

Wastewater Flow Monitoring Services

For

Pickard Architects

Golden Oaks Sewer Study

6014 Norwalk Blvd Project

Whittier, CA 90606

February 19, 2021 through March 9, 2021



Leaders in Sewer Flow Monitoring
Services

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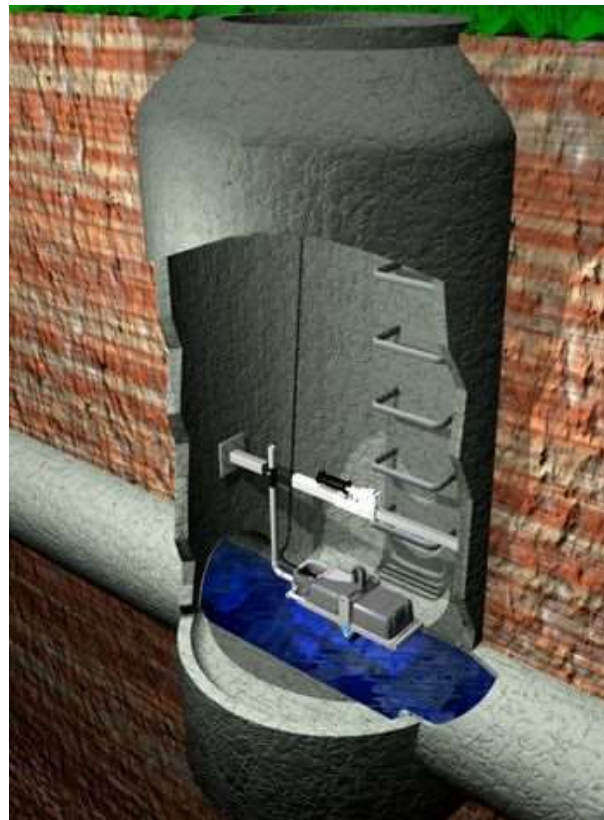


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Tab 1: Overview & Site-Specific Information

1.1 Overview

The City of Whittier (City) owns, operates, and maintains its own wastewater collection system. The wastewater generated in Whittier is collected by trunk sewers operated and maintained by the County of Los Angeles Consolidated Sewer Maintenance District (CSMD), which is managed by the County of Los Angeles Department of Public Works (LACDPW) Sewer Maintenance Division. The City sewer manholes monitored as part of this report can be found on CSMD Map C-2076.

The City's wastewater collection system consists of approximately 194 miles of sanitary sewer mains and 5,028 manholes. The Whittier Sewer Maintenance Division maintains 210 miles of sewer lines within the City. The Division routinely cleans these sewer lines once every twelve months and some areas on a more frequent basis. In addition to these City sewers, there are approximately 7 miles of private sewers and 14 miles of CSMD trunk sewers within the City limits that the City does not own or maintain.

Since the City and CSMD are responsible for properly managing, operating, and maintaining all portions of their wastewater collection system, sewer flow monitoring is required as a condition of development. This requirement not only helps to ensure adequate capacitance, but continually updates their databases with the most current information, allowing the City and the CSMD to improve the condition and performance of its wastewater collection system, reducing the occurrences of SSOs, and ensuring the health and safety of the community.

1.2 Project Description

Utility Systems Science & Software, Inc. (US³) was contracted by Pickard Architects to perform 14 full days of continuous sewer flow monitoring at two sewer manholes downstream from the point of connection with the proposed development. The study was requested by the City and was prepared in compliance with the City sewer study requirements. The site locations and sewer lines are shown on maps in Section 1.3.

US³ assessed permitting and traffic control requirements for the selected monitoring sites. Formal traffic control plans (TCPs) were prepared for the monitoring sites in accordance with the California Manual of Uniform Traffic Control Devices (CA MUTCD). Additional information regarding traffic control at each site is included in Section 1.4. An encroachment permit was approved by the City prior to the initiation of the flow monitoring study.

US³ performed an initial site inspection to evaluate the site hydraulics at the selected monitoring sites. **Note:** Each wastewater collection system is different, and some of the differences that affect flow monitoring include: slope of sewer line; age, condition and material of sewer line; number and type of connections; and sewer design, specifically the proximity of baffles, drop structures, pumps, siphons, and weirs. None of these structures were found within the selected manholes. In addition, since the hydraulics within the selected manholes were deemed acceptable for flow monitoring during the inspection, it was determined that the sites should provide an accurate representation of flow patterns during the study. Therefore, installation at the sites occurred on 2/19/2021.

The manholes were equipped with Hach Marsh-McBirney Flo-Dar® AV Sensors and Loggers. With the installation and removal of the equipment, the manholes were opened and confined space entry was limited to crossing the plane with hands and arms, but not actually entering the manholes. Even though US³ personnel did not enter the manholes during equipment installation or removal, they were fully trained and certified in Confined Space Entry and CPR, and in accordance with safety standards, gas readings were taken and recorded throughout the duration of the installation and removal process.



In summary, US³ performed the following services for this project:

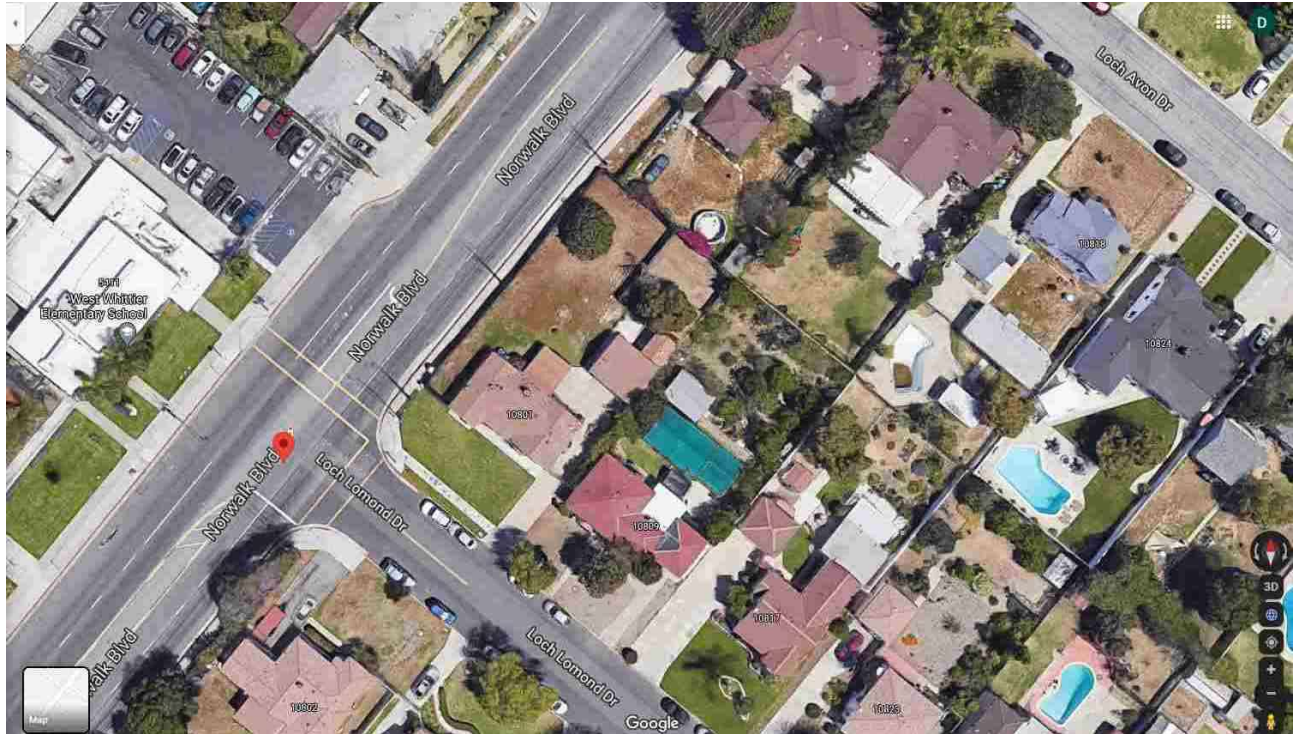
- Sewer Flow Monitoring
 - Detailed preliminary investigation
 - Assessment of permitting and traffic control requirements
 - Receipt of approved City Encroachment Permit
 - Inspection and evaluation of the selected sites
 - Installation of Marsh-McBirney Flo-Dar® AV Sensors and Loggers
 - Validation of hydraulic suitability
 - Calibration of flow monitoring equipment
 - Documentation of installation and calibration
 - Flow monitoring between 2/19/2021 and 3/09/2021
 - Removal of flow monitoring equipment
 - Validation of flow monitoring data
- Evaluation of the sanitary sewer at the monitored site/s
- Development of a report to discuss the flow monitoring data, including system statistics and graphs

1.3 Site Maps



Figures 1 & 2: The vicinity map (above) shows the temporary wastewater flow monitoring location northeast of the proposed project site. The manhole is located at latitude 33.989530 and longitude -118.064406. A plan view of the monitored sewer line from CSMD C-2076 is shown below.





Figures 3 & 4: The vicinity map (above) shows the temporary wastewater flow monitoring location of City manhole (MH) 20, which is located at latitude 33.986733 and longitude -118.067174. A plan view of the monitored sewer line from CSMD C-2076 is shown below.



1.4 Summary of Sites

Figure 5 below: The photo shows City MH 25 in the left-hand northbound lane of Norwalk Blvd at its intersection with Pleasant Way. The manhole is northwest of 6014 Norwalk Blvd.

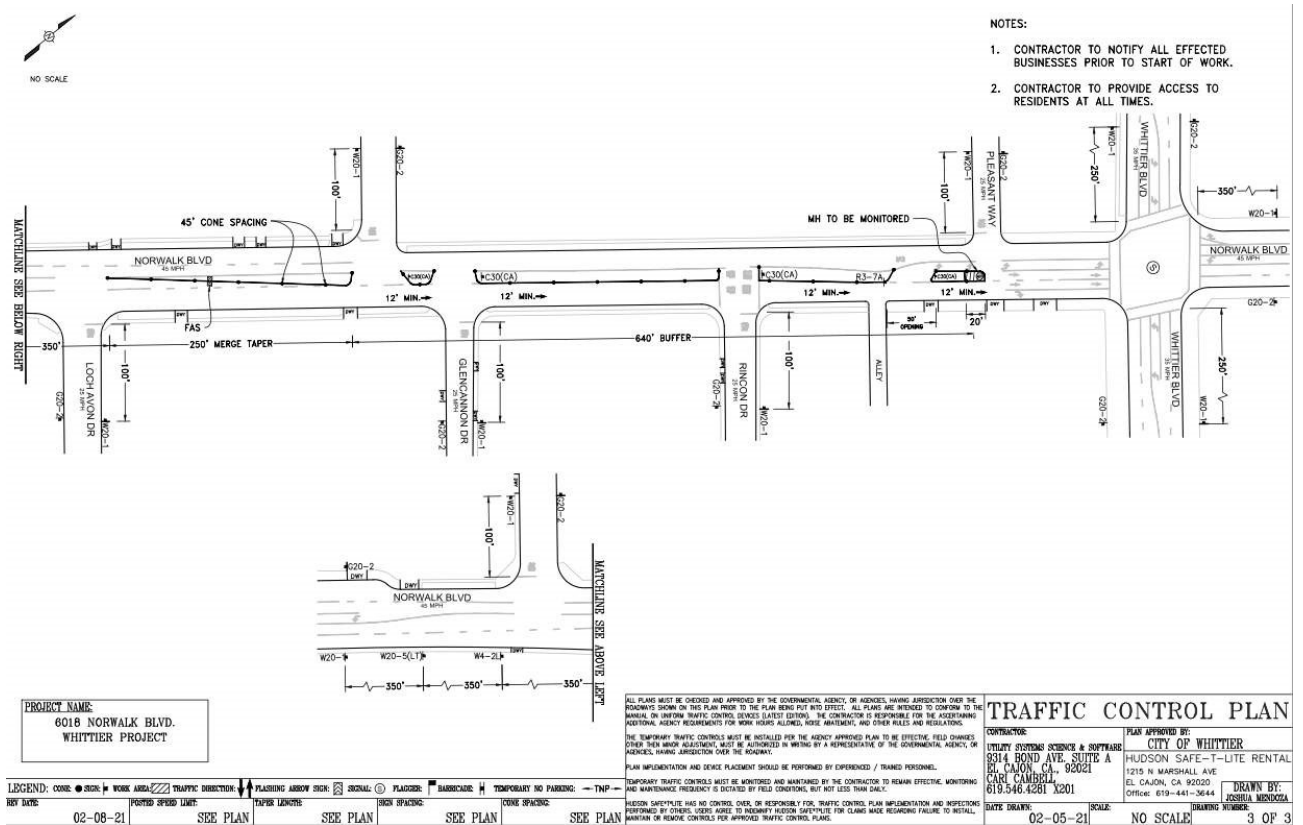


Figure 6: This is a relatively busy road, so the field team used a flashing arrow board, cones and signs for traffic control in accordance with the approved TCP (shown above) during installation and removal of the monitoring equipment. Surface conditions were dry. No issues were encountered.

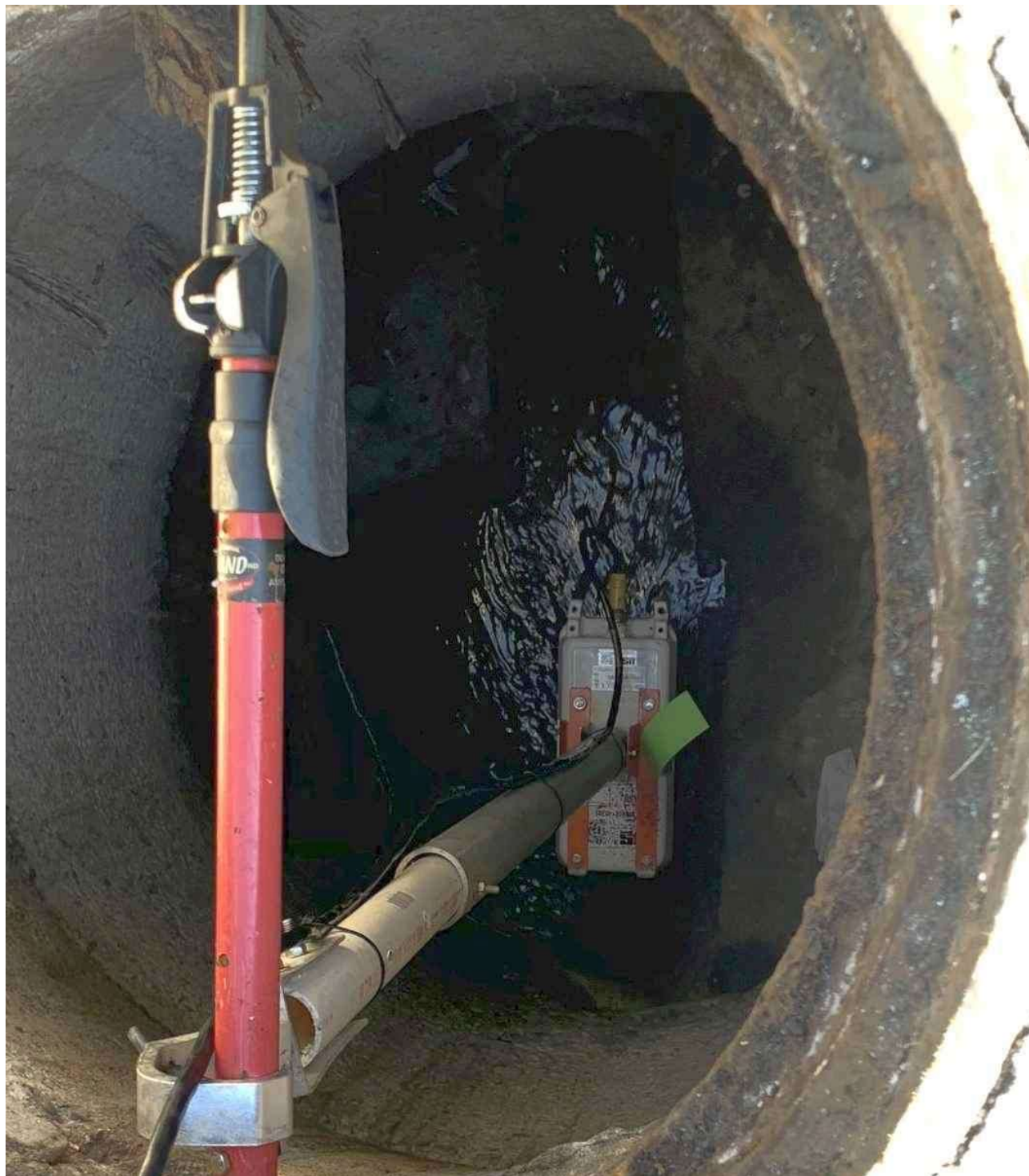


Figure 7 above: City MH 25 provided access to a 10-in sewer line, which entered from the northeast and discharged to the southwest, with a lateral entering from the northwest. Gas levels were within Occupational Safety and Health Administration (OSHA) permissible exposure limits ($O_2=20.9\%$; LEL, H_2S & $CO=0$). The flow monitoring equipment was set to monitor the downstream west line on 2/19/2021 to get the total flow. US³ followed up on this installation on 2/19/2021 to confirm equipment calibration

Figure 8 below: The photo shows City MH 20 in the center of the Loch Lomond and Norwalk Blvd intersection. The manhole is north of 10802 Loch Lomond Dr.

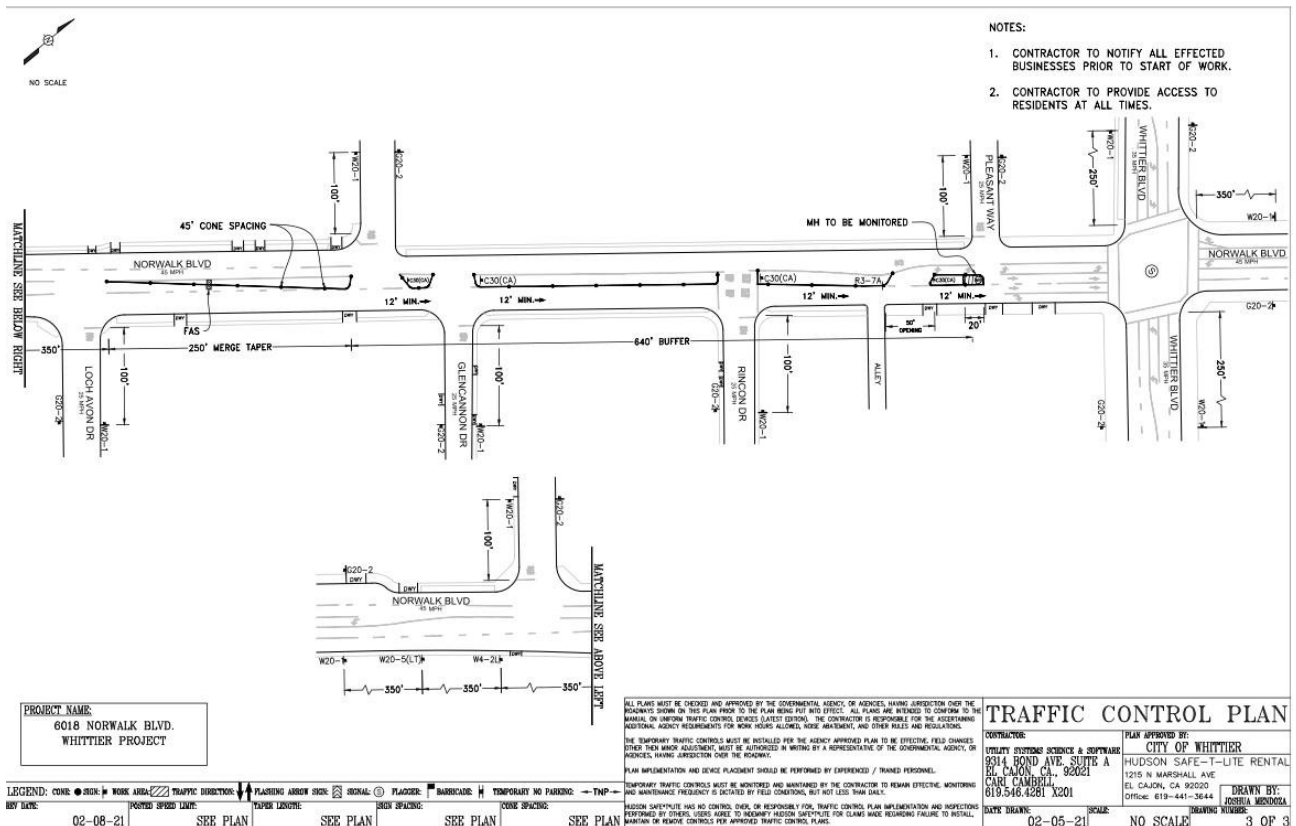


Figure 9: This is a relatively busy road adjacent to an elementary school, so the field team used a flashing arrow board, cones and signs for traffic control in accordance with the approved TCP (shown above) during installation and removal of the monitoring equipment. Surface conditions were dry. No issues were encountered.



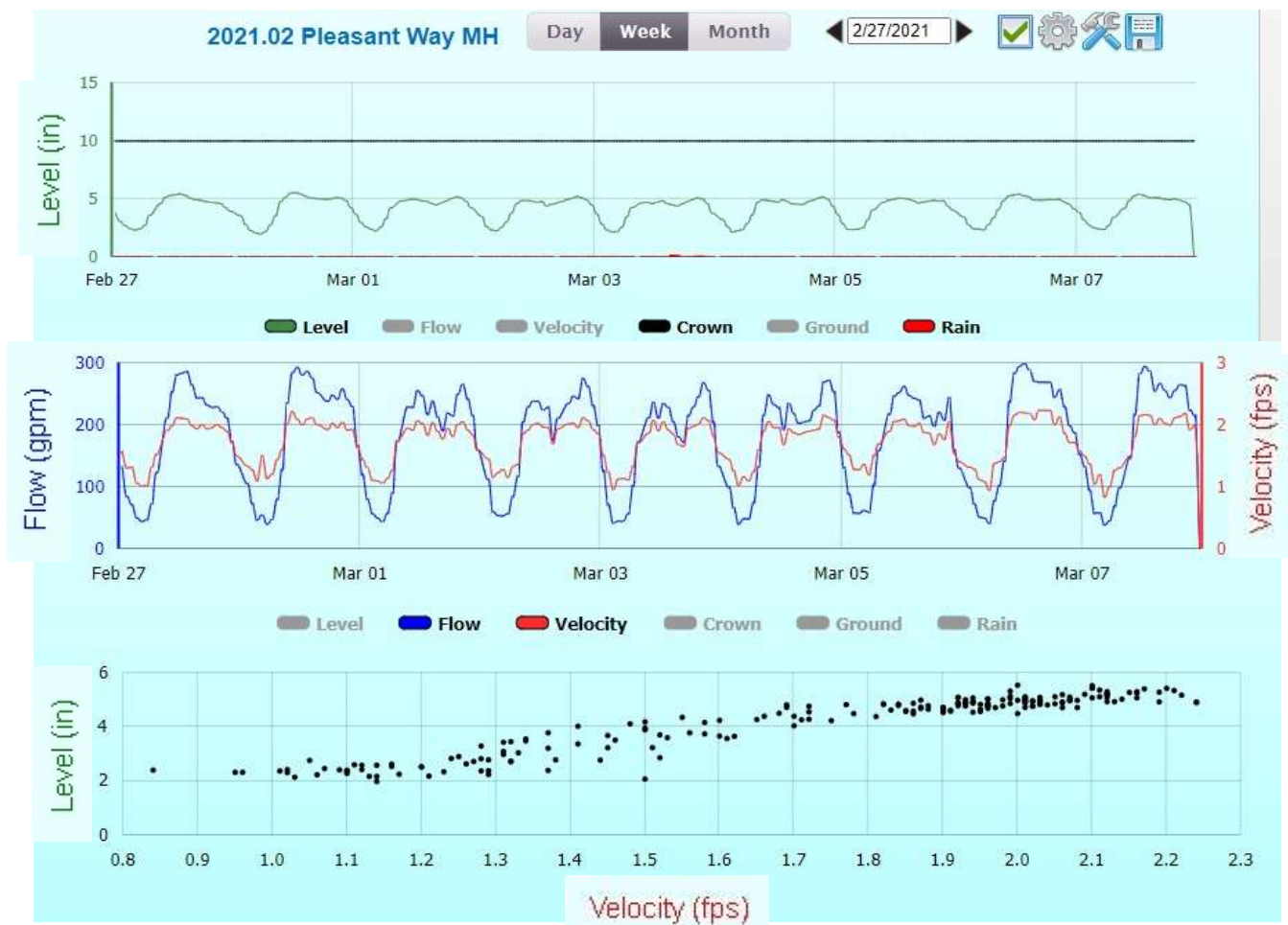
Figure 10 above: City MH 20 provided access to a 10-in sewer line, which entered from the northeast and discharged to the southwest, with a lateral entering from the east. Gas levels were within OSHA permissible exposure limits. The flow monitoring equipment was set to monitor the downstream west line on 2/19/2021 to get the total flow. US³ followed up on this installation on 2/19/2021 to confirm equipment calibration

1.5 Existing Capacity Analysis

The capacity evaluation method conformed to the following process:

1. Collect 15-minute (min) interval depth and velocity data points at each site over the entire monitoring period and determine the depth versus (vs) velocity relationship or pipe curve based on Manning's equation.
2. Determine statistically the minimum, maximum and average depths and flow rates at each site during the monitoring period.
3. Calculate the maximum theoretical unobstructed flow rate at each site.
4. Determine remaining capacity under peak flow conditions at each site, using the ratios of monitored daily flow depths to pipe diameter.

Figure 11 below: 2021.02 Pleasant Way MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot (bottom graph in Figure 11) shows an averaged representation of the depth vs. velocity data points for the monitored pipe from 2/27/2021 through 3/07/2021.

The data was divided into 200 time periods and each period was then averaged and graphed. The pattern of velocity and depth data points for a sewer operating in free-flow conditions over an extended period of time should conform to the depth vs velocity relationship of the Manning Equation, which is the basis for evaluating flow monitoring data. This equation (shown below) defines a commonly used theoretical relationship between depth and velocity in pipes operating under free flow conditions:

$$v = 1.486/n \times R^{2/3} \times S^{1/2}$$

Where,

v = velocity in feet (ft) per second (fps)

n = pipe roughness, defined as the Manning's Roughness Coefficient (0.013 was selected in accordance with the minimum value for multiple types of sewer pipes with manholes, inlets, etc., Chow 1959)

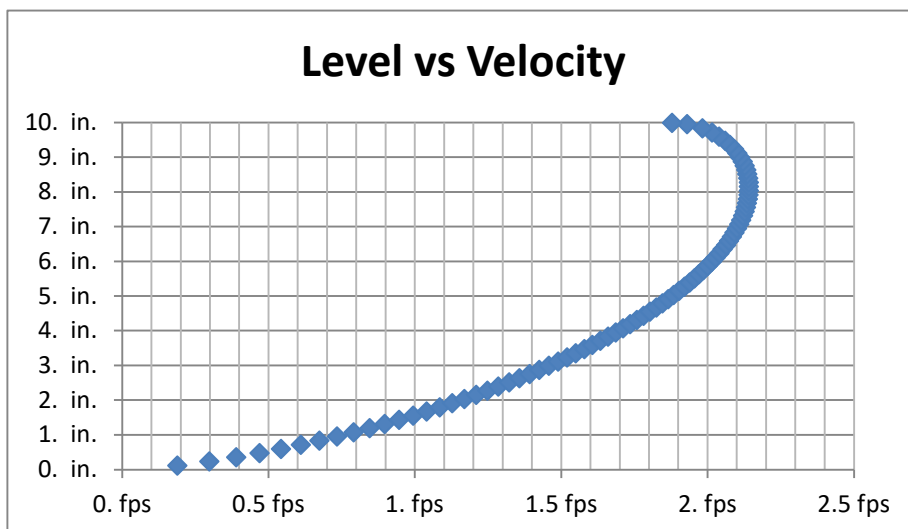
R = hydraulic radius, defined as the wetted area (ft²) divided by the wetted perimeter (ft)

S = hydraulic slope

The scatter plot from the Pleasant Way MH (City MH 25) shows the depth vs. velocity data points for the 10-inch downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. Using velocities (v) from this study in conjunction with the associated cross-sectional areas (A) computed using the monitored levels, the flow (Q) was calculated (Q=vA).

In order to derive the slope, the average level from the study was put into Manning's Equation ($v = 1.486/n \times R^{2/3} \times S^{1/2}$) and the slope was changed until the resulting velocity equaled the average velocity from the study. So, the calculated slope is based on the average flow data observed during the study, which at Pleasant Way MH 25 correlated with a theoretical hydraulic operating curve with a slope of ~0.22% (S= 0.002174656).

Figure 12 at right: This theoretical pipe curve was generated for a 10-in (0.83-ft) pipe with a slope of ~0.22%.



