Technical Memorandum 3A

NSMCSD Collection System Capacity Evaluation/Assurance, Management and Improvement Plan

Subject:	**Task 3A: Flow Monitoring Results**
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This Technical Memorandum (TM) summarizes the results of wet weather flow monitoring in the North San Mateo County Sanitation District (NSMCSD, District) sanitary sewer system during the 2007/08 winter season. The purpose of the flow monitoring was to quantify peak wet weather flows in various parts of the District's collection system and compare the magnitude of flows to those predicted in the 1993 City of Daly City Collection System Master Plan (1993 Master Plan). The flow monitoring program was recommended based on the review of the 1993 Master Plan and analysis of historical wastewater treatment plant (WWTP) flows, as discussed in the Draft TM on Review of 1993 Collection System Master Plan, previously submitted to the District.

This TM is divided into the following sections:

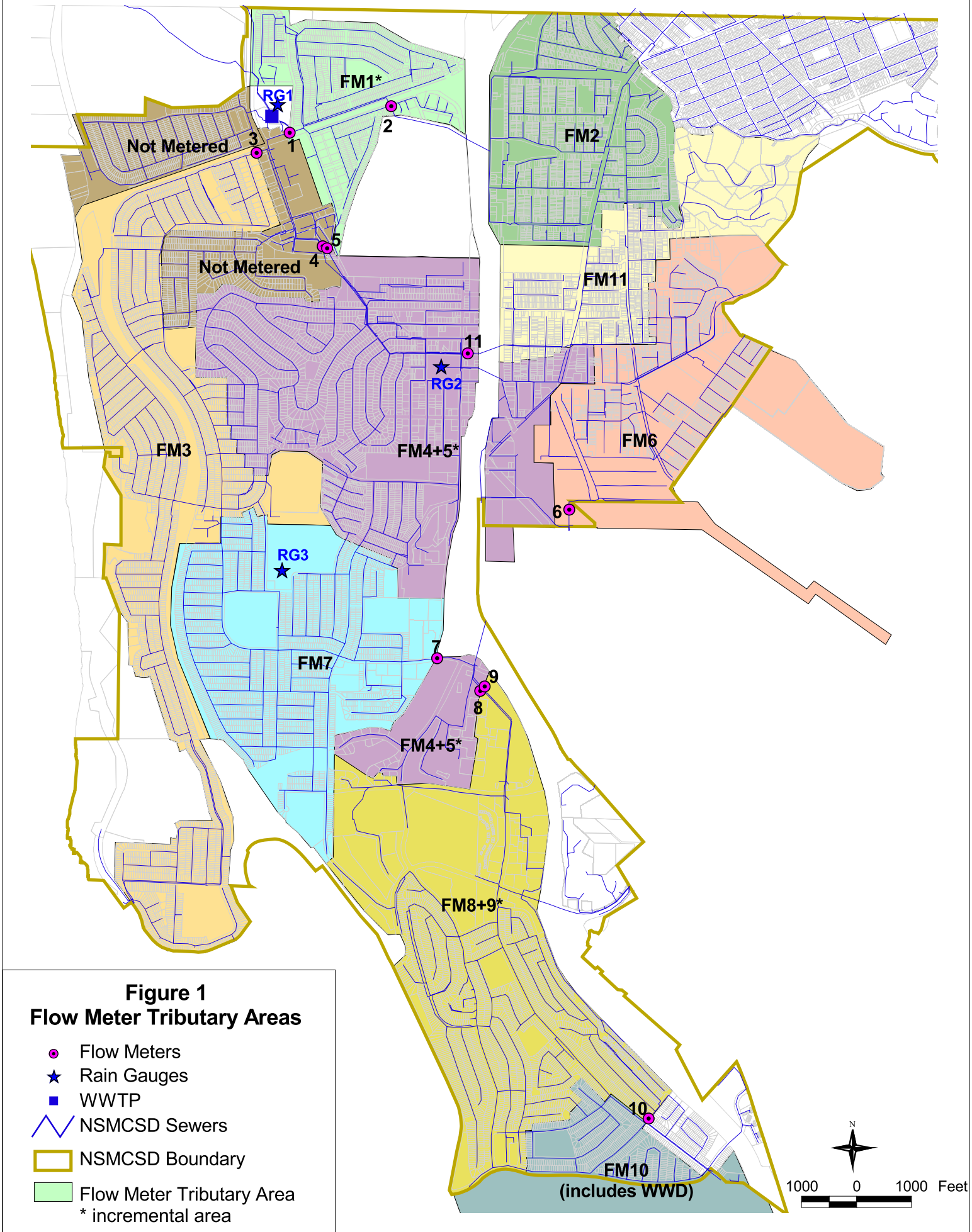
1. Flow Monitoring Program
2. Flow Monitoring Results
3. Comparison to 1993 Master Plan Flows
4. Summary and Conclusions

1 Flow Monitoring Program

The 2007/08 flow monitoring program consisted of eleven temporary flow meters and three rain gauges installed at various locations in the District's sanitary sewer system. The three rain gauges were located at the NSMCSD WWTP, Daly City Civic Center, and Westmoor Park, respectively. **Figure 1** shows the locations of the flow meters and their respective tributary areas, and **Figure 2** provides a schematic diagram of the meters indicating their upstream/downstream relationships. **Table 1** lists the meter locations and pipe sizes.

Note that flows from the combined (northeast) portion of the NSMCSD sewer system that discharges into the City of San Francisco's system, and flows from a few small areas in the southeastern portion of NSMCSD that discharge to South San Francisco's sewer system, were not included in the flow monitoring program. A few areas located west and south of the NSMCSD WWTP (labeled as "Not Metered" in Figure 1) were also not captured by any of the temporary flow meters but are included in the total WWTP flows evaluated in this TM. The non-metered areas comprise only about 5 percent of the total WWTP service area acreage.

The flow monitoring field work was conducted by V&A Consulting Engineers under contract to RMC. V&A utilized Sigma 910 and ISCO 4150 depth-velocity flow meters, which were installed in the inlet pipes of the meter manholes. V&A conducted a site reconnaissance of each site prior to meter installation, and visited the sites at regular intervals during the flow monitoring period to interrogate the meters and obtain field calibration measurements. The field calibration measurements (measurements of


FM1*
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FM7
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FM4+5*
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Figure 1
Flow Meter Tributary Areas
Flow Meters
Rain Gauges
WWTP
NSMCSD Sewers
NSMCSD Boundary
Flow Meter Tributary Area
* incremental area

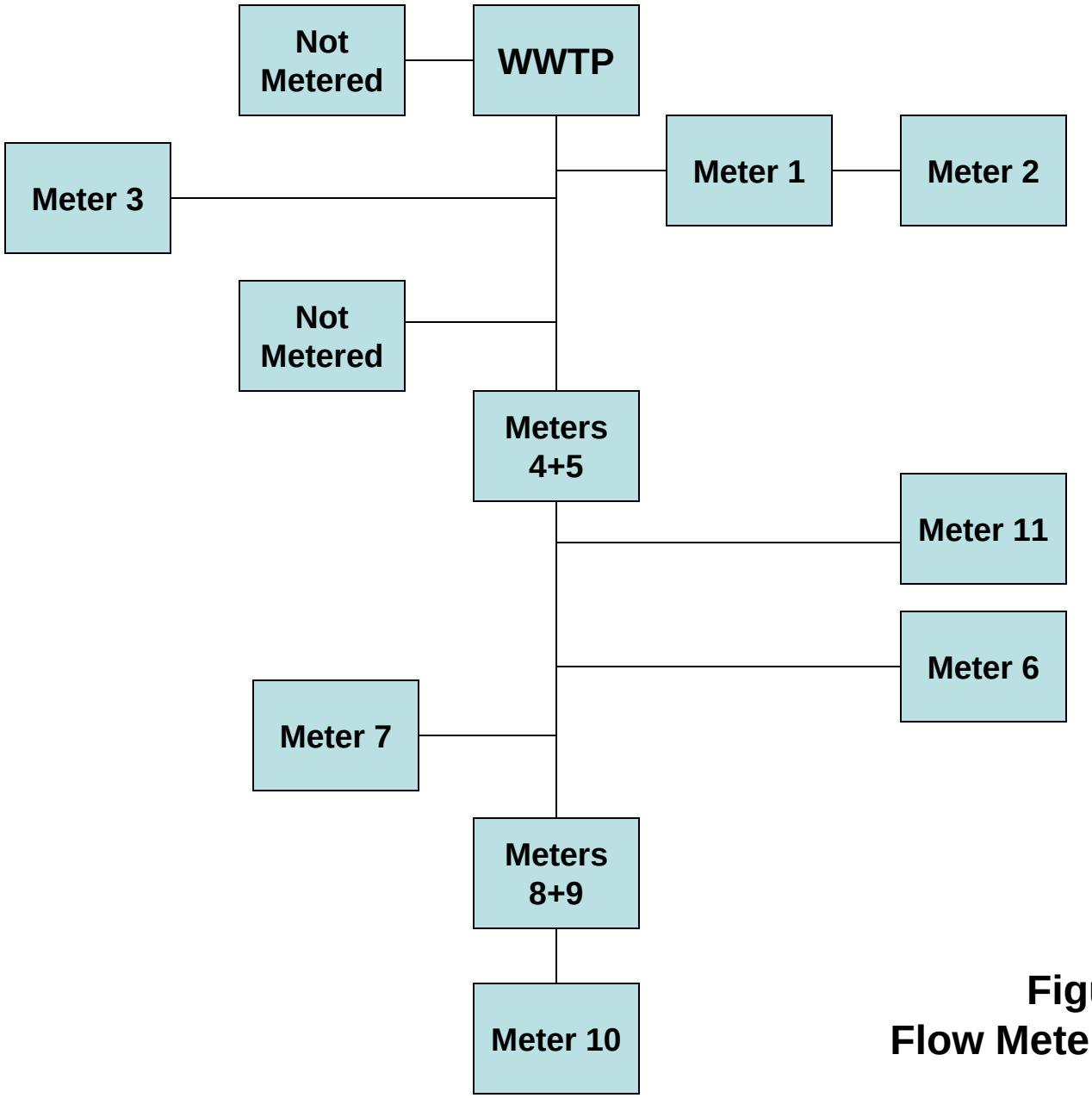


Figure 2
Flow Meter Schematic

flow depth and velocity taken with an independent measuring device) were used to confirm the meter recorded data and make adjustments if necessary.

