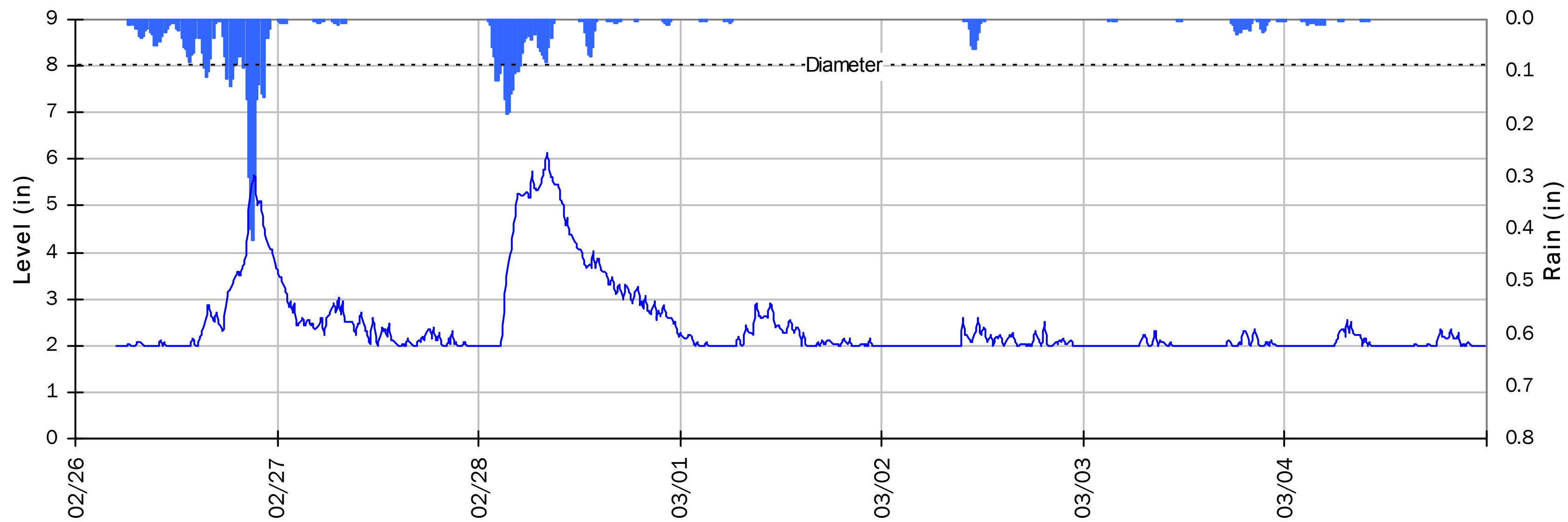
Weekly Level, Velocity and Flow Hydrographs

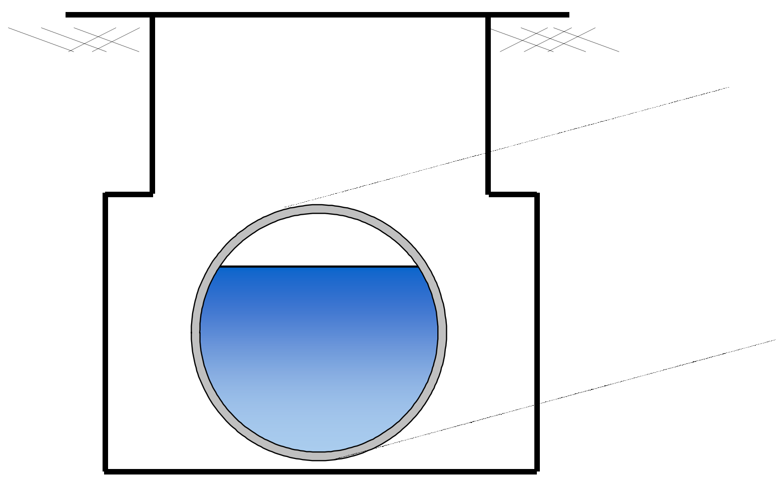


Avg Flow: 0.032 mgd **Peak Flow: 0.312 mgd** **Min Flow: 0.004 mgd**

SITE M5.2
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



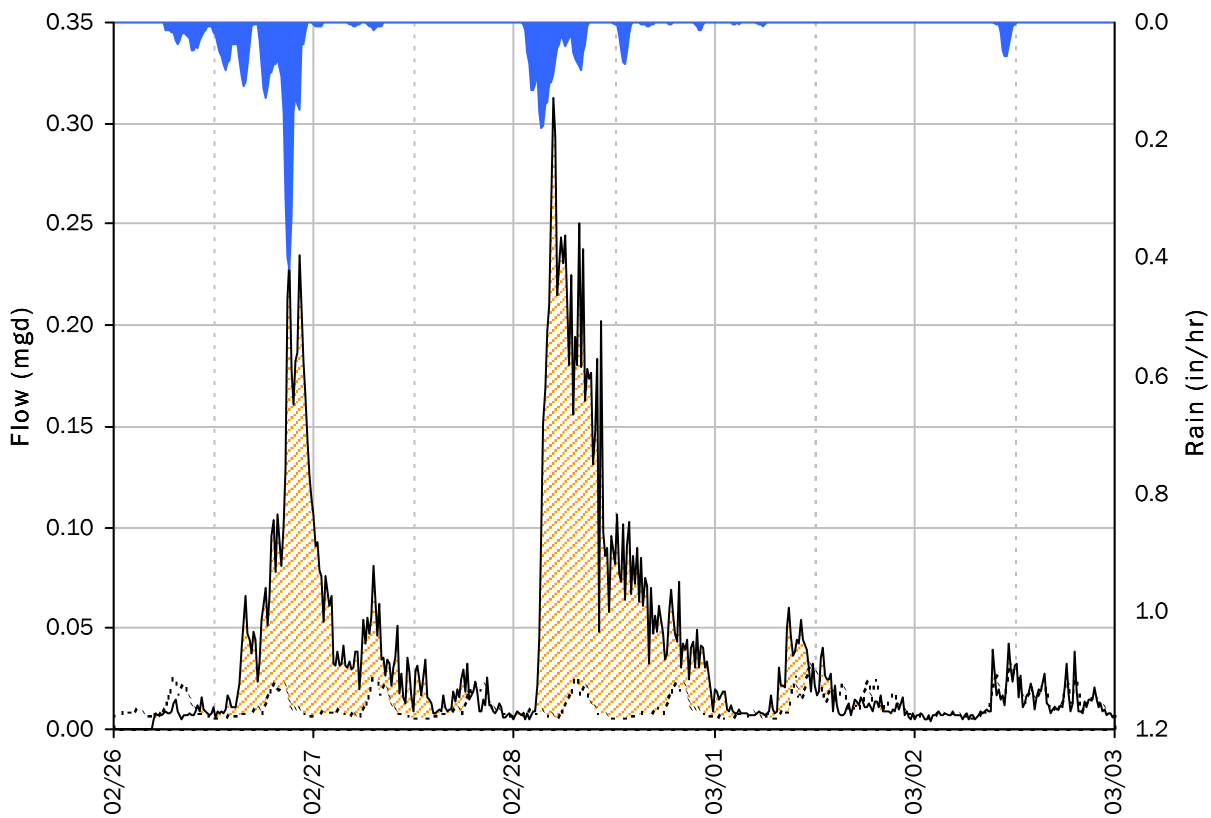


Pipe Diameter:	8	*inches*
Peak Measured Level:	6.14	*inches*
Peak d/D Ratio:	0.77	

SITE M5.2
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.31 *mgd*
PF: 27.55

Peak Level: 6.14 *in*
d/D Ratio: 0.77

Inflow / Infiltration

Peak I/I Rate: 0.31 *mgd*
Total I/I: 142,000 *gallons*

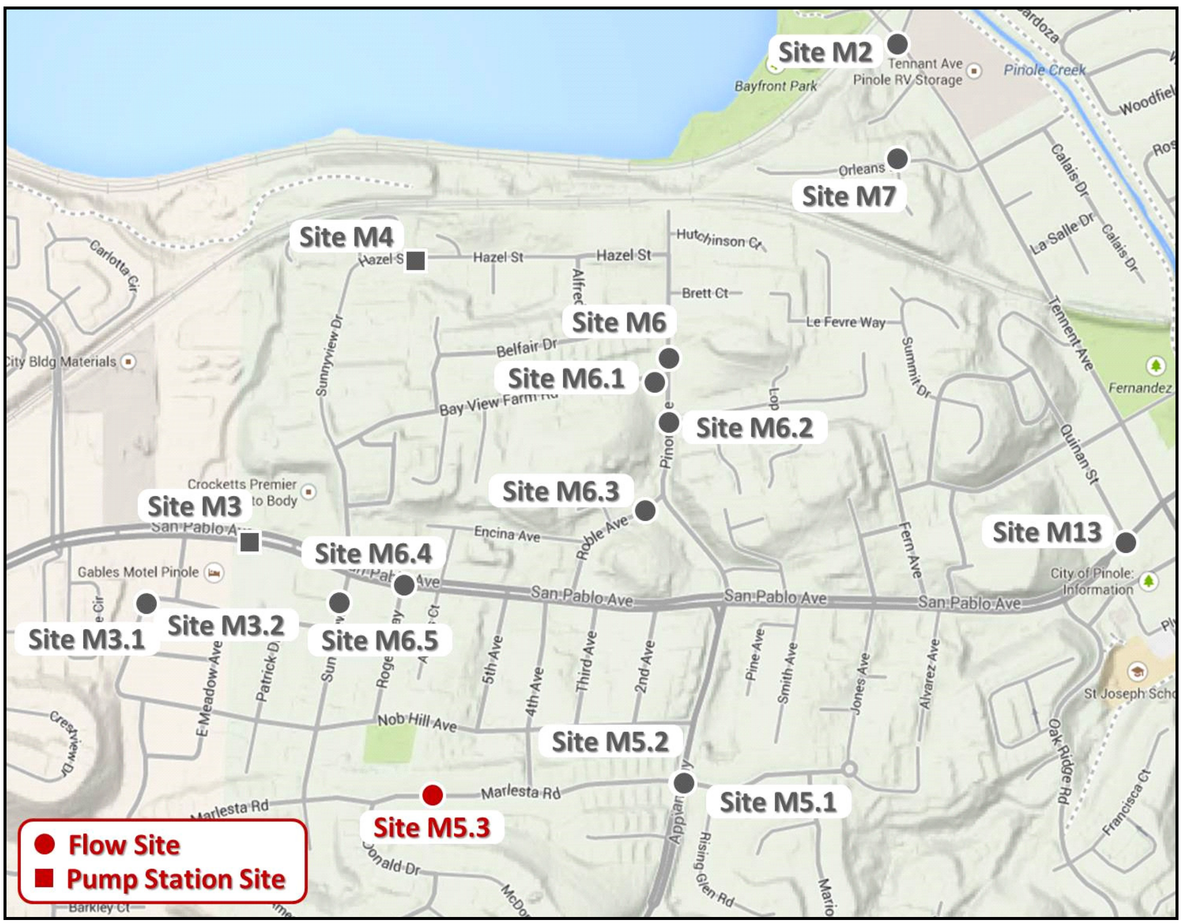
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M5.3

Location: 1171 Marlesta Rd.

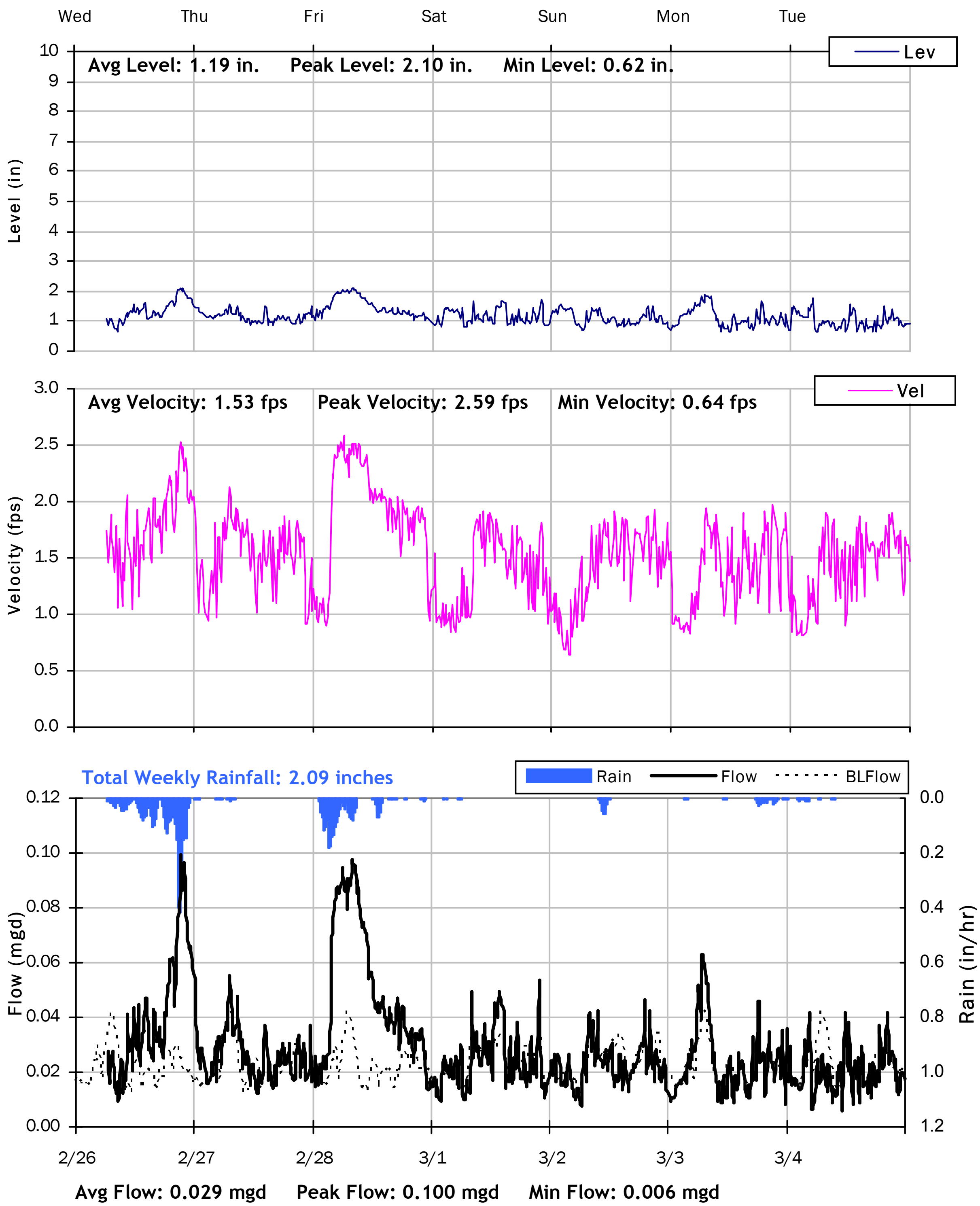
Data Summary Report



Vicinity Map: Site M5.3

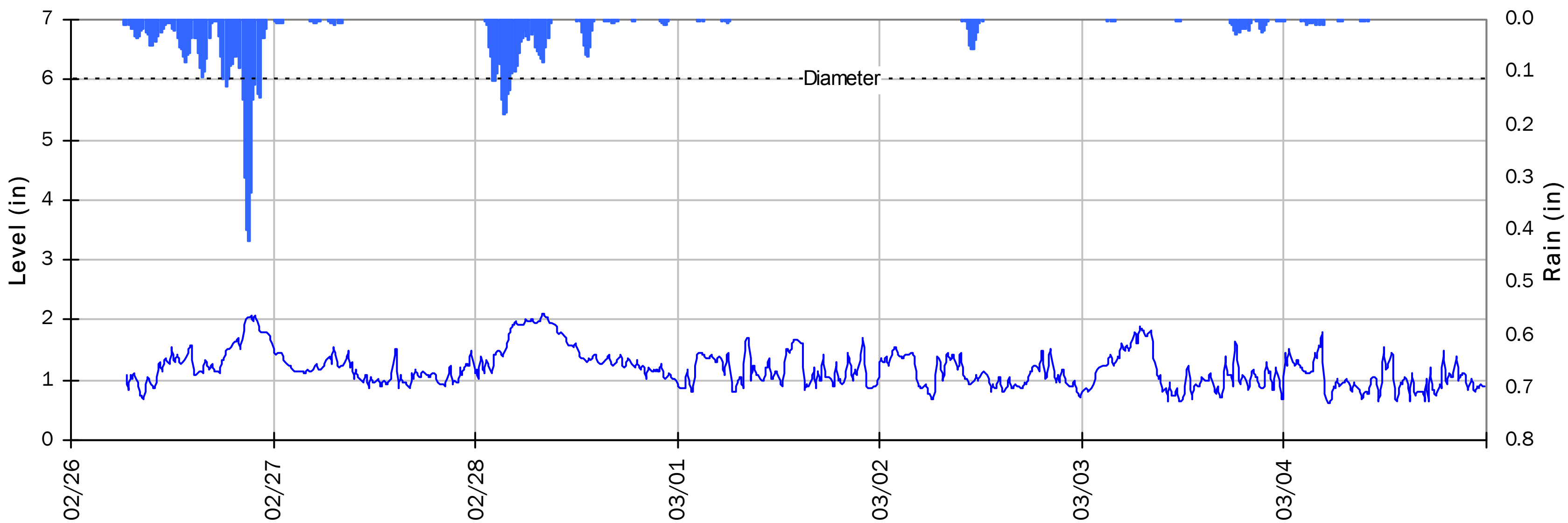
SITE M5.3

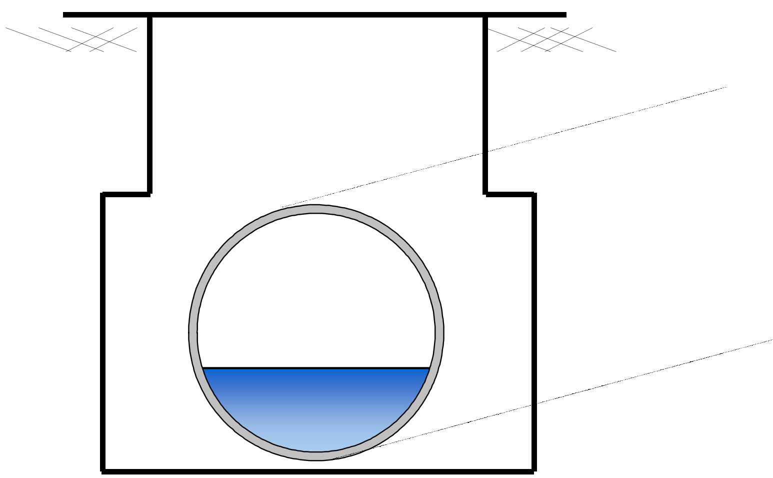
Weekly Level, Velocity and Flow Hydrographs



SITE M5.3
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



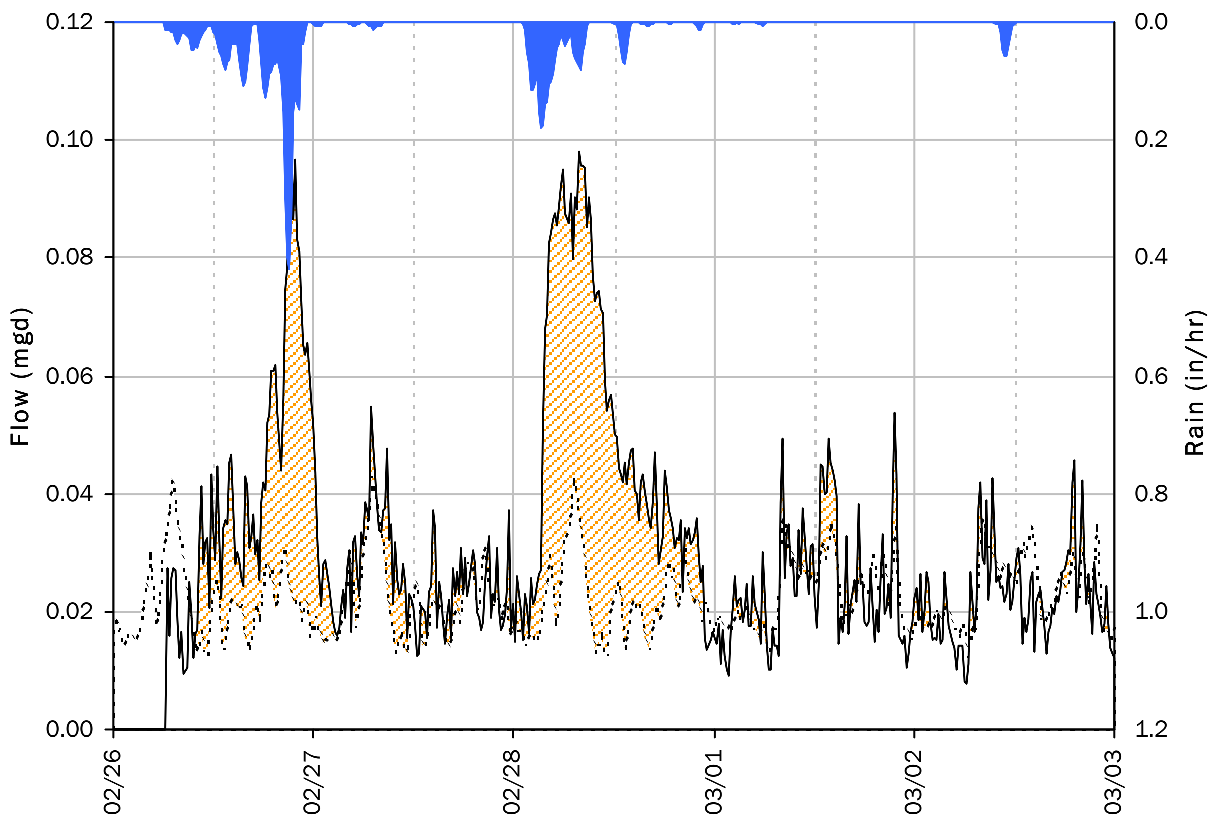


Pipe Diameter:	6	*inches*
Peak Measured Level:	2.1	*inches*
Peak d/D Ratio:	0.35	

SITE M5.3
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.10 *mgd*
PF: 4.49

Peak Level: 2.10 *in*
d/D Ratio: 0.35

Inflow / Infiltration

Peak I/I Rate: 0.08 *mgd*
Total I/I: 47,000 *gallons*

City of Pinole

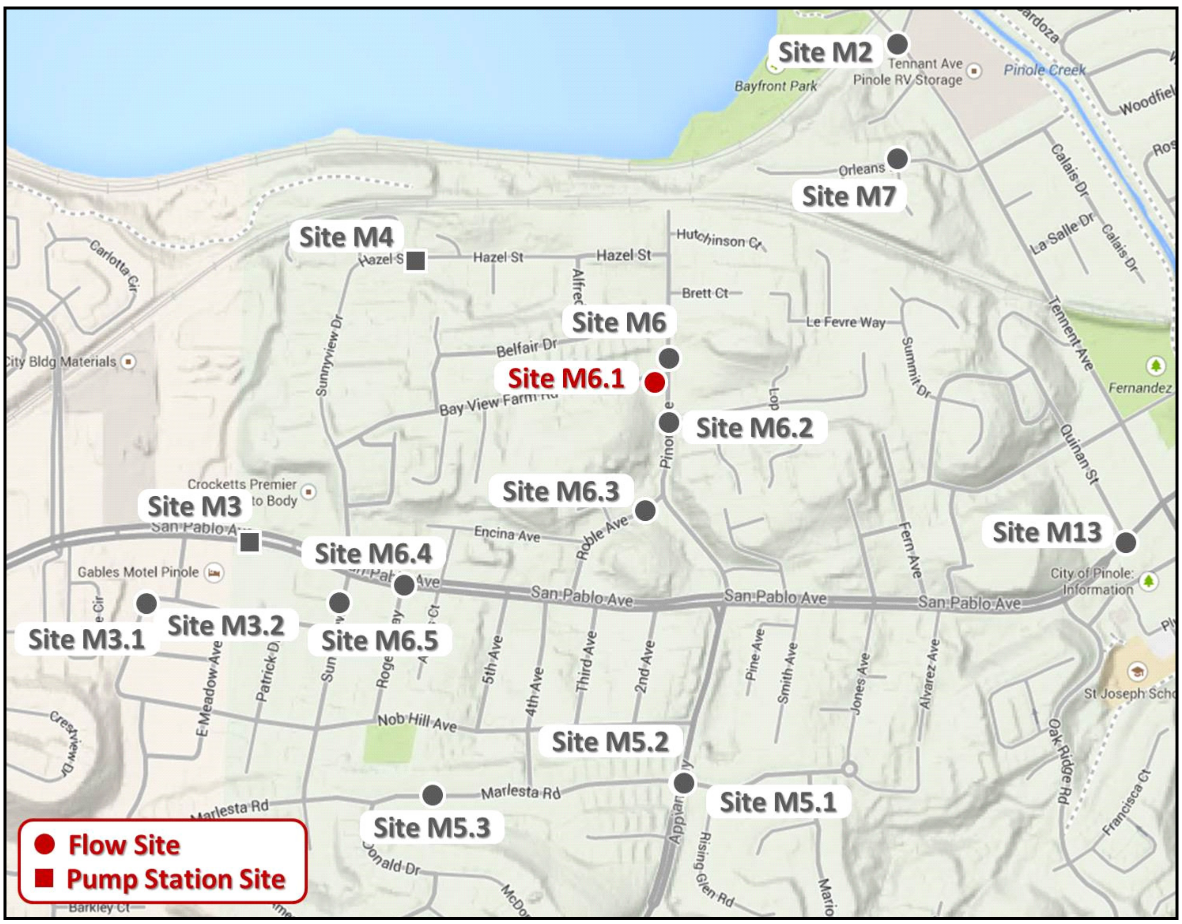
Sanitary Sewer Flow Monitoring

Temporary Monitoring: February 2014

Monitoring Site: Site M6.1

Location: Just west of intersection of Bay View Farm Rd. and Pinon Ave.

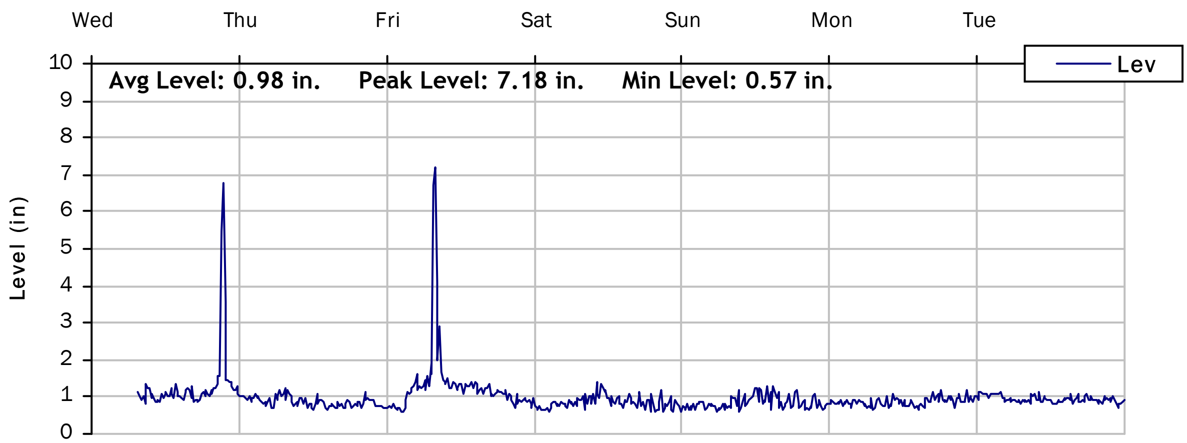
Data Summary Report

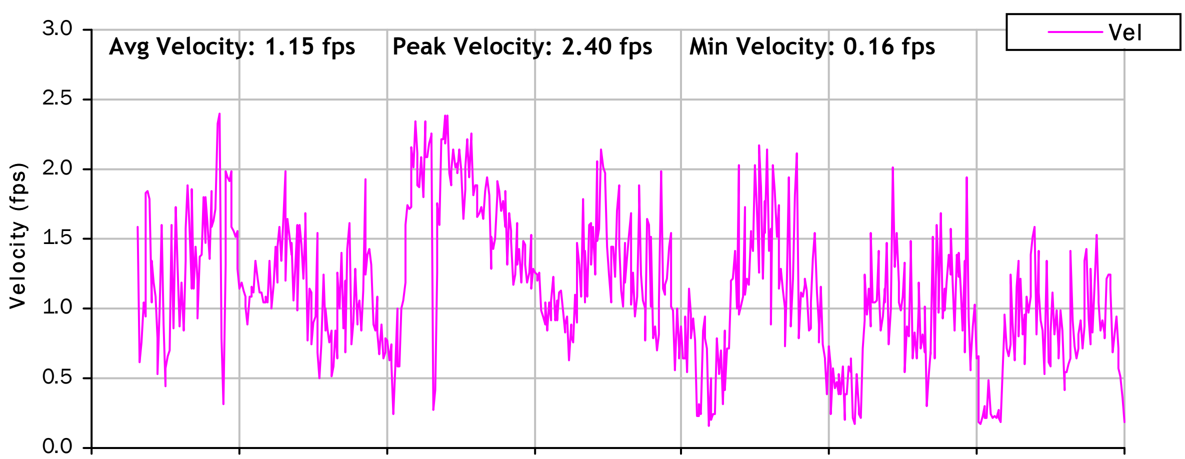


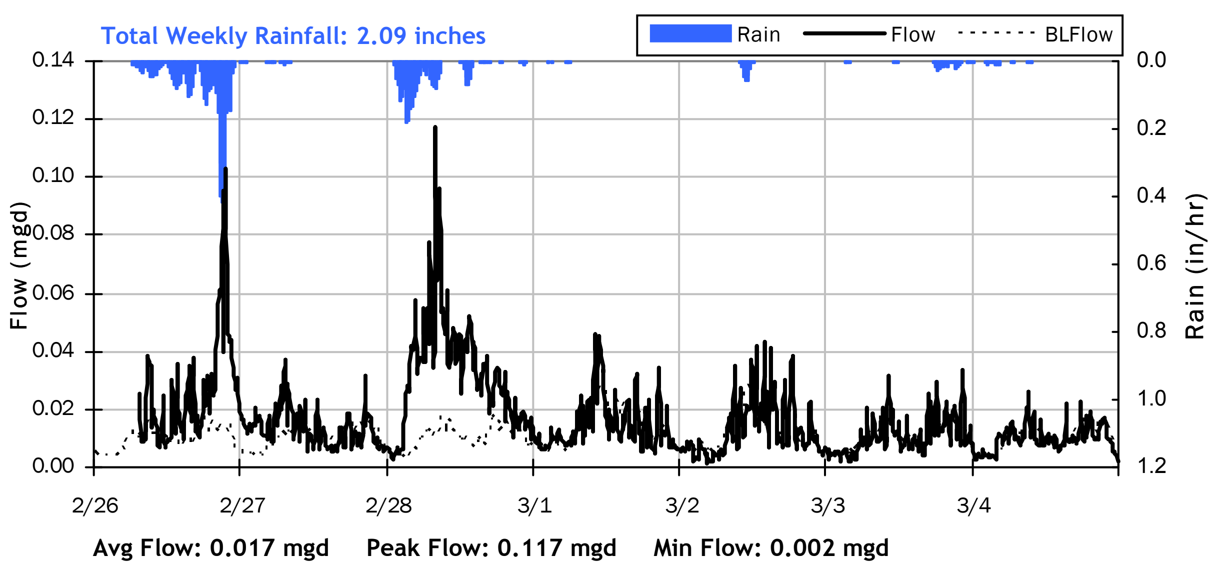
Vicinity Map: Site M6.1

SITE M6.1

Weekly Level, Velocity and Flow Hydrographs



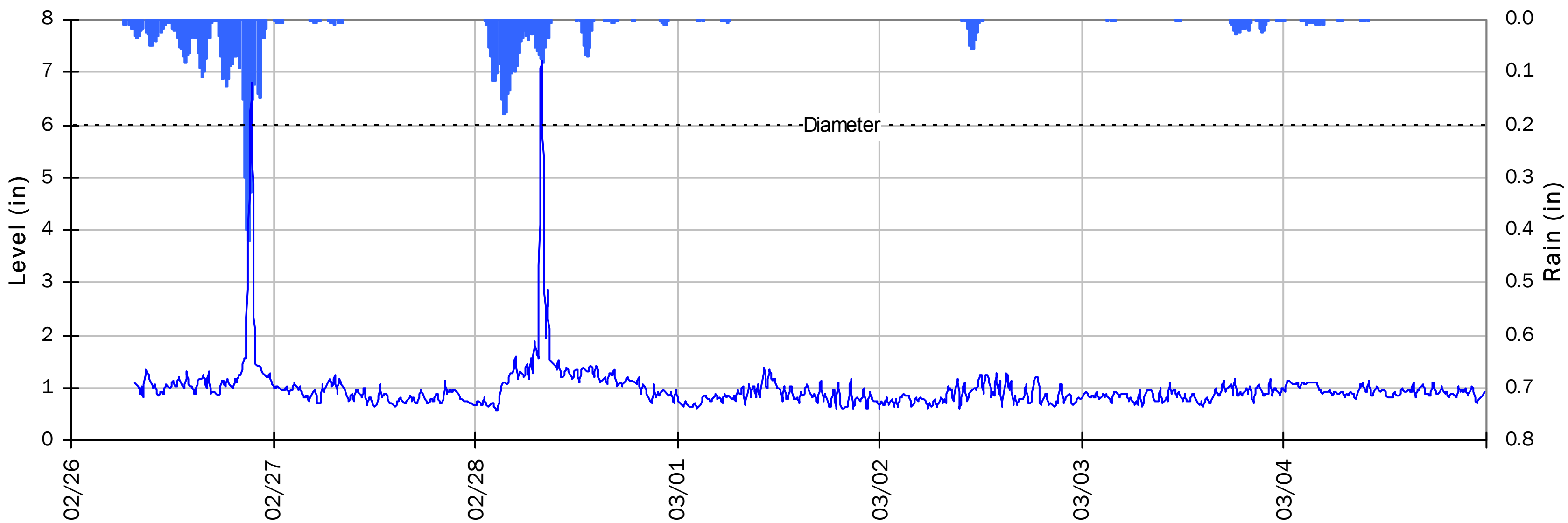


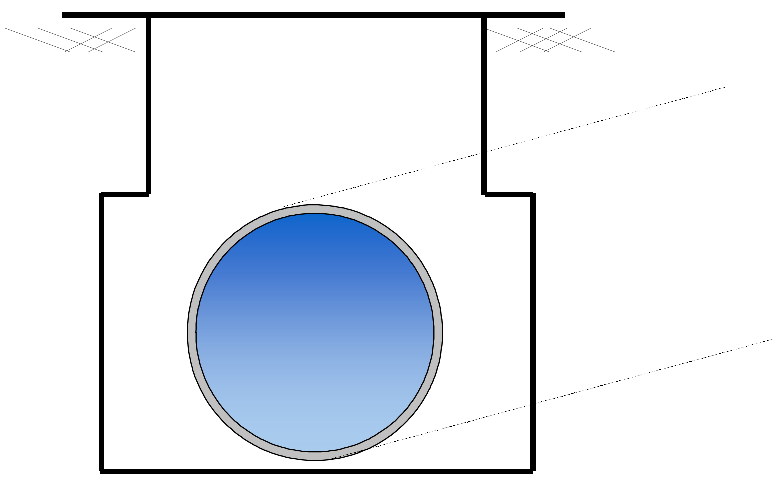


SITE M6.1

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





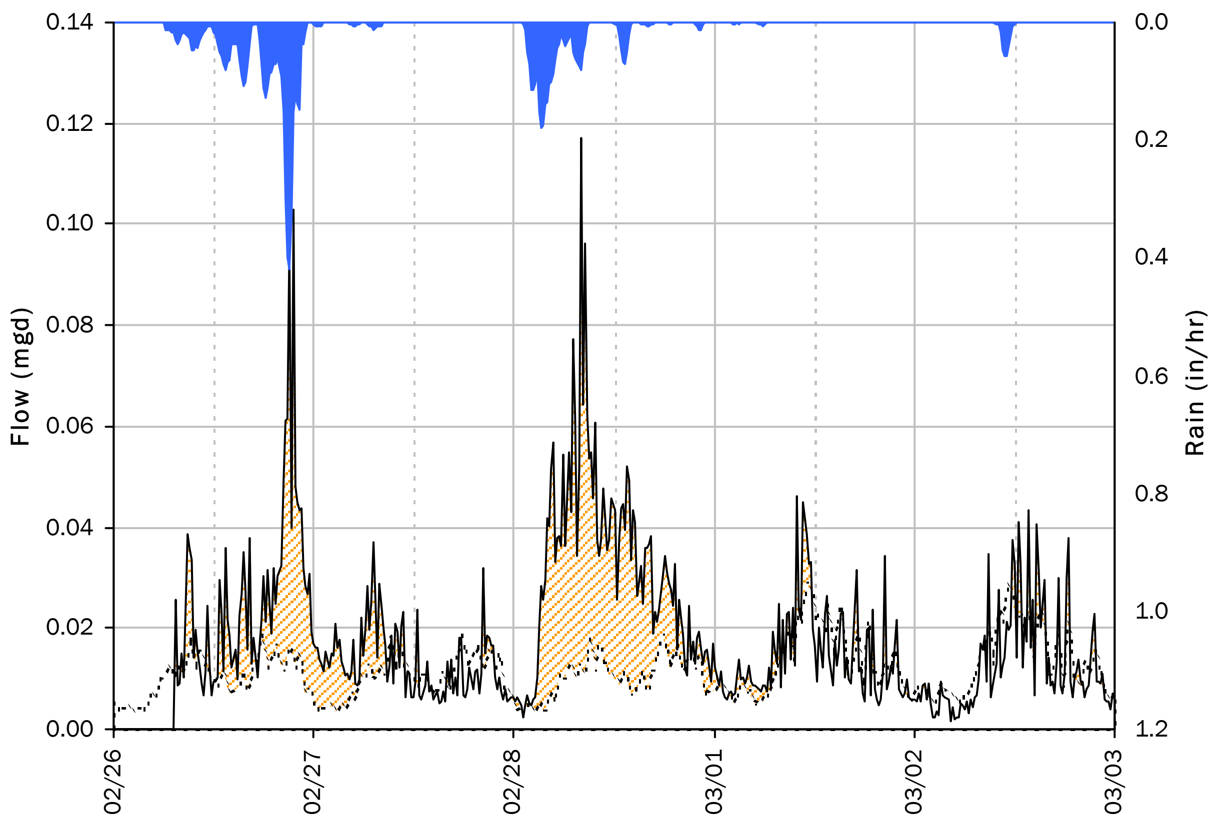
Pipe Diameter:	6	*inches*
Peak Measured Level:	7.18	*inches*
Peak d/D Ratio:	1.20	

Surcharged 1.2 inches over crown

SITE M6.1
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.12 *mgd*
PF: 10.37

Peak Level: 7.18 *in*
d/D Ratio: 1.20

Inflow / Infiltration

Peak I/I Rate: 0.10 *mgd*
Total I/I: 35,000 *gallons*

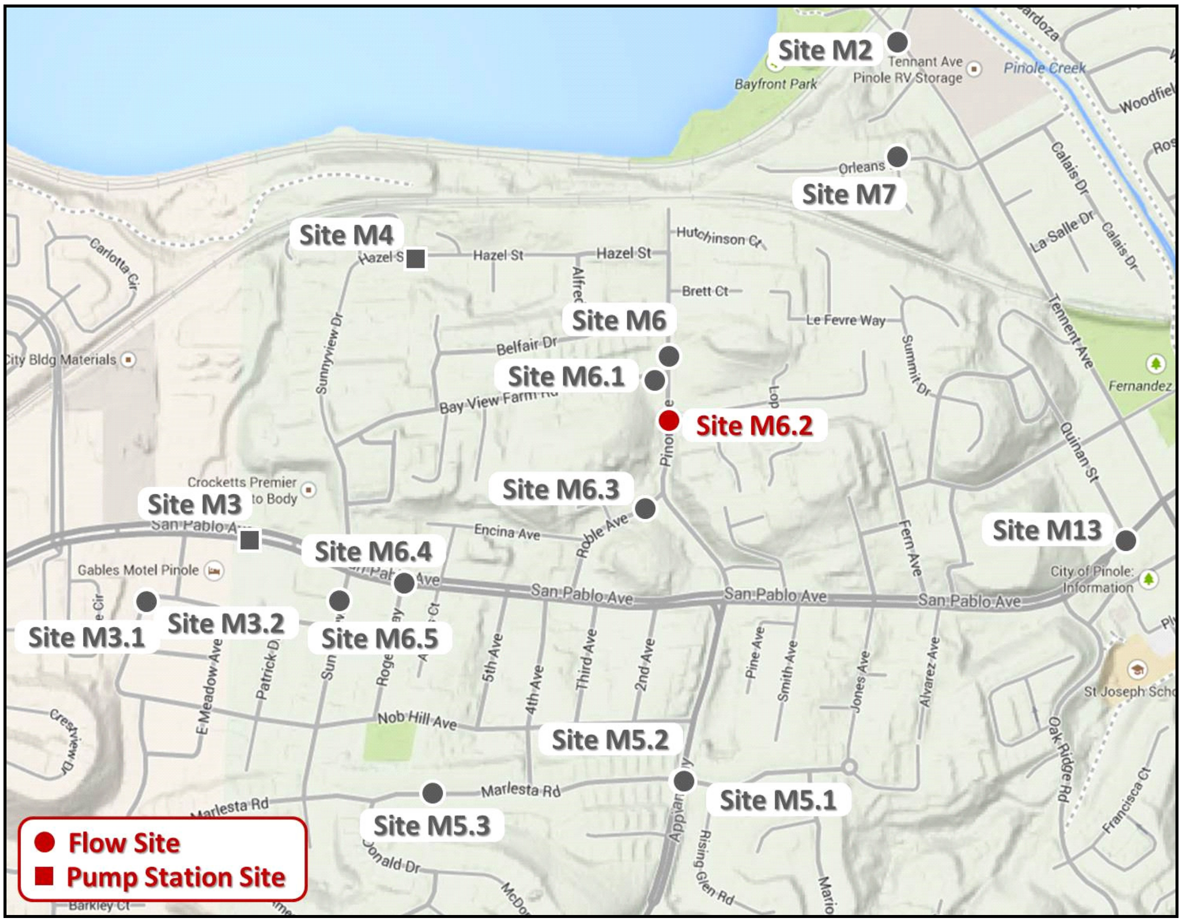
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M6.2

Location: Intersection of Pinon Ave. and Primrose Ln.

