Appendix 3-1

CSO Control Program Model Calibration and Verification Report

City of Terre Haute, Indiana

TERRE HAUTE
A LEVEL ABOVE

Combined Sewer Overflows Control Program Model Calibration and Verification Report December 2006

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CITY OF TERRE HAUTE, INDIANA

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Introduction

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1.1 Background

The purpose of this report is to describe the recalibration of the collection system hydraulic model that was originally calibrated in 2001 for use in the 2002 Terre Haute Long Term Control Plan. In the past five years, the City has made changes in the collection system that warrants model recalibration. To support this recalibration, a flow monitoring program was implemented in 2005 to collect more extensive data than was collected in the 2001 calibration effort.

1.2 Objectives

This report describes XP-SWMM model calibration and verification. The objective of the calibration and verification process is to obtain a calibrated and verified model that is acceptable to the regulatory agencies for CSO Control Alternatives Evaluation.

1.3 Software Information

The collection system model simulates runoff from the CSO service areas into the sewers and then routes the flow through the major trunk sewers, CSO diversion structures, and the interceptors to the Wastewater Treatment Plant (WWTP). The model software used for the collection system is SWMM2000 Version 8.52 of EPA's Storm Water Management Model (SWMM) from XP-Software.

This version of the model is commonly referred to as XP-SWMM and this notation will be used throughout the rest of the report when referring to the model.

XP-SWMM is one of the most comprehensive model packages available for assessing combined sewered and urban stormwater collection systems. XP-SWMM computations are based on the well-documented and widely accepted EPA SWMM model formulations. It may be used to simulate

continuous (multi-year) or single storm events. It can estimate runoff flow from several subcatchment basins and route the flow through the sewer system to treatment facilities or to the receiving waters.

The XP-SWMM model provides the following capabilities for the City:

- Developed from EPA SWMM software for technical and regulatory credibility of results.
- A user-friendly graphical interface for cost-effective use and updating.
- A physical based model with model formulations explicitly linked to actual conditions in the field as input by the user.
- Simulates the hydraulic conditions of the modeled trunk sewers, interceptors, gravity sewers, force mains, pump stations, and treatment plants during dry and wet weather.
- Evaluates CSO control alternatives and interceptor capacities.
- Can be periodically updated to reflect the implementation of the CSO control plan and the City's increased development.
- Estimates flows from separate sewered areas.

XP-SWMM has three main simulation components; RUNOFF, TRANSPORT, and EXTRAN. The RUNOFF block simulates the hydrologic response of the sewered area to generate runoff in response to rainfall. Most model parameters that are typically adjusted during model calibration are in the RUNOFF block. The TRANSPORT and EXTRAN blocks simulate conveyance of combined runoff and sanitary flow through sewer system conduits and flow diversion structures. The EXTRAN block is capable of simulating surcharged sewer conditions and outfall tailwater effects while the TRANSPORT block, though simpler and easier to apply, cannot directly simulate these conditions. The EXTRAN Block was used to model the City's trunk sewers to the CSO diversion structures and the interceptor system.

1.4 Model Input Data

The model is comprised of three types of data: sewer system data, rainfall data, and flow monitoring data. This section describes the model input data. **Figure 1-1** shows the entire CSO service area, individual CSO service area boundaries, flow meter locations and rain gauge locations. **Figure 1-2** shows a collection system schematic.

Sewer System Data

Terre Haute's combined sewer service area drains approximately 5,100 acres. Each CSO service area drains to a CSO diversion structure. The City's interceptor system collects and conveys flows from the CSO diversion structures to the WWTP for treatment. During dry weather, all flow is diverted through to the interceptor sewer. During large storms, excessive flows enter the diversion structure and overflow into the Wabash River through the outfall pipe. There are nine diversion structures and outfalls.

The model was built with pipe lengths, sizes and slopes that were determined from sewer system maps provided by the City.

Flow Monitoring Data

Seventeen area-velocity flow meters were placed within the system to measure flow for a six month period. Meters gathered data in the collection system from May 18, 2005 to November 22, 2005. The data was collected in 5-minute increments.

The flow monitoring data was then entered into the XP-SWMM model at the location of each gauge in order to compare modeled flow to actual metered flow.

Rainfall Data

The City of Terre Haute has four rain gauges in the collection system that it uses to record rainfall. The gauges are tipping bucket type gauges that tip after collecting 0.01 inches of rain. During the flow monitoring period, an additional three rain gauges were installed. **Table 1-1** lists the rainfall events during the 2005 flow monitoring period.

Each subcatchment was assigned a rain gauge for model calibration based on the Thiessen Polygon method.

1.5 Model Update

The XP-SWMM model was calibrated in 2002. The XP-SWMM model was updated in 2005. The following updates were made:

- City staff raised weirs. The weir heights were updated in the model based on field measurements conducted by the City.
- 1st St. cross connection and Oak and Crawford cross connections were updated based on field investigations conducted by the City.
- CSO 002 was closed by the City and this change was reflected in the model.
- Subcatchment 003-5 was removed from the model. Initial model runs indicated that less combined sewer area contributed to combined sewer in which the flow meter was located. The area was further evaluated and it was determined that subcatchment 003-5 is likely served by separate sewers. Therefore the subcatchment was removed and the flow meter calibrated well.

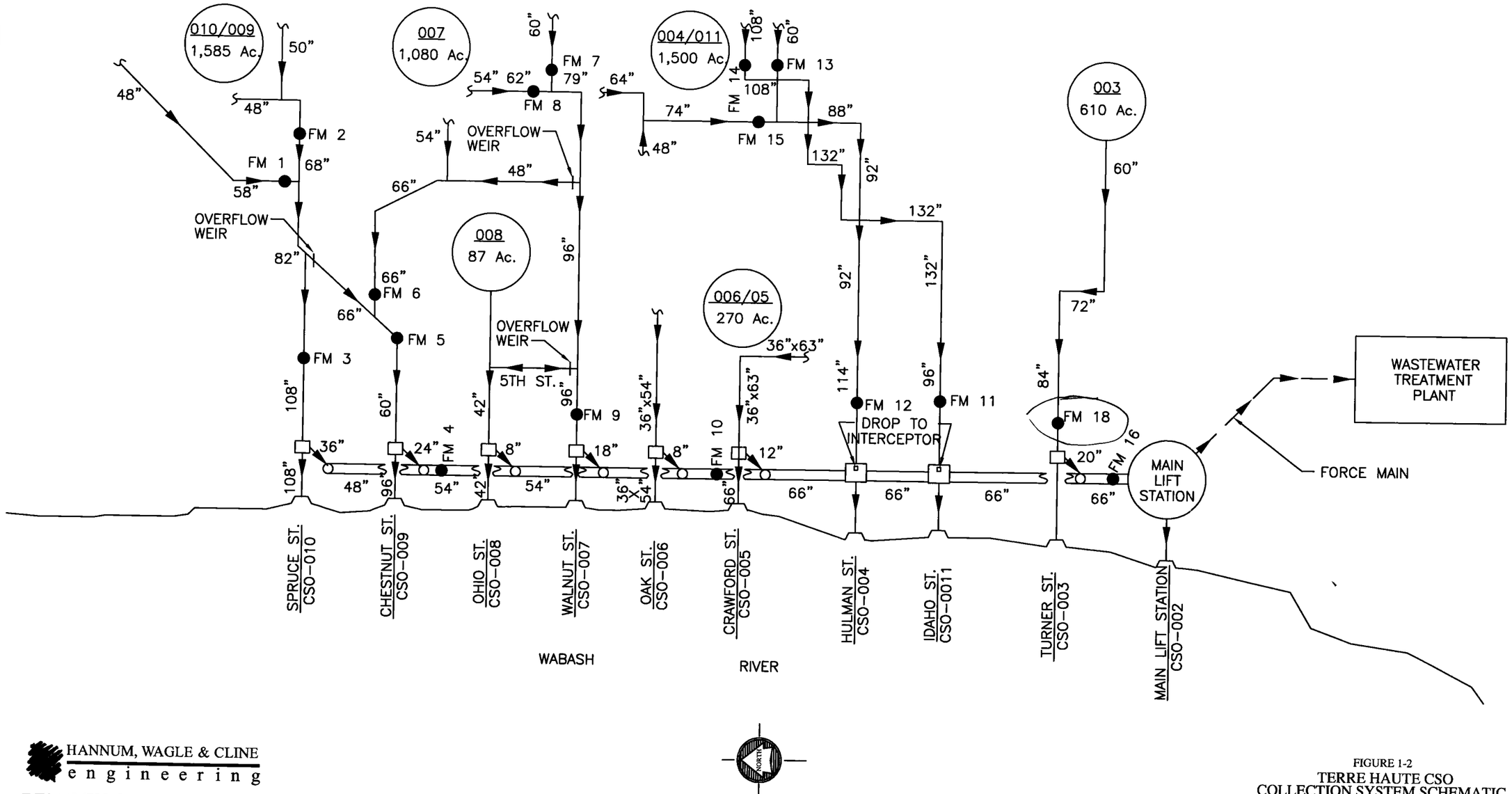

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FIGURE 1-2
TERRE HAUTE CSO
COLLECTION SYSTEM SCHEMATIC
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CSO Control Program
Model Calibration and Verification

Section 2
Model Calibration

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2.1 Calibration and Verification Objectives

The main objective of the model calibration was to obtain a good visual comparison of model and metered hydrographs, in terms of peak flow, total volume, peak flow rate time of occurrence, and shape of the hydrograph for a range of storm sizes. The goal of model calibration is for model results to meet or exceed the measured flow data to be conservative. The calibration process incorporates EPA's suggestions for model calibration along with the City's knowledge of the performance of its collection system in wet weather.

2.2 Dry Weather Calibration

Dry weather flow to the CSO diversion structure is the sum of sanitary flow and infiltration. Dry weather flow was estimated based on land use and flow monitoring information. The dry weather calibration consisted of comparing the dry weather model results to the actual flow monitoring data collected. A diurnal curve was created to simulate varied flow patterns over the course of a day by evaluating a period of one month.

The dry weather inputs were adjusted until the model results approximated the metered flows. The dry weather inputs are as shown in **Table 2-1**.

2.3 Wet Weather Calibration and Verification Summary

The wet weather calibration consisted of running the model with rainfall data collected from selected storms and then comparing the calculated results to the actual flow monitoring data collected. The model parameters were adjusted and the process repeated until the calculated results approximated the actual flow monitor measurements. Goals for the model calibration included:

- To match model runoff volumes (volume under curve) to actual runoff volumes (calculated with flow meter data) within approximately +/- 20%
- To match model runoff peak flow rates to actual flow monitor runoff peak flow rates within approximately +/- 20%
- To match model peak flow rate time of occurrence to actual flow monitored peak flow rate time of occurrence within approximately +/- one hour.

The model calibration effort consisted of calibrating runoff from CSO Service Areas 010, 009, 007, 004, 011 and 003. These areas comprise approximately 93% of the total combined sewer area.

Flow meters were installed in three types of locations to assist in calibration: upstream in the system, downstream in the system, and on interceptors.

Upstream Meters

Flow meters that were installed significantly upstream of the interceptor and upstream of major inputs and diversion structures are referred to as 'upstream meters'. The upstream meters provide redundancy and a quality control check to the downstream meters. The upstream meters typically yield higher quality flow data because they are in more ideal flow metering conditions than the downstream meters (i.e. not adjacent to weirs that cause turbulent hydraulic conditions).

Downstream Meters

Flow meters that were installed downstream of all major inputs and close to the CSO diversion structures that split flow to the interceptor and to an outfall are referred to as 'downstream meters'. The downstream meters measure the total runoff from an entire CSO area.

The hydraulic conditions close to weirs is variable and can cause uncertainty in downstream flow monitoring data. Upstream meters were used as a tool in downstream meter calibration.

Interceptors

Flow meters were installed on the interceptor to measure the flow split between the outfall and the throttle pipe to the interceptor.

The model calibration began with the most upstream flow meter. Once an upstream meter was calibrated, those parameters were not adjusted to calibrate downstream meters. Each CSO service area was calibrated independently. **Figure 1-2** is a schematic of CSO Service Areas and flow meter and rain gauge locations.

The runoff from the six CSO service areas was calibrated with two storms and then the model was verified independently with one storm.

2.4 Calibration

The June 12, 2005 and September 28, 2005 storms were used to calibrate the model. Storm event data is shown in **Table 1-1**. The June 12th storm had an average total rainfall of 1.70 inches. The September 28th storm had an average total rainfall of 0.57 inches. The goal was to calibrate the model with two storm events with even rainfall distribution and with various total rainfalls, intensities, and durations. The chosen storm events met this goal. Even rainfall distribution increases the likelihood that the rain gauge data represents the actual rainfall that occurred in the entire flow metered basin.

The rainfall data from the June 12th and September 28th storm events were entered into the XP-SWMM model. Modifications were made to percent impervious, subcatchment width, and depression storage to obtain the desired calibration curves. The model results were compared to the actual flow monitoring data collected. The model parameters were adjusted and the process repeated until the calculated results approximated the actual flow monitor measurements.

Table 2-2 shows the initial RUNOFF parameters, prior to calibration, and **Table 2-3** shows the final RUNOFF parameters, after calibration. An effort was made to balance the modeled response between storm events while striving to predict the meter response on the average.

2.5 Verification

According to EPA Guidance on Monitoring and Modeling (1999), "validation is the process of testing the calibrated model using one or more independent data set(s) of rainfall data."

After calibration, the next step consisted of using the July 21st storm, as shown in **Table 1-1**, to verify the model. The July 21st storm had an average total rainfall of 1.77 inches and was chosen because of even distribution of rainfall.

The model results were compared to the actual flow monitoring data collected. This validation effort resulted in a satisfactory verification. The validation proved the model calibration to be suitable for alternative evaluation.

2.6 Calibration Results

Tables 2-4 through **2-9** compare modeled and metered volume and peak for the calibration and verification storm events for each CSO Area.

Spruce St. - CSO Area 010

CSO Area 010 consists of 1,263 acres. CSO Area 010 was metered by two upstream meters (FM1 and FM2) and one downstream meter (FM3). The upstream meters measured runoff for approximately 85% of the CSO Service Area.

Figure 2-1 shows the calibration curves for the upstream meter, FM1. FM1 calibrated satisfactorily.

Figure 2-2 shows the calibration curves for the upstream meter, FM2. FM2 calibrated satisfactorily.

Figure 2-3 shows the calibration curves for the downstream meter, FM3. The model results for FM3 are acceptable; however the monitoring data from the FM3 is not within the goal percent difference and warrants explanation.