Table 1: Flow Monitoring Locations

Meter ID*	Meter Manhole	Upstream Manhole	Diam. (in.)	Location
1	MH-C04-119	MH-C04-120	24	John Daly Blvd. at WWTP
2	MH-D03-064	MH-D04-080	18	Mayfair Dr. at S. Mayfair Ave.
3	MH-C04-134	MH-C04-133	21	S. Mayfair Ave. betw. Crestwood & Lake Merced Blvd.
4	MH-C05-154	MH-C05-155	30	w/o Park Plaza Dr. south of Coronado Ave.
5	MH-C05-098	MH-C05-102	18	
11	MH-D06-133	MH-D06-134	24	90th St. east of Sullivan Ave.
6	MH-E07-089	MH-E07-090	15	Upstream of F Street Lift Station
7	MH-D08-014	MH-D08-025	15	Southgate Ave. at Sullivan Ave.
8	MH-D09-007	MH-D09-006	21	Serramonte Center
9	MH-D09-034	MH-D09-033	15	
10	MH-E13-053	MH-E13-085	15	Verducci Ct. northeast of Gellert Blvd.

* Listed in approximate downstream to upstream order (see schematic in Figure 2).

The flow meters were installed on December 22, 2007, and removed on March 2, 2008, for a total monitoring period of about ten weeks. During this period, a total of about 13 inches of rainfall fell on the service area. Very large storm events occurred on January 4 and January 25, each with rain totals in the range of 2-1/2 to over 4 inches. **Figures 3, 4, and 5** show plots of the hourly rainfall at the three rain gauges, and **Table 2** summarizes the rainfall amounts and intensities for the key storm events that occurred during the flow monitoring period.

Figure 3
Rainfall During 2007/08 Flow Monitoring Program
Rain Gauge 1 (NSMCSD WWTP)

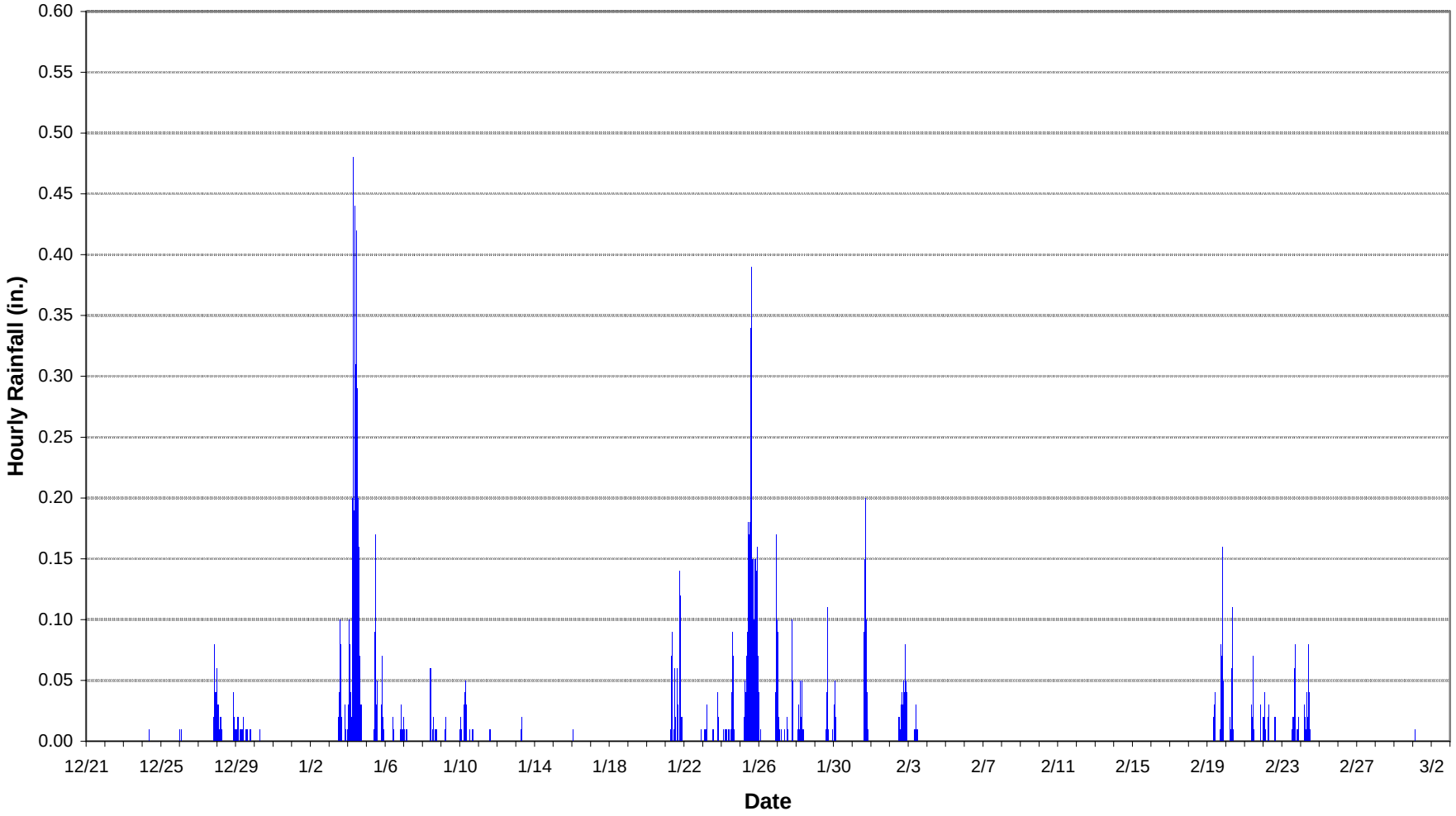


Figure 4
Rainfall During 2007/08 Flow Monitoring Program
Rain Gauge 2 (Daly City Civic Center)

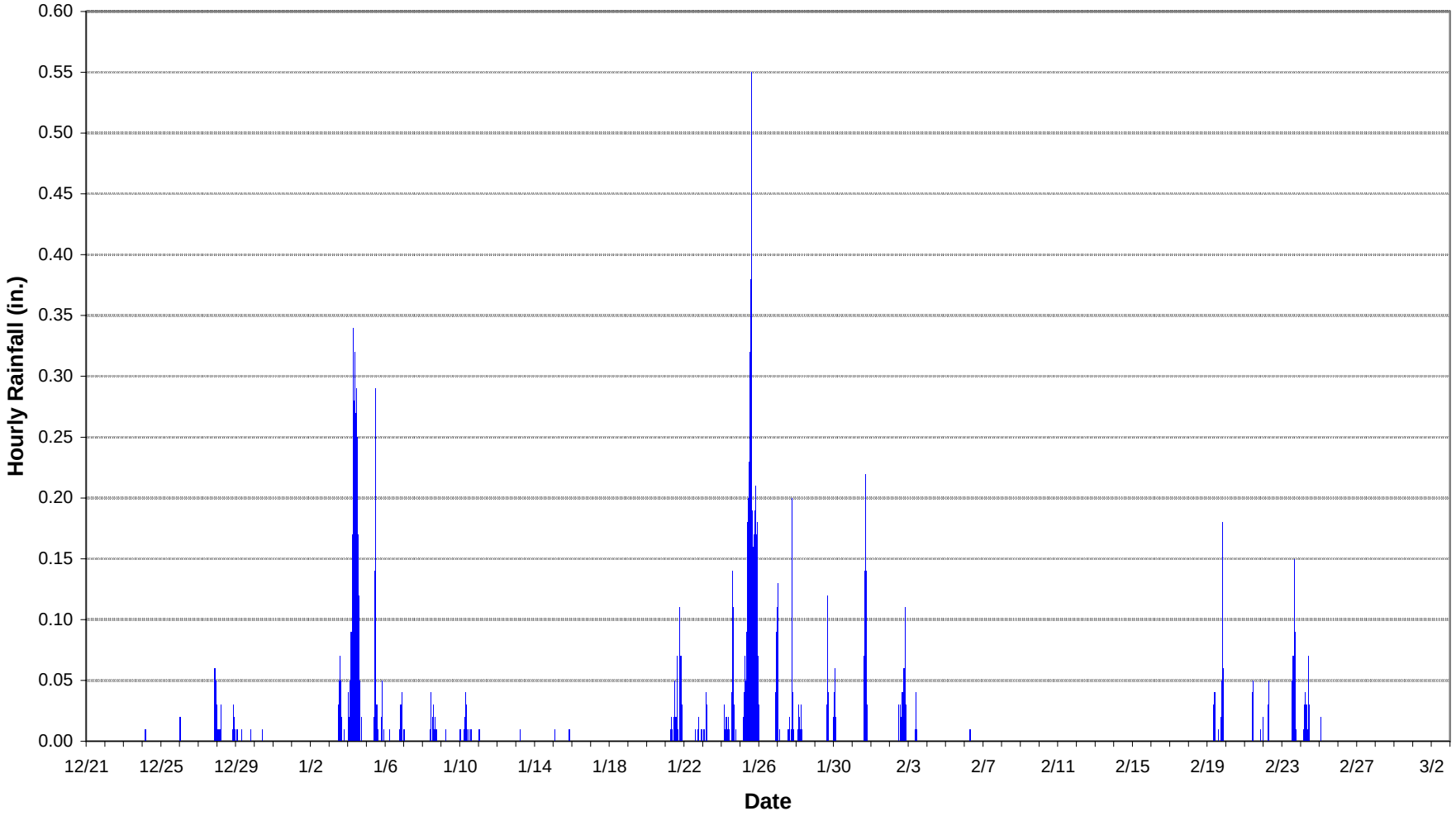


Figure 5
Rainfall During 2007/08 Flow Monitoring Program
Rain Gauge 3 (Westmoor Park)

