Section3
Flow Monitoring Data

SECTION 3 – FLOW MONITORING DATA

Section 2 described the existing facilities assessment that formed the basis for establishing the existing physical conditions of the Interceptor. This section discusses the flow monitoring procedures and results that generated part of the data required for flow assignment to the VVWRA Interceptor Model.

Flow monitoring was an essential component of Interceptor Model calibration. The flow monitoring work included two general tasks:

1. Review of previously conducted flow monitoring.
2. Installation of temporary field flow monitors as part of this SMP.

Flow monitoring was required for three important steps in the calibration process:

1. To establish dry weather flow inputs to loading points; both daily average and the diurnal pattern.
2. To estimate and quantify the impacts of inflow and infiltration during storms in the High Desert.
3. To test Interceptor Model output under current flow conditions.

3.1 PREVIOUSLY CONDUCTED FLOW MONITORING

Flow monitoring that was conducted prior to the preparation of this SMP was acquired, compiled and incorporated where appropriate. This existing data came from several sources:

1. From regular monitoring conducted by VVWRA from 2000 to 2009 for billing purposes.
2. From the RWWRF Influent Flow Meter.

3. Special flow monitoring conducted for the VVWRA *Interceptor Facilities Plan Amendment*, dated September 2007.
4. From the City of Hesperia Sewer Master Plan.
5. From the City of Victorville Sewer Master Plan.
6. From permanent flow meters installed by VVWRA in Interceptor in various strategic locations.

3.1.1 VVWRA Interceptor Historical Flow Monitoring

VVWRA has conducted periodic flow monitoring from 2000-2009 for member agency billing purposes. This data is summarized in Table 3-1. Trends are shown in Figures 3-1.

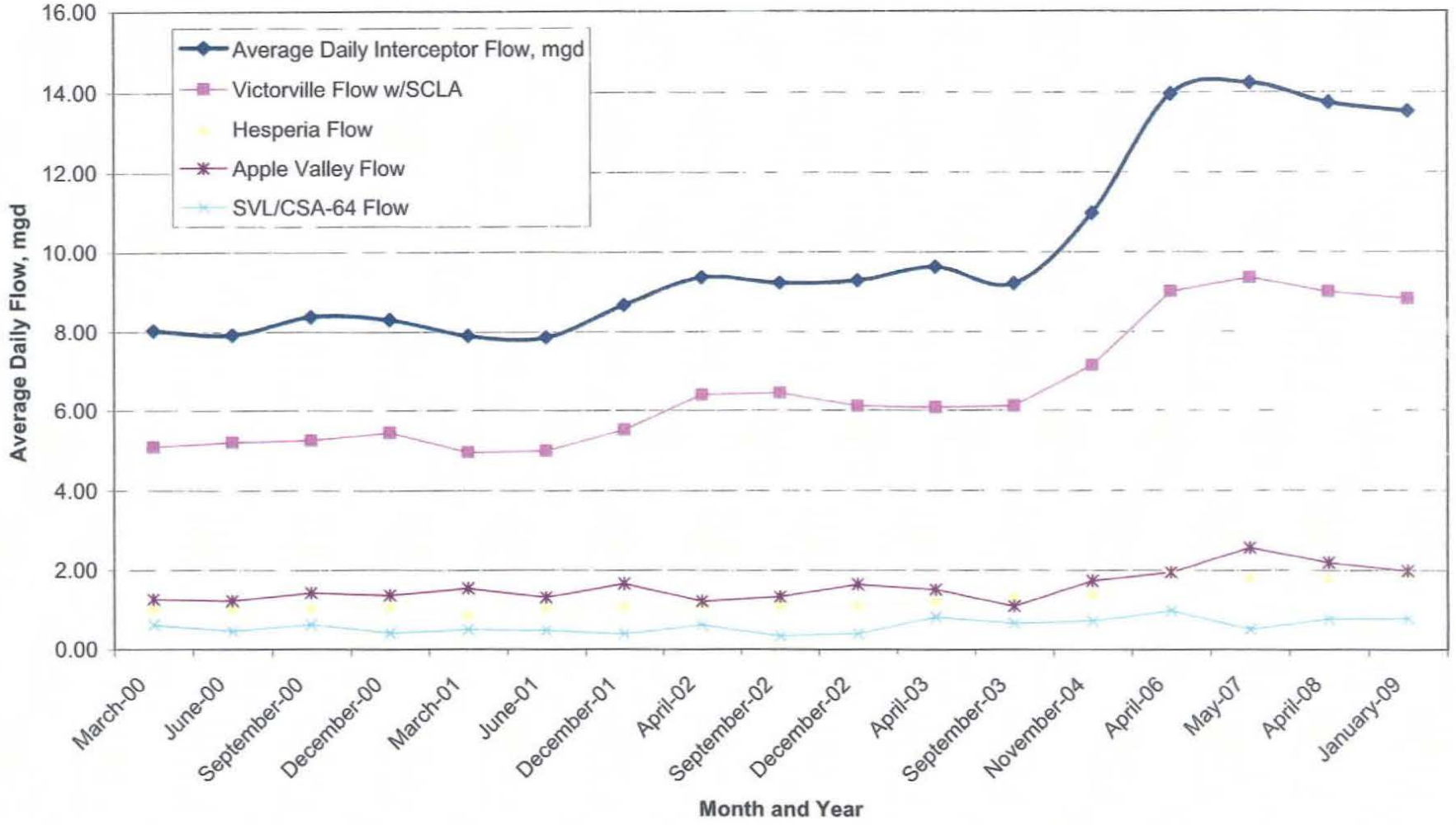
Table 3-1
VVWRA Historical Flow Monitoring

Month-Year	Victorville		Hesperia		Apple Valley		CSA-64/SVL/CSA-42		Total[1]
	mgd	cfs	mgd	cfs	mgd	cfs	mgd	cfs	mgd
March-00	5.09	7.87	1.05	1.62	1.27	1.96	0.62	0.96	8.03
June-00	5.20	8.04	1.03	1.59	1.23	1.90	0.46	0.71	7.92
September-00	5.25	8.12	1.06	1.64	1.44	2.23	0.63	0.97	8.38
December-00	5.44	8.42	1.08	1.67	1.37	2.12	0.41	0.63	8.30
March-01	4.95	7.66	0.90	1.39	1.55	2.40	0.50	0.77	7.90
June-01	4.98	7.70	1.07	1.66	1.32	2.04	0.48	0.74	7.85
December-01	5.51	8.52	1.11	1.72	1.66	2.57	0.39	0.60	8.67
April-02	6.39	9.89	1.14	1.76	1.22	1.89	0.61	0.94	9.36
September-02	6.43	9.95	1.12	1.73	1.33	2.06	0.34	0.53	9.22
December-02	6.10	9.44	1.14	1.76	1.64	2.54	0.40	0.62	9.28
April-03	6.06	9.37	1.24	1.92	1.51	2.34	0.81	1.25	9.62
September-03	6.10	9.44	1.35	2.09	1.09	1.69	0.66	1.02	9.20
November-04	7.12	11.01	1.40	2.17	1.73	2.68	0.72	1.11	10.97
April-06	8.99	13.91	2.04	3.16	1.94	3.00	0.98	1.52	13.95
May-07	9.34	14.45	1.82	2.82	2.56	3.96	0.51	0.79	14.23
April-08	8.98	13.89	1.80	2.78	2.19	3.39	0.77	1.19	13.74
January-09	8.81	13.63	1.95	3.02	1.98	3.06	0.78	1.21	13.52

1 Total is sum of Monitored Flow

2 Flow includes SCLA 1 and 2 connections

Figure 3-1
Historical Flow Monitoring
Interceptor Flow by Member Agency and Total Flow



The field monitoring data shows that the VVWRA Service Area flow peaked in 2007 at 14.23 mgd and has since declined to a field monitor recorded flow of 13.52 mgd in the first quarter of 2009. Overall flow monitoring volumes are higher than those registered at the plant influent flow meter (See Table 3-2 below) and depict a much sharper increase during the heavy growth periods of 2005 to 2007 and a steeper decline during the economic recession, and resultant slow growth period of 2007 to the present. Typically the flow monitors record a sum of flows higher in volume than the plant meter. In the industry it is currently estimated that a properly installed field meter can have an accuracy range of ± 10%, while the magnetic flow meter at the plant is rated at plus or minus 2% accuracy. This discrepancy in accuracy could explain the difference between field monitored flow and the flow monitored at the RWWRF.