ADS Environmental Services ® completes CSO site reports upon the installation of flow meters. Of the 17 flow meters in Terre Haute, only two CSO site reports contained comments noting variable hydraulic conditions. The CSO Site Report for FM3, as shown in **Figure 2-4**, was one of the two meters that had a comment about variable flow conditions:

"Flow goes through grate, which accumulates debris. This debris could cause variable flow patterns. Silt could be variable."

ADS area-velocity meters calculate flow from one depth measurement and one velocity measurement. The flow is calculated assuming that the measured velocity measurement is the average over the flow area. If there are variable hydraulic conditions, there is a higher chance that the measured velocity is not representative of the average velocity, which causes erroneous flow values.

Furthermore, the model assumes there is no silt accumulation in pipes. If there is silt accumulation is the existing system, the metered flow would be less than the modeled flow because the model assumes the full flow area of the pipe is available.

In conclusion, CSO Area 010 calibrated satisfactorily. The calibration was achieved by adjusting the downstream meter by the adjustment factors used in calibration for the upstream meters.

Chestnut St. - CSO Area 009

CSO Area 009 consists of approximately 322 acres. CSO Area 009 was metered by one upstream meter (FM6) and one downstream meter (FM5). The upstream meter measured runoff for approximately 67% of the CSO Service Area.

Figure 2-5 shows the calibration curves for the upstream meter, FM6. FM6 calibrated satisfactorily.

Figure 2-6 shows the calibration curves for the downstream meter, FM5. The model results for FM5 are acceptable, however the monitoring data from the FM5 is not within the goal percent difference and warrants explanation.

ADS Environmental Services ® completes CSO site reports upon the installation of flow meters. Of the 17 flow meters in Terre Haute, only two CSO site reports contained comments noting variable hydraulic conditions. The CSO Site report for FM5, as shown in **Figure 2-7**, was one of the two meters that had a comment about variable flow conditions:

"Flow is somewhat choppy and has an uneven velocity profile due to intersection of pipes upstream of sensors."

ADS area-velocity meters calculate flow from one depth measurement and one velocity measurement. The flow is calculated assuming that the measured velocity measurement is the average over the flow area. If there an uneven velocity profile, there is a higher chance that the measured velocity is not representative of the average velocity, which causes erroneous flow values.

A 66-inch pipe discharges in close proximity to the meter, causing turbulent flow conditions. The depth and velocity measurements in such conditions are not reliable, therefore this meter was not used in calibration.

In conclusion, CSO Area 009 calibrated satisfactorily. The calibration was achieved by adjusting the downstream meter by the adjustment factors used in calibration for the upstream meter.

Walnut St. - CSO Area 007

CSO Area 007 consists of approximately 1,080 acres. CSO Area 007 was metered by two upstream meters (FM7 and FM8) and one downstream meter (FM9). The upstream meters measured runoff for approximately 70% of the CSO Service Area.

Figure 2-8 shows the calibration curves for the upstream meter, FM7. FM7 calibrated satisfactorily.

Figure 2-8 shows the calibration curves for the upstream meter, FM8. FM8 calibrated satisfactorily.

Figure 2-10 shows the calibration curves for the downstream meter, FM9. FM9 calibrated satisfactorily.

In conclusion, CSO Area 007 calibrated satisfactorily.

Hulman St. - CSO Area 004 & Idaho St. – CSO Area 011

CSO Areas 004 and 011 consist of approximately 1,500 acres. These two CSO areas are addressed together in this section because there are several interconnections between them. CSO Areas 004 and 011 were metered by three upstream meters (FM13, FM14, and FM15) and two downstream meters (FM11 and FM12).

Figure 2-11 shows the calibration curves for the upstream meter, FM13. FM13 calibrated satisfactorily.

Figure 2-12 shows the calibration curves for the upstream meter, FM14. FM14 calibrated satisfactorily.

Figure 2-13 shows the calibration curves for the upstream meter, FM15. FM15 calibrated satisfactorily.

Figure 2-14 shows the calibration curves for the downstream meter, FM11. FM11 calibrated satisfactorily.

Figure 2-15 shows the calibration curves for the downstream meter, FM12. The model results for FM12 are acceptable, however the monitoring data from the FM12 is not within the goal percent difference and warrants explanation. It appears that the flow meters calculated erroneous flow values for several reasons.

According to Mannings theory in open pipe flow, flow depth increases as velocity increases. Mannings equation predicts the increase of depth with increase in velocity. Contrary to theory, during each calibration and verification storm event, flow depth does not increase with velocity. **Figures 2-16 through 2-18** show a theoretical Mannings curve and metered depth and velocity data for the calibration and verification events. The condition in which depth does not increase with velocity cannot exist, therefore, the calibration was achieved by adjusting the FM12 by the adjustment factors used in the successful calibration of the upstream meters.

Furthermore, flow meters are typically calibrated during dry weather. The CSO Area 004 114-inch trunk sewer has a very slow, low dry weather flow, as commented in the ADS CSO Site Report (see **Figure 2-19**). CSO Area 004 dry weather flow is very low because a weir diverts the majority of the dry weather flow to CSO 011. Low flow depths are difficult for the meter to measure. In addition, very low flows are significantly different than wet weather flows in very large pipes. Therefore, there is uncertainty in the flow meter calibration for FM12.

As further proof, solids and debris settles in very slow flow conditions. The first flush of a wet weather event will convey the solids downstream and potentially foul the flow meter sensors. Both calibration hydrographs show a sudden, unrealistic decrease in flow that could be caused by a fouled sensor.

There is confidence in the model output of FM12 because all of the upstream meters in CSO Areas 004 and 011 that calculate the upstream runoff calibrated satisfactorily and FM12 was adjusted based on those meters. In conclusion, CSO Areas 004 and 011 calibrated satisfactorily.

Turner St. - CSO Area 003

CSO Area 003 consists of approximately 610 acres. CSO Area 003 was metered by one downstream meter (FM18).

Figure 2-20 shows the calibration curves for the downstream meter, FM18. FM18 calibrated satisfactorily.

Interceptors

Three flow monitors were installed on the interceptor, FM4, FM10, and FM16. **Figure 2-21 to 2-23** shows the calibration curves for these meters.

FM16, the most downstream interceptor flow meter, directly upstream of the WWTP lift station, calibrated satisfactorily. The successful calibration of the most downstream meter builds confidence in the model because it predicts the total flow to the WWTP which is a combination all upstream meters, giving more confidence in all of the other meters upstream in the system.

FM4 and FM10 could not be calibrated within the approximate percent difference goal, because of the installation of trash racks on the on the throttle pipes that convey flow to the interceptor. The trash and debris accumulation on the racks is variable. In addition, the trash racks are cleaned on an as-needed basis. The model cannot predict the variability of trash limiting the flow to the interceptor. The model simulates flow the interceptor as if there were no trash rack. As expected, the model overestimates interceptor flow for FM4 and FM10. Furthermore, the trash racks will be removed as part of the LTCP. Therefore, although the model predicted flow for FM4 and FM10 is higher than metered flow, the calibration is acceptable because it simulates the future condition of no trash racks.

Non-Flow Monitored Areas

Subsequently, the remainder of the non-monitored service areas was revised using adjustment factors derived from calibrated CSO Service Areas.

CITY OF TERRE HAUTE, INDIANA

Combined Sewer Overflow Long-Term Control Plan

Calibration and Verification Report

Table 1-1
2005 Monitored Rainfall Events

Greeley and Hansen
Hannum, Wagle & Cline

Date	*Average Rainfall (inches)*	*Rainfall Range for Rain Gauges*[3] *(inches)*	*Duration (hours)*	*Maximum Intensity (in/hr)*	*No. of Dry Days Prior to Storm*
5/19/2005	0.56	0.35 - 0.86	1.2	0.85	3
6/12/2005[1]	1.70	1.51 - 1.80	10.2	0.61	1
7/11/2005	0.55	0.44 - 0.74	8.8	0.35	24
7/21/2005[2]	1.79	1.74 - 1.87	4.3	1.04	2
7/26/2005	0.50	0.45 - 0.56	3.6	0.38	4
8/12/2005	1.09	0.81 - 1.48	7.8	0.84	15
8/13/2005	0.56	0.46 - 0.73	3.3	0.59	0
8/19/2005	0.98	0.39 - 1.43	4.0	0.77	4
8/30/2005	0.42	0.31 - 0.51	11.7	0.13	2
9/19/2005	0.87	0.68 - 1.18	9.5	0.30	2
9/25/2005	1.77	1.55 - 2.05	18.1	0.52	4
9/28/2005[1]	0.57	0.52 - 0.59	3.50	0.40	2

[1] Model Calibration storms
[2] Model Verification storm
[3] Rain gauges from 4 City rain gauges and 3 ADS rain gauges

Table 2-1
Dry Weather Flow Inputs

Greeley and Hansen
Hannum, Wagle & Cline

Subcatchment Number	*Flow Rate*	*Flow*	*Units*
003-204TN	0.072	0.072	CFS
003-209TN	0.059	0.059	CFS
003-210TN	0.0243	0.0376	MGD
003-217TN	0.062	0.062	CFS
003-225TN	0.13	0.13	CFS
003-226N	0.039	0.039	CFS
004-061N	0.2	0.2	CFS
004-102TN	0.2	0.2	CFS
004-110N	0.0035	0.0054	MGD
004-140TN	0.095	0.095	CFS
004-245TN	0.037	0.037	CFS
004-255TN	0.036	0.036	CFS
004-257N	0.093	0.093	CFS
004-288TN	0.105	0.1625	MGD
004-290TN	0.097	0.097	CFS
004-292TN	0.064	0.064	CFS
004-295TN	0.07	0.07	CFS
004-298TN	0.039	0.039	CFS
004-332TN	1.1	1.702	MGD
004-342N	0.039	0.039	CFS
301IN	0.001	0.001	CFS
009-092N	0.3	0.3	CFS
009-312TN	0.15	0.15	CFS
010-014TN	0.1	0.1547	MGD
010-018N	0.05	0.05	CFS
010-020N	0.035	0.0542	MGD
010-021N	0.043	0.043	CFS
010-033TN	1.5	2.3208	MGD
010-042TN	0.061	0.061	CFS
010-045N	0.07	0.07	CFS
010-129N	0.044	0.044	CFS
010-151TN	0.047	0.047	CFS
010-236TN	0.081	0.081	CFS
010-266N	0.033	0.033	CFS
010-270TN	0.047	0.047	CFS
010-302TN	1	1	CFS
010-303TN	0.09	0.1393	MGD
010-318TN	0.09	0.09	CFS
010-319TN	0.048	0.048	CFS
011-083N	0.079	0.079	CFS
011-121N	0.097	0.097	CFS
011-174TN	0.057	0.057	CFS
011-183TN	0.054	0.054	CFS
011-190TN	0.824	0.824	CFS
011-198TN	0.0635	0.0982	MGD
010-171TN	0.079	0.079	CFS
004/011-6N	0.045	0.045	CFS
011-150N	0.029	0.029	CFS
010-1N	0.033	0.033	CFS
009-325TN	0.062	0.062	CFS
008-100N	0.058	0.058	CFS
007-160N	0.11	0.11	CFS
007-120N	0.112	0.112	CFS
007-5N	0.151	0.151	CFS
004-338TN	0.1	0.1	CFS
5/6-200N	0.063	0.063	CFS
5/6-210N	0.026	0.026	CFS
005/006-1N	0.026	0.026	CFS
5/6-100N	0.069	0.069	CFS
120IN	0.001	0.001	CFS
307IN	0.002	0.002	CFS
360IN	0.001	0.0015	MGD
010-330TN	0.034	0.0526	MGD
003-400N	0.745	1.1527	MGD
007-150N	0.017	0.0263	MGD
007-200N	0.012	0.0186	MGD
007-152N	0.009	0.009	CFS

Table 2-2
Initial Model Data

Greeley and Hansen
Hannum, Wagle & Cline

CSO Service Area	*Subcatchment Number*	*Runoff Model Point of Concentration*	*Combined Area (Acres)*	*Percent Impervious*	*Subcatchment Width (ft)*	*Overland Slope (%)*	*Depression Storage (in)*		*Overland Mannings "n"*		*Rain Gauge*[1]
							Impervious	*Pervious*	*Impervious*	*Pervious*	
003	003-1	003-209TN	97	19%	1,117	0.003	0.058	0.188	0.014	0.20	ADS1
	003-2	003-204TN	105	45%	1,387	0.003	0.052	0.187	0.014	0.20	ADS1
	003-3	003-217TN	86	43%	1,341	0.003	0.056	0.190	0.014	0.20	ADS1
	003-4	003-226N	131	34%	2,597	0.003	0.057	0.164	0.014	0.19	ADS1
	003-5	003-225TN	194	23%	1,921	0.001	0.080	0.192	0.014	0.20	ADS1
004/011	004/011-1	004-292TN	124	37%	1,593	0.008	0.034	0.176	0.014	0.18	ADS3
	004/011-2	004-290TN	122	27%	932	0.003	0.058	0.200	0.014	0.20	ADS3
	004/011-3	011-121N	134	37%	1,617	0.001	0.080	0.192	0.014	0.20	ADS3
	004/011-4	004-295TN	153	19%	1,384	0.001	0.118	0.175	0.014	0.19	ADS3
	004/011-5	011-083N	130	26%	1,088	0.003	0.056	0.186	0.014	0.19	ADS3
	004/011-6	004/011-6N	96	28%	1,447	0.001	0.112	0.176	0.014	0.19	ADS3
	004/011-7	004-298TN	78	17%	1,299	0.0004	0.150	0.182	0.014	0.20	ADS3
	004/011-8	004-140TN	166	17%	1,507	0.004	0.047	0.187	0.014	0.20	ADS3
	004/011-9	011-150N	42	25%	1,141	0.003	0.054	0.194	0.014	0.20	ADS3
	004/011-10	004-342N	68	19%	1,407	0.006	0.040	0.186	0.014	0.20	ADS3
	004/011-11	011-183TN	70	23%	1,264	0.002	0.073	0.200	0.014	0.20	ADS3
	004/011-12	011-174TN	74	23%	728	0.003	0.057	0.200	0.014	0.20	ADS3
	004/011-13	004-245TN	72	30%	1,044	0.001	0.094	0.179	0.014	0.20	ADS3
	004/011-14	004-255TN	49	30%	1,072	0.002	0.067	0.194	0.014	0.20	ADS3
	004/011-15	004-257N	126	24%	1,375	0.003	0.057	0.197	0.014	0.20	ADS3
005/006	005/006-1	005/006-1N	56	48%	768	0.014	0.026	0.177	0.014	0.20	ADS3
	005/006-2	5/6-210N	29	56%	358	0.005	0.041	0.200	0.014	0.20	ADS3
	005/006-3	5/6-200N	83	26%	1,065	0.003	0.055	0.199	0.014	0.20	ADS3
	005/006-4	5/6-100N	103	50%	1,721	0.012	0.027	0.187	0.014	0.20	ADS3
007	007-1	007-160N	117	65%	1,001	0.003	0.055	0.198	0.014	0.20	ADS3
	007-2	007-120N	138	37%	1,820	0.002	0.076	0.199	0.014	0.20	ADS3
	007-3	004-102TN	160	32%	1,587	0.001	0.088	0.198	0.014	0.20	ADS3
	007-4	004-061N	200	36%	2,815	0.005	0.042	0.191	0.014	0.20	City6
	007-5	007-5N	212	28%	2,249	0.006	0.039	0.194	0.014	0.20	City7
	007-6	004-338TN	185	19%	2,239	0.002	0.068	0.184	0.014	0.20	City7
	007-7	007-152N	67	30%	1,217	0.005	0.043	0.150	0.014	0.17	ADS3
008	008-1	008-100N	87	65%	1,647	0.008	0.034	0.147	0.014	0.19	City4
009	009-1	009-325TN	105	73%	1,631	0.005	0.043	0.068	0.014	0.19	City4
	009-2	009-312TN	108	62%	1,574	0.005	0.043	0.058	0.014	0.20	City4
	009-3	009-092N	109	42%	1,973	0.003	0.052	0.187	0.014	0.20	ADS2
010	010-1	010-1N	80	34%	1,091	0.002	0.064	0.141	0.014	0.19	City4
	010-2	010-302TN	150	23%	1,633	0.005	0.045	0.181	0.014	0.20	City4
	010-3	010-236TN	108	31%	1,180	0.002	0.077	0.196	0.014	0.20	ADS2
	010-4	010-319TN	69	31%	679	0.003	0.060	0.192	0.014	0.20	ADS2
	010-5	010-129N	56	33%	593	0.003	0.055	0.197	0.014	0.20	ADS2
	010-6	010-318TN	111	37%	1,340	0.003	0.060	0.199	0.014	0.20	ADS2
	010-7	010-171TN	129	31%	1,338	0.001	0.096	0.187	0.014	0.20	ADS2
	010-8	010-270TN	87	30%	1,227	0.002	0.074	0.182	0.014	0.19	ADS2
	010-9	010-266N	52	22%	815	0.002	0.064	0.190	0.014	0.20	ADS2
	010-10	010-018N	110	29%	1,327	0.004	0.048	0.176	0.014	0.19	ADS2
	010-11	010-021N	56	26%	968	0.003	0.057	0.200	0.014	0.20	City6
	010-12	010-151TN	60	24%	939	0.002	0.064	0.200	0.014	0.20	ADS2
	010-13	010-042TN	96	23%	991	0.002	0.064	0.190	0.014	0.20	City6
	010-14	010-045N	99	22%	1,542	0.004	0.050	0.196	0.014	0.20	City6