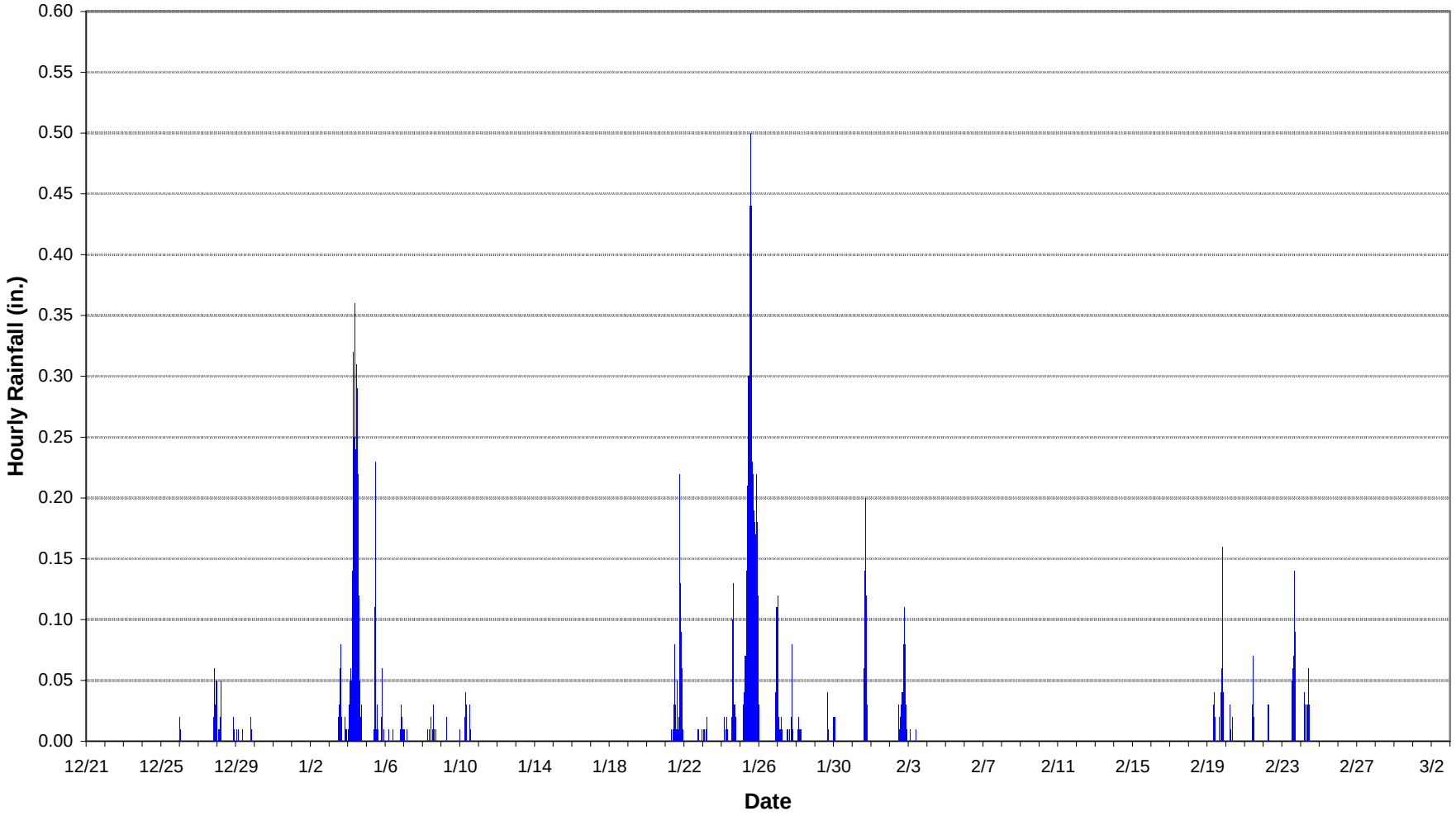


Table 2: Rainfall Events

Start Date	Start Time	Duration (hrs.)	Storm Rainfall (in.)				Average Intensity (in/hr)	Max. Hour (in.)			
			WWTP	Civic Center	West-moor	Avg.		WWTP	Civic Center	West-moor	Avg.
12/27/07	19:30	11	0.40	0.32	0.33	0.35	0.03	0.08	0.07	0.06	0.07
1/3/08	12:15	5	0.26	0.22	0.21	0.23	0.05	0.10	0.07	0.08	0.08
1/4/08	**1:15**	**17**	**3.09**	**2.57**	**2.55**	**2.74**	**0.16**	**0.48**	**0.34**	**0.36**	**0.39**
1/5/08	9:30	6	0.36	0.56	0.42	0.45	0.07	0.20	0.36	0.28	0.28
1/21/08	7:00	15	0.64	0.51	0.75	0.63	0.04	0.19	0.13	0.23	0.18
1/24/08	12:45	6	0.22	0.33	0.33	0.29	0.05	0.09	0.16	0.15	0.13
1/25/08	**4:00**	**21**	**2.85**	**3.79**	**4.37**	**3.67**	**0.17**	**0.39**	**0.55**	**0.54**	**0.49**
1/26/08	21:15	7	0.51	0.43	0.45	0.46	0.07	0.17	0.14	0.13	0.15
1/27/08	18:45	3	0.15	0.26	0.11	0.17	0.05	0.10	0.20	0.08	0.13
1/31/08	15:00	6	0.59	0.60	0.55	0.58	0.10	0.21	0.22	0.20	0.21
2/2/08	11:15	12	0.41	0.42	0.49	0.44	0.04	0.09	0.14	0.12	0.12
2/19/08	17:00	5	0.41	0.31	0.30	0.34	0.06	0.16	0.18	0.16	0.17
2/23/08	13:15	5	0.19	0.43	0.41	0.34	0.06	0.10	0.16	0.14	0.13
2/24/08	5:00	7	0.24	0.24	0.22	0.23	0.03	0.10	0.07	0.07	0.08

2 Flow Monitoring Results

Plots of the flows measured at the NSMCSD WWTP and at each of the monitoring locations during the flow monitoring period are included in the attachments to this TM. All of the meters show a flow response to the storm events of January 4 and January 25, and many of them showed responses to other smaller storm events, indicating that the sewer system is subject to rainfall-dependent infiltration and inflow (RDI/I). **Table 3** summarizes the average and peak flows recorded at the WWTP and each of the flow monitor sites. The flow response, as indicated by the ratio of the peak wet weather flow (PWWF) to the average dry weather flow (ADWF) as measured during the monitoring period, was most noticeable for Meters 1, 2, 5, and 6, which had wet weather peaking factors exceeding 4. The overall wet weather peaking factor for the total system, as measured at the WWTP, was about 3.8. Note that these values are not atypical for Bay Area communities and are lower than those for many older sewer systems, some of which experience peak wet weather flows exceeding 10 times average dry weather flow.

In general, the peak flows recorded at the meter sites did not exceed pipe capacity, as indicated by the maximum flow depths and depth-to-diameter (d/D) ratios shown in Table 3. The two exceptions were Meters 5 and 9, which experienced surcharge during the January 25 storm. Both of these meters are located on pipes that run parallel to larger diameter trunk sewers (Meters 4 and 8 were located adjacent to Meters 5 and 9, respectively, on these larger sewers), so it is possible that the high flows were caused by upstream flow diversions from the larger to the smaller trunk sewers during peak flow periods. (For this reason, Table 3 also shows the total flows for Meters 4+5 and Meters 8+9). The surcharge at Site 5 reached about 3 feet above the pipe; however the pipe is 36 feet deep at this location so there was no risk of overflow. The surcharge at Site 9 was only about 8 inches.

Table 3: Flow Monitoring Results

Meter ID	Diam. (in.)	ADWF (mgd)	PDWF (mgd)	PWWF (mgd)	DW Peaking Factor	WW Peaking Factor	Max. Depth (in.)	Max. d/D
WWTP		5.81	10.3	22.3	1.8	3.8		
1	24	1.05	1.80	5.41	1.7	5.1	9	0.4
2	18	0.79	1.25	3.56	1.6	4.5	9	0.5
3	21	0.79	1.62	2.46	2.0	3.1	5	0.2
4	30	3.20	5.40	9.26	1.7	2.9	24	0.8
5	18	0.89	1.27	5.82	1.4	6.5	56	3.1
4+5		*4.09*	*6.67*	*14.95*	*1.6*	*3.7*		
11	24	0.49	0.82	1.11	1.7	2.3	4	0.2
6	15	0.41	0.94	1.74	2.3	4.3	5	0.3
7	15	0.66	1.21	1.60	1.8	2.4	6	0.4
8	21	0.95	1.77	3.40	1.9	3.6	13	0.6
9	15	1.19	1.91	2.69	1.6	2.3	24	1.6
8+9		*2.14*	*3.65*	*5.96*	*1.7*	*2.8*		
10	15	0.64	1.03	1.28	1.6	2.0	4	0.3

ADWF = average dry weather flow during monitoring period
PDWF = peak dry weather flow during monitoring period
PWWF = peak wet weather flow during monitoring period
DW Peaking Factor = PDWF/ADWF
WW Peaking Factor = PWWF/ADWF
d/D = flow depth to diameter ratio

3 Comparison to 1993 Master Plan Flows

The 1993 Master Plan provides projections of year 2010 peak wet weather flows for a 5-year frequency design storm event. The 5-year storm used in the 1993 Master Plan was a uniform intensity, 4-hour duration event with a total rainfall of 1.8 inches (average 0.45 inches/hour intensity). The two major storm events (January 4 and 25) that occurred during the 2007/08 monitoring period had total 4-hour rainfall amounts ranging from about 1.2 to 1.7 inches at the three rain gauges (average intensities ranging from 0.30 to 0.43 inches/hour) and peak intensities ranging from about 0.35 to 0.55 inches/hour. Therefore, these events were comparable in intensity to the 1993 Master Plan design storm.

Table 4 compares the peak wet weather flows measured during the 2007/08 monitoring period to the projected 2010 5-year uniform intensity design storm peak wet weather flows from the 1993 Master Plan. The 1993 Master Plan flows were determined from the model output contained in the Appendix to the Master Plan Report at the location of the meter sites (or equivalent location in cases where there have been changes to the system since the 1993 Master Plan). The table indicates the magnitudes of the metered and Master Plan peak wet weather flows and the metered PWWF as a percentage of the predicted 2010 PWWF.