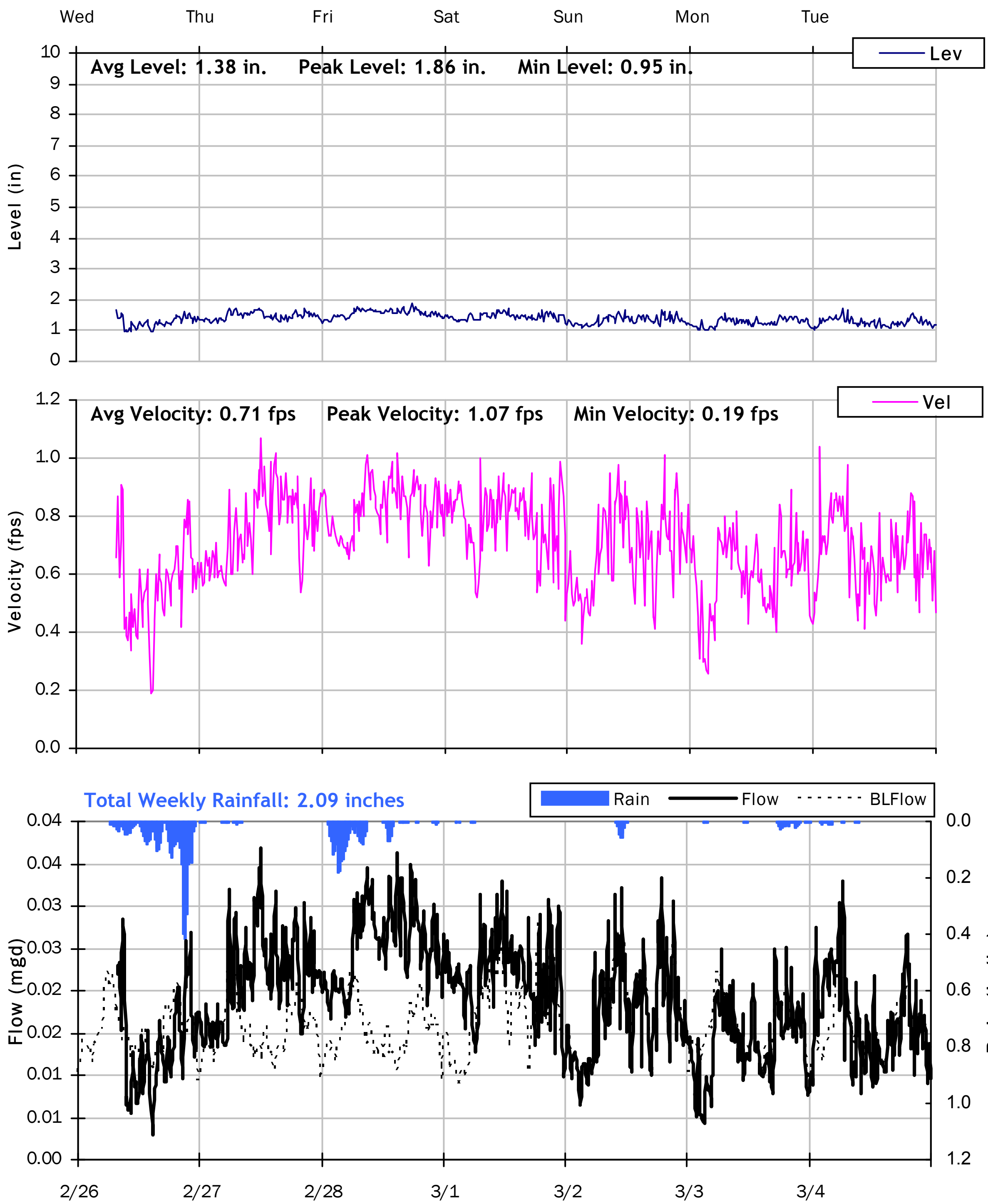
Data Summary Report



Vicinity Map: Site M6.2

SITE M6.2

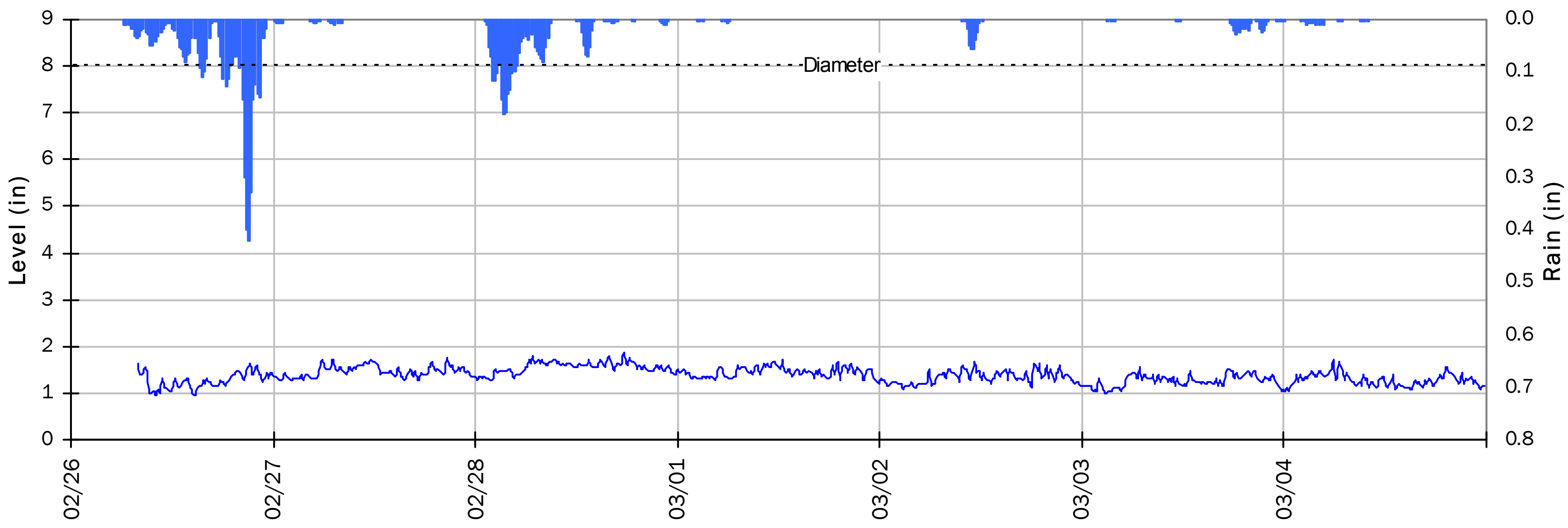
Weekly Level, Velocity and Flow Hydrographs

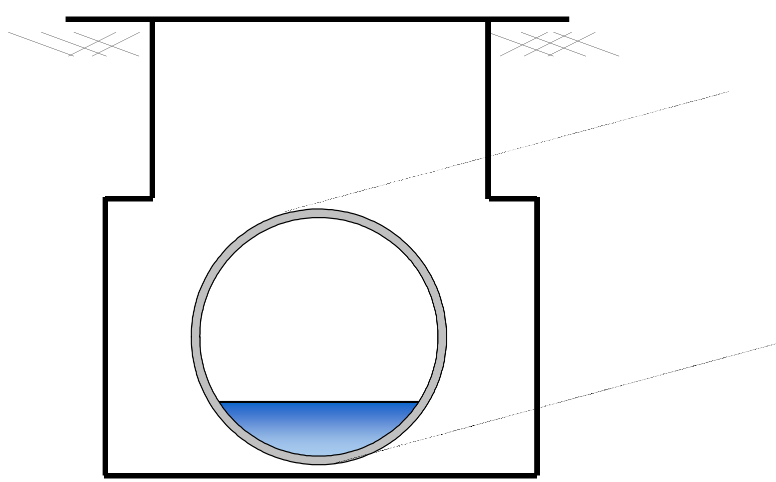


Avg Flow: 0.019 mgd **Peak Flow: 0.037 mgd** **Min Flow: 0.003 mgd**

SITE M6.2
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



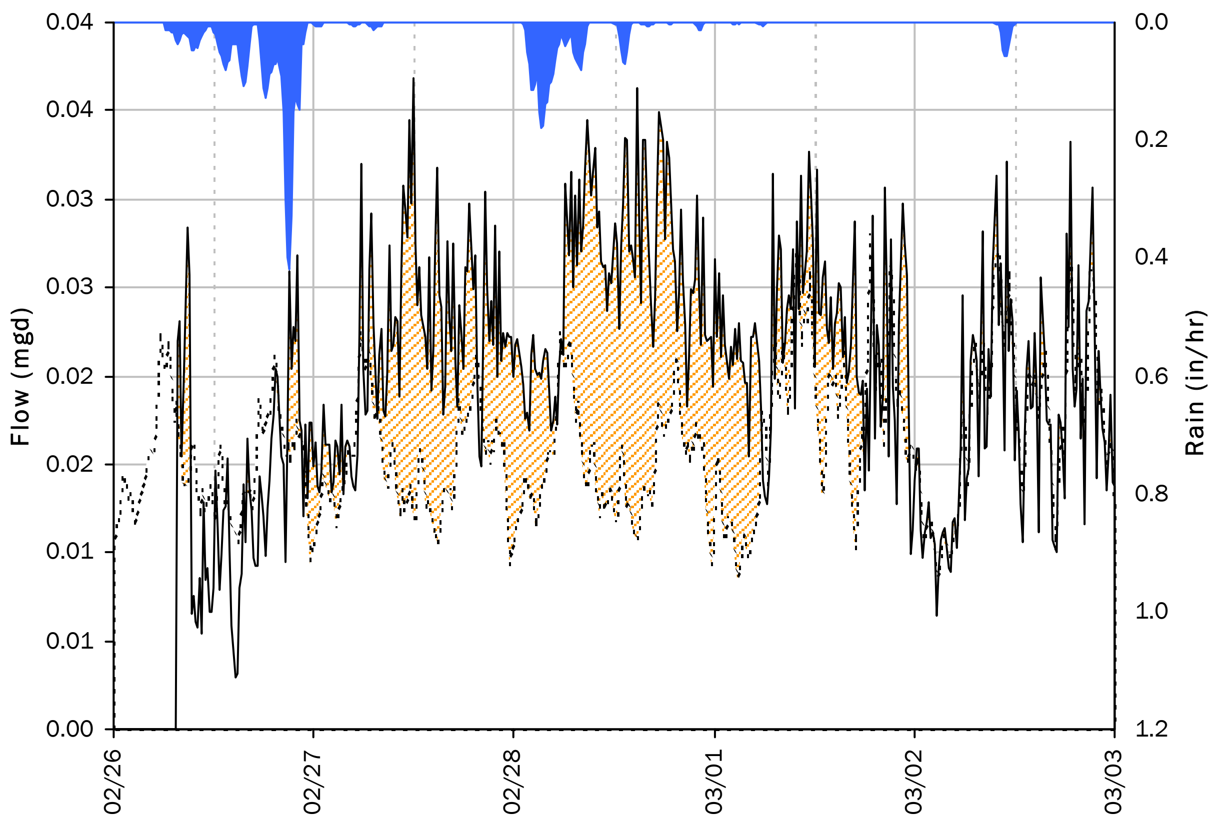


Pipe Diameter:	8	*inches*
Peak Measured Level:	1.86	*inches*
Peak d/D Ratio:	0.23	

SITE M6.2
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.04 *mgd*
PF: 2.34

Peak Level: 1.86 *in*
d/D Ratio: 0.23

Inflow / Infiltration

Peak I/I Rate: 0.03 *mgd*
Total I/I: 21,000 *gallons*

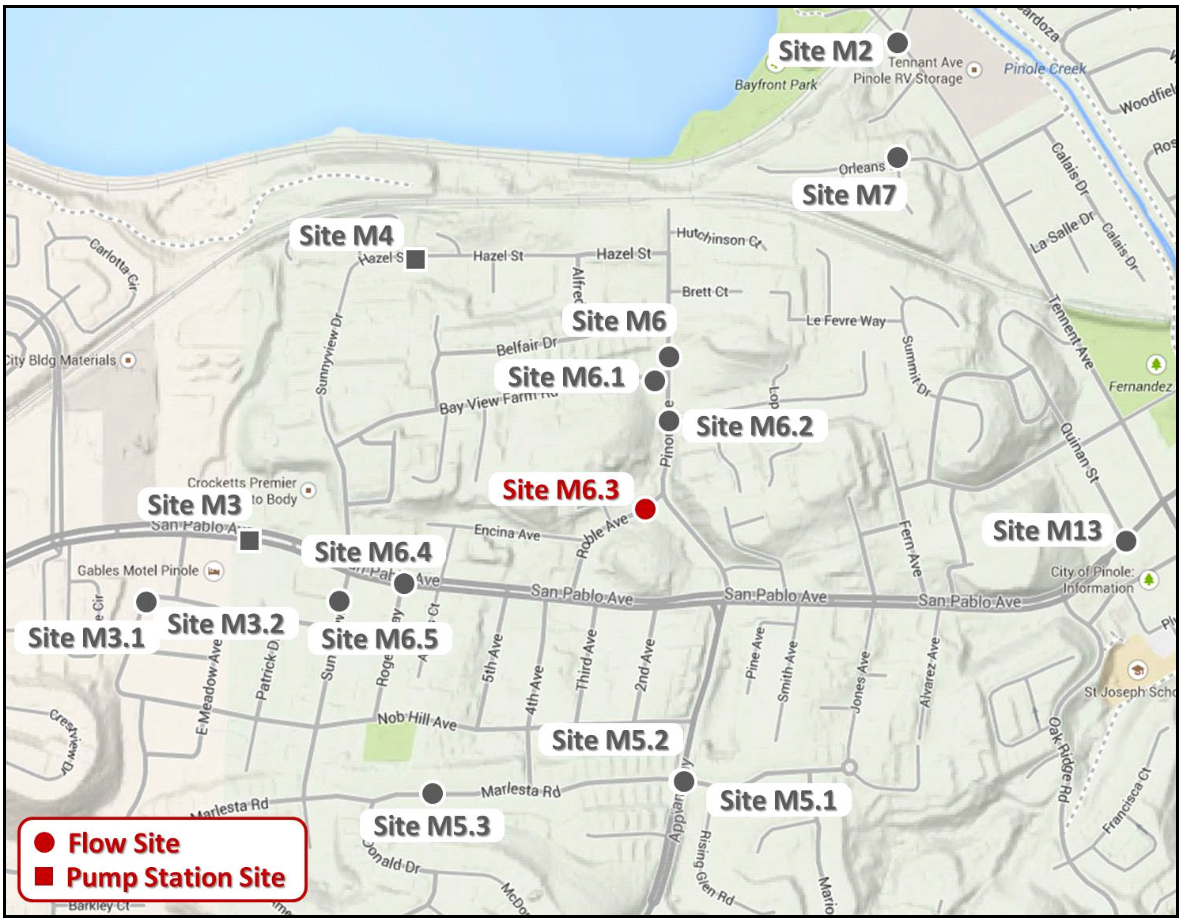
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M6.3

Location: Roble Ave., west of Pinon Ave.

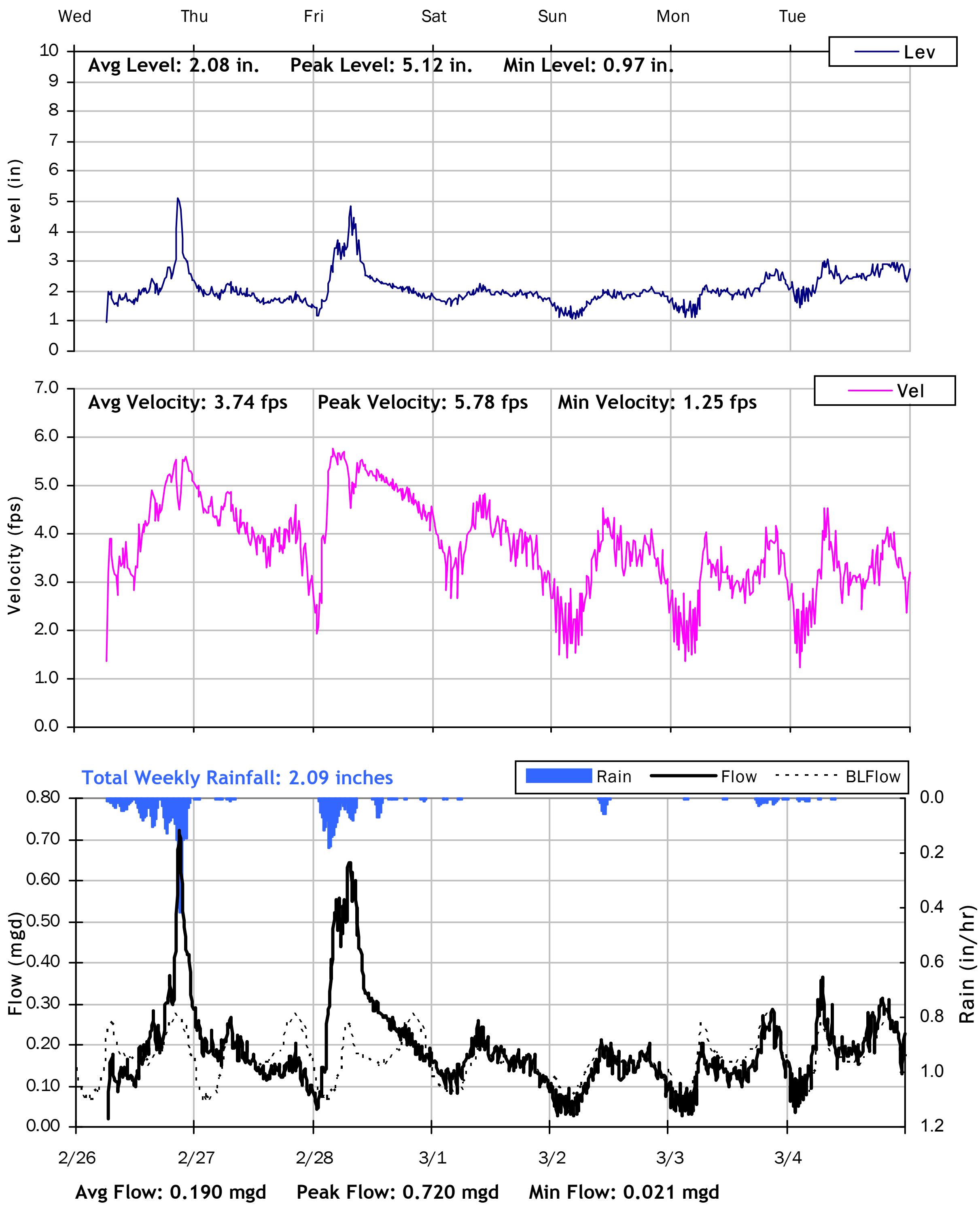
Data Summary Report



Vicinity Map: Site M6.3

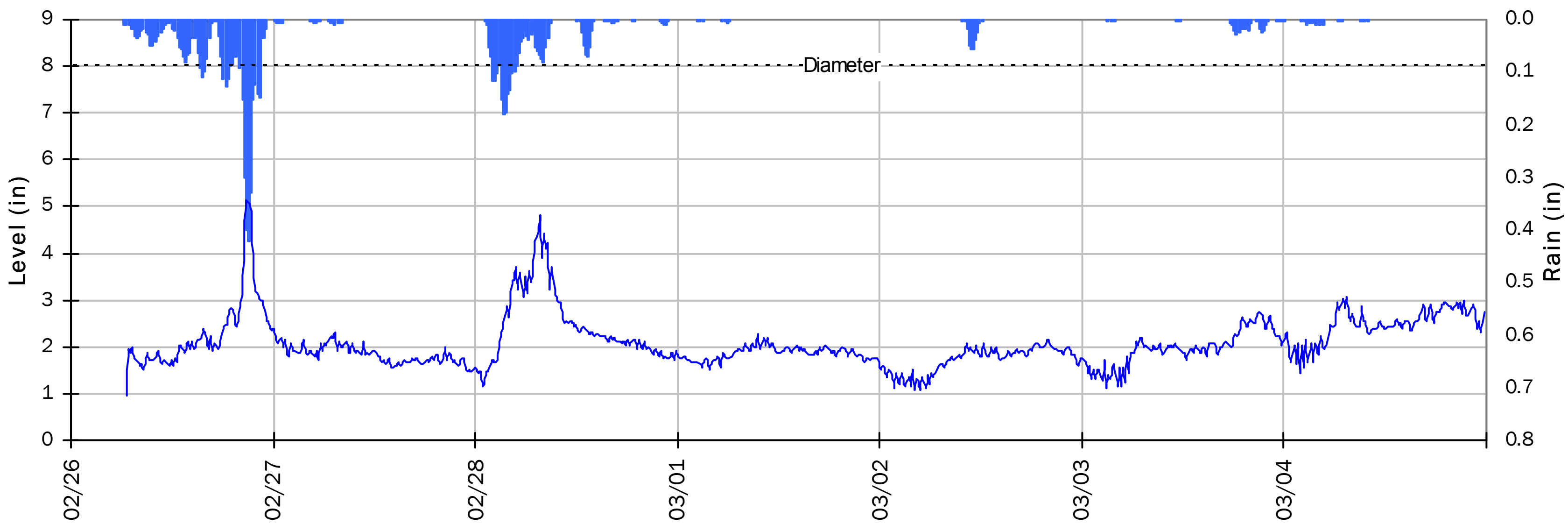
SITE M6.3

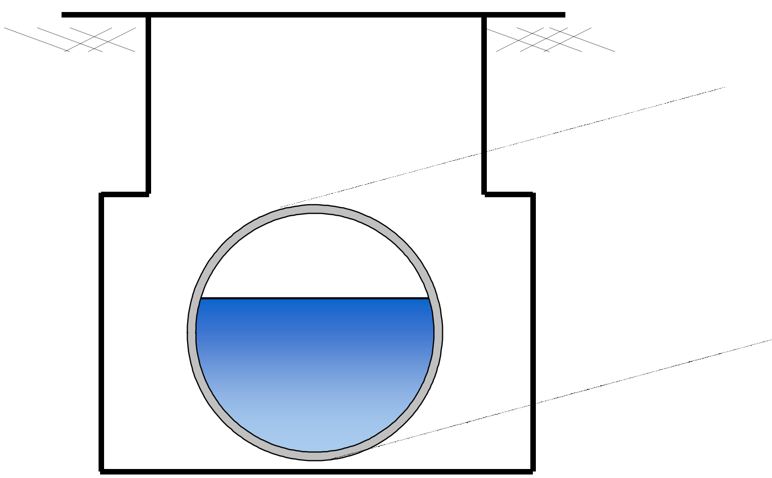
Weekly Level, Velocity and Flow Hydrographs



SITE M6.3
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



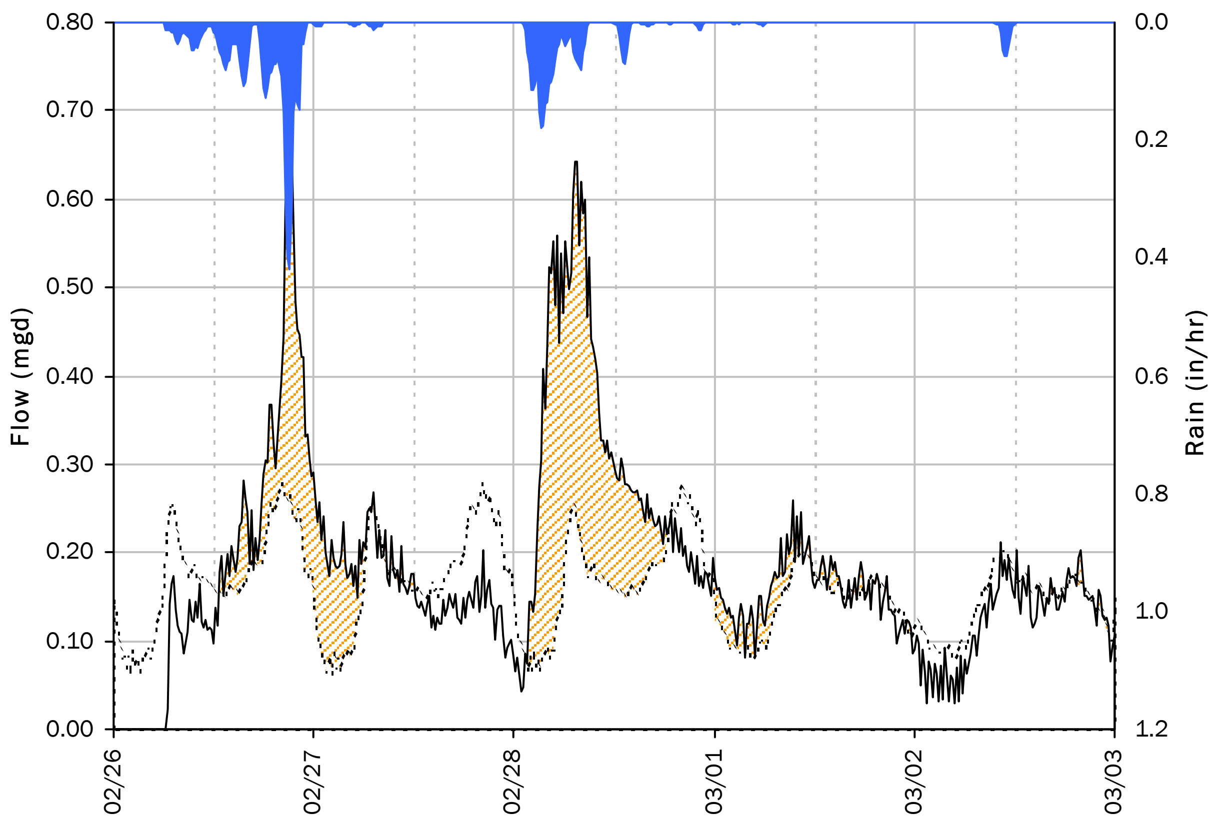


Pipe Diameter:	8	*inches*
Peak Measured Level:	5.12	*inches*
Peak d/D Ratio:	0.64	

SITE M6.3
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.72 *mgd*
PF: 4.43

Peak Level: 5.12 *in*
d/D Ratio: 0.64

Inflow / Infiltration

Peak I/I Rate: 0.46 *mgd*
Total I/I: 198,000 *gallons*

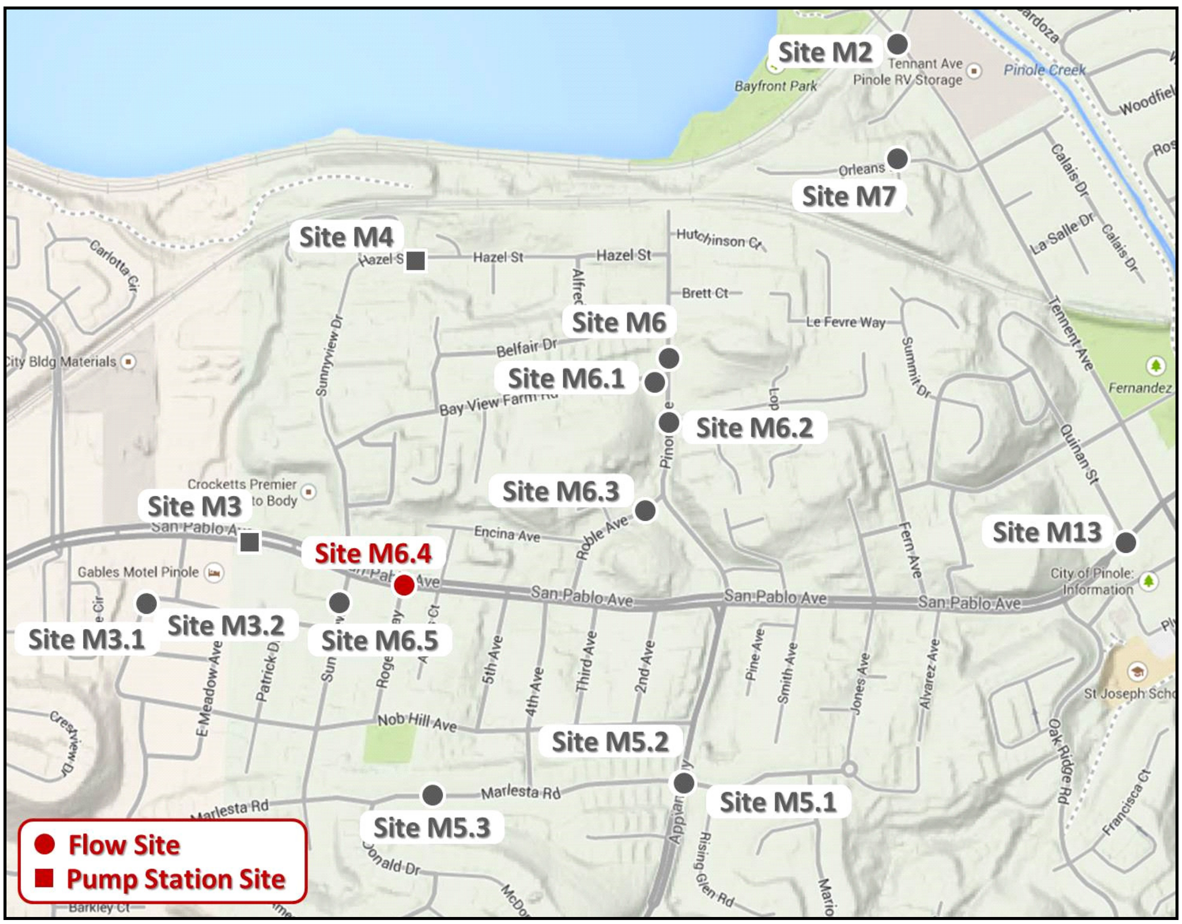
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M6.4