3.1.2 VVWRA Influent Flow Meter

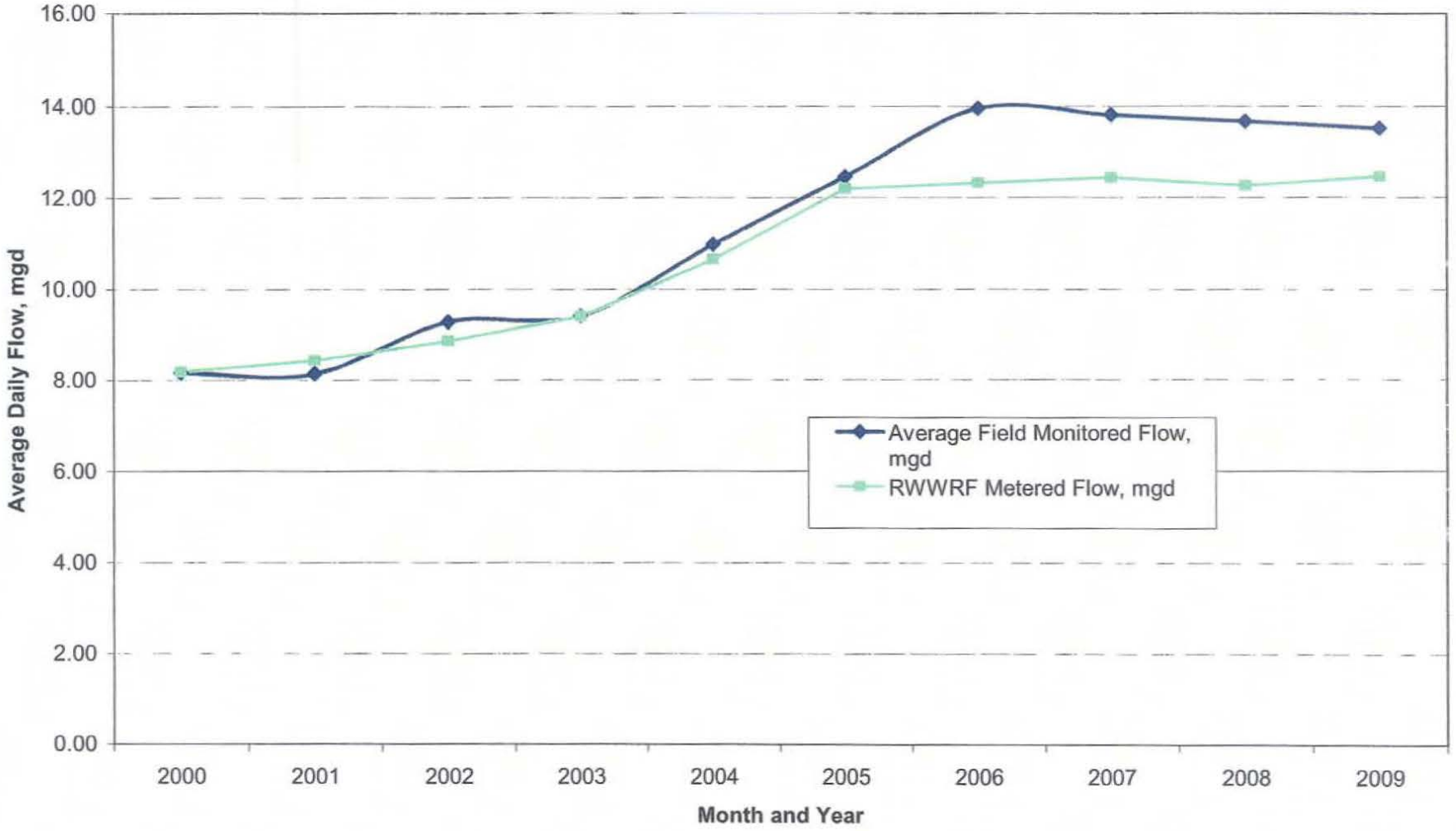
VVWRA's RWWRF has a magnetic flow meter on the influent feed line to the plant. This flow meter was replaced in 2008, as part of the 18 mgd Upgrades Project. Data from this flow meter verifies the trends from the historical field flow monitoring, although typically the field meters overestimate flow slightly, as summarized in Table 3-2 and Figure 3-2.

Table 3-2
RWWRF Influent Flow Meter

Year	Average RWWRF Flow, mgd[1]	Annual % Increase
2000	8.19	
2001	8.43	2.8%
2002	8.85	4.7%
2003	9.4	5.9%
2004	10.63	11.6%
2005	12.19	12.8%
2006	12.32	1.1%
2007	12.43	0.9%
2008	12.26	-1.4%

[1] Average annual flow recorded at VVWRA RWWRF

Figure 3-2
Influent Flow Meter vs. Historical Flow Monitoring
Total Flow (Avg Yearly)



The Influent Flow Meter and the associated Raw Sewage Storage Basin (RSSB) at the RWWRF were an important component of the inflow and infiltration estimation. Figure 3-3 shows a schematic of the system.

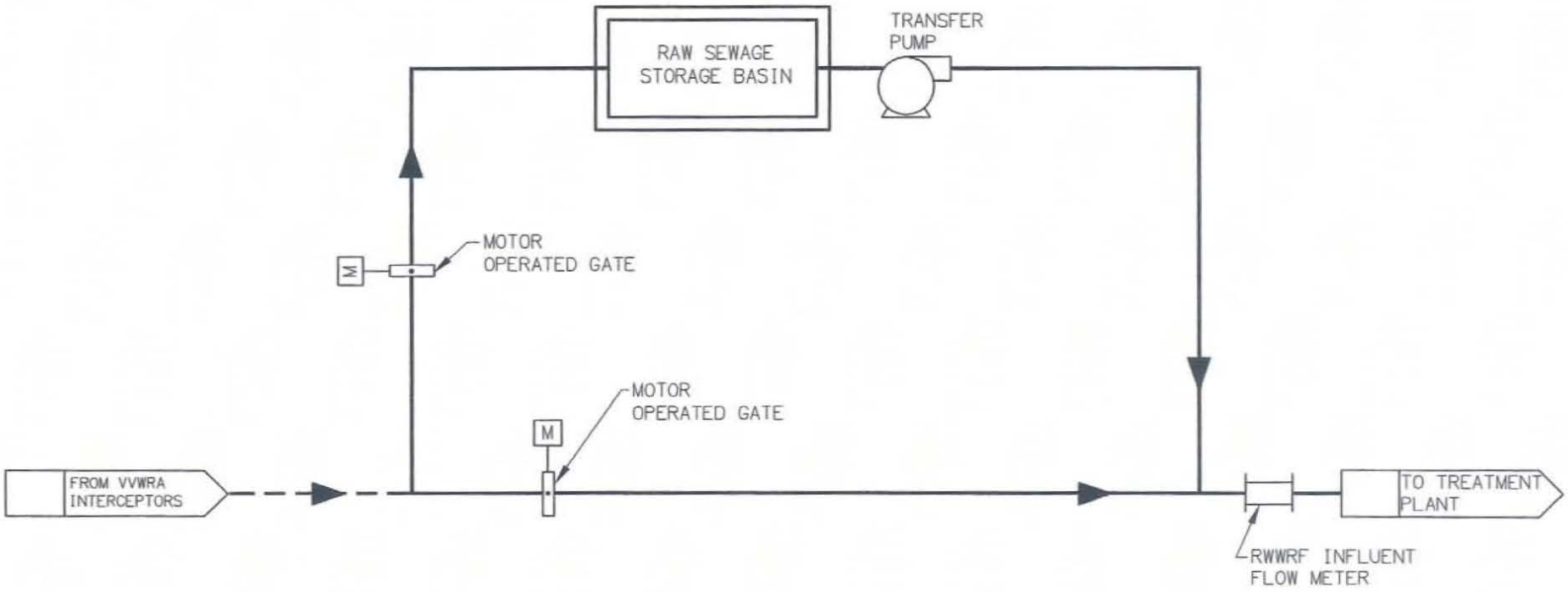
During heavy rain storms, flow is diverted to the RSSB. When the storm subsides, this flow is pumped back to the plant through the influent flow meter. Therefore, inflow and infiltration in the Service Area can be estimated by summing the Influent Flow Meter daily flow with the volume stored in the RSSB on the day(s) of the storm.

3.1.3 Flow Monitoring from the Interceptor System Facilities Plan Amendment, 2007

Flow monitoring was conducted in 2007 as part of the work for the *VVWRA Interceptor System Facilities Plan Amendment*. The amendment focused on the portion of the Interceptor downstream from the Upper Narrows. Field surveys and model calibration were conducted similarly to what was conducted in preparation of this SMP. The flow monitoring supplemented the Interceptor Model calibration and testing.

Downstream Services, Inc. conducted the flow monitoring in August 2007 at six locations:

1. Manhole VV-503—Selected because of its proximity, immediately downstream from the Upper Narrows, its very flat slope and its 36-inch size.
2. Manhole VV-421—Selected because of its steep slope and 27-inch size.
3. Manhole VV-317—Selected because of its steep slope and location just upstream from the Lower Narrows.



H:\PDATA\1010598\CADD\WATER\EXHIBITS\6495_FLOW_SCH.DWG JMILEY 11/17/09 12:25 pm

Victor Valley Wastewater Reclamation Authority	Victor Valley Wastewater Reclamation Authority Regional Wastewater Reclamation Plant Expansion 20111 Shay Road Victorville, Ca 92394	RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION 14725 ALTON PARKWAY IRVINE, CALIFORNIA 92618-2027 949.472.3505 • FAX 949.472.8373 • www.RBF.com	Victor Valley Wastewater Reclamation Authority	FIGURE
			SEWER MASTER PLAN RWWRF INFLUENT STORAGE SCHEMATIC	3-3

4. Manhole VV-303—Selected because of its flat slope and location just downstream from the Lower Narrows.
5. Manholes VV-133 and VV-216—Selected because of their proximity to the RWWRF and their side-by side location in the flattest slope portion of the double-barrel.

Table 3-3 summarizes the results.

Table 3-3
Downstream 2007 Flow Monitoring Data

Flow Monitoring Location	August 2007 Flow, mgd
MH VV-503	7.24
MH VV-421	7.02
MH VV-317	8.55
MH VV-303	9.6
Double Barrel (MH VV-133 & MH VV-216)	10.8

mgd = million gallons per day

Note: Lower downstream flow at VV-421 compared to VV-503 most likely due to normal range of error associated with field installed flow monitors.

The purpose for this flow monitoring was to confirm Mannings "N" values so that near term capacity of the VVWRA Interceptor from the Upper Narrows to the RWWRF could be more accurately assessed. The data indicated a low "N" for flatter-sloped clay pipes, an "N" slightly higher for steeper sloped clay pipes and an "N" near or slightly above the typical design value of 0.013 for the concrete pipe.

3.1.4 City of Hesperia Flow Monitoring

A Flow-monitoring study performed by DownStream Services, Inc. was completed for the City of Hesperia's Wastewater Master Plan, which was issued as a final draft in March 2007. The monitoring was conducted in support of the City of Hesperia planning efforts. Flow monitors were placed at twelve locations in the City of Hesperia Sewer

system. The flow data was collected during dry weather from April 24, 2006 to April 28, 2006. The flow data from this monitoring was especially useful in this Master Plan effort in order to calibrate the diurnal flow patterns for the three (3) major loading points to the VVWRA Interceptor from the Hesperia sewer system. The flow monitoring is summarized in Table 3-4.