Table 4: Comparison of Metered Flows to 1993 Master Plan Flows

Meter ID	Diam. (in.)	1993 Master Plan Model Pipe	1993 Master Plan Basins	Metered PWWF (mgd)	Master Plan 2010 PWWF (mgd)	Metered Flow as % of Master Plan Flow
WWTP			D01-D22, WWD	22.3	32.1*	69%
1	24	30371-30425 & 30468-30480	D06, D09-D11	5.4	9.8	55%
2	18	40414-40413	D10, D11	3.6	6.6	55%
3	21	40497-40483	D01, D03, D04	2.5	6.0	42%
4	30	3051021-305641		9.3	11.6	
5	18	305102-30598		5.8	3.6	
4+5			D02, D12-D22, WWD	15.0	15.2	99%
11	24	406272-406271	D14	1.1	1.3	85%
6	15	50741-507200	D17, D18(p)	1.7	1.7	100%
7	15	40813-40814	D02, D19(p), D20	1.6	1.9	84%
8	21			3.4		
9	15			2.7		
8+9		40906-40907	D19(p), D21, D22, WWD	6.0	6.5	92%
10	15	513531-51353	D22(p), WWD	1.3	3.2	41%

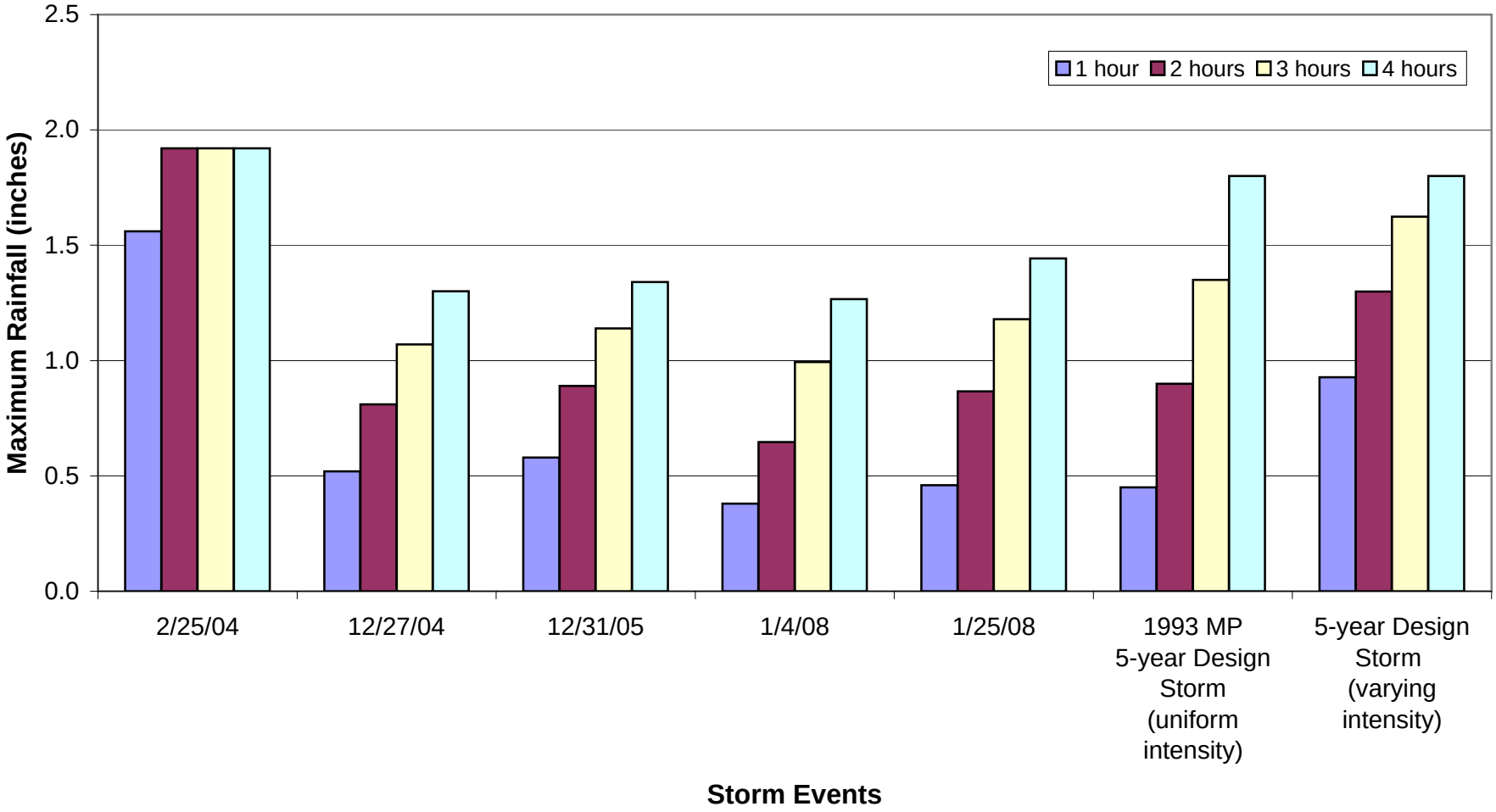
WWD = Westborough Water District
(p) indicates part of basin included in meter area
* Based on model output (pipe 30419) from the 1993 Master Plan Appendix. Sum of basin flows is reported as 34.4 mgd in Table 3-7 of the Master Plan report.

Figure 6 compares the rainfall for durations of 1 to 4 hours for the 1993 Master Plan design storm and the monitored storm events from the 2007/08 monitoring period (average rainfall for the three gauges), as well as for three other large rainfall events in 2004 and 2005 that were analyzed with respect to WWTP flow response in the previous Draft TM on Review of 1993 Collection System Master Plan. The graph shows that the monitored storm events in 2007/08 and the December events in 2004 and 2005 are comparable to the Master Plan design event for short (1- to 2-hour) durations. These short durations are the most critical for sewer capacity, as the peak RDI/I flow response in the system, particularly in upstream areas, typically occurs within 1 to 2 hours of the peak rainfall.

However, as discussed in the previous TM, use of a *uniform intensity* design storm is a non-conservative approach. Most agencies utilize a design rainfall event that includes a higher intensity peak hour rainfall (e.g., equivalent to a 1-hour, 5-year frequency rainfall intensity), resulting in a more conservative peak flow than a uniform intensity design storm. As shown in Figure 6, the peak hour intensity for a more accepted, varying intensity 5-year design storm would be significantly higher (on the order of 0.9 inches/hour) than any of the monitored or historical events shown, except for that of February 25, 2004. (The latter storm created severe flooding in several parts of Daly City due to its very high intensity.) Therefore, it is likely that the flows in the system under such a varying intensity design storm could be substantially higher than the flows experienced in the system during the 2007/08 storms.

The results presented in Table 4 indicate that while the estimated total PWWF to the WWTP appears to be well within the predictions of the 1993 Master Plan, there are areas of the system where flows are very close to the 2010 predictions for the uniform intensity 5-year design storm. In particular, the entire

Figure 6
Rainfall vs. Duration for Monitored and Design Storm Events



system upstream of Meters 4 and 5 (located on the parallel trunk sewers near Park Plaza Drive just south of the Westlake Shopping Center) is very close to predicted 2010 flows, and the area tributary to the F Street Lift Station (Meter 6) may be a particular concern.

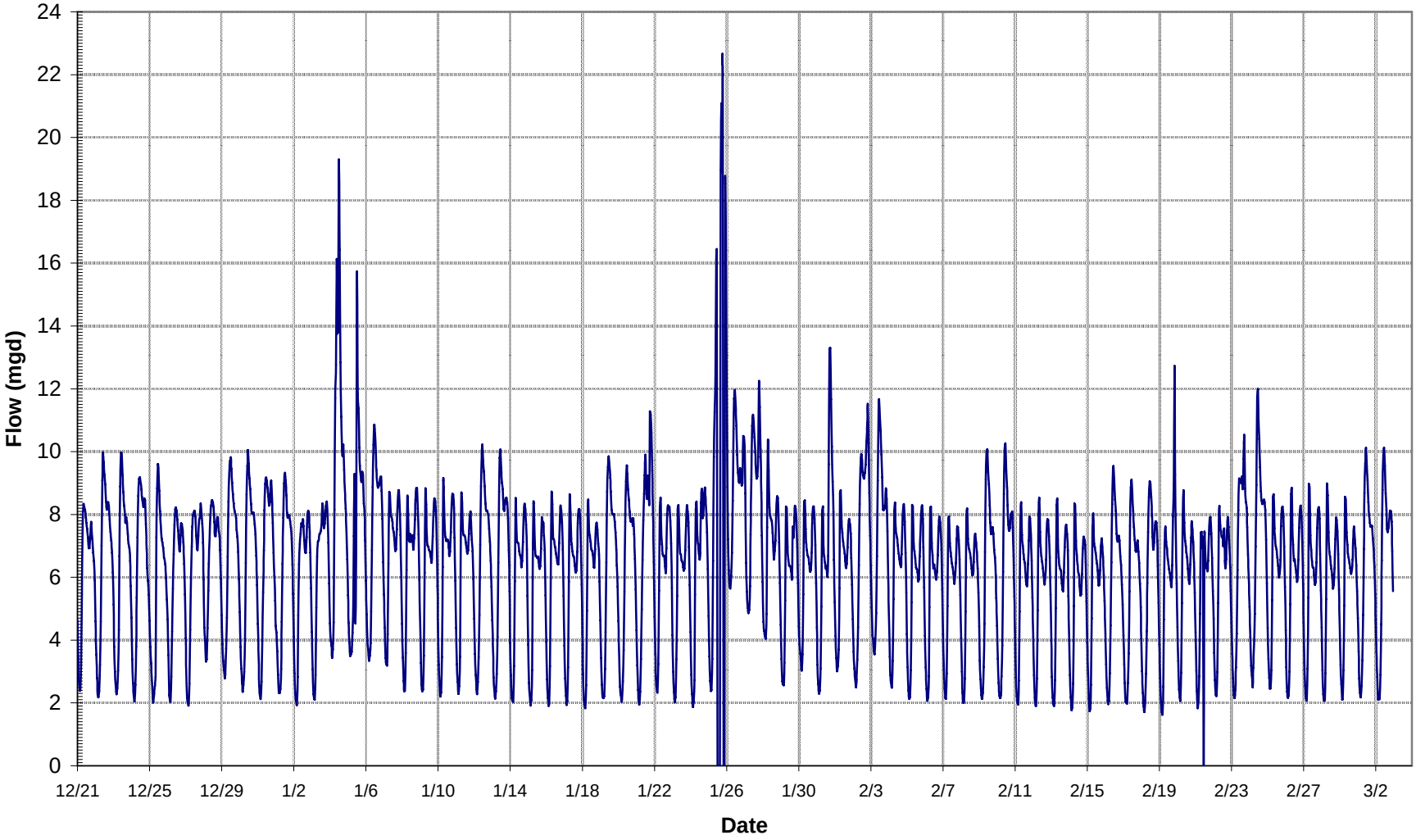
4 Summary and Conclusions

The results of the 2007/08 flow monitoring indicate that the ability of the system to handle additional flows from new development, or flows from a more conservative, varying intensity design storm or from storms exceeding a 5-year recurrence frequency, may be an issue in some areas of the system. Based on the District's excellent record with respect to sanitary sewer overflows (SSOs), this may not be cause for immediate concern. However, these results do indicate that more detailed capacity analysis of the system may be warranted.