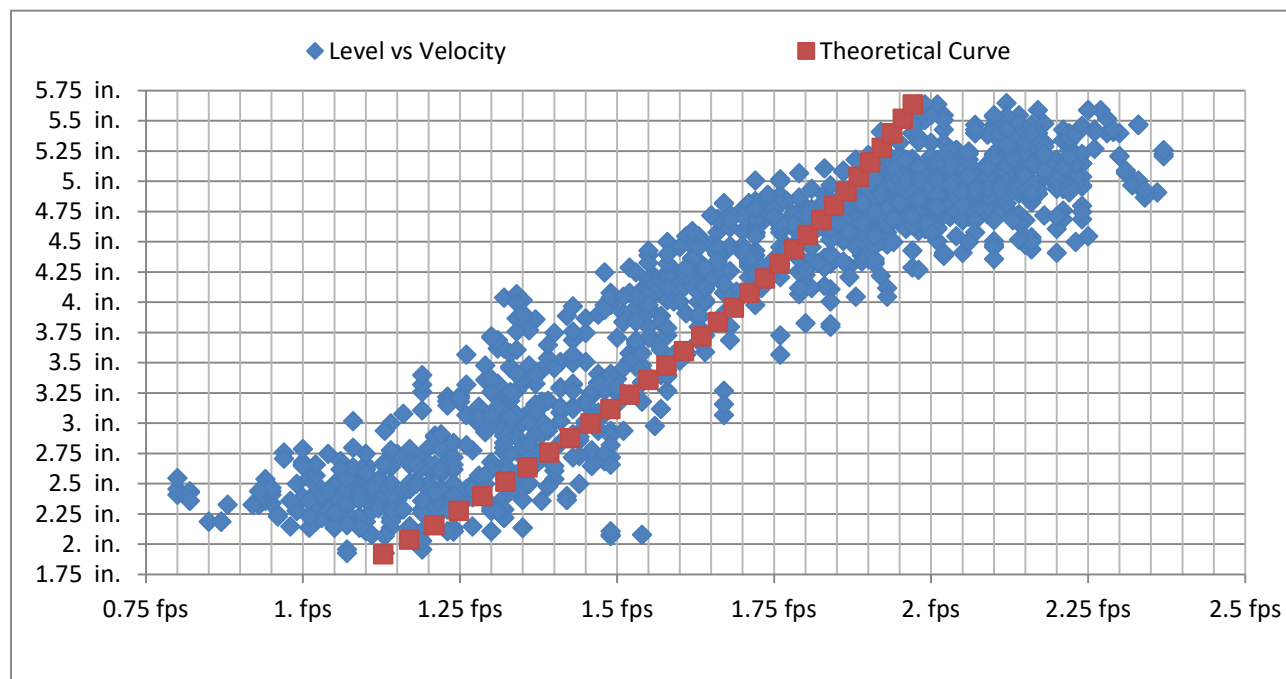


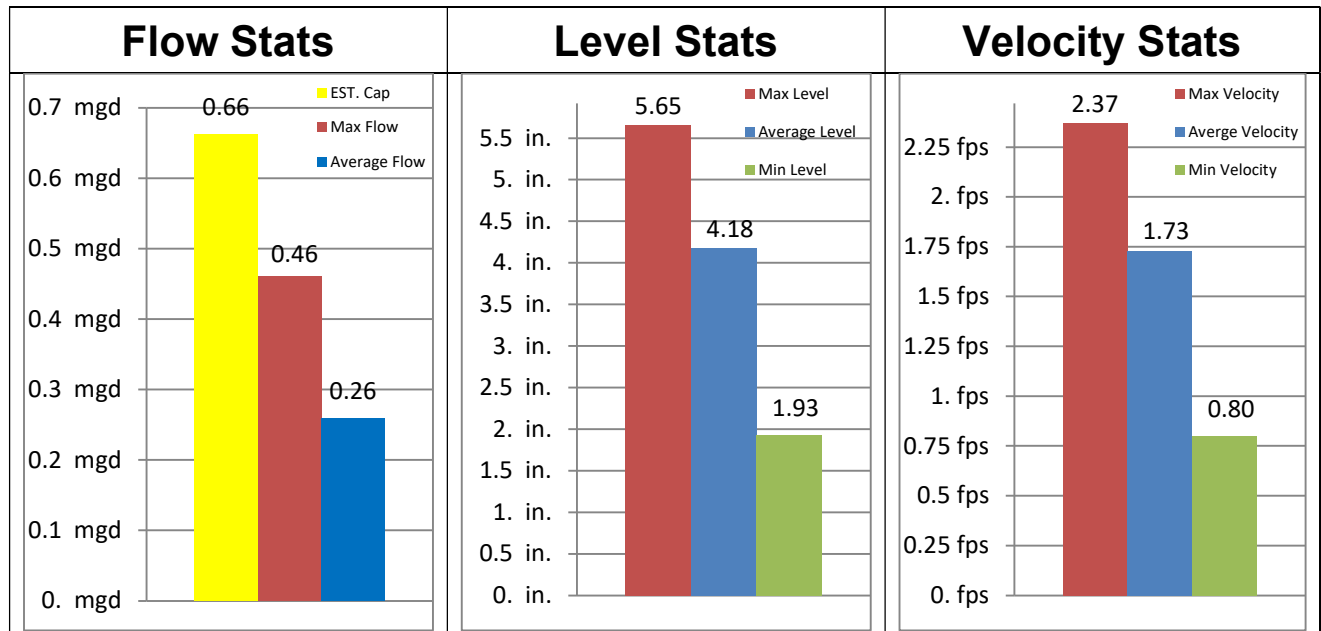
Figure 13 above: The scatter plot contains all of the data points collected at a 15-min collection interval over the entirety of the study. Since the flows at MH 25 utilized ~19% to ~57% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, almost all of the data falls into an acceptable area along the theoretical curve; however, the level to velocity relationship is slightly skewed.

To summarize the site statistics from the data analysis at 2021.02 Pleasant Way MH:

- During peak flows (Q_{PF}), 0.4606 million gallons per day (mgd) or ~320 gallons per minute (gpm) utilized ~70% of the pipe's capacity.
- During average flows (Q_{AF}), 0.2585 mgd or ~180 gpm utilized ~39% of the pipe's capacity.
- According to common practice in sewer system design, velocities need to exceed 2.0 fps a minimum (min) of once per day to provide sufficient scouring action for self-cleaning. The maximum velocity at MH 25 was 2.37 fps with an average velocity of 1.73 fps. Since velocities exceeded 2.0 fps every day during this study, the site is not expected to have issues with regard to settlement of normal system solids.
- According to common practice in sewer system design, the depth versus diameter (d/D) ratio for gravity drains of less than 15 inches in diameter should be no greater than 0.50 for the ultimate peak flow condition. The average d/D ratio for the site during this study was ~0.42 and the maximum was ~0.57. Therefore, this 10-in pipe exceeds the d/D ratio limitation of 0.50 under peak flow conditions.

The following is a graphical representation of site statistics (stats) from the data analysis:



The pipe capacity was estimated using a Manning’s Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with LACDPW standards for a vitrified clay sewer pipe (VCP) with manholes, inlets, etc.). From the theoretical hydraulic operating curve for a 10-in pipe with a slope of $\sim 0.22\%$ ($S = 0.002174656$), with the pipe completely full, the velocity is expected to be ~ 1.8785 fps. When this velocity is input into the Flo-Ware program from City MH 25, a maximum capacity of ~ 0.6622 mgd is produced. This is a reasonable assumption based on the levels and velocities observed during this study.

2021.02 Pleasant Way MH Level (depth) vs Pipe Diameter

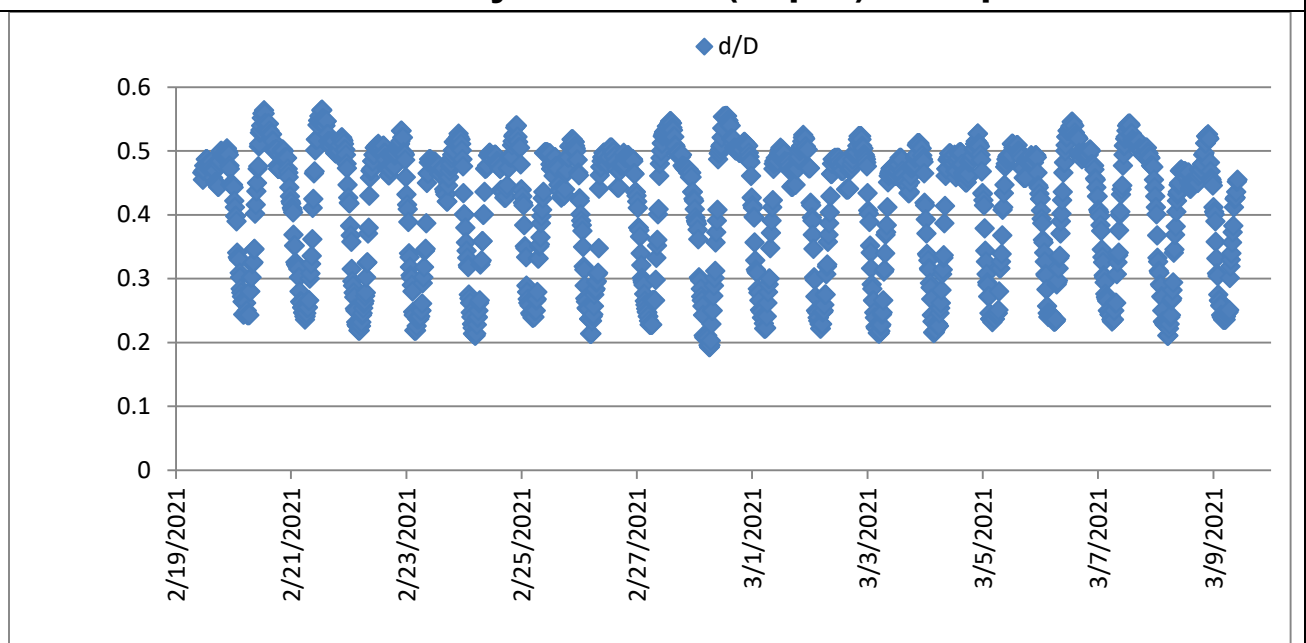
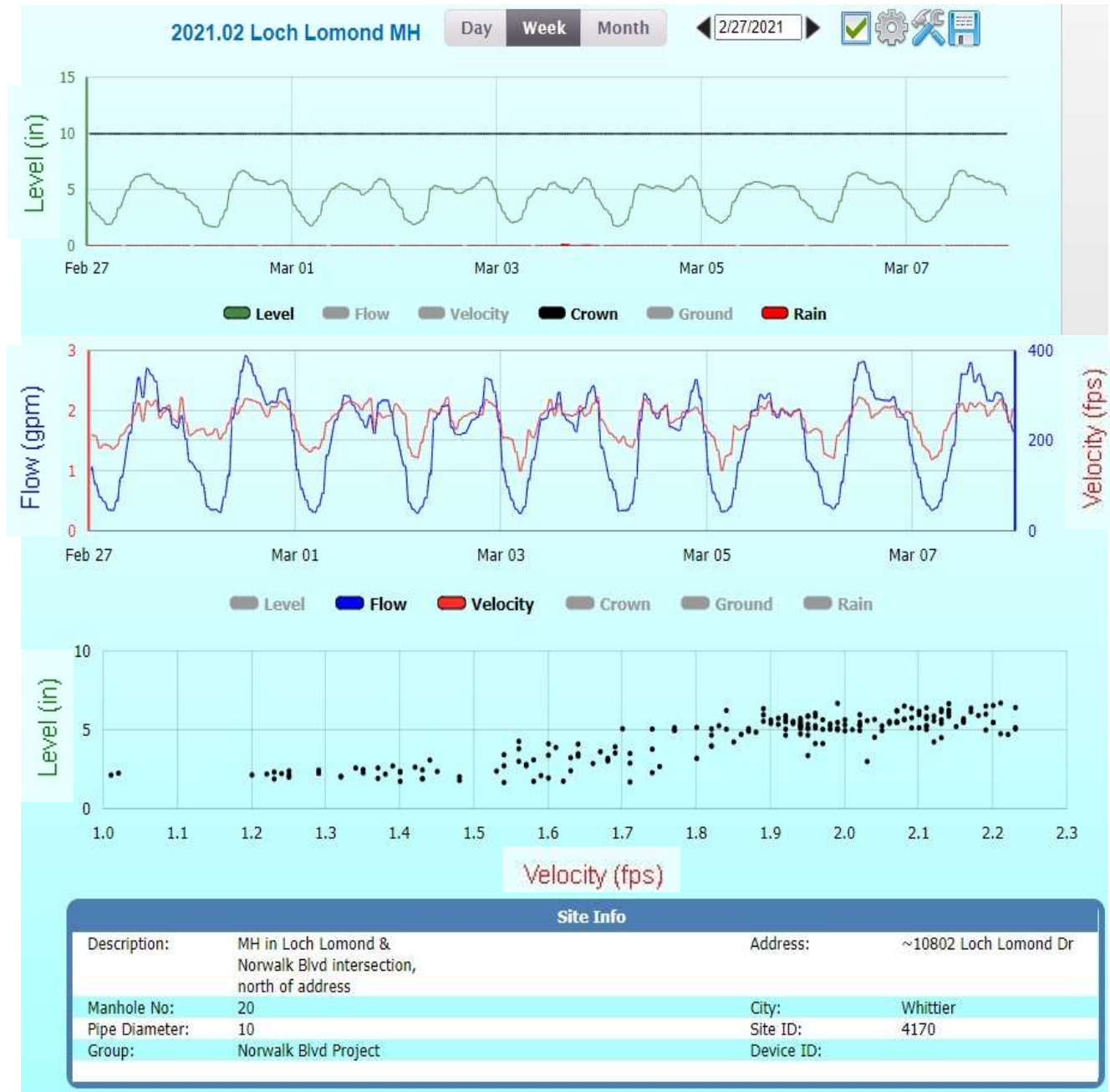


Figure 14 below: 2021.02 Loch Lomond MH graphs of level, flow & velocity, and scatter plot of level in relation to velocity from US³ Flow Monitoring Website (<http://us3.uscubed.com/>)



The scatter plot above shows the depth vs velocity data points for the 10-in downstream pipe, which should resemble a theoretical hydraulic operating curve based on the site-specific characteristics of the pipe. Monitored velocities and levels were compared to theoretical hydraulic operating curves at different slopes, which led to the conclusion that the data best resembled a curve with the slope of ~0.23% ($S=0.0022650937$) at Loch Lomond MH (City MH 20).

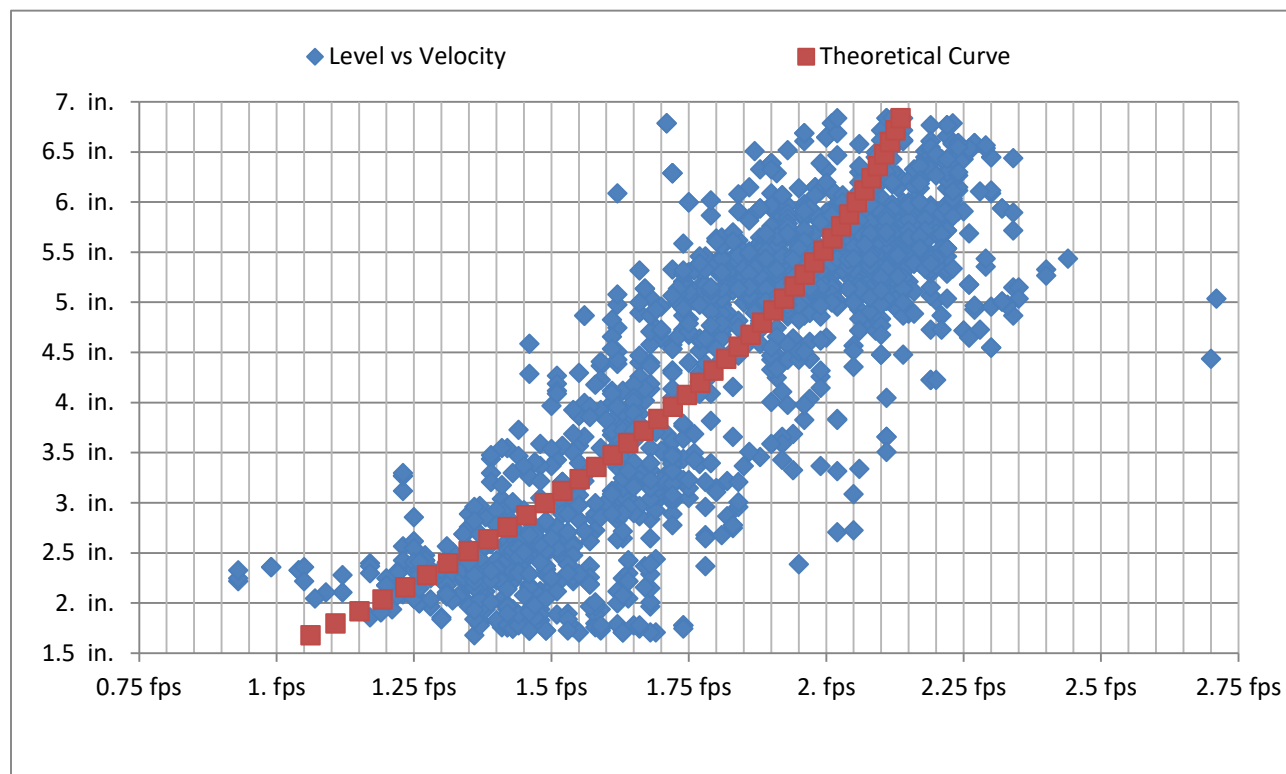


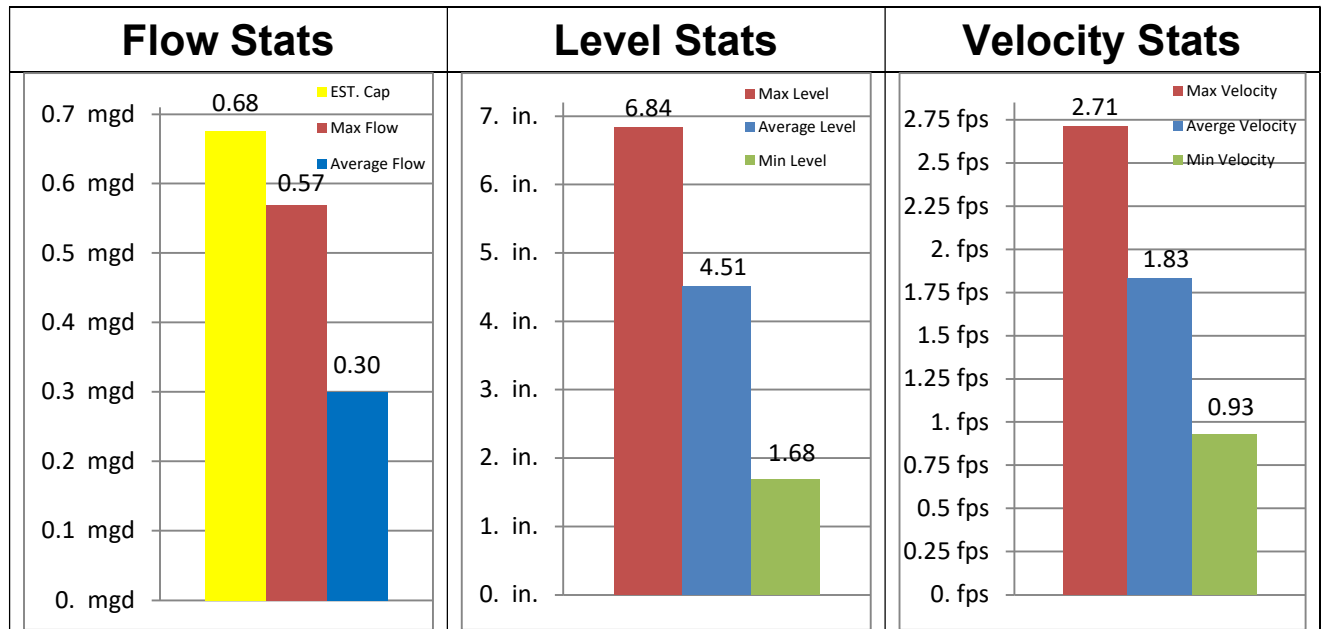
Figure 15 above: The scatter plot contains all of the data points collected at a 15-min collection interval over the entirety of the study. Since the flows at MH 20 utilized ~17% to ~68% of the pipe depth during the study, that portion of its theoretical curve has been overlaid onto its scatter plot.

As shown in the scatter plot above, while a majority of the data falls into an acceptable area along the theoretical curve, this data set has more of a cloud formation, which is indicative of processed or non-conforming flow. This is flow that does not conform to the theoretical level-velocity relationship expected under free-flow conditions, such as what occurs during dumping, jetting, pumping, etc. This type of flow is more common in commercial and industrial areas because they are more likely to generate processed flows.

To summarize the site statistics from the data analysis at 2021.02 Loch Lomond MH:

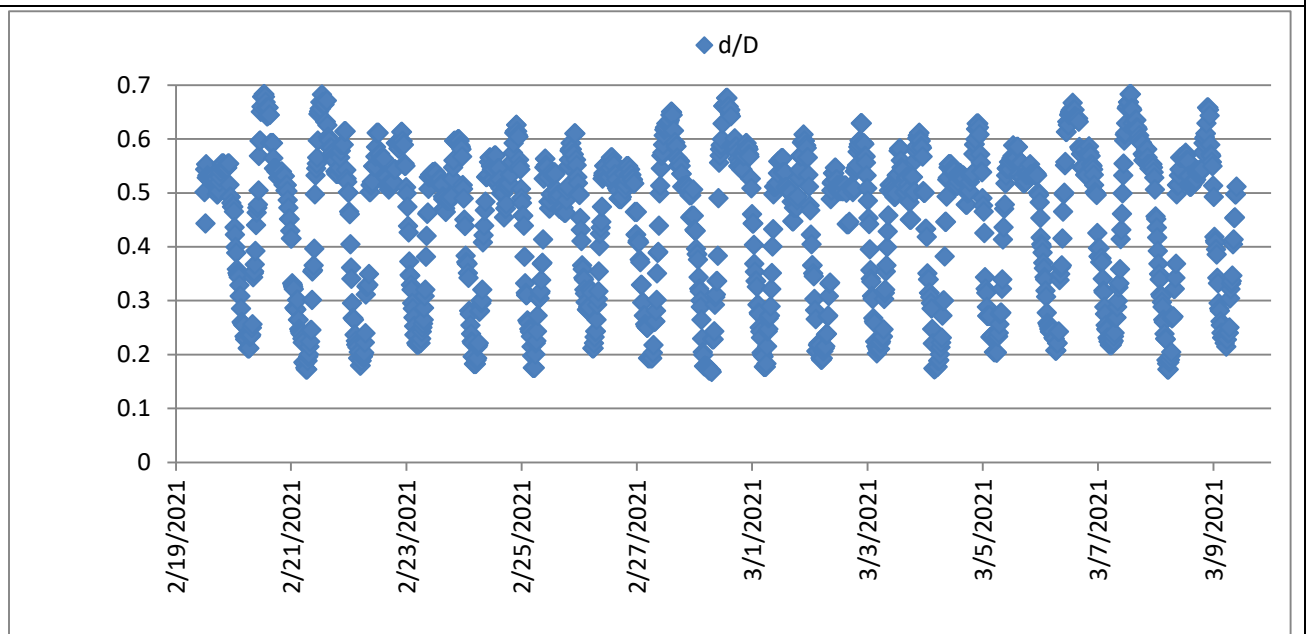
- During Q_{PF} , 0.5687 mgd or ~395 gpm utilized ~84% of the pipe's capacity.
- During Q_{AF} , 0.2999 mgd or ~208 gpm utilized ~44% of the pipe's capacity.
- The maximum velocity at City MH 20 was 2.71 fps with an average velocity of 1.83 fps. Since velocities exceeded 2.0 fps every day during this study, the site is not expected to have issues with regard to settlement of normal system solids.
- The average d/D ratio for the site during this study was ~0.45 and the maximum was ~0.68. Therefore, this 10-in pipe exceeded the d/D ratio limitation of 0.50 under peak flow conditions.

The following is a graphical representation of the site statistics from the data analysis:



The pipe capacity was estimated using a Manning’s Circular Pipe Flow Capacity chart, where $n=0.013$ (in accordance with LACDPW standards for a VCP with manholes, inlets, etc., Chow 1959). From the theoretical hydraulic operating curve for a 10-in pipe with a slope of $\sim 0.23\%$ ($S=0.0022650937$), with the pipe completely full, the velocity should be ~ 1.9172 fps, which when input into the Flo-Ware program from City MH 20 produced a maximum capacity of 0.6758 mgd. This is a reasonable assumption based on the levels and velocities observed during this study.

2021.02 Loch Lomond MH Level (depth) vs Pipe Diameter



1.6 Proposed Flow Generation

This sewer system assessment was developed under conditions existing between 2/19/2021 and 3/09/2021 to analyze for potential capacity limitations in the monitored lines, which includes the anticipated effects of the proposed project at 6018 Norwalk Blvd in Whittier (APN 8174-041-028). The proposed project consists of demolishing the existing retail and residential buildings and replacing them with new retail spaces and 19 residential units currently referred to as Golden Oaks Senior Living.

Mean loading per unit of usage has been calculated in accordance with estimated average daily sewage flows provided by the Los Angeles County Department of Public Works. Therefore, based on the appropriate flow in gallons per day (gpd) per unit of occupancy (UO), the proposed flow generation was calculated as follows:

- (17) 1-bedroom dwelling unit (DU) x 200 gpd/DU = 3400 gpd = 0.0034 million gallons per day (mgd)
- (2) 2-bedroom DU x 250 gpd/DU = 500 gpd = 0.0005 mgd
- 1400 ft² retail space x 100 gpd/1000 ft² = 140 gpd = 0.00014 mgd

Table 1 below is a summary of the estimated flow to be generated by the proposed project. In accordance with LACDPW sewer capacity study requirements, the peaking factor used to determine Q_{PF} for sewer diameters less than 15 inches is 2.5.

User Category	Number of UOs	Q_{AF} per UO (gpd)	Total Q_{AF} (gpd)	Total Q_{AF} (mgd)	$2.5 \times Q_{AF} =$ Total Q_{PF} (mgd)
Residential: Condo – 1 Bedroom	17	200	3400	0.00340	0.00850
Residential: Condo – 2 Bedroom	2	250	500	0.00050	0.00125
Retail: Shops & Stores	1400	100	140	0.00014	0.00035
Total					0.01010

Therefore, the estimated peak flow generated by the proposed Project is ~0.0101 mgd or 0.0156 cfs. In the next section, this flow will be added to the peak flow observed during this study to determine the adequacy of available sewer capacity.

1.7 Conclusions

Calculations in this report are based on steady uniform flow with steady flow defined as the discharge being constant with time, and uniform flow defined as the slope of the water surface and cross-sectional flow area being constant in the length of pipe analyzed. Using velocities from this study in conjunction with the associated cross-sectional areas depicted by the monitored levels, the flow was calculated using the Continuity Equation, and the slope was derived using Manning's Equation. The capacity of each monitored 10-inch pipe was different because the calculated slopes were different based on the average levels and velocities observed during this study.

Field crews installed the equipment on 2/19/2021. Gas levels at all of the sites were well within safety limits throughout the study, typically with O₂ at 20.9% and no detectable traces of LEL, H₂S or CO. Flow monitoring equipment at each site was calibrated using site-specific characteristics and manual level and velocity readings for adjustment and verification.

Follow-up on the installations confirmed equipment was reading properly at both sites. A final field calibration check was performed at the sites prior to removing the equipment on 3/09/2021. In addition, all of the equipment went through diagnostic testing before and after the study with less than a 1% deviation between manual and meter level readings and less than a 5% deviation between manual and meter velocity readings. Therefore, equipment calibration was verified in accord with manufacturer specifications.

2021.02 Pleasant Way MH: The graphs for this site showed a fairly consistent daily flow pattern with a good level to velocity relationship. In addition, velocities exceeded the minimum requirements to provide sufficient scouring action for self-cleaning.

In order to determine the maximum allowable flow within the monitored pipe segment, the calculated slope based on the average flow data observed during the study (~0.22%) was used to generate a theoretical hydraulic operating curve for the 10-in pipe. At half pipe (5 inches), the velocity from the theoretical curve was ~1.8784 fps, which when input into the Flo-Ware program from City MH 25 produced an expected capacity of ~0.3311 mgd (0.5123 cfs). Since peak flow was 0.4606 mgd (0.7127 cfs), there is no capacity available because the pipe had already exceeded its d/D limit of 0.50 at peak flow.

As previously stated, the calculated slope is based on the average flow data observed during the study, so it is important to note that the calculated capacity of this sewer line is a slightly conservative estimate due to the slightly skewed level to velocity relationship at this site. This is a reasonable assumption since the average maximum velocity from the study (2.25 fps) coincided with an average level of ~5.15 inches, and according to the theoretical curve, the velocity at 5.1572 inches should be 1.9013 fps, which is a difference of 15.5%.

2021.02 Loch Lomond MH: The graphs for this site showed fairly consistent daily levels, but the velocities were more erratic. However, velocities did exceed the minimum requirements to provide sufficient scouring action for self-cleaning.

In order to determine the maximum allowable flow within the monitored pipe segment, the calculated slope based on the average flow data observed during the study (~0.23%) was used to generate a theoretical hydraulic operating curve for the 10-in pipe. At half pipe (5 inches), the velocity from the theoretical curve was ~1.9170 fps, which when input into the Flo-Ware program from City MH 20 produced an expected capacity of ~0.3379 mgd (0.5228 cfs). Since peak flow was 0.5687 mgd (0.8799 cfs), there is no capacity available because the pipe had already exceeded its d/D limit of 0.50 at peak flow.

The average maximum velocity at this site was 2.31 fps, which coincided with an average level of ~5.55 inches, and according to the theoretical curve, the velocity at 5.5518 inches should be 1.9995 fps, which is a difference of 13.44%. As with City MH 25, the data was skewed on the conservative side where the data tends toward greater velocities at higher levels than that of the theoretical curve.

According to Visual Crossing Weather Data, the only measurable rain event during the study in this monitoring site's zip code occurred on 3/03/2021 (0.47 inches), but no conclusive evidence of infiltration or inflow was noted at either monitoring site.

Table 2 below is a summary of the flow data with regard to the d/D capacity limit of 0.50.

Existing + Proposed Flow Information	Q _{PF} (mgd)	Proposed Q _{PF} (mgd)	Total Q _{PF} (mgd)	Estimated Half Pipe Capacity (mgd)	Available Capacity (mgd)	Total Q _{PF} d/D
Pleasant Way MH 25	0.4606	0.0101	0.4707	0.3311	0	0.62
Loch Lomond MH 20	0.5687		0.5788	0.3379	0	0.71

The following procedure was used to calculate the Total Q_{PF} d/D. Using the calculated slope from City MH 25 (~0.22%) to generate a theoretical hydraulic operating curve for the 10-in pipe, at 6.2289 inches, the velocity is expected to be 2.0390 fps, which when input into the Flo-Ware program from City MH 25 produced the expected flow of 0.4707 mgd, and d/D = 6.2289/10 = 0.6229.