Location: Intersection of San Pablo Ave. and Rogers Way

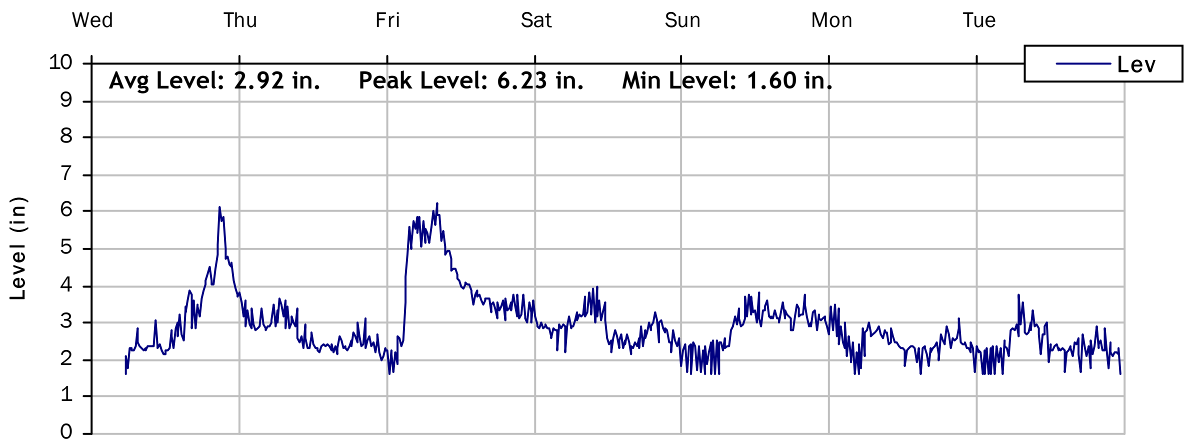
Data Summary Report

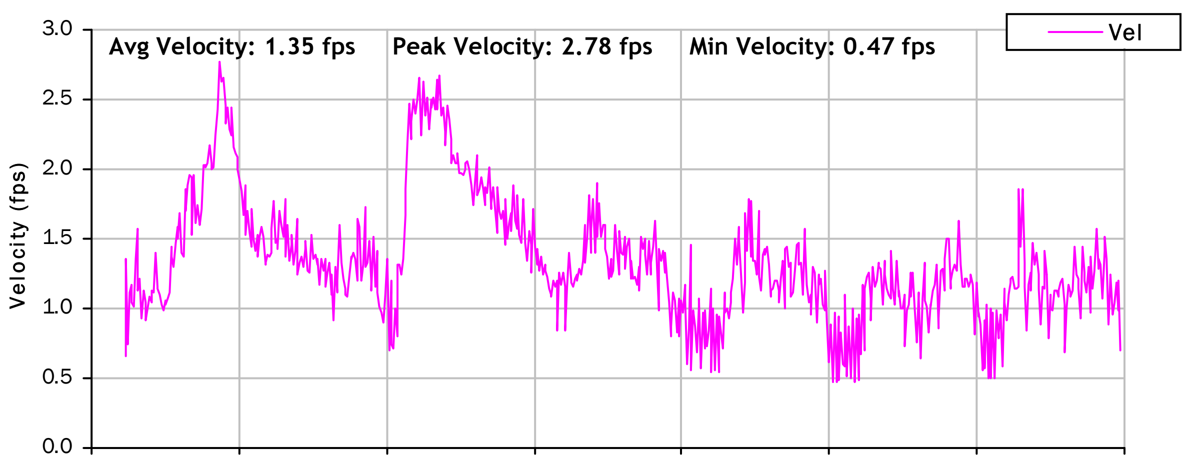


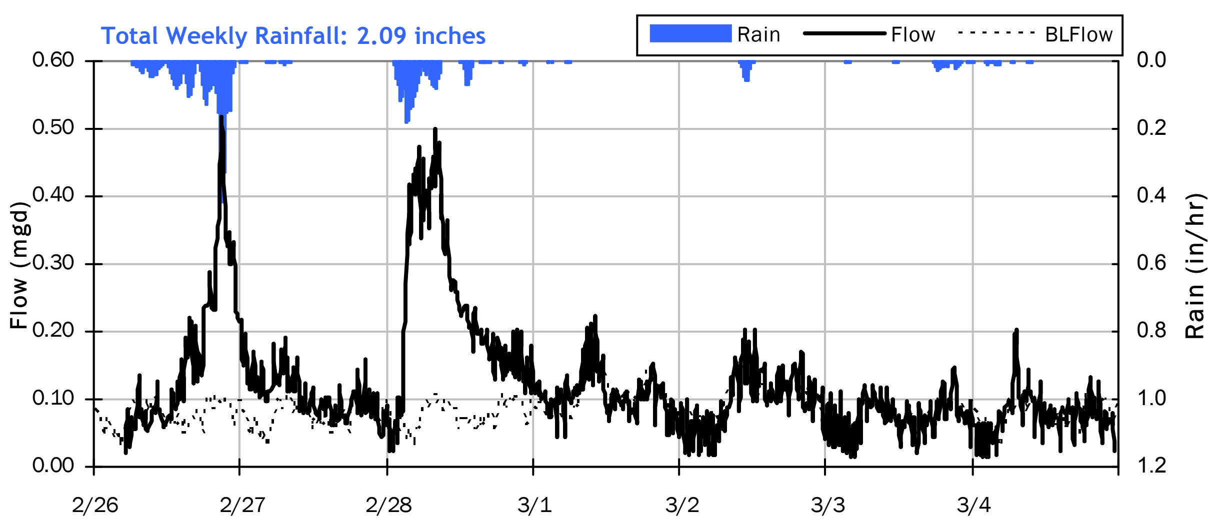
Vicinity Map: Site M6.4

SITE M6.4

Weekly Level, Velocity and Flow Hydrographs

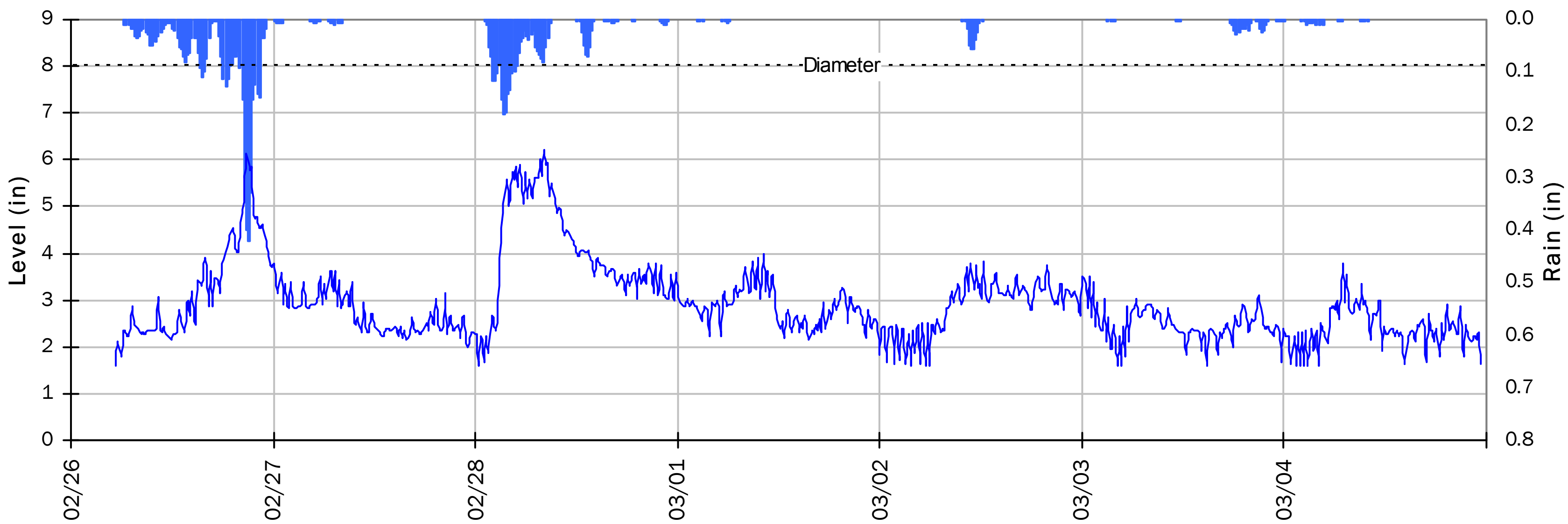


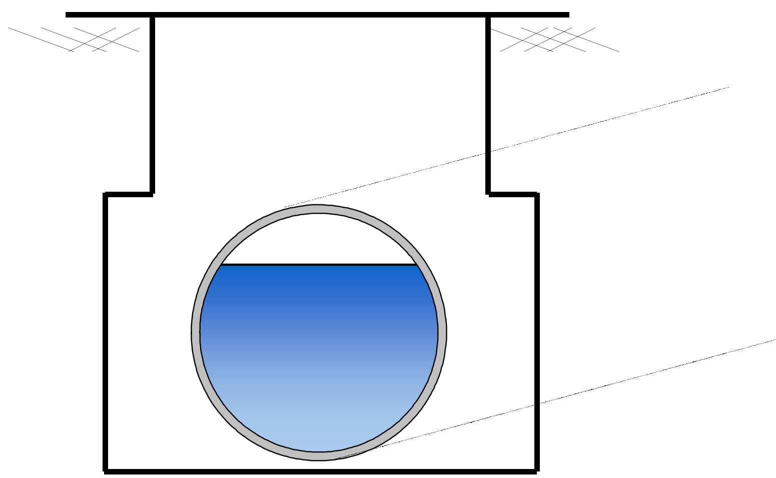




SITE M6.4
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



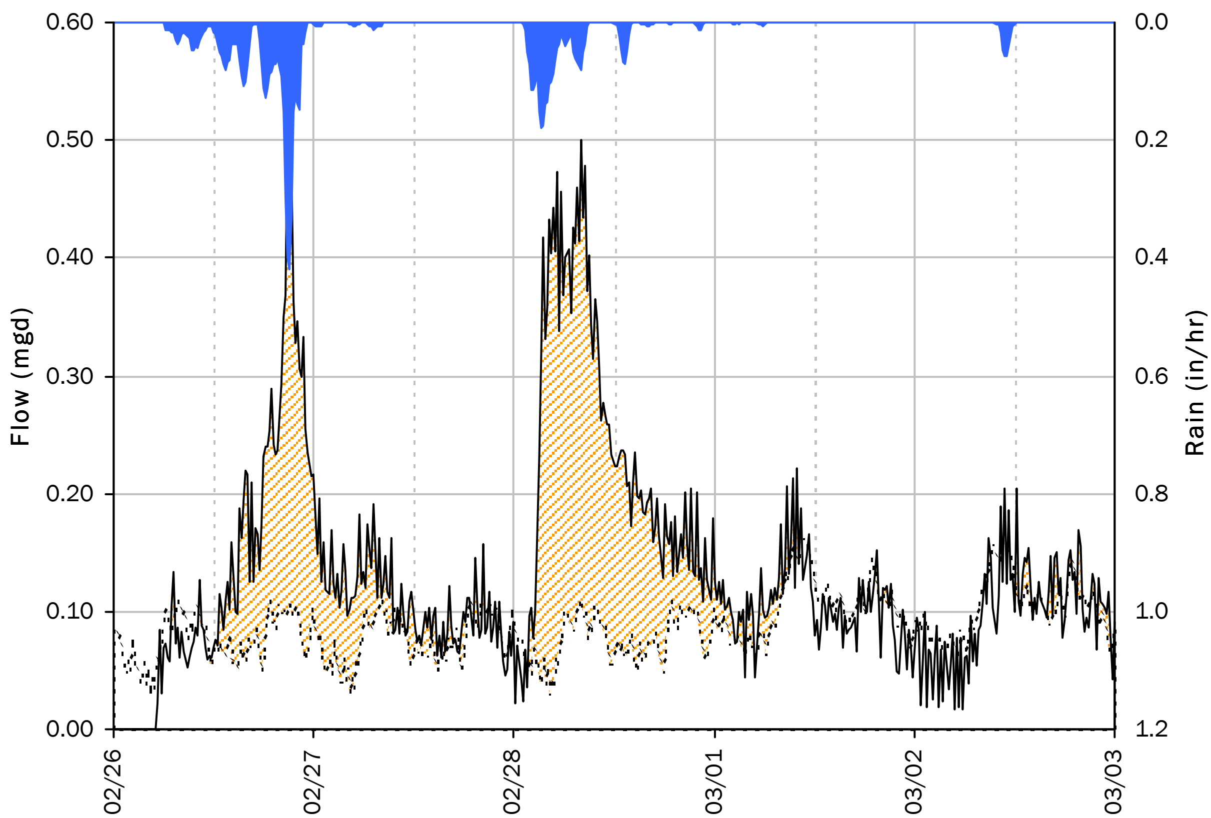


Pipe Diameter:	8	*inches*
Peak Measured Level:	6.23	*inches*
Peak d/D Ratio:	0.78	

SITE M6.4
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.51 *mgd*
PF: 6.14

Peak Level: 6.23 *in*
d/D Ratio: 0.78

Inflow / Infiltration

Peak I/I Rate: 0.42 *mgd*
Total I/I: 267,000 *gallons*

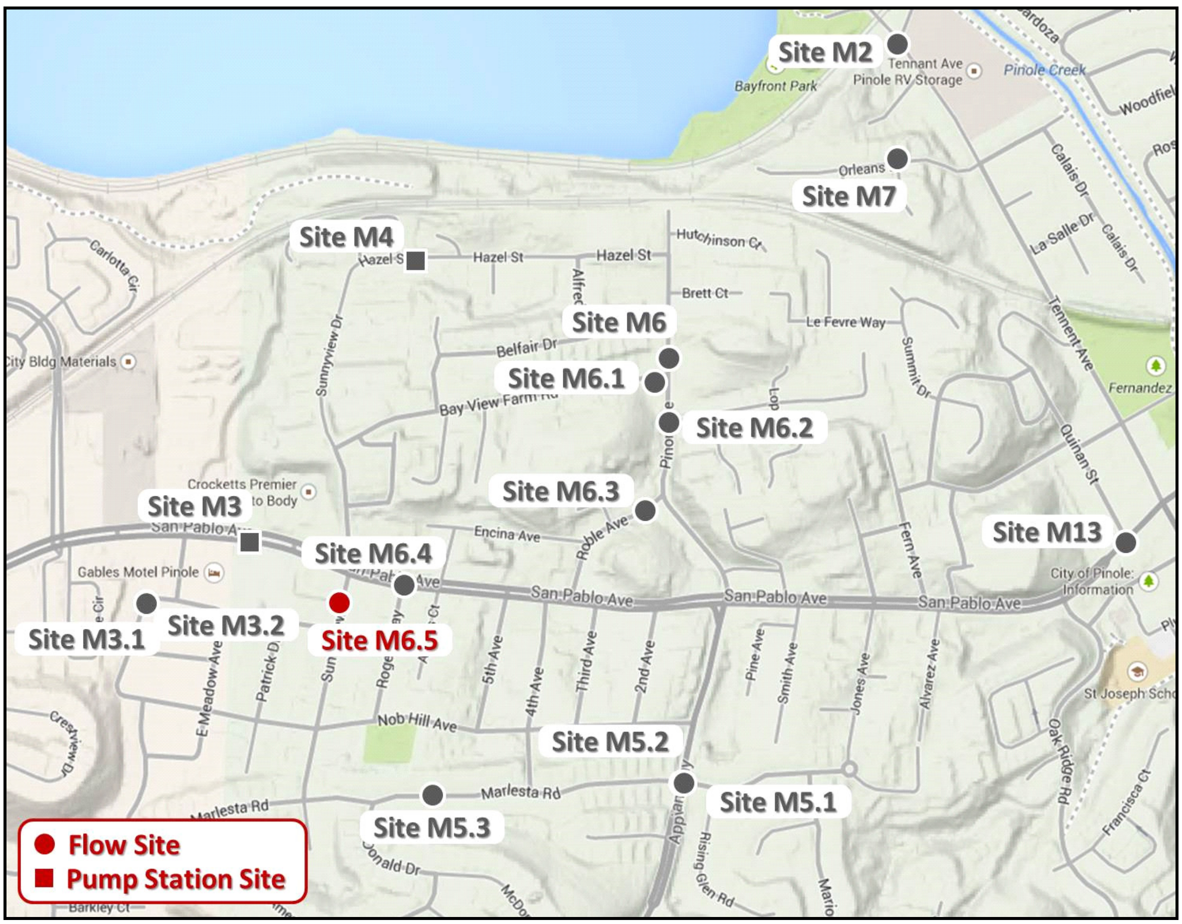
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: February 2014

Monitoring Site: Site M6.5

Location: 747 Sunnyview Dr.

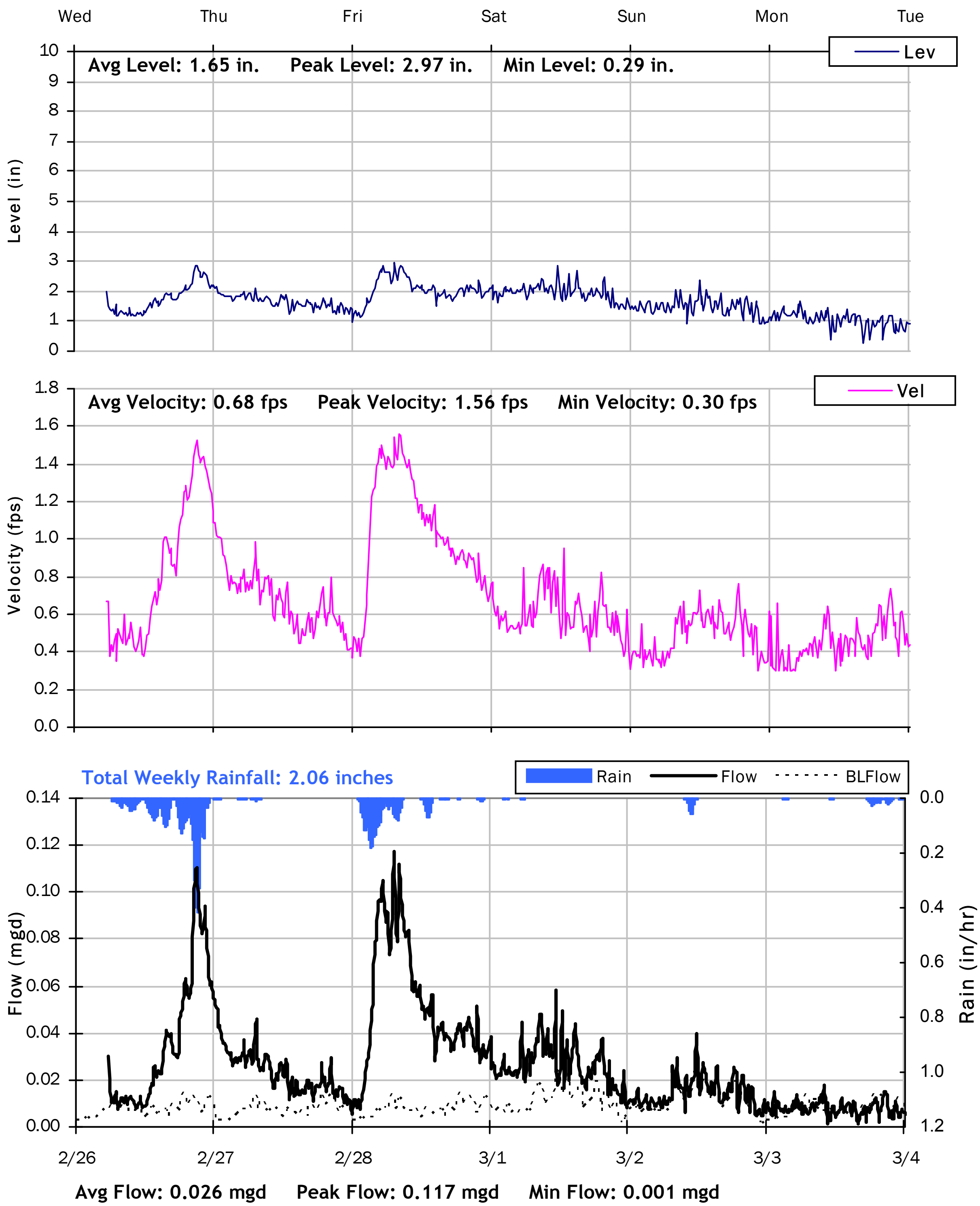
Data Summary Report



Vicinity Map: Site M6.5

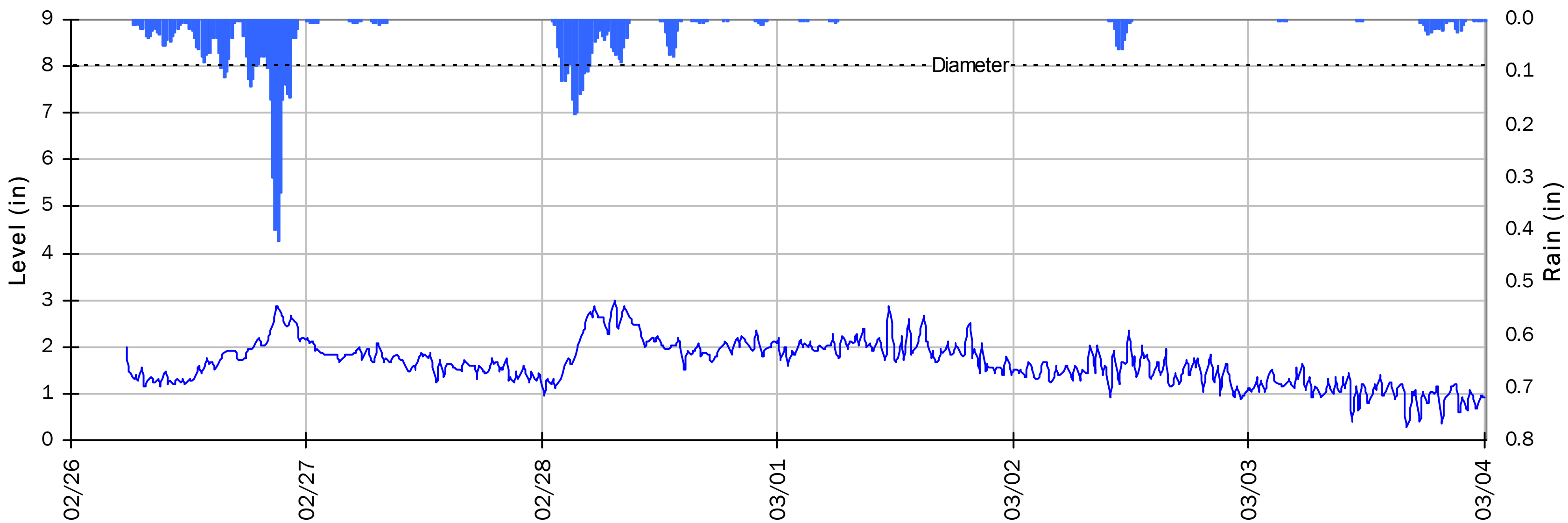
SITE M6.5

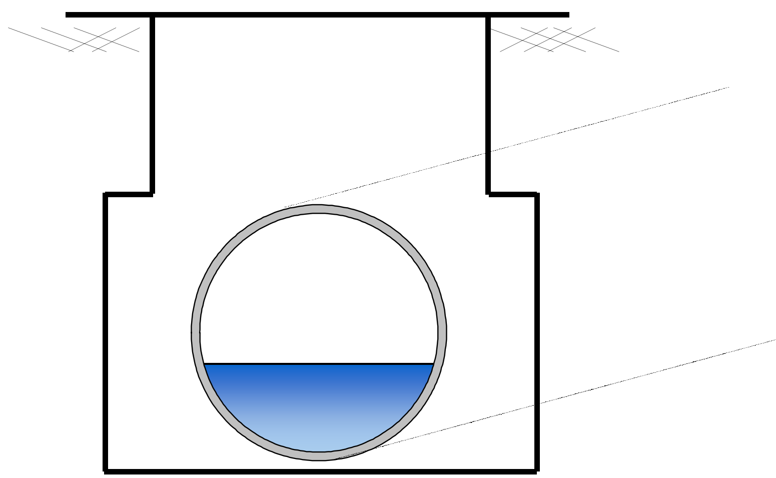
Weekly Level, Velocity and Flow Hydrographs



SITE M6.5
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



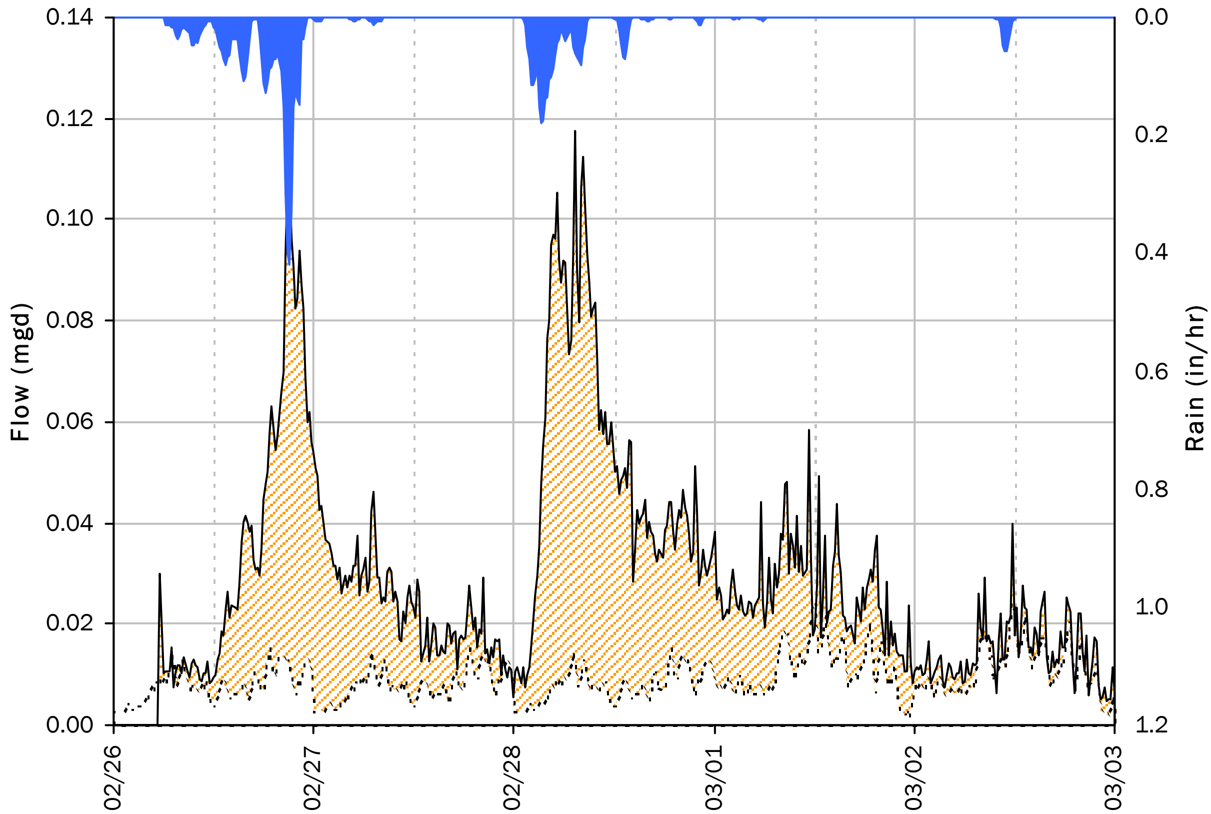


Pipe Diameter:	8	*inches*
Peak Measured Level:	2.97	*inches*
Peak d/D Ratio:	0.37	

SITE M6.5
I/I Summary: Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 2 Detail Graph



Storm Event I/I Analysis (Rain = 1.98 inches)

Capacity

Peak Flow: 0.12 *mgd*
PF: 13.49

Peak Level: 2.97 *in*
d/D Ratio: 0.37

Inflow / Infiltration

Peak I/I Rate: 0.11 *mgd*
Total I/I: 96,000 *gallons*

APPENDIX F. FLOW MONITORING SITES DATA, GRAPHS, INFORMATION: PHASE 3

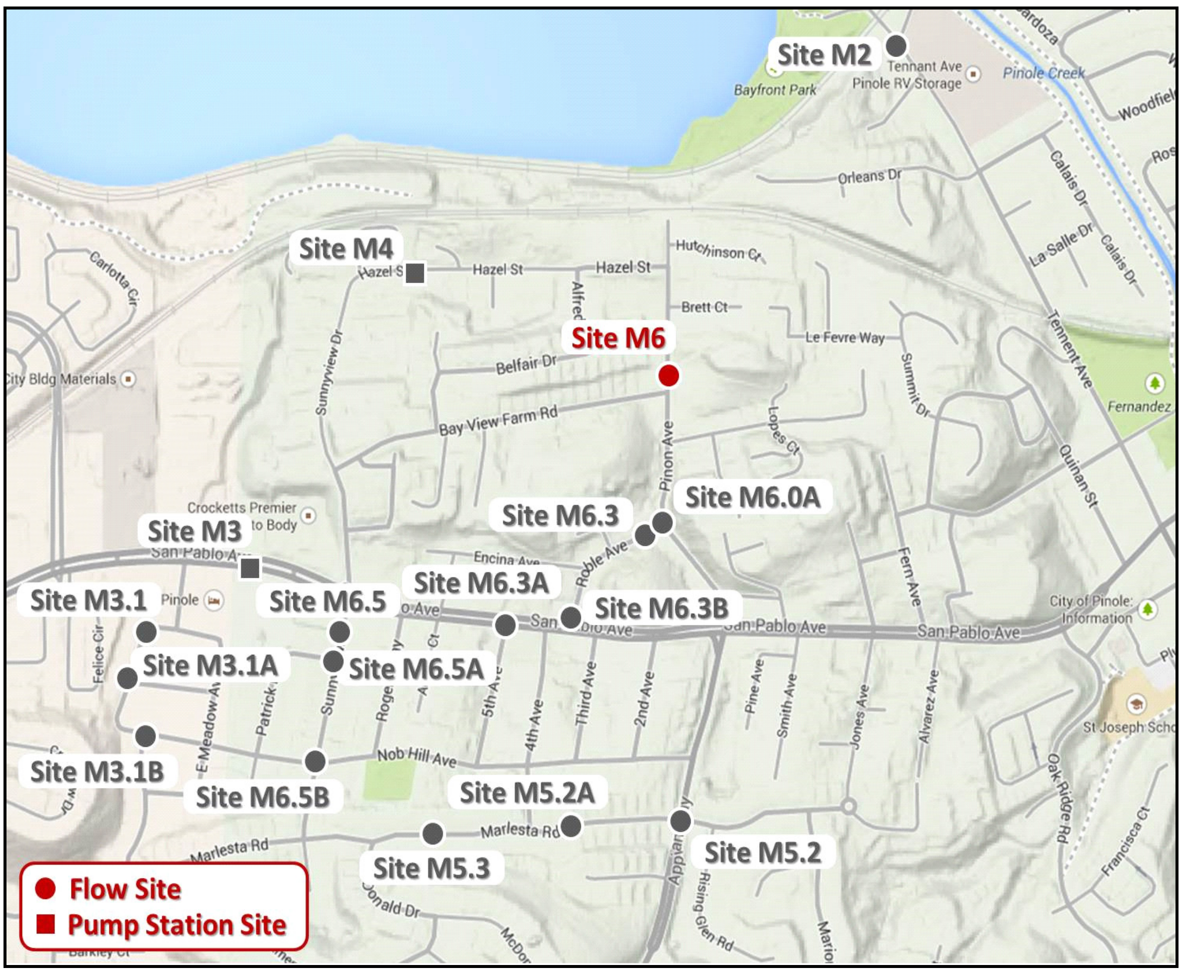
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6

Location: Pinon Ave., north of Bay View Farm Rd.

Data Summary Report

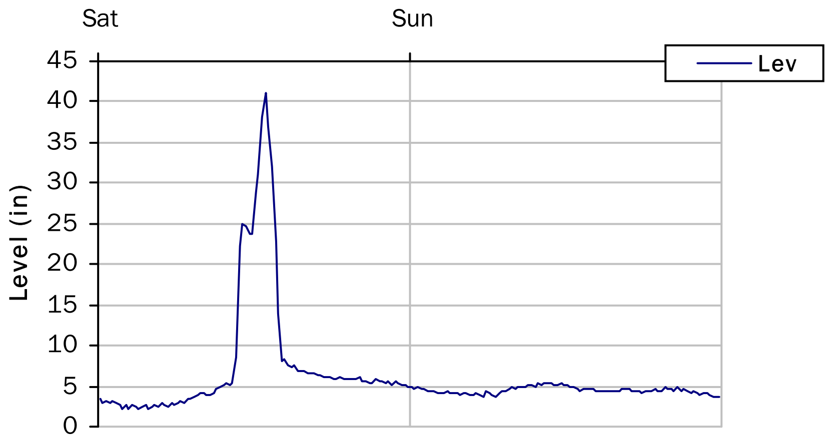


Vicinity Map: Site M6

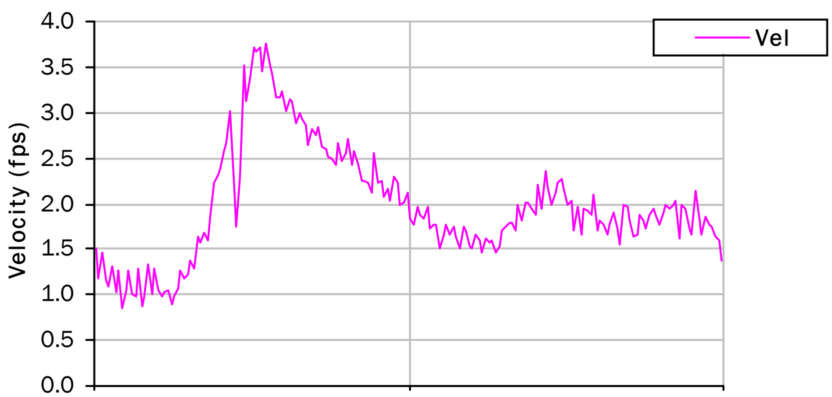
SITE M6

Weekly Level, Velocity and Flow Hydrographs

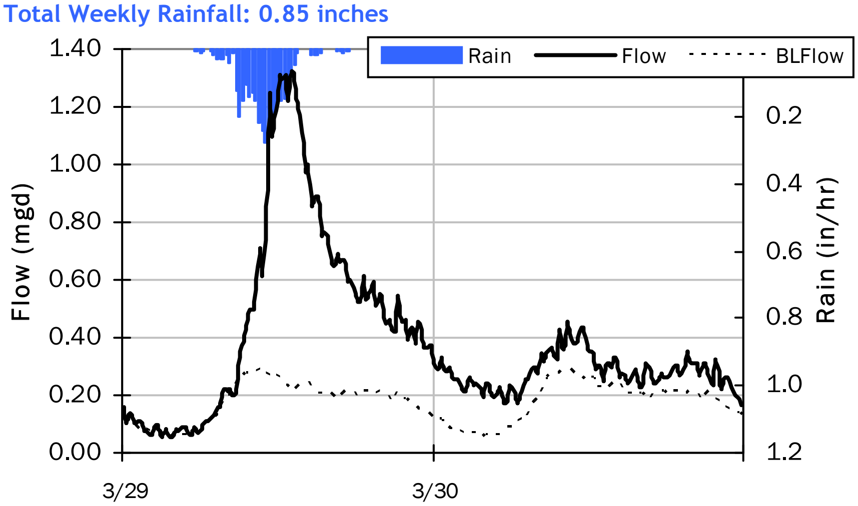
Avg Level: 6.18 in. Peak Level: 41.01 in. Min Level: 2.12 in.



Avg Velocity: 1.98 fps Peak Velocity: 3.76 fps Min Velocity: 0.86 fps



Total Weekly Rainfall: 0.85 inches

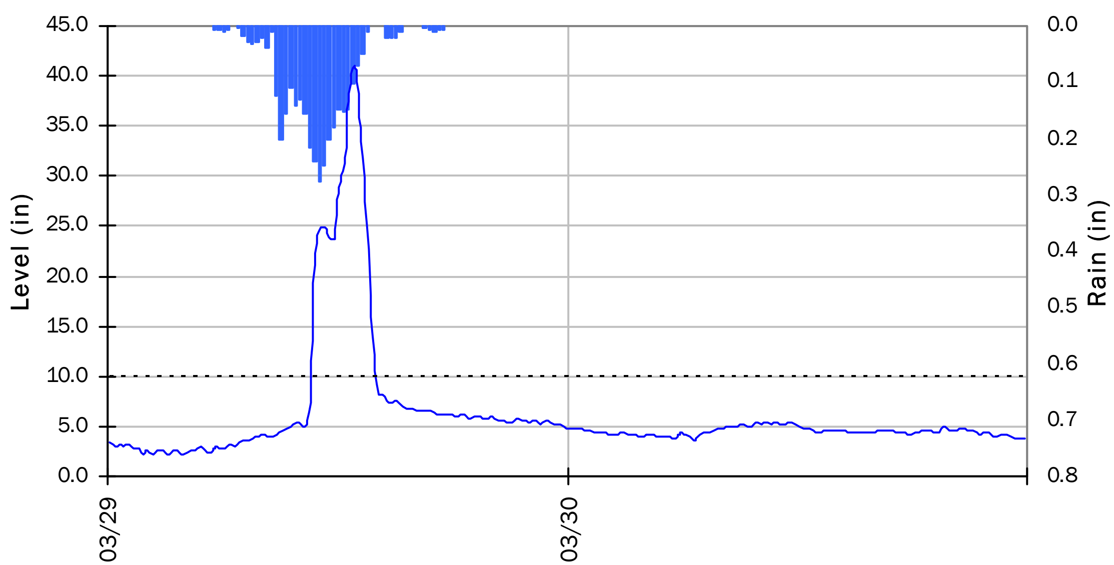


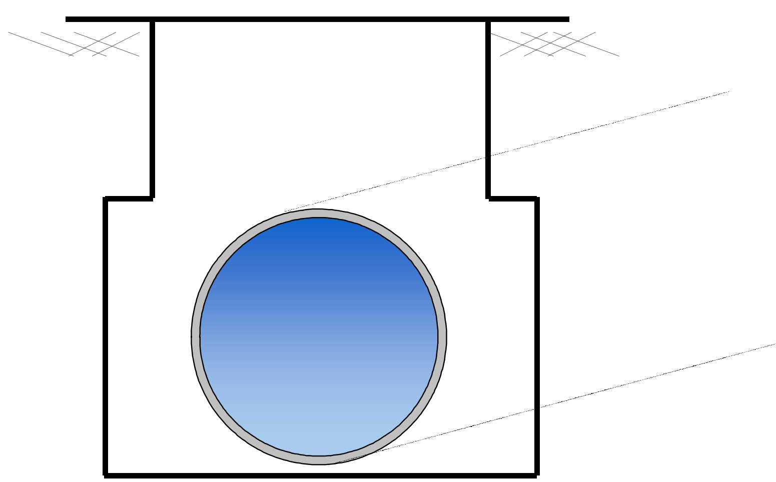
Avg Flow: 0.380 mgd Peak Flow: 1.324 mgd Min Flow: 0.053 mgd

SITE M6

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





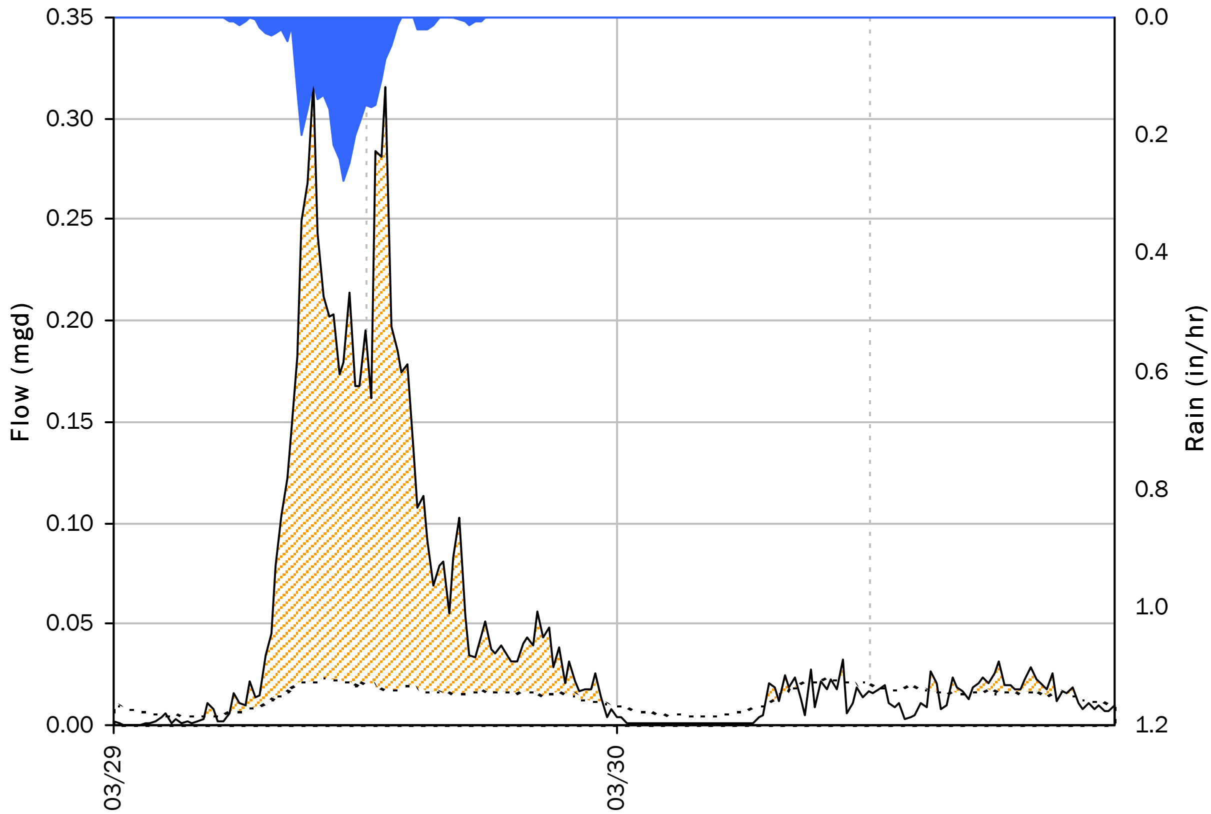
Pipe Diameter:	10	*inches*
Peak Measured Level:	41.0	*inches*
Peak d/D Ratio:	4.10	

Surcharged 31.0 inches over crown

SITE 3.1
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.32 *mgd*

PF: 24.33

Peak Level: 2.61 *in*

d/D Ratio: 0.44

Inflow / Infiltration

Peak I/I Rate: 0.30 *mgd*

Total I/I: 60,000 *gallons*

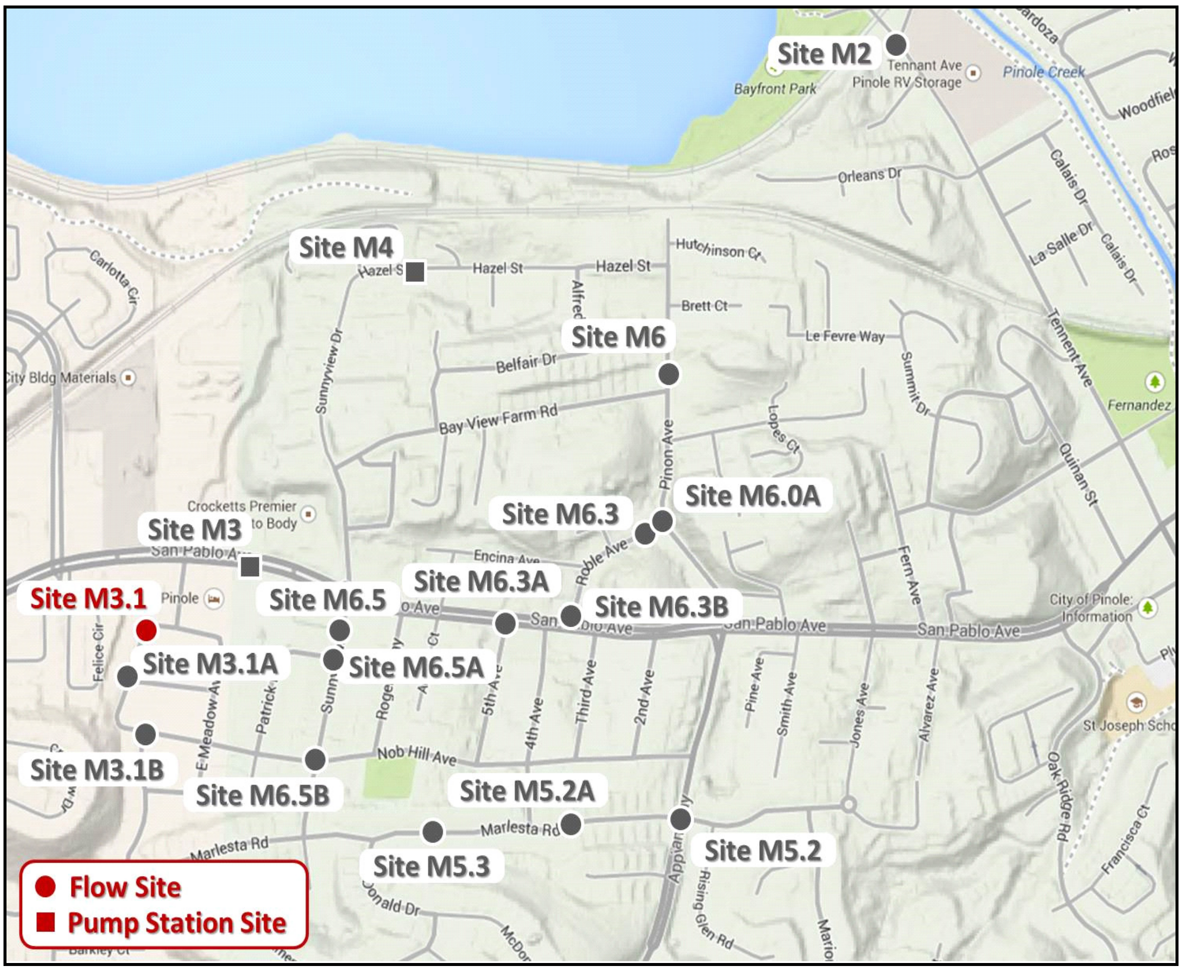
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M3.1

Location: 830 Meadows Ave.