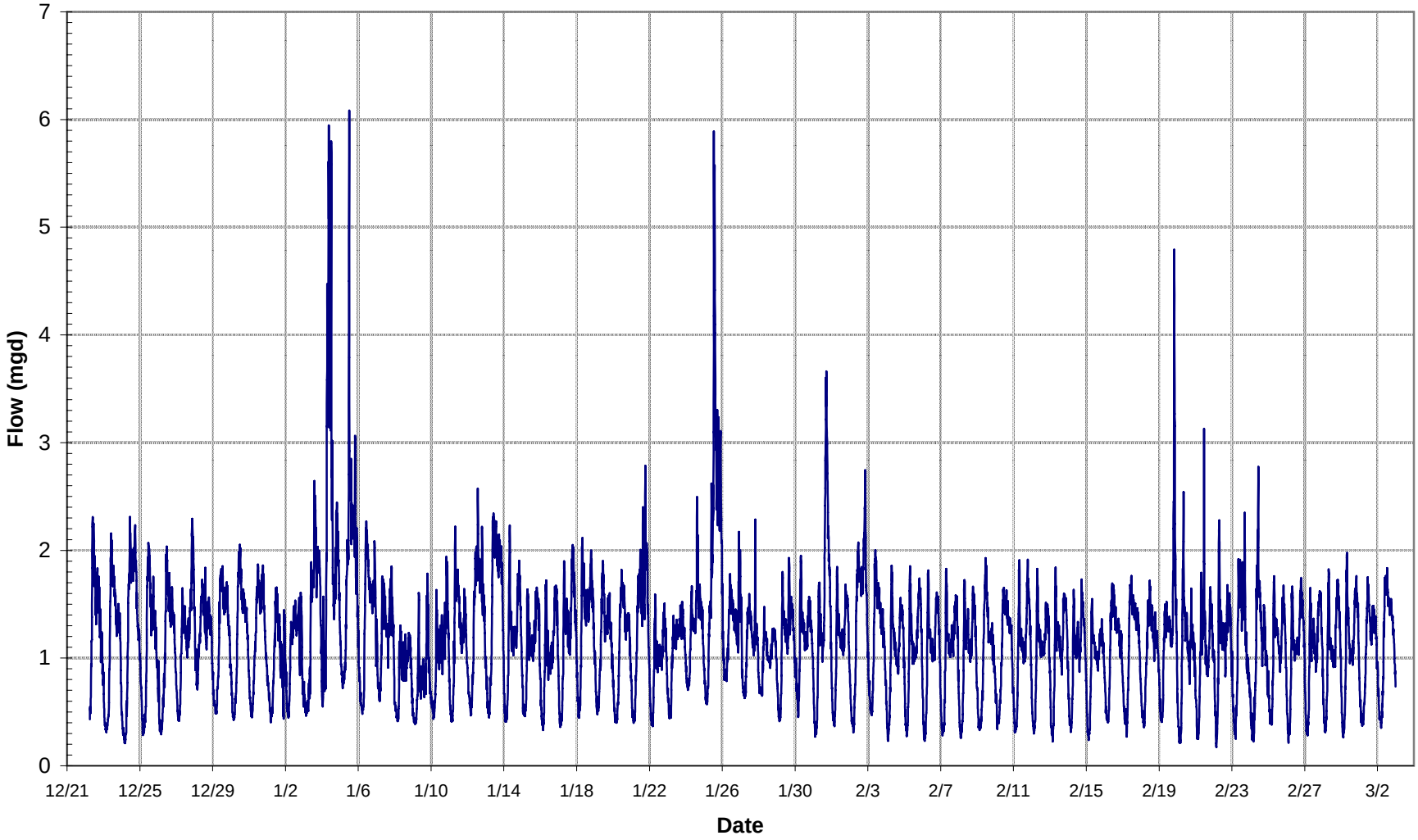
For this reason, RMC recommends that the District proceed with development of an updated hydraulic model of the trunk sewer system. The new model would reflect the current configuration of the system, including all capacity improvement projects constructed since the 1993 Master plan; would incorporate updated land use and development projections; and would be calibrated to the 2007/08 flow monitoring data. The modeling effort would also include definition of the appropriate design storm event to be used for capacity evaluation. Once constructed, the model could be used to evaluate the current capacity of the system with respect to existing and projected design flows in order to identify any required additional capacity improvements or potential I/I reduction efforts that the District should plan for as part of implementing its Sewer System Management Plan (SSMP). Should the District adopt this recommendation, a plan and schedule for completion of the hydraulic model and capacity analysis would be developed and incorporated into the System Evaluation and Capacity Assurance Plan element of the District's SSMP.

Attachments

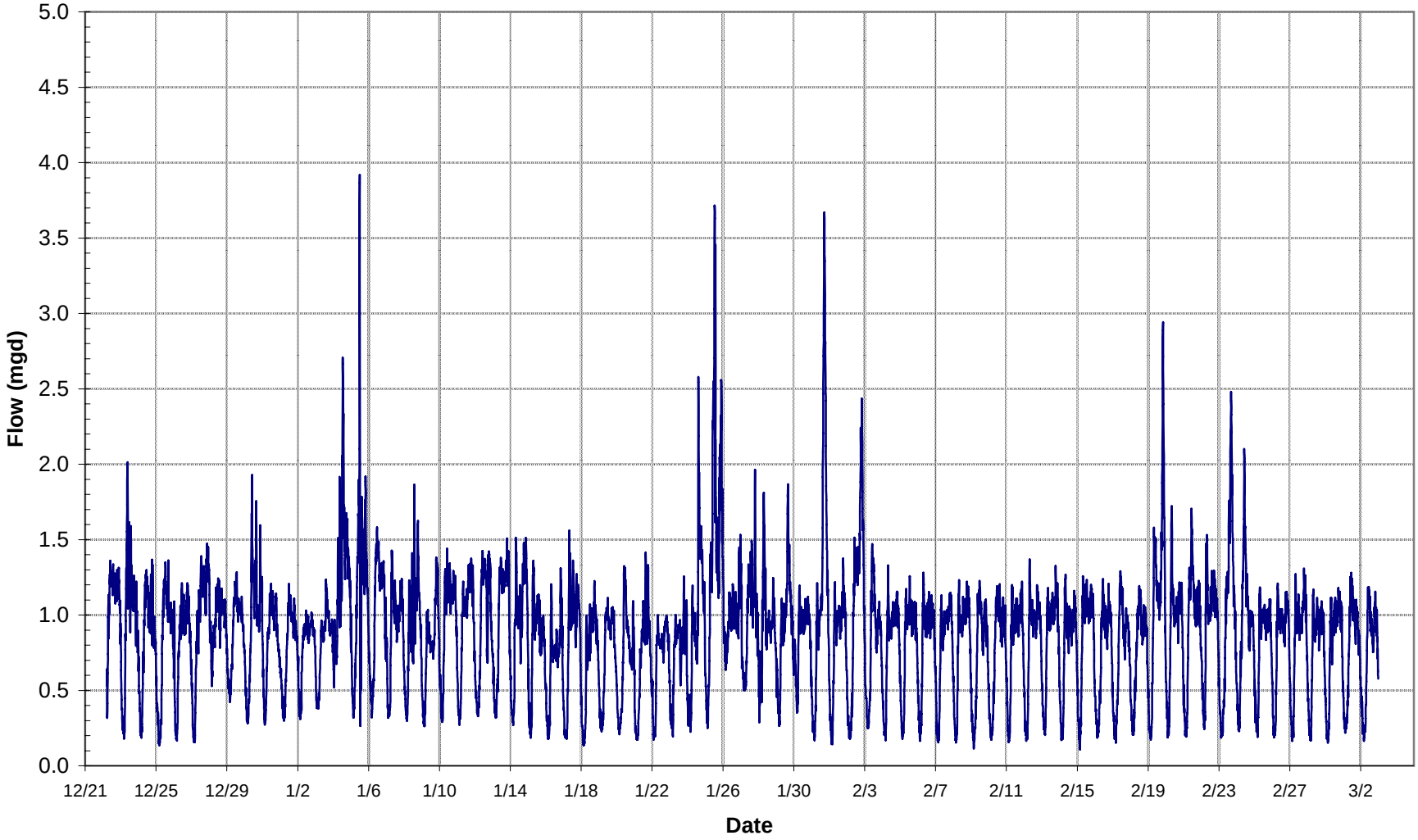
NSMCSD 2007/08 Flow Monitoring Program
WWTP Influent Flow