[1]Rain gauge assignments based on Thiessen Polygon Method. ADS refers to ADS rain gauge. City refers to city rain gauge.

Table 2-3
Final Model Data

Greeley and Hansen
Hannum, Wagle & Cline

CSO Service Area	*Subcatchment Number*	*Runoff Model Point of Concentration*	*Combined Area (Acres)*	*Percent Impervious*	*Subcatchment Width (ft)*	*Overland Slope (%)*	*Depression Storage (in)*		*Overland Mannings "n"*		*Rain Gauge*[1]
							Impervious	*Pervious*	*Impervious*	*Pervious*	
003	003-1	003-209TN	97	10%	559	0.003	0.116	0.188	0.014	0.20	ADS1
	003-2	003-204TN	105	23%	694	0.003	0.104	0.187	0.014	0.20	ADS1
	003-3	003-217TN	86	22%	671	0.003	0.112	0.190	0.014	0.20	ADS1
	003-4	003-226N	131	17%	1,299	0.003	0.114	0.164	0.014	0.19	ADS1
004/011	004/011-1	004-292TN	124	51%	2,390	0.008	0.034	0.176	0.014	0.18	ADS3
	004/011-2	004-290TN	122	26%	5,592	0.003	0.116	0.200	0.014	0.20	ADS3
	004/011-3	011-121N	134	51%	2,426	0.001	0.080	0.192	0.014	0.20	ADS3
	004/011-4	004-295TN	153	26%	2,076	0.001	0.118	0.175	0.014	0.19	ADS3
	004/011-5	011-083N	130	25%	6,528	0.003	0.112	0.186	0.014	0.19	ADS3
	004/011-6	004/011-6N	96	39%	2,171	0.001	0.112	0.176	0.014	0.19	ADS3
	004/011-7	004-298TN	78	17%	7,794	0.0004	0.300	0.182	0.014	0.20	ADS3
	004/011-8	004-140TN	166	17%	9,042	0.004	0.094	0.187	0.014	0.20	ADS3
	004/011-9	011-150N	42	50%	2,567	0.003	0.068	0.194	0.014	0.20	ADS3
	004/011-10	004-342N	68	19%	8,442	0.006	0.080	0.186	0.014	0.20	ADS3
	004/011-11	011-183TN	70	26%	948	0.002	0.091	0.200	0.014	0.20	ADS3
	004/011-12	011-174TN	74	26%	546	0.003	0.071	0.200	0.014	0.20	ADS3
	004/011-13	004-245TN	72	29%	6,264	0.001	0.188	0.179	0.014	0.20	ADS3
	004/011-14	004-255TN	49	29%	6,432	0.002	0.134	0.194	0.014	0.20	ADS3
	004/011-15	004-257N	126	23%	8,250	0.003	0.114	0.197	0.014	0.20	ADS3
005/006	005/006-1	005/006-1N	56	48%	768	0.014	0.026	0.177	0.014	0.20	ADS3
	005/006-2	5/6-210N	29	56%	358	0.005	0.041	0.200	0.014	0.20	ADS3
	005/006-3	5/6-200N	83	26%	1,065	0.003	0.055	0.199	0.014	0.20	ADS3
	005/006-4	5/6-100N	103	32%	5,163	0.012	0.027	0.187	0.014	0.20	ADS3
007	007-1	007-160N	117	42%	4,004	0.003	0.110	0.198	0.014	0.20	ADS3
	007-2	007-120N	138	24%	7,280	0.002	0.152	0.199	0.014	0.20	ADS3
	007-3	004-102TN	160	28%	3,333	0.001	0.110	0.198	0.014	0.20	ADS3
	007-4	004-061N	200	32%	5,912	0.005	0.053	0.191	0.014	0.20	City6
	007-5	007-5N	212	40%	1,687	0.006	0.098	0.194	0.014	0.20	City7
	007-6	004-338TN	185	27%	1,679	0.002	0.068	0.184	0.014	0.20	City7
	007-7	007-152N	67	19%	4,868	0.005	0.086	0.150	0.014	0.17	ADS3
008	008-1	008-100N	87	65%	1,647	0.008	0.034	0.147	0.014	0.19	City4
009	009-1	009-325TN	105	61%	6,524	0.005	0.043	0.068	0.014	0.19	City4
	009-2	009-312TN	108	51%	7,870	0.005	0.086	0.058	0.014	0.20	City4
	009-3	009-092N	109	35%	9,865	0.003	0.104	0.187	0.014	0.20	ADS2
010	010-1	010-1N	80	30%	2,455	0.002	0.064	0.141	0.014	0.19	City4
	010-2	010-302TN	150	20%	3,674	0.005	0.045	0.181	0.014	0.20	City4
	010-3	010-236TN	108	26%	1,770	0.002	0.130	0.196	0.014	0.20	ADS2
	010-4	010-319TN	69	28%	2,037	0.003	0.225	0.192	0.014	0.20	ADS2
	010-5	010-129N	56	30%	1,779	0.003	0.206	0.197	0.014	0.20	ADS2
	010-6	010-318TN	111	34%	4,020	0.003	0.225	0.199	0.014	0.20	ADS2
	010-7	010-171TN	129	26%	1,967	0.001	0.162	0.187	0.014	0.20	ADS2
	010-8	010-270TN	87	25%	1,841	0.002	0.125	0.182	0.014	0.19	ADS2
	010-9	010-266N	52	19%	1,223	0.002	0.108	0.190	0.014	0.20	ADS2
	010-10	010-018N	110	25%	1,991	0.004	0.081	0.196	0.014	0.19	ADS2
	010-11	010-021N	56	22%	1,452	0.003	0.096	0.200	0.014	0.20	City6
	010-12	010-151TN	60	20%	1,409	0.002	0.108	0.200	0.014	0.20	ADS2
	010-13	010-042TN	96	19%	1,487	0.002	0.108	0.190	0.014	0.20	City6
	010-14	010-045N	99	19%	2,313	0.004	0.084	0.196	0.014	0.20	City6

[1]Rain gauge assignments based on Thiessen Polygon Method. ADS refers to ADS rain gauge. City refers to city rain gauge.

CITY OF TERRE HAUTE, INDIANA

Combined Sewer Overflow Long-Term Control Plan
Calibration and Verification Report

Table 2-4
CSO Area 010 Modeled and Metered Comparison

Greeley and Hansen
Hannum, Wagle & Cline

Storm/Rainfall	*Flow Meter*	*Volume*			*Peak*		
		Metered (mg)	*Modeled (mg)*	*% Difference*	*Metered (mgd)*	*Modeled (mgd)*	*% Difference*
Calibration							
June 12 1.70"	FM1	4.2	4.4	6%	28.6	28.5	0%
	FM2	6.8	7.5	10%	53.5	59.8	12%
	FM3[1]	11.3	14.9	31%	76.9	119.9	56%
September 28 0.57"	FM1	1.3	1.3	1%	13.9	16.1	16%
	FM2	2.0	1.9	-3%	25.9	28.7	11%
	FM3[1]	3.2	4.1	25%	34.8	46.2	33%
Verification							
July 21 1.79"	FM1	3.3	3.8	14%	20.5	28.9	41%
	FM2	7.9	6.9	-13%	52.0	60.7	17%
	FM3[1]	12.1	13.9	15%	75.2	111.4	48%

[1] FM3 warrants explanation. See page 2-4 in text.

CITY OF TERRE HAUTE, INDIANA

Combined Sewer Overflow Long-Term Control Plan

Calibration and Verification Report

Table 2-5
CSO Area 009 Modeled and Metered Comparison

Greeley and Hansen
Hannum, Wagle & Cline

Storm/Rainfall	*Flow Meter*	*Volume*			*Peak*		
		Metered (mg)	*Modeled (mg)*	*% Difference*	*Metered (mgd)*	*Modeled (mgd)*	*% Difference*
Calibration							
June 12 1.70"	FM6	4.0	4.6	16%	38.9	37.8	-3%
	FM5[1]	9.1	9.0	-1%	90.8	58.9	-35%
September 28 0.57"	FM6	1.3	1.3	6%	31.8	29.0	-9%
	FM5[1]	3.8	2.8	-27%	76.5	38.6	-49%
Verification							
July 21 1.79"	FM6	4.4	4.5	2%	53.3	60.5	14%
	FM5[1]	13.4	8.4	-37%	152.1	63.7	-58%

[1] FM5 warrants explanation. See page 2-5 in text.

CITY OF TERRE HAUTE, INDIANA

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Table 2-6
CSO Area 007 Modeled and Metered Comparison

Greeley and Hansen
Hannum, Wagle & Cline

Storm/Rainfall	*Flow Meter*	*Volume*			*Peak*		
		Metered (mg)	*Modeled (mg)*	*% Difference*	*Metered (mgd)*	*Modeled (mgd)*	*% Difference*
Calibration							
June 12 1.70"	FM7	7.0	6.1	-12%	42.1	43.5	3%
	FM8	4.9	5.0	2%	36.7	39.8	8%
	FM9	14.5	15.1	4%	96.3	107.8	12%
September 28 0.57"	FM7	1.7	1.9	10%	21.6	22.0	2%
	FM8	1.5	1.5	-3%	24.5	26.9	10%
	FM9	3.8	4.5	18%	52.7	47.0	-11%
Verification							
July 21 1.79"	FM7	6.7	6.4	-4%	56.5	49.9	-12%
	FM8	5.1	5.0	-2%	42.5	52.1	23%
	FM9	14.0	15.7	12%	98.9	109.3	11%

Table 2-7
CSO Area 004 & 011 Modeled and Metered Comparison

Greeley and Hansen
Hannum, Wagle & Cline

Storm/Rainfall	*Flow Meter*	*Volume*			*Peak*		
		Metered (mg)	*Modeled (mg)*	*% Difference*	*Metered (mgd)*	*Modeled (mgd)*	*% Difference*
Calibration							
June 12 1.70"	FM13	1.1	0.8	-20%	8.2	8.1	-1%
	FM14	1.9	1.9	-4%	13.9	13.0	-6%
	FM15	2.5	2.6	2%	24.6	23.1	-6%
	FM11	12.0	11.6	-4%	87.6	74.4	-15%
	FM12[1]	No Data	4.9	-	No Data	40.0	-
September 28 0.57"	FM13	0.2	0.3	18%	4.6	5.8	25%
	FM14	0.4	0.7	81%	5.9	6.7	15%
	FM15	0.6	0.7	15%	12.5	14.3	15%
	FM11	2.9	3.8	35%	37.7	41.8	11%
	FM12[1]	No Data	1.6	-	No Data	23.4	-
Verification							
July 21 1.79"	FM13	1.1	0.9	-12%	12.9	13.2	2%
	FM14	1.6	1.9	17%	16.5	17.0	3%
	FM15	2.6	2.7	2%	31.9	37.9	19%
	FM11	11.5	11.9	4%	86.2	85.3	-1%
	FM12[1]	2.2	5.3	139%	30.4	61.4	102%

[1] FM12 warrants explanation. See page 2-7 in text.