Data Summary Report

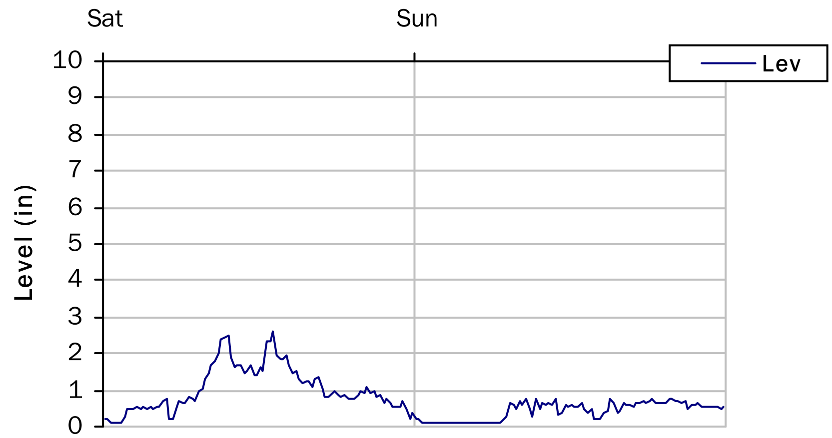


Vicinity Map: Site M3.1

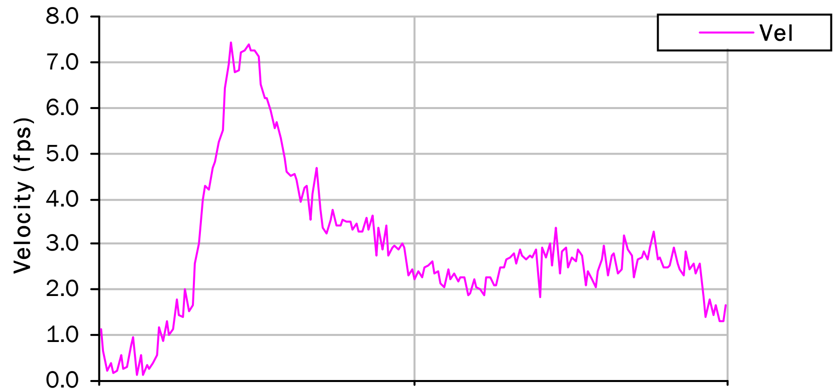
SITE M3.1

Weekly Level, Velocity and Flow Hydrographs

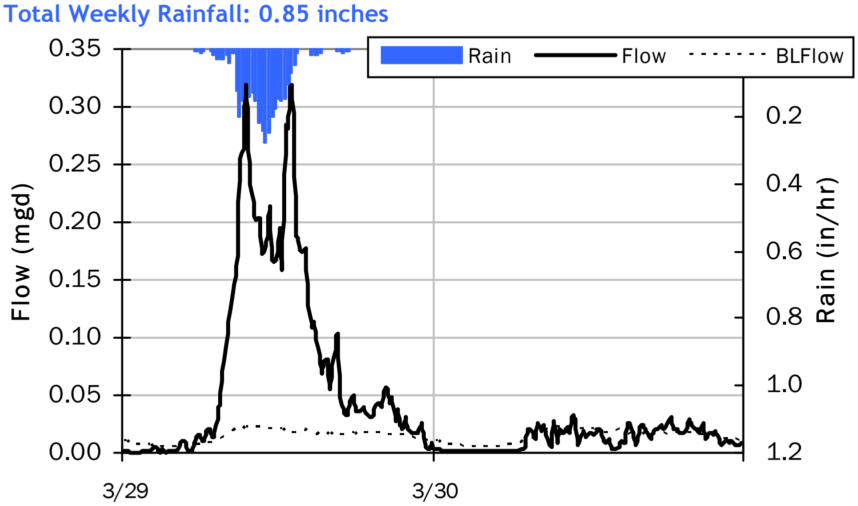
Avg Level: 0.74 in. Peak Level: 2.61 in. Min Level: 0.11 in.



Avg Velocity: 2.90 fps Peak Velocity: 7.44 fps Min Velocity: 0.13 fps



Total Weekly Rainfall: 0.85 inches

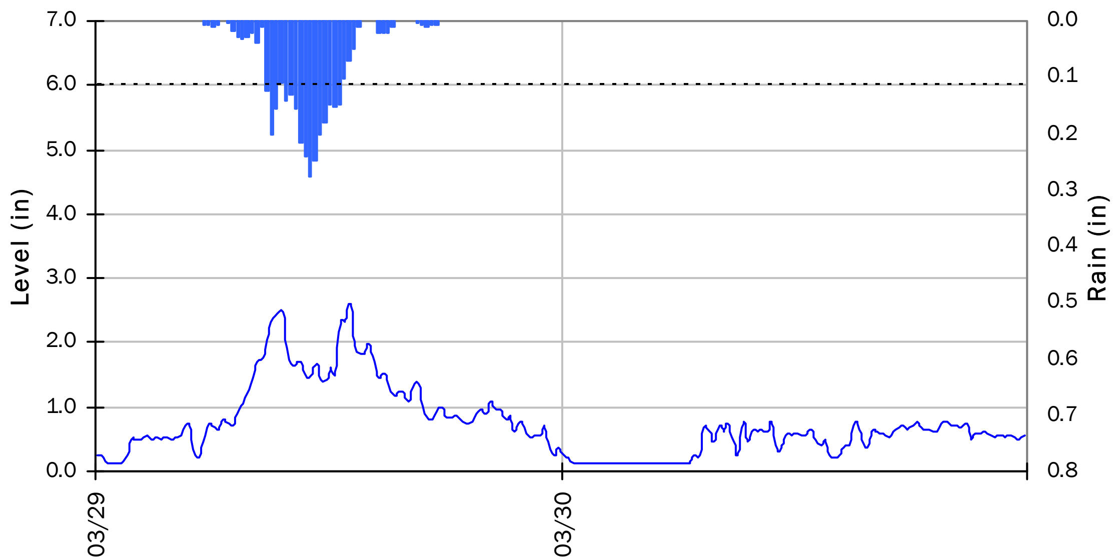


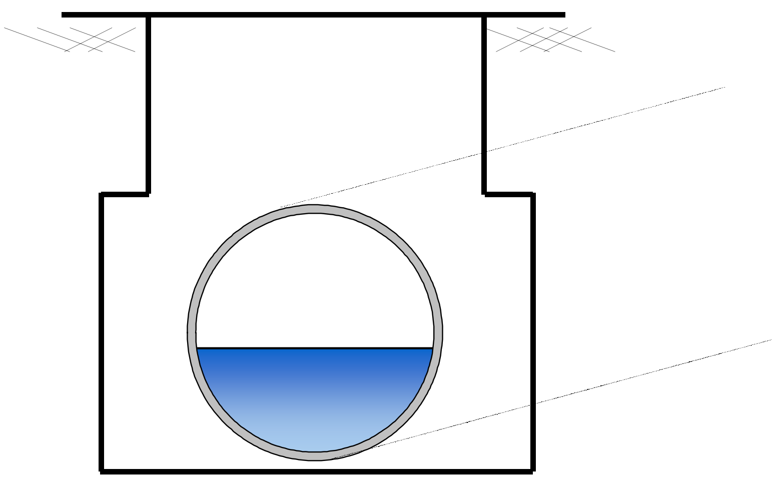
Avg Flow: 0.044 mgd Peak Flow: 0.319 mgd Min Flow: 0.000 mgd

SITE M3.1

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



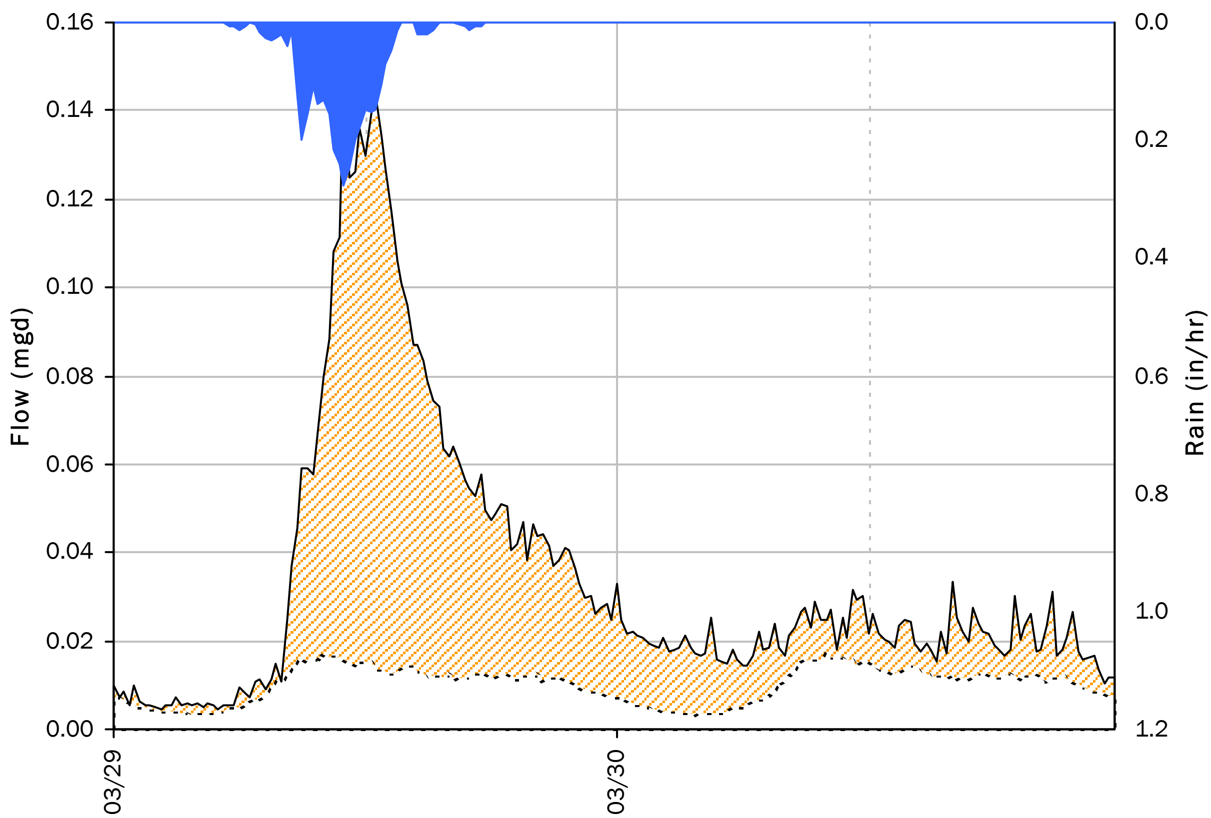


Pipe Diameter:	6	*inches*
Peak Measured Level:	2.61	*inches*
Peak d/D Ratio:	0.44	

SITE 3.1A
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.15 *mgd*
PF: 15.37

Peak Level: 5.85 *in*
d/D Ratio: 0.98

Inflow / Infiltration

Peak I/I Rate: 0.13 *mgd*
Total I/I: 48,000 *gallons*

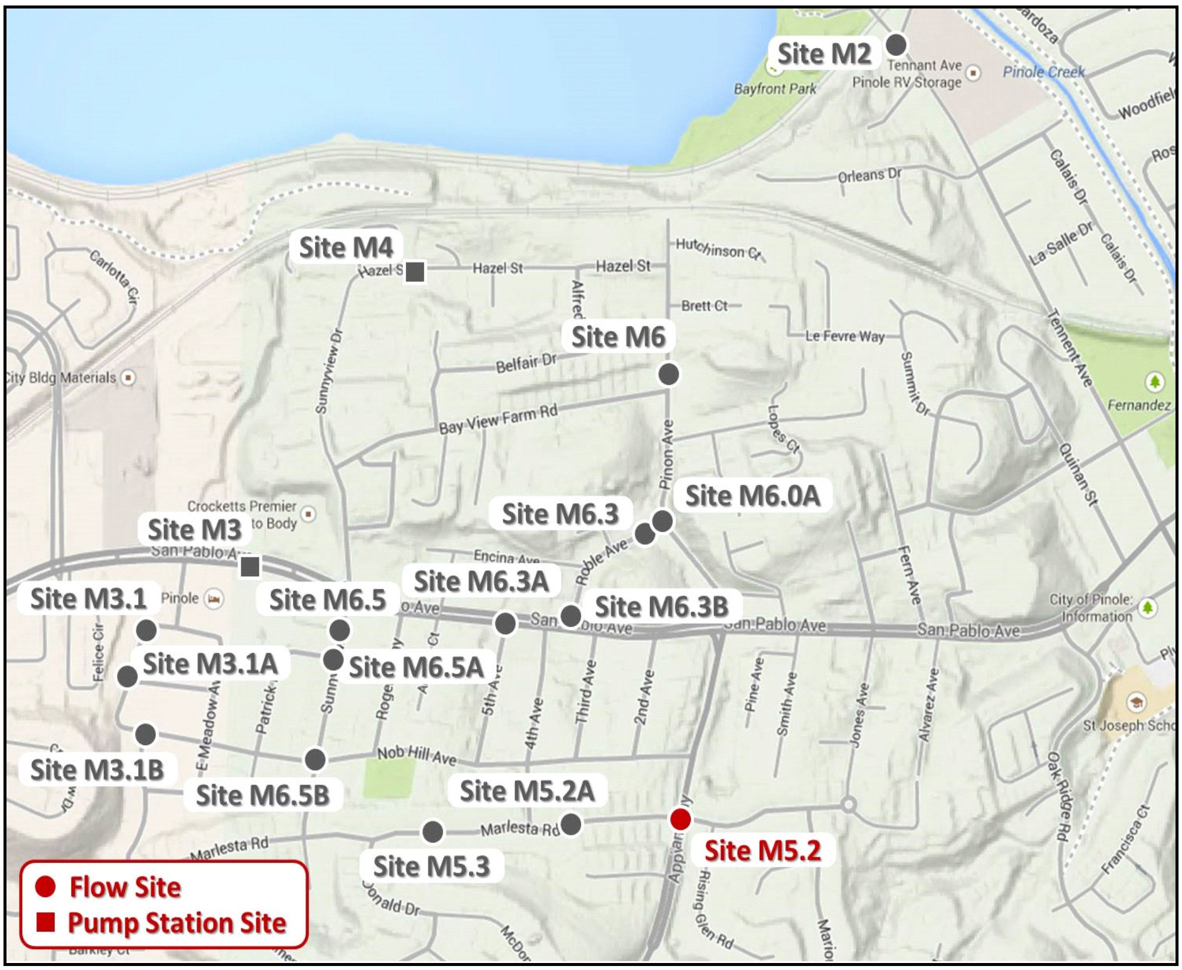
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M5.2

Location: Intersection of Appian Way and Marlesta Rd.

Data Summary Report

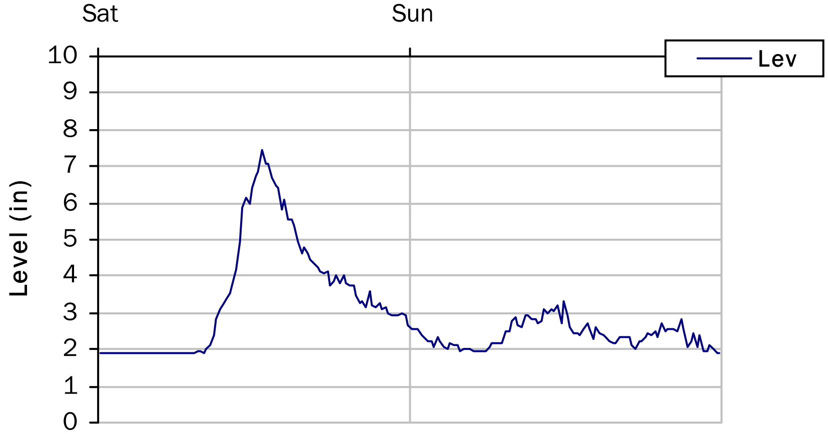


Vicinity Map: Site M5.2

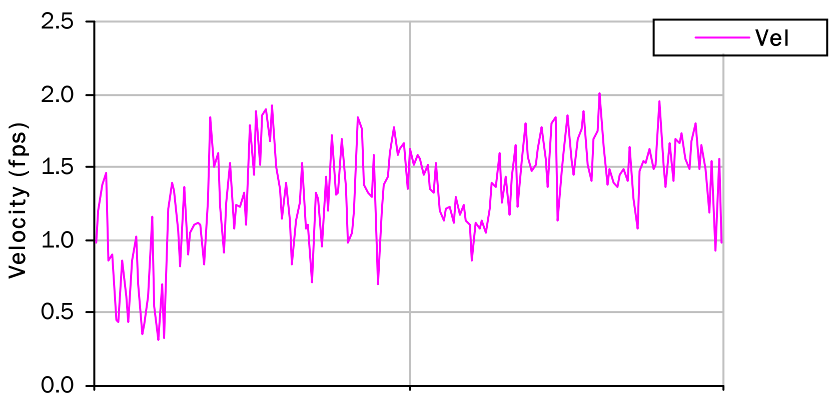
SITE M5.2

Weekly Level, Velocity and Flow Hydrographs

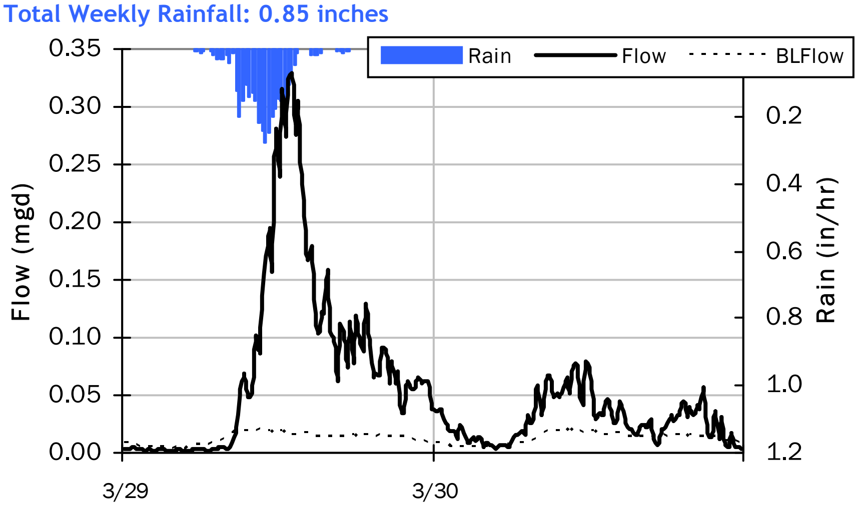
Avg Level: 2.94 in. **Peak Level: 7.47 in.** **Min Level: 1.90 in.**



Avg Velocity: 1.33 fps **Peak Velocity: 2.01 fps** **Min Velocity: 0.32 fps**



Total Weekly Rainfall: 0.85 inches

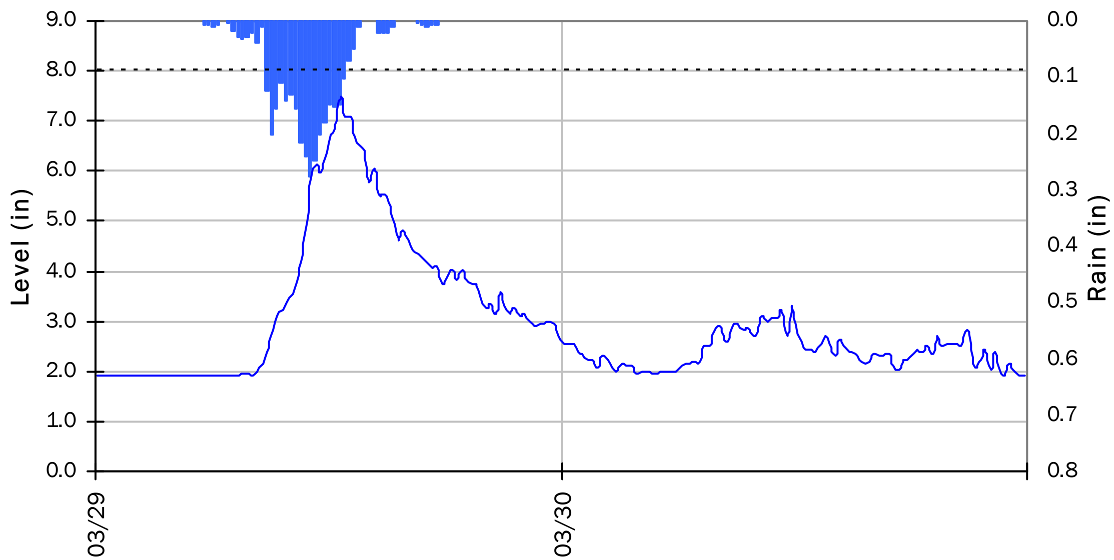


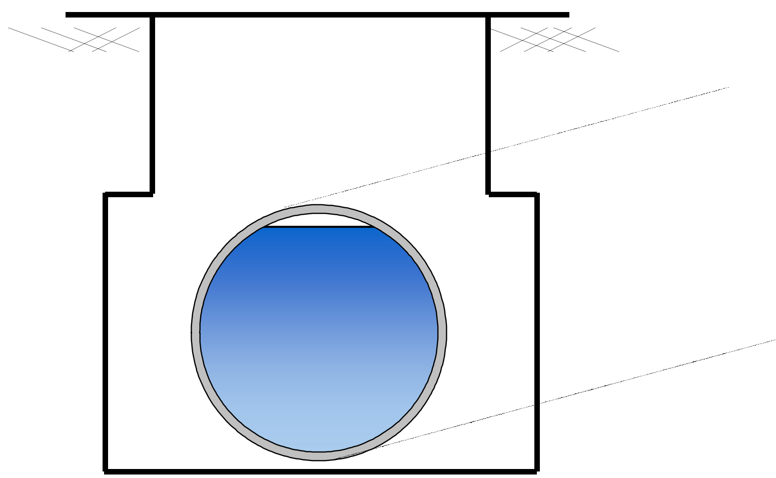
Avg Flow: 0.054 mgd **Peak Flow: 0.329 mgd** **Min Flow: 0.001 mgd**

SITE M5.2

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



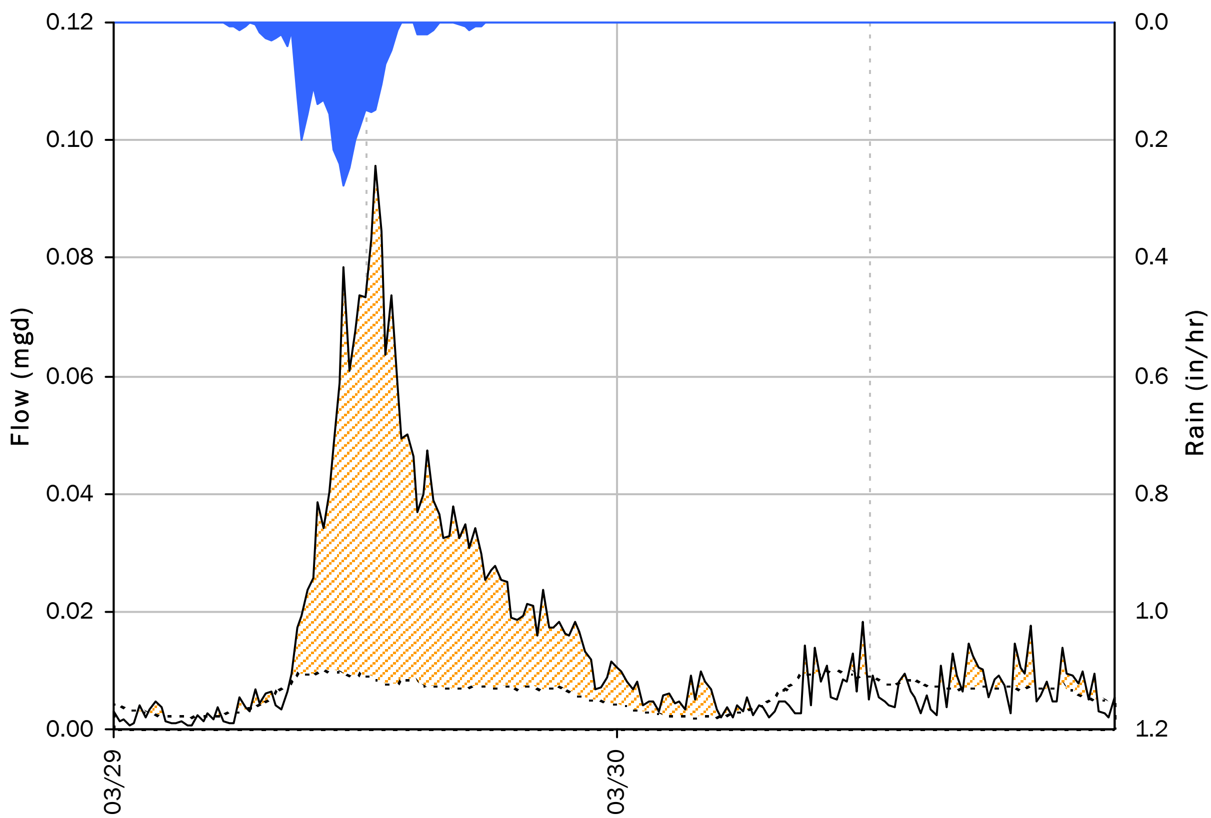


Pipe Diameter:	8	*inches*
Peak Measured Level:	7.47	*inches*
Peak d/D Ratio:	0.93	

SITE 3.1B
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.10 *mgd*
PF: 16.66

Peak Level: 2.03 *in*
d/D Ratio: 0.34

Inflow / Infiltration

Peak I/I Rate: 0.09 *mgd*
Total I/I: 18,000 *gallons*

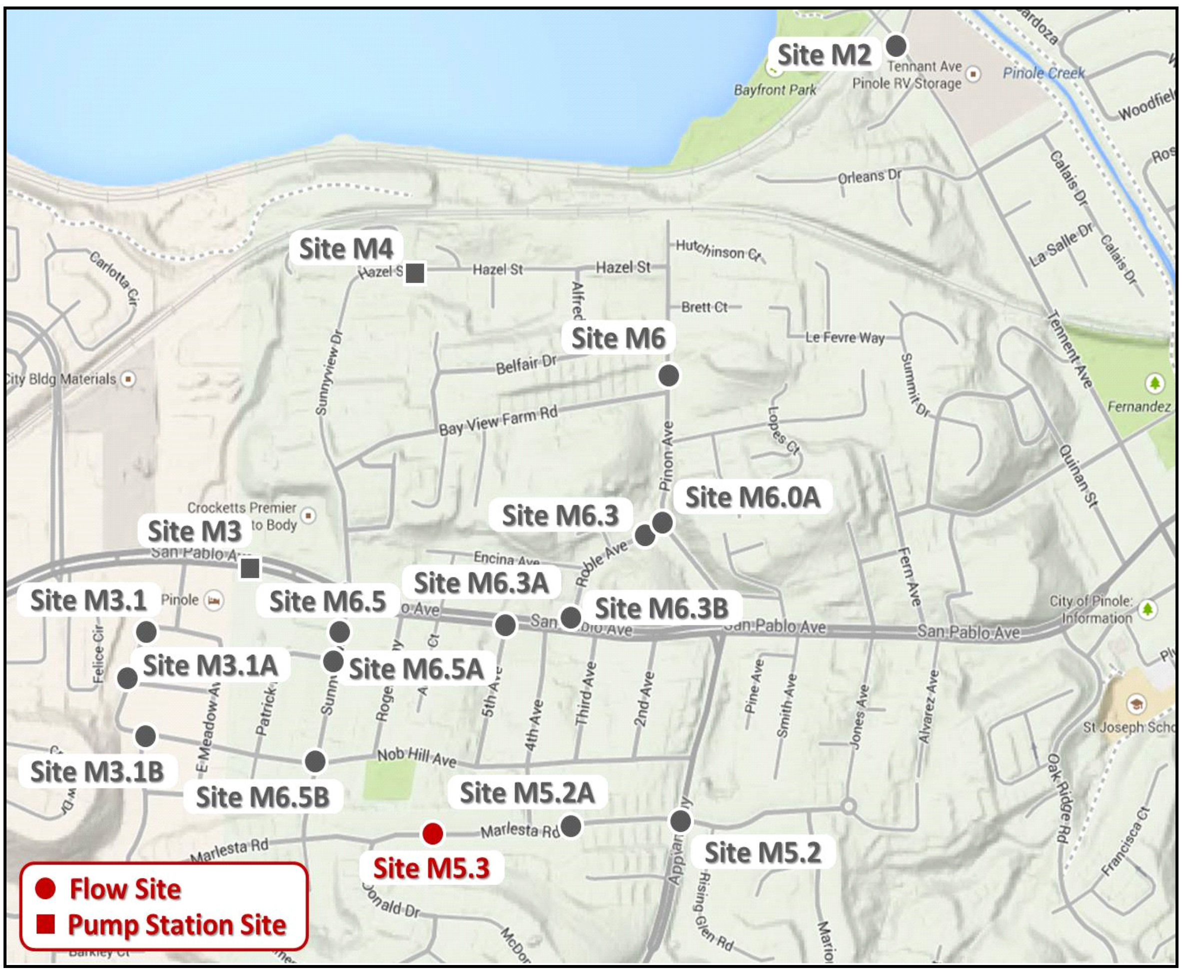
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M5.3

Location: 1171 Marlesta Rd.