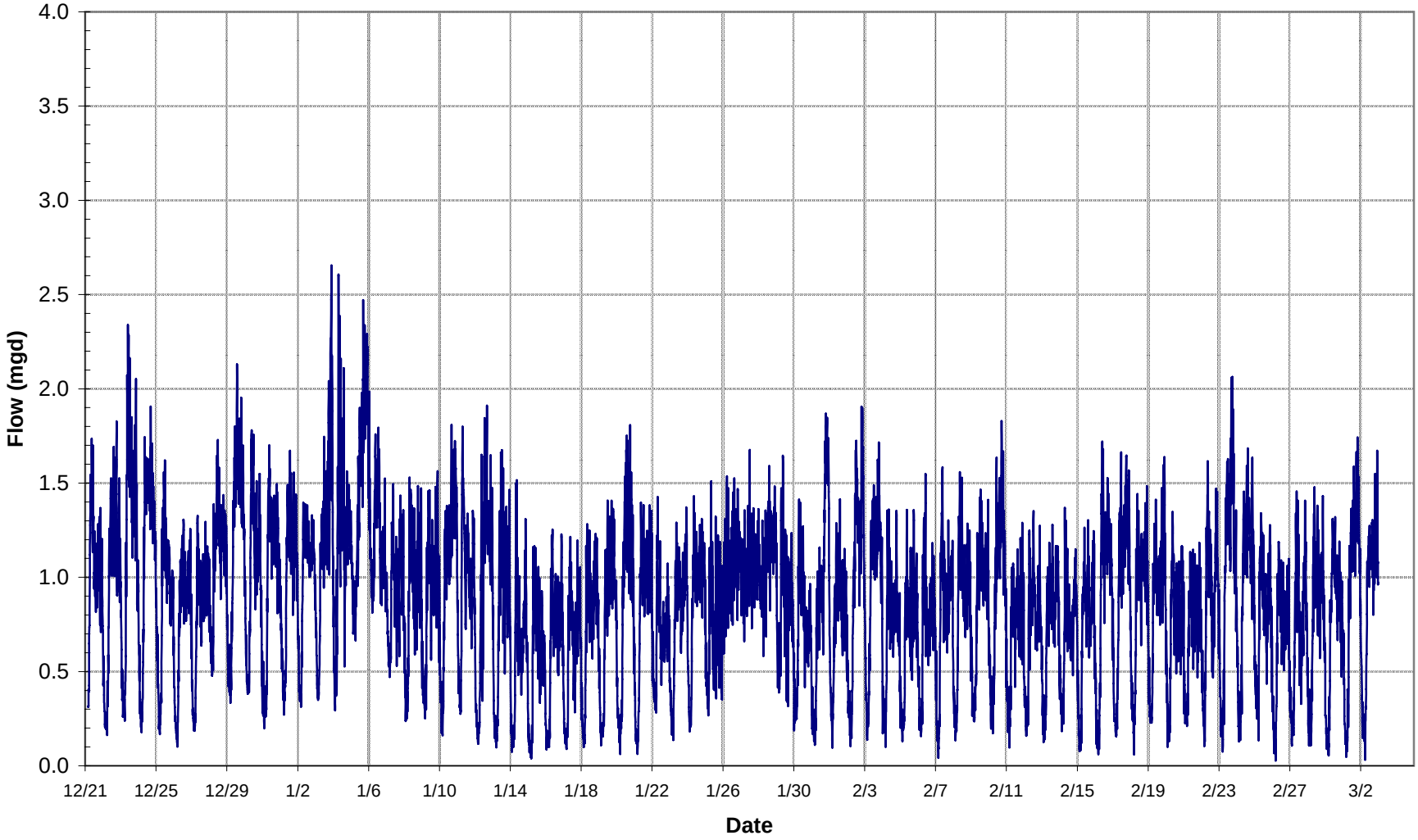
NSMCSD 2007/08 Flow Monitoring Program
Site 1



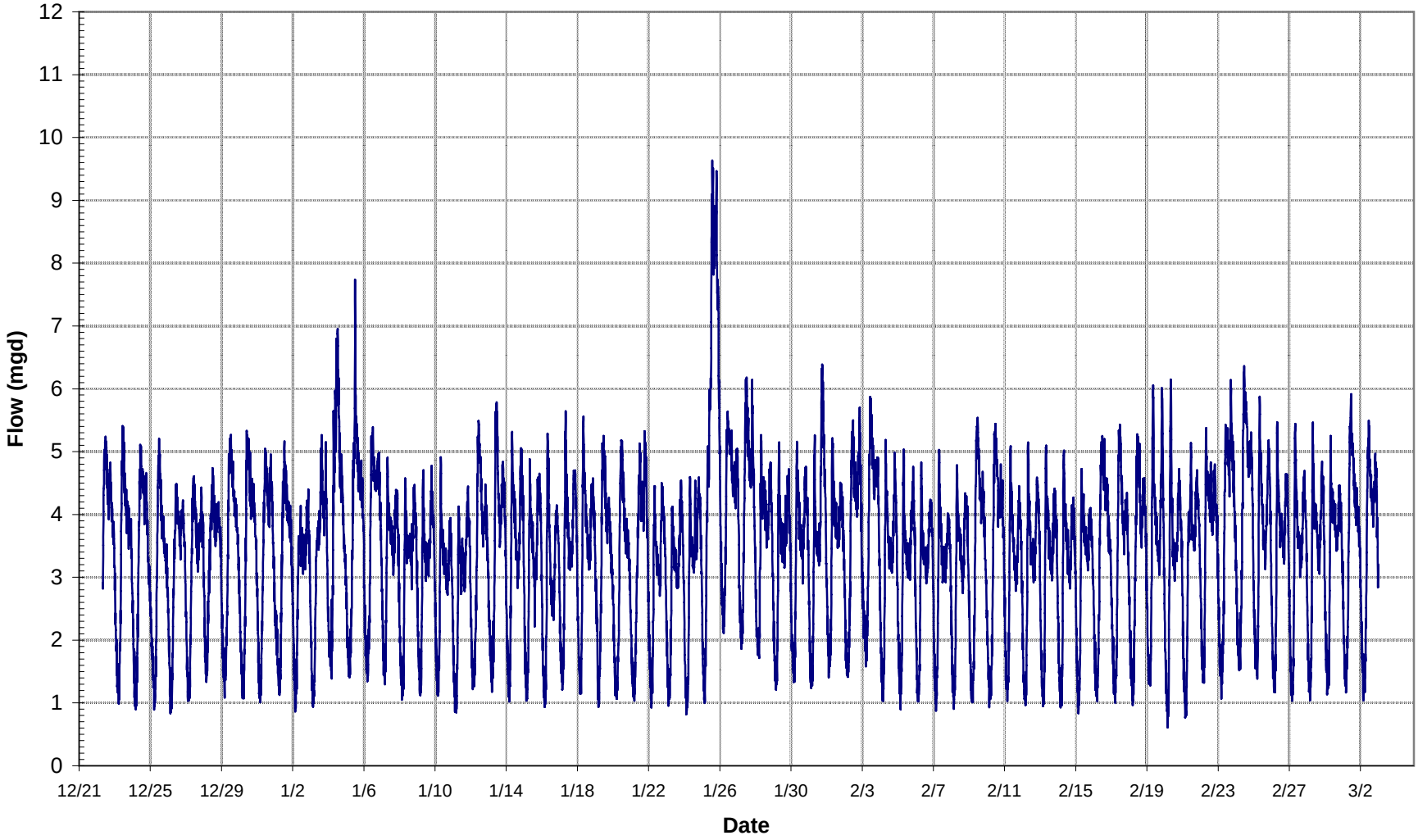
NSMCSD 2007/08 Flow Monitoring Program
Site 2



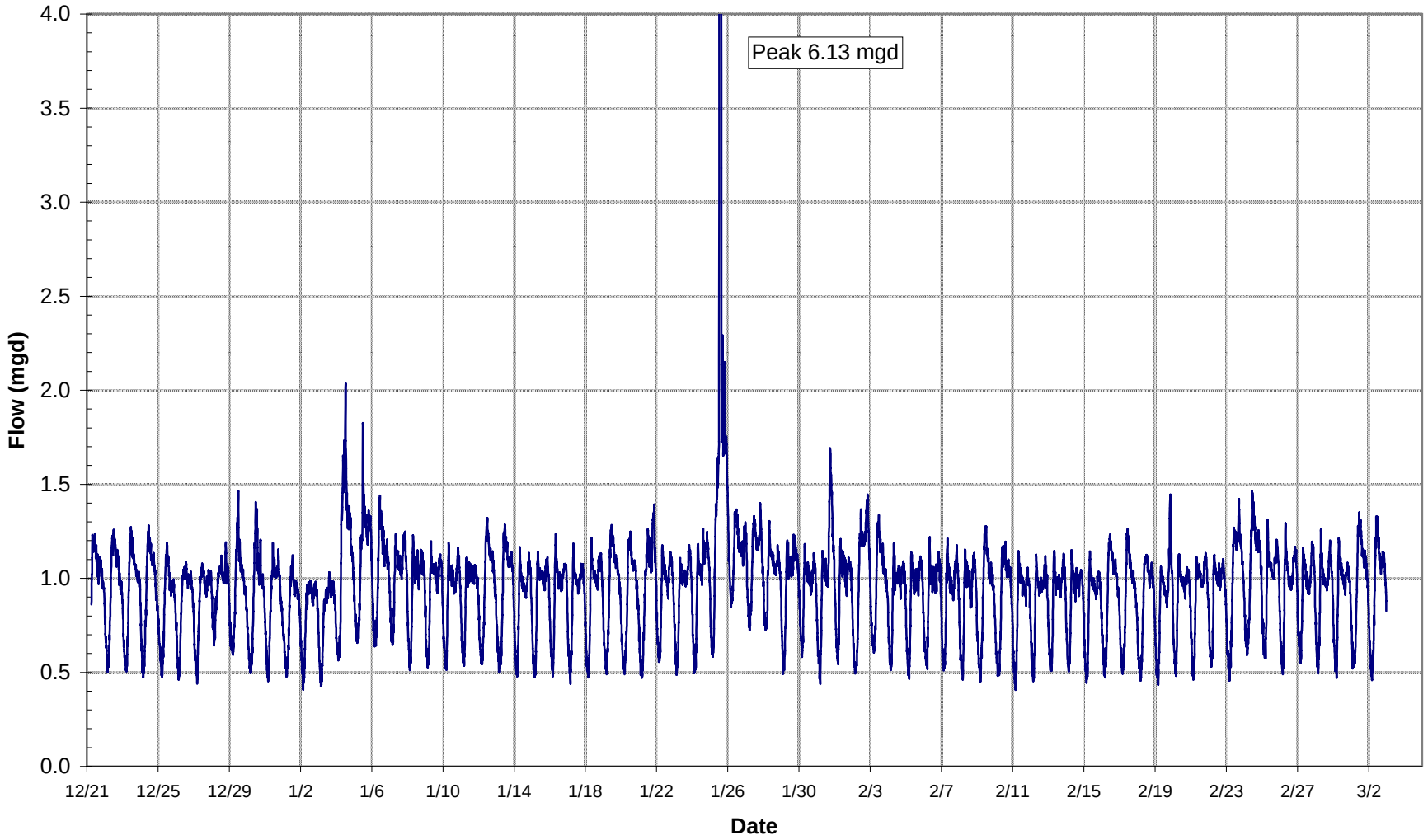
NSMCSD 2007/08 Flow Monitoring Program
Site 3