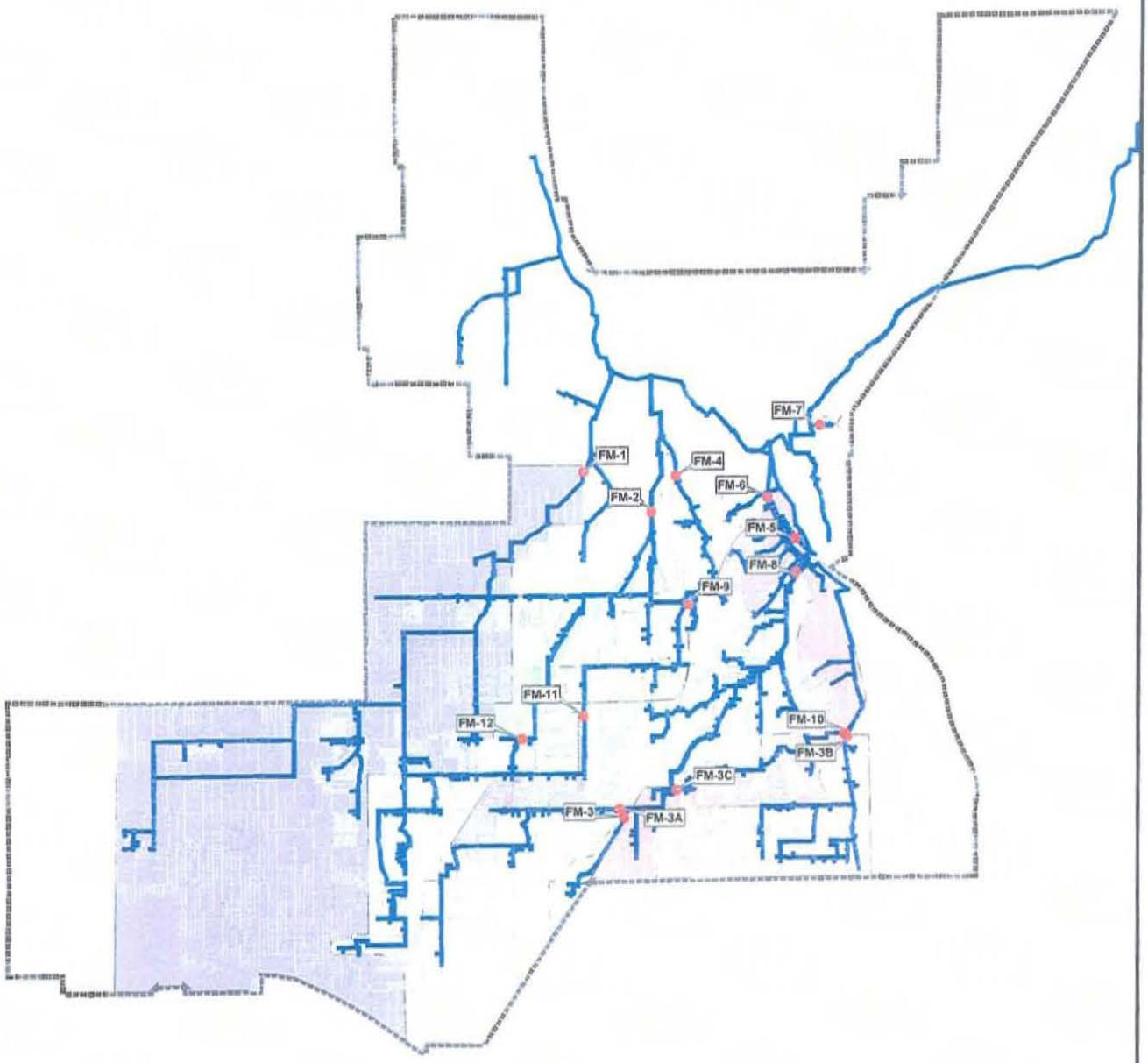
Table 3-4
Hesperia Wastewater Master Plan Flow Monitoring Summary

Flow Monitor No.	City of Hesperia MH No.	Location Description	Average Measured Flow, mgd	Peak Hour Measured Flow, mgd
1	185	Sultana Street west of Topaz Ave	0.2	0.41
2	110	Yucca Street west of Maple Avenue	0.221	0.42
3	10	Yucca Street at the intersection with Maple Avenue	0.28	0.481
4	33	Maple Avenue north Main Street	0.598	0.968
5	22	North of the intersection of Banning Avenue and Mauna Loa Street	0.698	1.094
6	12	West of the intersection of Lemon Street and Hesperia Road	0.854	1.433
7	1	17592 Lemon Street west of I Avenue at crest of the hill	1.213	1.799
8	50	12033 Mariposa Road (south of Bear Valley Road and east of the I-15 ramp)	0.757	0.109[1]
9	10	Bear Valley Road west of the intersection with Locust Avenue	0.177	0.299
10	1	16061 Bear Valley Road	0.267	0.411
11	10	17537 W. Santa Fe Avenue	0.447	0.597
12	15	On I Avenue west of the intersection with Willow Street and north of the railroad tracks	0.381	0.502

All data in table above directly from *City of Hesperia Wastewater Master Plan*, Final Draft Report March 2007
1 As reported in *City of Hesperia Wastewater Master Plan*, Final Draft Report March 2007

3.1.5 City of Victorville Flow Monitoring

Flow monitoring was performed for the City of Victorville's Sewer System Master Plan from October 25, 2006 to November 5, 2006. The flow monitoring locations are shown in Figure 3-4. The flow monitoring data from the City of Victorville was used to confirm the diurnal patterns at the Victorville loading manholes assigned to the VVWRA Model.



Legend

Wastewater Collection System

- Flow Monitoring Locations
- Modeled Sewer Network

Tributary Areas

- FM-1
- FM-2
- FM-3
- FM-3A
- FM-3B
- FM-4
- FM-5-6
- FM-7
- FM-8
- FM-9
- FM-10
- FM-11
- FM-12

Planimetric

- Parcels
- Sphere of Influence

N

DRAFT FINAL

EarthTech	CITY OF VICTORVILLE DEPARTMENT OF ENGINEERING

Figure 3-2

Flow Monitoring Locations and Tributary Areas

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

JOB NO.

FIGURE 3-4
VICTORVILLE MASTER PLAN FLOW MONITORING LOCATIONS

3.2 FLOW MONITORING CONDUCTED FOR THIS SMP

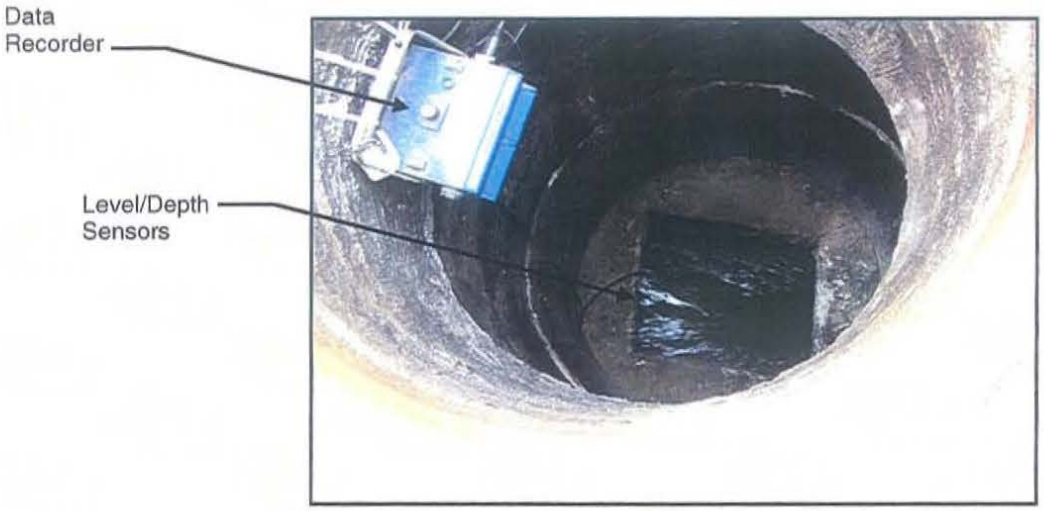
Flow monitoring was completed as part of this SMP in order to provide Interceptor Model calibration data for the portions from Hesperia to the Upper Narrows. The portion of the Interceptor Model between the Upper Narrows and RWWRF was calibrated for the Interceptor System Facilities Plan Amendment finalized in September 2007. The calibration done under this SMP, therefore, completes the Interceptor Model.

New monitoring was conducted using a combination of velocity and level sensors. Flow was then calculated using the formula: Flow (Q) = Velocity (V) x Area (A). Area was calculated from measured flow depth.

Velocity and depth sensors were installed in the incoming sewer to the manhole. Equipment was manufactured by Isco, utilizing an ultrasonic Doppler sensor for velocity and a pressure transducer for sewage depth. Data from these continuous sensors were transmitted to a programmable controller that recorded readings every fifteen minutes.

Manual, instantaneous measurements are taken of velocity and depth during meter installation and removal. These measurements facilitate monitoring equipment calibration. Velocity typically varies throughout the cross section of flow due to variable friction factors. The manual measurements are used to average out these variations and calibrate the data. Figure 3-5 shows a photograph of the typical monitoring equipment installed in a manhole.

Figure 3-5
Typical Flow Monitor Equipment Installation



3.2.1 Hesperia Flow Monitoring

The initial flow monitoring, conducted in Hesperia for this master plan effort, took place in December 2007 and was initiated in response to an overflow that occurred near Lemon St at I Ave in Hesperia's downtown area. The overflow occurred during an intense winter storm at Manhole #67 which has the shallowest depth to pipe in VVWRA's entire Hesperia system. Figure 3-6 shows the location of the three (3) manholes where flow monitors were installed and the location of the overflow event.