Data Summary Report

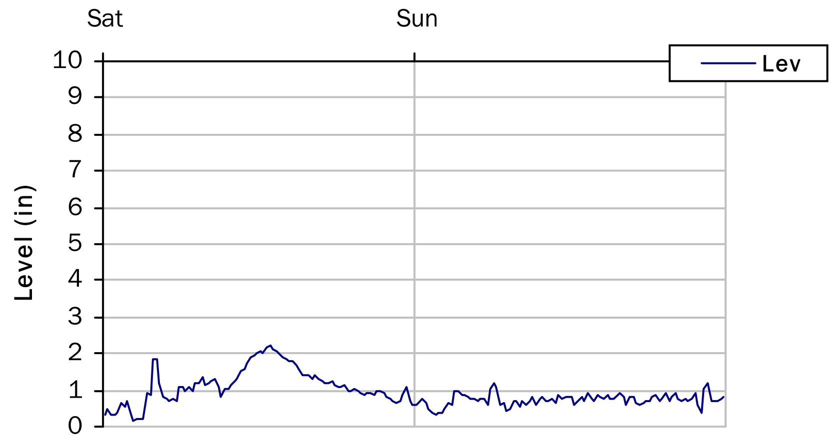


Vicinity Map: Site M5.3

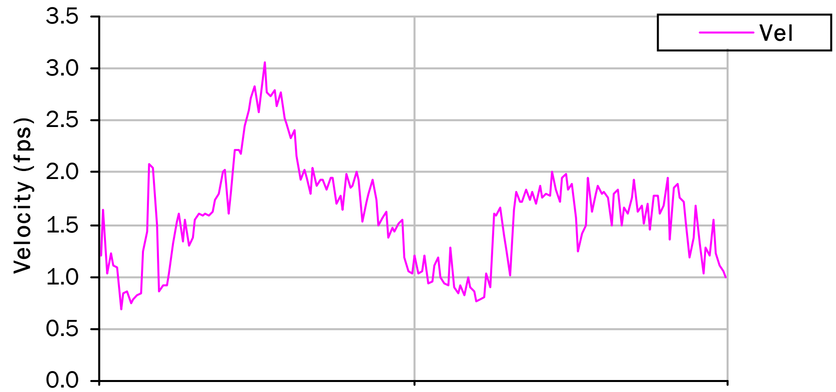
SITE M5.3

Weekly Level, Velocity and Flow Hydrographs

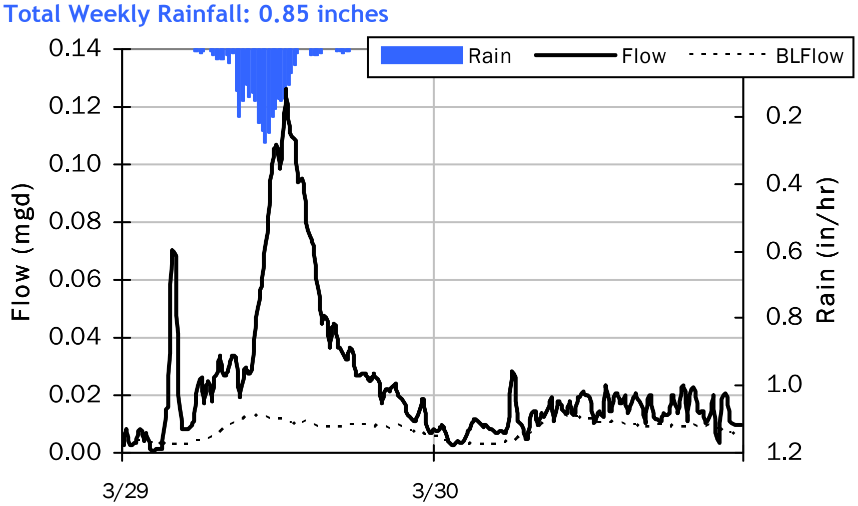
Avg Level: 0.93 in. **Peak Level: 2.21 in.** **Min Level: 0.18 in.**



Avg Velocity: 1.60 fps **Peak Velocity: 3.06 fps** **Min Velocity: 0.69 fps**



Total Weekly Rainfall: 0.85 inches

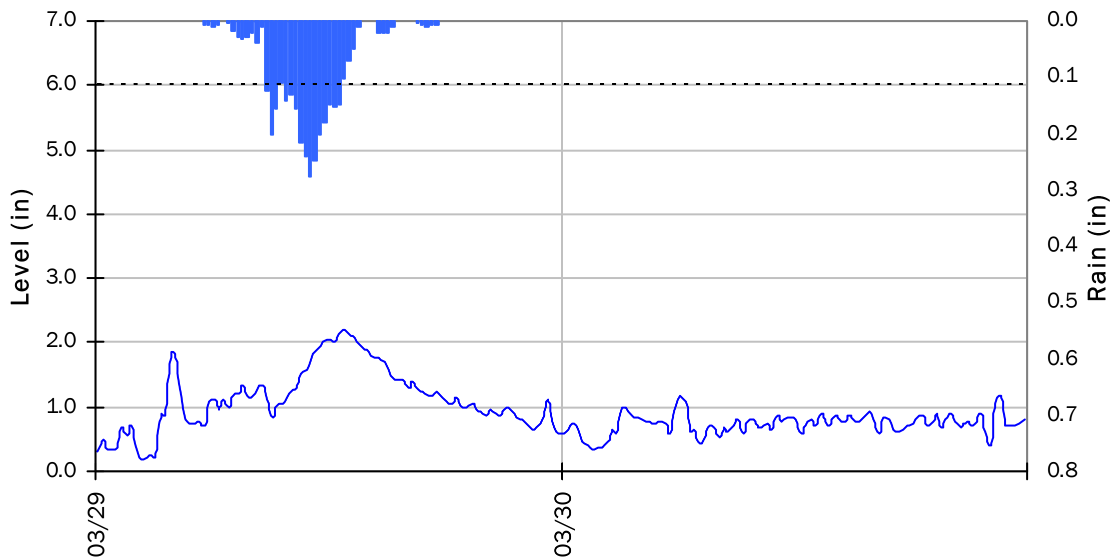


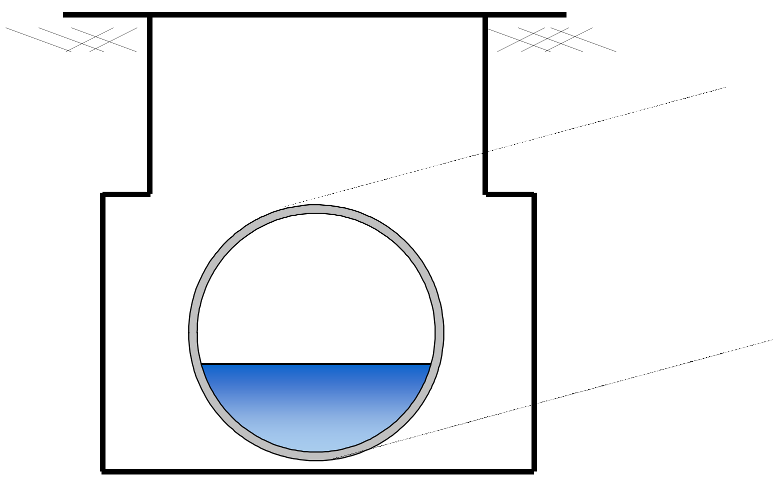
Avg Flow: 0.024 mgd **Peak Flow: 0.125 mgd** **Min Flow: 0.001 mgd**

SITE M5.3

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



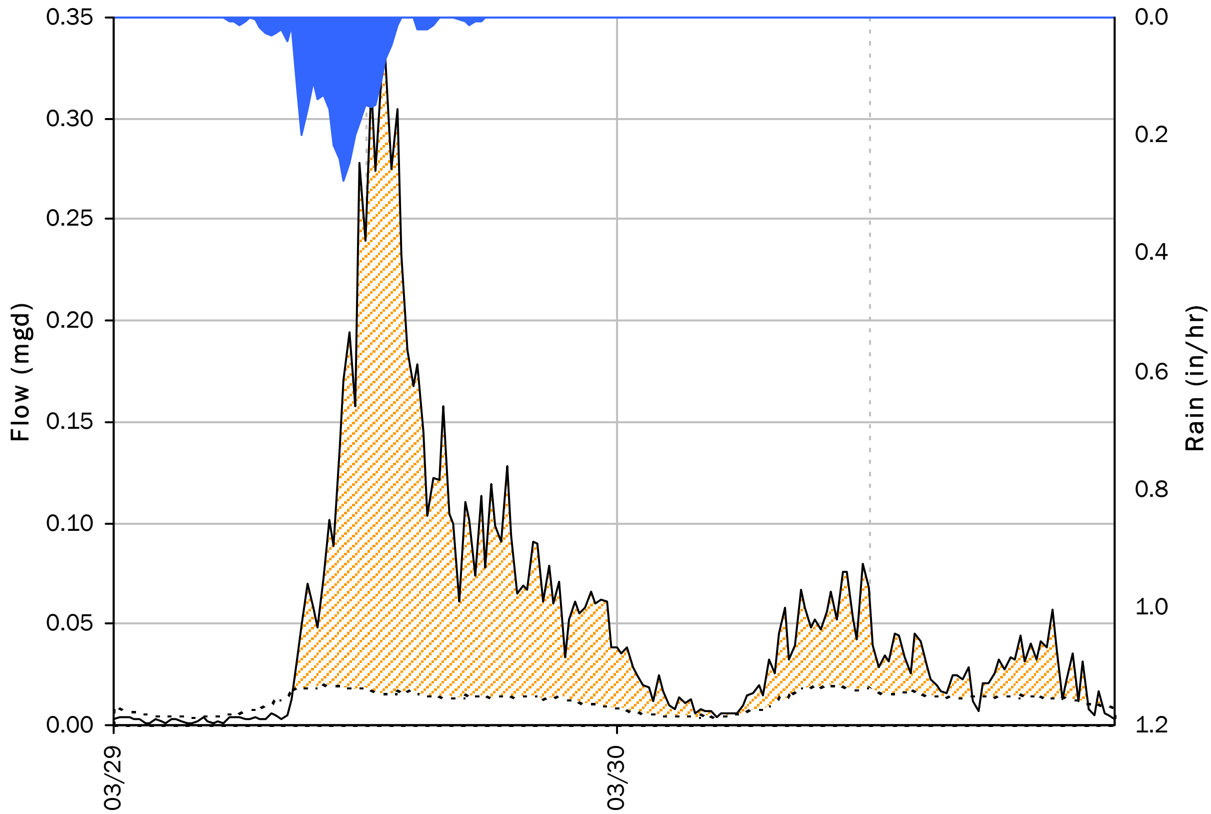


Pipe Diameter:	6	*inches*
Peak Measured Level:	2.21	*inches*
Peak d/D Ratio:	0.37	

SITE 5.2
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.33 *mgd*
PF: 28.70

Peak Level: 7.47 *in*
d/D Ratio: 0.93

Inflow / Infiltration

Peak I/I Rate: 0.31 *mgd*
Total I/I: 83,000 *gallons*

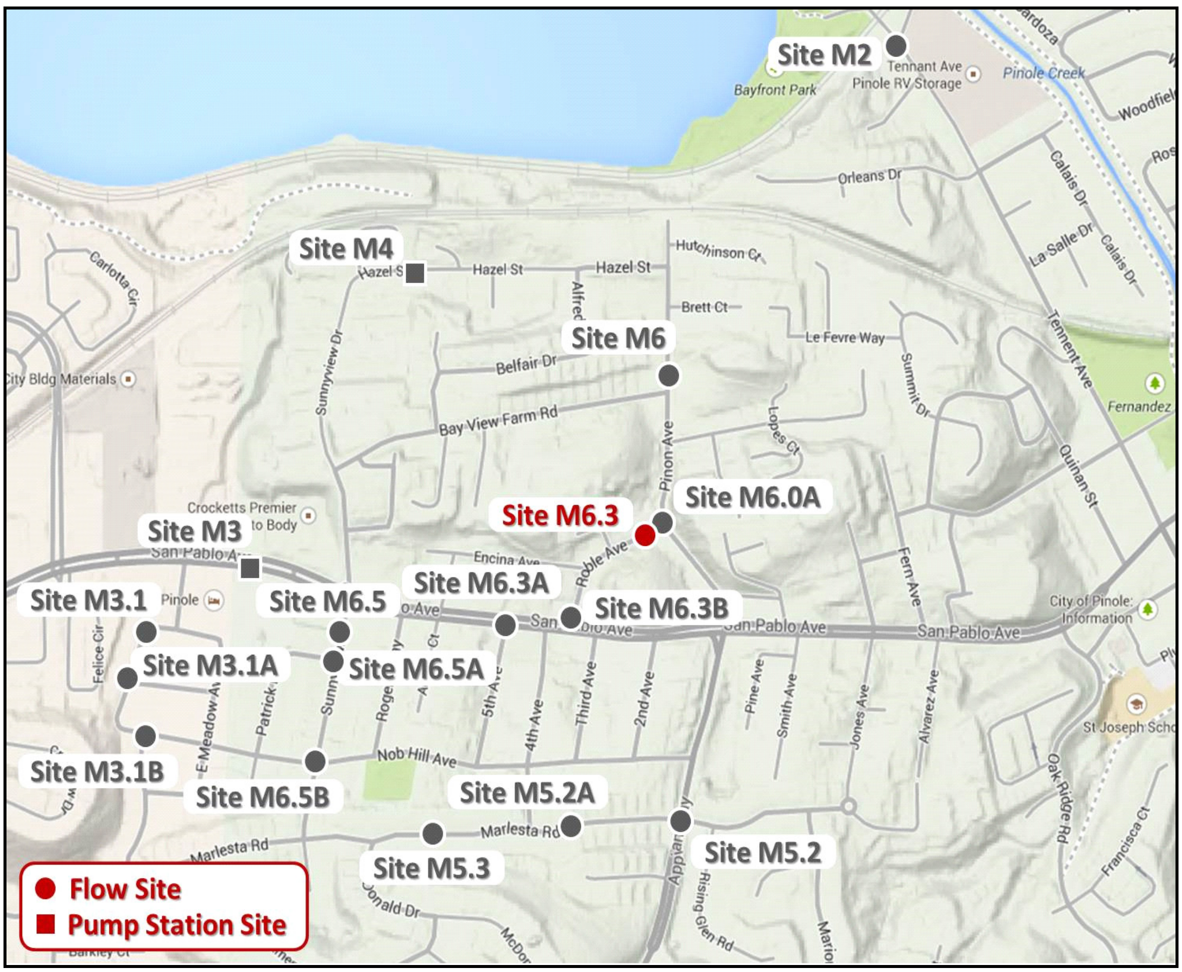
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.3

Location: Roble Ave., west of Pinon Ave.

Data Summary Report

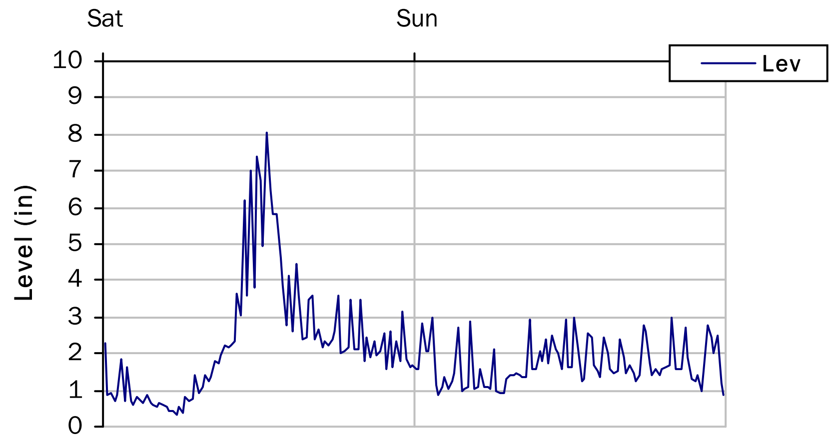


Vicinity Map: Site M6.3

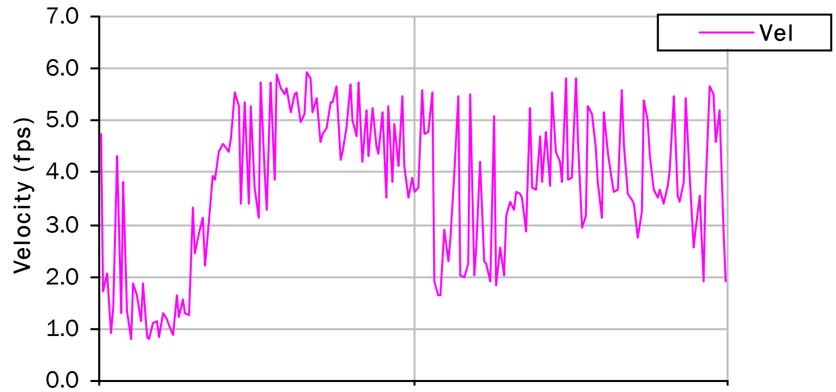
SITE M6.3

Weekly Level, Velocity and Flow Hydrographs

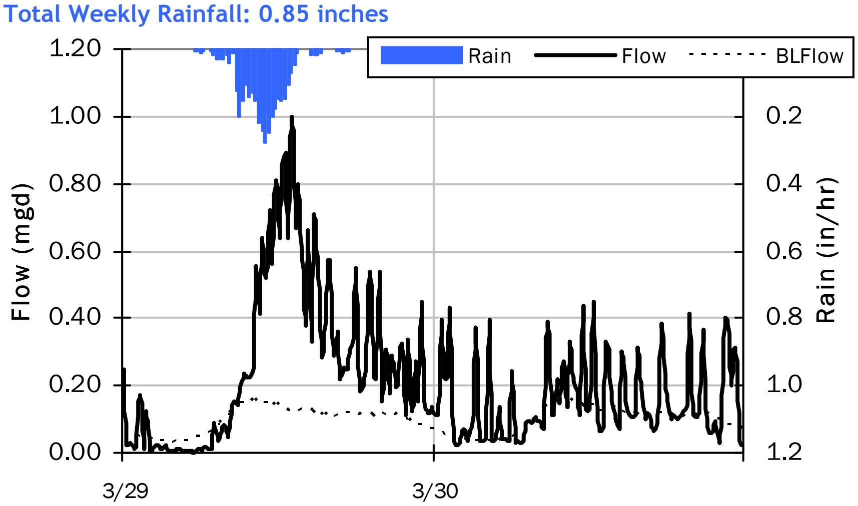
Avg Level: 2.03 in. Peak Level: 8.07 in. Min Level: 0.32 in.



Avg Velocity: 3.76 fps Peak Velocity: 5.91 fps Min Velocity: 0.80 fps



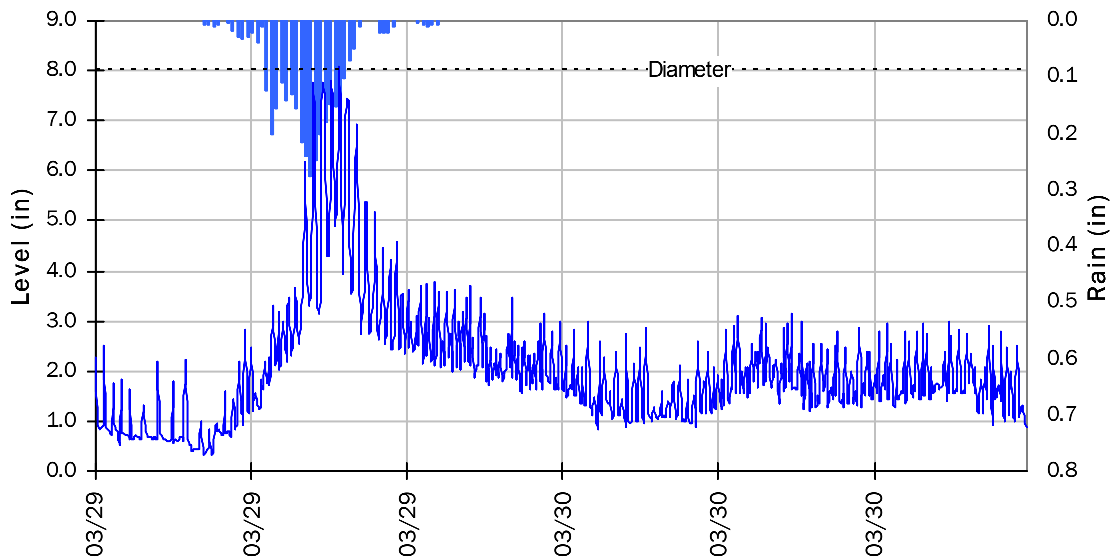
Total Weekly Rainfall: 0.85 inches

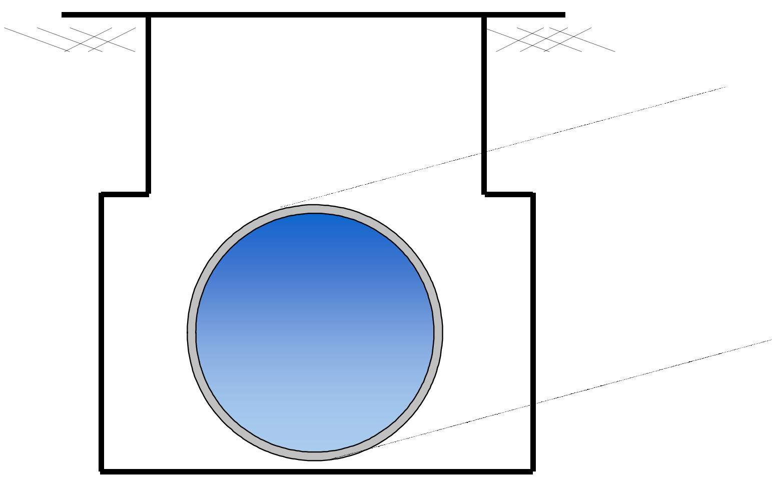


Avg Flow: 0.212 mgd Peak Flow: 1.002 mgd Min Flow: 0.003 mgd

SITE M6.3
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period





Pipe Diameter: 8 *inches*

Peak Measured Level: 8.07 *inches*

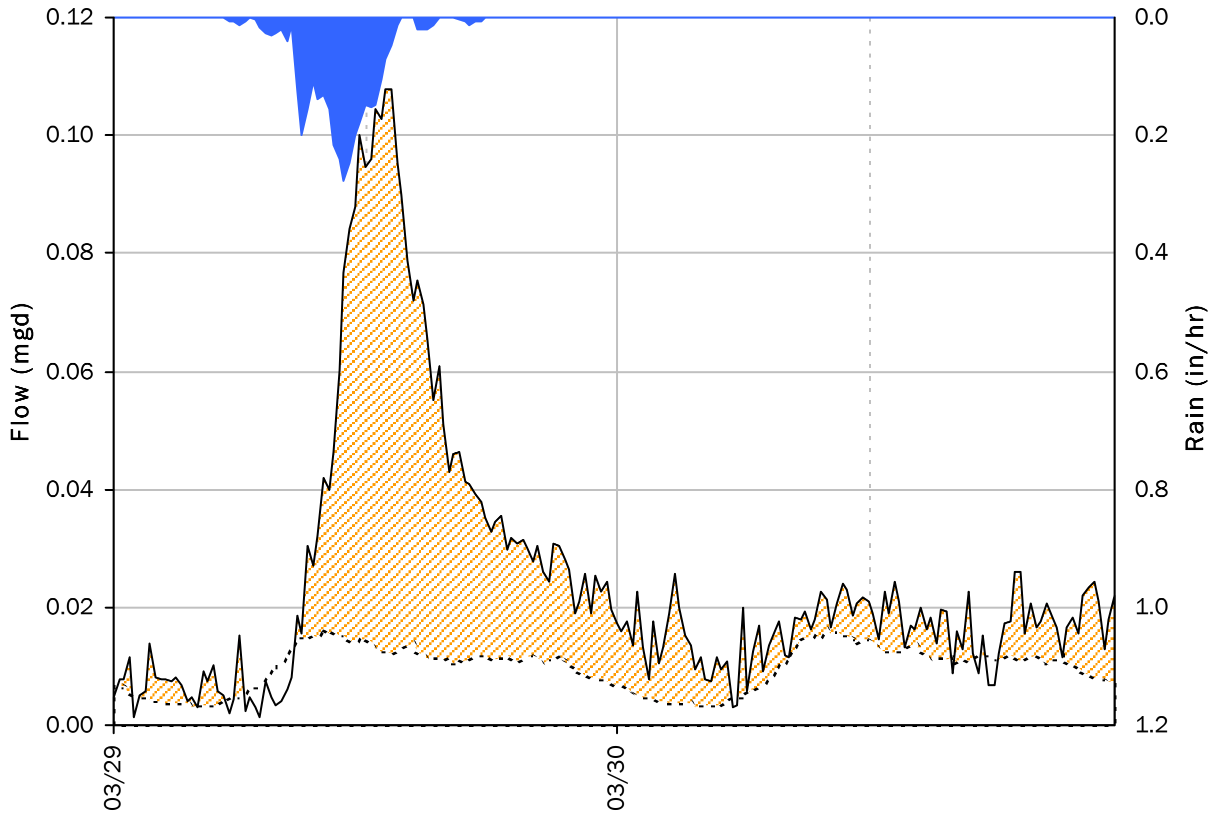
Peak d/D Ratio: 1.01

Surcharged 0.1 inches over crown

SITE 5.2A
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.11 *mgd*
PF: 11.99

Peak Level: 3.20 *in*
d/D Ratio: 0.53

Inflow / Infiltration

Peak I/I Rate: 0.10 *mgd*
Total I/I: 30,000 *gallons*

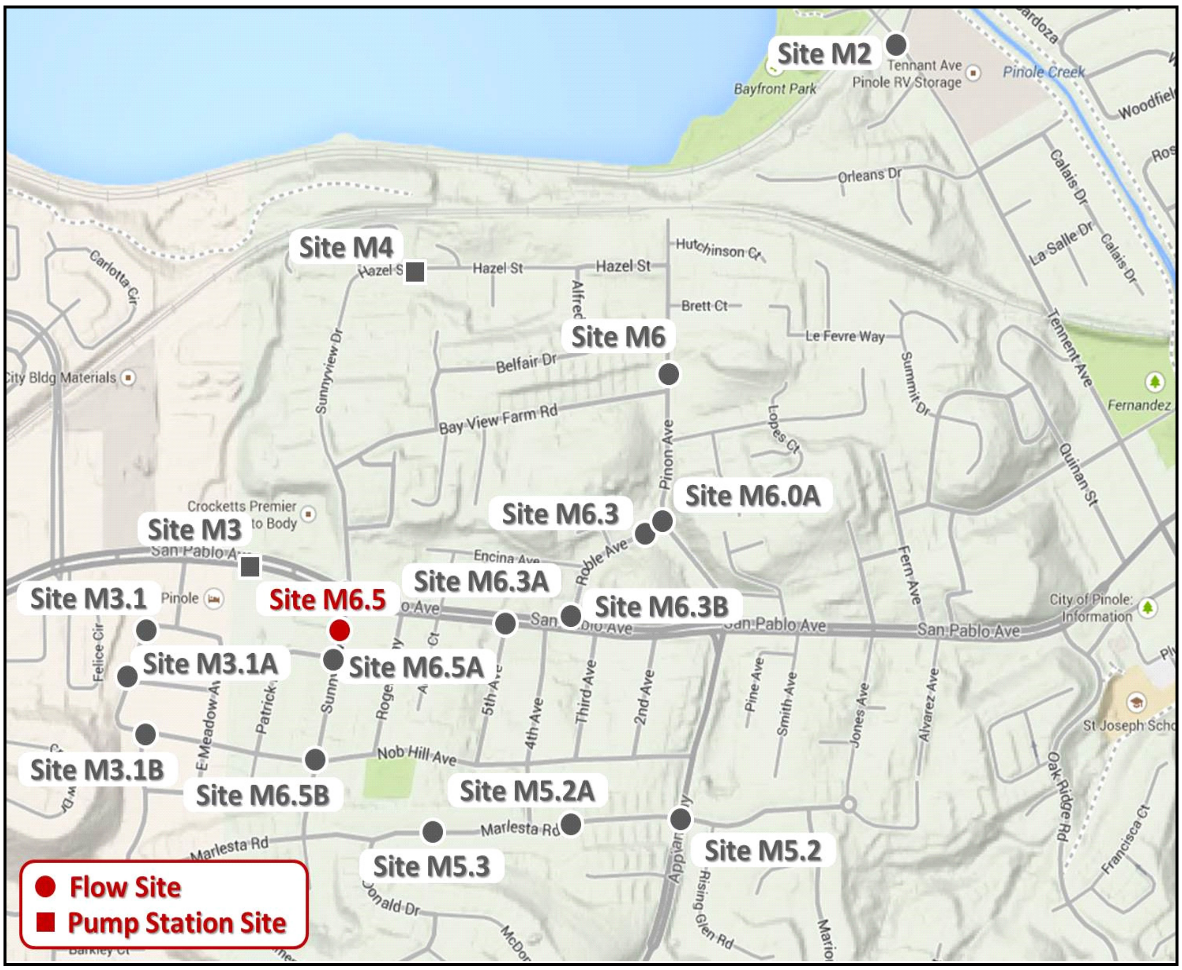
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.5

Location: 747 Sunnyview Dr.

Data Summary Report

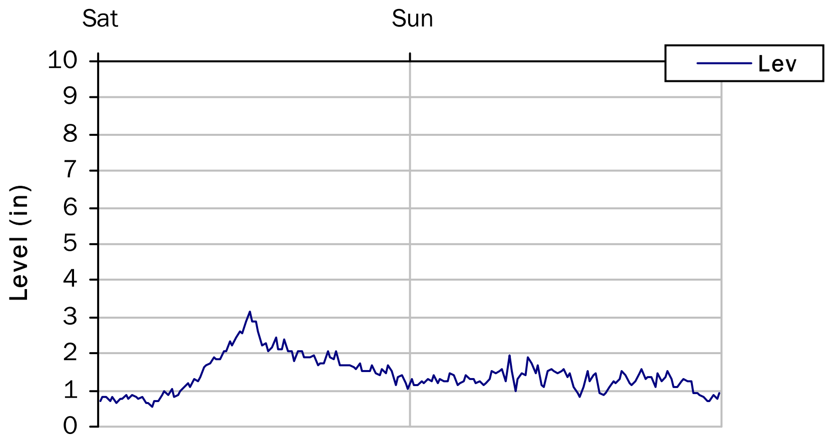


Vicinity Map: Site M6.5

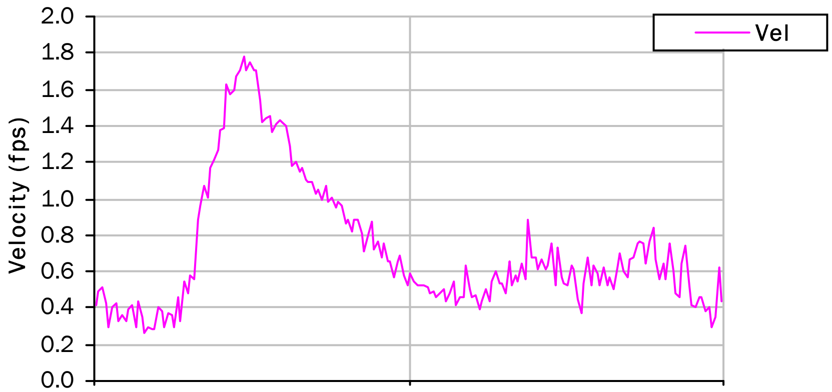
SITE M6.5

Weekly Level, Velocity and Flow Hydrographs

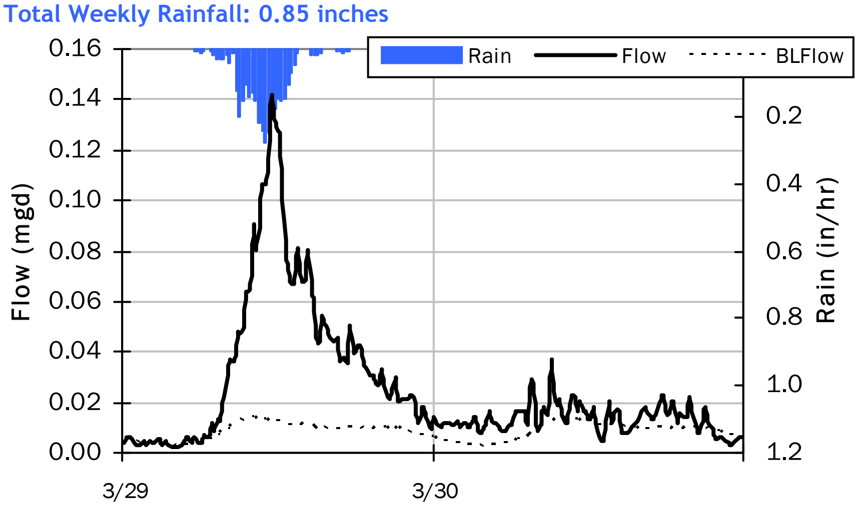
Avg Level: 1.42 in. Peak Level: 3.15 in. Min Level: 0.54 in.



Avg Velocity: 0.72 fps Peak Velocity: 1.78 fps Min Velocity: 0.26 fps



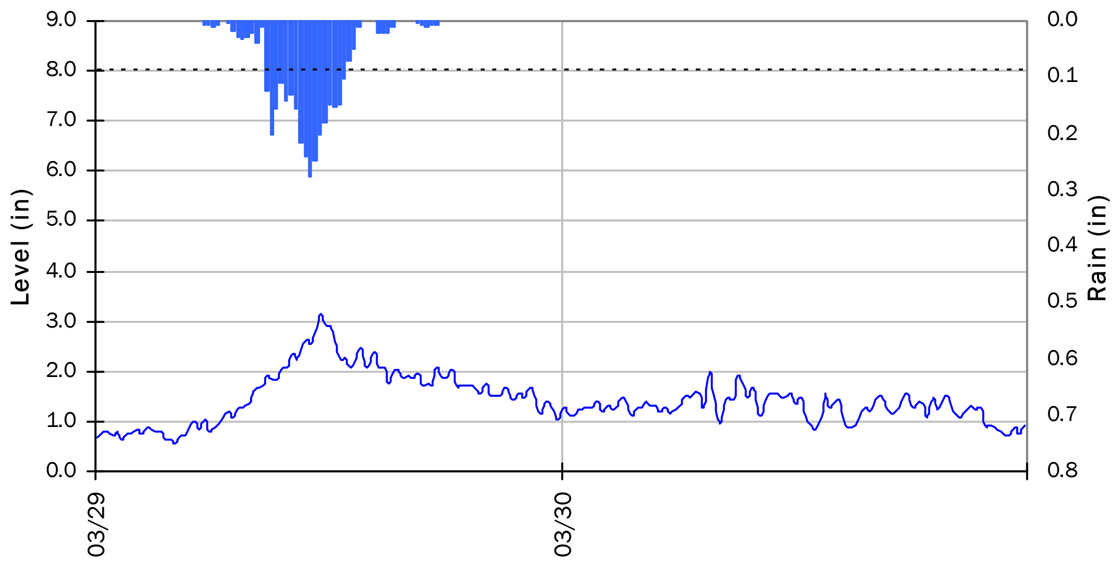
Total Weekly Rainfall: 0.85 inches

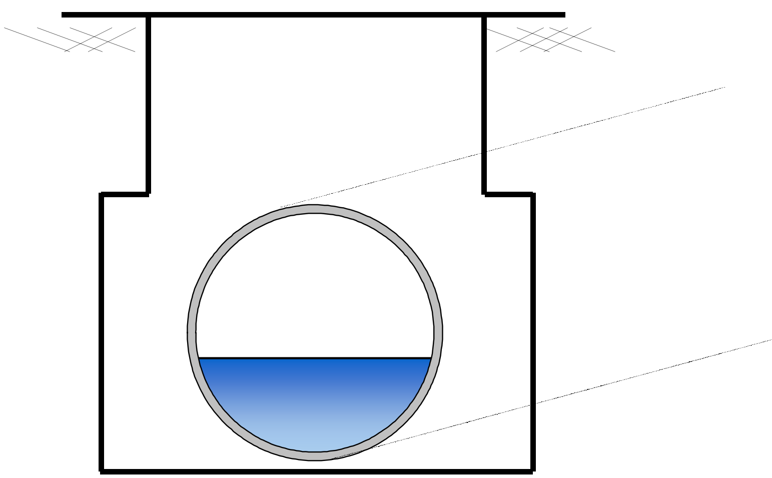


Avg Flow: 0.025 mgd Peak Flow: 0.141 mgd Min Flow: 0.002 mgd

SITE M6.5
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



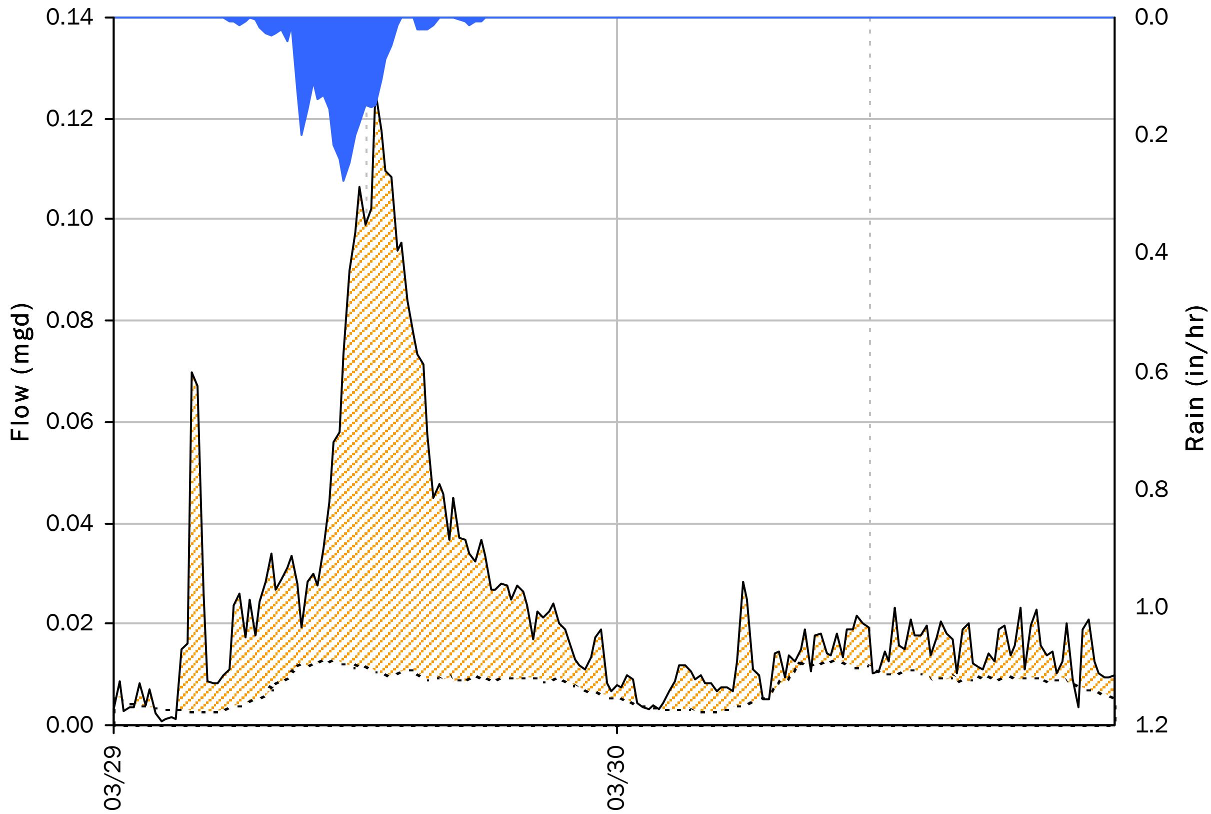


Pipe Diameter:	8	*inches*
Peak Measured Level:	3.15	*inches*
Peak d/D Ratio:	0.39	

SITE 5.3
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.13 *mgd*
PF: 17.01

Peak Level: 2.21 *in*
d/D Ratio: 0.37

Inflow / Infiltration

Peak I/I Rate: 0.11 *mgd*
Total I/I: 33,000 *gallons*

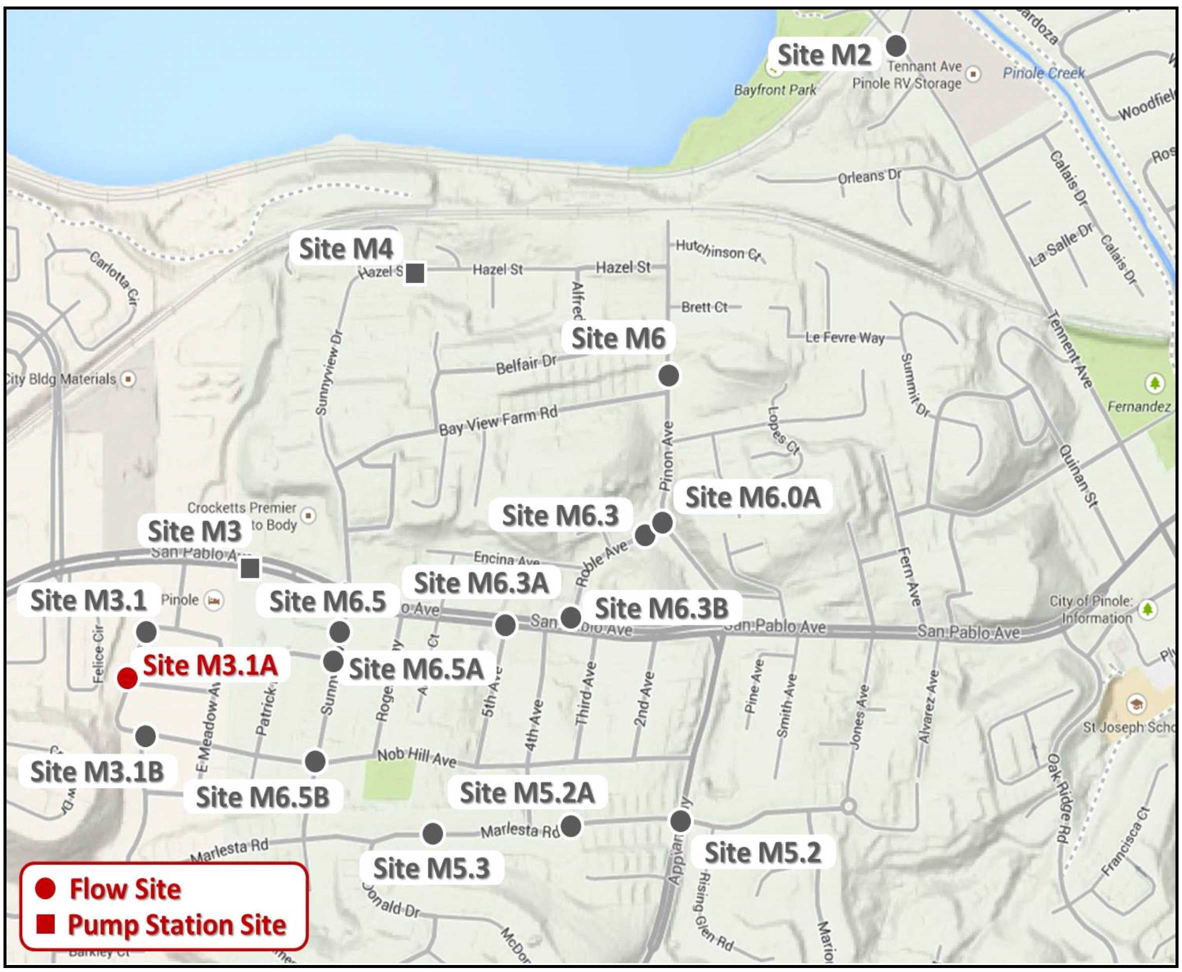
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M3.1A

Location: Intersection of Meadow Ave. and Betty Ave.