The same method was used for calculating the d/D for City MH 20. Using the calculated slope (~0.23%) to generate a theoretical hydraulic operating curve for the 10-in pipe, at 7.1245 inches, the velocity is expected to be 2.1544 fps, which when input into the Flo-Ware program from City MH 20 produced the expected flow of 0.5788 mgd, and d/D = 7.1245/10 = 0.7124

Tab 2: Calibration Site Sheets & Flo-Ware Graphs



Pickard Architects

MH at ~6014 Norwalk Blvd

Whittier, CA 90606

2021.02 Pleasant Way MH

MH # 25

Access:

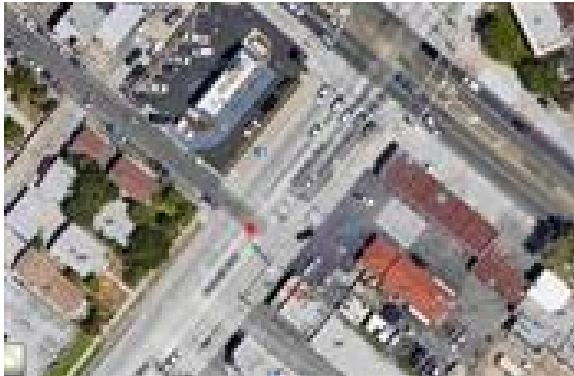
MH in Norwalk & Pleasant Way intersection, NW of address

System Type:

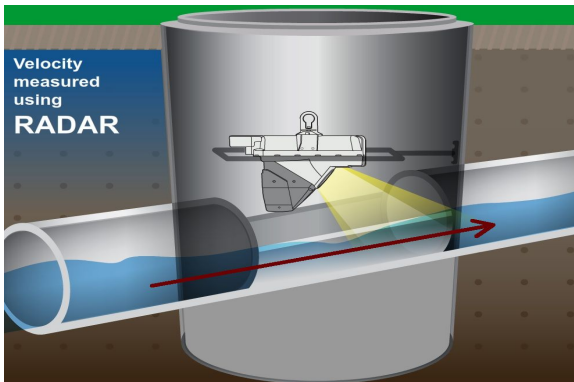
Sanitary Storm

Install Date: 2/19/2021

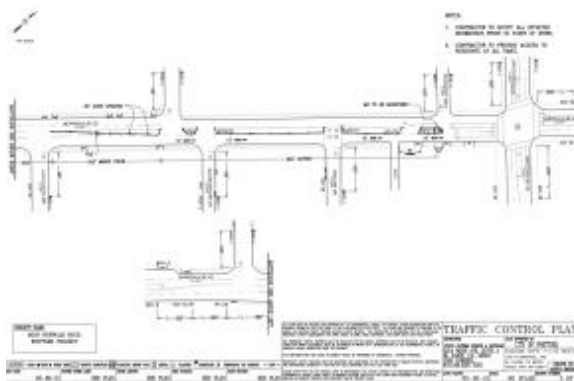
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 84"

MH Coordinates: 33.989530, -118.064406

Moderate open channel hydraulics with some turbulence due to inflow from lateral

Avg Velocity	Avg Measured Level	Multiplier
1.75 fps	4.2"	1.0

Gas

O2	H2S	CO	LEL
20.9	0	0	0

Notes

Two inlets from NE & NW; monitored downstream line to get total flow.

Traffic Safety

Used arrow board, cones & signs in accord w/approved TCP per site-specific CA MUTCD TC requirements.

Land Use

Residential	Commercial	Industrial	Trunk
X			

Manhole Depth	99"
Monitored Pipe Size	10"
Inner Pipe Size (In/Out)	10"/10"
Pipe Shape	Round
Pipe Condition	Good
Manhole Material	Concrete & brick
Silt	None observed
Velocity Profile Data	Passed
Velocity Profile Taken	0.4 2-D
Sensor Offset	15.04"
Sensor Dist. to Crown	5.04"
Sensor Direction	Downstream
Flow Heading	Southwest <input type="checkbox"/>



Meter Site Document

2021.02 Pleasant Way MH

MH at ~6014 Norwalk Blvd

Whittier, CA 90606

Site



Manhole Before Install



Installation Process



Installed



Upstream



Downstream



Temporary Flow Study

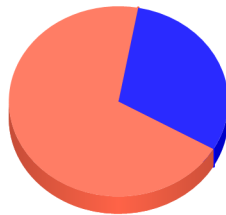
Pickard Architects

2021.02 Pleasant Way MH

Meter Start Date	From	2/19/2021	
Meter Stop Date	To	3/9/2021	
Velocity (fps)	Level (in)	Flow (mgd)	
Average	1.735	4.200	0.261
Maximum	2.370	5.650	0.461
Minimum	0.800	1.930	0.049
Pipe Size	10.000		
Estimated Capacity (mgd)	0.662		
Capacity Used	69.53 %		
Sensor Type	Hach - Flodar		

Estimated Capacity Usage

■ % Capacity Used ■ Estimated Capacity Available



Utility Systems, Science and Software

9314 Bond Av, Suite A
El Cajon, CA 92021

601 N. Parkcenter Dr, Suite 209
Santa Ana, CA 92705



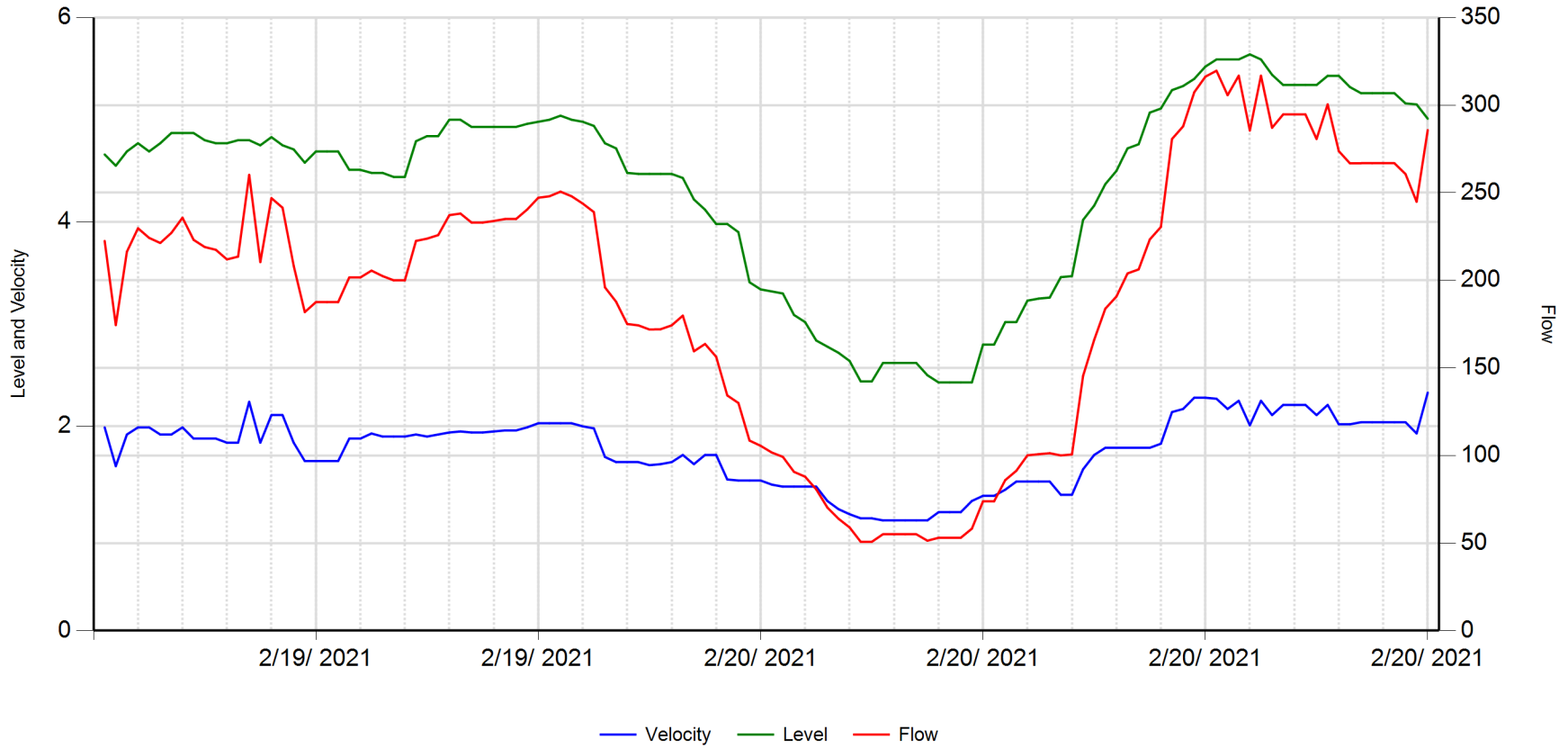


Statistics for 2021.02 Pleasant Way MH: 02/19/2021 thru 03/09/2021

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
2/19/21	212.59	260.21	156.39	0.31	0.37	0.23	1.87	2.24	1.61	4.71	5.04	3.98	306,126	
2/20/21	185.83	319.65	50.76	0.27	0.46	0.07	1.73	2.33	1.08	4.28	5.64	2.43	267,600	
2/21/21	191.40	319.86	36.53	0.28	0.46	0.05	1.72	2.33	0.80	4.34	5.65	2.36	275,613	
Week:	196.61	319.86	36.53	0.28	0.46	0.05	1.77	2.33	0.80	4.44	5.65	2.36	849,339	
2/22/21	183.29	276.46	41.74	0.26	0.40	0.06	1.76	2.24	1.05	4.20	5.32	2.19	263,936	
2/23/21	173.42	281.32	33.89	0.25	0.41	0.05	1.70	2.21	0.85	4.13	5.27	2.19	249,723	
2/24/21	175.83	290.55	43.61	0.25	0.42	0.06	1.71	2.16	0.99	4.16	5.40	2.11	253,189	
2/25/21	172.09	281.67	45.69	0.25	0.41	0.07	1.67	2.23	1.00	4.17	5.18	2.39	247,812	
2/26/21	179.11	276.11	38.89	0.26	0.40	0.06	1.74	2.23	0.95	4.16	5.05	2.14	257,925	
2/27/21	180.82	295.55	41.67	0.26	0.43	0.06	1.72	2.16	0.99	4.21	5.47	2.28	260,387	
2/28/21	185.92	299.03	35.42	0.27	0.43	0.05	1.76	2.31	1.07	4.20	5.55	1.93	267,720	
Week:	178.64	299.03	33.89	0.26	0.43	0.05	1.72	2.31	0.85	4.17	5.55	1.93	1,800,691	
3/1/21	177.39	270.21	41.18	0.26	0.39	0.06	1.70	2.21	1.01	4.20	5.25	2.22	255,447	

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
3/2/21	180.33	289.44	48.61	0.26	0.42	0.07	1.74	2.23	1.08	4.19	5.23	2.22	259,679	
3/3/21	170.63	275.97	39.31	0.25	0.40	0.06	1.69	2.24	0.95	4.08	5.12	2.14	245,713	0.47
3/4/21	178.50	283.54	37.78	0.26	0.41	0.05	1.73	2.23	0.98	4.16	5.27	2.15	257,037	
3/5/21	176.00	274.79	53.54	0.25	0.40	0.08	1.74	2.19	1.17	4.15	5.11	2.32	253,443	
3/6/21	186.04	310.49	38.19	0.27	0.45	0.06	1.74	2.36	0.88	4.24	5.46	2.33	267,896	
3/7/21	184.06	310.62	36.32	0.27	0.45	0.05	1.73	2.29	0.82	4.22	5.43	2.33	265,053	
Week:	178.99	310.62	36.32	0.26	0.45	0.05	1.73	2.36	0.82	4.18	5.46	2.14	1,804,268	0.47
3/8/21	181.28	309.93	46.32	0.26	0.45	0.07	1.85	2.37	1.16	4.02	5.26	2.11	261,043	
3/9/21	104.03	243.96	52.57	0.15	0.35	0.08	1.51	2.25	1.19	3.09	4.55	2.36	149,800	
Week:	142.65	309.93	46.32	0.21	0.45	0.07	1.68	2.37	1.16	3.56	5.26	2.11	410,842	
Totals:	177.82	319.86	33.89	0.26	0.46	0.05	1.73	2.37	0.80	4.15	5.65	1.93	4,865,141	0.47

2021.02 Pleasant Way MH

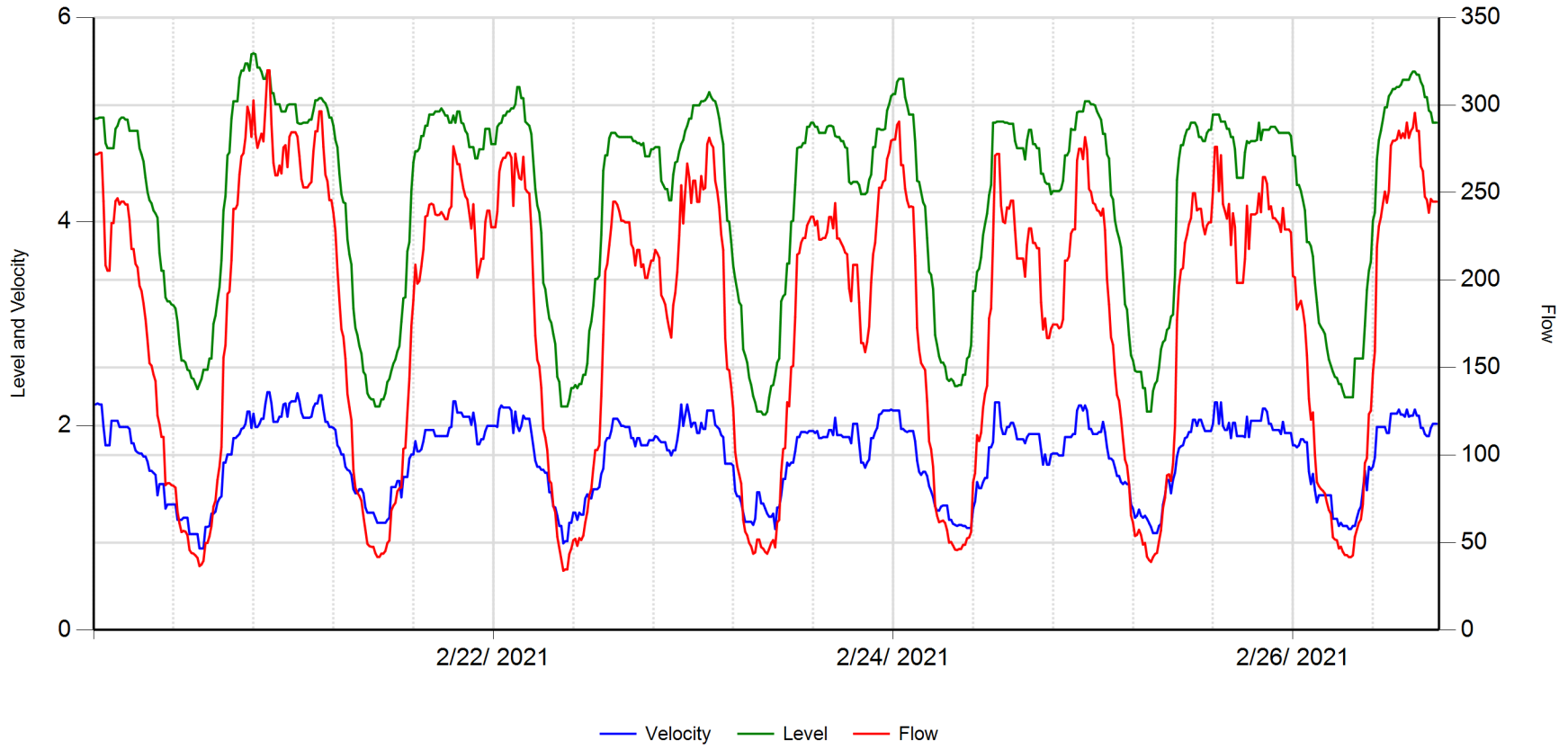


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.763	4.364	190.784	RainFall	Inches
Maximum	2.330	5.640	319.652		
Minimum	1.080	2.430	50.764		




3/12/2021

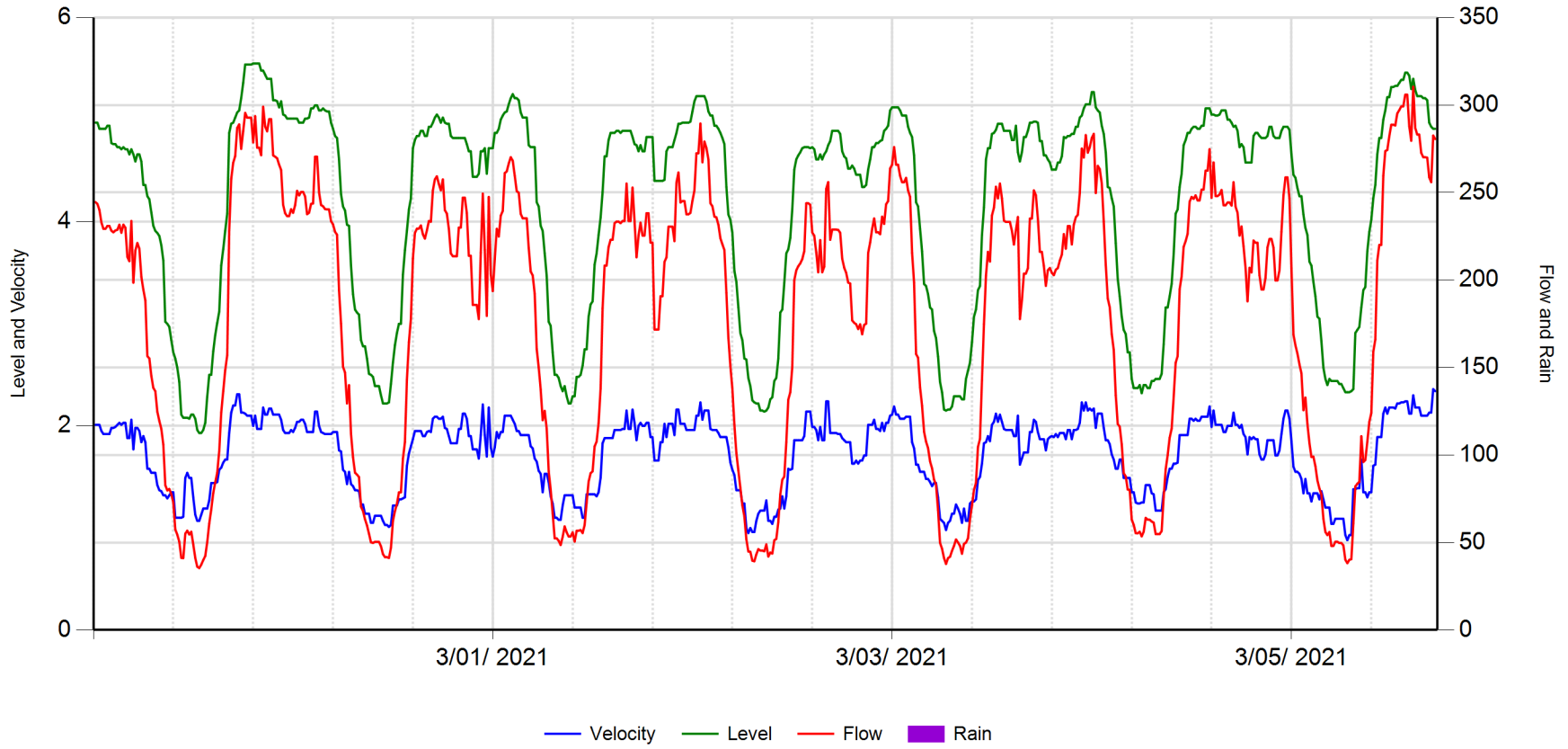
2021.02 Pleasant Way MH



	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.715	4.199	179.696	RainFall	Inches
Maximum	2.330	5.650	319.860		
Minimum	0.800	2.110	33.889		


3/12/2021

2021.02 Pleasant Way MH

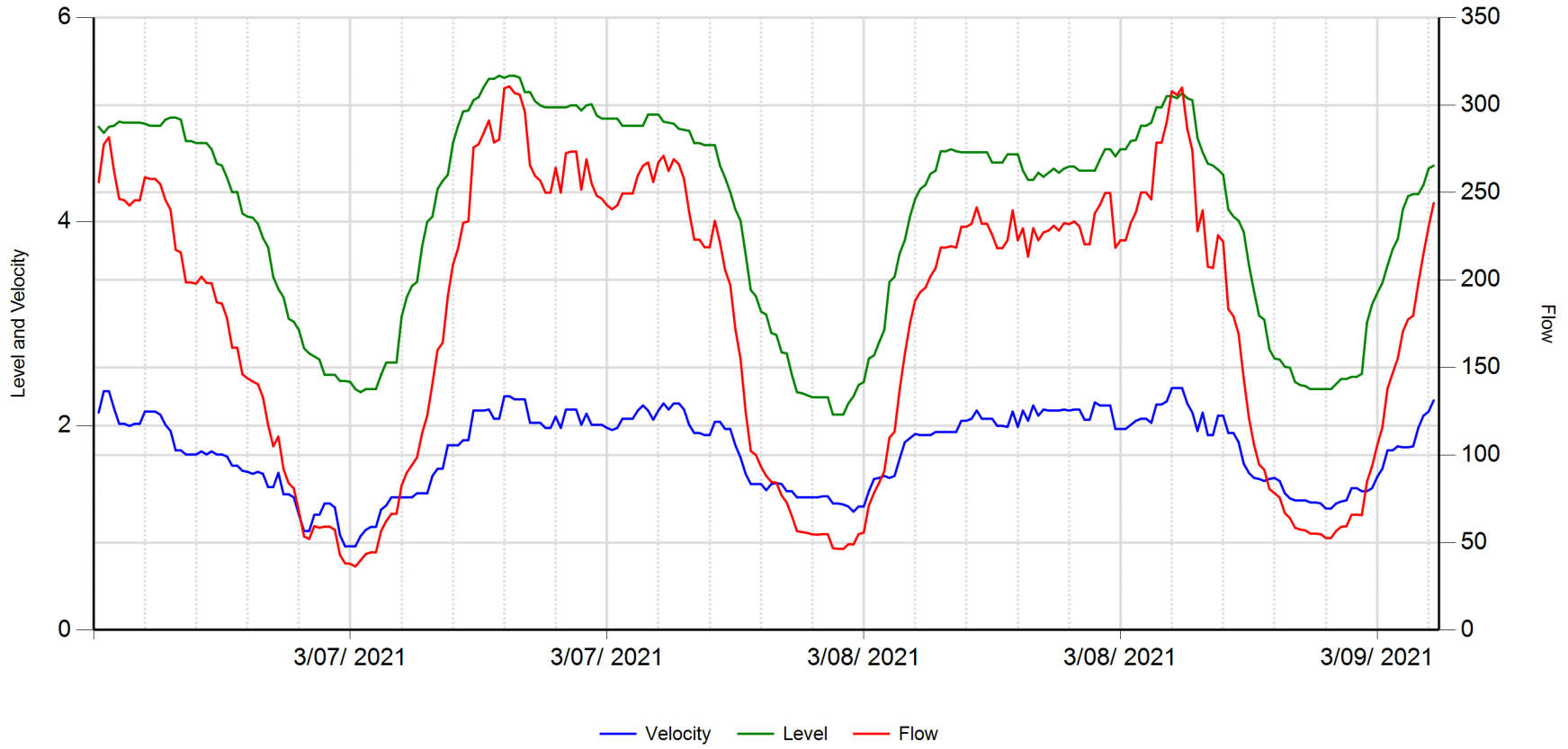


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.729	4.170	178.926	RainFall	Inches
Maximum	2.360	5.550	310.485		
Minimum	0.880	1.930	35.417		0.470




3/12/2021

2021.02 Pleasant Way MH

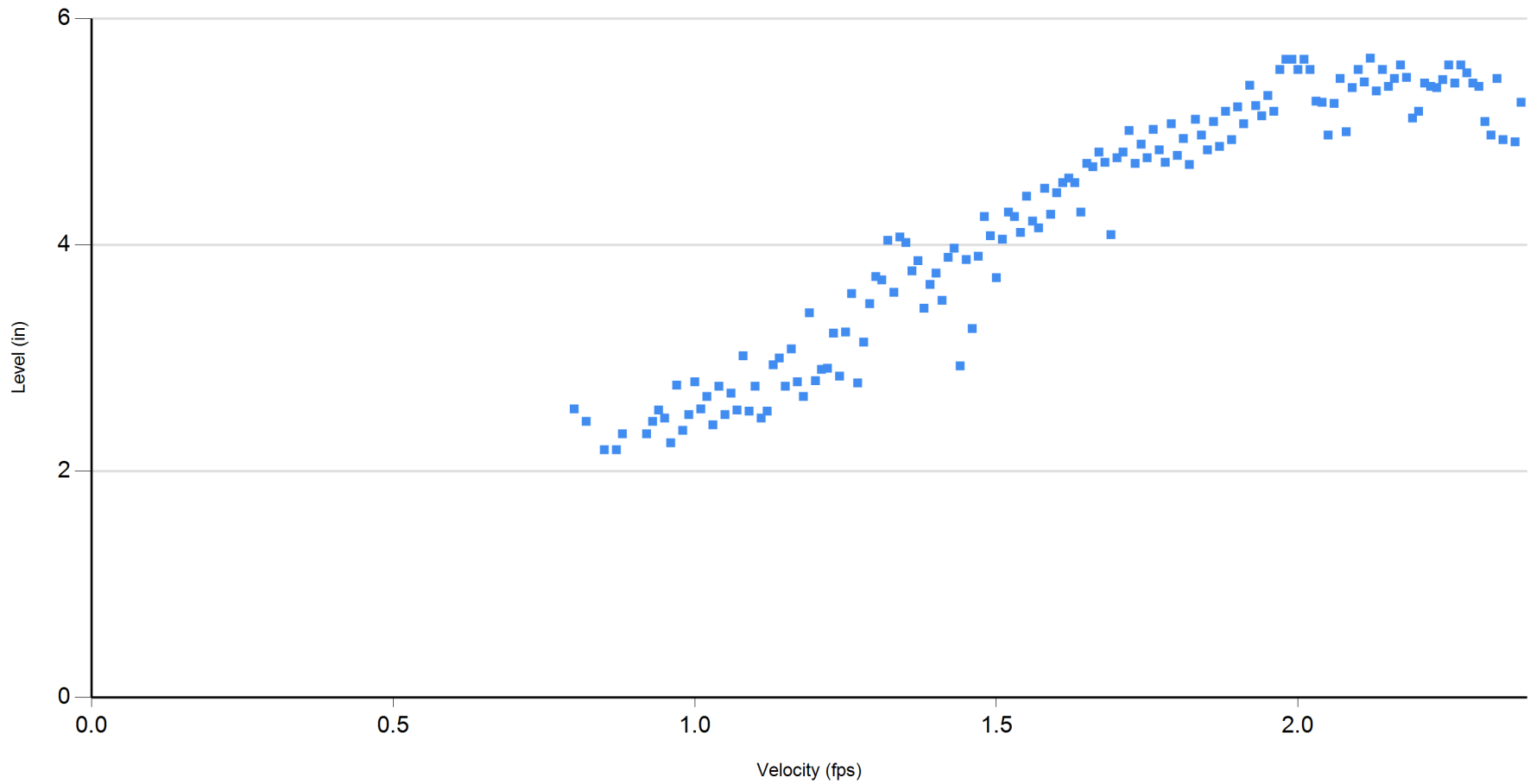


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.759	4.048	175.531	RainFall	Inches
Maximum	2.370	5.430	310.624		
Minimum	0.820	2.110	36.319		



3/12/2021

2021.02 Pleasant Way MH



2/19/2021 thru 3/09/2021



3/12/2021 10:14:40 AM



Pickard Architects

MH at ~10802 Loch Lomond Dr

Whittier, CA 90606

2021.02 Loch Lomond MH

MH # 20

Access:

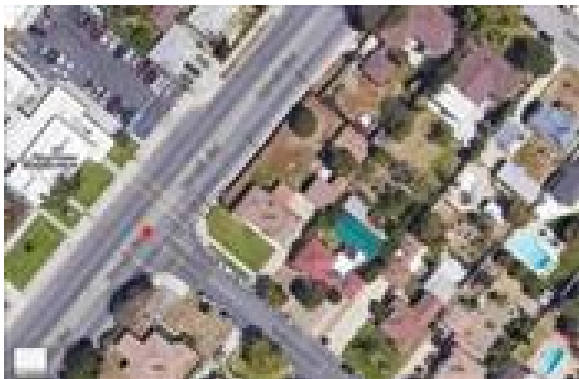
MH in Loch Lomond & Norwalk Blvd intersection, north of address

System Type:

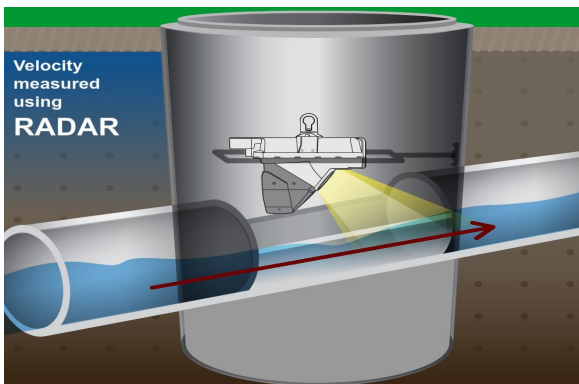
Sanitary Storm

Install Date: 2/19/2021

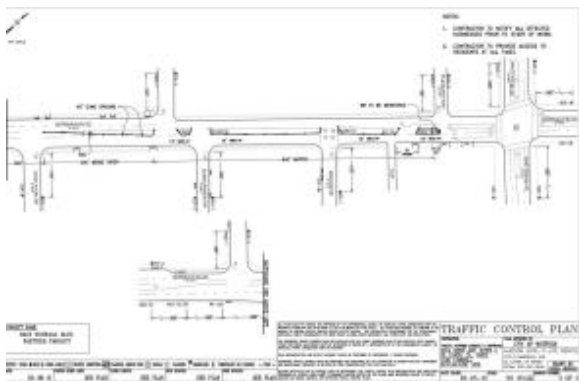
Map



Technology



Traffic Plan



Flow Meter

Meter Depth: 49"			
MH Coordinates: 33.986733, -118.067174			
Moderate open channel hydraulics with some turbulence due to inflow from lateral			
Avg Velocity	Avg Measured Level	Multiplier	
1.8 fps	4.5"	1.0	
Gas			
O2	H2S	CO	LEL
20.9	0	0	0

Notes

Two inlets from NE & SE; monitored downstream line to get total flow.