The monitors recorded data for one week. The resultant average weekday and weekend hourly flow from this monitoring is shown in Figures 3-7 through 3-9.

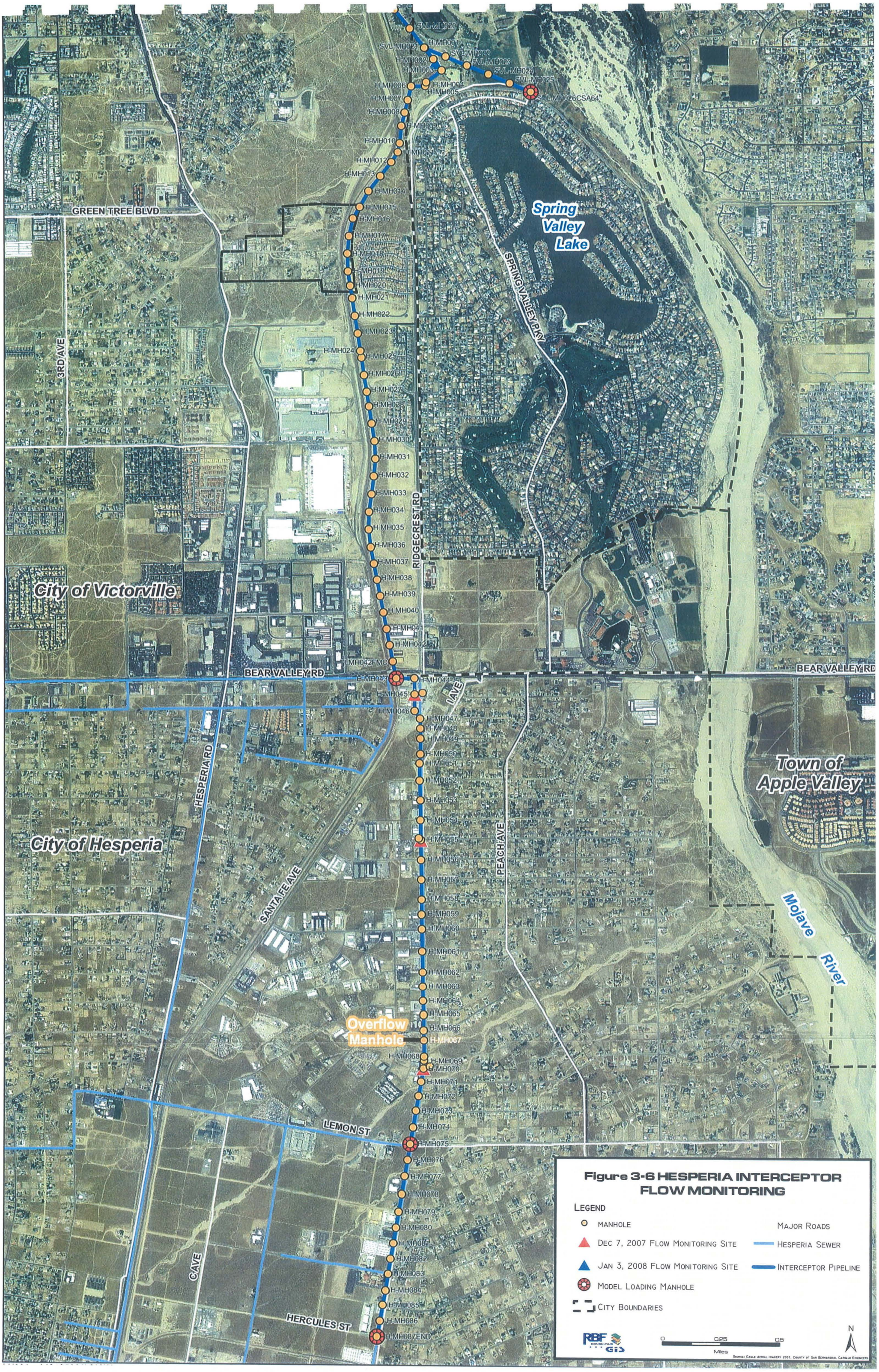


Figure 3-6 HESPERIA INTERCEPTOR FLOW MONITORING

LEGEND

- MANHOLE
- DEC 7, 2007 FLOW MONITORING SITE
- JAN 3, 2008 FLOW MONITORING SITE
- MODEL LOADING MANHOLE
- CITY BOUNDARIES

MAJOR ROADS

- HESPERIA SEWER
- INTERCEPTOR PIPELINE

0 0.25 0.5 Miles

N

SOURCE: EAGLE AERIAL IMAGERY 2007, COUNTY OF SAN BERNARDINO, CAROLLO ENGINEERS

Figure 3-7
Hesperia MH 45
Weekend/Weekday Average Hourly Flow
(18" Pipe)

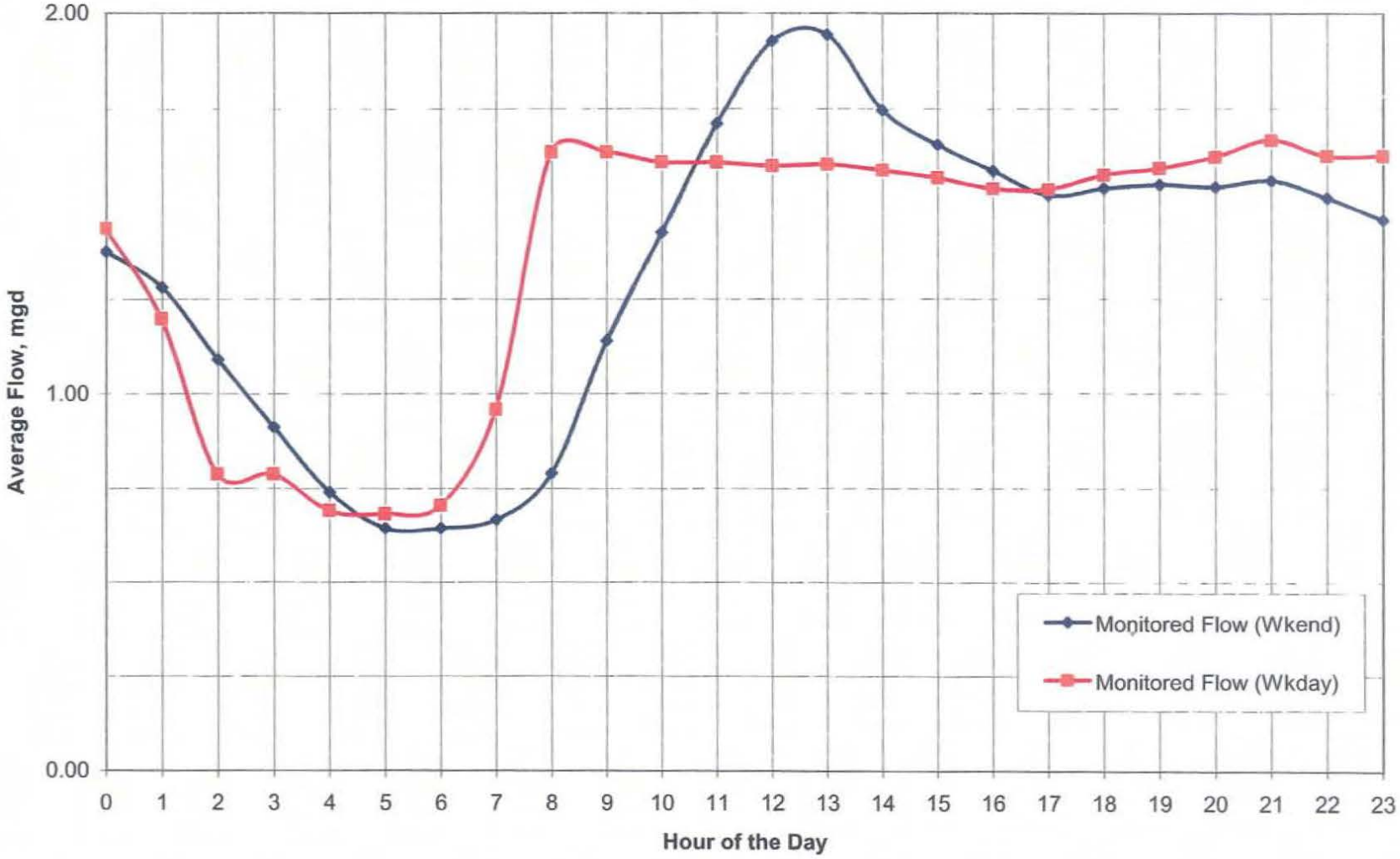


Figure 3-8
Hesperia MH 55
Weekend/Weekday Average Hourly Flow
(18" Pipe)