Data Summary Report

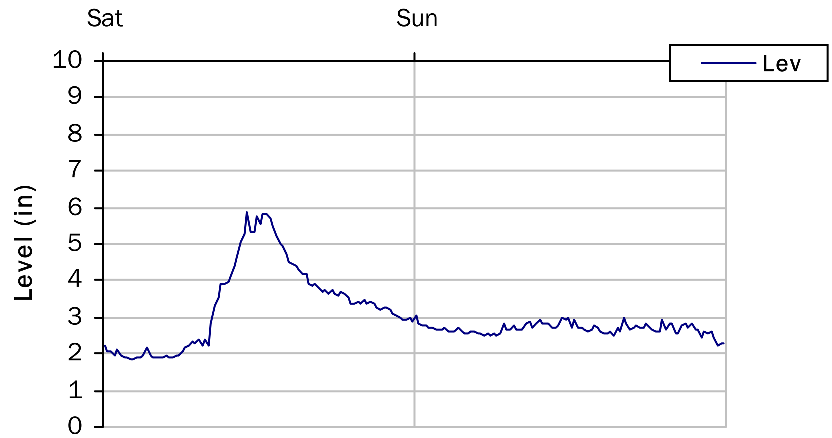


Vicinity Map: Site M3.1A

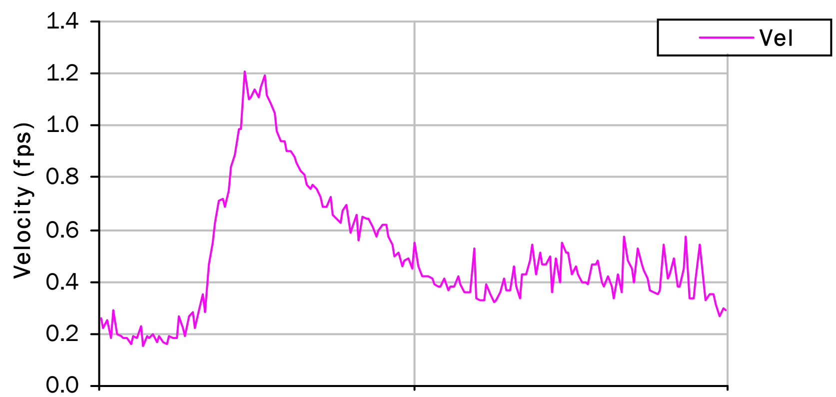
SITE M3.1A

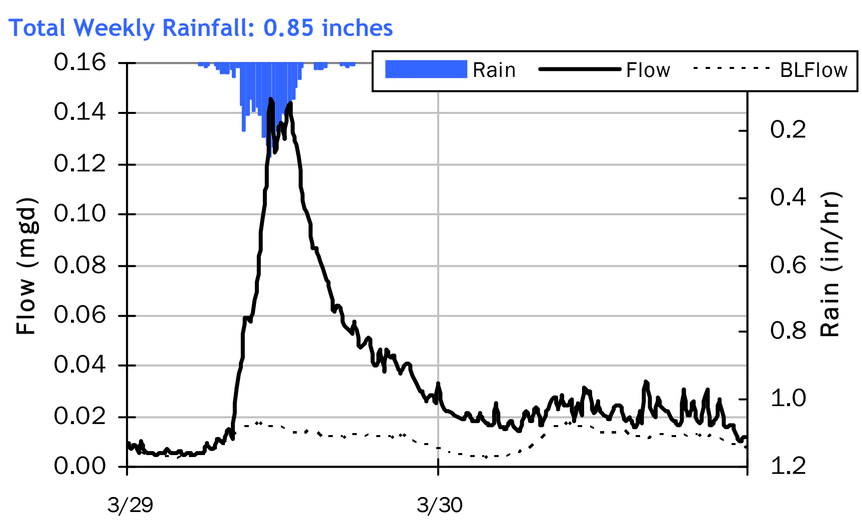
Weekly Level, Velocity and Flow Hydrographs

Avg Level: 3.02 in. Peak Level: 5.85 in. Min Level: 1.85 in.



Avg Velocity: 0.49 fps Peak Velocity: 1.21 fps Min Velocity: 0.15 fps

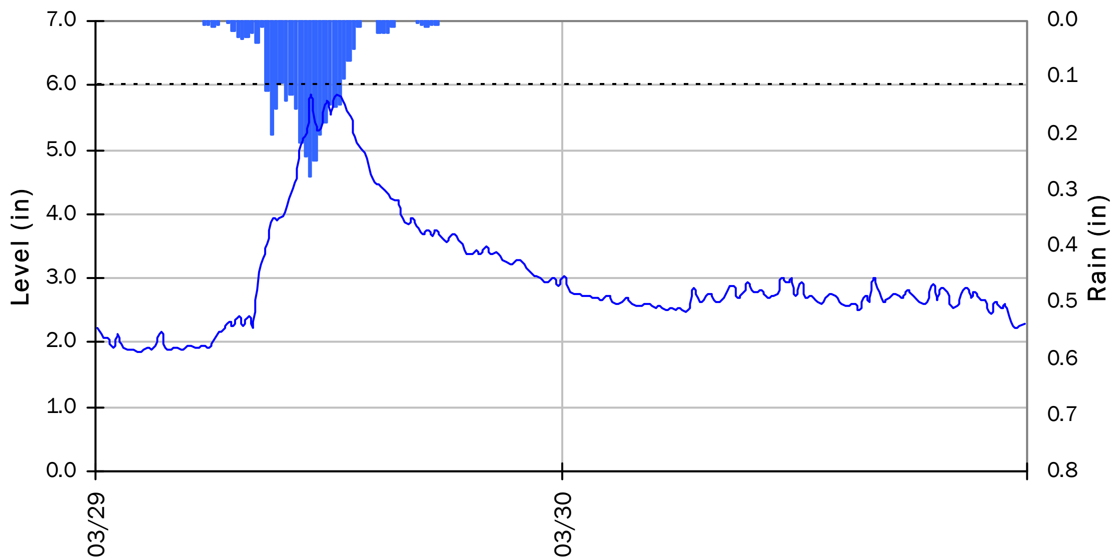


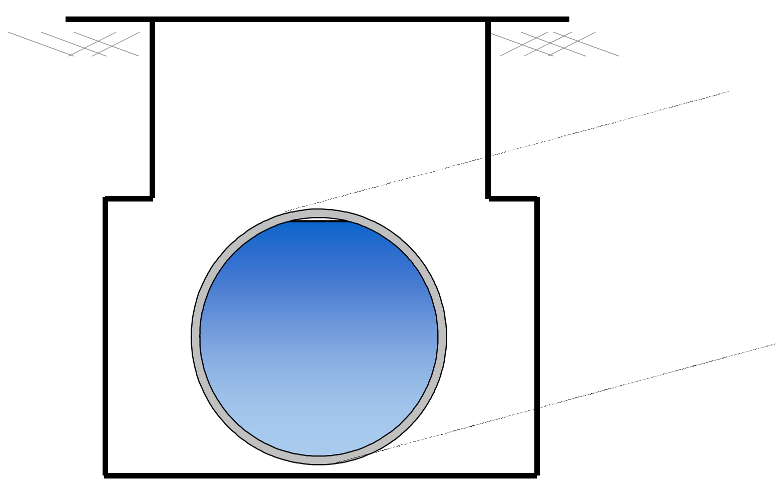


Avg Flow: 0.034 mgd Peak Flow: 0.146 mgd Min Flow: 0.005 mgd

SITE M3.1A
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



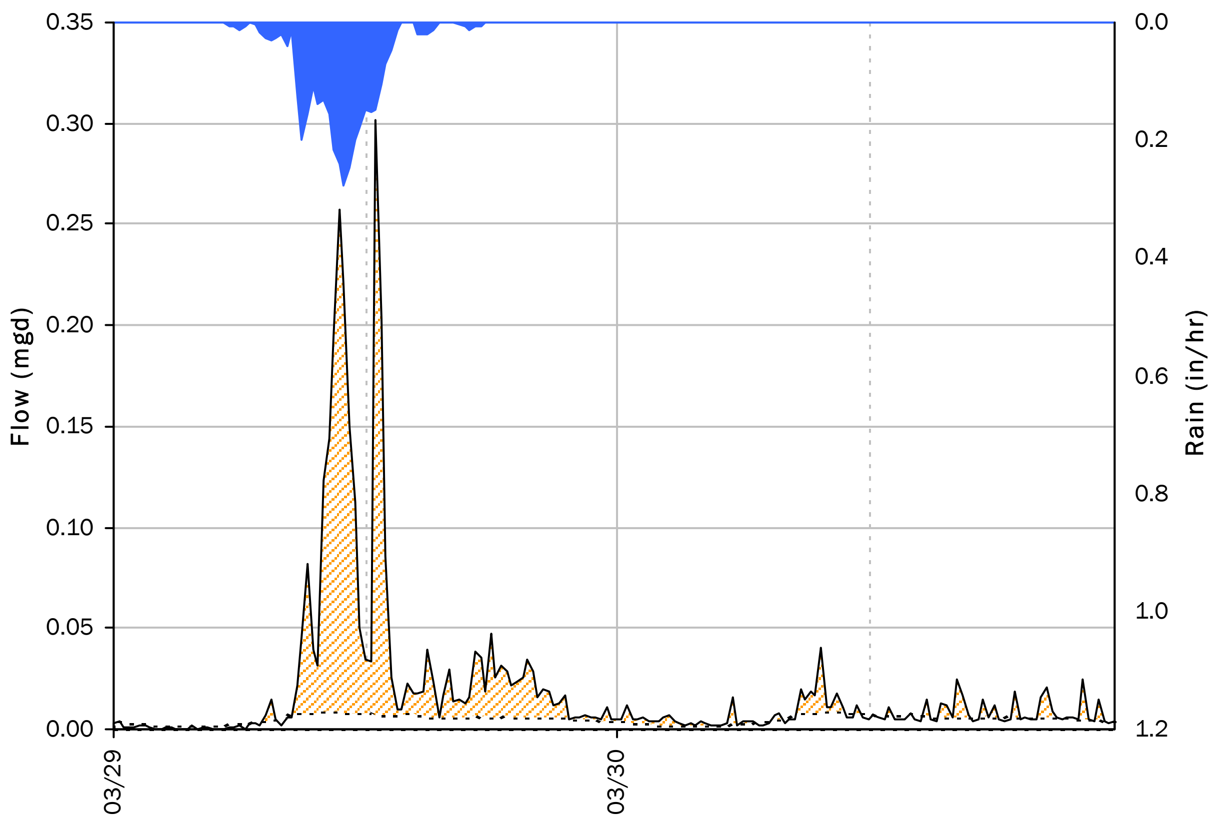


Pipe Diameter:	6	*inches*
Peak Measured Level:	5.85	*inches*
Peak d/D Ratio:	0.98	

SITE 6.3A
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.30 *mgd*
PF: 61.48

Peak Level: 3.15 *in*
d/D Ratio: 0.53

Inflow / Infiltration

Peak I/I Rate: 0.30 *mgd*
Total I/I: 29,000 *gallons*

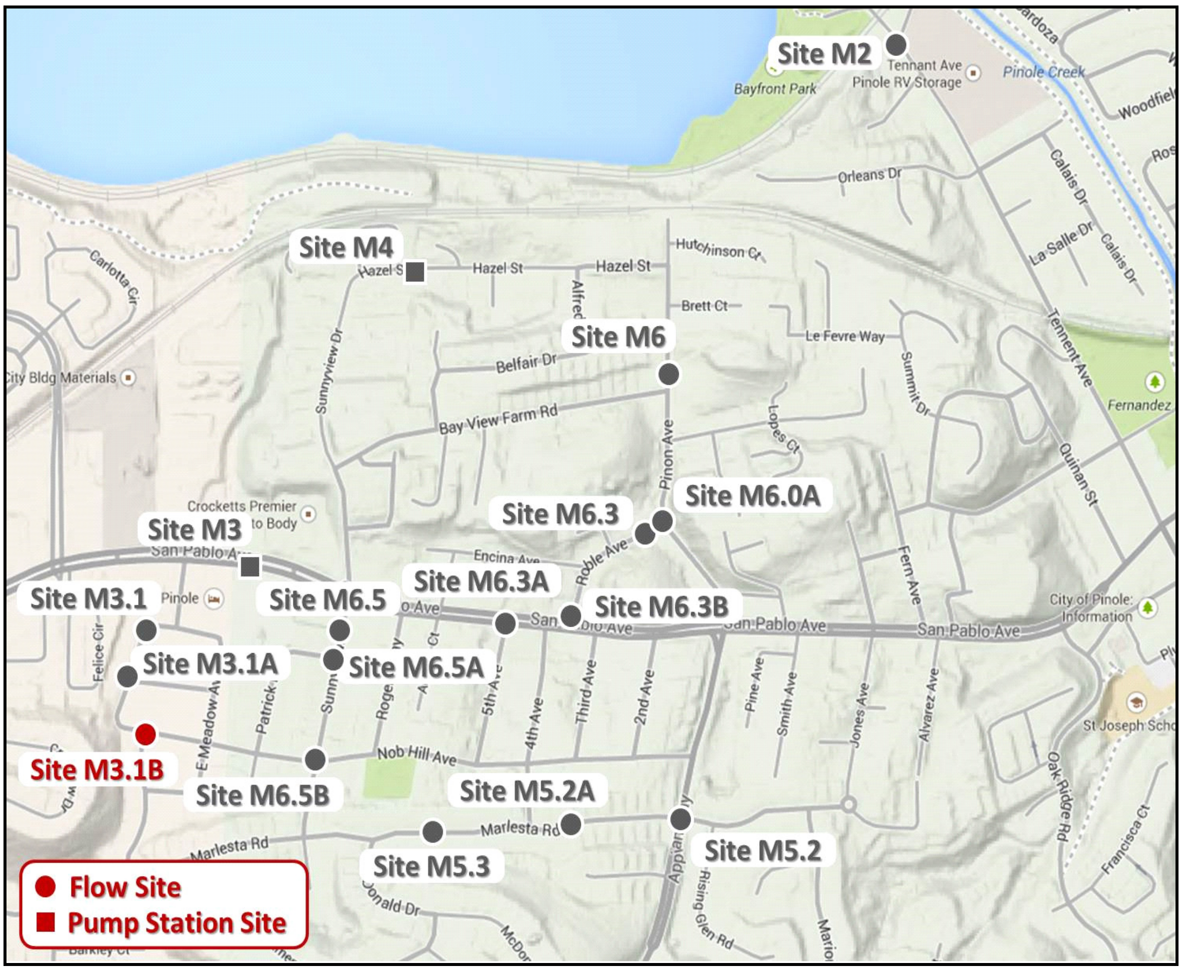
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M3.1B

Location: Intersection of Meadow Ave. and Nob Hill Ave.

Data Summary Report

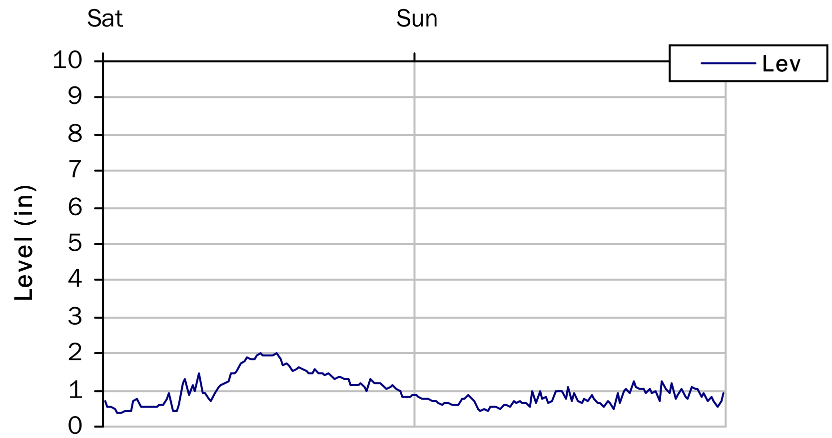


Vicinity Map: Site M3.1B

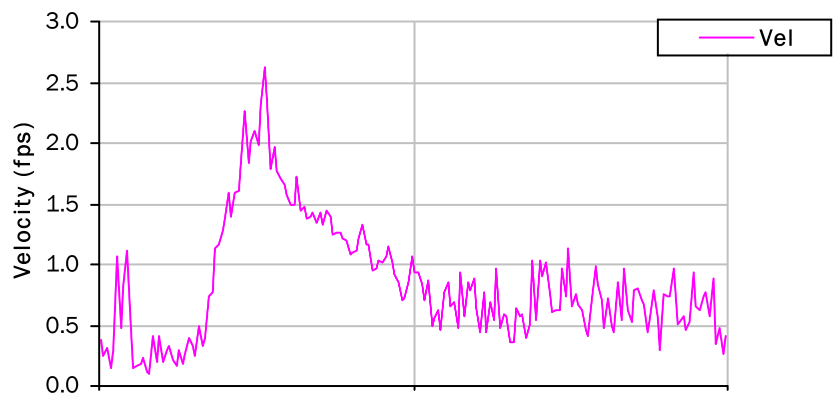
SITE M3.1B

Weekly Level, Velocity and Flow Hydrographs

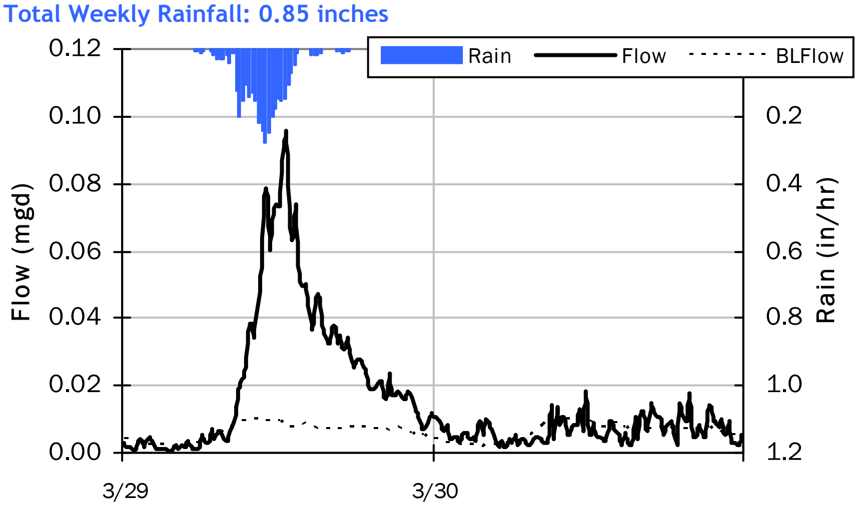
Avg Level: 0.97 in. Peak Level: 2.03 in. Min Level: 0.37 in.



Avg Velocity: 0.85 fps Peak Velocity: 2.62 fps Min Velocity: 0.10 fps



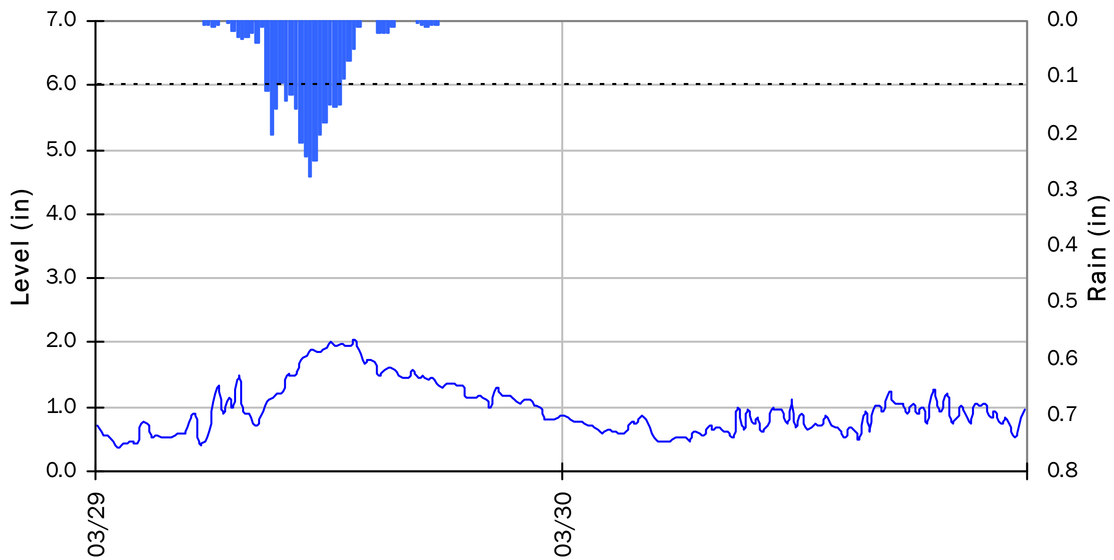
Total Weekly Rainfall: 0.85 inches

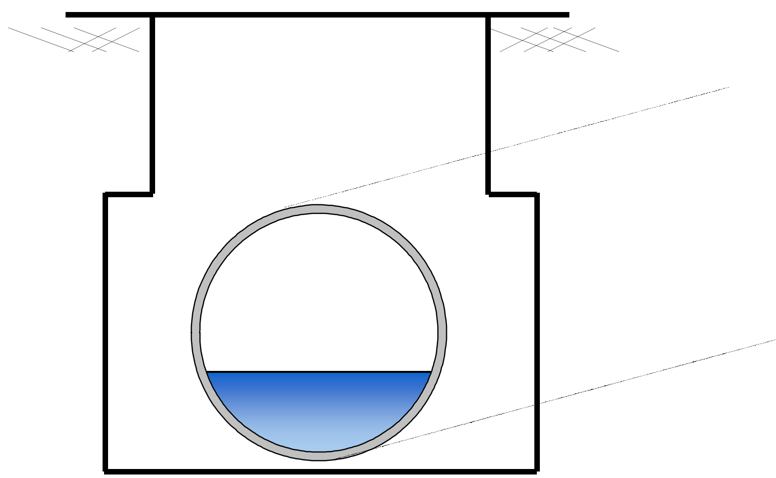


Avg Flow: 0.015 mgd Peak Flow: 0.095 mgd Min Flow: 0.001 mgd

SITE M3.1B
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



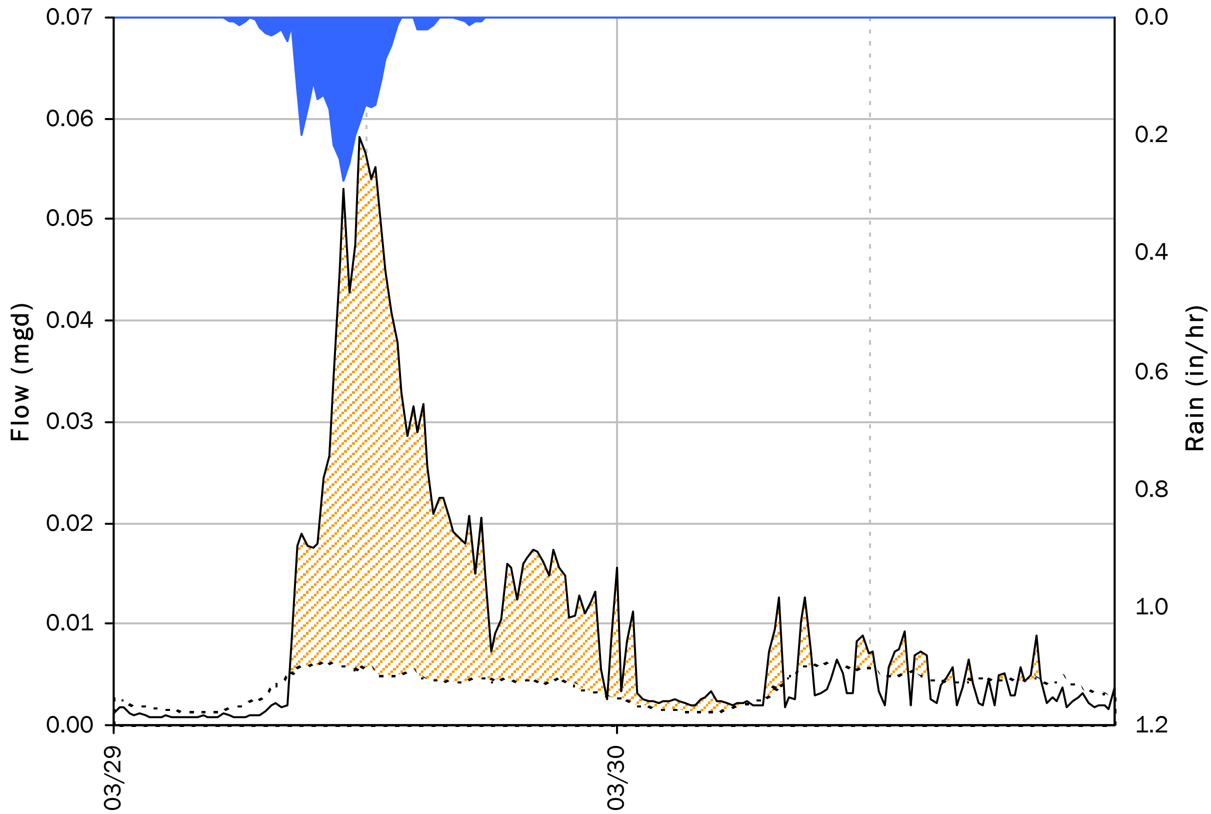


Pipe Diameter:	6	*inches*
Peak Measured Level:	2.03	*inches*
Peak d/D Ratio:	0.34	

SITE 6.3B
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.06 *mgd*
PF: 16.12

Peak Level: 1.26 *in*
d/D Ratio: 0.16

Inflow / Infiltration

Peak I/I Rate: 0.05 *mgd*
Total I/I: 12,000 *gallons*

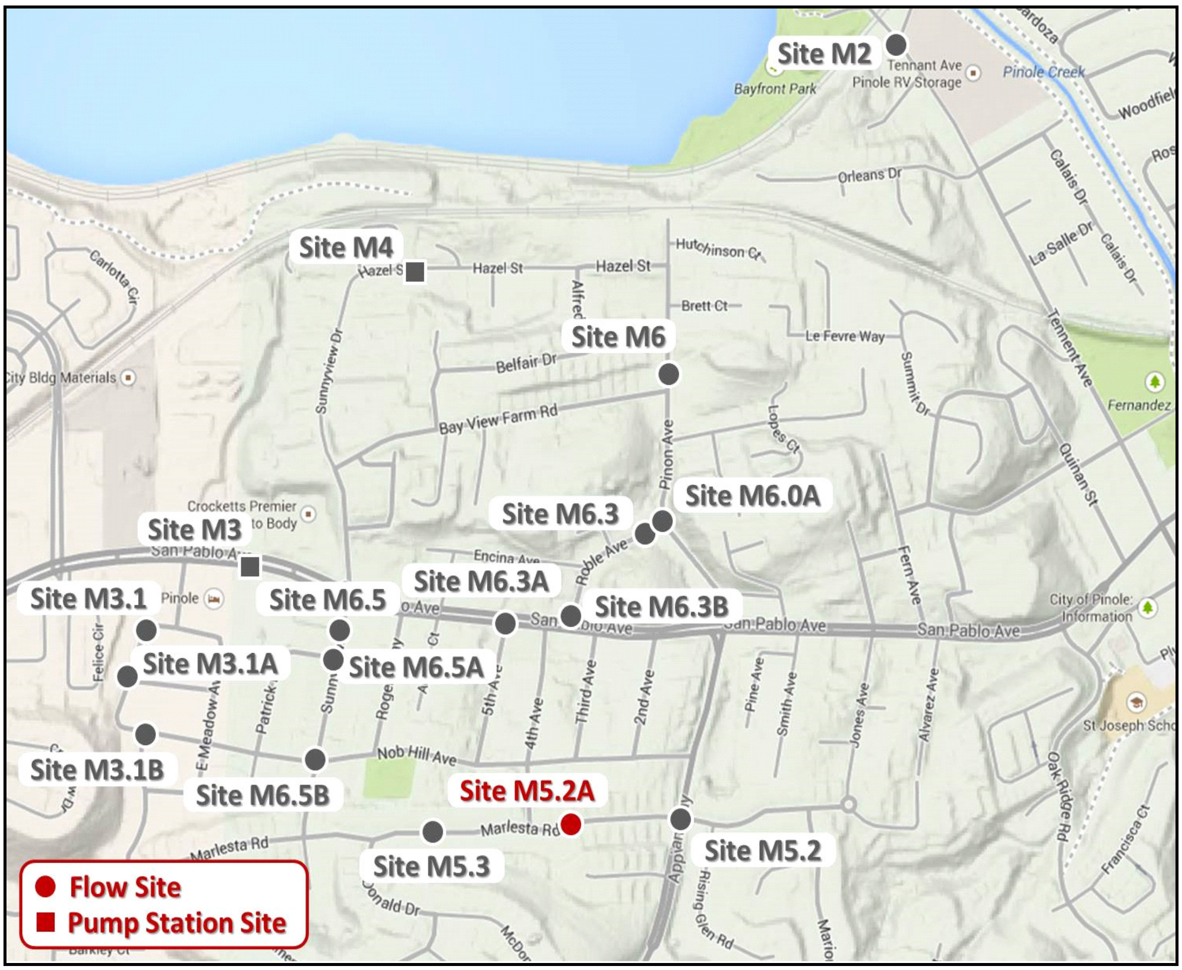
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M5.2A

Location: 1367 Marlesta Rd.

Data Summary Report

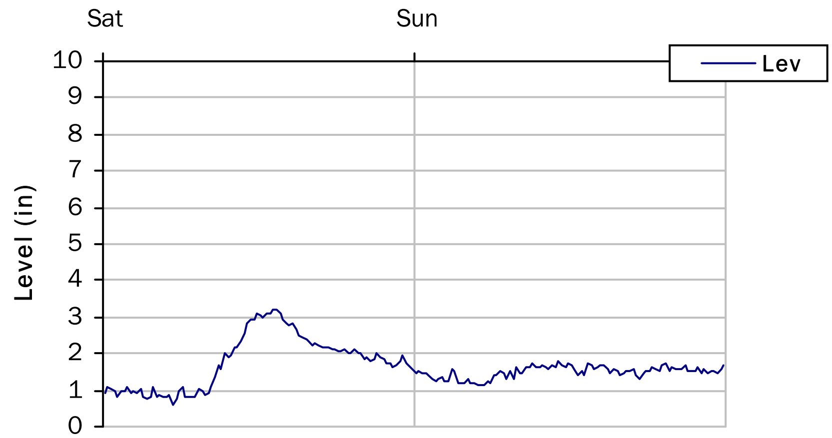


Vicinity Map: Site M5.2A

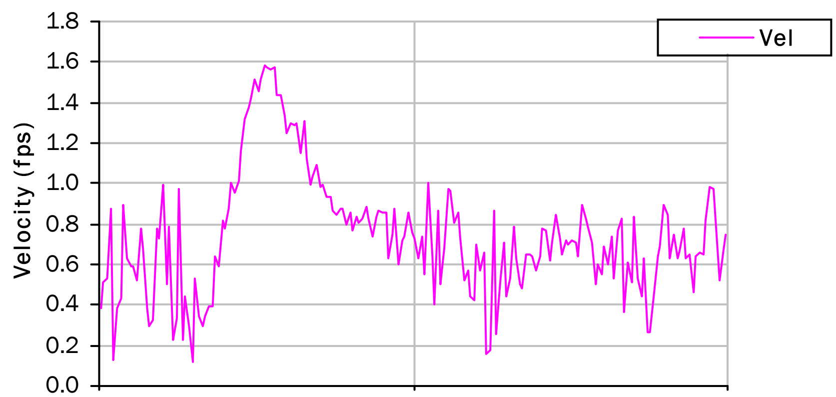
SITE M5.2A

Weekly Level, Velocity and Flow Hydrographs

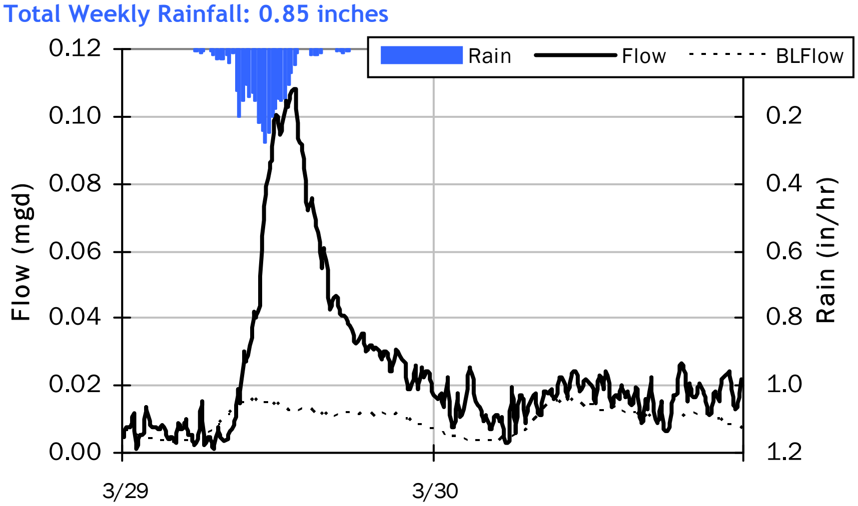
Avg Level: 1.64 in. **Peak Level: 3.20 in.** **Min Level: 0.60 in.**



Avg Velocity: 0.74 fps **Peak Velocity: 1.58 fps** **Min Velocity: 0.12 fps**



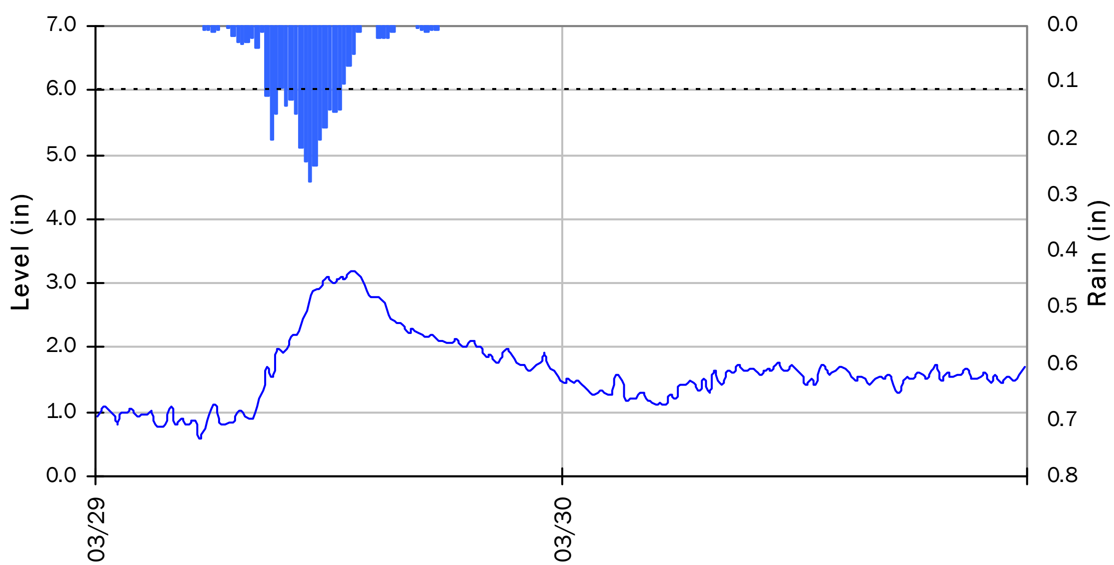
Total Weekly Rainfall: 0.85 inches

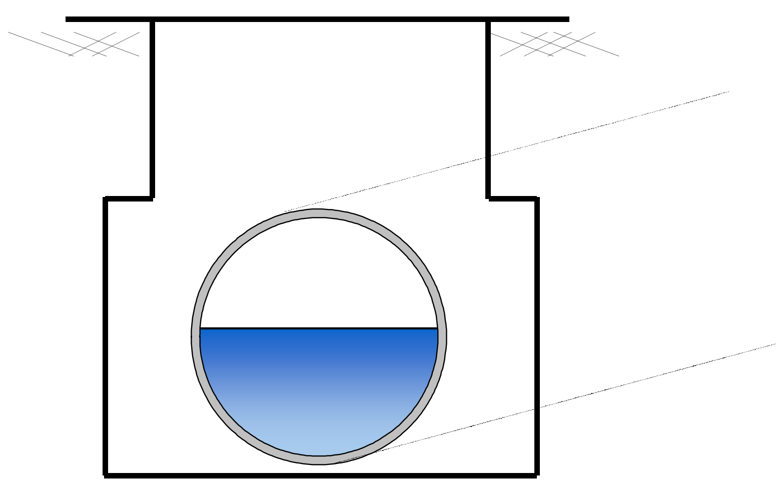


Avg Flow: 0.025 mgd **Peak Flow: 0.108 mgd** **Min Flow: 0.001 mgd**

SITE M5.2A
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



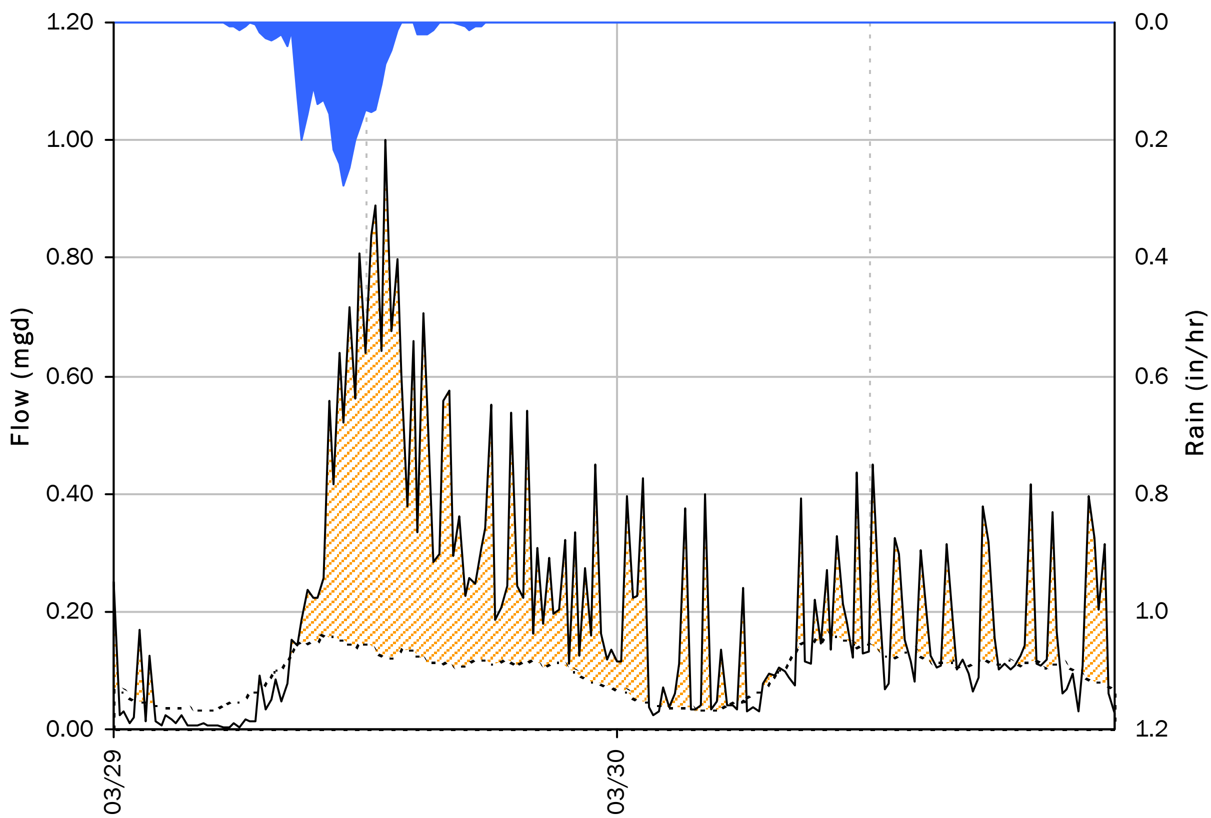


Pipe Diameter:	6	*inches*
Peak Measured Level:	3.2	*inches*
Peak d/D Ratio:	0.53	

SITE 6.3
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 1.00 *mgd*
PF: 11.12