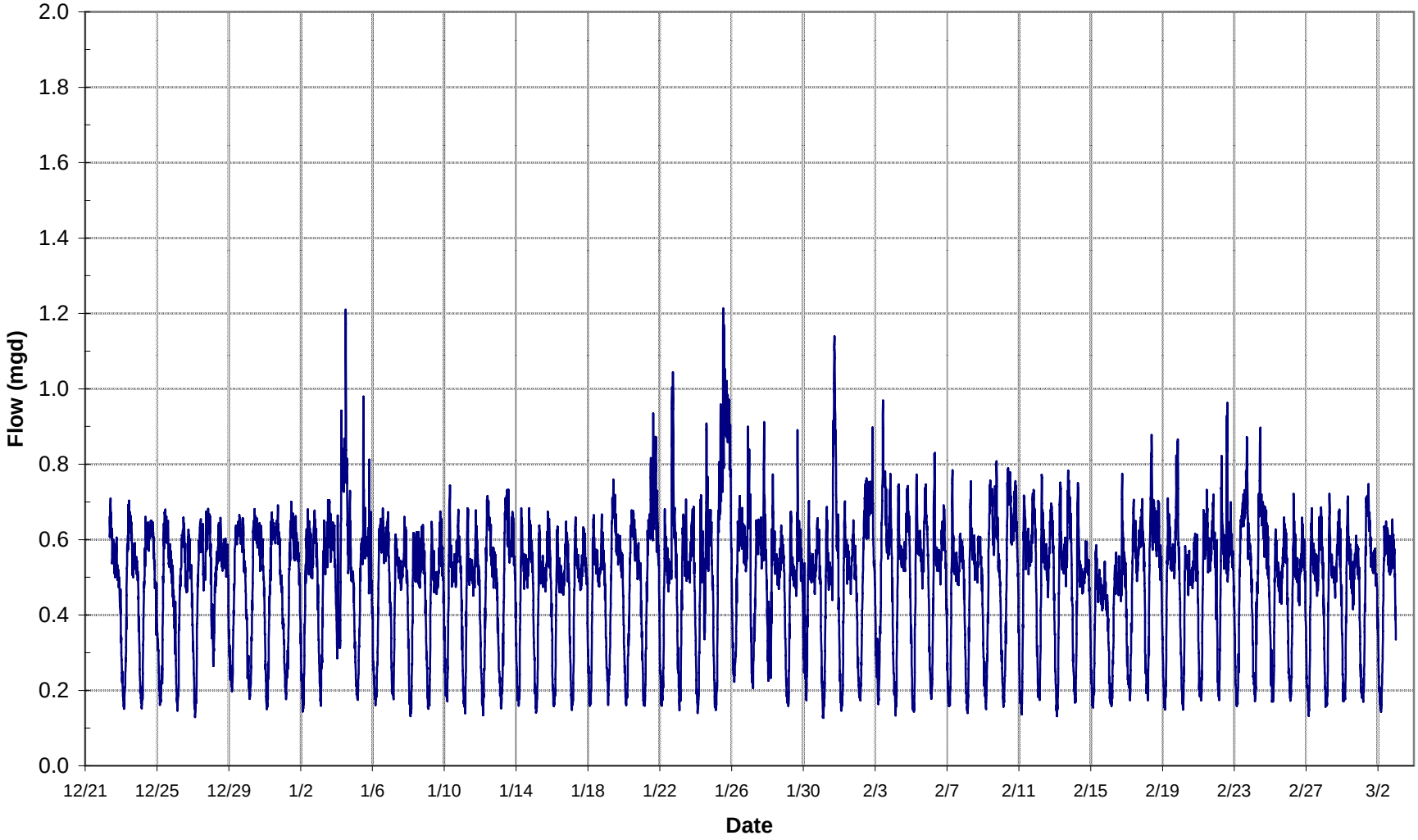
NSMCSD 2007/08 Flow Monitoring Program
Site 4



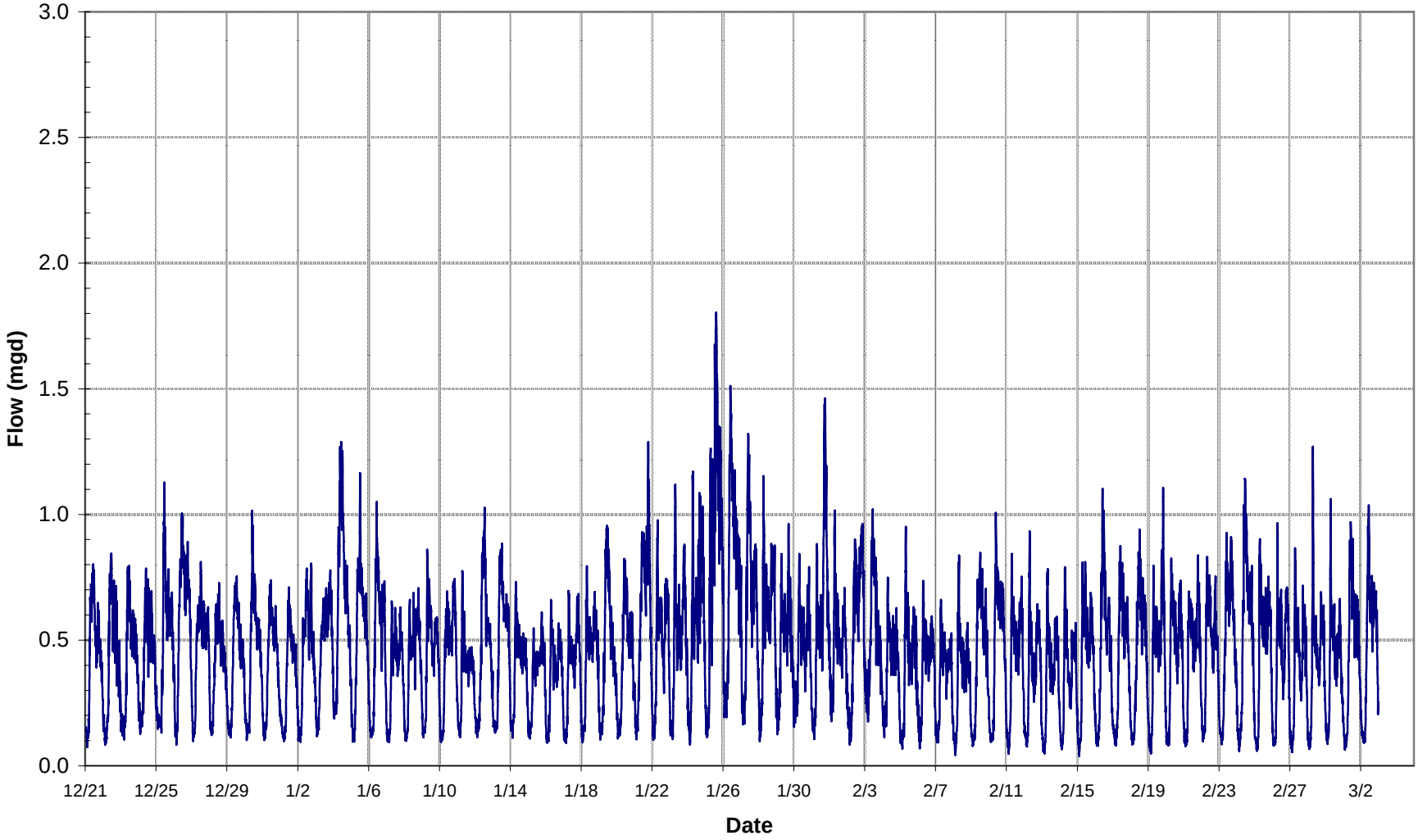
NSMCSD 2007/08 Flow Monitoring Program
Site 5