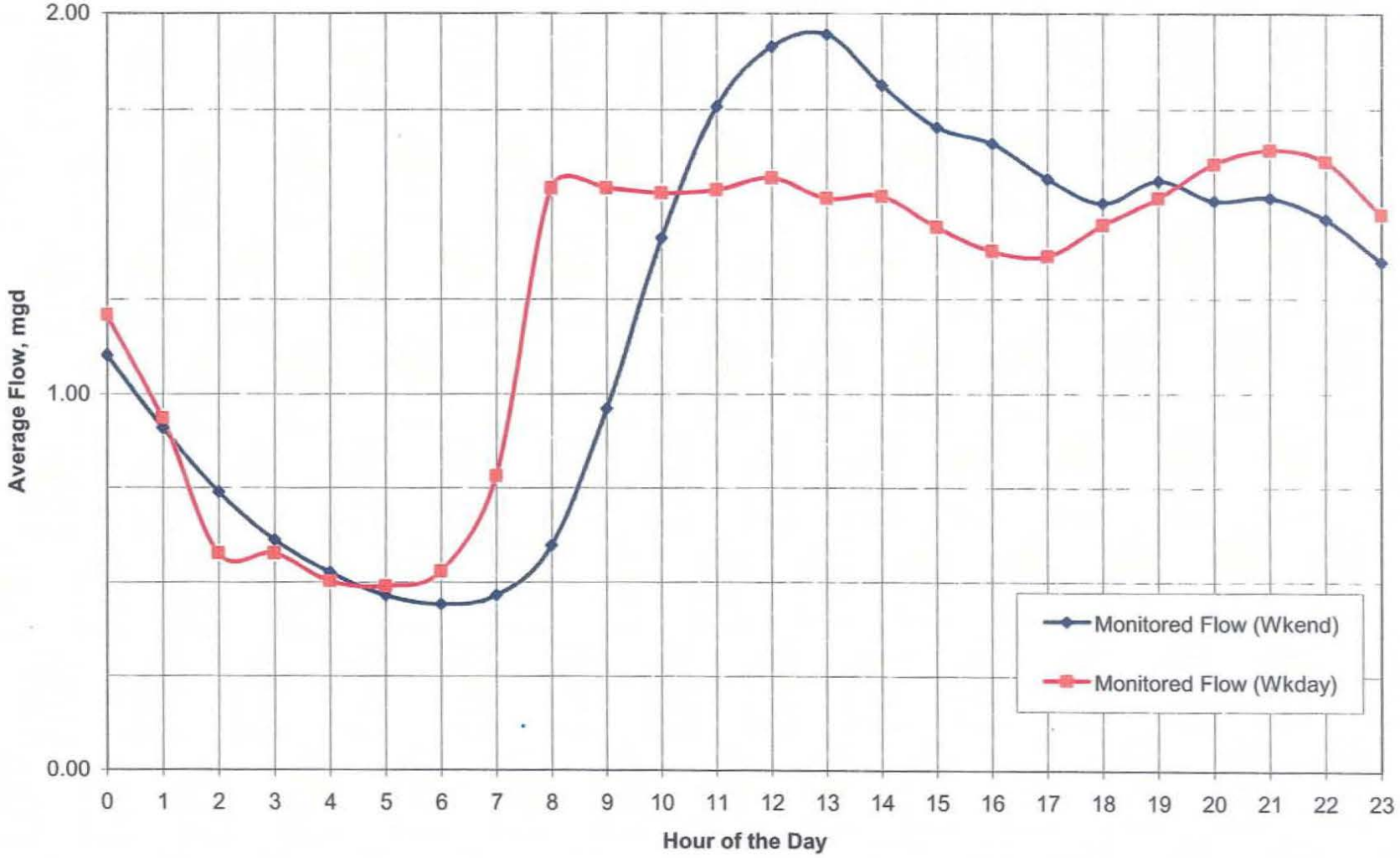
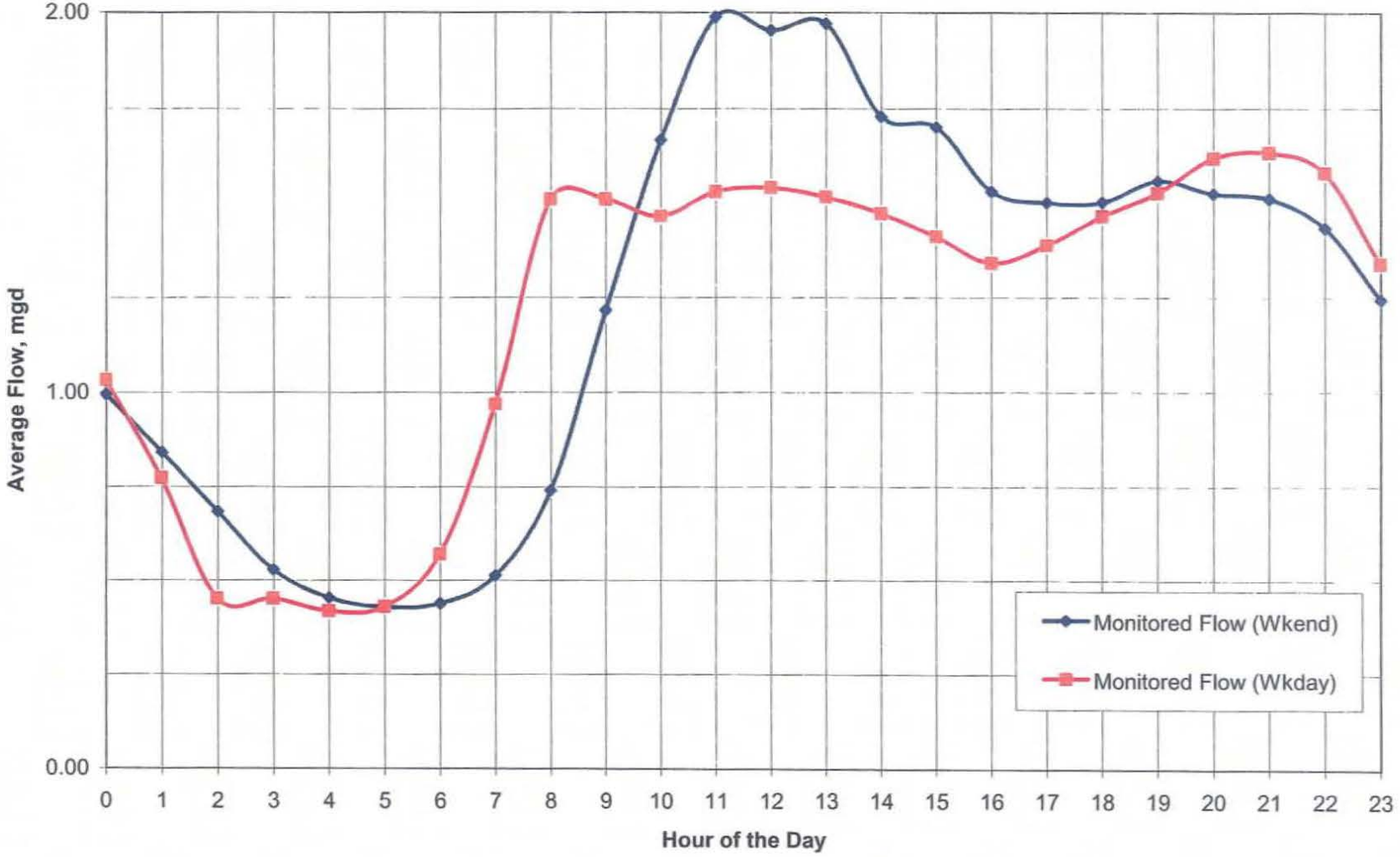


Figure 3-9
Hesperia MH 70
Weekend/Weekday Average Hourly Flow
(15" Pipe)



3.2.2 Spring Valley Lake/CSA 64

In March 2008, flow monitors were placed along the Spring Valley Lake/CSA 64 pipeline within the VVWRA system. Three locations were selected to provide a complete flow analysis of this system and provide a maximum range of pipe slopes for Manning's "N" calibration in the hydraulic model. This is discussed in detail later in this section.

The first location installed was at SVL Manhole #22. This location collects sewer flow from the Spring Valley Lake community only. The second location was at SVL Manhole #17. This location provided flow from both the Spring Valley Lake and Hesperia systems, but upstream of the Victorville VSD #2 connection. The third location along the SVL/CSA 64 Interceptor was at SVL Manhole #4. This location provided a total flow from Spring Valley Lake, Hesperia and VSD #2. The installed locations are shown on Figure 3-10.

The resultant average weekday and weekend hourly flow from the monitoring is shown in Figures 3-11 through 3-13.

A-MH004

A-MH004

A-MH002

SVL-MH004

SVL-MH007

BNSF Rail

Riverside #2
Pump Station

PS

SVL-MH015VSD2

SVL-MH017

SVL-MH022

SVL-MH026CSA64

Figure 3-10 SVL/CSA-64 Flow Monitoring

Interceptor Pipeline Diameter
- 10"
- 12"
- 15"
- 16"
- 18"
- 21"
- 24"
- 27"
- 36"

- Manhole
- Loading Manhole
- Flow Monitoring Location March 2008
- PS Pump Station
- Proposed Gravity Sewer from Nanticoke PS
- Force Main
- City Boundaries

RBF Consulting GIS

N

0 700 1400
Feet

Figure 3-11
Spring Valley Lake MH 22
Weekend/Weekday Average Hourly Flow
(21" Pipe)