CITY OF TERRE HAUTE, INDIANA

Combined Sewer Overflow Long-Term Control Plan
Calibration and Verification Report

Table 2-8
CSO Area 003 Modeled and Metered Comparison

Greeley and Hansen
Hannum, Wagle & Cline

Storm/Rainfall	*Flow Meter*	*Volume*			*Peak*		
		Metered (mg)	*Modeled (mg)*	*% Difference*	*Metered (mgd)*	*Modeled (mgd)*	*% Difference*
Calibration							
June 12 1.70"	FM18	4.0	4.1	5%	27.2	28.2	4%
September 28 0.57"	FM18	0.9	1.2	35%	14.6	14.3	-2%
Verification							
July 21 1.79"	FM18	3.5	4.0	15%	50.0	48.0	-4%

CITY OF TERRE HAUTE, INDIANA

Combined Sewer Overflow Long-Term Control Plan
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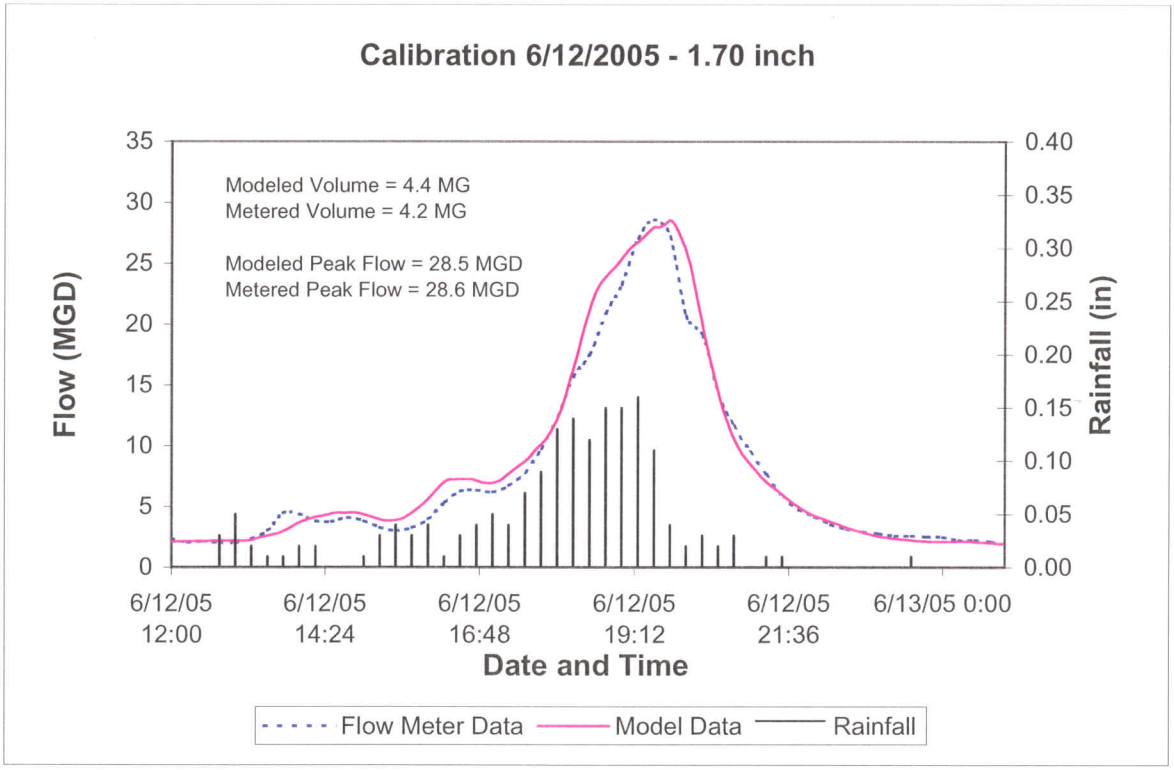
Table 2-9
Interceptors Modeled and Metered Comparison

Greeley and Hansen
Hannum, Wagle & Cline

Storm/Rainfall	*Flow Meter*	*Volume*			*Peak*		
		Metered (mg)	*Modeled (mg)*	*% Difference*	*Metered (mgd)*	*Modeled (mgd)*	*% Difference*
Calibration							
June 12 1.70"	FM4[1]	7.3	11.0	51%	19.2	30.9	61%
	FM10[2]	15.3	19.9	30%	41.0	52.6	28%
	FM16	15.5	16.8	8%	34.0	34.9	3%
September 28 0.57"	FM4[1]	3.7	4.8	30%	24.6	42.1	71%
	FM10[2]	No Data	8.6	-	No Data	59.7	-
	FM16	7.5	7.6	1%	40.9	59.3	45%
Verification							
July 21 1.79"	FM4[1]	3.2	7.9	147%	23.0	47.3	106%
	FM10[2]	11.9	14.5	22%	43.0	63.4	48%
	FM16	12.0	12.7	6%	35.3	83.9	137%

[1] FM4 warrants explanation. See page 2-8 in text.
[2] FM10 warrants explanation. See page 2-8 in text.

Figure 2-1
U/S Flow Meter 01
CSO Area 010 - Spruce St.



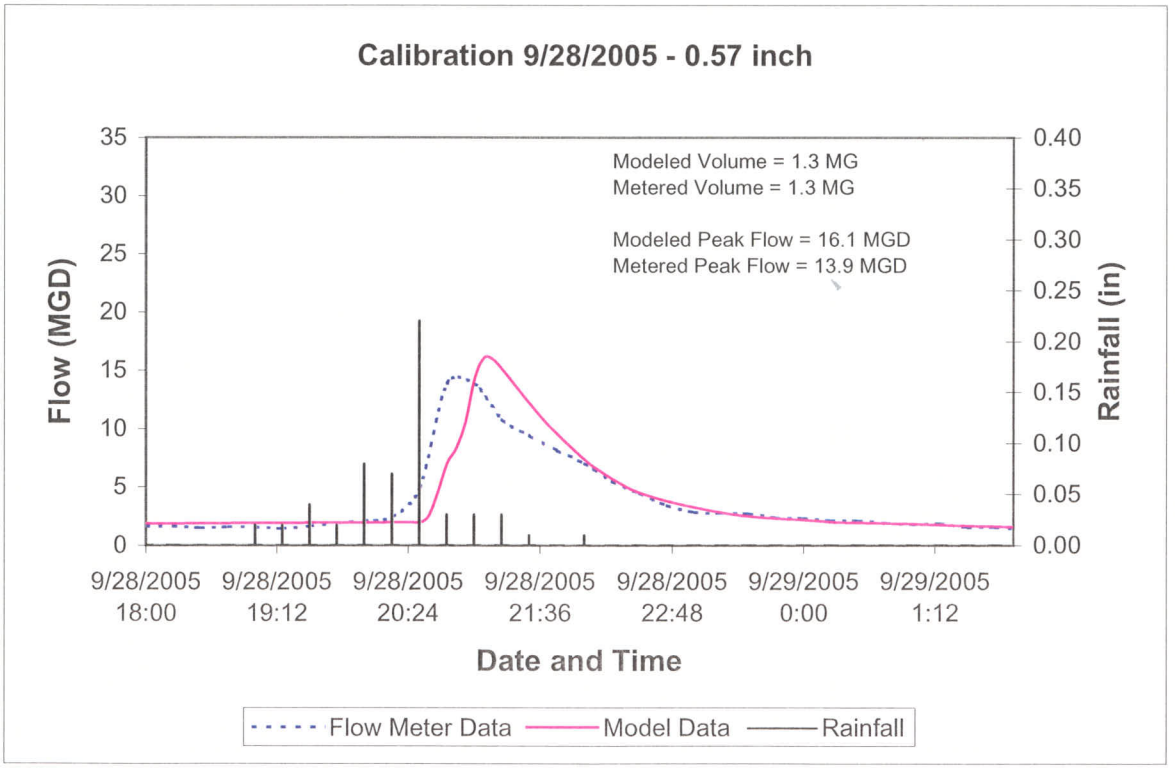


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Figure 2-1
U/S Flow Meter 01
CSO Area 010 - Spruce St.

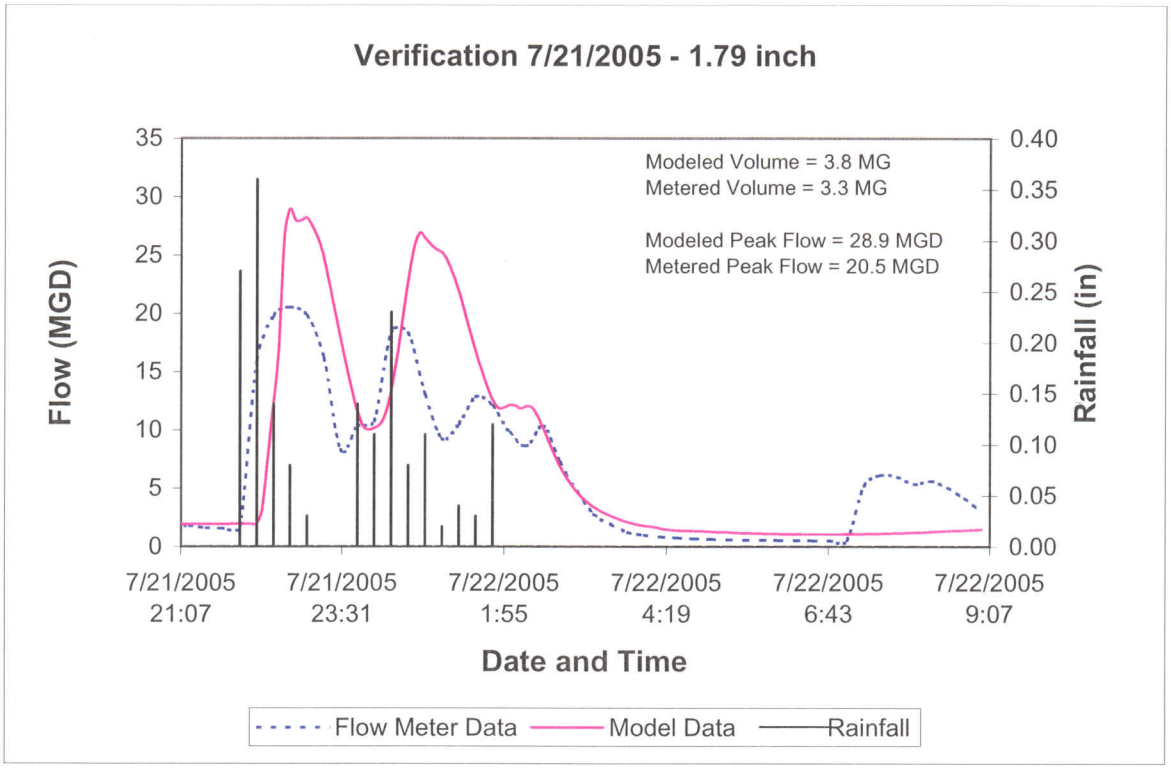
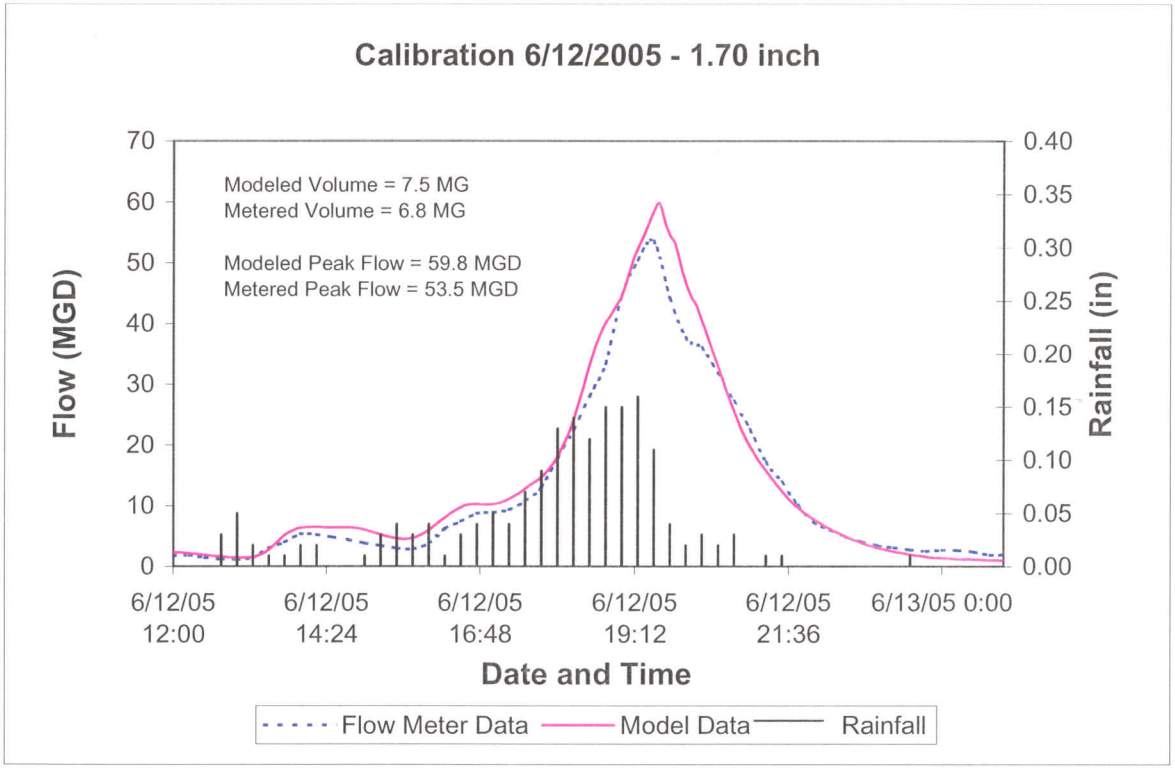


Figure 2-2
U/S Flow Meter 02
CSO Area 010 - Spruce St.



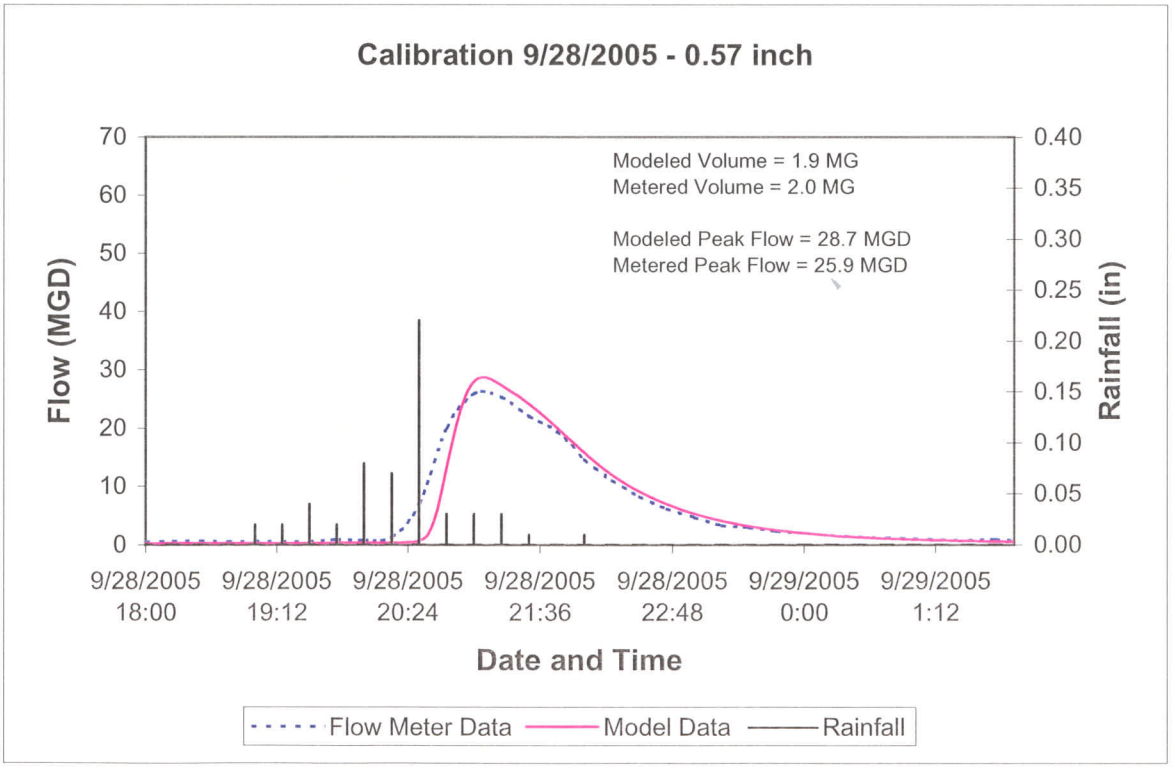


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Figure 2-2
U/S Flow Meter 02
CSO Area 010 - Spruce St.