Traffic Safety

Used arrow board, cones & signs in accord w/approved TCP per site-specific CA MUTCD TC requirements.

Land Use

Residential	Commercial	Industrial	Trunk
X			

Manhole Depth	66"
Monitored Pipe Size	10"
Inner Pipe Size (In/Out)	10"/10"
Pipe Shape	Round
Pipe Condition	Good
Manhole Material	Brick
Silt	None observed
Velocity Profile Data	Passed
Velocity Profile Taken	0.4 2-D
Sensor Offset	17.07"
Sensor Dist. to Crown	7.07"
Sensor Direction	Downstream
Flow Heading	Southwest <input type="checkbox"/>



Meter Site Document

2021.02 Loch Lomond MH

MH at ~10802 Loch Lomond Dr

Whittier, CA 90606

Site



Manhole Before Install



Installation Process



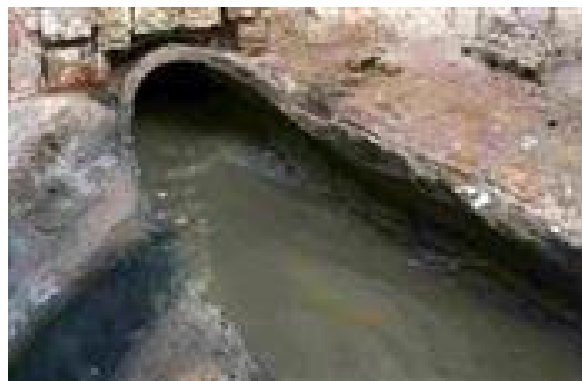
Installed



Upstream



Downstream



Temporary Flow Study

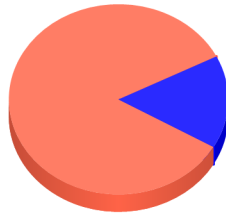
Pickard Architects

2021.02 Loch Lomond MH

Meter Start Date	From	2/19/2021	
Meter Stop Date	To	3/9/2021	
Velocity (fps)	Level (in)	Flow (mgd)	
Average	1.839	4.539	0.303
Maximum	2.710	6.840	0.569
Minimum	0.930	1.680	0.053
Pipe Size	10.000		
Estimated Capacity (mgd)	0.675		
Capacity Used	84.21 %		
Sensor Type	Hach - Flodar		

Estimated Capacity Usage

■ % Capacity Used ■ Estimated Capacity Available



Utility Systems, Science and Software

9314 Bond Av, Suite A
El Cajon, CA 92021

601 N. Parkcenter Dr, Suite 209
Santa Ana, CA 92705

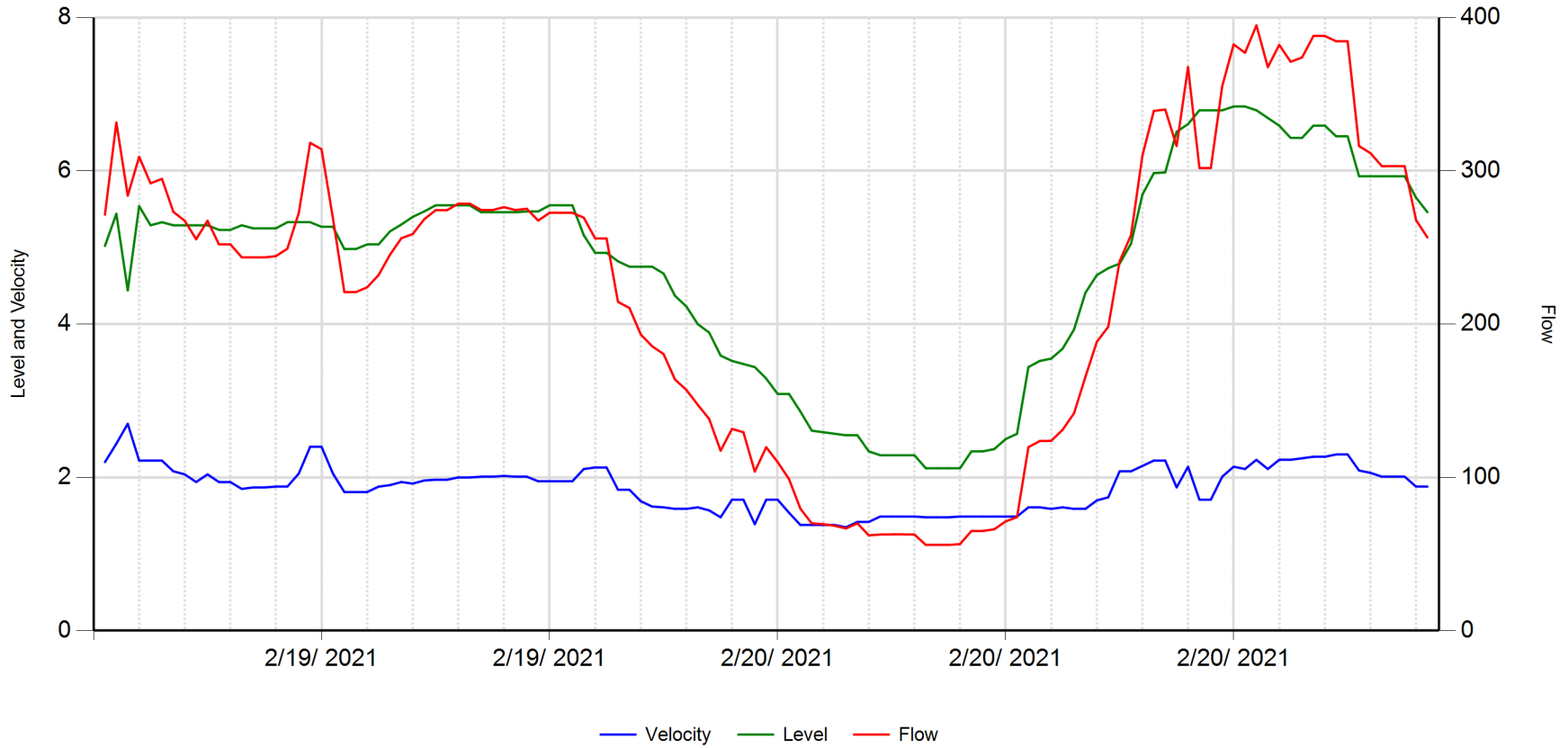


Statistics for 2021.02 Loch Lomond MH: 02/19/2021 thru 03/09/2021

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
2/19/21	254.24	331.53	147.36	0.37	0.48	0.21	1.98	2.70	1.59	5.18	5.55	4.00	366,112	
2/20/21	211.75	394.93	55.97	0.31	0.57	0.08	1.83	2.35	1.35	4.58	6.84	2.12	304,924	
2/21/21	213.74	380.28	36.60	0.31	0.55	0.05	1.81	2.29	1.17	4.60	6.83	1.73	307,792	
Week:	226.58	394.93	36.60	0.33	0.57	0.05	1.87	2.70	1.17	4.79	6.84	1.73	978,828	
2/22/21	208.37	349.65	41.32	0.30	0.50	0.06	1.82	2.22	1.23	4.55	6.14	1.80	300,049	
2/23/21	198.34	333.26	53.47	0.29	0.48	0.08	1.78	2.25	1.23	4.45	6.00	2.19	285,610	
2/24/21	205.15	354.44	42.15	0.30	0.51	0.06	1.81	2.24	1.28	4.52	6.27	1.83	295,411	
2/25/21	198.71	327.29	41.18	0.29	0.47	0.06	1.84	2.33	1.35	4.37	6.11	1.76	286,147	
2/26/21	203.81	308.12	52.01	0.29	0.44	0.07	1.86	2.26	1.37	4.44	5.66	2.12	293,492	
2/27/21	207.80	367.71	45.90	0.30	0.53	0.07	1.81	2.32	1.31	4.54	6.51	1.94	299,231	
2/28/21	223.87	392.43	36.87	0.32	0.57	0.05	1.93	2.22	1.36	4.58	6.77	1.68	322,370	
Week:	206.58	392.43	36.87	0.30	0.57	0.05	1.83	2.33	1.23	4.49	6.77	1.68	2,082,309	
3/1/21	203.94	316.11	40.28	0.29	0.46	0.06	1.85	2.28	1.26	4.40	6.09	1.78	293,677	

	Flow (GPM)			Flow (MGD)			Velocity (FPS)			Level (inches)				
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Total Gal	Rain
3/2/21	203.93	360.35	38.82	0.29	0.52	0.06	1.86	2.71	1.19	4.39	6.30	1.91	293,663	
3/3/21	204.23	330.21	37.57	0.29	0.48	0.05	1.82	2.32	0.93	4.46	6.12	2.03	294,090	0.47
3/4/21	205.32	337.64	40.90	0.30	0.49	0.06	1.84	2.21	1.39	4.45	6.29	1.73	295,658	
3/5/21	199.39	331.94	38.68	0.29	0.48	0.06	1.78	2.23	0.99	4.45	5.89	2.04	287,128	
3/6/21	220.87	389.79	44.86	0.32	0.56	0.06	1.85	2.29	1.22	4.67	6.68	2.08	318,059	
3/7/21	225.01	380.55	42.64	0.32	0.55	0.06	1.84	2.30	1.05	4.73	6.84	2.18	324,018	
Week:	208.96	389.79	37.57	0.30	0.56	0.05	1.83	2.71	0.93	4.51	6.84	1.73	2,106,293	0.47
3/8/21	218.52	389.65	41.53	0.31	0.56	0.06	1.87	2.34	1.39	4.61	6.59	1.73	314,666	
3/9/21	105.57	265.55	46.94	0.15	0.38	0.07	1.49	2.10	1.12	3.14	5.12	2.15	152,020	
Week:	162.04	389.65	41.53	0.23	0.56	0.06	1.68	2.34	1.12	3.87	6.59	1.73	466,685	
Totals:	205.93	394.93	36.60	0.30	0.57	0.05	1.82	2.71	0.93	4.48	6.84	1.68	5,634,116	0.47

2021.02 Loch Lomond MH

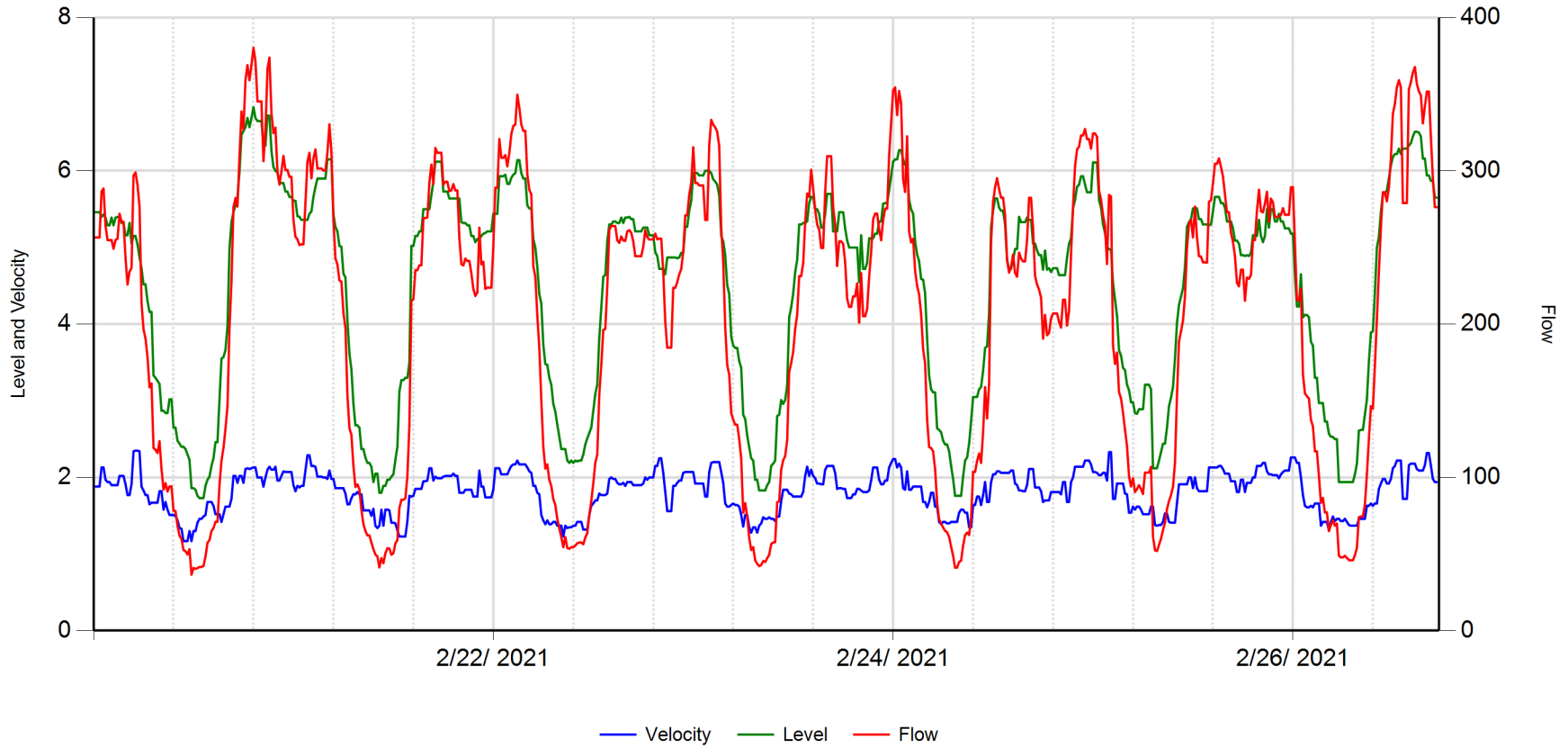


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.866	4.754	224.853	RainFall	Inches
Maximum	2.700	6.840	394.929		
Minimum	1.350	2.120	55.972		




3/12/2021

2021.02 Loch Lomond MH

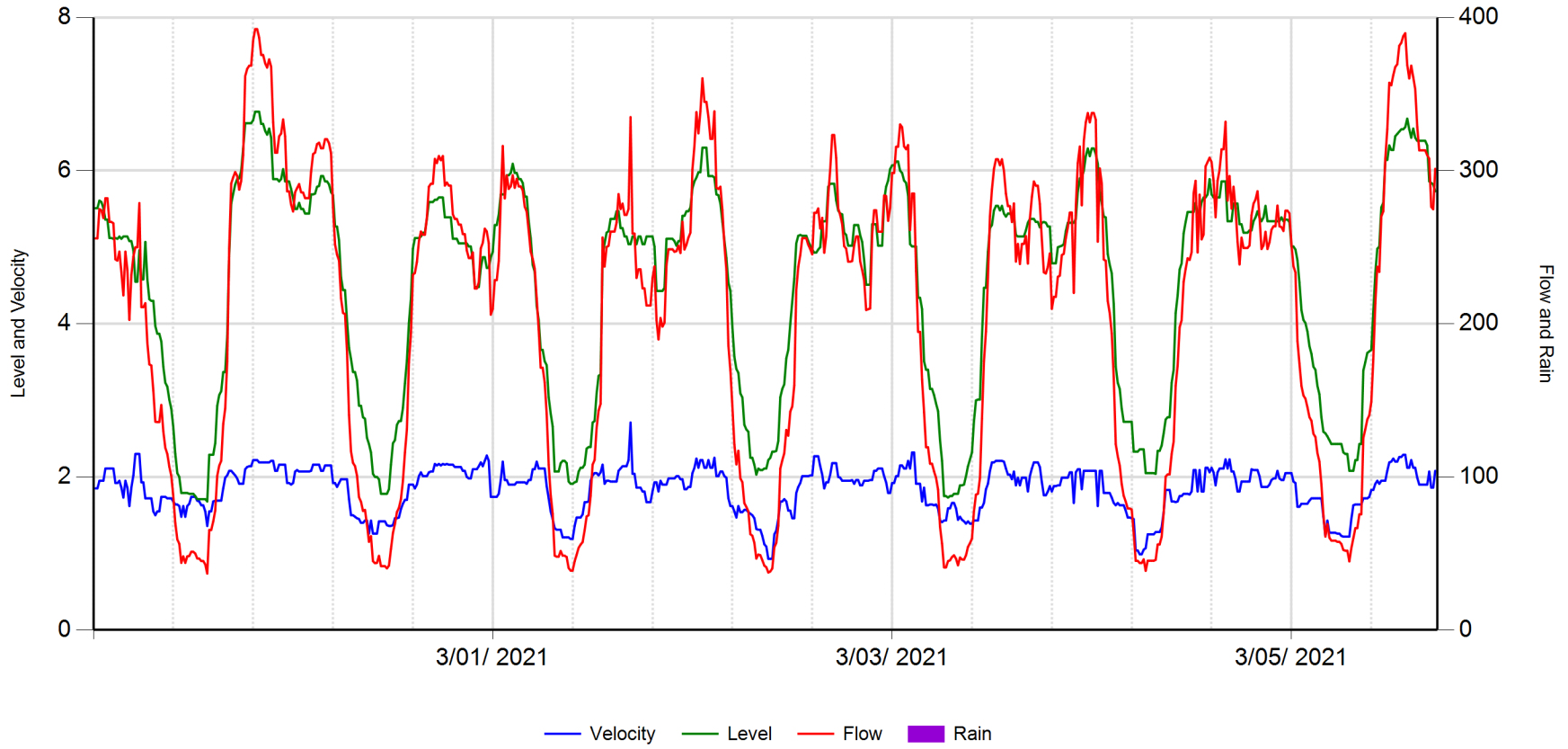


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.819	4.495	205.257	RainFall	Inches
Maximum	2.350	6.830	380.277		
Minimum	1.170	1.730	36.597		



3/12/2021

2021.02 Loch Lomond MH

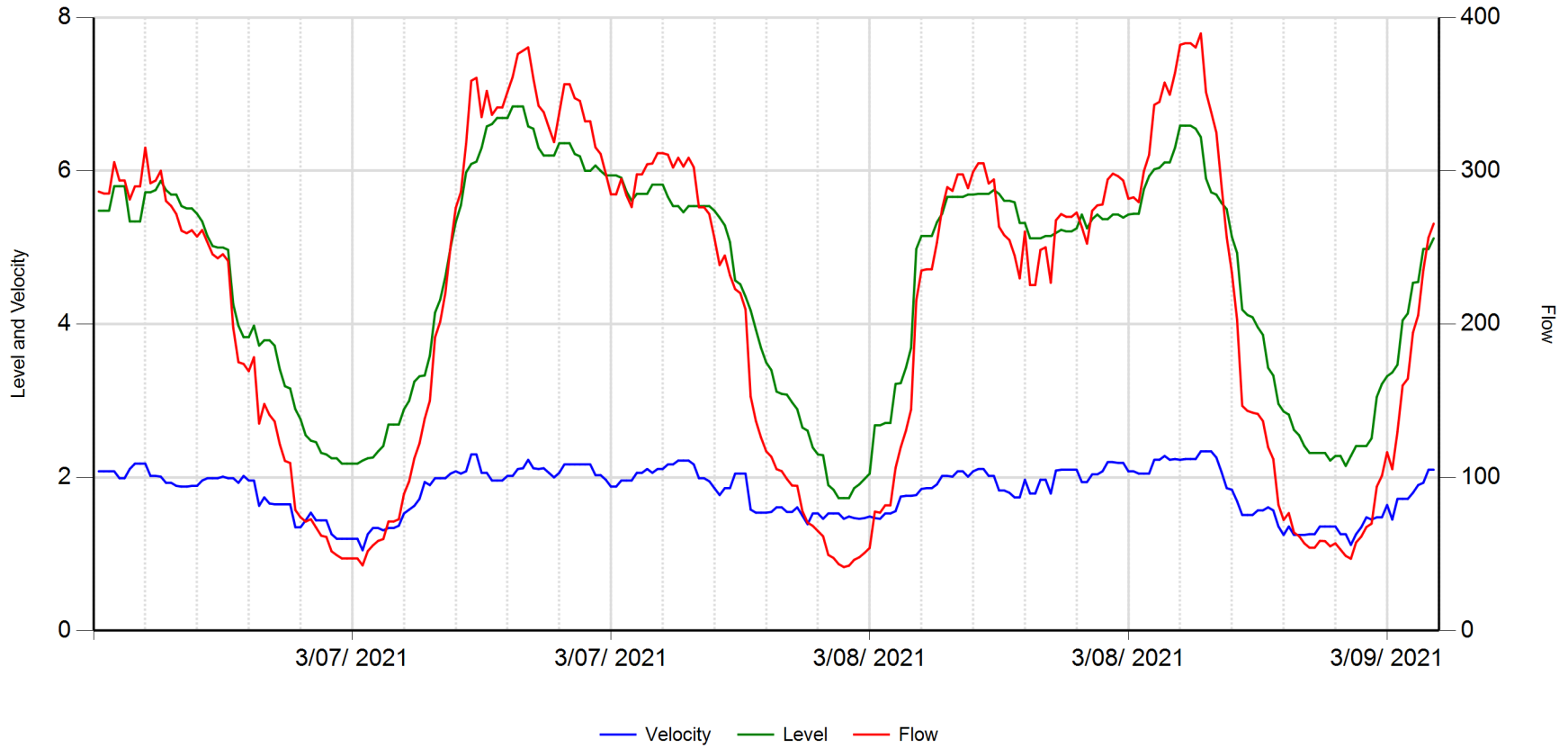


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.842	4.475	207.621	RainFall	Inches
Maximum	2.710	6.770	392.429		
Minimum	0.930	1.680	36.875		0.470



3/12/2021

2021.02 Loch Lomond MH

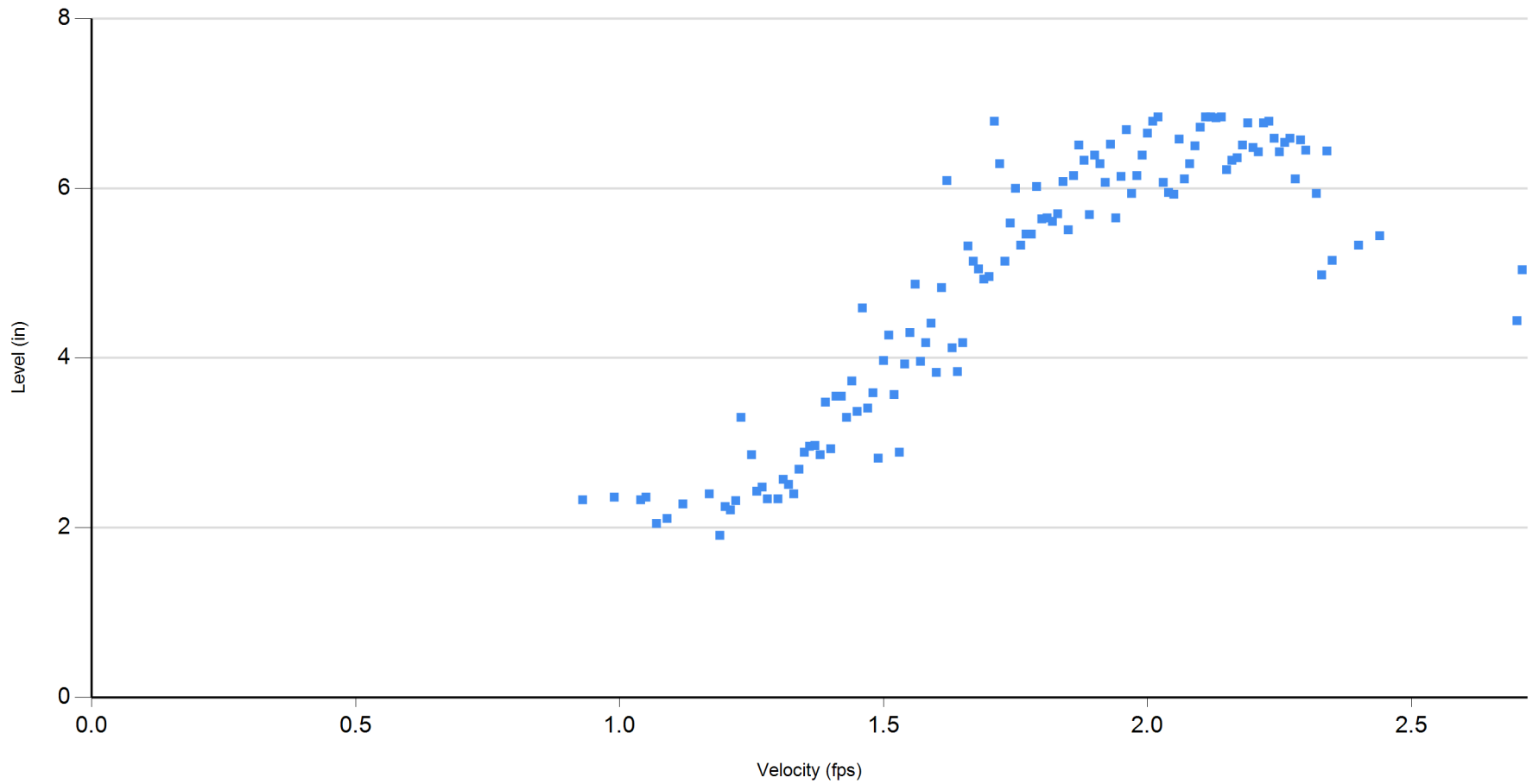


	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.822	4.528	210.323	RainFall	Inches
Maximum	2.340	6.840	389.652		
Minimum	1.050	1.730	41.528		



3/12/2021

2021.02 Loch Lomond MH



2/19/2021 thru 3/09/2021



3/12/2021 10:14:06 AM

Tab 3: Methods & Procedures & Equipment

3.1 Methods and Procedures

Utility Systems Science & Software provided Pickard Architects with an off the shelf, non-proprietary flow monitoring solution that included two state of the art Hach Flo-Dar® AV Sensor systems. The project course of action is listed below. The US³ team:

- Assessed permitting and traffic control at the sites on Norwalk Blvd in Whittier, CA.
- Validated the sites for suitability for sewer flow monitoring.
- Prepared the traffic control plan and obtained a City Encroachment Permit.
- Coordinated with the City, the Los Angeles County Department of Public Works and the Central Maintenance Yard for installation of equipment.
- Installed and removed traffic control in accord with site-specific CA MUTCD requirements for both the installation and removal of equipment.
- Installed and calibrated the flow monitoring equipment per manufacturer recommendations.
- Removed the equipment, validated the data and prepared the data reports.
 - Follow-up on the installations confirmed equipment was reading properly at the site. All of the equipment went through diagnostic testing before and after the study with less than a 1% deviation between manual and meter level readings and less than a 5% deviation between manual and meter velocity readings. Therefore, equipment calibration was verified in accordance with manufacturer specifications.
 - 2021.02 Pleasant Way MH: maximum depth/Diameter (d/D) = ~0.57 and peak flow = ~0.4606 mgd.
 - 2021.02 Loch Lomond MH: maximum depth/Diameter (d/D) = ~0.68 and peak flow = ~0.5687 mgd.