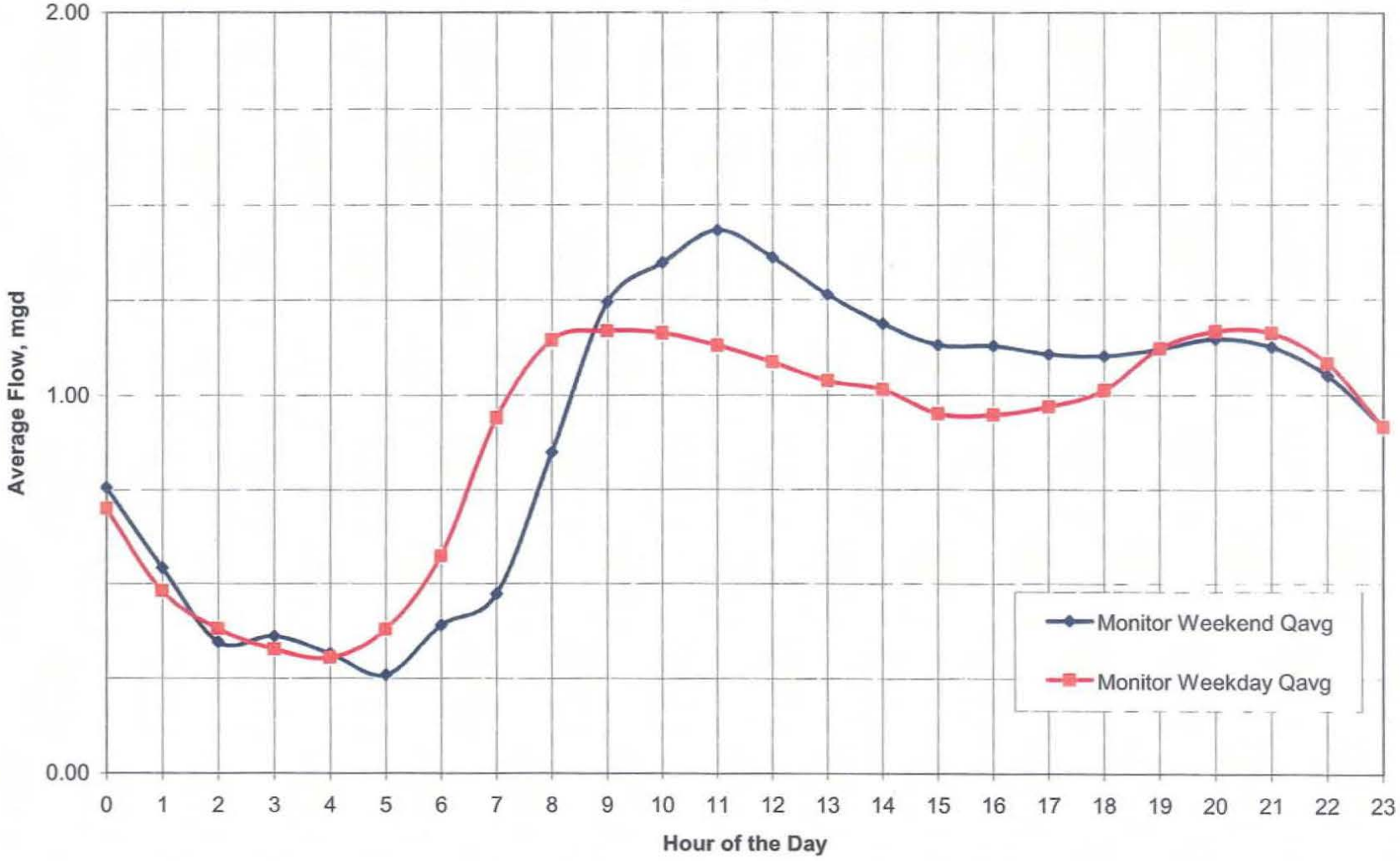


Figure 3-12
Spring Valley Lake MH 17
Weekend/Weekday Average Hourly Flow
(21" Pipe)

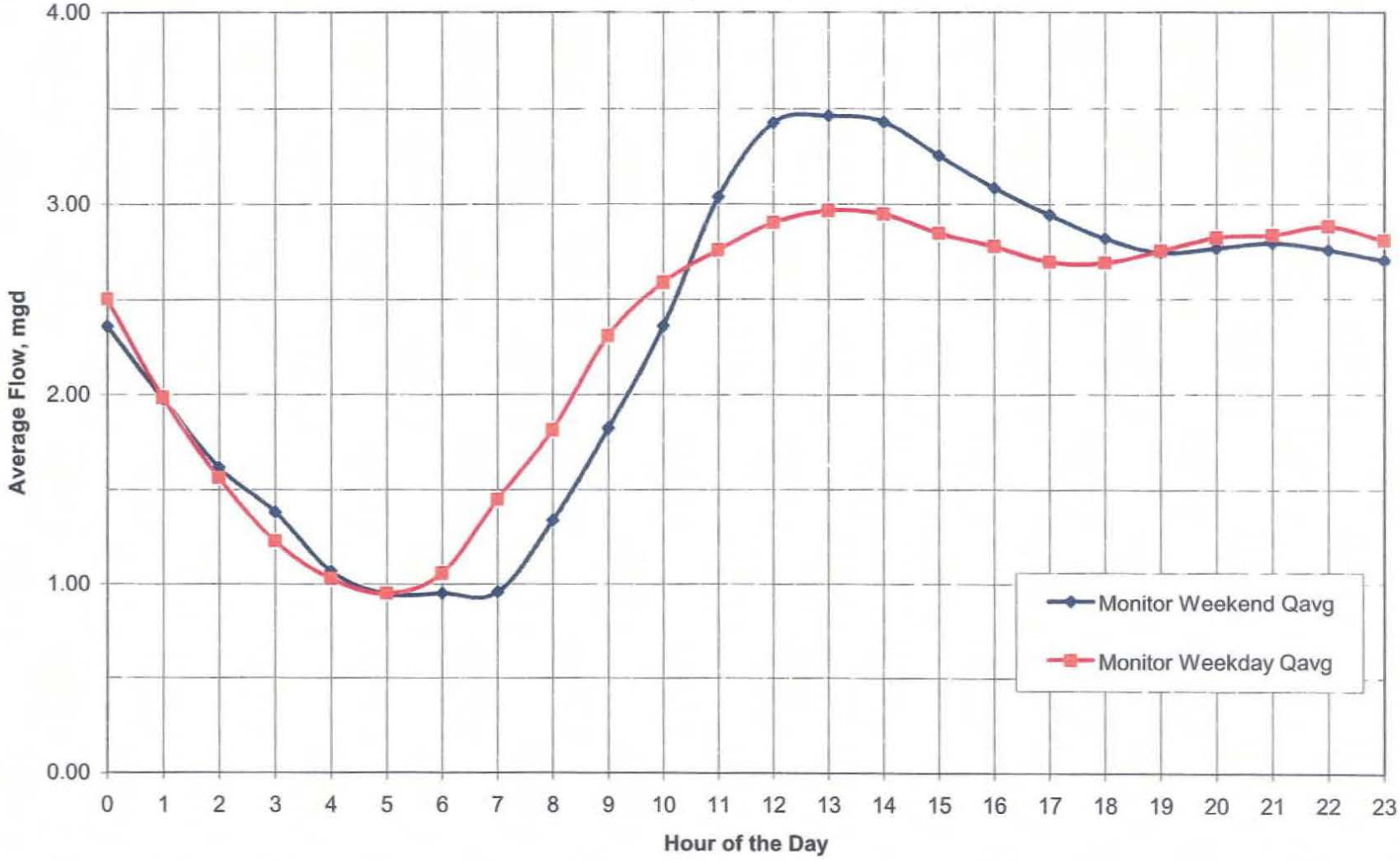
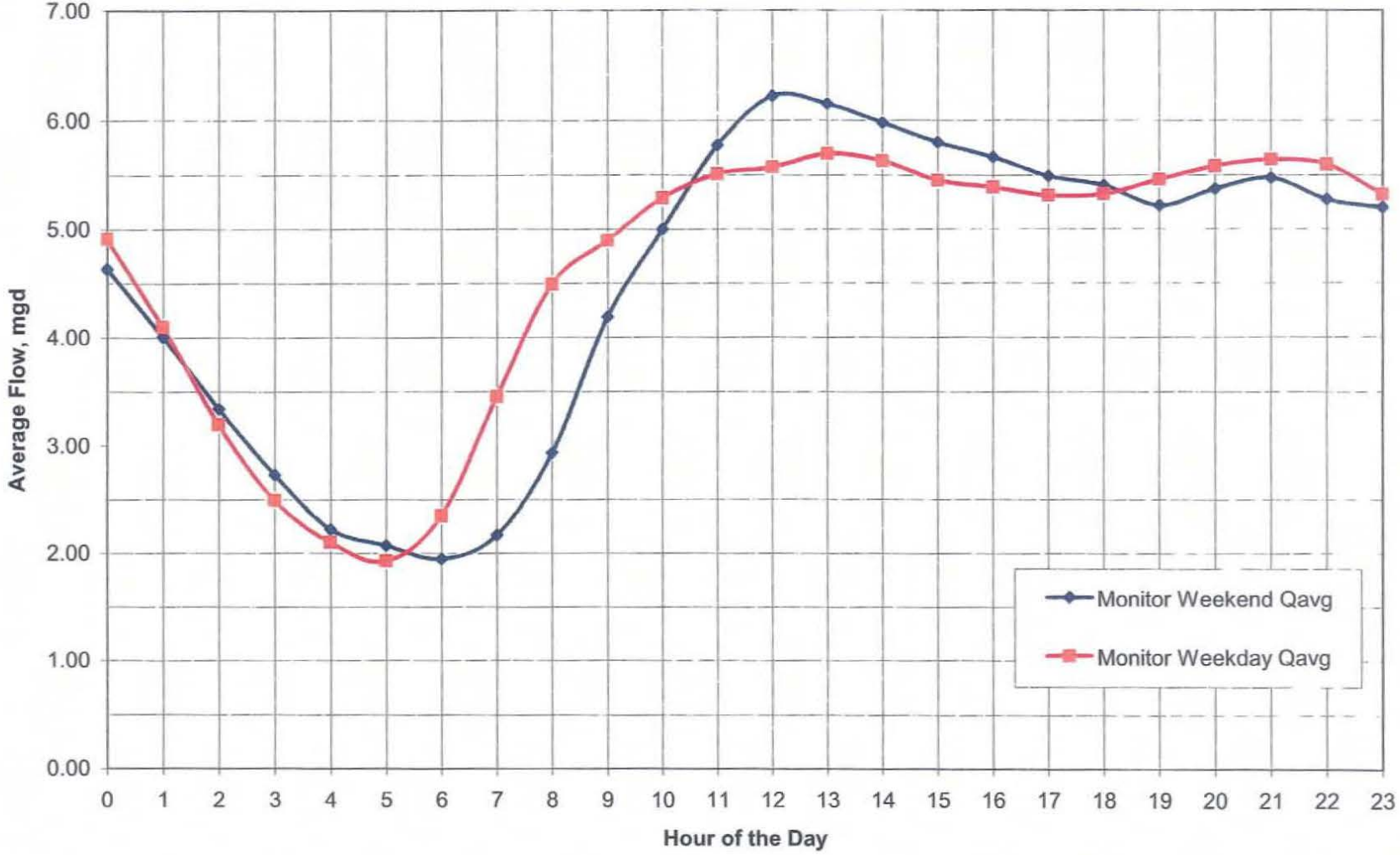


Figure 3-13
Spring Valley Lake MH 04
Weekend/Weekday Average Hourly Flow
(27" Pipe)



3.2.3 Apple Valley

The Town of Apple Valley has no historical flow monitoring results other than the data recorded at the end of the South Apple Valley line that was conducted for VVWRA billing purposes. In the absence of existing data the flow monitoring effort was necessary not only along the VVWRA Interceptor in Apple Valley but also within the Town's major connection points to the Interceptor. This was necessary to provide Interceptor flow loading and diurnal patterns for hydraulic model calibration. The Town of Apple Valley also has several sewer pump stations in the system that required special consideration and field investigation in support of this Master Plan.