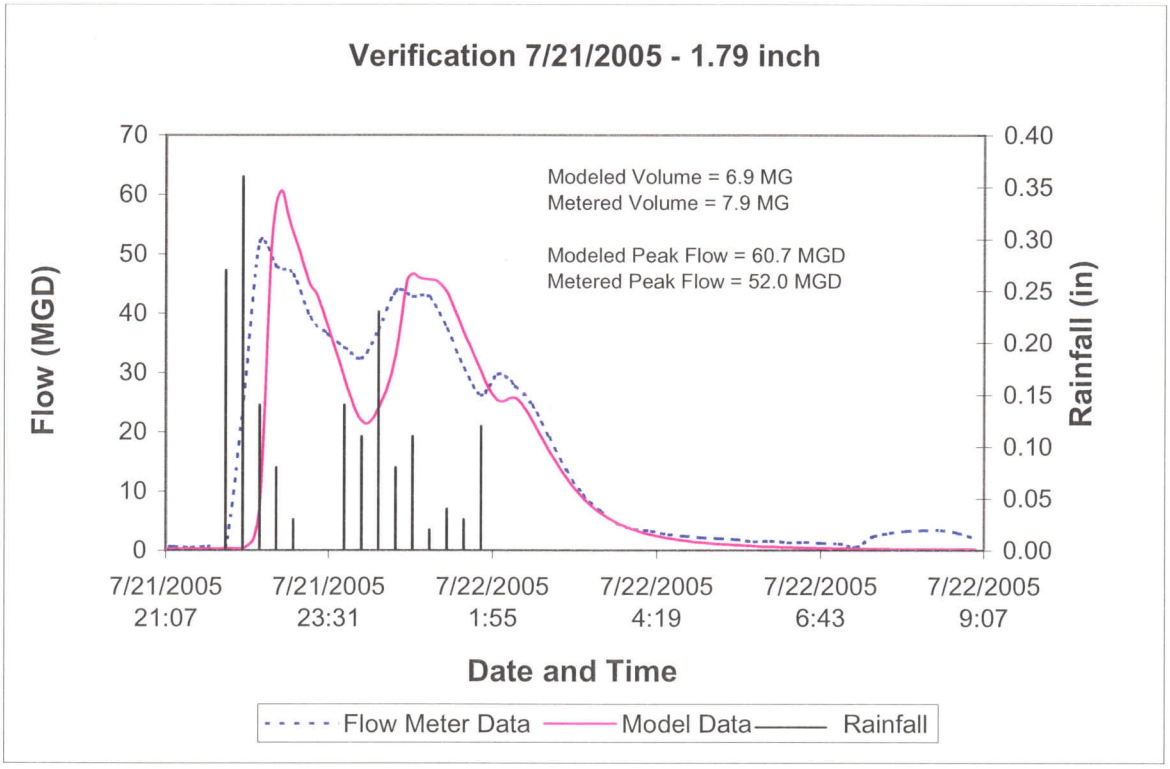
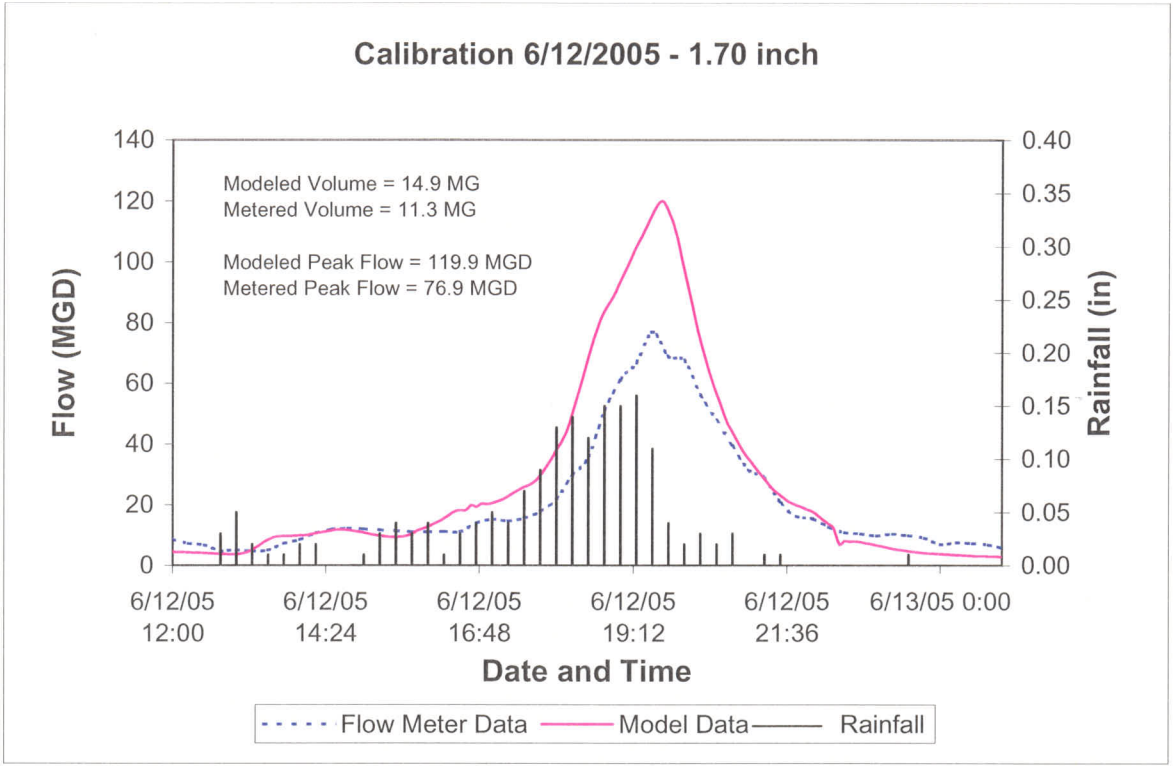


Figure 2-3
D/S Flow Meter 03
CSO Area 010 - Spruce St.



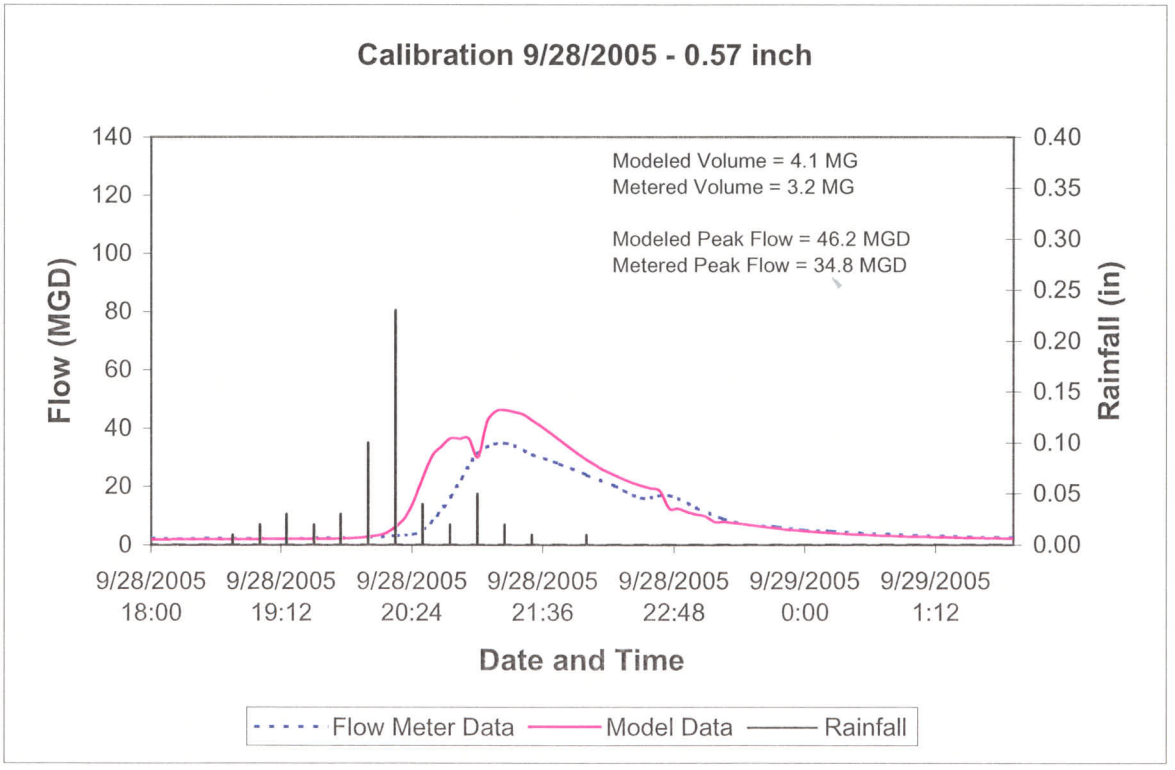


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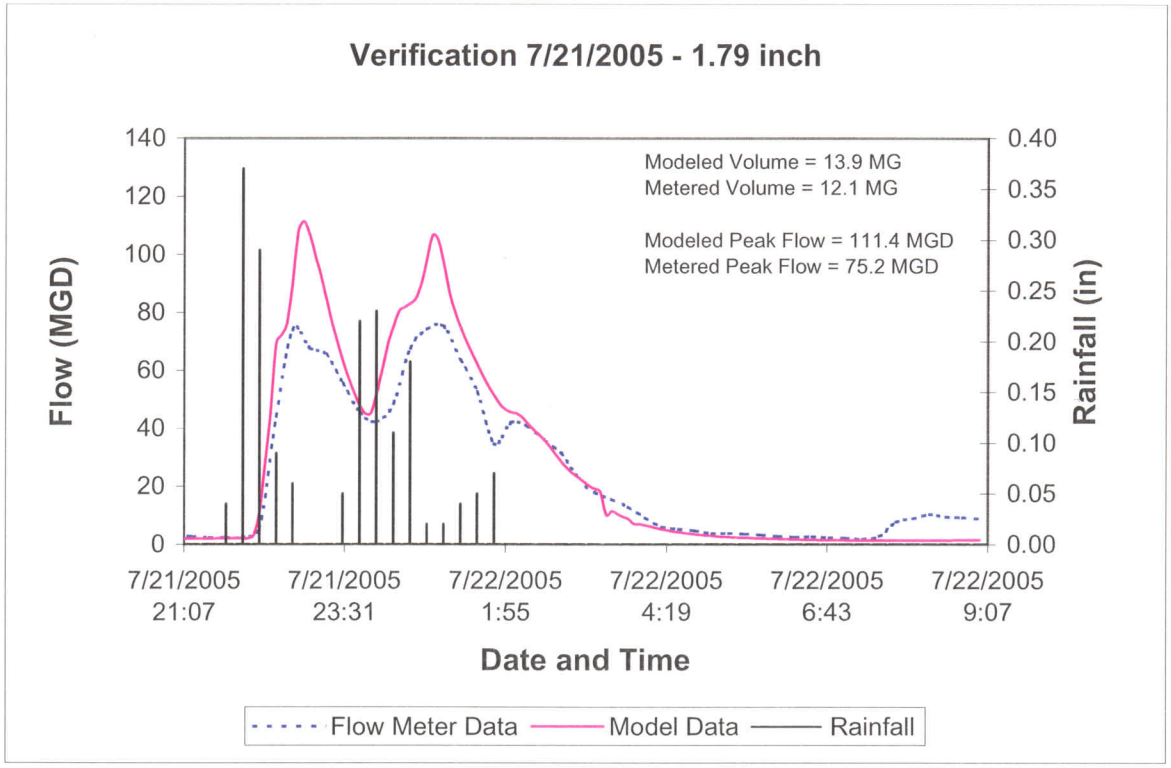
Figure 2-3
D/S Flow Meter 03
CSO Area 010 - Spruce St.