Equipment

Figure at right: Equipment installed for the Sewer Flow Monitoring Study

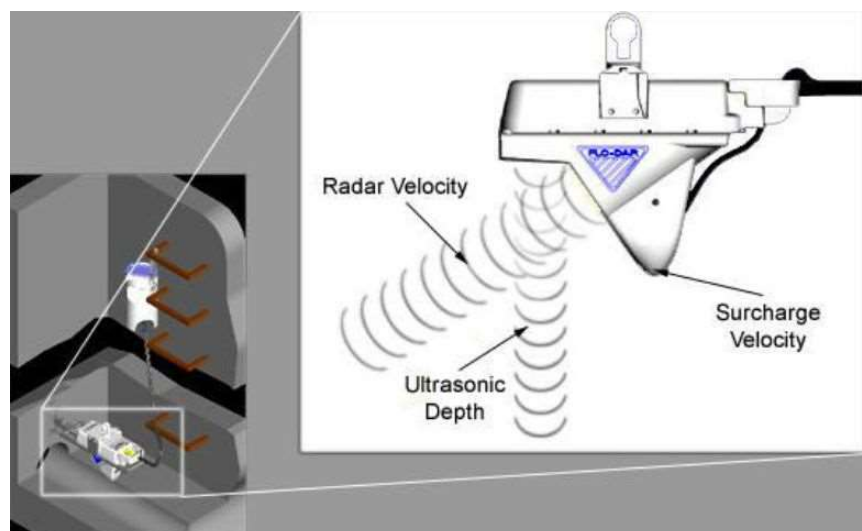




Figure: Web-Enabled Flo-Dar® AV Sensor, Radar-Based Velocity/Area Flow Meter

3.1.1 SPECIFICATIONS

- **Enclosure**
 - IP68 Waterproof rating, Polystyrene
- **Dimensions**
 - 160.5 W x 432.2 L x 297 D mm (6.32 x 16.66 x 11.7 in.),
 - With SVS, D = 387 mm (15.2 in.)
- **Weight**
 - 4.8 kg (10.5 lbs.)
- **Operating Temperature**
 - -10 to 50°C (14 to 122°F)
- **Storage Temperature**
 - -40 to 60°C (-40 to 140°F)
- **Power Requirements**
 - Supplied by FL900 Flow Logger, Flo-Logger, or Flo-Station

- **Interconnecting Cable**
 - Disconnect available at both sensor and logger or Flo-Station
 - Polyurethane, 0.400 (± 0.015) in. diameter; IP68
 - Standard length 9 m (30 ft), maximum 305 m (1000 ft)
- **Cables – available in two styles:**
 - Connectors at both ends
 - Connector from sensor with open leads to desiccant hub, desiccant hub with connector to logger. A potting/sealant kit will be included. This can be used to run the cable through conduit.
- **Certification**
 - Certified to: FCC Part 15.245: FCC ID: VIC-FLODAR24
 - Industry Canada Spec. RSS210. v7: IC No.: 6149A-FLODAR24

SURCHARGE DEPTH MEASUREMENT

- Auto zero function maintains zero error below 0.5 cm (0.2 in.)
- **Method**
 - Piezo-resistive pressure transducer with stainless steel diaphragm
- **Range**
 - 3.5 m (138 in.), overpressure rating 2.5 x full scale

VELOCITY MEASUREMENT

- **Method**
 - Radar
- **Range**
 - 0.23 to 6.10 m/s (0.75 to 20 ft/s)
- **Frequency Range**
 - 24.075 to 24.175 GHz, 15.2 mW (max.)
- **Accuracy**
 - $\pm 0.5\%$; ± 0.03 m/s (± 0.1 ft/s)

DEPTH MEASUREMENT

- **Method**
 - Ultrasonic
- **Standard Operating Range from Flo-Dar® Housing to Liquid**
 - 0 to 152.4 cm (0 to 60 in.)
- **Optional Extended Level Operating Range from Transducer Face to Liquid**
 - 0 to 6.1 m (0 to 20 ft.) with 43.18 cm (17 in.) dead band, temperature compensated.
- **Accuracy**
 - $\pm 1\%$; ± 0.25 cm (± 0.1 in.)

FLOW MEASUREMENT

- **Method**
 - Based on Continuity Equation
- **Accuracy**
 - $\pm 5\%$ of reading typical where flow is in a channel with uniform flow conditions and is not surcharged, $\pm 1\%$ full scale max.

SURCHARGE CONDITIONS DEPTH/VELOCITY DEPTH (Std with Flo-Dar® Sensor)

- **Surcharge depth supplied by Flo-Dar® sensor.**

VELOCITY (Optional Surcharge Velocity Sensor)

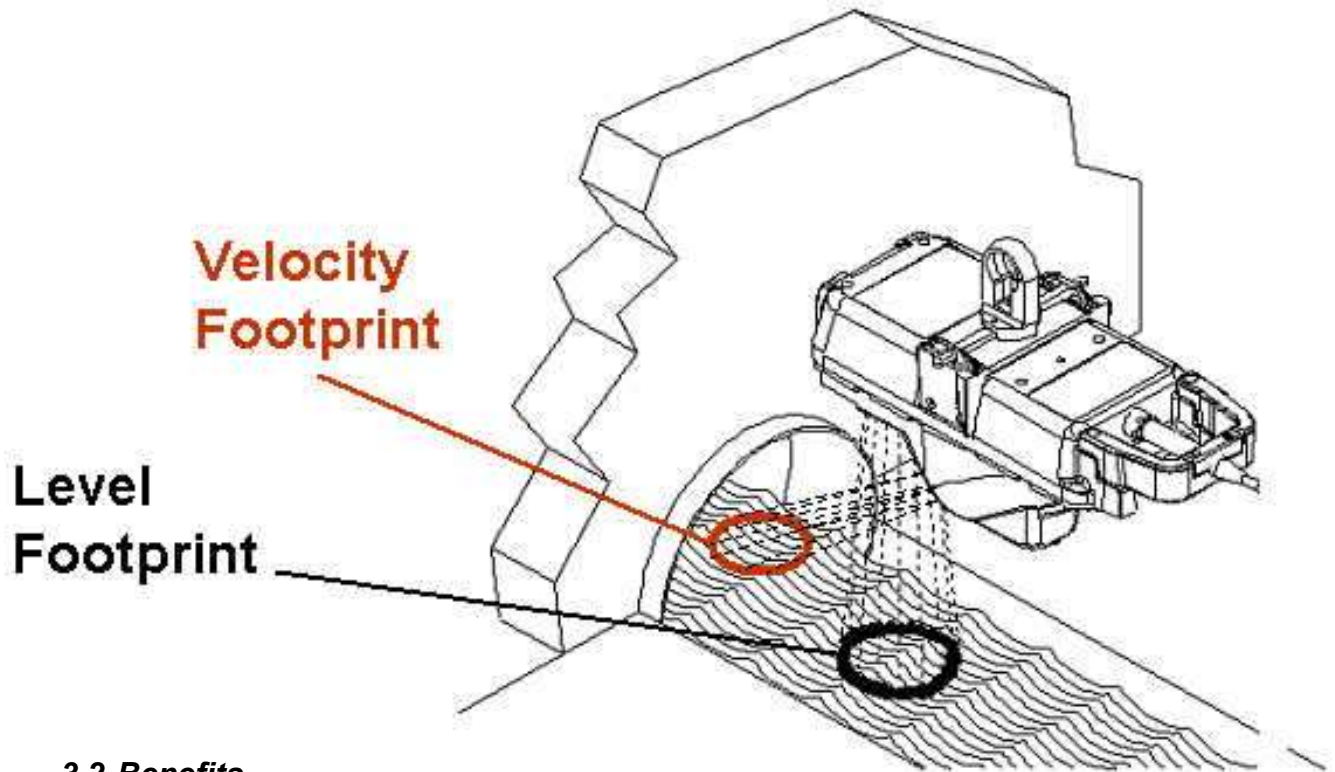
- **Method**
 - Electromagnetic
- **Range**
 - ± 4.8 m/s (± 16 ft/s)
- **Accuracy**
 - ± 0.15 ft/s or 4% of reading, whichever is greater.
- **Zero Stability**
 - ± 0.05 ft/s

The Flo-Dar® Open Channel Flow Meters provide an innovative approach to open channel flow monitoring. Combining digital Doppler radar velocity sensing with ultrasonic pulse echo level sensing, Flo-Dar® provides accurate open channel flow monitoring without the fouling problems associated with submerged sensors.

3.1.2 Perfect Solution for Difficult Flow Conditions:

- Flows with High Solids Content
- High Temperature Flows
- Caustic Flows
- Large Man-Made Channel
- High Velocities
- Shallow Flows





3.2 Benefits

- 3.2.1 Personnel have no contact with the flow during installation.
- 3.2.2 Maintenance caused by sensor fouling is eliminated.
- 3.2.3 Field Replaceable / Interchangeable Sensors and Monitors

3.3 How It Works

Flo-Dar® transmits a digital Doppler radar beam that interacts with the fluid and reflects back signals at a different frequency than that which was transmitted. These reflected signals are compared with the transmitted frequency. The resulting frequency shift provides an accurate measure of the velocity. Level is detected by ultrasonic pulse echo. Flow is then calculated based on the Continuity Equation:

$$Q = V \times A, \text{ Where } Q = \text{Flow}, V = \text{Average Velocity and } A = \text{Area}$$

3.4 Accurate Flow Measurements

Flo-Dar® provides the user with highly accurate flow measurements under a wide range of flows and site conditions. By measuring the velocity of the fluid from above, Flo-Dar® eliminates accuracy problems inherent with submerged sensors including sensor disturbances, high solids content and distribution of reflectors.

Understanding the Flo-DarTM Flow Measuring System

Independent tests verify non-contact flowmeter is highly accurate under both open channel and surcharge conditions

Flo-Dar is the only non-contact open channel velocity/area type flow meter available for measurement of flows in municipal wastewater and storm water sewers. Flo-Dar consists of a radar-based velocity measurement system and an ultrasonic-based pulse echo depth measurement system.

Flo-Dar has an optional surcharge velocity sensor (electromagnetic type) and depth sensor (pressure transducer) that provides the continuation of accurate flow data where intermittent, surcharged flow conditions are experienced.

Flo-Dar combines the information from the velocity and depth systems along with site specific data (pipe size, pipe shape, velocity profile) and provides the user with highly accurate, reliable flow data under a wide range of flow velocities and depths. Since the radar velocity sensor and the ultrasonic depth sensor cease to provide useful data when submerged, Flo-Dar has an optional surcharge velocity sensor (electromagnetic type) and depth sensor (pressure transducer) that provides for the continuous measurement of accurate flow data where intermittent, surcharged flow conditions are experienced.

The data system merges the data from these two independent flow systems and provides the user with a single flow signal that accurately represents flow over a range from a dry pipe to extreme surcharge conditions. Accuracy tests performed at Alden Research Labs have shown that the Flo-Dar is highly accurate under both open channel and surcharge (submerged) conditions.

Accuracy tests performed at Alden Research Labs have shown that the Flo-Dar is highly accurate under both open channel and surcharge (submerged) conditions.

Measurement of Flow Under Free Flow, Non-submerged Conditions

Open Channel Velocity

Open channel flow is any flow in a channel that has a free surface. Flo-Dar measures open channel flow as depicted in Figure 1. The radar velocity sensor measures flow in a manner similar to how radar guns measure the velocity of a baseball or an automobile.

Marsh-McBirney has developed and patented a process that yields an accurate determination of the average velocity from the measurement of the surface velocity at a known point on the flow surface.

Factors that influence the accuracy and stability of the measured surface velocity signal:

- 1. Transmitted Frequency*
- 2. Speed of Microwaves in Air*
- 3. Angle of Microwave Beam*
- 4. Calculation of Mean Velocity*

A radar “horn” contained inside of the watertight housing transmits a microwave beam through the housing at a defined angle to the flow surface. Disturbances on the surface reflect some of the microwaves back to the horn. The frequency of these returning microwave signals have been shifted (the Doppler effect) by an amount directly proportional to the speed of the moving surface. This frequency shift is detected and measured by the Flo-Dar flow meter and the data is stored as a measure of the surface velocity.

Since the accurate measurement of open channel flow requires the accurate determination of the average velocity of the flow stream, the measured surface velocity must be dynamically modified to obtain an accurate average velocity for use in the Continuity Equation, $Q = V_{av} \times A$. Marsh-McBirney has developed and patented a process that yields an accurate determination of the average velocity from the measurement of the surface velocity at a known point on the flow surface.

If one analyzes each of the four factors that influence the accuracy and stability of the measured surface velocity signal, it becomes obvious that a Doppler Radar based velocity sensor is very accurate and stable:

1. Transmitted Frequency - The transmitted frequency of 24.175 GHz is controlled to an accuracy of +/- 0.065%
2. Speed of Microwaves in Air - Essentially constant at the speed of light
3. Angle of Microwave Beam - The sensor is placed in a rigid mount that is positioned parallel to the water surface (i.e. nearly level). The sensor can be removed from the mount and reinstalled while easily maintaining its original mounting location.
4. Calculation of Average Velocity—The relationship between the sensed (surface) velocity and the average velocity varies with pipe size and water depth.

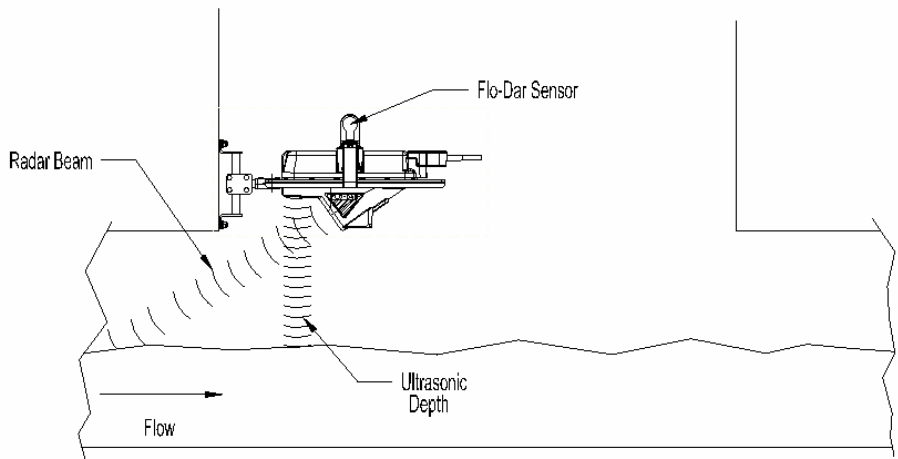


Figure 1

By applying algorithms developed through basic hydraulic principles and from actual flow data taken at Alden Labs and at various customer sites, the surface velocity is transformed into an accurate representation of the mean velocity.

Since the location of the sensing region on the flow surface is known, the repeatability of the surface velocity measurement is excellent and its relationship to the mean velocity is very predictable.

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Figures 2a, 2b, 2c and 2d depict the relationship that exists between various velocity contours and the mean velocity at different **depth/Diameter** ratios. Note that the velocity gradients that exist throughout the flow cross section are generally represented at the flow's surface - essentially creating a "finger-print" of the velocity contours that exist beneath the surface.

As one might expect, the velocities near the wall are less than the mean velocity and those near the surface are greater than the mean velocity. Since a) the radar sensor measures surface velocity at a known location on the flow surface, and b) these various surface velocities have known relationships to the mean velocity, then the mean velocity can be reliably and accurately calculated.

The accuracy of the calculated average velocity, after correction, is typically between 2% to 5%.

Note that the velocities present on the surface are typically within 10% of the average velocity. The accuracy of the calculated mean velocity, after correction, is typically between 2% to 5%. (See Note 1.)

Ultrasonic Pulse Echo Depth Measurement

Ultrasonic pulse echo depth sensors operate by energizing a piezoelectric transducer with an electronic pulse. This pulse creates an ultrasonic pulse of energy that travels to the flow surface where a portion of the energy returns to the transducer.

The transit time to the flow surface and back is recorded and the distance calculated by knowing the speed of sound at the site which has been corrected by an embedded temperature sensor. The accuracy of the depth measurement is 1%, +/- 0.1 inch .

Measurement of Flow Under Submerged Conditions

Electromagnetic (EM) Surge Velocity Sensor

As stated previously, the radar based velocity sensor measures the surface velocity of the flowing stream by detecting the average speed of the surface irregularities. When the radar sensor becomes totally submerged, it becomes "blind" and is no longer capable of measuring the fluid velocity.

Figures 2a, 2b, 2c and 2d depict the relationship that exists between various velocity contours and the mean velocity at different depth/Diameter ratios. Note that the velocity gradients that exist throughout the flow cross section are generally represented at the flow's surface—essentially creating a “finger-print” of the velocity contours that exist beneath the surface.

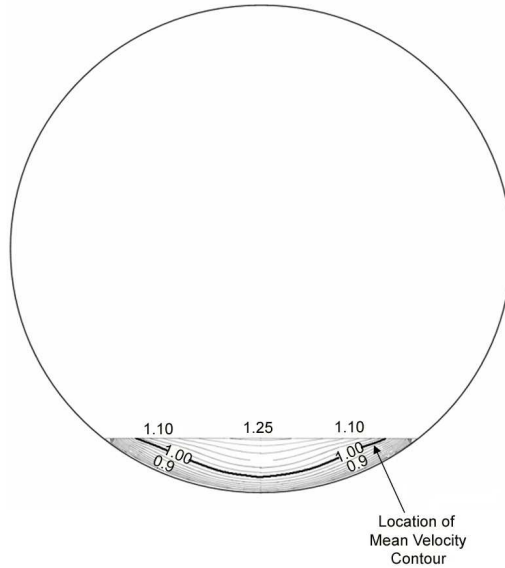


Figure 2a:
d/D= 0.10

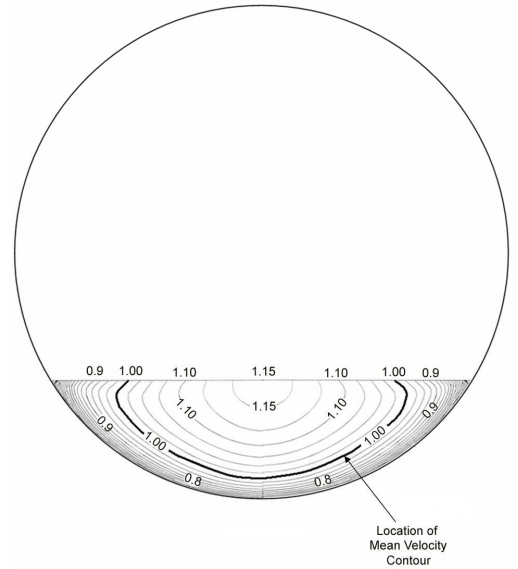


Figure 2b:
d/D= 0.25

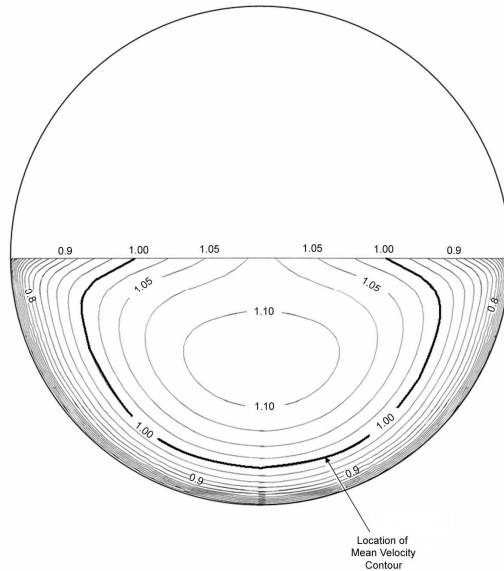


Figure 2c:
d/D= 0.50

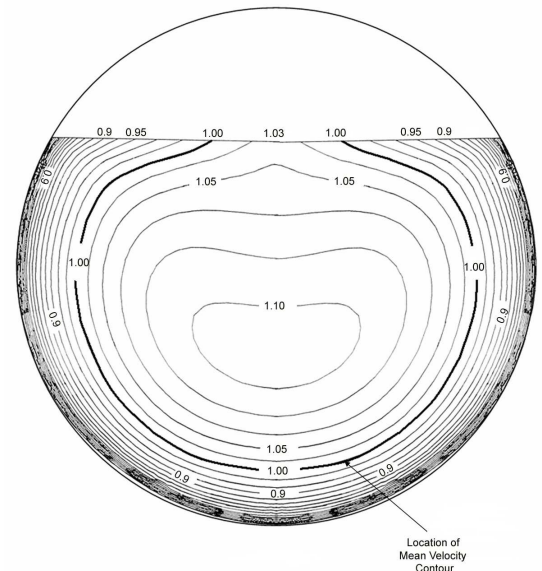


Figure 2d:
d/D= 0.75

To allow for the uninterrupted measurement of flow under conditions that change from open channel flow to submerged flow as experienced in sewers that surcharge, Marsh-McBirney has added an additional surcharge velocity sensor. Placed on the underside of the standard Flo-Dar sensor, this electromagnetic sensor becomes active when the flow level rises to within four inches of the Radar horn and remains activated until the flow once again falls beneath that depth.

To allow for the uninterrupted measurement of flow under conditions that change from open channel flow to submerged flow as experienced in sewers that surcharge, Marsh-McBirney has added an additional surcharge velocity sensor.

Placed on the underside of the standard Flo-Dar sensor, this electromagnetic sensor becomes active when the flow level rises to within 4 inches of the Radar horn and remains activated until the flow once again falls beneath that depth.

The optional surcharge velocity sensor is based on the Faraday Principle of Electromagnetic Induction. This is the same well-proven principle that “full bore” or “spool-piece” magmeters utilize, the most widely used method of measuring wastewater flow in full pipes.

In the Marsh-McBirney design, an electromagnet embedded within the streamlined sensor generates a magnetic field in the flowing stream. The flow of the water passing through this magnetic field generates voltages in the water that are directly proportional to the speed of the water passing the sensor. Marsh-McBirney uses an in-house 120 foot long towing basin for calibration of electromagnetic sensors. Tow carriage accuracy is better than +/- 0.5%.

Surcharge Depth Sensor

Once submerged conditions exist, the ultrasonic depth sensor ceases to provide useful depth information. To measure depth of the flow during surcharge conditions, a pressure transducer embedded in the Flo-Dar sensor is used in the system.

The location of the surcharge velocity sensor relative to the crown of the pipe is shown in Figure 3. This location provides sensing of the velocity stream just below the crown of the pipe where the flow exits the upstream piping. Empirical data, verified by independent tests at Alden Labs in Holden, Massachusetts indicate that the velocity measured at this location, when multiplied by 0.9, is typically equal to the average velocity.

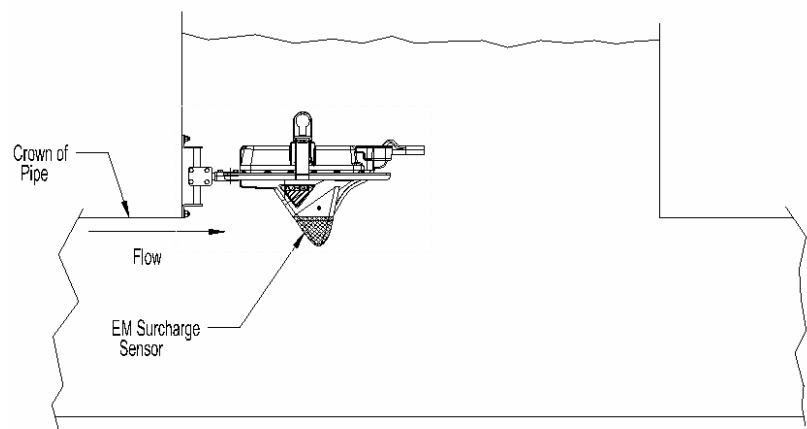


Figure 3

Laboratory Tests

In September 2002 Marsh-McBirney contracted Alden Research Labs of Holden, Massachusetts to perform flow accuracy tests on the Flo-Dar sensor with an electromagnetic surcharge sensor. The Flo-Dar was subjected to a flow range of 400 gpm to over 9000 gpm in a pipe size of 23.5 inches. The pipe had a slope of approximately zero. The test results are shown in Figure 4, Figure 5, Figure 6 and Figure 7.

The flow tests showed that the Flo-Dar compared very favorably with the Alden flow standard (weigh tank) over a wide range of flows where the open channel flow ranged from 400 gpm to 6000 gpm, and the surcharge (submerged) flow ranged from 6000 gpm to 9000 gpm.

The flow tests showed that the Flo-Dar compared very favorably with the Alden flow standard (weigh tank) over a wide range of flows where the open channel flow ranged from 400 gpm to 6000 gpm, and the surcharge (submerged) flow ranged from 6000 gpm to 9000 gpm.

Tests were also run to depict how Flo-Dar performs under transition conditions where the flow goes from an open channel condition to a surcharge (submerged) condition.

Test results show that the data from the open channel radar sensor and surcharge electromagnetic sensor overlay each other and the Alden Standard. Tests were run under both free flow conditions as well as where the pipe outlet was partially blocked so as to create an entirely different velocity/depth relationship.

Additional flow accuracy tests were run on a 36" pipe at Alden on July 17, 2003. All of the data points were shown to be within 3.5% of the Alden Standard.

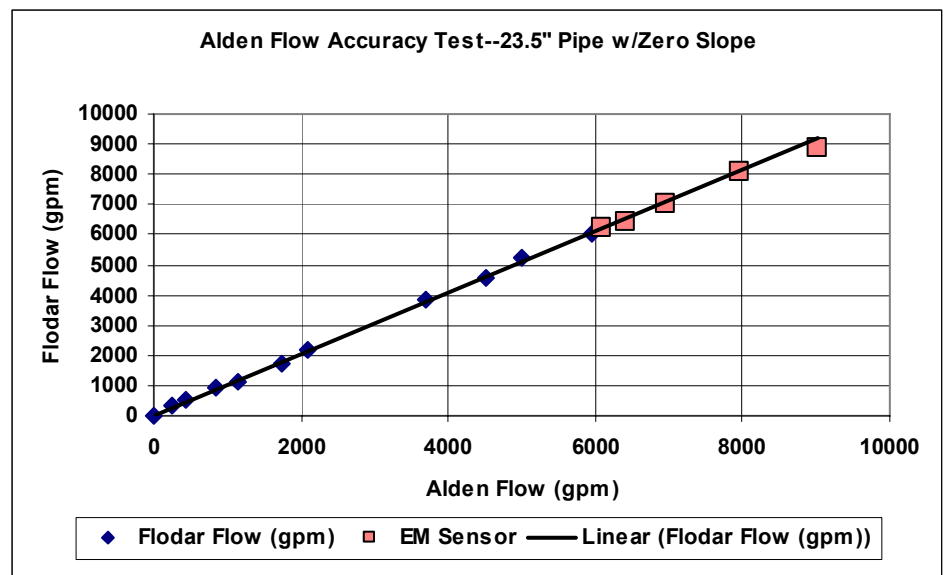


Figure 4 compares the Flo-Dar flow vs. the Alden Standard (weigh tank). The flow condition for this test was both open channel flow and surcharge (submerged) flow.

Test results show that the data from the open channel radar sensor and surcharge electromagnetic sensor overlay each other and the Alden Standard.

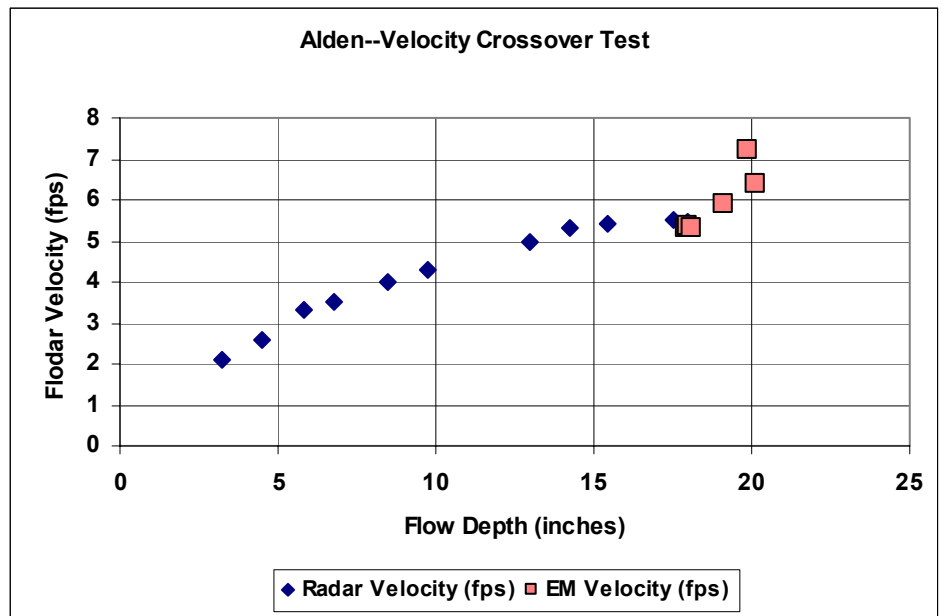


Figure 5 compares the velocity measured by the Radar sensor plotted against flow depth. Note that when the depth reaches approximately 18 inches the EM surcharge sensor has been activated. There is one data point where both sensors are active and then the EM surcharge sensor continues to measure after the radar sensor has become submerged and inoperative.

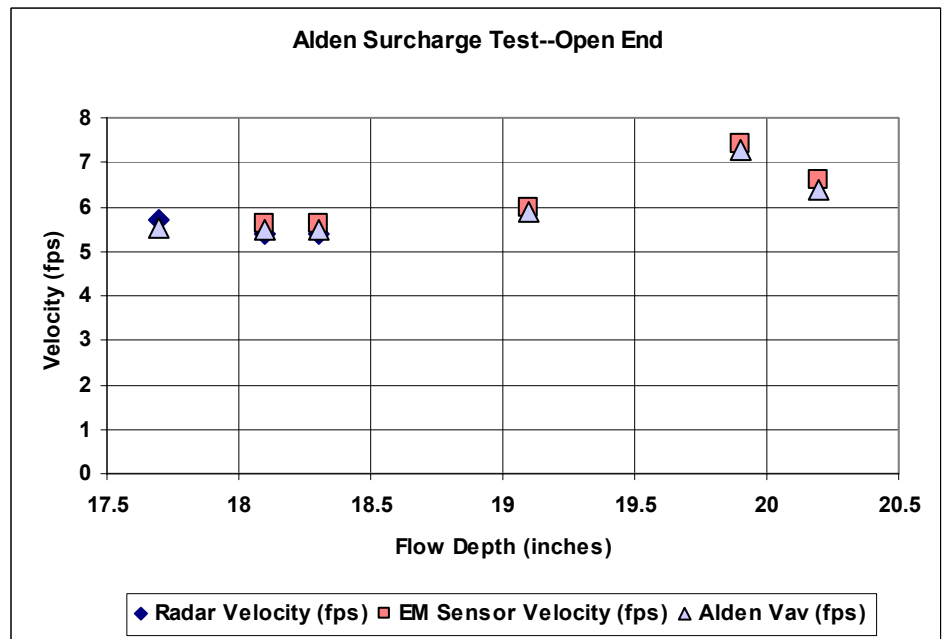


Figure 6 depicts a second surcharge test where the flow was incremented more slowly in order to achieve additional data points in the area where both the Radar sensor and the EM surcharge sensors are active simultaneously. Note that both the Radar sensor and the EM sensor are active between flow depths of 18 inches and 18.5 inches. Also, note how both the Radar and EM data points overlay each other and the Alden standard.

The accuracy of Flo-Dar under both open channel conditions as well as surcharge (submerged) conditions is more than adequate for the most demanding of metering applications including open channel billing applications.