The flow monitoring for VVWRA's South Apple Valley Interceptor took place in March of 2008. Eight (8) locations were selected for installation to provide a complete data set for current flow conditions in the area. Figure 3-14 shows the flow monitoring locations for South Apple Valley.

Four (4) of the locations were directly along the VVWRA interceptor. These were South Apple Valley (SAV) Manholes #68, #43, #17 and #2. The resultant average weekday and weekend hourly flow from these four monitoring locations is shown in Figures 3-15 through 3-18.

City of Victorville

Town of Apple Valley

CORWIN RD

RIMROCK RD

APPLE VALLEY RD

SENECA RD

BNSF Rail

Riverside #2
Pump Station
PS

A-MH011
AMH-017
A-MH009
A-MH010
A-MH024
A-MH007
A-MH043
A-MH045
A-MH004
A-MH004
A-MH002
SVL-MH004
A-MH063
A-MH063
A-MH068
A-MH070END
SVL-MH015VSD2
SVL-MH017

Figure 3-14 South Apple Valley Flow Monitoring

Interceptor Pipeline Diameter
- 10"
- 12"
- 15"
- 16"
- 18"
- 21"
- 24"
- 27"
- 36"

- Manhole
- Loading Manhole
- Flow Monitoring Location March 2008
- PS Pump Station
- Proposed Gravity Sewer from Nanticoke PS
- Force Main
- City Boundaries

RBF Consulting GIS

N

0 1300 2600
Feet

Figure 3-15
South Apple Valley MH 68
Weekend/Weekday Average Hourly Flow
(15" Pipe)

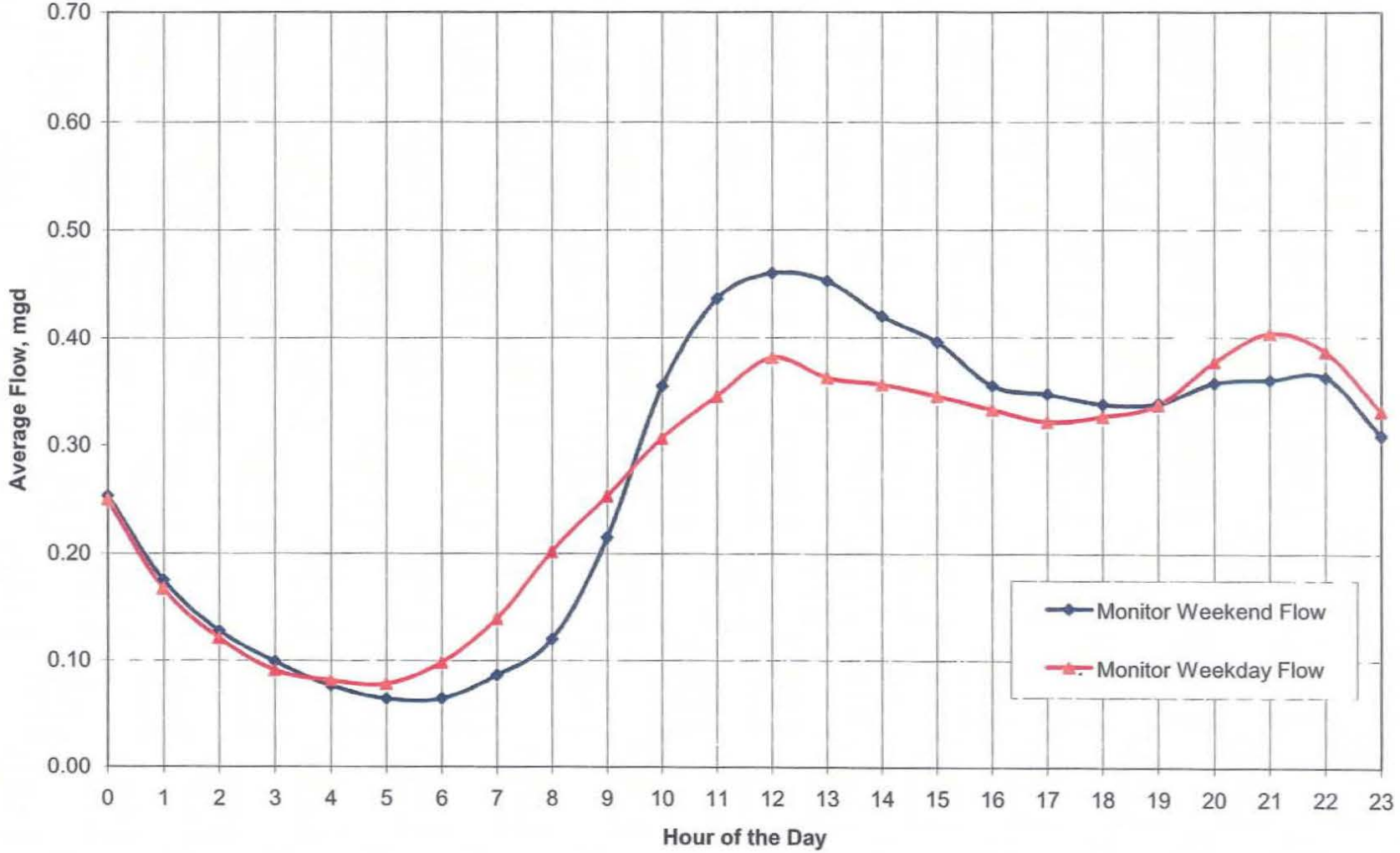


Figure 3-16
South Apple Valley MH 43
Weekend/Weekday Average Hourly Flow
(12" Pipe)

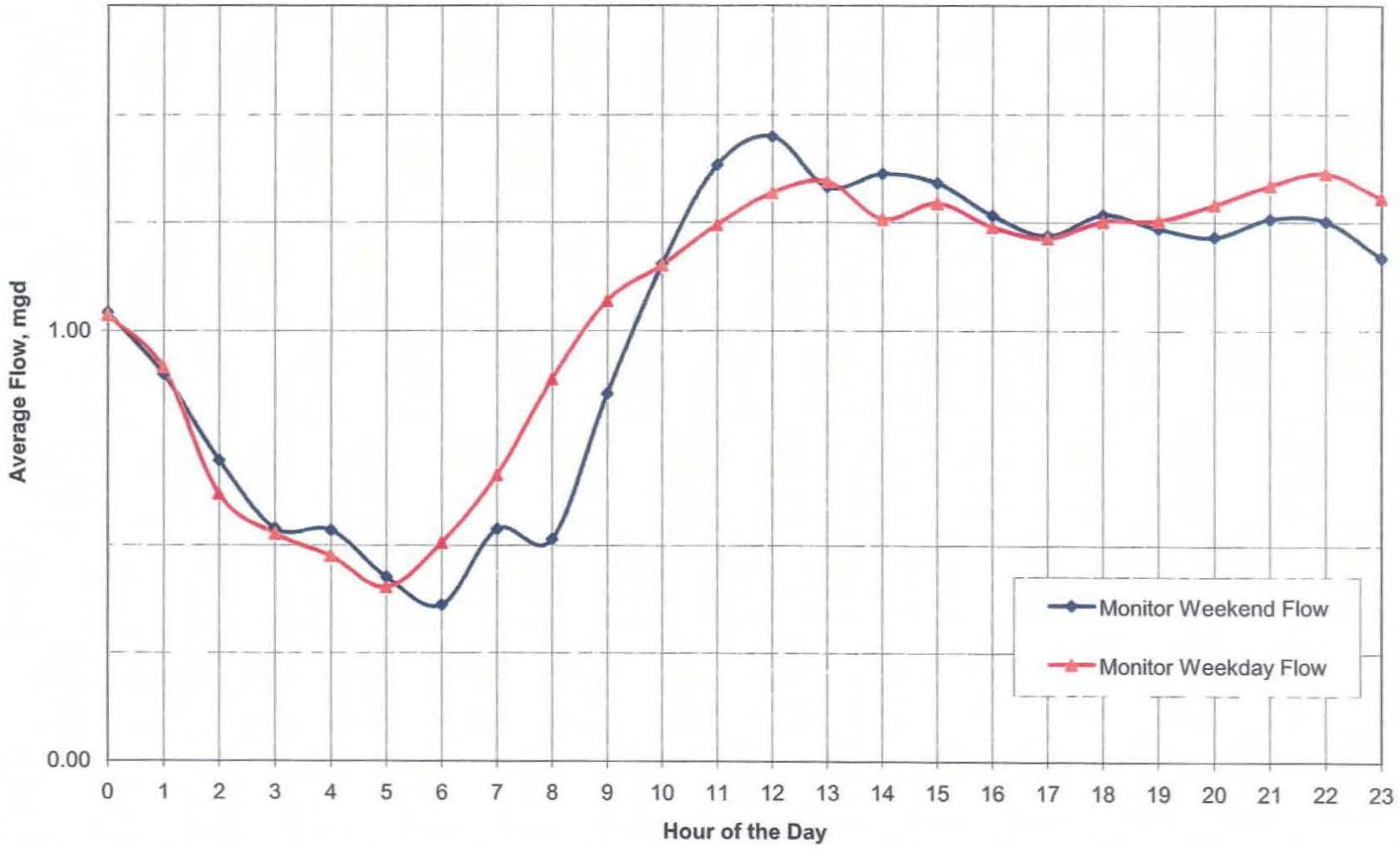


Figure 3-17
South Apple Valley MH 17
Weekend/Weekday Average Hourly Flow
(15" Pipe)