Peak Level: 8.07 *in*
d/D Ratio: 1.01

Inflow / Infiltration

Peak I/I Rate: 0.88 *mgd*
Total I/I: 230,000 *gallons*

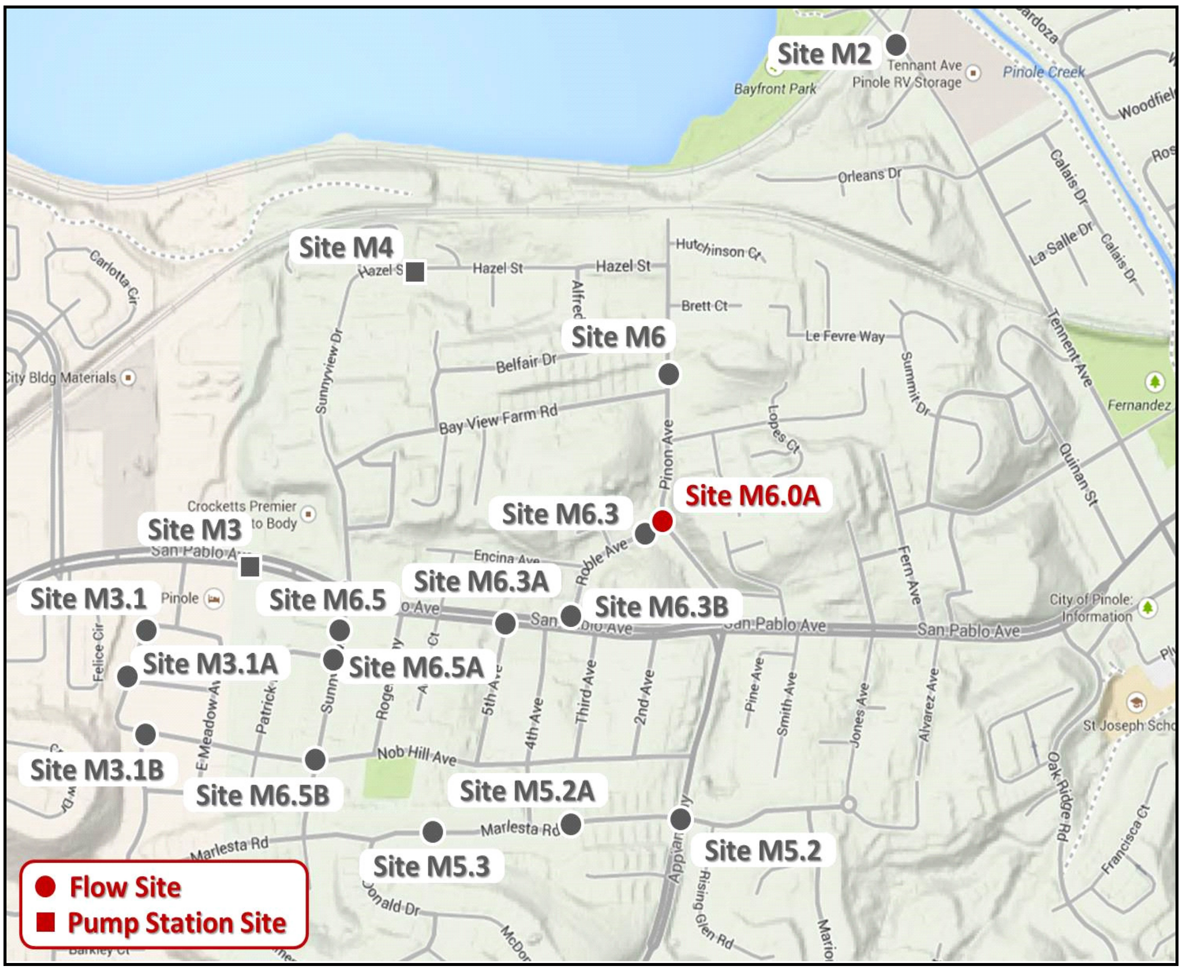
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.0A

Location: Intersection of Roble Ave. and Pinon Ave.

Data Summary Report

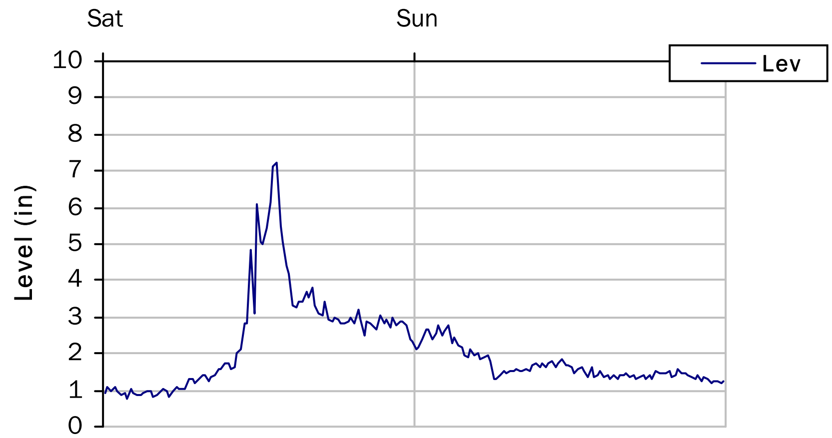


Vicinity Map: Site M6.0A

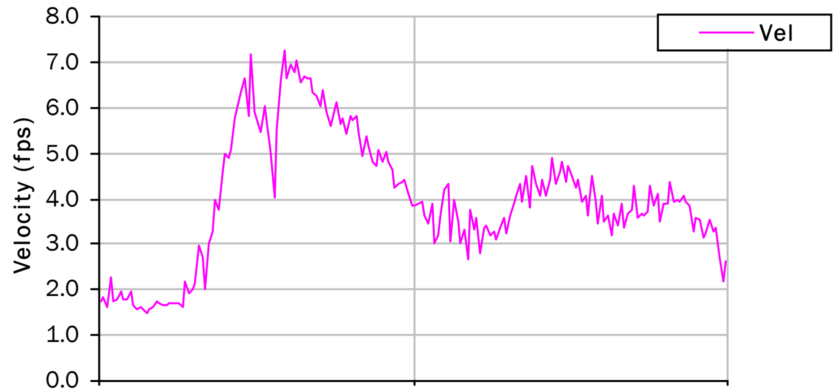
SITE M6.0A

Weekly Level, Velocity and Flow Hydrographs

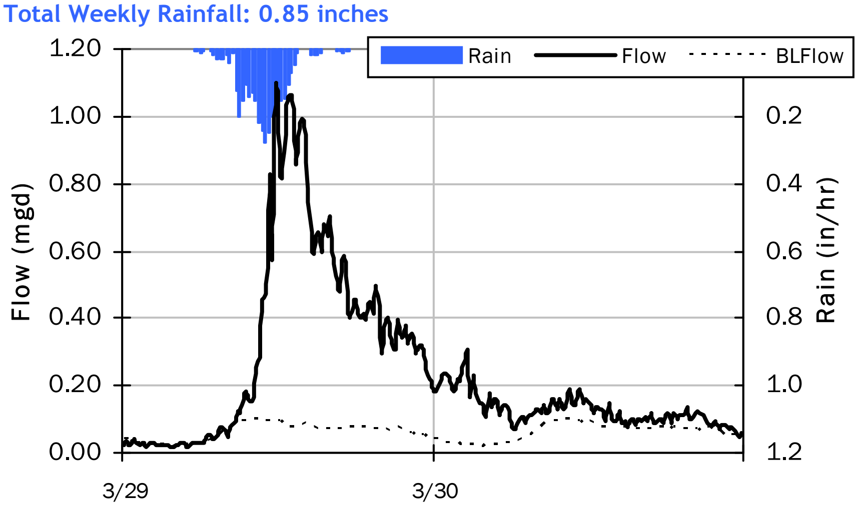
Avg Level: 2.08 in. Peak Level: 7.24 in. Min Level: 0.77 in.



Avg Velocity: 3.99 fps Peak Velocity: 7.27 fps Min Velocity: 1.50 fps



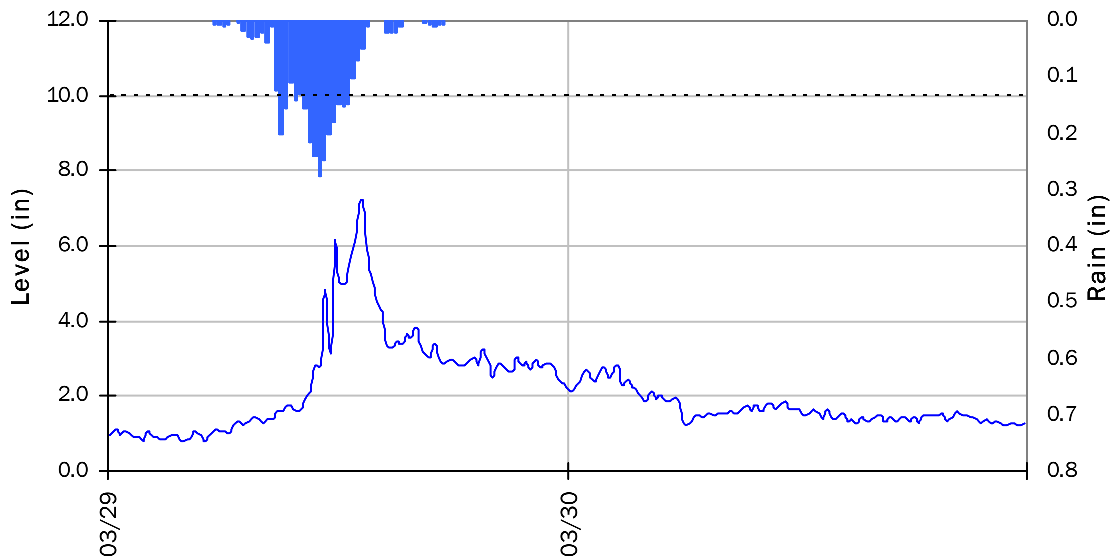
Total Weekly Rainfall: 0.85 inches

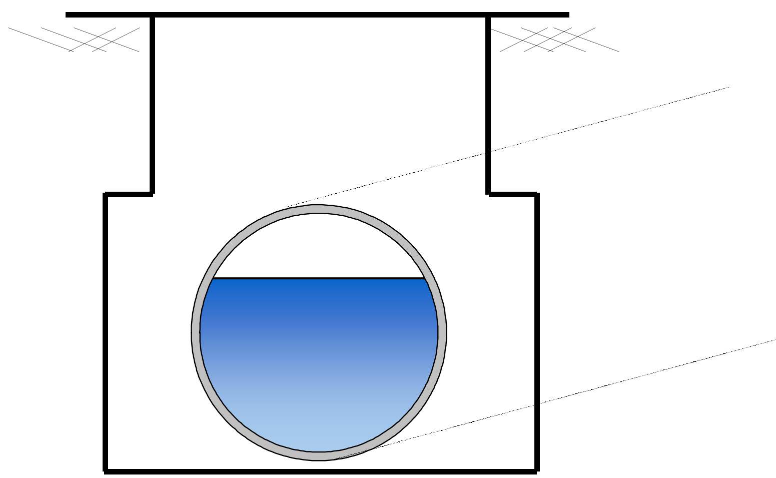


Avg Flow: 0.231 mgd Peak Flow: 1.091 mgd Min Flow: 0.019 mgd

SITE M6.0A
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



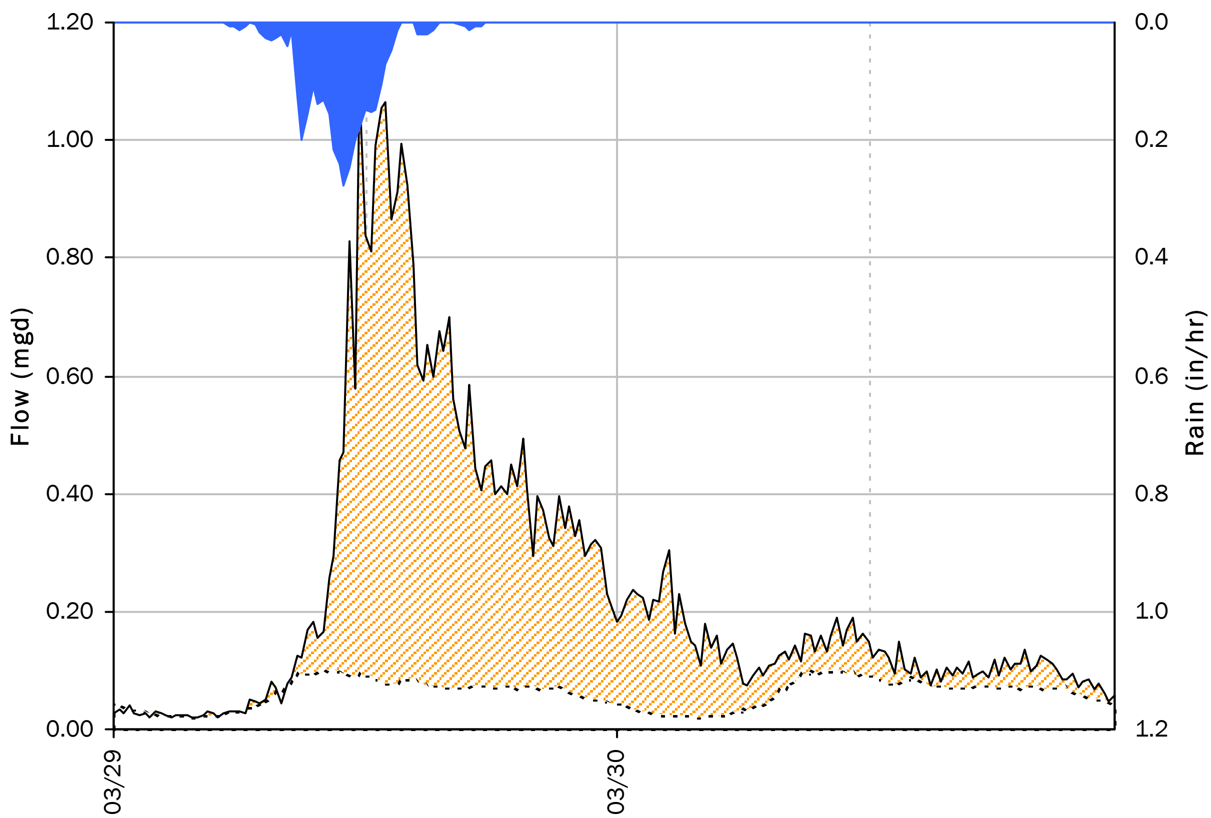


Pipe Diameter:	10	*inches*
Peak Measured Level:	7.24	*inches*
Peak d/D Ratio:	0.72	

SITE 6.0A
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 1.09 *mgd*
PF: 19.03

Peak Level: 7.24 *in*
d/D Ratio: 0.72

Inflow / Infiltration

Peak I/I Rate: 1.00 *mgd*
Total I/I: 339,000 *gallons*

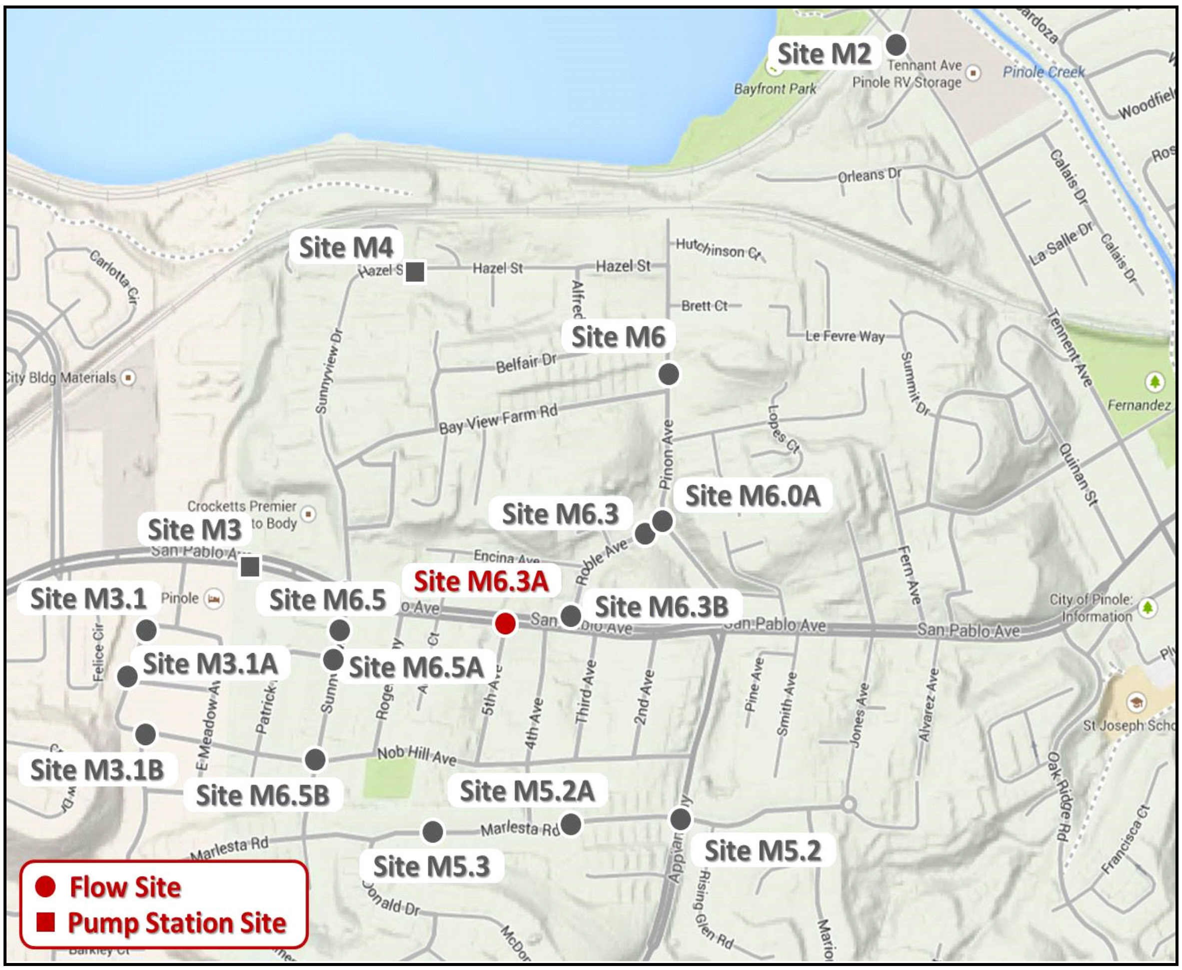
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.3A

Location: Intersection of San Pablo Ave. and 5th Ave.

Data Summary Report

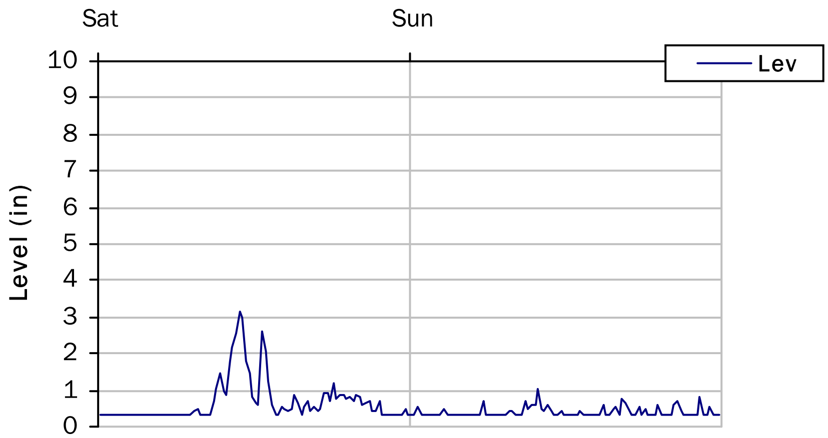


Vicinity Map: Site M6.3A

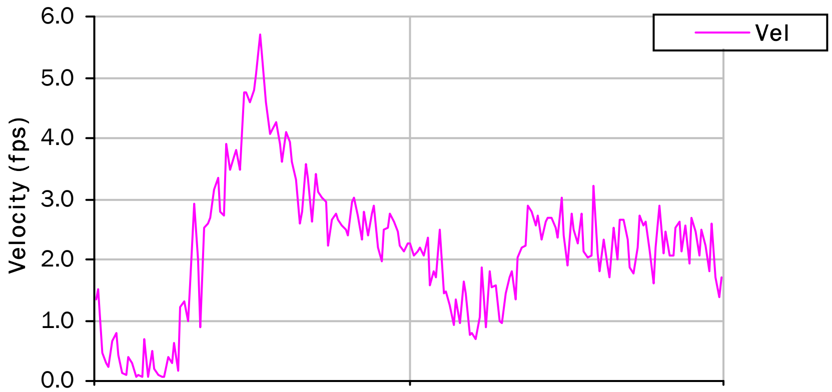
SITE M6.3A

Weekly Level, Velocity and Flow Hydrographs

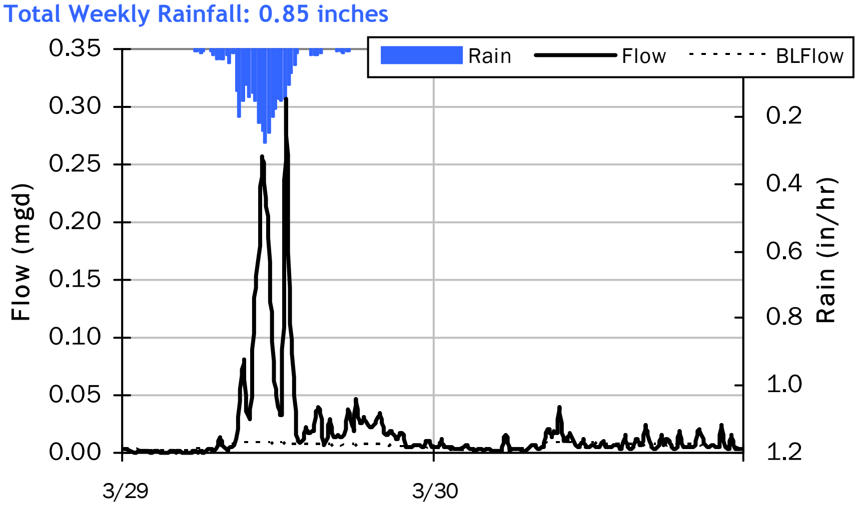
Avg Level: 0.53 in.   Peak Level: 3.15 in.   Min Level: 0.30 in.



Avg Velocity: 2.19 fps   Peak Velocity: 5.70 fps   Min Velocity: 0.07 fps



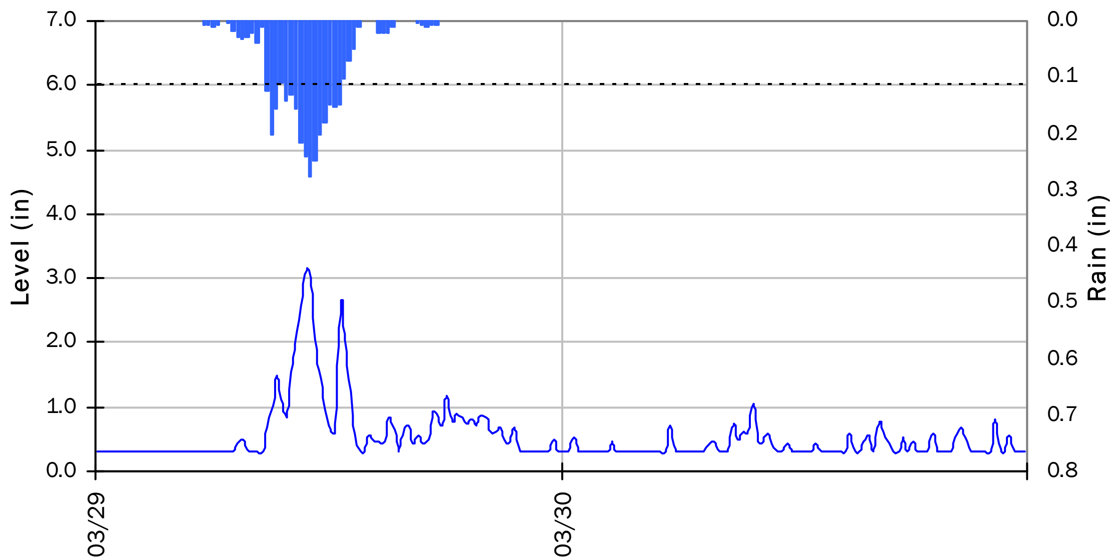
Total Weekly Rainfall: 0.85 inches

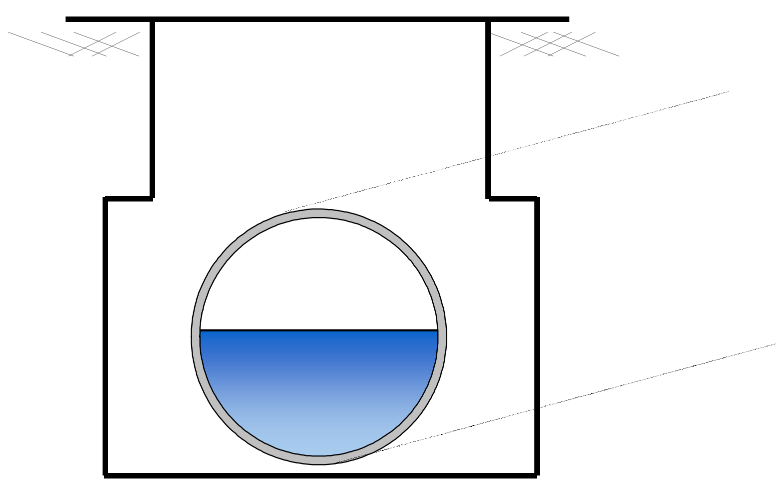


Avg Flow: 0.020 mgd   Peak Flow: 0.302 mgd   Min Flow: 0.000 mgd

SITE M6.3A
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



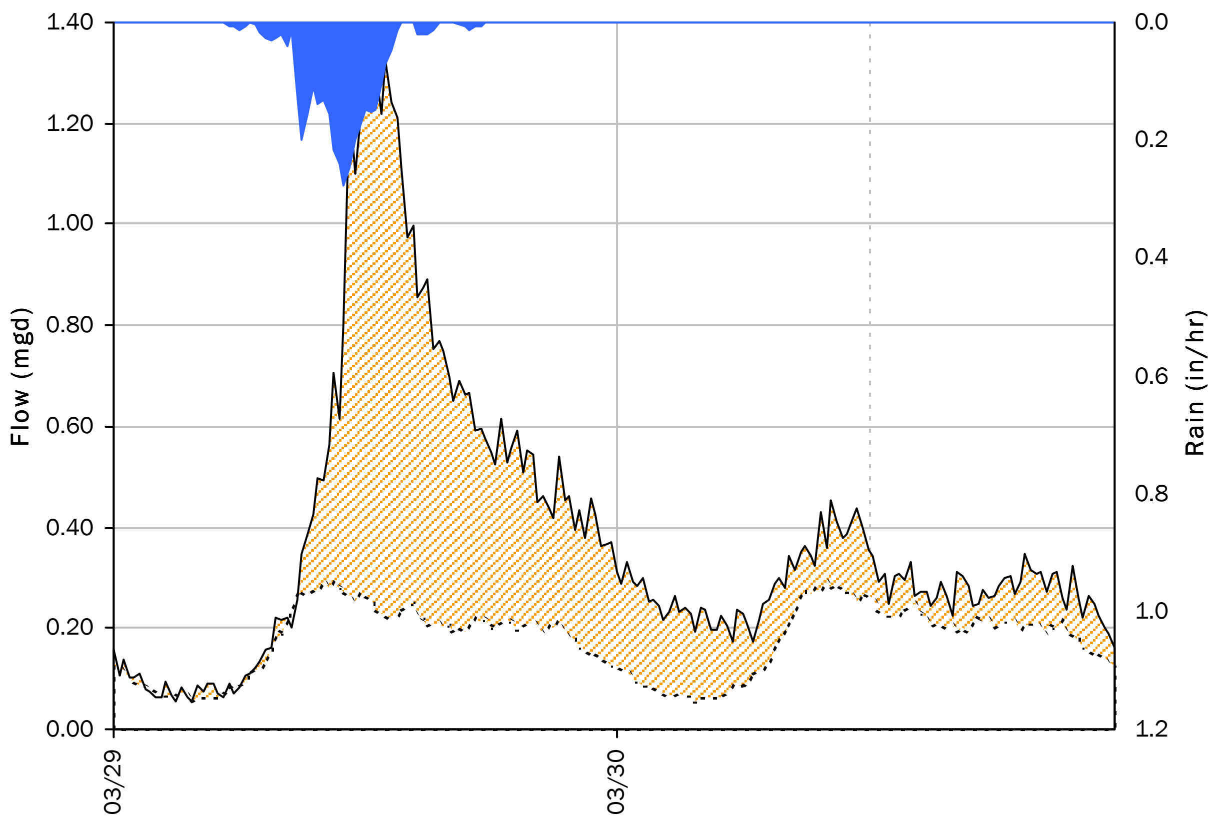


Pipe Diameter:	6	*inches*
Peak Measured Level:	3.15	*inches*
Peak d/D Ratio:	0.53	

SITE 6
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 1.32 *mgd*
PF: 8.09

Peak Level: 41.01 *in*
d/D Ratio: 4.10

Inflow / Infiltration

Peak I/I Rate: 1.10 *mgd*
Total I/I: 408,000 *gallons*

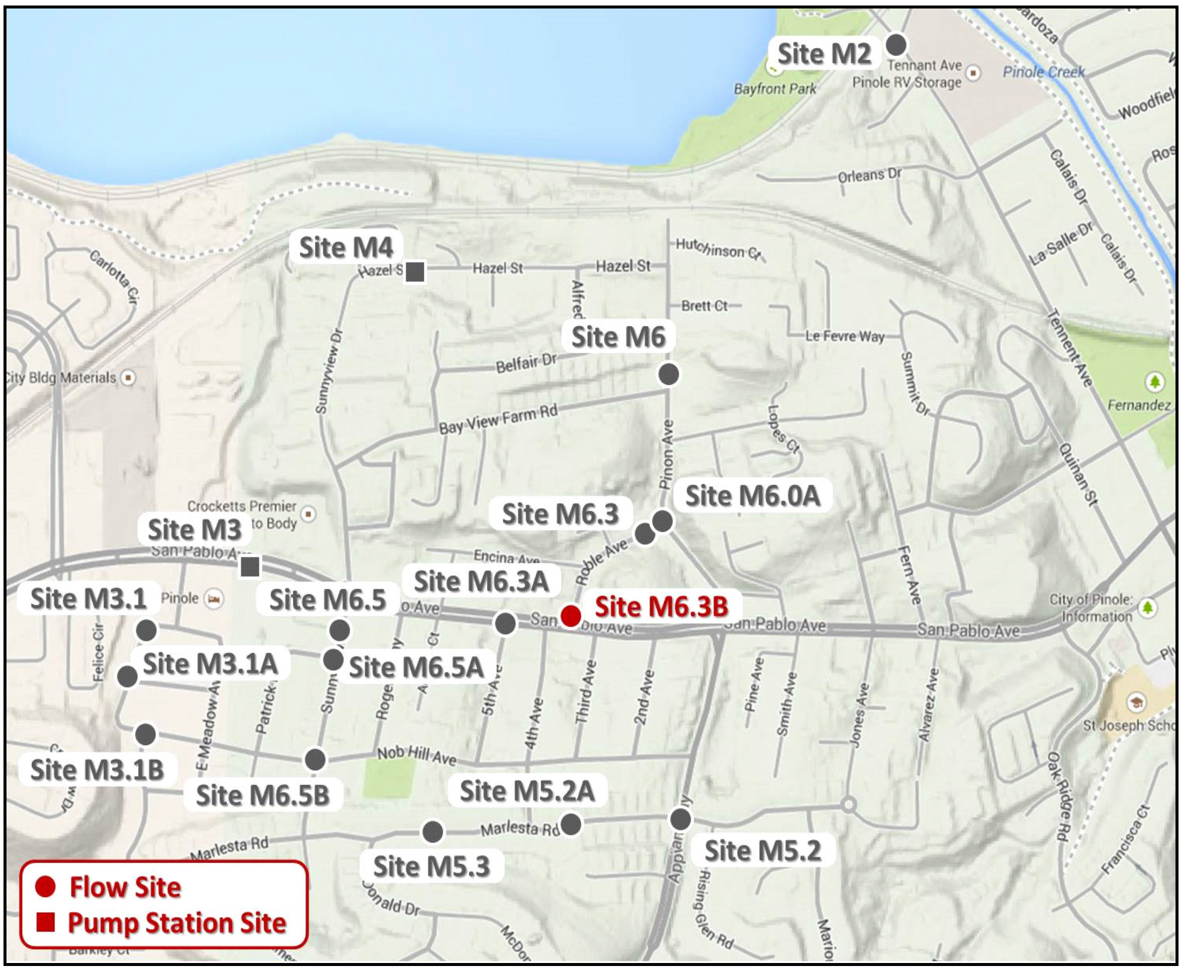
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.3B

Location: Intersection of San Pablo Ave. and Roble Ave.

Data Summary Report

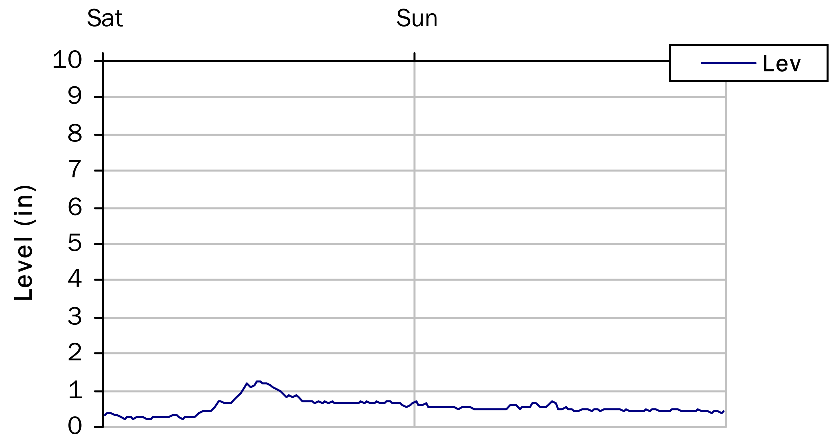


Vicinity Map: Site M6.3B

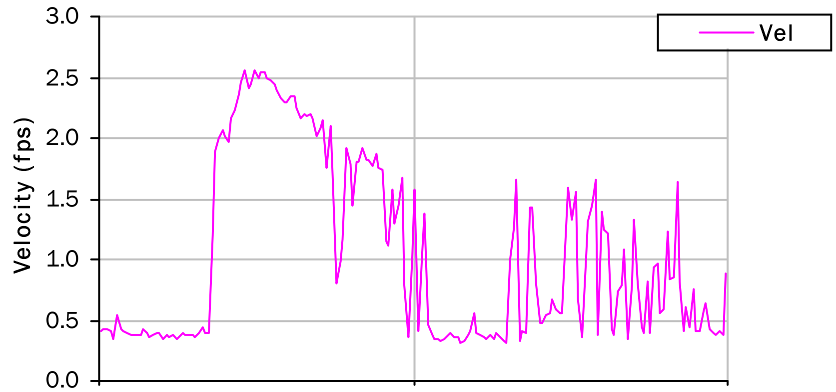
SITE M6.3B

Weekly Level, Velocity and Flow Hydrographs

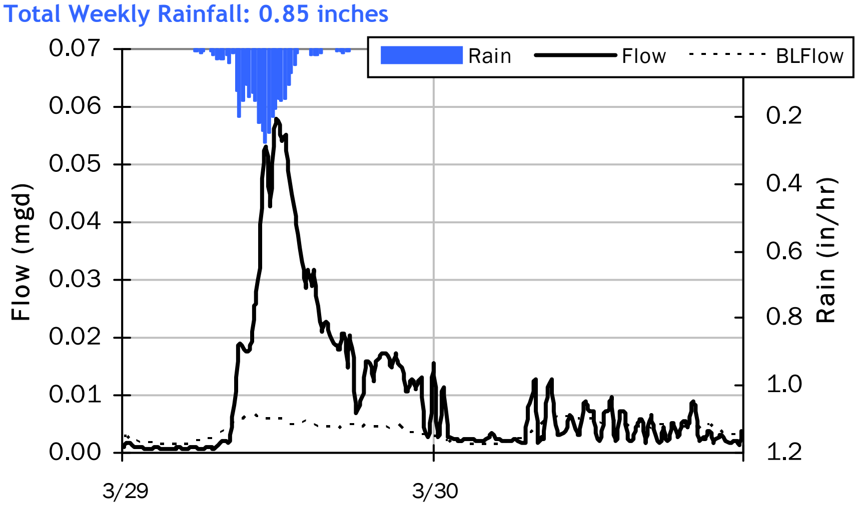
Avg Level: 0.56 in.   Peak Level: 1.26 in.   Min Level: 0.23 in.