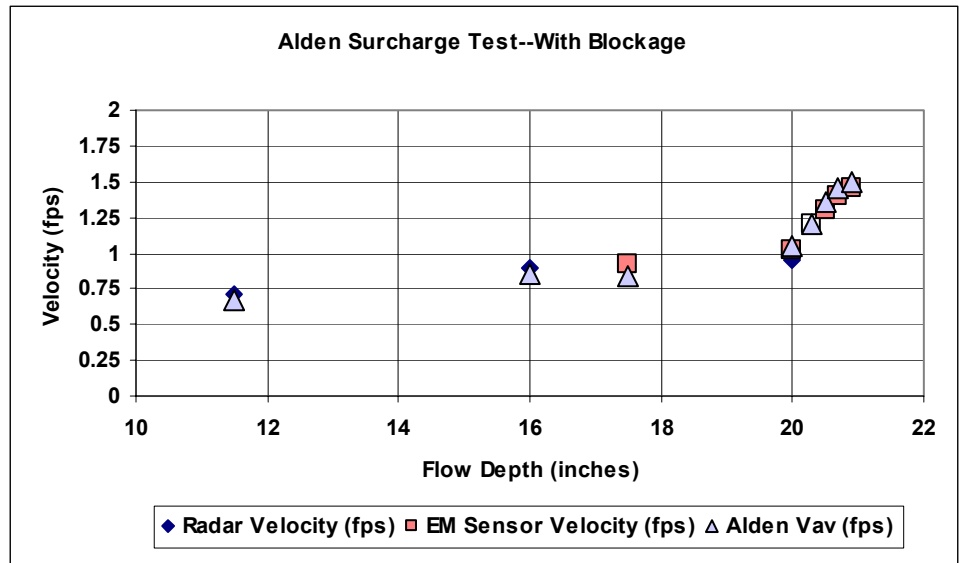


Figure 7 depicts the result of a surcharge test at a lower flow rate. In this test, a round plate with multiple holes was placed at the outlet of the test pipe so as to achieve submerged flow at a lower velocity. Note the consistency of both the Radar velocity data and the EM velocity data as compared to the Alden standard.

Additional tests performed at Alden in 2003 on a 36" pipe again validated Flo-Dar's accuracy under open channel and surcharge flow.

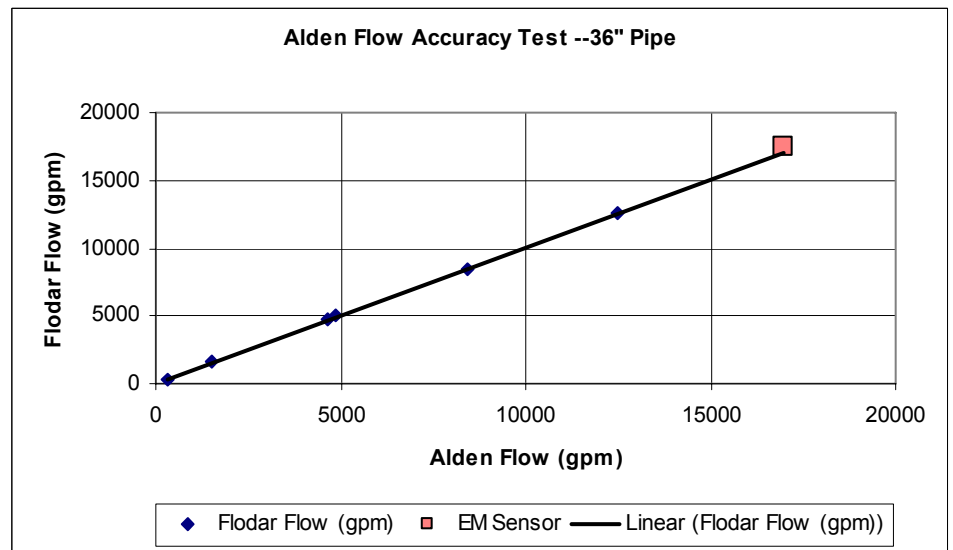


Figure 8 compares the Flo-Dar flow vs. the Alden Standard (weigh tank) for flow accuracy tests in a 36" pipe. These tests were performed on July 17, 2003. Note that at 17,000 gpm the sensor was under surcharge conditions. All of the data points were shown to be within 3.5% of the Alden Standard.

Flo-Dar measures open channel velocity and depth by non-contact means virtually eliminating the need to periodically clean the sensors as required by all submerged type sensors.

Data recovery from Flo-Dar deployments ranges between 98% to 100% even under site conditions that render most submerged sensors inoperable.

The Flo-Dar data logger records all four of the flow parameters - open channel surface velocity and depth, and surcharged velocity and depth. When the water depth is below the bottom of the Flo-Dar sensor, only the surface velocity and the flow depth of the open channel flow are used in the flow calculation.

Once the flow depth is such that both the surcharge depth sensor is activated and a conductivity switch is activated, then flow is calculated using the full pipe dimensions for area and the surcharge velocity sensor for velocity.

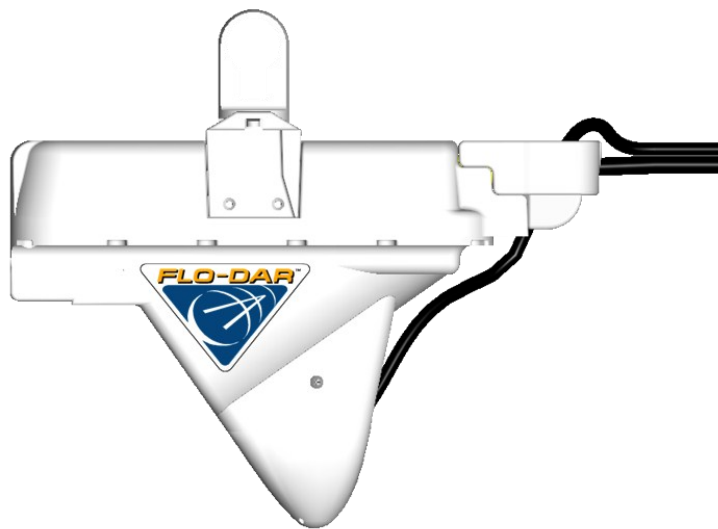
Conclusions

Flo-Dar is a rugged, general purpose flow meter for use in most open channels such as sanitary sewers, storm water sewers and other man-made channels such as aqueducts as well as certain natural channels such as small streams. Flo-Dar measures open channel velocity and depth by non-contact means virtually eliminating the need to periodically clean the sensors as required by all submerged type sensors. Data recovery from Flo-Dar deployments ranges between 98% to 100% even under site conditions that render most submerged sensors inoperable.

The accuracy of Flo-Dar under both open channel conditions as well as surcharge (submerged) conditions is more than adequate for the most demanding of metering applications including open channel billing applications.

Note 1. The accuracy of open channel flow meters can be affected by adverse conditions present at any metering site. The accuracy specifications of most manufacturers are generally stated under ideal conditions.

Open Channel Flow Monitoring Study



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1) Locate the following parts (See Figure 1):

- | | |
|--------------------------------|---|
| 1) Flo-Dar Sensor | 7) Extension Pipe, Tee Fitting, and Bushing |
| 2) Flo-Dar Logger | 8) Clamp Set with qty. (8) 1/4-20 Bolts |
| 3) Flo-Dar Communication Cable | 9) Desiccant Capsule |
| 4) Flo-Ware Software CD | 10) Laser-Alignment Tool |
| 5) Sensor Mounting Frame | 11) Installation & Operations Manual |
| 6) Jack-Bar Assembly | 12) Start-Up Guide (not pictured) |



Figure 1

Methods & Procedures

2) Flo-Ware Software Configuration.

1. Insert the “Flo-Ware For Windows Resources CD” into your drive.
2. Select (single-click) “floware4.exe” from the “Software” box on your screen.
3. Select “Save” from the “File Download—Security Warning” screen.
4. Select “Save” from the “Save As” screen.
5. Select “Run” from the “Download Complete” screen.
6. Select “Run” from the “Internet Explorer—Security Warning” screen.
7. An installation wizard will initiate and load the files onto your hard drive.
8. Select the language you want to use from the “Select Language” screen.
9. Select “Next” from the “Welcome” screen.
10. Select “Next” from the “Choose Destination Location” screen.
11. Select “Next” from the “Select Components” screen.
12. Select “Next” from the “Start Installation” screen.
13. Select “Finish” from the “Installation Complete” screen.
14. Scroll down the screen and find “Flo-Dar / SVS” on the left side of the screen. Select (single-click) “floodar.exe” from that box on your screen
15. Select “Run” from the “File Download—Security Warning” screen.
16. Select “Run” from the “Internet Explorer—Security Warning” screen.
17. An installation wizard will initiate and install the files onto your hard drive.
18. Select “Finish” from the “Flo-Dar / SVS File Driver Installation” screen.

NOTE: There are ample help files on the “Flo-Ware for Windows Resources CD”

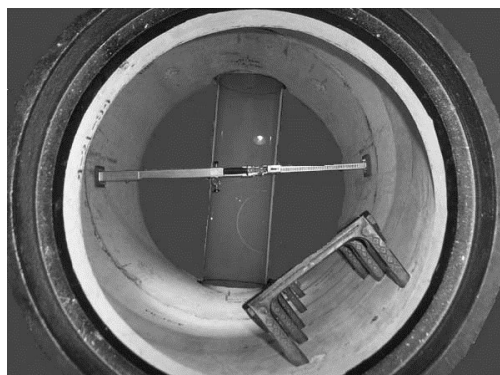
3) Set up the mounting frame and jack-bar assembly.

- A) Install the jack-bar assembly in the manhole. As a general rule, the jack-bar should be approximately 20” to 24” above the crown (top) of the pipe. In order to reduce movement of the jack-bar due to the cantilever action of the sensor, the jack-bar should be located as parallel to the pipe and invert of the manhole as possible.

MOST Desirable Jack-Bar Mount



LEAST Desirable Jack-Bar Mount



B) Assemble the frame, clamp-set, bushing, tee, and extension as shown in figure 2. Position the frame as close as possible to the lip of the pipe by sliding the assembly along the jack-bar with the slide. Be sure to secure the set-screw.

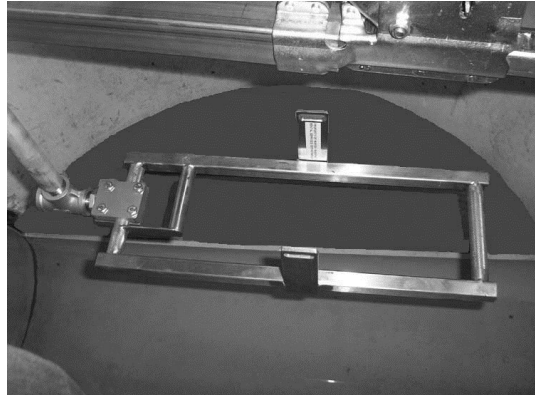


Figure 2

C) Set the elevation of the frame (measured to the top of the frame tubes) to be 6" above the inside crown of the pipe (for pipe I.D. under 25") or 5" above the inside crown of the pipe (for pipe I.D. of 25" and greater). An easy way to set the frame elevation is to measure the distance from the bottom of the manhole invert to the top of the mounting frame tubes. (This assumes that there is no drop or hydraulic jump from the lip of the pipe to the invert) Set the dimension to equal the pipe I.D. plus 6" (for pipe I.D. under 25") or the pipe I.D. plus 5" (for pipe I.D. of 25" or greater).



Figure 3

D) If you are not interested in measuring flow under surcharge conditions, or if you are sure the site will not surcharge, you can mount the sensor at any elevation above the surface of the water as long as the frame is within 60" of the water surface. When the sensor is mounted at higher elevations than those shown in Figure 3, it will still read normal velocity and level readings. Surchage level will still be recorded properly, but surcharge velocity readings will not be possible. If you are mounting the sensor at higher elevations, it is still necessary to confirm the location of the velocity radar beam as described on pages 5 & 6 of this guide.

E) Align and level the frame by placing the laser alignment tool in the frame as shown in figure 4. Utilize the bubble-level on the tool to level the frame.

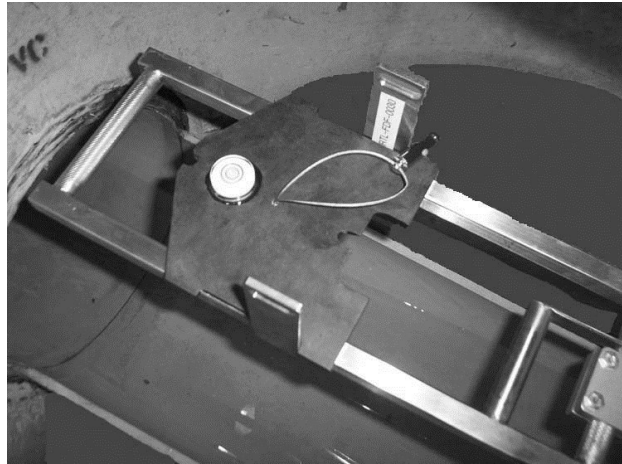


Figure 4

F) Snap the laser-pointer into the laser alignment tool as shown below in figure 5. It is a tight fit. Make sure the pointer is firmly and evenly seated in its slot as shown.



Figure 5

G) With the laser-pointer snapped into the tool, as shown, place the alignment tool back into the frame. The laser is now set up to duplicate the velocity radar beam angle. Use the laser-pointer to shine the beam onto the surface of the water. Ideally, the beam should be aligned so that it lands in the middle of the surface of the water inside the pipe.

NOTE: There are numerous adjustment points on the frame and jack-bar assembly.

H) Remove the laser-pointer from the tool and re-install it into the tool as shown below in figure 6. With the laser-pointer in the position shown, it is now set up to duplicate the ultra-sonic level transducer beam location.

D) Align the beam so that it lands in the middle of the channel you are measuring.

NOTE: You may have to check level, velocity laser alignment, and level laser alignment several times to ensure all three are correct. Adjusting one or more of the alignments will often affect one or more of the other adjustments! It is critical to remember to tighten all bolts on the jack-bar and clamp set to assure that the sensor frame does not move, once positioned correctly.

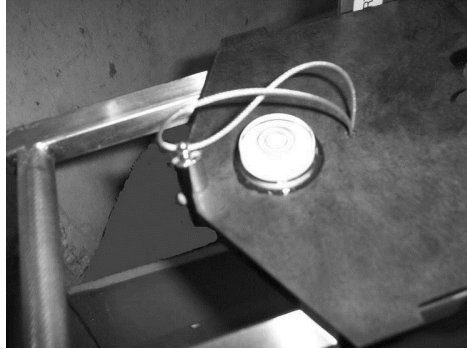


Figure 6

4) Install the Sensor.

A) Gently lower the sensor into the mounting frame and lock it in place by rotating the bail assembly (located on top of the sensor) 90 degrees. The two locking arms will extend out to engage the slots in the vertical side webs of the frame ensuring that the sensor will not dislodge from the frame, particularly if the manhole surcharges.

NOTE: Make sure the sensor is placed in the frame so that the cables are exiting the sensor on the downstream (manhole effluent) side. (see Figure 7 below)

5) Connect the Data Logger.

A) Connect the sensor cables to the data logger. Make sure the grey cable-end connects to the connector marked grey. Connect the yellow cable-end to the connector marked yellow. Tighten the threaded cable connector-ends securely to the data logger connectors.

B) Remove the desiccant capsule from the vacuum-sealed bag and plug it onto the brass A.P.R. fitting (located next to the yellow cable connector) on the data logger. See Figure 8 below.

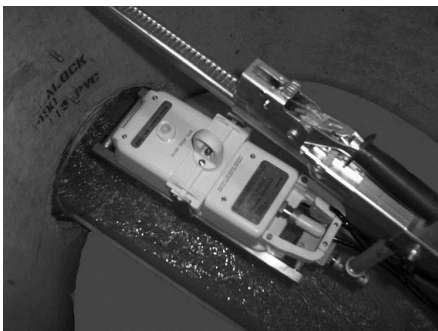


Figure 7



Figure 8

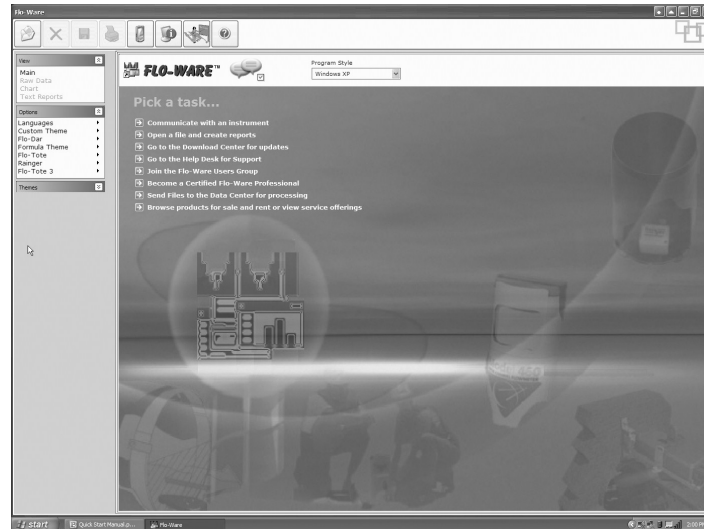
6) Configure the Data Logger using Flo-Ware Software.

A) Connect the interface cable from the data logger to the laptop's 9-pin serial port.

NOTE: If your laptop does not have a 9-pin serial port, you will have to use a USB port with a USB-to-serial port adapter (not provided by Marsh-McBirney).

B) Double-click the "Flo-Ware" icon on your computer's desktop.

C) When Flo-Ware opens, you will see the screen shown below.



D) Place your cursor on the line that says "Communicate with an instrument" and single-click. A small pop-up window will open. Place your cursor over the "Flo-Dar" line and single-click. A second pop-up window will appear. Single-click on the word "communications". The site set-up screen will appear as shown below.

The screenshot shows the 'Site Setup' dialog box. It has tabs for 'Site Setup', 'Read Meter', 'Real Time', 'View Data', 'Preferences', and 'Add-In'. The 'Site Setup' tab is active. It contains fields for 'Site ID', 'Location', 'Cycle Time' (15 min), 'Samples' (1 per cycle), 'Flow Unit' (MGD), and 'Start Type' (Immediate). There are also 'Read Setup' and 'Send Setup' buttons. A 'Multiplier' field is set to 1.00. A 'Channels' table is shown at the bottom with columns for Name, Logging, and Unit. The 'User' field is set to 'Quality Control'.

Name	Logging	Unit
Velocity	On	Feet Per Second
Level	On	Inches
Temperature	Off	Celsius
Surcharge Level	Off	Inches

- E) Proceed to enter your specific site information into the appropriate boxes in the site set-up screen. An example of a typical set-up is shown below, along with explanations-actions of the input required from the user.

The screenshot shows the 'Communications - Flo-Dar' software window. It has a menu bar with 'Site Setup', 'Read Meter', 'Real Time', 'View Data', 'Preferences', and 'Add-In'. Below the menu bar are buttons for 'Save Site', 'Delete Site', 'Read Setup', and 'Send Setup'. The main area contains several input fields and dropdown menus:

- Site ID: Manhole #15 (dropdown)
- Location: Elm Street, Anytown, USA (text boxes)
- Cycle Time: 15 min (spin box)
- Samples: 1 per cycle (spin box)
- Flow Unit: MGD (dropdown)
- Start Type: Immediate (dropdown)
- Multiplier: 1.00 (spin box)
- Memory: Fixed (dropdown)
- Shape: Circular (dropdown)
- Diameter: 24.00 in (spin box)
- Sediment: 0.00 in (spin box)
- Sensor Offset: 30.00 in (spin box)
- Extended Setup (dropdown)
- S/N (text box)

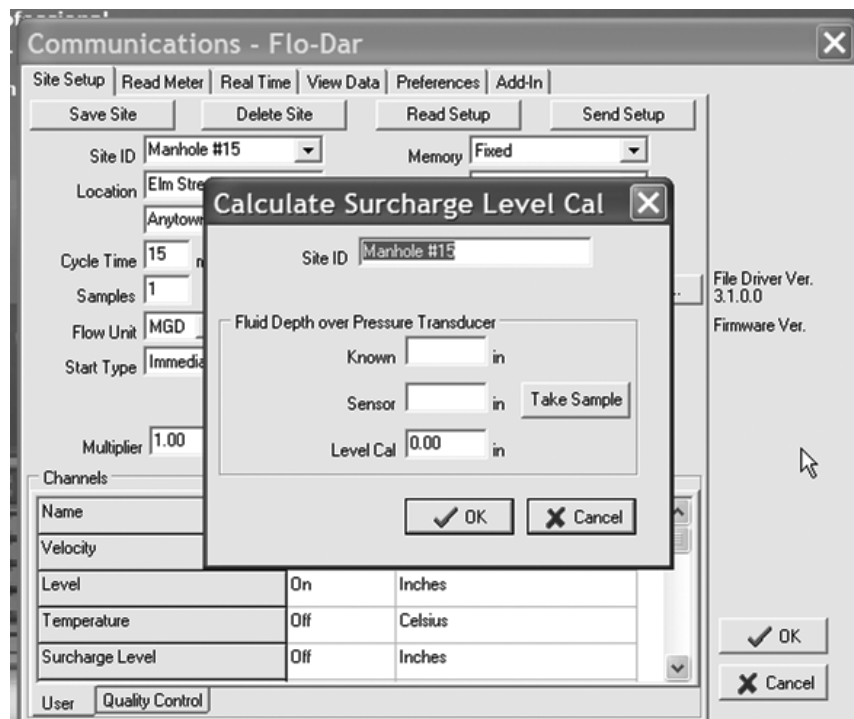
On the right side, there are labels for 'File Driver Ver. 3.1.0.0' and 'Firmware Ver.'. At the bottom right are 'OK' and 'Cancel' buttons. At the bottom left is a 'User' field with 'Quality Control' entered.

The 'Channels' section at the bottom contains a table:

Name	Logging	Unit
Velocity	On	Feet Per Second
Level	On	Inches
Temperature	Off	Celsius
Surcharge Level	Off	Inches

- Site I.D. and Location are self-explanatory. You MUST enter something in the site I.D. box in order for the program to work.
- Cycle time is the time interval between the start of each sample.
- Number of samples is the number of 1-minute samples that the instrument will take at the beginning of each cycle.
- Flow Units can be selected by using the pull-down arrow to view the available choices.
- Start Type is either immediate or delayed. If you choose a delayed start, you can use the pull-down arrow to reveal a calendar box and time box. You can use the pull down arrow on the calendar box to view convenient calendars which allow you to click on the date you desire. When using a delayed start, the instrument will “sleep” until the desired start-up date and time are reached. It will then “wake up” and start sampling.
- Multiplier should be left at 1.00 for most applications in round pipes. If you have a round pipe greater than 54” in diameter, or you are using the instrument in a square/rectangular channel, or an odd-shaped channel, contact the Customer Support Department at 714-542-1004 for instructions about the multiplier.
- Memory can be either “Fixed” or “Wrapped”. If you choose “Fixed”, the instrument will stop collecting data once the memory is full. In “Wrapped” mode, when the memory becomes full, the instrument will continue collecting data and will over-write the first data point, then the second, etc., with new data. This will continue indefinitely until a new set-up is downloaded to the instrument.

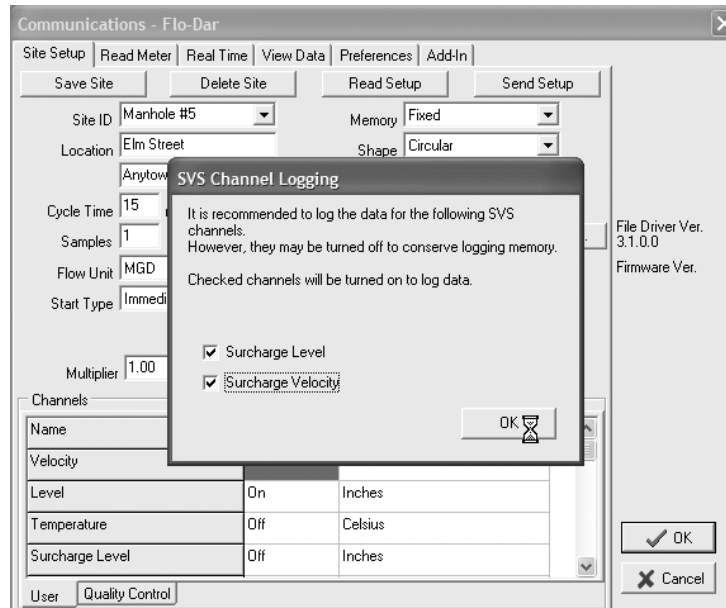
- Shape is self-explanatory. If you are measuring flow in an odd-shaped conduit, please call the US3 at 714-542-1004 for detailed instructions.
- Diameter is the INSIDE diameter of the pipe. This dimension should be measured in the field. Often, the pipe diameter is not what one assumes from the specs on a given pipe. Always measure the inside diameter to be sure of the dimension.
- Sediment is the amount of non-flowing sediment that may be in the bottom of the pipe. The software will take sediment into account when calculating cross-sectional area for the flow calculation. If there is no sediment, leave the number at 0.00.
- Sensor offset is the dimension from the top surface of the horizontal sensor mounting frame tubing, to the bottom of the invert or channel. (see Figure 3, page 4) If you want to measure flow in a surcharge condition, or if you want to set the instrument up to measure flow in case the manhole surcharges, then the mounting frame should be located so that the sensor offset dimension is equal to the pipe diameter plus 6 inches for pipe diameters up to 24", or equal to the pipe diameter plus 5 inches for pipe diameters greater than 24".
- Single-click on the "Extended Setup" button.
- Single-click on "Surcharge Level Cal"
- A window marked "Calculate Surcharge Level Cal will appear as shown below.



- Type 0.00 in the box marked "known".
- Single-click on the "Take Sample" box.
- Allow the unit to perform a real time sample of the surcharge pressure transducer. This will take approx. 45 seconds. The software will fill in the box marked "Sensor" and the box marked "Level Cal" with the proper values automatically.

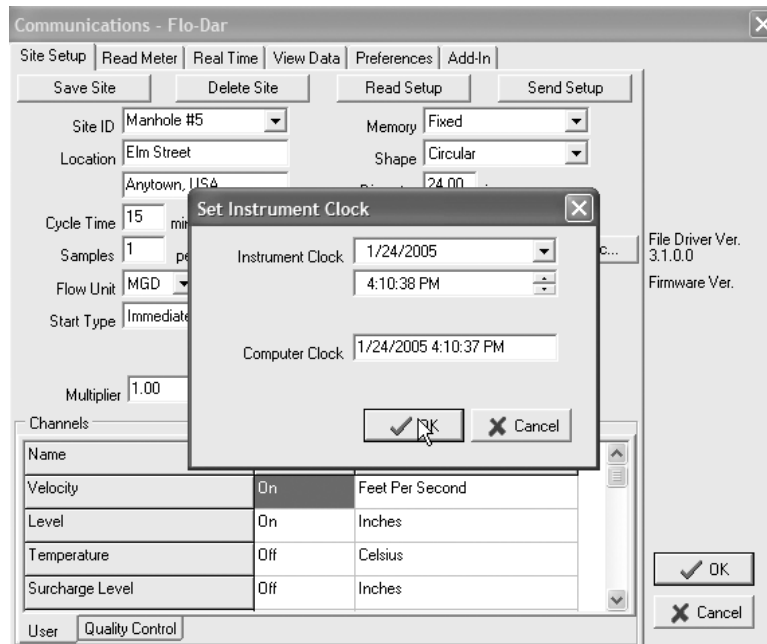
7) Save the site information to your hard drive by clicking on the “Save Site” button near the upper left-hand corner of the set-up screen.

8) Download the site information to the data logger by clicking on the “Send Setup” button near the upper right-hand corner of the site set-up screen.

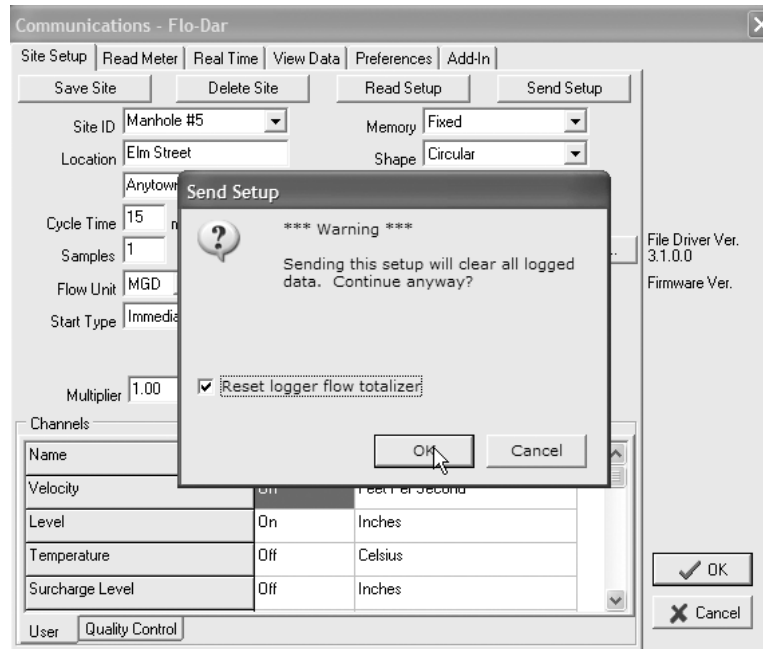


9) Turn on (check the boxes) both of the SVS channels as shown above.