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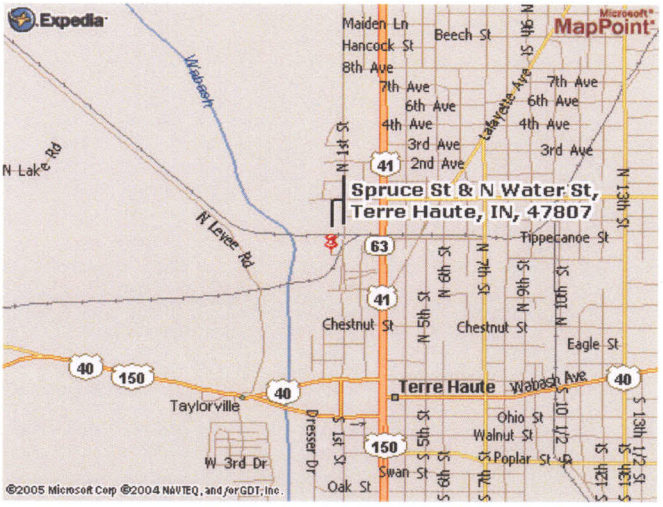
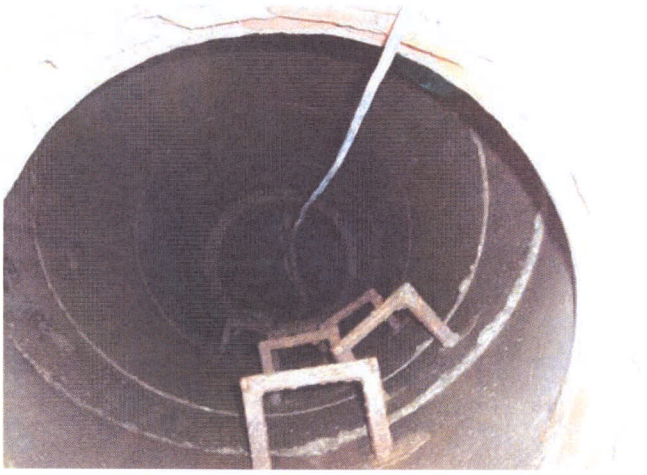
CSO SITE REPORT

Project Name:	Terre Haute 2005
Project Number:	30096.11
Contact Name:	Toni Presnel
Contact Number:	(812) 234-2551

Site Name:	Terre_FM03	Monitor Series:	1506	Monitor S/N:	9000	Map #:	
Address / Location:	Intersection of Spruce and Water St.			Manhole #:			
				Pipe Diameter:		107 Inches	
Access:	Drive	Traffic Volume:	Light	Communications Number:		NA	



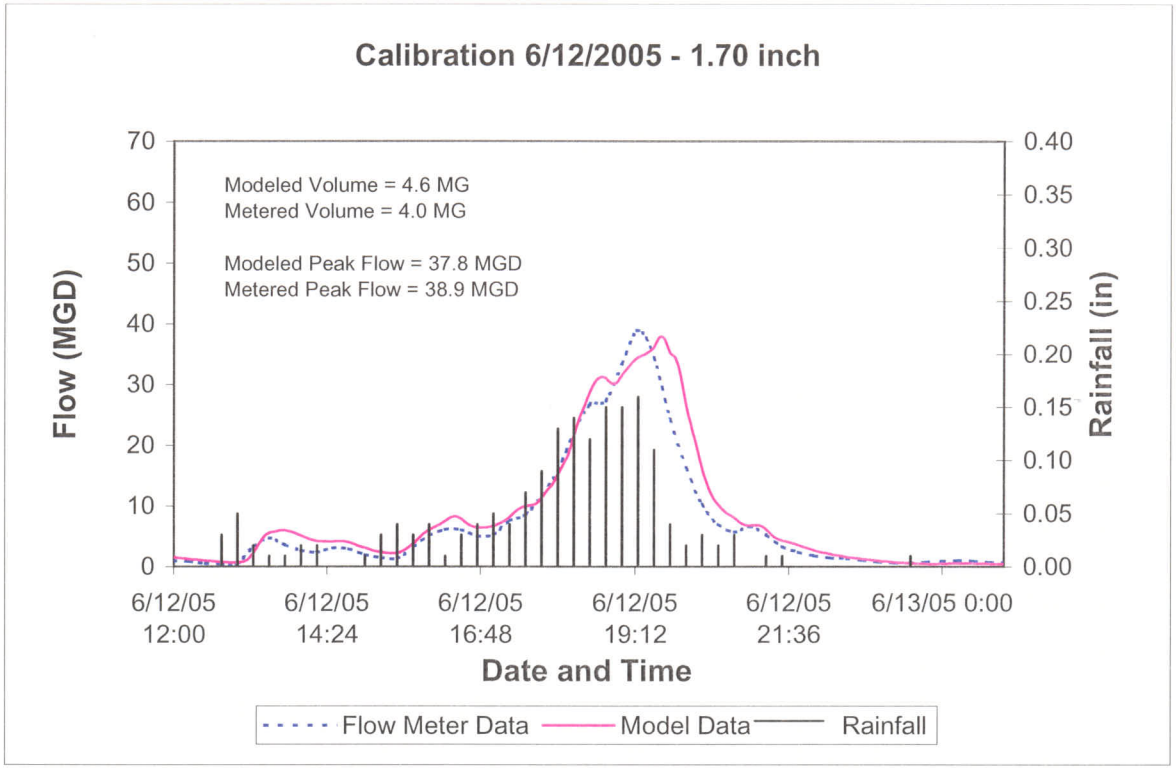
Monitoring Point Information			Manhole Structure Information			
Installation Type:	Doppler Special Installation		Manhole Depth / Cover Notes	25 Feet		
Sensors / Devices:	Pressure depth and Velocity		Manhole Material / Condition:	Concrete		Fair
Monitoring Location:	Upstream		MH Air Quality / Crew Size:	Acceptable		2
Monitor Location:	Manhole		Overflow Type / Dimensions:			
Rain Gauge Zone:	RG3		Onset to Overflow Depth:	Inches		
Installation QC:	Eric Hehmann		Outfall Distance / Gates:		Feet	
Hydraulics / Data Quality Rating:	Smooth Flow	B	Active Pipe Connections?			
Negative Velocity Potential	No		Pipe Material / Condition:	Brick		Fair
			Mini System Characteristics:	Commercial		



Incoming

Meter Confirmation Information:			Communications and AC Power Information:	
Date/Time:	May 23, 2005	1:45 PM	Telephone Pole #:	N/A
Pipe Diameter:	107 H x 110.00 W Inches		Distance From Manhole:	N/A
Pipe Shape:	Circular		Road Cut Length:	N/A
Depth of Flow (Wet Dof):	11.5 Inches		Antenna Type / Surface:	
Range (Air Dof):	Inches		AC Power Pole #:	N/A
Ultra. Physical Offset:	Inches		AC Power Trench Length:	N/A
Waves or Ripples (+/-) :	0.38 Inches		**Additional Site Information / Comments:**	
Peak Velocity:	1.53 fps		Flow goes through grate, which accumulates debris. This debris could cause variable flow patterns. Silt could be variable.	
Pipe Obstruction / Depth:	Gravel	0.5 Inches		
Pressure Serial # / Range:	37279	5 psi / 0-11.5 ft.		
Confirm Performed By:	Ira Goldfarb			

Figure 2-5
U/S Flow Meter 06
CSO Area 009 - Chestnut St.



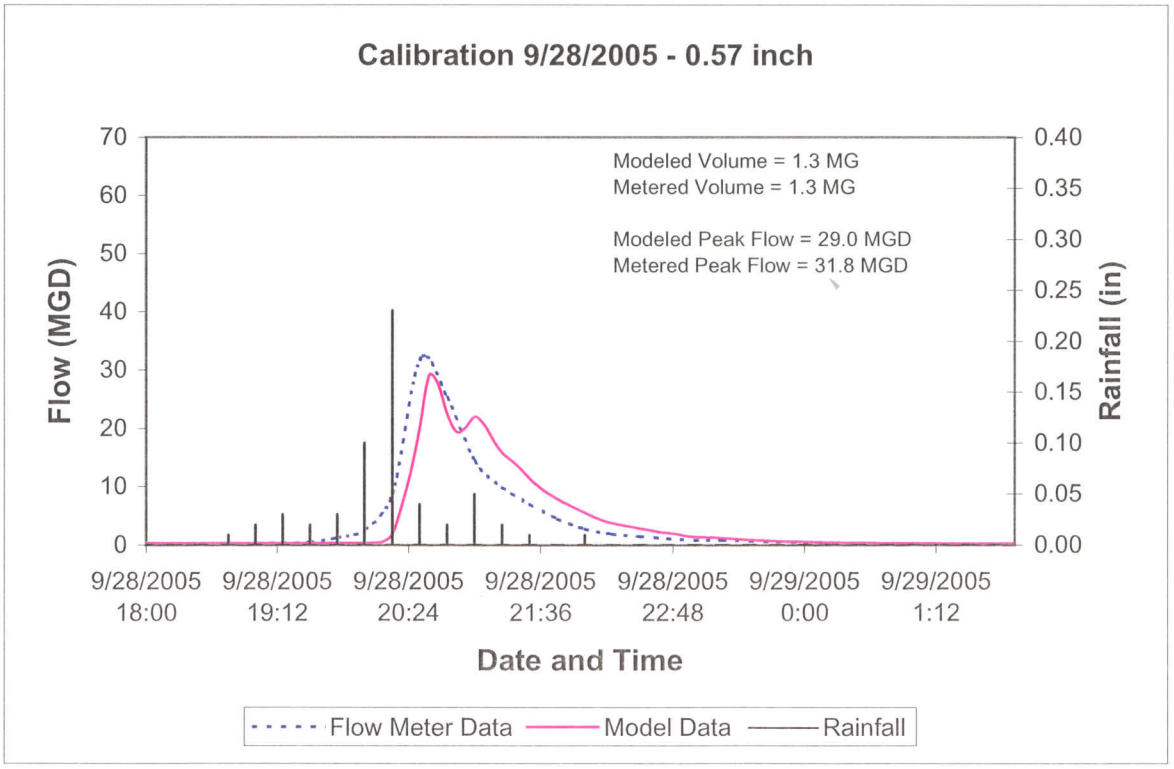


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Figure 2-5
U/S Flow Meter 06
CSO Area 009 - Chestnut St.

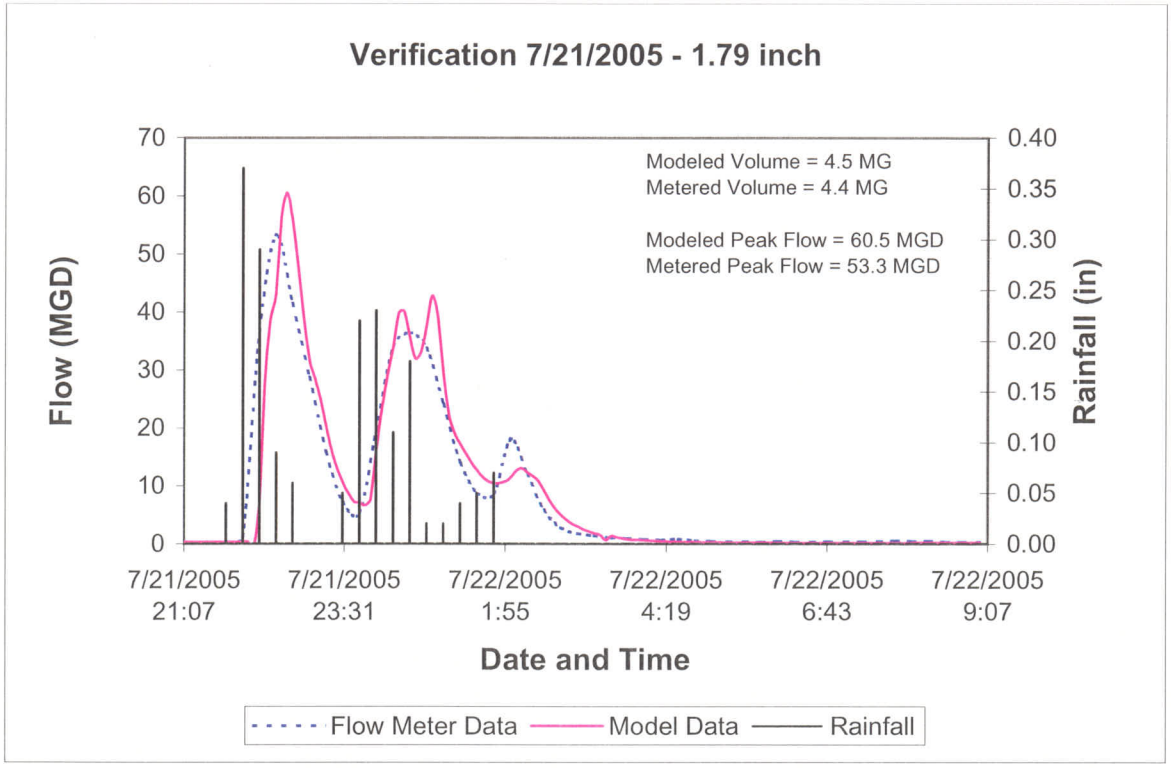
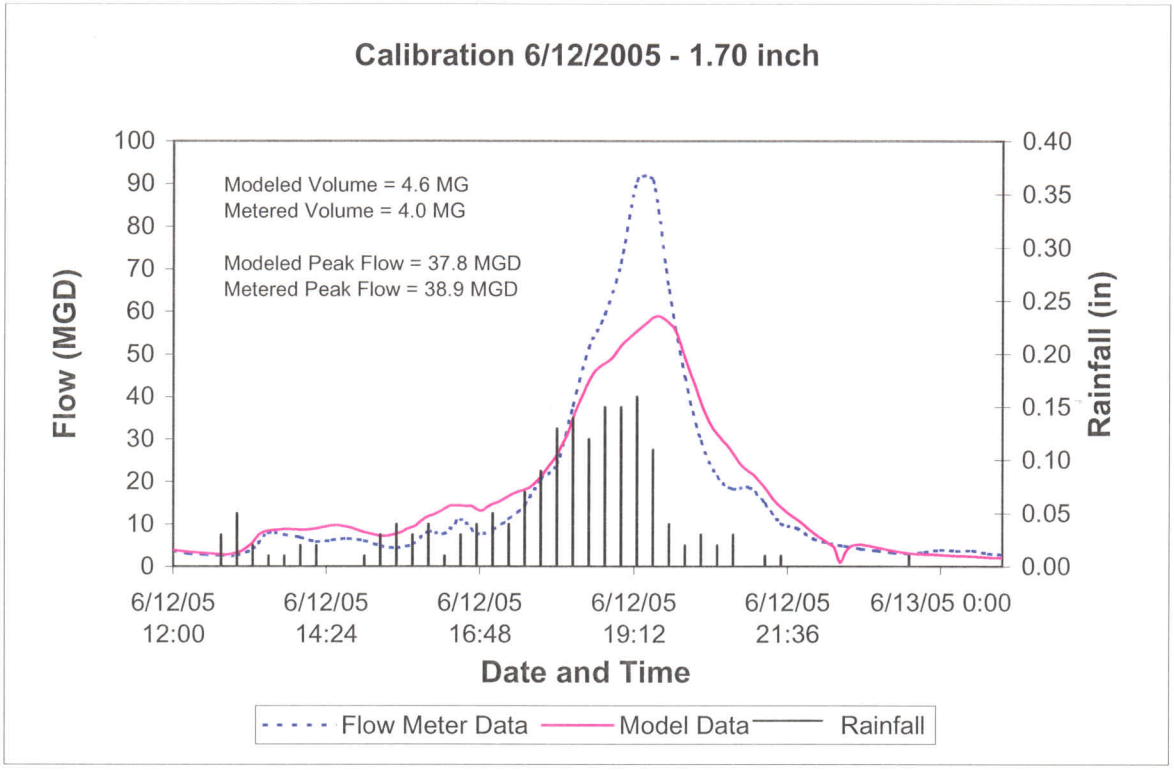


Figure 2-6
D/S Flow Meter 05
CSO Area 009 - Chestnut St.