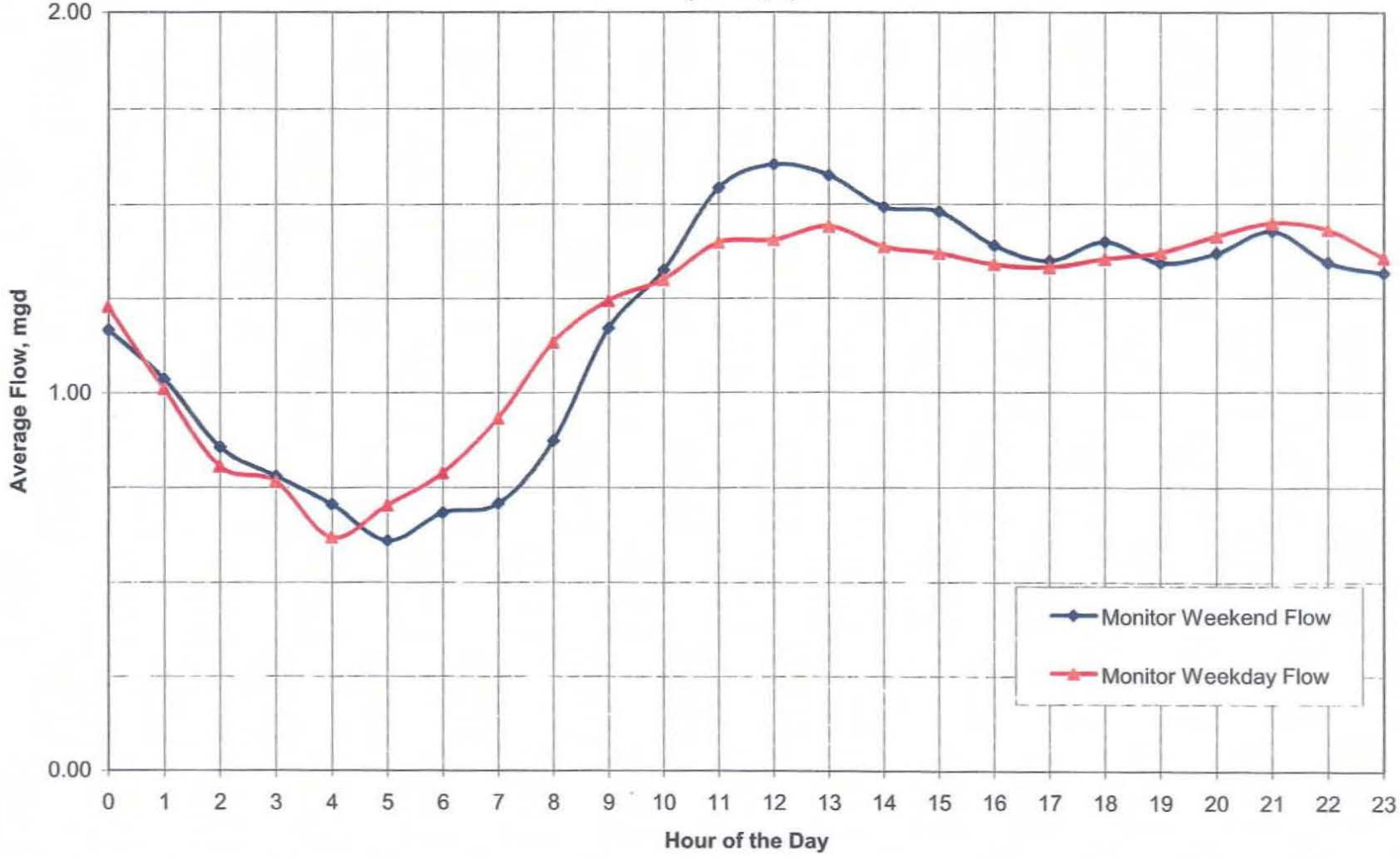
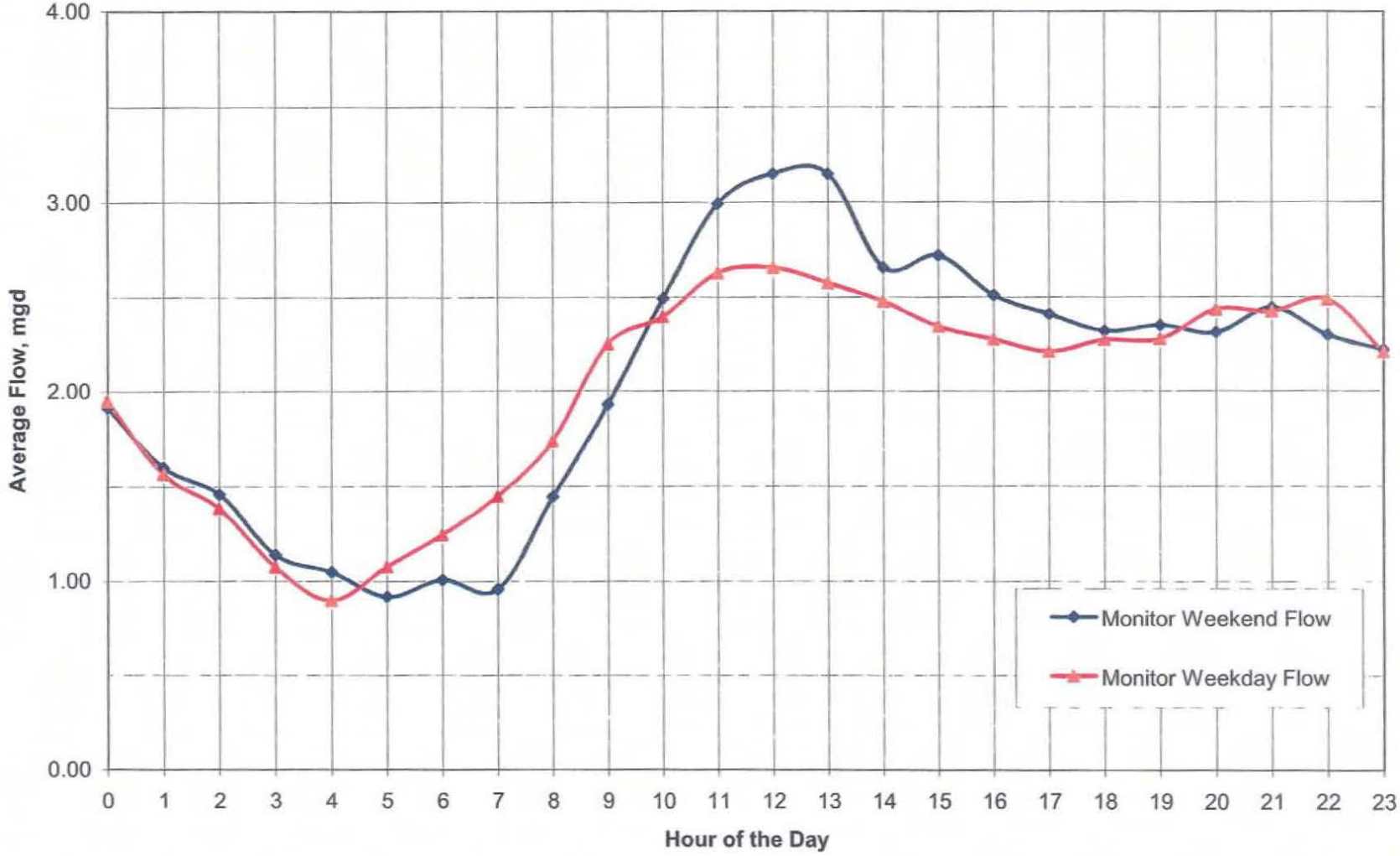


Figure 3-18
South Apple Valley MH 02
Weekend/Weekday Average Hourly Flow
(16" Pipe)



The North Apple Valley Interceptor was not targeted for flow monitoring due to the extremely small amount of flow generated in the line. This Interceptor has one connection from a juvenile detention facility. In May 2007, Downstream Inc. flow monitoring estimated average flow of 1,540 gpd.

3.2.4 Wet Weather Monitoring

In January, 2008 a relatively intense storm was forecasted to hit the high desert area. In response to this, flow meters were placed in three locations within the VVWRA system in an effort to estimate Inflow and Infiltration (I/I) from the member agencies collection systems. A meter was placed at Hesperia Manhole #2, located within Mojave Regional Park near the end of the VVWRA's Hesperia Interceptor. A meter was placed in South Apple Valley Manhole #3, located behind the Lewis Learning Center near the South Apple Valley connection to the main VVWRA Interceptor. A third meter was placed along the Victorville Sewer just upstream of the VSD-3 connection in the City of Victorville. Rain gauges were also placed at existing VVWRA metering stations located nearby the flow monitoring installations.

The storm that was forecasted dropped much less rain than what was anticipated, however, data from the rain gauges indicated two separate events that dropped approximately 0.50 inch of rain. Figure 3-19 shows the results of the January storm.

The I/I data recorded from this event along with data from the RWWRF influent flow meter from an intense storm that hit the service area on November 30 and December 1, 2007 was used to estimate I/I contribution from each of the member agency Interceptor systems.

Figure 3-19
Wet Weather Rainfall Results