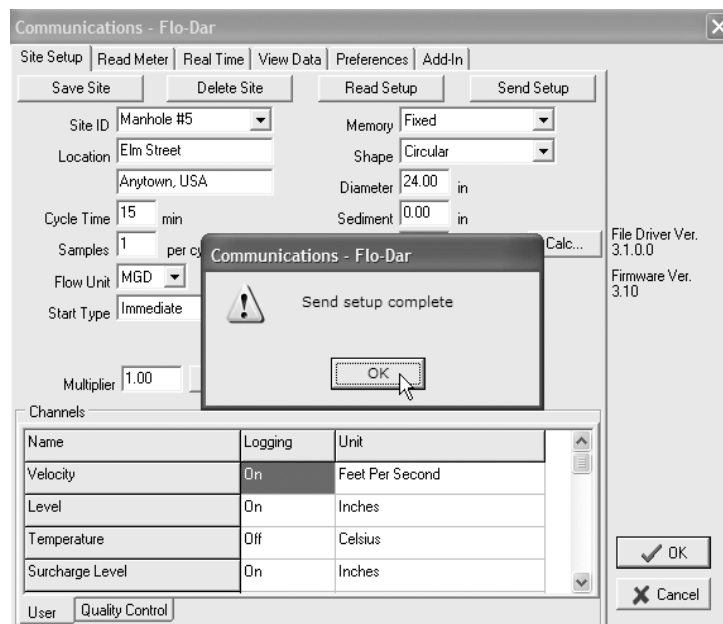
10) Adjust the instrument clock to match your laptop computer clock as shown below. Use the pull-downs next to the date and time to help you set the instrument clock time. Click OK.



11) A warning screen will appear as shown below. Select whether or not you want to reset the logger flow totalizer, then click OK.

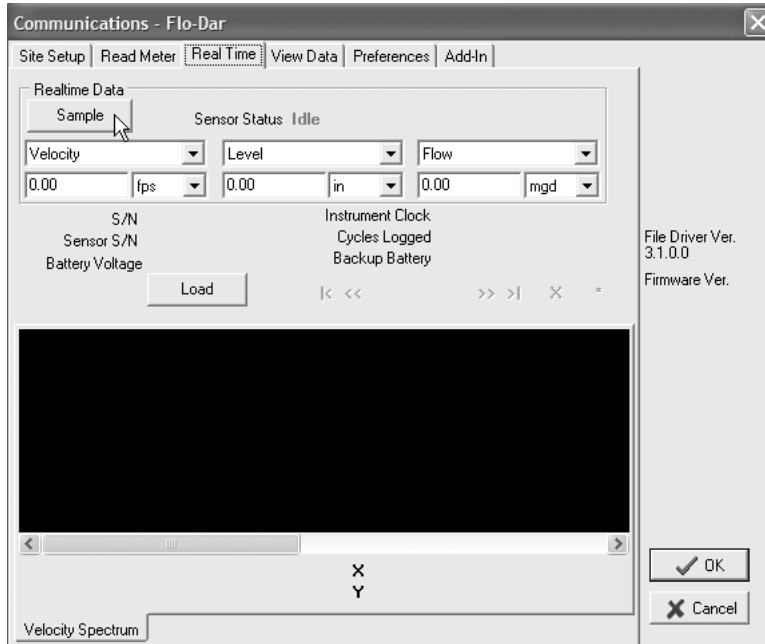


12) The “Send setup complete” screen (shown below) will appear, indicating that you have successfully sent the setup data to the instrument. The instrument will now begin collecting data.

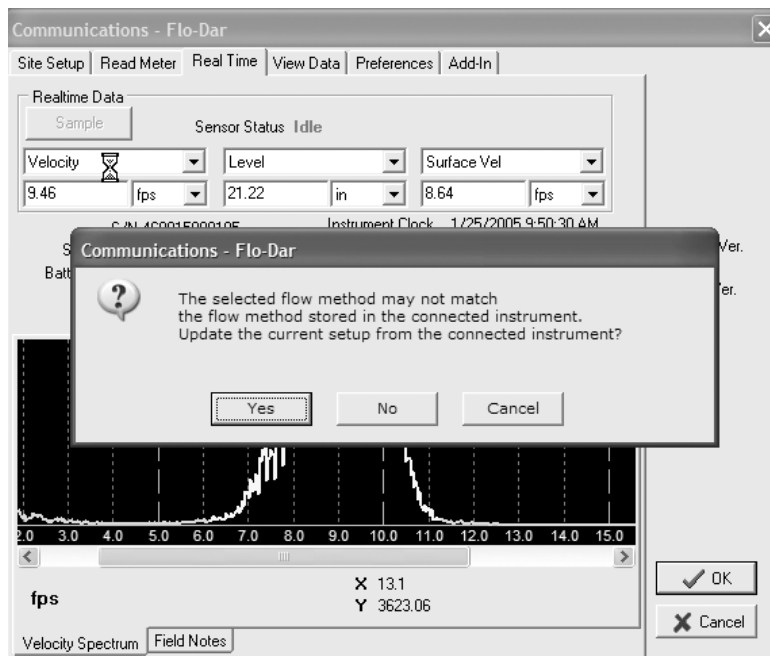


13) Collect real-time readings to confirm proper operation of the instrument before leaving the metering site.

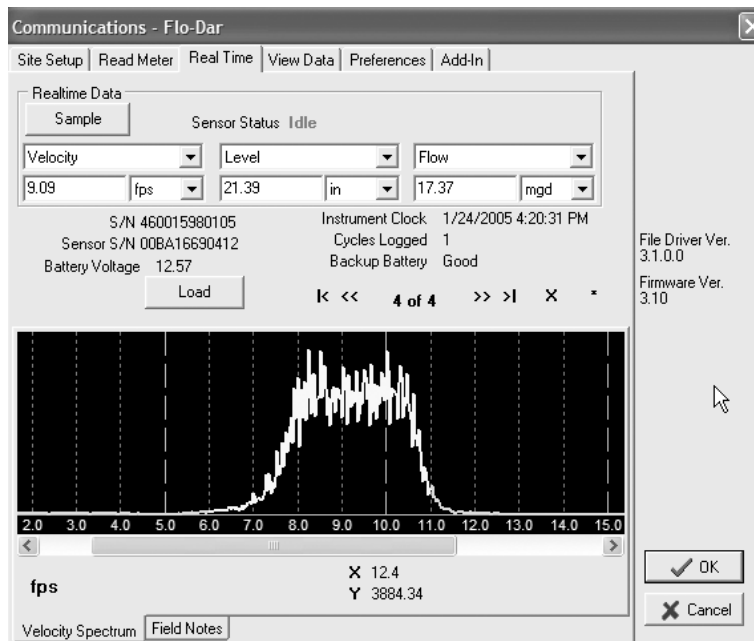
A) Single-click on the “Real Time” tab on the Communications Screen. The real time screen will appear as shown below.



B) Single-click on the “Sample” button. You may or may not see the following pop up window appear.



C) Single-click the “Sample” button. It will take about 45 to 60 seconds for the meter to sample velocity, level, and send the data packet to the data logger. It will then display the real time sample on the screen (see below).



D) Confirm the level reading on the screen matches the actual water level in the pipe.
Confirm that the velocity reading on the screen matches the velocity you approximate in the pipe.

14) Close the real time window and Flo-Ware main screen.

15) Disconnect the communications cable from your laptop to the data logger.

16) Screw the protective metal cap onto the communications port connector. in order to protect the connector from damage due to water or dirt.

17) Coil the sensor cables and secure them to the top ladder rung. Hang the data logger from the top ladder rung. (See Figure 9 next page.)

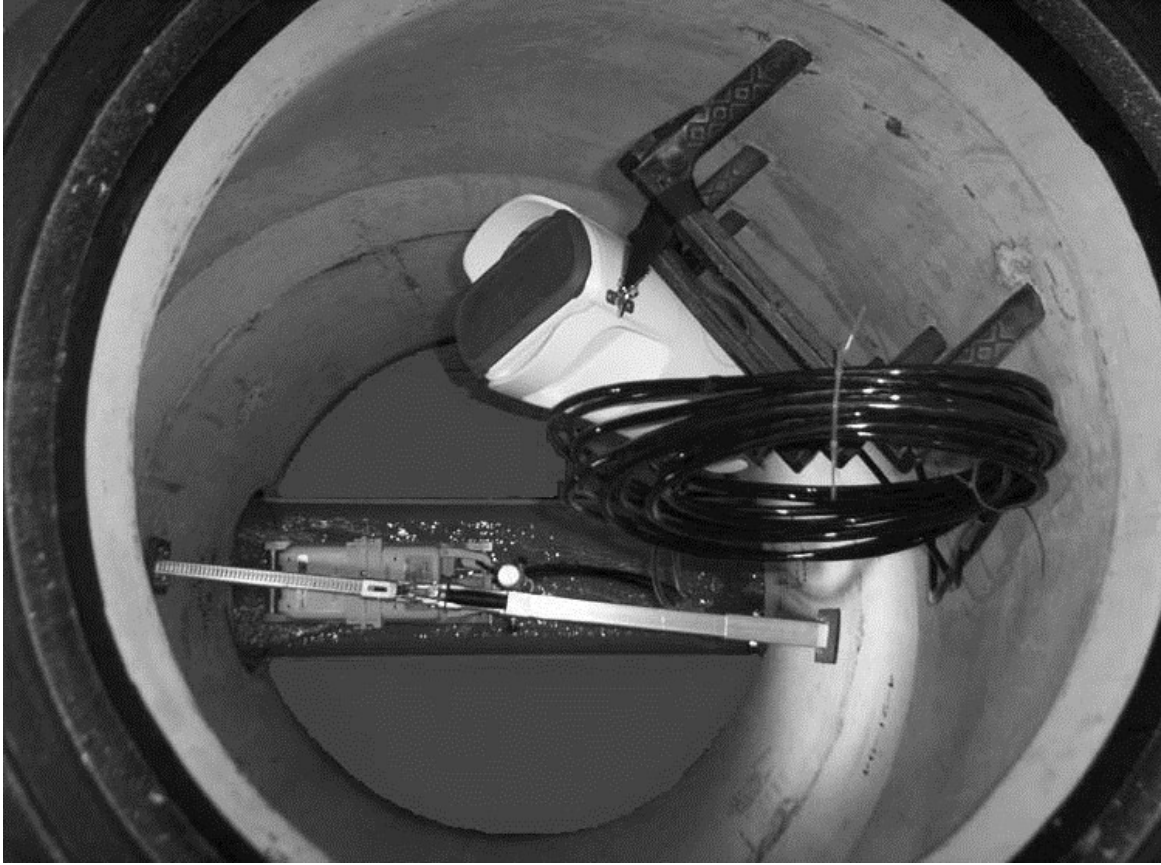


Figure 9

You have successfully installed the Flo-Dar Flowmeter. Please remember to secure the manhole lid prior to leaving the site.

If you have any questions regarding this flowmeter, please contact US3. Please note that telephone support is available Monday through Friday between 9:00 AM and 5:00 PM U.S. Pacific Standard Time.

Marsh-McBirney FLO-DAR® Area/Velocity Radar Flow Meter Sensor



The Flo-Dar Sensor provides an ideal solution for non-contact, maintenance-free portable or permanent sewer flow monitoring.

Features and Benefits

The Flo-Dar Area/Velocity Radar Flow Meter provides a revolutionary approach to open channel flow monitoring. The sensor combines advanced Digital Doppler Radar velocity sensing technology with ultrasonic pulse echo depth sensing to remotely measure open channel flow. Use with FL900 Series Flow Logger or Flo-Logger/Logger XT for portable monitoring; for permanent monitoring sites, the Flo-Dar can be connected to the Flo-Station which displays flow rate, velocity, and level. (See Lit. No. 2709 [standard] or Lit. No. 2711 [wireless] for Flow Logger product information, or Lit. No. 2616 for Flo-Station product information). Intrinsically safe models available.

Accurate Flow Measurement

Flo-Dar provides the user with highly accurate flow measurements under a wide range of flows and site conditions. By measuring the velocity of the fluid from above, Flo-Dar eliminates accuracy problems inherent with submerged sensors including sensor disturbances, high solids content and distribution of reflectors.

Non-Contact Sensor Eliminates Lost Data

No lost data with non-contact, above the flow sensor that is unaffected by fouling due to debris and grease.

Easy Installation and Maintenance

As the sensor is mounted above the flow, personnel have little or no contact with the flow during installation. Future sensor removal can be done without the need for confined space entry.

Independent Accuracy / Long-Term Stability Verification

Flo-Dar sensor accuracy and long-term stability (up to 3 years without need for site calibration) from low flow depths up to surcharge conditions has been independently verified

many times over the years including a formal evaluation by the Alden Research Laboratory, Inc. and recent field evaluations done by municipalities and consulting engineering firms.

Perfect Solution for Difficult Flow Conditions

Operates in the most difficult conditions including flows with high solids content, high temperature, shallow and caustic flows, large man-made channels, and high velocities up to 20 ft/s.

Optional Surcharge Velocity Sensor

During surcharge events Flo-Dar's optional electromagnetic sensor will continue to provide uninterrupted and accurate flow monitoring through dry and wet weather flows without the need for routine sensor cleaning or maintenance.

Applications

Municipal

- Sanitary Sewer Evaluation Studies
- Collection Systems
- Capacity Studies
- Combined Sewer Overflows
- Inflow and Infiltration (I&I) Studies
- Billing / Custody Transfer
- Plant Influent and Effluent

Industrial

- Process Waste
- Plant Influent
- Plant Effluent
- Non-contact Cooling Water
- Stormwater Monitoring and Compliance

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage



Be Right™

WW

IW

C

Specifications*

FLO-DAR SENSOR

Enclosure

IP68 Waterproof rating, Polystyrene

Dimensions

160.5 W x 432.2 L x 297 D mm (6.32 x 16.66 x 11.7 in.), with SVS, D = 387 mm (15.2 in.)

Weight

4.8 kg (10.5 lbs.)

Operating Temperature

-10 to 50°C (14 to 122°F)

Storage Temperature

-40 to 60°C (-40 to 140°F)

Power Requirements

Supplied by FL900 Flow Logger, Flo-Logger, or Flo-Station

Interconnecting Cable

-Disconnectable at both sensor and logger or Flo-Station

Polyurethane, 0.400 (±0.015) in. diameter; IP68
Standard length 9M (30 ft), maximum 305 m (1000 ft)

Cables are available in two styles:

-connectors both ends
-connector from sensor with open leads to desiccant hub, desiccant hub with connector to logger. A potting/sealant kit will be included. This can be used to run the cable through conduit.

Important Note: The sensor cable assembly with desiccant hub is compatible with either the Marsh-McBirney Flo-Logger/Logger XT or the Hach FL900 Series Flow Loggers. When using this cable assembly with the Marsh-McBirney Flo-Logger, do not disconnect the desiccant cartridge that is attached to the Flo-Logger itself. It is important to keep the air tube plugged.

If using Flo-Dar cable with Flo-Station, the cable will have bare leads to the Flo-Station (30 to 1000 ft. lengths) and there will be no desiccant hub, as the air tube terminates inside of the Flo-Station housing.

Warranty

1 year

Set-up/Data Retrieval

Flo-Ware for Windows software is the user on-site set-up, data management, and report generation software. It is compatible with desktop/laptop computers utilizing Windows operating system.

Certification

The Flo-Dar Transmitter is certified to the following requirements:

- Transmitter type: Field Disturbance Sensor
- Frequency: 24.125 GHz - Doppler pulse
- Maximum rated power output: 128 dbuV (ave) @ 3 meters

Certified to: FCC Part 15.245: FCC ID: VIC-FLODAR24
Industry Canada Spec. RSS210. v7: IC No.: 6149A-FLODAR24

Use of this device is subject to the following conditions:

1. There are no used serviceable items inside this device.
2. The user must install this device in accordance with the supplied installation instructions and must not modify the device in any manner whatsoever.
3. Any service involving the transmitter must only be performed by Hach Company.
4. The user must ensure that no one is within 20 cm of the face of the transmitter when operating.

SURCHARGE DEPTH MEASUREMENT

Auto zero function maintains zero error below 0.5 cm (0.2 in.)

Method

Piezo-resistive pressure transducer with stainless steel diaphragm

Range

3.5 m (138 in.), overpressure rating 2.5 x full scale

VELOCITY MEASUREMENT

Method

Radar

Range

0.23 to 6.10 m/s (0.75 to 20 ft/s)

Frequency Range

24.075 to 24.175 G-Hz, 15.2mW (max.)

Accuracy

±0.5%; ±0.03 m/s (±0.1 ft/s)

DEPTH MEASUREMENT

Method

Ultrasonic

Standard Operating Range from Flo-Dar Housing to Liquid

0 to 152.4 cm (0 to 60 in.)

Optional Extended Level Operating Range from Transducer Face to Liquid

0 to 6.1 m (0 to 20 ft.) with 43.18 cm (17 in.) dead band, temperature compensated.

Accuracy

±1%; ±0.25 cm (±0.1 in.)

FLOW MEASUREMENT

Method

Based on Continuity Equation

Accuracy

±5% of reading typical where flow is in a channel with uniform flow conditions and is not surcharged, ±1% full scale max.

SURCHARGE CONDITIONS DEPTH/VELOCITY

DEPTH (Std with Flo-Dar Sensor)

Surcharge depth supplied by Flo-Dar sensor.

VELOCITY (Optional Surcharge Velocity Sensor)

Method

Electromagnetic

Range

±4.8 m/s (±16 ft/s)

Accuracy

±0.15 ft/s or 4% of reading, whichever is greater.

Zero Stability

> ±0.05 ft/s

CERTIFICATION INTRINSICALLY SAFE

The Flo-Dar and Surcharge Velocity Sensors are certified to Class I, Zone 1 Standards. They conform to ANSI/UL 60079-11 and are certified to CAN/CSA E60079-11 and EN 60079-11 standards.

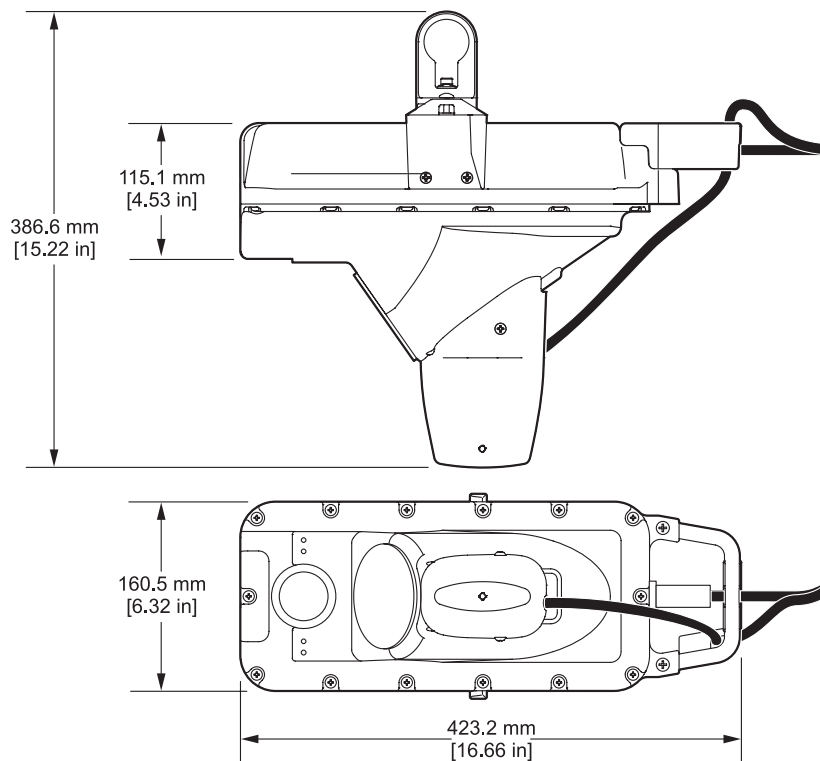


The Flo-Dar sensor meets CE requirements.

Engineering Specifications

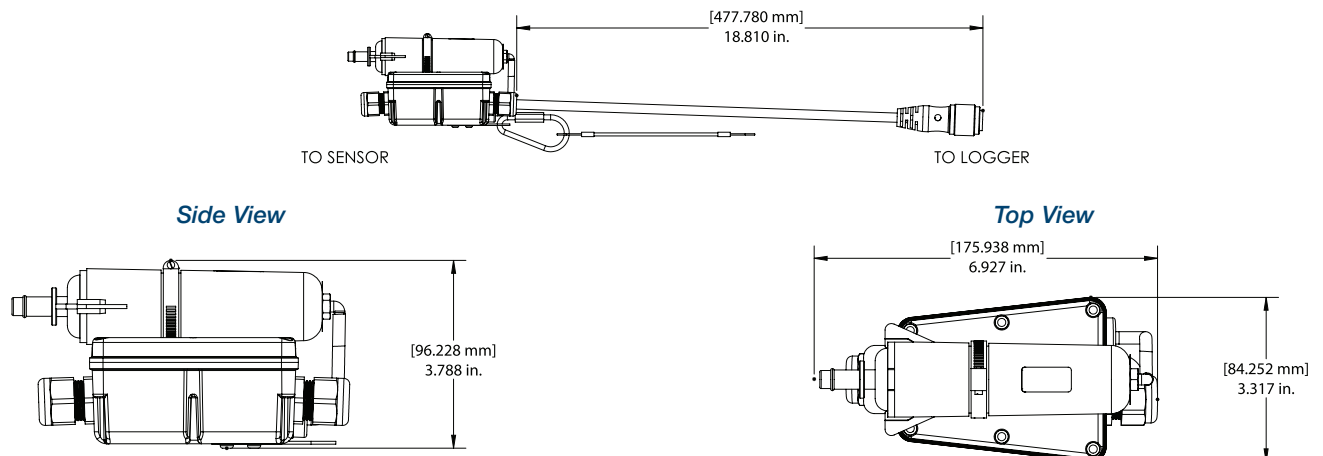
1. The flow meter shall be capable of measuring level, average velocity and surcharge depth.
2. The method of velocity measurement shall be Doppler radar.
3. The sensor shall combine advanced Doppler Radar velocity sensing technology with ultrasonic pulse echo depth sensing to remotely measure open channel flow.
4. Flow shall be calculated based on the Continuity Equation ($Q=V \times A$), where Q =Flow, V =Average Velocity and A =Area.
5. The range of velocity measurement shall be 0.23 to 6.10 m/s (0.75 to 20 ft/s).
6. The method of depth measurement shall be ultrasonic.
7. The standard operating range for depth measurement shall be 0 to 152.4 cm (0 to 60 in.) with an optional operating range of 0 to 6.1 m (0 to 20 ft.) with 43.18 cm (17 in.) deadband, temperature compensated.
8. The flow meter shall have a surcharge condition velocity sensor option.
9. Exterior dimensions of the sensor shall not exceed 160.5 W x 432.2 L x 297 D mm (6.32 W x 16.66 L x 11.7 D in.) or 160.5 W x 432.2 L x 387 D mm (6.32 W x 16.66 L x 15.2 D in.) with Surcharge Velocity option.
10. The sensor shall be able to measure bi-directional surcharge flow.
11. Optional Intrinsically Safe models available for flow monitoring in hazardous locations.
12. The model shall be the Marsh-McBirney Flo-Dar Open Channel Flow Meter Sensor.

Dimensions



Flo-Dar Area/Velocity Radar Flow Meter

The desiccant hub assembly includes a junction box to connect sensor cable to the desiccant and subsequently to the FL900 Logger. The desiccant can easily be replaced without need to purchase a separate desiccant module.



*Desiccant Hub Assemblies for use with portable FL900 Series Loggers and Flo-Logger.
(Sensor cable for use with Flo-Station will not contain a desiccant hub and will have bare wires on cable end.)*

Ordering Information

Configure FLO-DAR Sensor to Logger (Portable)

Flo-Dar Sensor	Model 4000	-	4	X	X
Flo-Dar Sensor with specified cable length (need to add cable as separate line item)			4		
Non Intrinsically Safe Surcharge Velocity Sensor Option (IMPORTANT NOTE: SVS cable length MUST MATCH FloDar Sensor Cable length)				0 3	
Non Extended Range Extended Range Option —Allows use in flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60". SVS Option requires Remote Extended Range below. Remote Extended Range Option with 6' sensor cable —Flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60".					0 1 2

Configure FLO-DAR Sensor to Flo-Station (Permanent)

Flo-Dar Sensor	Model 4000	-	9	X	X
Flo-Dar Sensor with specified cable length (need to add cable as separate line item)			9		
Non Intrinsically Safe Surcharge Velocity Sensor Option (IMPORTANT NOTE: SVS cable length MUST MATCH Flo-Dar Sensor Cable length)				0 3	
Non Extended Range Extended Range Option —Allows use in flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60". SVS Option requires Remote Extended Range below. Remote Extended Range Option with 6' sensor cable —Flow depths up to 18 feet. Allow for 18" deadband. Standard unit max depth is 60".					0 1 2

Cables

FD9000CBL-XXX*	FL900 Series Logger to Flo-Dar sensor. Cable w/two connectors.
FDJCTBOXCBL-XXX*	FL900 Series Logger to Flo-Dar sensor. Cable with connector to sensor, open end to desiccant hub, desiccant hub with connector to sensor. Includes finishing kit for potting/sealing desiccant hub. For use with conduit.
6000062XX*	SVS Sensor with connector for use with FL900 Series Logger.
570011800-XXX* Model 4000-9	Flo-Station to Flo-Dar sensor Cable with one connector and bare leads.
6000059XX*	SVS Sensor with bare leads for use with Flo-Station. *Contact customer service for product numbers.
Available Cable Lengths (in feet)	
30	125 225 400 700
60	150 250 450 800
75	175 300 500 900
100	200 350 600 1000

See Lit. No. 2709 (standard models) and Lit. No. 2711 (wireless models) for FL900 Series Flow Logger ordering information. See Lit. No. 2616 for Flo-Station ordering information.

Mounting Hardware

800016701	Permanent Sensor Mount—Includes sensor frame & all mounting hardware. Portable Sensor Mounts Available (Sizes 34-107") Contact Sales.
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Accessories & Spares

245000501	Sensor Retrieval Pole - Used to place and retrieve sensor from mounting bracket. Pole extends to 7.3 m (21 ft.)
510012701	Sensor Retrieval Hook - Used with Sensor Retrieval Pole
570011401	Grounding Strap (required with Retrieval Pole and Hook when used with IS units)
8755500	Bulk desiccant beads (1.5 pounds)

Lit. No. 2708 Rev 2

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In the interest of improving and updating its equipment, Hach Company reserves the right to alter specifications to equipment at any time.



At Hach, it's about learning from our customers and providing the right answers. It's more than ensuring the quality of water—it's about ensuring the quality of life. When it comes to the things that touch our lives...

Keep it pure.

Make it simple.

Be right.

For current price information, technical support, and ordering assistance, contact the Hach office or distributor serving your area.

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www.hachflow.com

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Telephone: +32-87-899799
Fax: +32-87-899790
E-mail: site@flow-tronic.com
www.flow-tronic.com



Be Right™

Hach FL900 Series Cellular Wireless Flow Logger

FLOW

NEW!



When combined with the Flo-Dar or Flo-Tote 3 sensor, the Hach FL900 Series Wireless Flow Logger takes flow monitoring to a whole new level. With features that reduce site time and increase crew safety, the wireless flow monitoring system allows you to easily manage your flow data 24/7, as well as your budget.

WW

Features and Benefits

The FL900 Wireless Flow Logger provides users with a reliable, budget saving open channel wireless flow monitoring solution for open portable flow monitoring applications. Flow data is accessible 24/7 with Hach fsDATA web-based software. When combined with the Flo-Dar or Flo-Tote 3 sensor, the system will drastically reduce site time and increase safety for monitoring crews.

Increase Monitoring Crew Safety

With the time saving features designed into the FL900 Wireless Flow Loggers, crews spend less time in the manhole and less time on site to decrease monitoring costs while increasing the safety of flow monitoring crews.

Plug and Play Sensor Ports

The FL900 Series Flow Logger is available with 1, 2 or 4 sensor ports. The sensor ports are "plug and play"; the logger auto-detects the type of sensor connected (Flo-Dar, Surcharge Velocity Sensor or Flo-Tote 3) to allow customers maximum flexibility for their Hach flow sensor inventories.

Flow Monitoring Data at Your Fingertips with fsDATA™ Web-Based Software

Hach fsDATA web-based flow meter software is the ideal time-saving and economical solution for the management of your Hach wireless flow meters and data 24/7. With

fsDATA routine site visits to collect flow data are eliminated keeping flow monitoring crews safe. (See Lit. No. 2707 for additional information on fsDATA.)

Easy Installation/Versatile Mounting Options

The logger can be quickly attached to a wall, pole or manhole ladder in minutes. Users can choose to hang logger from standard carabiner or optional 4-bolt wall mount for pole, horizontal or vertical wall mount or ladder rung mount.

LED Gives Quick Confirmation of Logger Status

Get peace of mind the logger is ready to capture the next flow event, before you leave the site. The rugged FL900 Wireless Flow Logger includes a status LED panel. The indicator light on the top of the logger shows the status of the instrument and modem (if equipped with wireless option). The user can manually send a call to the server to make sure the network connection is good by simply swiping the magnet over the call initiation target.

IW

C

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage



Be Right™

Specifications*

FL900 SERIES FLOW LOGGER PORTABLE DC POWERED ELECTRONICS (Includes Models FL901, FL902 & FL904)

Dimensions (W x D x H)

25.4 x 22 x 40 cm (10.0 x 8.7 x 16.0 in.)

Enclosure

PC/ABS structural foam

Environmental Rating

NEMA 6P (IP68)

Weight (Using Model FL900)

4.5 kg (10 lb)—no batteries; 6.3 kg (14 lb)—2 batteries;
8.2 kg (18 lb)—4 batteries

Operating Temperature

-18 to 60°C (0 to 140°F) at 95% RH

Storage Temperature

-40 to 60°C (-40 to 140°F)

Power Requirements

8 to 18 Vdc from batteries or external power source,
2.5W max.

Battery Life at 15 minute logging intervals (at room temperature)

185 days with 4 lantern batteries and a Flo-Dar sensor,
306 days with 4 lantern batteries and a Flo-Tote sensor

The optional long life alkaline battery pack can be used to extend battery life, if the Flow Logger is ordered with the external power option connector.

LED Status Indicator

- Green Flashes every 3 seconds during normal operation.
Flashes every 15 seconds during sleep mode.
- Red Flashes when an attached sensor does not agree with the logger program, when an expected sensor is not found or the sensor is not working properly.