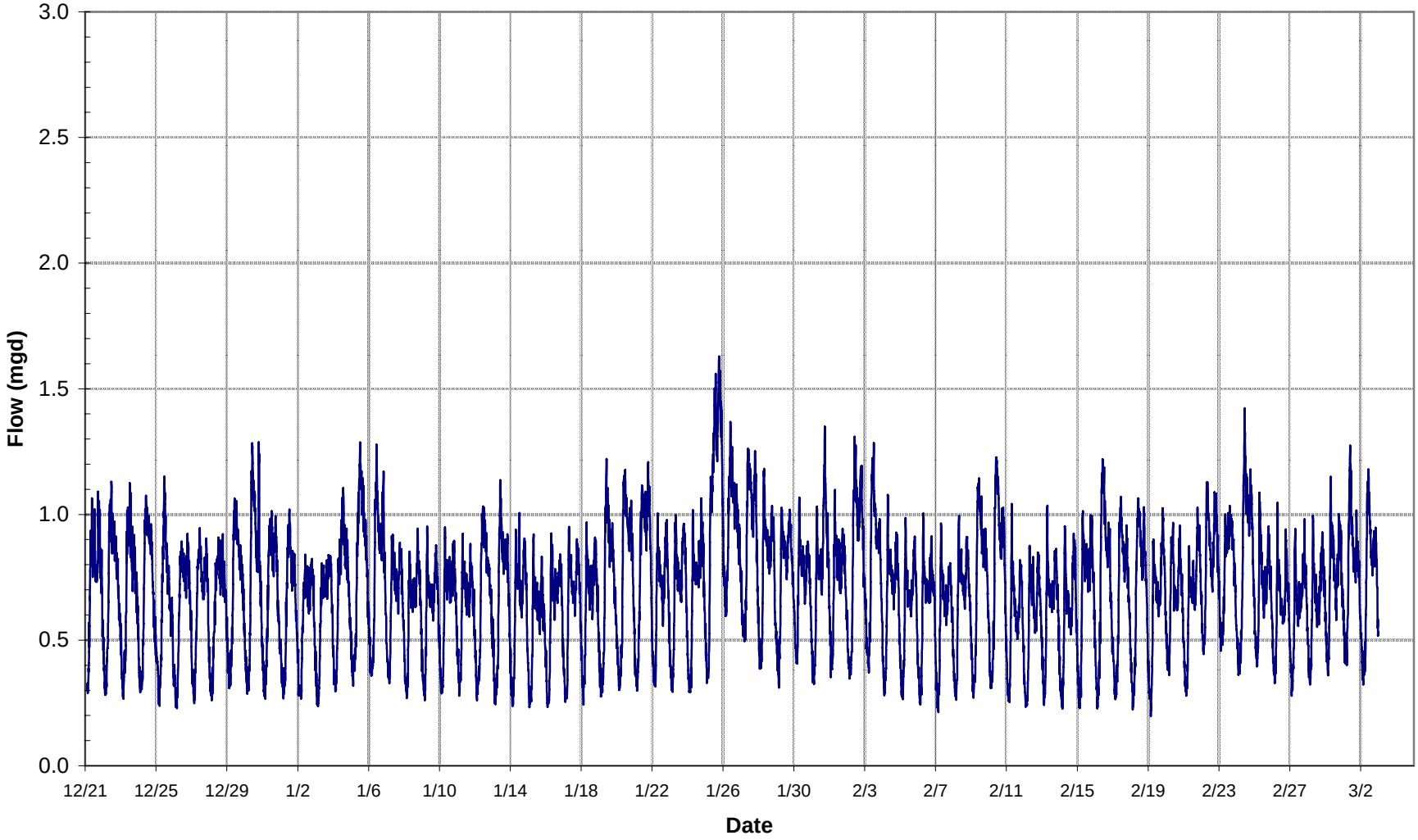
NSMCSD 2007/08 Flow Monitoring Program
Site 11



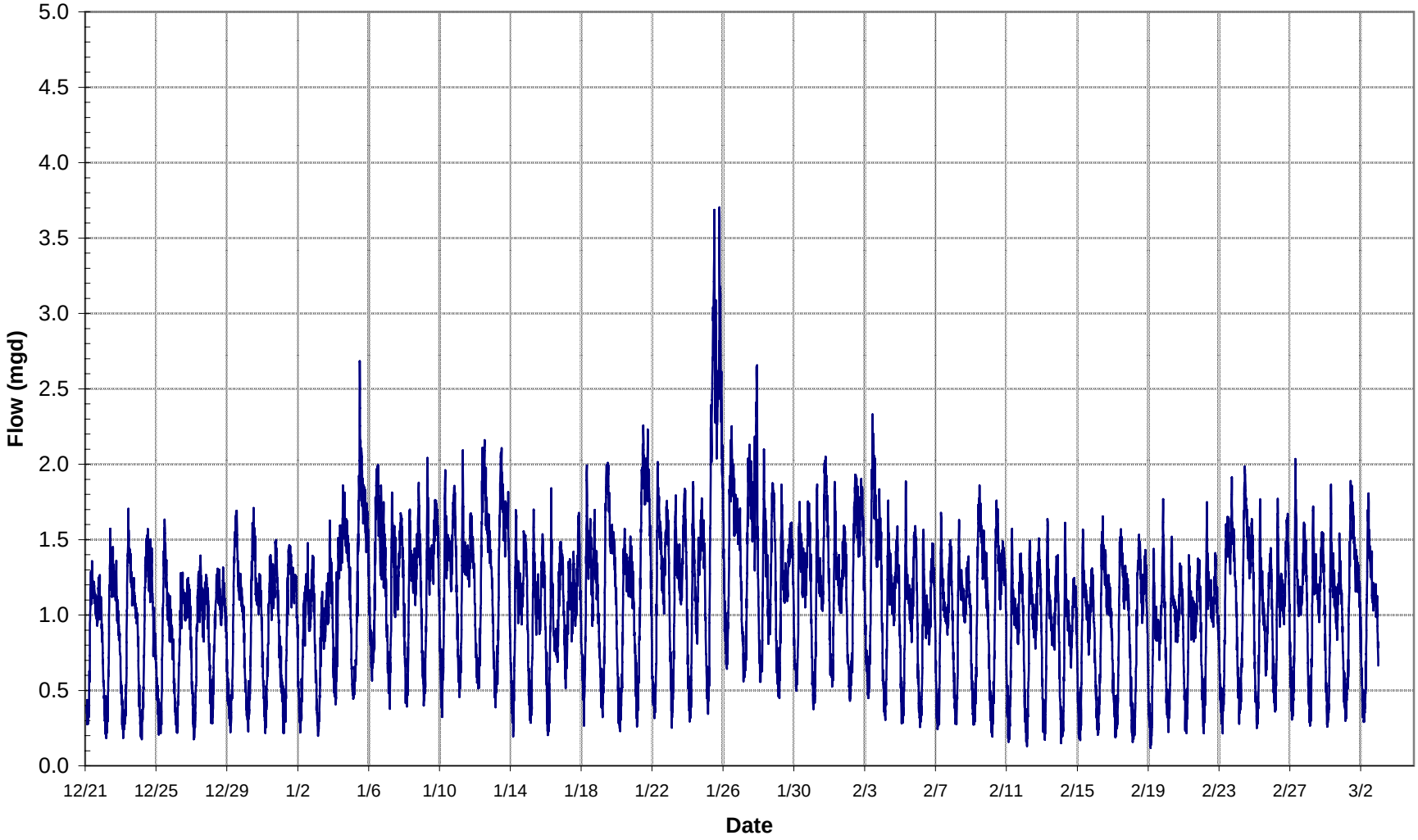
NSMCSD 2007/08 Flow Monitoring Program
Site 6



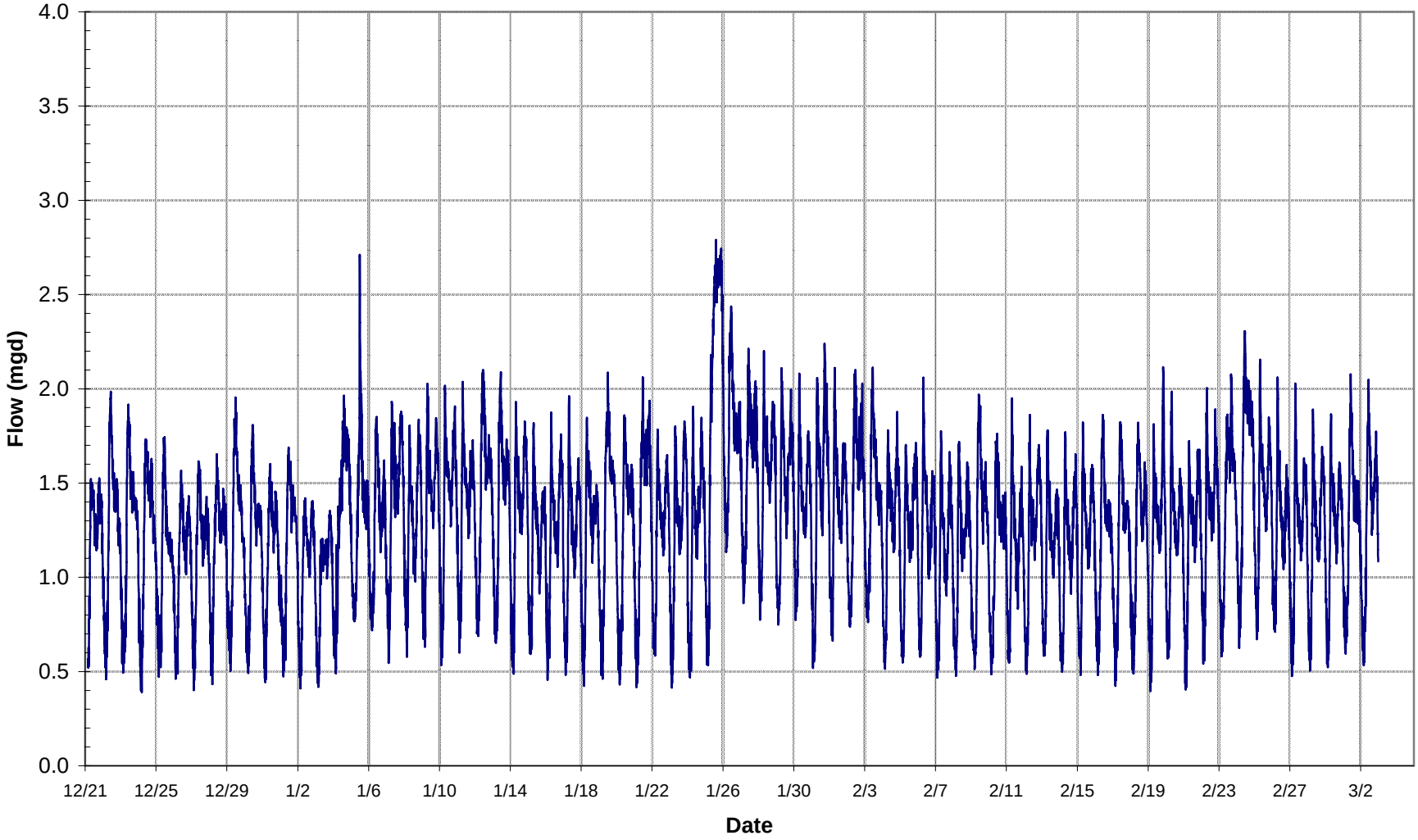
NSMCSD 2007/08 Flow Monitoring Program
Site 7



NSMCSD 2007/08 Flow Monitoring Program
Site 8



NSMCSD 2007/08 Flow Monitoring Program
Site 9



NSMCSD 2007/08 Flow Monitoring Program
Site 10