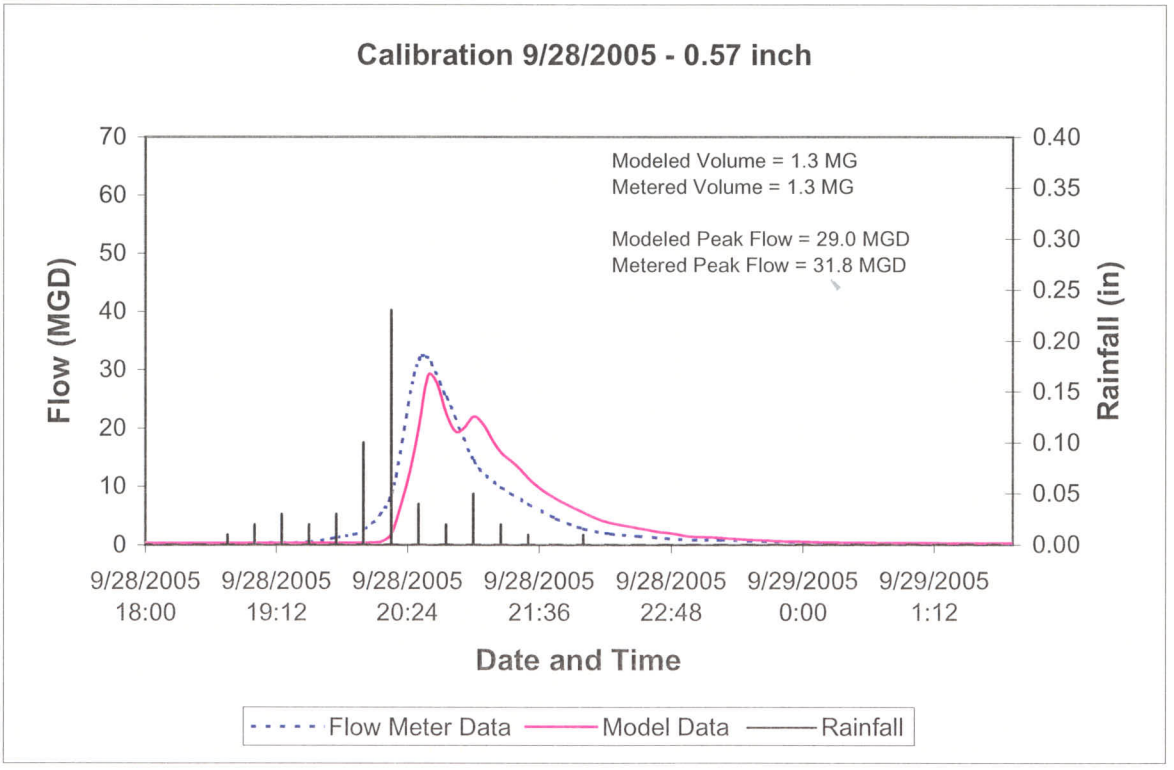


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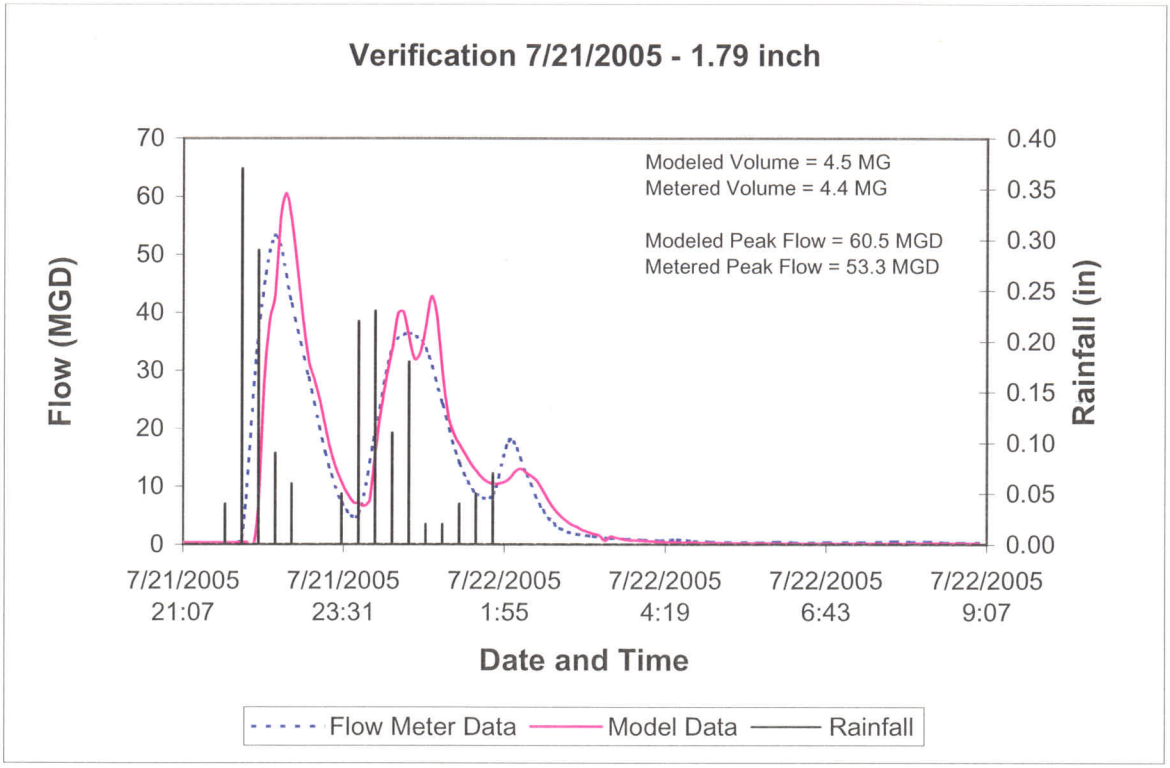
Figure 2-6
D/S Flow Meter 05
CSO Area 009 - Chestnut St.



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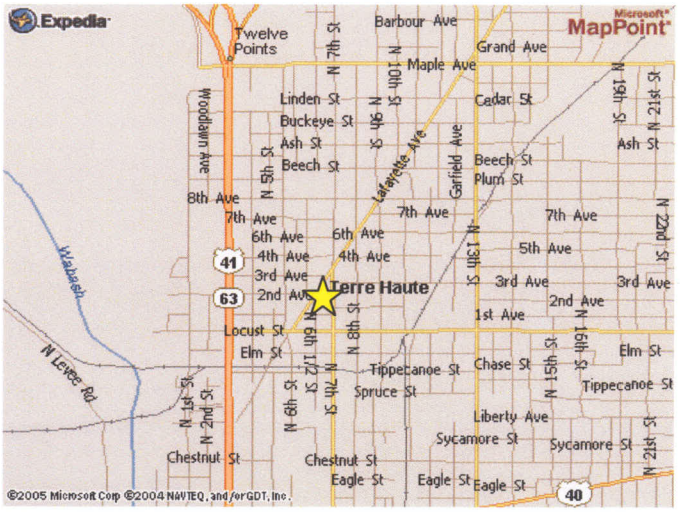
CSO SITE REPORT

Project Name:	Terre Haute 2005
Project Number:	30096.11
Contact Name:	Toni Presnel
Contact Number:	(812) 234-2551

Site Name:	Terre_FM05	Monitor Series:	1506	Monitor S/N:	9749	Map #:	
Address / Location:	Just southwest of Lafayette and 4th Street			Manhole #:			
				Pipe Diameter:	88 Inches		
Access:	Drive	Traffic Volume:	Light	Communications Number:	NA		



Monitoring Point Information			Manhole Structure Information			
Installation Type:	Doppler Special Installation		Manhole Depth / Cover Notes	18 Feet		
Sensors / Devices:	Ultra, Velocity, Pressure (Non I.S.)		Manhole Material / Condition:	Brick		Fair
Monitoring Location:	Downstream		MH Air Quality / Crew Size:	Acceptable		2
Monitor Location:	Manhole		Overflow Type / Dimensions:			
Rain Gauge Zone:	RG3		Onset to Overflow Depth:	Inches		
Installation QC:	Eric Hehmann		Outfall Distance / Gates:		Feet	
Hydraulics / Data Quality Rating:	Choppy flow with an skewed velocity profile.	C	Active Pipe Connections?	Yes		
Negative Velocity Potential	No		Pipe Material / Condition:	Brick		Fair
			Mini System Characteristics:	Other		

Outgoing

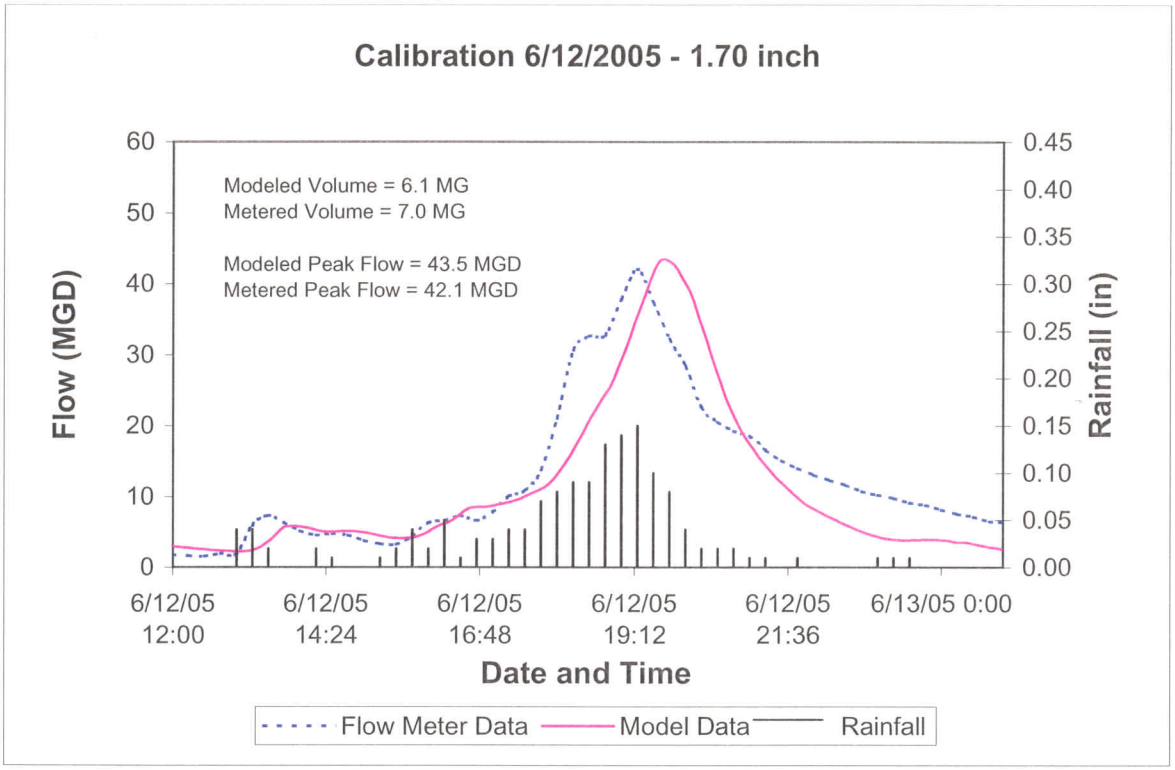
Meter Confirmation Information:		
Date/Time:	May 18, 2005	12:30 PM
Pipe Diameter:	88.00 H x 88.00 W Inches	
Pipe Shape:	Circular	
Depth of Flow (Wet Dof):	8.5 Inches	
Range (Air Dof):	77.25 Inches	
Ultra. Physical Offset:	1.5 Inches	
Waves or Ripples (+/-) :	0.5 Inches	
Peak Velocity:	1.48 fps	
Pipe Obstruction / Depth:	0 Inches	
Pressure Serial # / Range:	36436	5 psi / 0-11.5 ft.
Confirm Performed By:	Ira Goldfarb	

Communications and AC Power Information:	
Telephone Pole #:	N/A
Distance From Manhole:	N/A
Road Cut Length:	N/A
Antenna Type / Surface:	
AC Power Pole #:	N/A
AC Power Trench Length:	N/A

Additional Site Information / Comments:

Flow is somewhat choppy and has an uneven velocity profile due to intersection of pipes upstream of sensors.

Figure 2-8
U/S Flow Meter 07
CSO Area 007 - Walnut St.



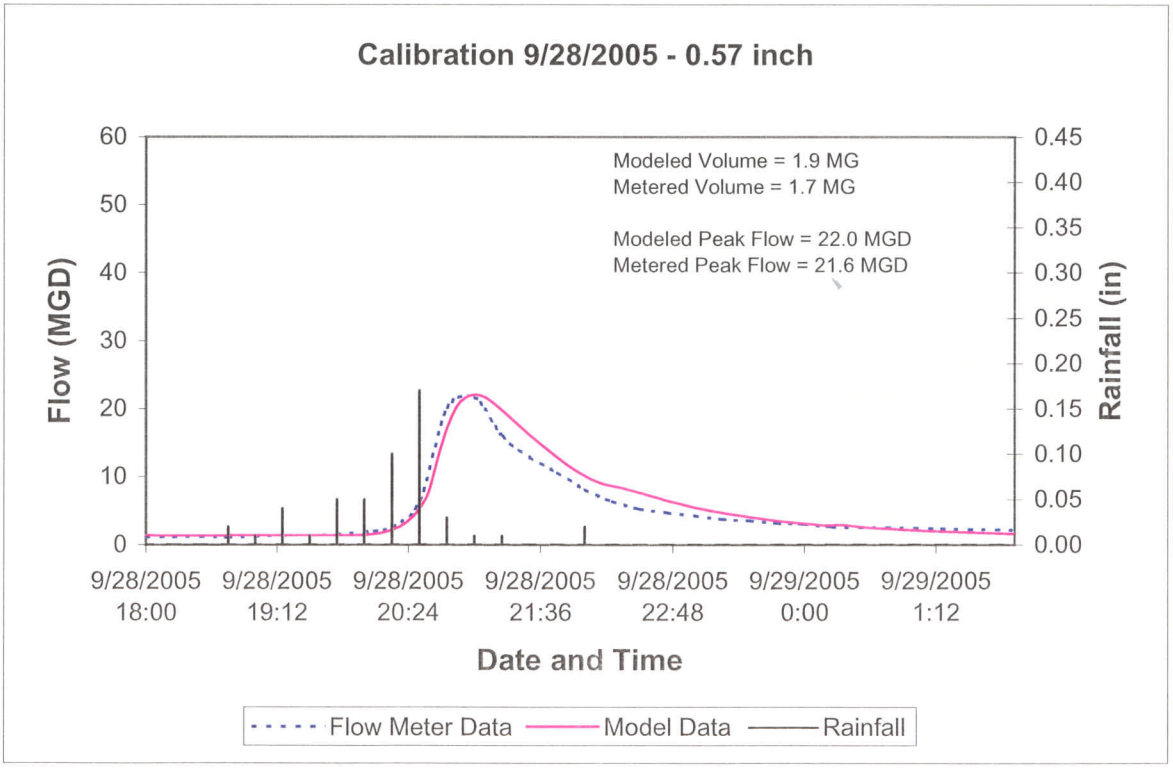


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Figure 2-8
U/S Flow Meter 07
CSO Area 007 - Walnut St.