LED Modem Indicator

- Stays green during a call to the server. Goes blank after the call is successfully completed and terminated.
- Flashes red if the call to the server failed.

Sensor Ports

1, 2 or 4 ports

Connectors

Stainless steel connectors

Datalog Channels

16 maximum

Alarms

Maximum of 16 channel alarms including high/high, high, low, low/low and system alarms including low battery, low RTC battery, low slate memory, slate memory full.

Alarm Actions

Trigger sampler, change logging interval, change call interval, send an e-mail, or send text message (SMS).

Logging Intervals

1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes
Primary and secondary intervals for dynamic logging.

Data Storage

Event Log: 1,000 events maximum in non-volatile flash memory
Sample History: 2,000 sample events maximum in non-volatile flash memory
Datalog: 325,000 data points; 1128 days for 3 channels at 15-minute log intervals

Local Communication

USB

RS232 (Baud rates: 9600, 19200, 38400, 57600, 115200)

Remote Communication (optional)

Wireless modem; CDMA or GPRS technology with a mobile provider, CDMA2000 1xRTT or GPRS.

Protocols

Modbus RTU; Modbus ASCII; Mobile-Terminated SMS;
Mobile-Originated SMS; TCP/IP

Timebase Accuracy

±0.002%, synchronized every 24 hours with server software and modem

Supported Sensors

Flo-Tote 3, Flo-Dar, Flo-Dar with SVS, Rain Gauge

Sampler Interface

Compatible with Sigma 900 Standard, Sigma 900 Max, Hach SD900 to support set-point sampling, flow- pacing, and logging sample history.

Desktop Software

Flo-Ware for Windows software is required for programming the logger, data management, and report generation software. It is compatible with desktop/lap top computers utilizing Windows operating system. Minimum resolution needed is 1024x768.

Internet Application Software

FSDATA web-based software for flow meter data management and report generation for wireless flow meters and data access 24/7.

Certifications

Logger: CE; optional AC power supply: UL/CSA/CE

Warranty

1 year



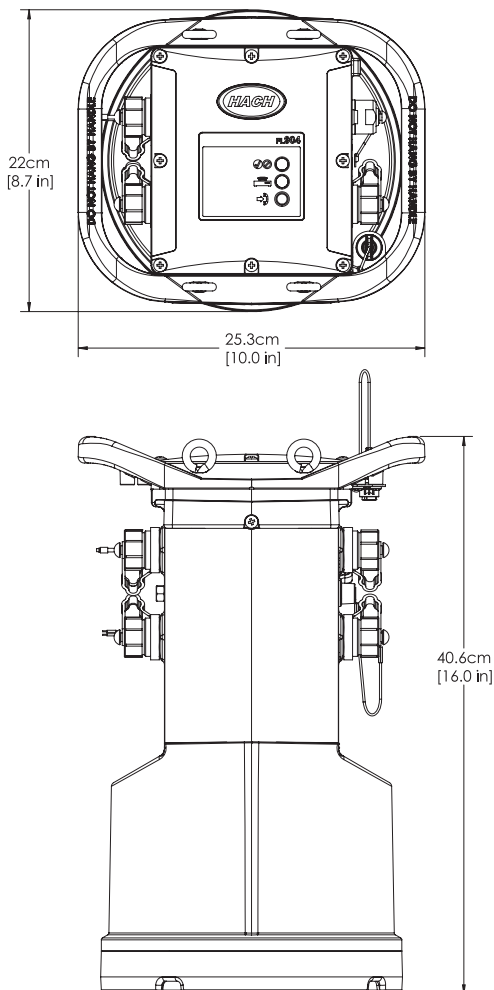
The FL900 Series Loggers meet CE requirements.

*Specifications subject to change without notice.

Engineering Specifications

- Exterior dimensions of the Flow Logger shall be 25.4 W x 22 D x 40 cm H (10.0 W x 8.7 D x 16.0 in. H)
- The Flow Logger enclosure material shall be PC/ABS structural foam with NEMA 6P (IP68) rating.
- The operating temperature for the Flow Logger shall be -18 to 60°C (0 to 140°F) at 95% relative humidity and storage temperature of -40 to 60°C (-40 to 140°F).
- Power requirements of the Flow Logger shall be 8 to 18 Vdc from batteries or external power source, 2.5W max.
- When used with a Flo-Dar sensor, the Flow Logger shall have a battery life of 185 days utilizing 4 6v alkaline batteries at a 15 minute logging interval (at room temp.). When used with a Flo-Tote sensor, the Flow Logger shall have a battery life of 306 days utilizing 4 6v alkaline batteries at a 15 minute logging interval (at room temperature). A long-life battery for longer deployments shall be available option.
- The Flow Logger shall have 1, 2 or 4 sensor ports with stainless steel connector, 1 communications port and 1 auxiliary port.
- The Flow Logger shall have primary logging intervals of 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes.
- The Flow Logger shall have secondary logging intervals available to modify the logging rate based on a defined channel alarm condition or trigger.
- Optional remote communication shall be available on the FL900 Series Loggers via Wireless modem; CDMA2000 1xRTT or GPRS.
- The Flow Logger data storage event log shall be 1,000 events maximum in non-volatile flash memory.
- Timebase Accuracy of the Flow Logger shall be 0.002% synchronized every 24 hours with server software and modem.
- The Flow Logger shall support the Flo-Dar, Flo-Dar with SVS, Flo-Tote 3 Sensors and Rain Gauge.
- The Flow Logger shall be compatible with Sigma 900 Standard, Sigma 900 Max and Hach SD900 to support set point sampling, flow-pacing and sample history logging.
- The Flow Logger shall be able to connect to a lap top or desk top PC using either USB or RS232 serial connection.
- The Flow Logger shall have an LED indicator for operating /programming status visible on the topmost horizontal surface of the logger.
- The internet data management software shall indicate sites in alarm condition in either a map view or list view.
- When connected to an external power source, the FL900 series logger shall be capable of power switching, i.e. drawing power from the external source and conserving the alkaline batteries inside the logger base. At the time the external power source reaches a low alarm condition, it will then switch the power draw to the alkaline batteries mounted inside the base of the logger.
- The internet software for flow data management shall be Hach FSDATA.
- The logger will be a Hach FL901, FL902, or FL904 Flow Logger.

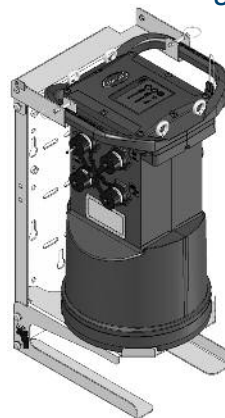
Dimensions



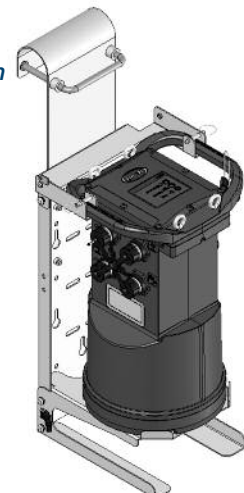
Installation/Mounting Options



*Flow Logger
Suspension Cable with
Carabiner (Standard)*



*Flow Logger Wall Mount
Prod. No. 8542700
(Optional)*



*Flow Logger Ladder Rung Mount
Prod. No. 854450
(Optional)*

Ordering Information

FL90X Electronics (Flow Logger)	Model FL90	Sensor Connector(s)	Country Code	Modem	Rain Gauge
1 Sensor Connector		1	97		
2 Sensor Connectors		2			
4 Sensor Connectors		4			
None				X	
AT&T (Activated)				A	
GPRS no SIM				G	
Sprint (Inactive)				R	
Sprint (Activated)				S	
No Rain Gauge Connector					X
With Rain Gauge Connector					R

Cables

- 8528700** Cable, External power, 2 wire, 9 ft.
8528200 Cable, Communication, RS232
8528300 Cable, Communication, USB
8528400 Cable, Aux, 7pin MIL 5015 (Connect to Sigma Sampler), 9 ft.
8528401 Cable, Aux, 7pin MIL 5015 (Connect to Sigma Sampler), 25 ft

Antennas

- 5228400** Antenna, Half Wave (824-894, 1850-1990 MHz)
 —US for Verizon, Sprint, AT&T, T-Mobile (Is attached to Logger)
6241804 Antenna, Mini-Wing, Quad (824-960, 1710-2170 MHz)
 —US for Verizon, Sprint, AT&T, T-Mobile (Customer to Mount)
6683000 Antenna, Traffic Rated In Road/Burial (1850-1990 MHz)
 —US for use with Sprint only wireless service
6246200 Antenna, Traffic Rated In Road/Burial (824-896 MHz)
 —US for use with Verizon only wireless service
5255400 Antenna, Traffic Rated Manhole Lid (824-896, 1850-1990 MHz)
 —US for Verizon, Sprint, AT&T, T-Mobile

Software

- Model T200-200** Flo-Ware Desktop Software
FS-HOSTING Monthly data hosting service for FS-DATA
FS-DATAFR Monthly wireless service

Mounting Hardware

- 8543800** Wall mount bracket (304 Stainless)
8545600 Wall mount bracket with ladder hanger (304 Stainless)
8542700 Wall mount bracket with AC Power Supply shelf (304 Stainless)
8544500 Wall mount bracket with AC Power Supply Shelf with ladder hanger (304 Stainless)

Replacement Parts

- 8755500** Desiccant refill beads, Bulk 1.5 lb
11013M Battery, 6V lantern
8542900 Battery, long-life alkaline
8543000 Battery pack top cap adaptor and cable
 (for long-life alkaline battery pack 800017701)
8542800 Rain Gauge with 100 ft. cable

Lit. No. 2711

G101.5 Printed in U.S.A.

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In the interest of improving and updating its equipment, Hach Company reserves the right to alter specifications to equipment at any time.

At Hach, it's about learning from our customers and providing the right answers. It's more than ensuring the quality of water—it's about ensuring the quality of life. When it comes to the things that touch our lives...

Keep it pure.

Make it simple.

Be right.

For current price information, technical support, and ordering assistance, contact the Hach office or distributor serving your area.

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www.flow-tronic.com



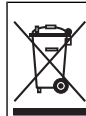
Be Right™

User Instructions

Antennas for flow products

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.



Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/98/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.

Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.

Product components

Make sure that all components have been received. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

Required equipment/software

Make sure that the following requirements are available:

- FL900 Series flow logger with modem option or Sigma 930T
- Remote host computer operating FSDATA or Telogers for Windows server software
- Portable computer operating FSDATA, FloWare or Telogers for Windows
- Activated wireless account

FL900 Series Flow Logger

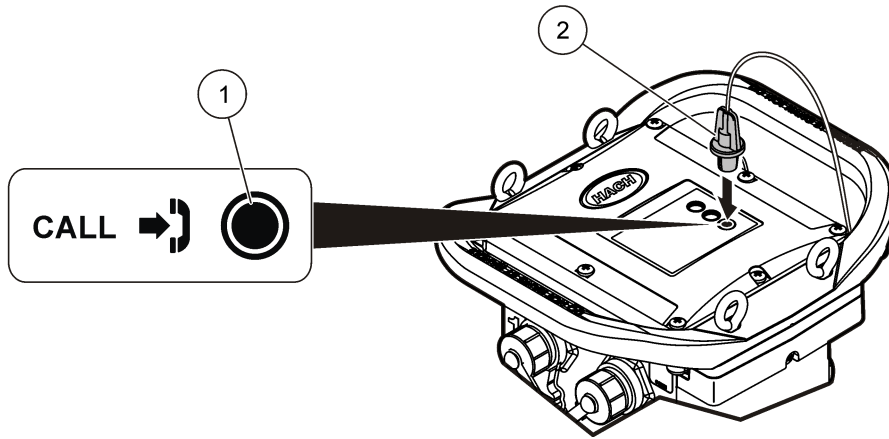
Verify the telemetry (wireless option)

The user can manually send a call to the server to make sure that the network communication is good.

1. Temporarily attach the antenna to the logger to test the antenna and the cell coverage at the site location before installation.
2. Touch the magnet to the call initiation target ([Figure 1](#)). The modem LED indicator changes to green.
3. Look at the modem LED indicator during the call (45 to 90 seconds) and wait for a change:
 - LED goes off—the connection to the server is good.
 - LED flashes red—the connection to the server failed.

Note: If the connection failed, refer to the instrument user manual for more information.

Figure 1 Call the server



1 Call initiation target	2 Magnet
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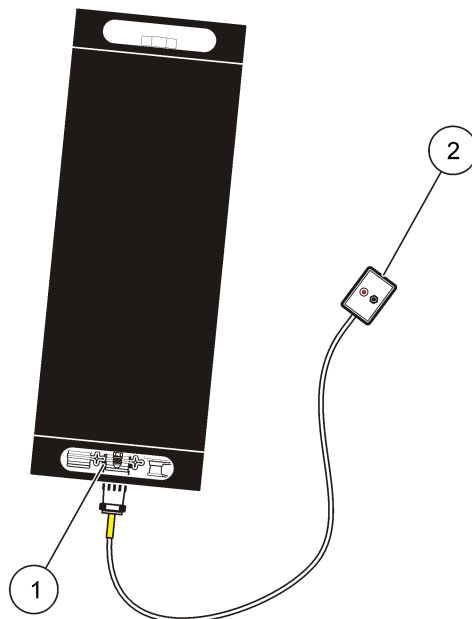
930T Flow meter

Verify the wireless connection

The tamper button is used to examine if the wireless connection is working.

1. Temporarily attach the antenna to the logger to test the antenna and the cell coverage at the site location before installation.
2. Attach the tamper module to the RS232 connector on the flow meter ([Figure 2](#)).
3. Push the tamper button to start a cellular call from the flow meter to the remote host computer.
4. Go to the event log in Telogers for Windows to make sure that the data was successfully downloaded from the flow meter to the remote host computer. Refer to the 930T documentation for further information about telemetry troubleshooting.

Figure 2 Tamper module connected to the 930T Flow meter



1 RS232 connector	2 Tamper module
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Installation

⚠ WARNING

Electromagnetic radiation hazard. To meet the requirements of the FCC Grant, CE Mark and other regulatory bodies, do not use or install the device with an antenna that is not supplied by the manufacturer. Make sure that all antennas are kept at a minimum distance of 20 cm (7.9 in.) from all personnel in normal use.

NOTICE

Test the antenna and cell coverage at the site location before installation.

NOTICE

Make sure that the flow meter is programmed to call the host PC before installation.

Half wave antenna

NOTICE

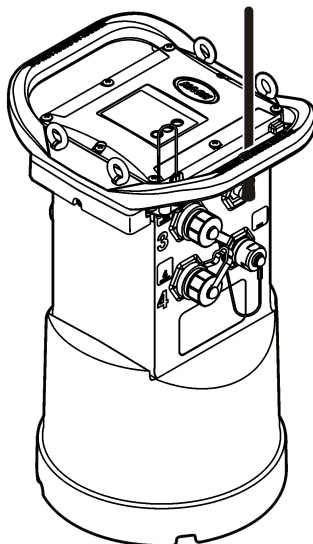
The half wave antenna is intended for above-ground use.

1. Unpack the antenna ([Figure 3](#)).
2. Bend the antenna at the joint to a 90 degree angle between the antenna and the swivel fitting.
3. Put the antenna extension inside of the logger handle ([Figure 4](#)).
4. Align the threads from the antenna fitting to the antenna receptacle on the logger. Hand-tighten by turning the swivel end.

Figure 3 Half wave antenna



Figure 4 Half wave antenna attached



Traffic rated manhole lid antenna

Required tools:

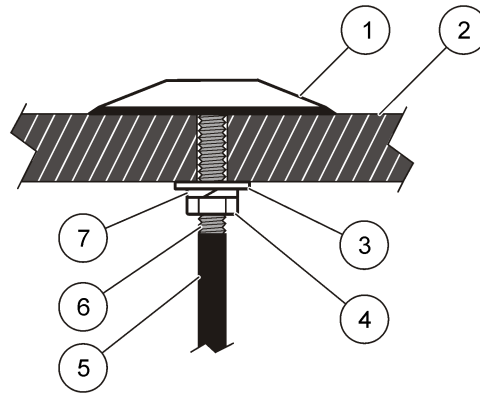
- 31.75 mm (1¼ in.) open-end wrench
- Large nylon Ty-wrap cable ties

1. Unpack the antenna ([Figure 5](#)) or disassemble the antenna from the instrument.
2. Make sure that the manhole lid has a 25.4 mm (1 in.) hole for the antenna neck to fit into.
Note: Do not use the pick hole. Use a drill, motor oil for lubrication and increasing size drill bits to drill the 25.4 mm (1 in.) hole if needed. Make sure that the location of the hole does not coincide with the ribs on the underside of the manhole lid.
3. Remove the manhole lid and put the lid in a stable position where the lid top and bottom are accessible.
4. Remove the nut and washers from the threaded neck on the base of the antenna ([Figure 6](#)).
5. Put the antenna cable and neck through a hole on the manhole lid until the base of the antenna is against the top of the manhole lid.
6. Install the flat washer, then the lock washer and then the nut on to the threaded neck of the antenna.
7. Tighten the nut with the open-end wrench until both washers are flush against the base of the manhole lid and the antenna is tight ([Figure 6](#)).
8. Connect the antenna cable to the instrument connector labeled "Antenna". To make sure proper transmission, hand-tighten the connections.
9. Attach any excess cable to the access ladder or another non-obstructing location with Ty-wrap cable ties.
10. Replace the manhole lid.

Figure 5 Traffic rated manhole lid antenna



Figure 6 Manhole lid installation



1	Antenna top	5	Antenna cable
2	Manhole lid	6	Antenna threaded neck
3	Flat washer	7	Lock washer
4	31.75 mm (1 1/4 in.) nut		

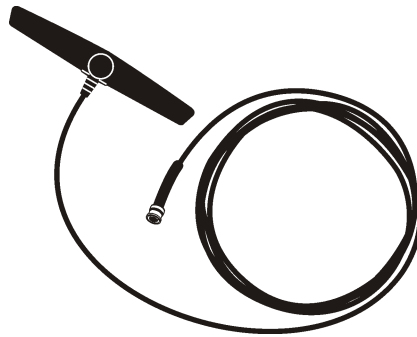
Wing Quad antenna

The Wing Quad antenna can be attached to an interior wall or to a window for a longer term deployment or the antenna can be attached to a manhole lid for a short term deployment.

Required tools:

- Large nylon Ty-wrap cable ties
1. Unpack the antenna ([Figure 7](#)).
 2. To attach the antenna to a window or a wall, remove the adhesive backing and push the antenna to a clean surface.
 3. To attach the antenna to a manhole, make sure that the manhole lid has a hole large enough for the antenna connector to fit into.
Note: Do not use the pick hole. Use a drill, motor oil for lubrication and increasing size drill bits to drill the 1" hole if needed. Make sure that the location of the hole does not coincide with the ribs on the underside of the manhole lid.
 4. Remove the manhole lid and put the lid in a stable position where the lid top and bottom are accessible.
 5. Put the antenna cable and neck through a hole on the manhole lid until the base of the antenna is against the top of the manhole lid.
 6. Attach the antenna to the manhole lid with heavy tape or tar tape.
 7. Connect the antenna cable to the instrument connector labeled "Antenna". To make sure proper transmission, hand-tighten the connections.
 8. Attach any excess cable to the access ladder or another non-obstructing location with Ty-wrap cable ties.
 9. Replace the manhole lid.

Figure 7 Wing Quad antenna



Traffic rated in-road/burial antenna

Required tools:

- Asphalt saw or auger: saw capable of cutting 127 mm (5 in.) in diameter and 76.2 mm (3 in.) deep into a road surface or ground
- Asphalt chisel
- Hammer drill with 19.1 to 25.4 mm ($\frac{3}{4}$ to 1 in.) asphalt drill bit (for antenna cable installation)
- Sakrete asphalt mix (Asphalt patch)
- Bondo; Mar-Hyde P606 Traffic Detector Wire Loop Sealer or equal
- Shovel, if placing in the ground

The traffic rated in-road/burial antenna is intended for burial beneath the road surface or ground adjacent to a manhole or vault that is being monitored ([Figure 9](#)).

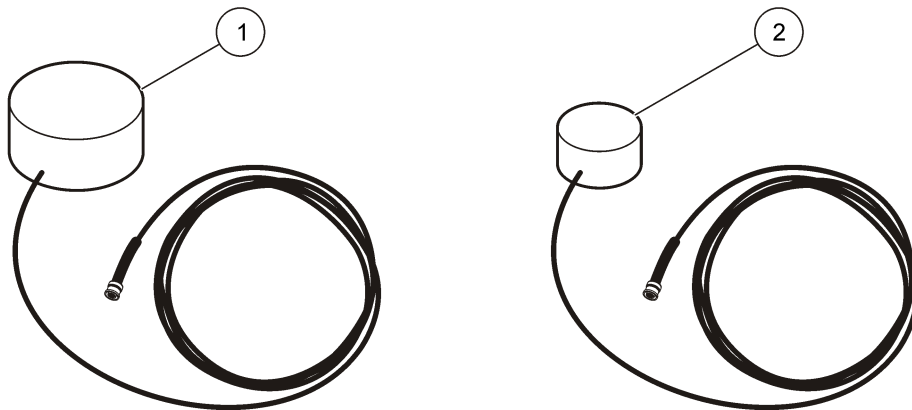
NOTICE

The antenna should be installed in the road approximately 152.4 to 203.2 mm (6 to 8 in.) inches from the manhole or vault containing the flow meter.

1. Unpack the antenna ([Figure 8](#)) or disassemble the antenna from the instrument.
2. Excavate a hole or trench in the road surface or ground approximately 127 mm (5 in.) in diameter (or square) and 76.2 mm (3 in.) deep.
3. Select the closest position from the excavated hole to the manhole. Drill a 19.1 to 25.4 mm ($\frac{3}{4}$ to 1 in.) hole from the selected position to the manhole. Make sure to drill the hole below the steel manhole cover support ring ([Figure 9, List item](#) on page 7).
4. Put the antenna cable through the drill hole into the manhole or vault.
5. Install the antenna in the excavated hole. Pull the antenna cable taut. Locate the antenna so that the ceramic side of the antenna is approximately 6.4 ($\frac{1}{4}$ in.) to 12.7 mm ($\frac{1}{2}$ in.) maximum below the road or ground surface. Make sure the antenna sits safely in the hole.
6. Attach the antenna cable to the antenna connector.
7. Make sure that the antenna is working by placing a call from the instrument (refer to [Verify the wireless connection](#) on page 2).
8. When the operation of the antenna is confirmed, permanently bury the antenna.
 - a. Insert asphalt mix around the antenna and pack it in place. Make sure the antenna is sitting firmly on a solid base and cannot be rocked back and forth.
 - b. Install the asphalt mix around the antenna. The mix should be level with the road surface but not over the antenna surface.
 - c. Pour the Bondo sealer on and over the asphalt mix and over the top of the antenna. There should be no more than 6.4 mm ($\frac{1}{4}$ in.) of Bondo sealer over the top of the antenna.

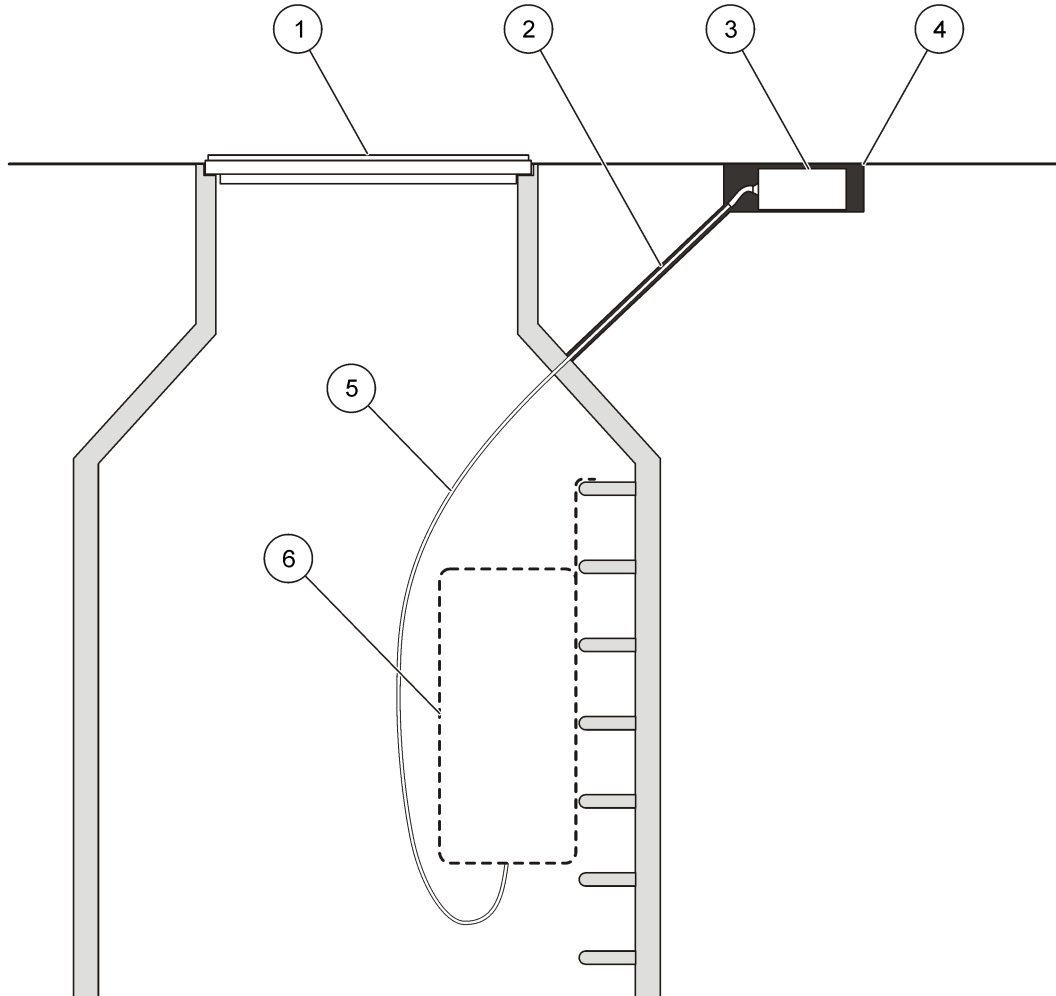
- d. Connect the desired sensors and options to the flow meter. Calibrate the sensors and install the flow meter in the manhole.

Figure 8 Burial antennas



1 Traffic rated in-road/burial antenna (Verizon)	2 Traffic rated in-road/burial antenna (Sprint)
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Figure 9 Burial antenna assembly



1 Manhole cover	4 Trench or hole for antenna
2 19.1 to 25.4 mm (¾ to 1 in.) hole	5 Antenna cable
3 Antenna	6 Flow meter

Replacement Parts

Note: Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.

Description	Item no.
Half wave, 824-894 & 1850-1990 MHz, 3 dBi	5228400
Half wave European, 870-960 & 1710-1880 MHz, 3dBi	5255300
Traffic rated manhole lid quad, 824-896 & 1850-1990 MHz, 3 dBi	5255400
Wing Quad, 824-960 & 1710-2170 MHz, 2.15 dBi	6241804
Traffic rated in-road/burial antenna (Verizon), 824-896 MHz, 3 dBi	6246200
Traffic rated in-road/burial antenna (Sprint), 1850-1990 MHz, 3 dBi	6683000



Tab 4: DVD with Raw Flow Monitoring Data

Tab 5: US³ Company Information

US³ is a California Corporation **Federal ID No. 33-0729605** and qualifies as a Minority Business Enterprise. US³ has certified as an MBE with the California Public Utility Commission's authorized clearinghouse, **Verification Number: 97ES0008**.

US³ is a specialty service company for the Water & Waste Water industry, providing monitoring and control for Utilities since 1996. US³ is in the forefront of this industry by taking the proven technological approaches developed in other high-tech industries and applying them to protect one of our most precious natural resources - our water.

US³ engineers and technical personnel have applied advanced instrumentation system technology to water/wastewater open channel flow monitoring, pipeline evaluation, engineering, and data analysis, all coupled to the power of the Internet. This unique integrated systems approach allows the company to bring greater insight and intelligence to gathering information about water/wastewater system performance of our clients, and in turn, to support the fulfillment of their commitments to manage and cost effectively design, operate, and maintain these systems.

Moreover, **US³** supports Municipalities, Consulting Engineering firms and other water/waste water systems integrators by providing temporary technical services for engineering, software programming and technical site maintenance and calibration site support work, primarily in the Water and Waste Water industries.

Key Personnel Assigned

US³ provided the necessary resources to fully implement this project. Primary in support of this effort were the following personnel:

Mr. Mark Serres: Mr. Serres is a degreed electrical engineer with over 25 years of experience with fresh/wastewater systems, project management, and systems integration in relation to complex industrial systems. This includes experience in industrial automation and water/wastewater industries. Mr. Serres is responsible for assuring client satisfaction and marshalling the required resources to meet the project requirements.

Mr. Thomas Williams: Mr. Williams is an Engineering Manager with over 18 years of experience in complex systems development for wastewater monitoring. This experience includes hydraulic compatibility, instrumentation, communications and analysis. Mr. Williams is responsible for assuring that the required equipment is designed and calibrated to meet the project requirements.

Darlene Szczublewski, PE: Mrs. Szczublewski is a licensed Civil Engineer in multiple states. She has over 15 years of engineering experience with stormwater/wastewater

related projects. She assisted in the completion of several Sanitary Sewer Evaluation Surveys and Capacity Analysis projects to meet Consent Decrees as well as completing numerous Infiltration and Inflow (I&I) studies for other clients. Mrs. Szczublewski has developed numerous flow data analysis techniques to present a clear informative picture of flow in a monitored system. Her work also includes the development of training programs for clients describing I&I and capacity analysis methodologies. Mrs. Szczublewski is responsible for analyzing the data as well as the data collection process and assuring that the reports meet the project requirements.



Figure: All technicians are certified for Confined Space Entry.

Name, Title, Address and Telephone numbers of persons to contact concerning this report.

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Senior Civil Engineer

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