Avg Velocity: 1.04 fps   Peak Velocity: 2.56 fps   Min Velocity: 0.31 fps



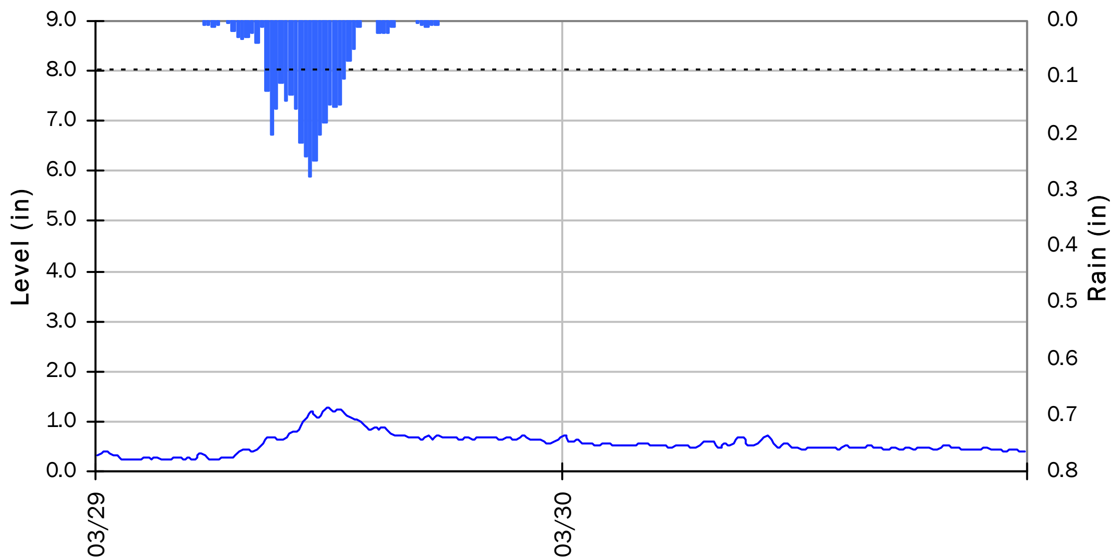
Total Weekly Rainfall: 0.85 inches

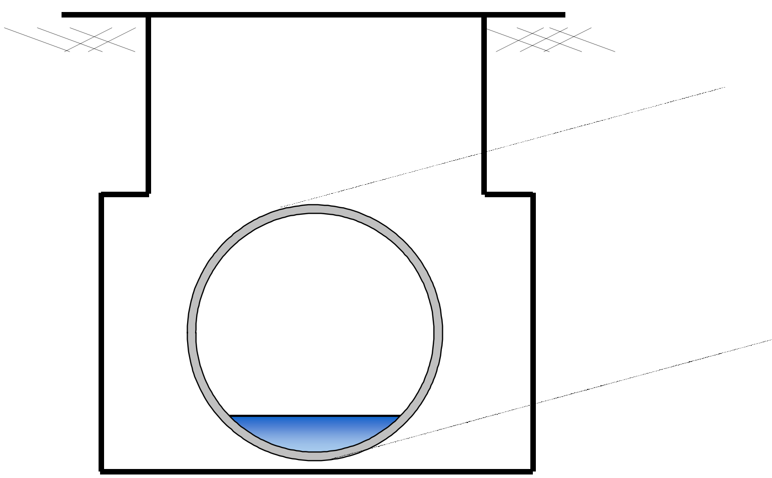


Avg Flow: 0.010 mgd   Peak Flow: 0.058 mgd   Min Flow: 0.001 mgd

SITE M6.3B
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



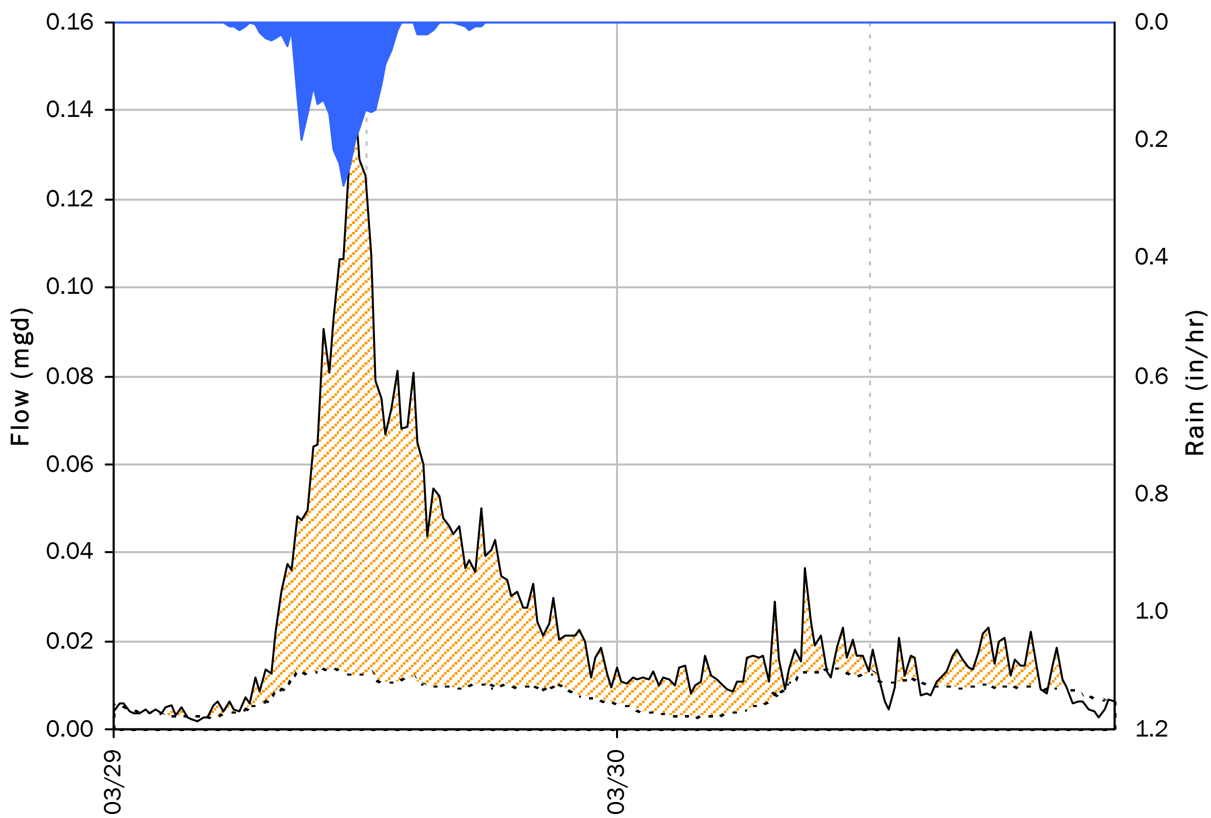


Pipe Diameter:	8	*inches*
Peak Measured Level:	1.26	*inches*
Peak d/D Ratio:	0.16	

SITE 6.5
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.14 *mgd*
PF: 18.00

Peak Level: 3.15 *in*
d/D Ratio: 0.39

Inflow / Infiltration

Peak I/I Rate: 0.13 *mgd*
Total I/I: 33,000 *gallons*

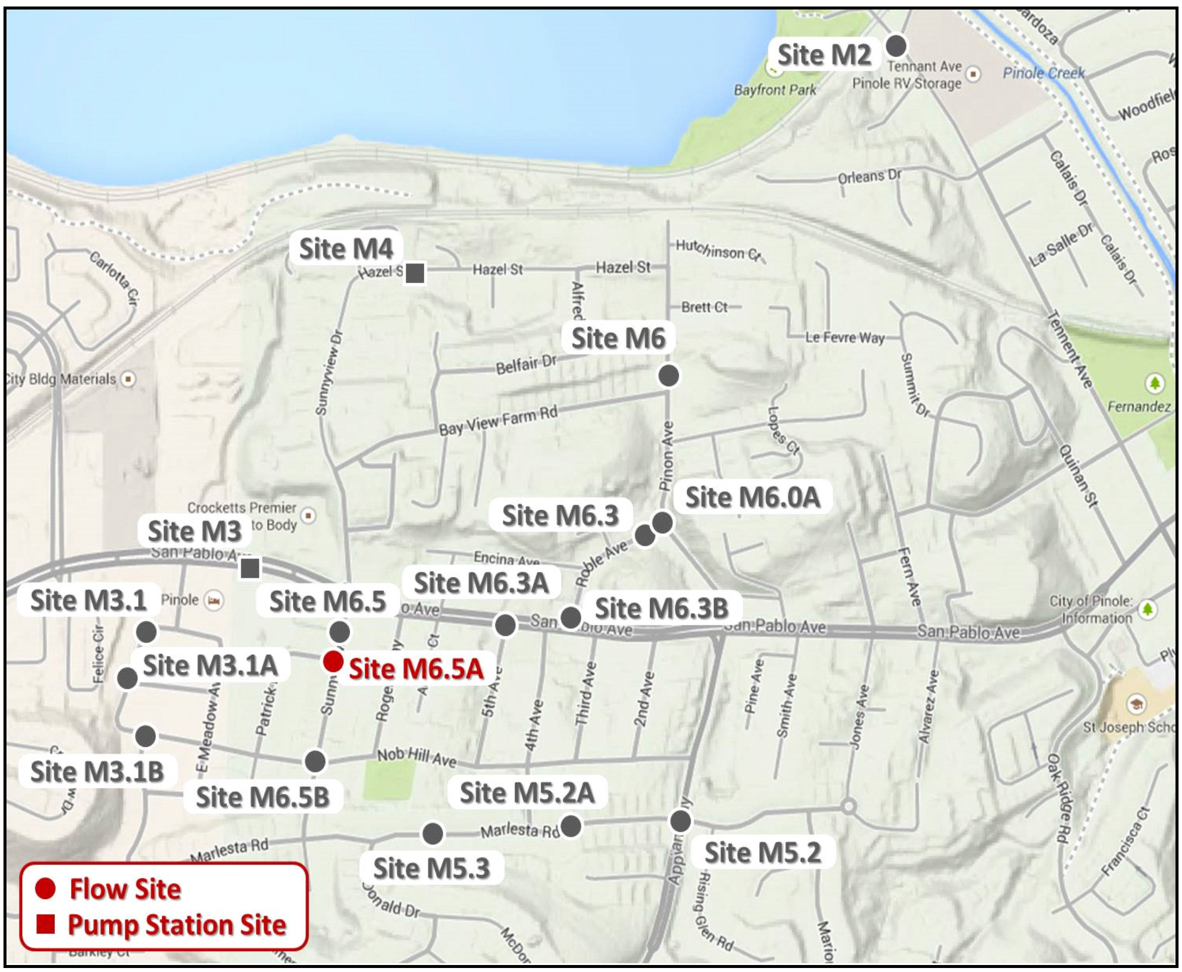
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.5A

Location: Intersection of Sunnyview Dr. and Patrick Dr.

Data Summary Report

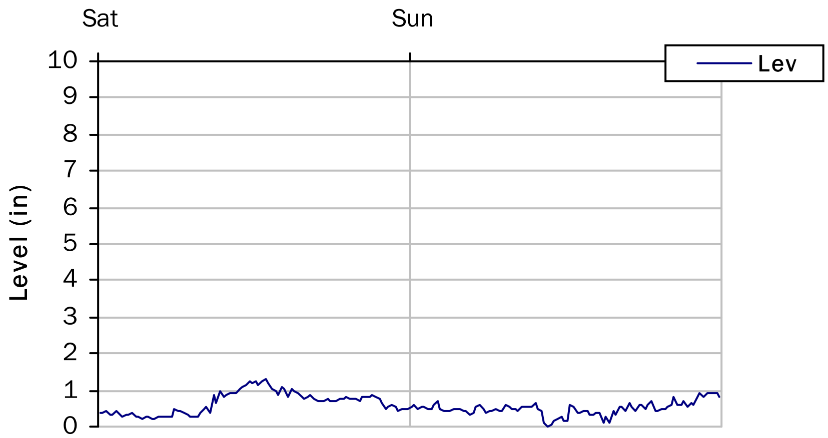


Vicinity Map: Site M6.5A

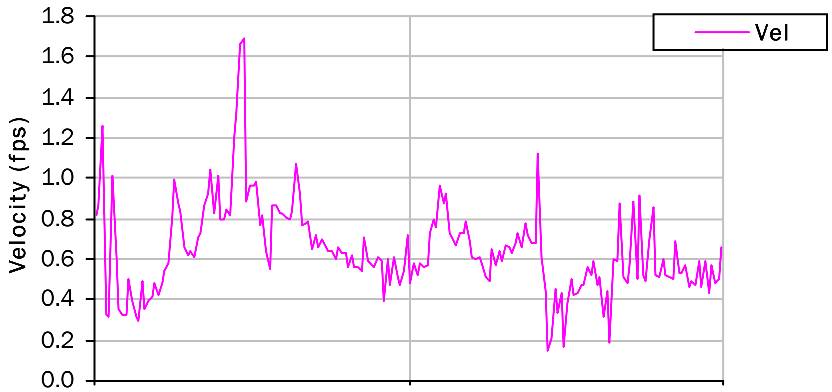
SITE M6.5A

Weekly Level, Velocity and Flow Hydrographs

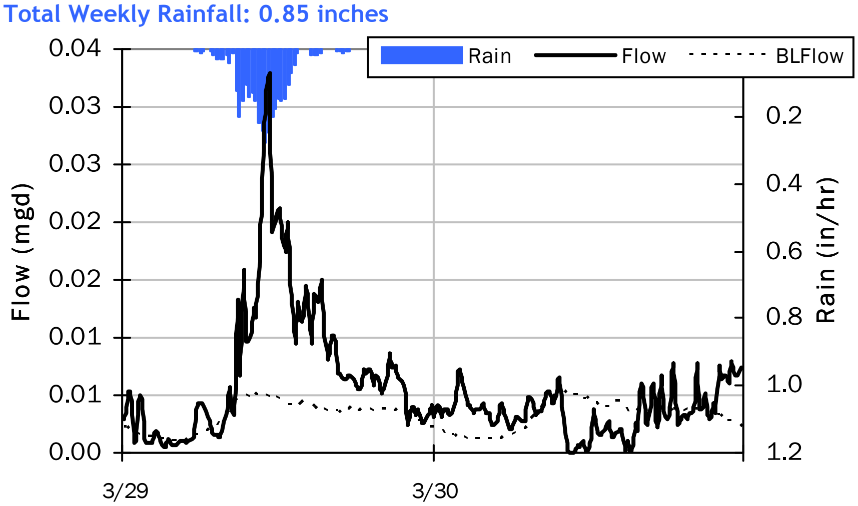
Avg Level: 0.58 in. **Peak Level: 1.32 in.** **Min Level: 0.01 in.**



Avg Velocity: 0.64 fps **Peak Velocity: 1.69 fps** **Min Velocity: 0.15 fps**



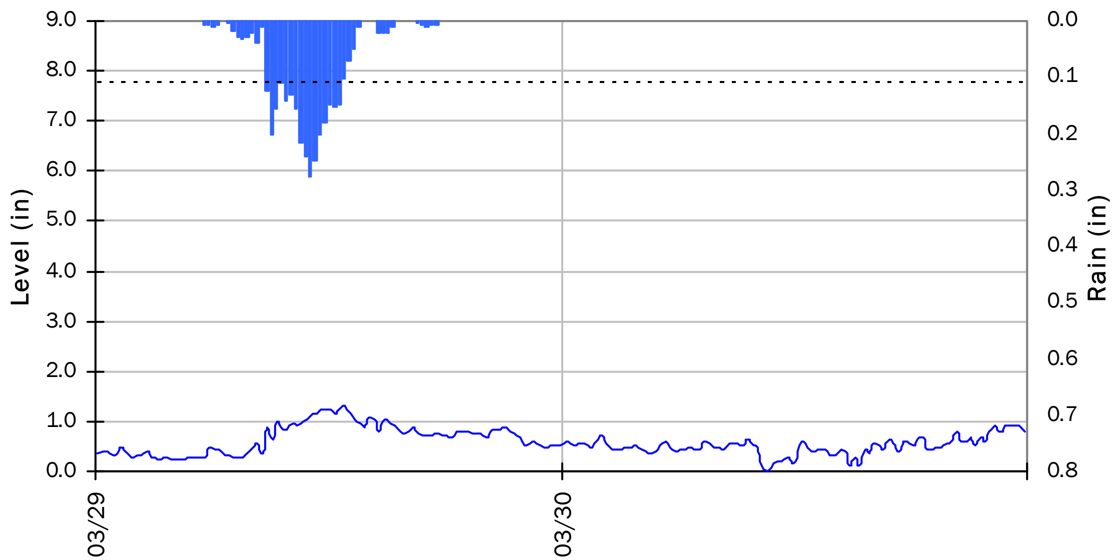
Total Weekly Rainfall: 0.85 inches

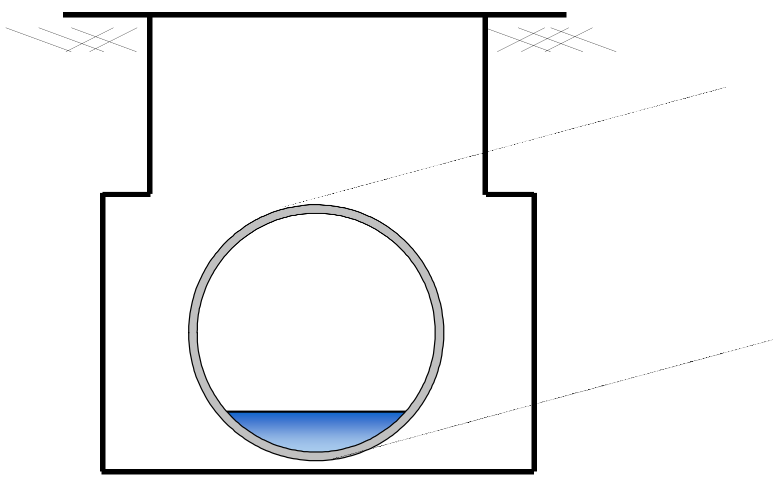


Avg Flow: 0.006 mgd **Peak Flow: 0.033 mgd** **Min Flow: 0.000 mgd**

SITE M6.5A
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



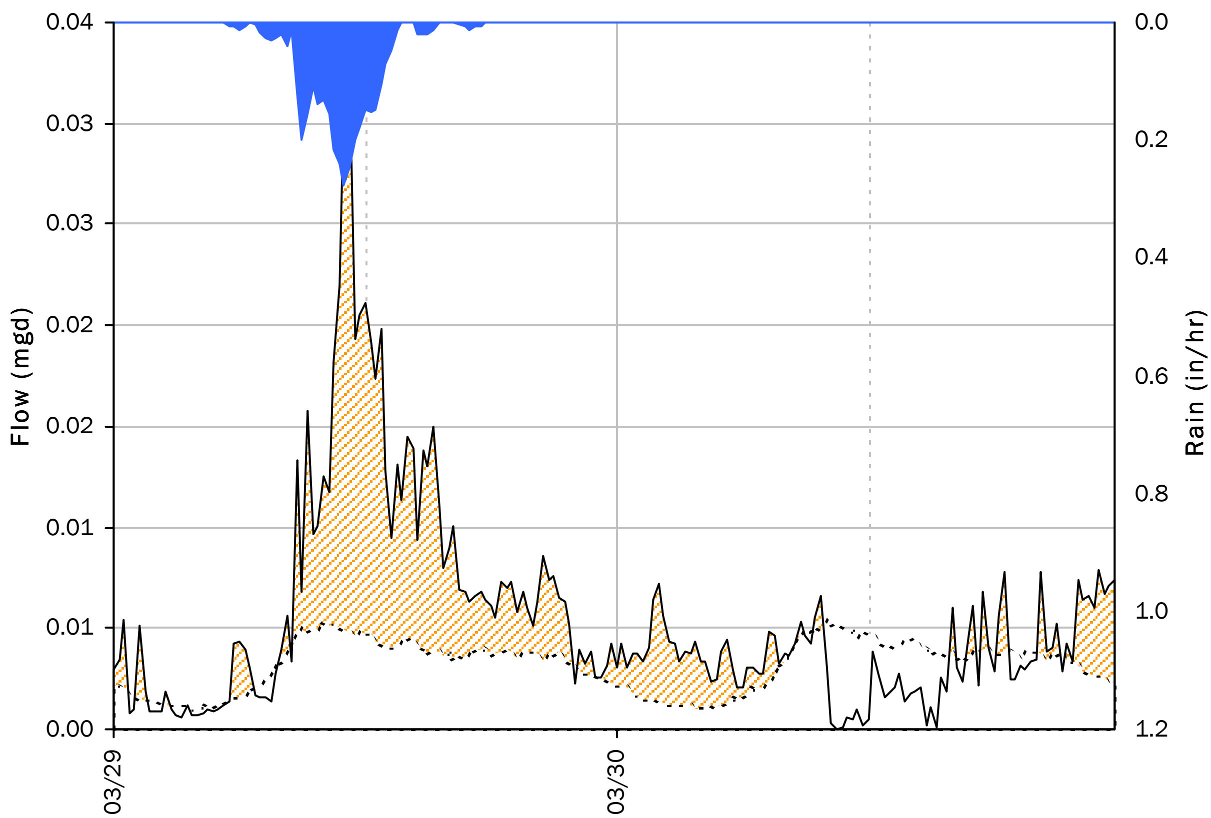


Pipe Diameter:	7.75	*inches*
Peak Measured Level:	1.32	*inches*
Peak d/D Ratio:	0.17	

SITE 6.5A
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.03 *mgd*
PF: 11.06

Peak Level: 1.32 *in*
d/D Ratio: 0.17

Inflow / Infiltration

Peak I/I Rate: 0.03 *mgd*
Total I/I: 5,000 *gallons*

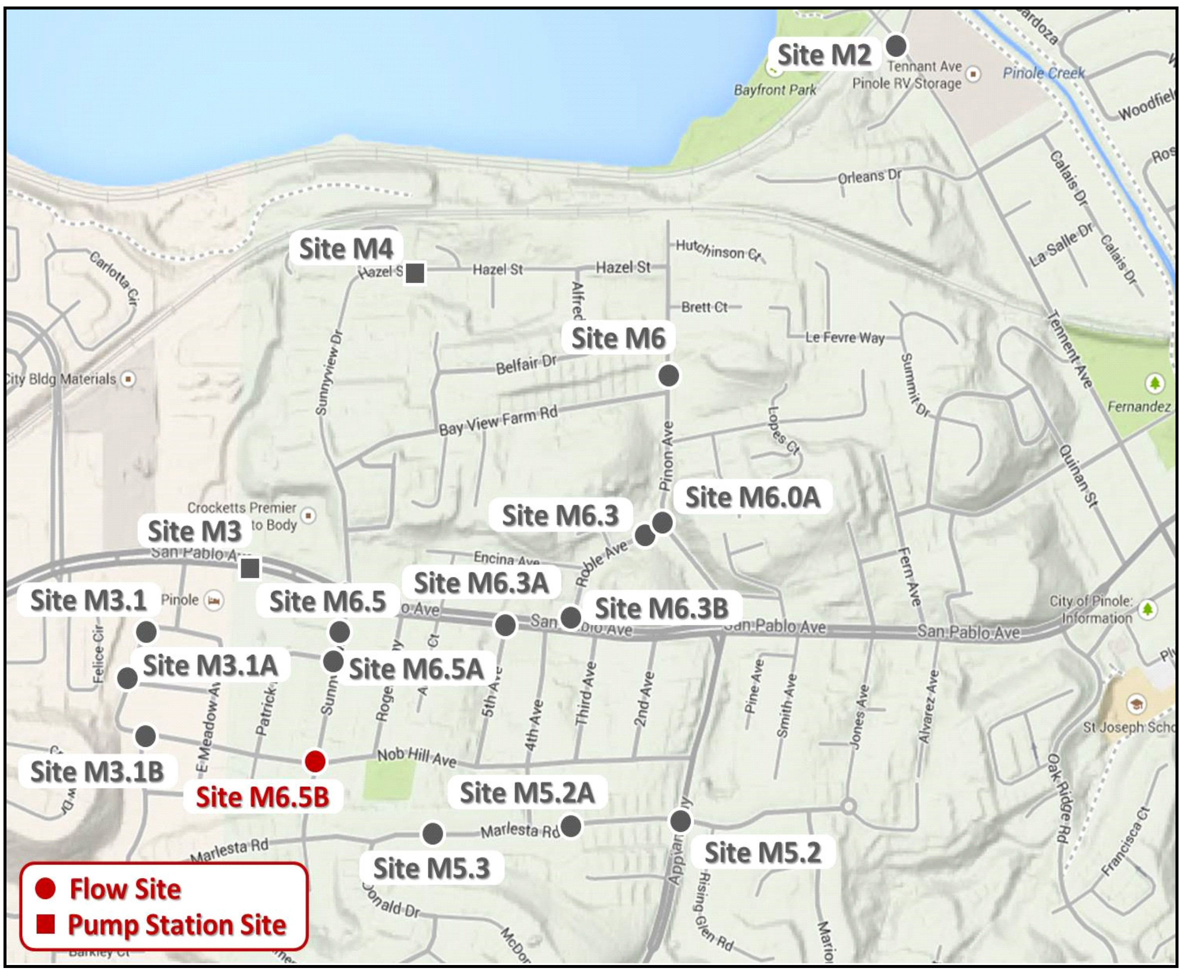
City of Pinole

Sanitary Sewer Flow Monitoring
Temporary Monitoring: March 2014

Monitoring Site: Site M6.5B

Location: Intersection of Sunnyview Dr. and Nob Hill Ave.

Data Summary Report

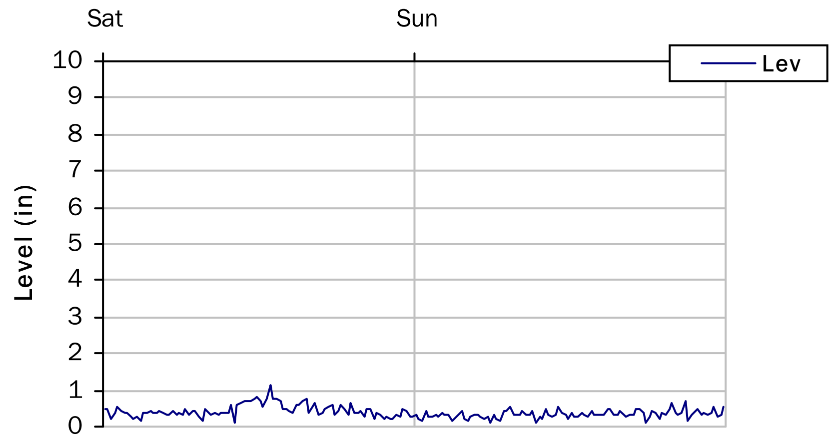


Vicinity Map: Site M6.5B

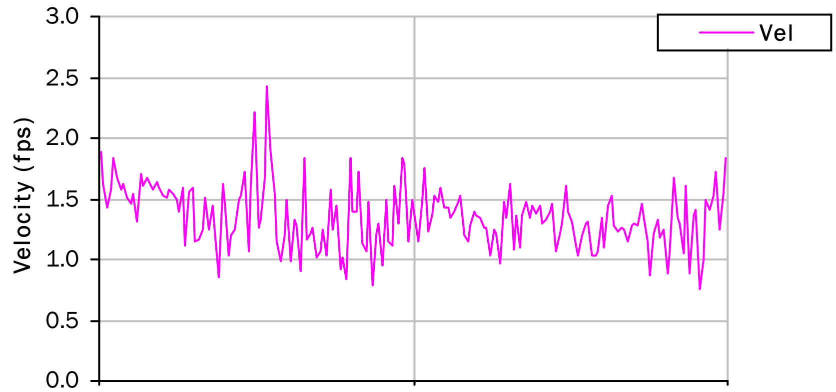
SITE M6.5B

Weekly Level, Velocity and Flow Hydrographs

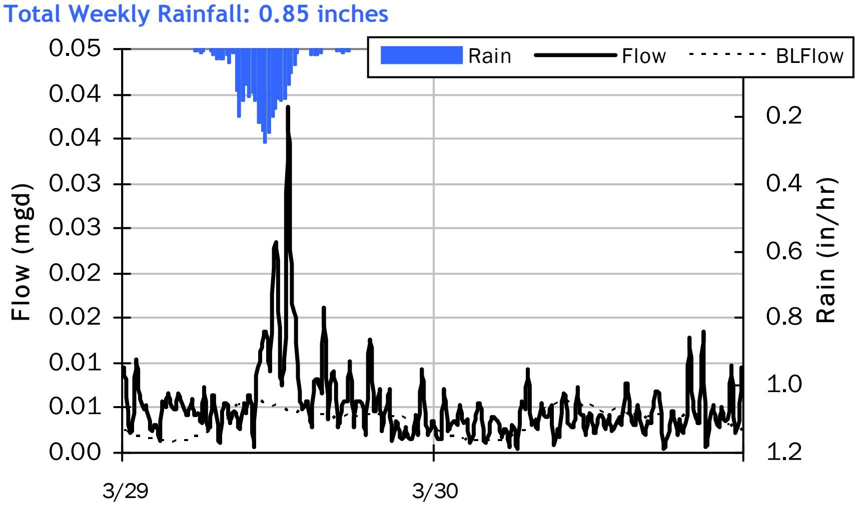
Avg Level: 0.39 in. **Peak Level: 1.12 in.** **Min Level: 0.10 in.**



Avg Velocity: 1.36 fps **Peak Velocity: 2.42 fps** **Min Velocity: 0.76 fps**



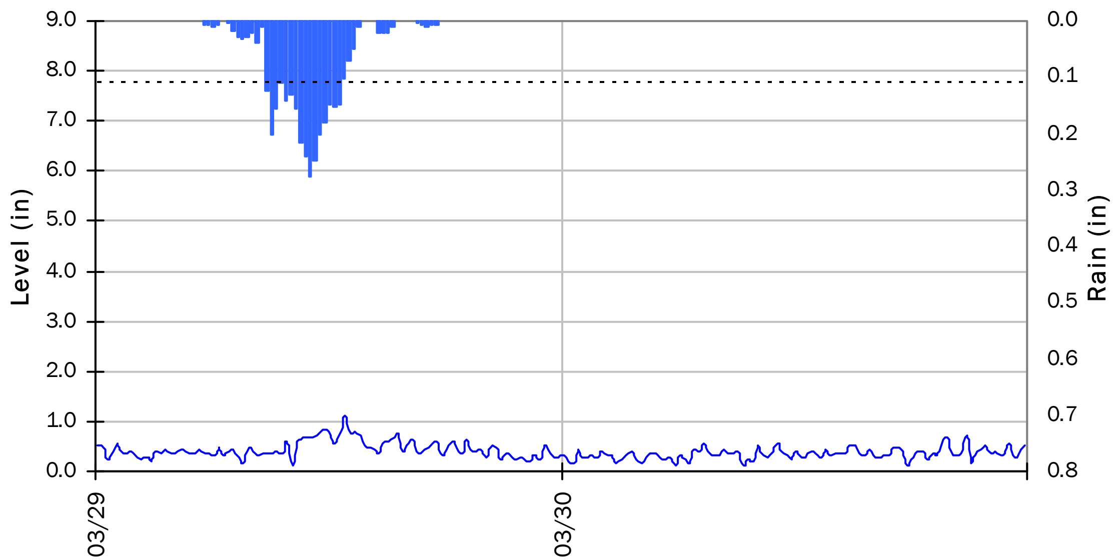
Total Weekly Rainfall: 0.85 inches

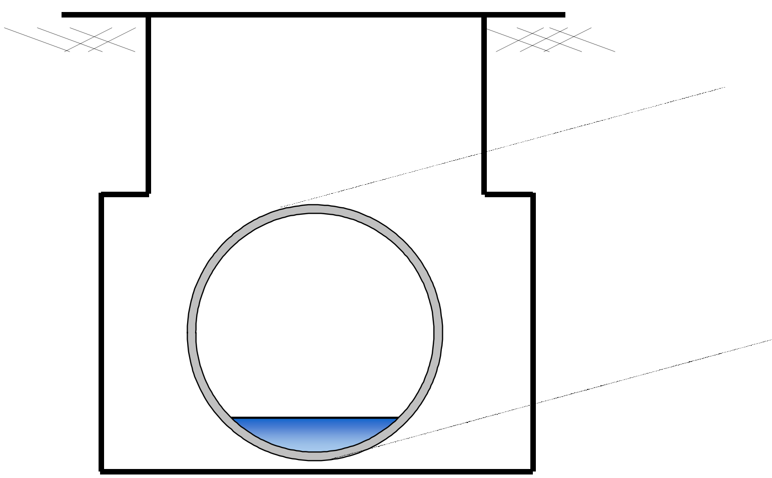


Avg Flow: 0.005 mgd **Peak Flow: 0.039 mgd** **Min Flow: 0.001 mgd**

SITE M6.5B
Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Monitoring Period



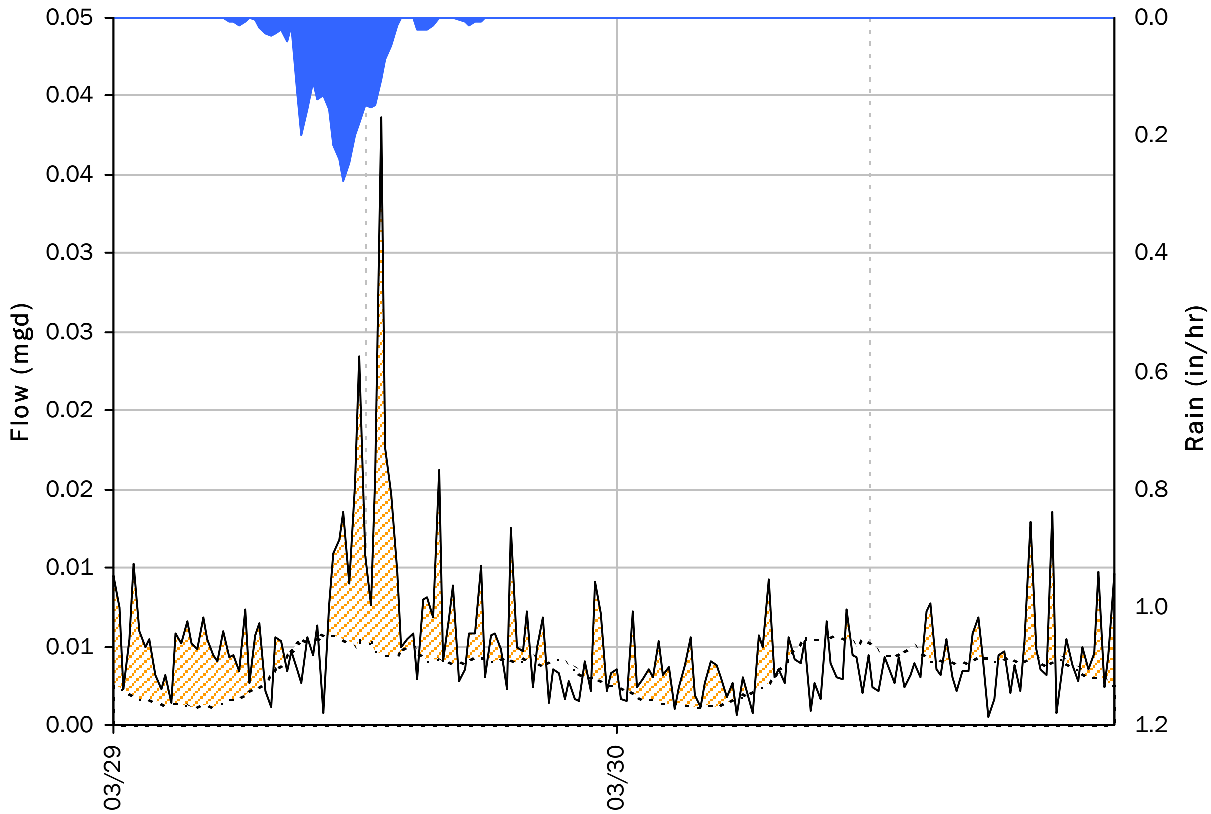


Pipe Diameter:	7.75	*inches*
Peak Measured Level:	1.12	*inches*
Peak d/D Ratio:	0.14	

SITE 6.5B
I/I Summary: Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period

Event 3 Detail Graph



Storm Event I/I Analysis (Rain = 0.85 inches)

Capacity

Peak Flow: 0.04 *mgd*
PF: 11.78

Peak Level: 1.12 *in*
d/D Ratio: 0.14

Inflow / Infiltration

Peak I/I Rate: 0.03 *mgd*
Total I/I: 3,000 *gallons*