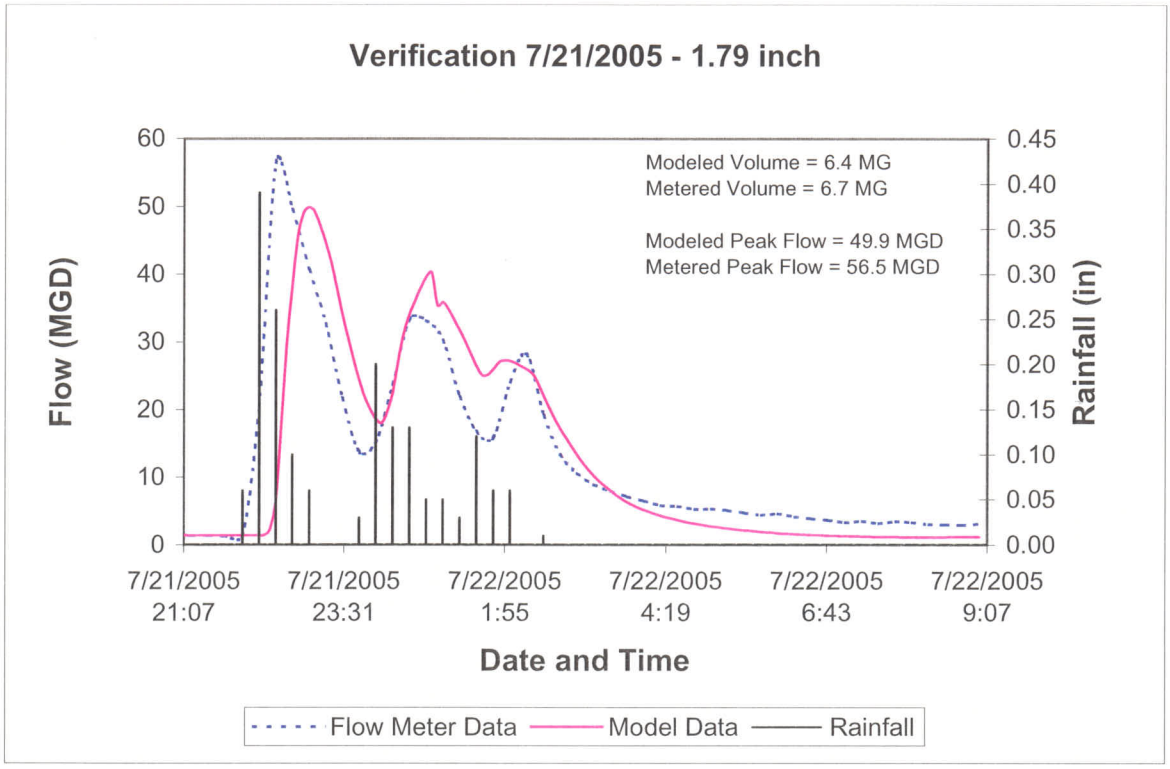
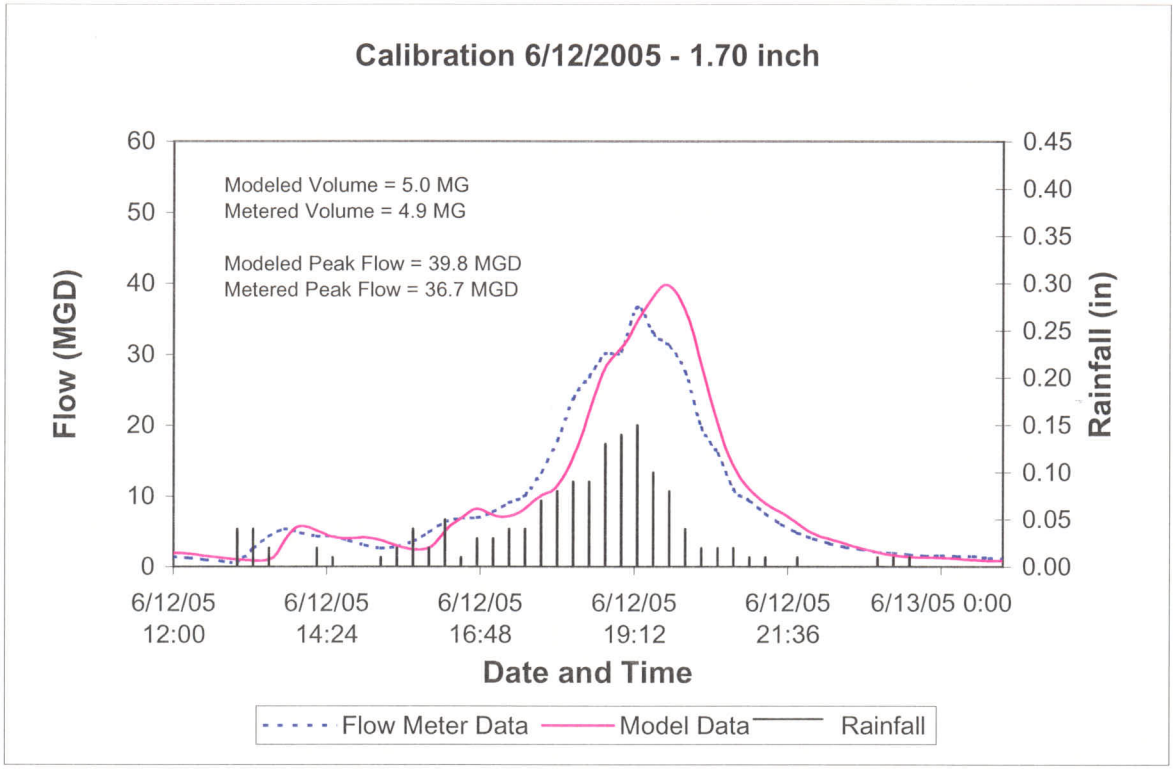


Figure 2-9
U/S Flow Meter 08
CSO Area 007 - Walnut St.



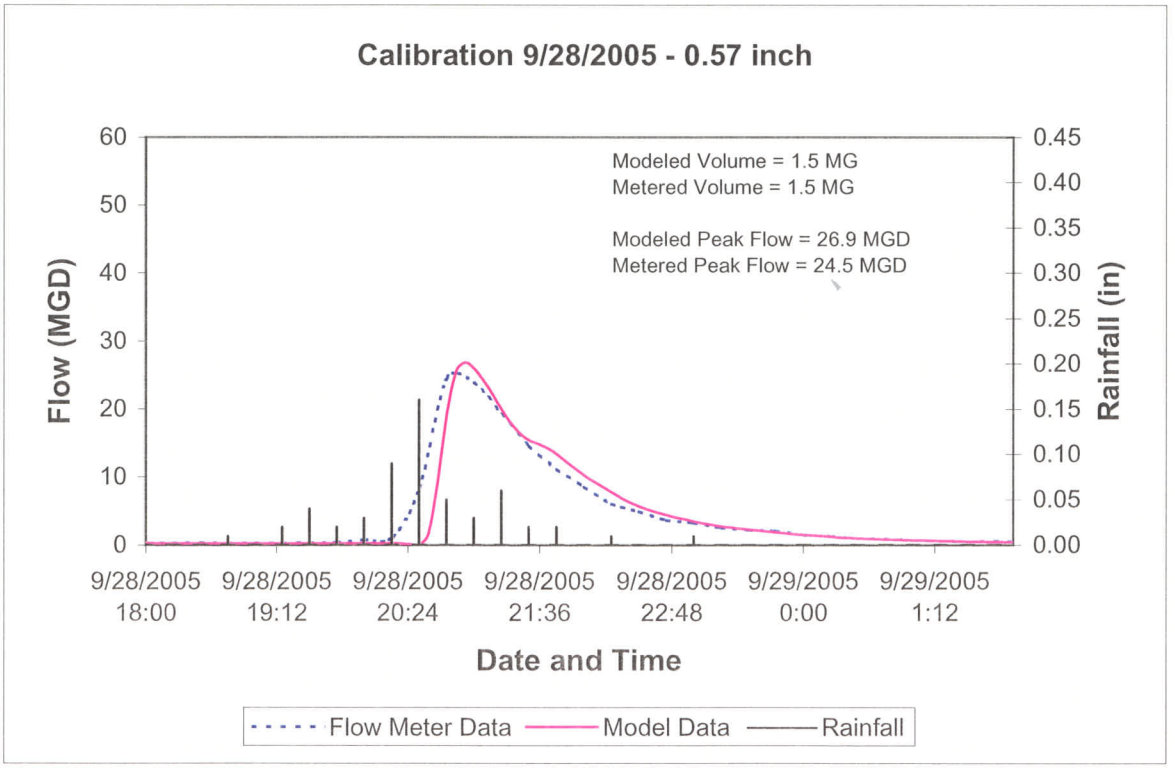


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Figure 2-9
U/S Flow Meter 08
CSO Area 007 - Walnut St.

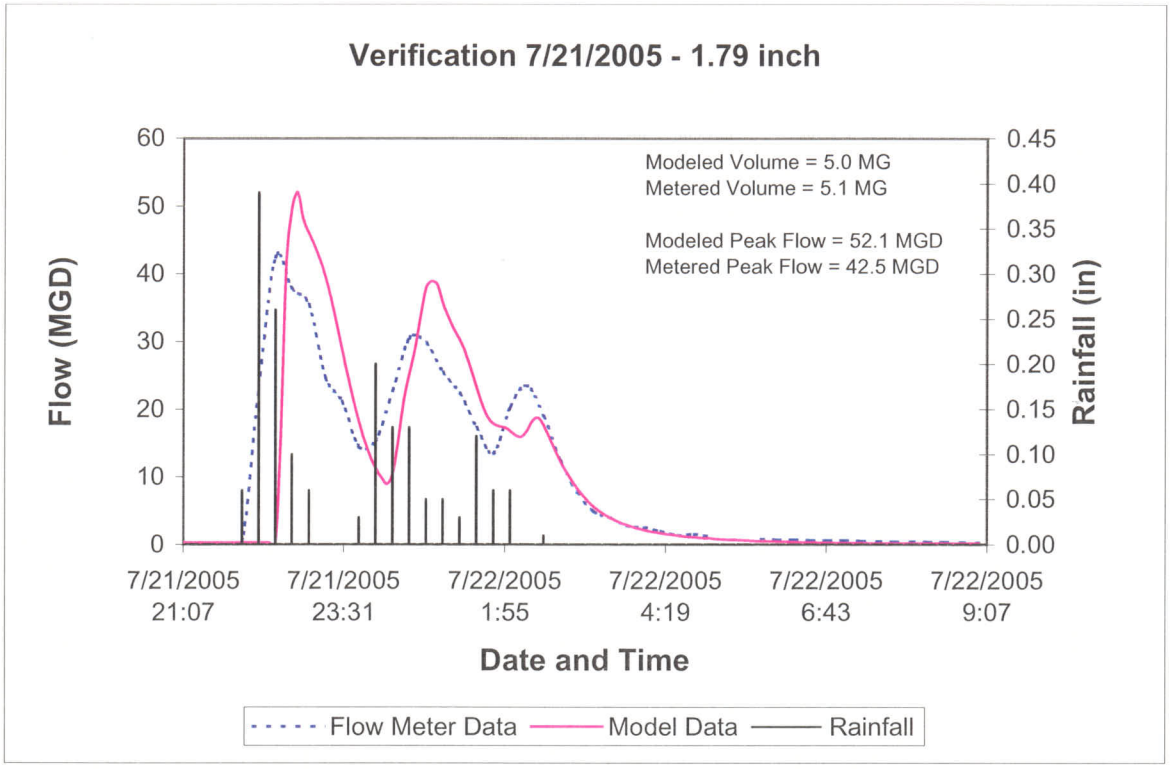
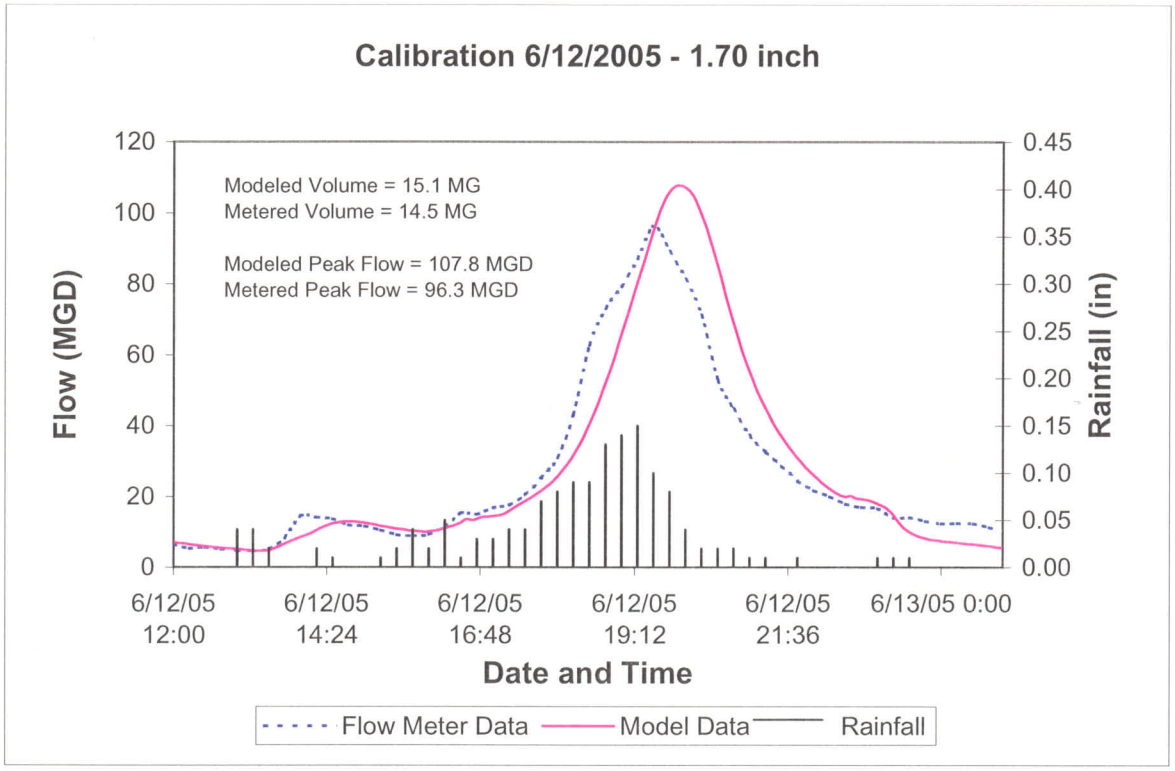


Figure 2-10
D/S Flow Meter 09
CSO Area 007 - Walnut St.



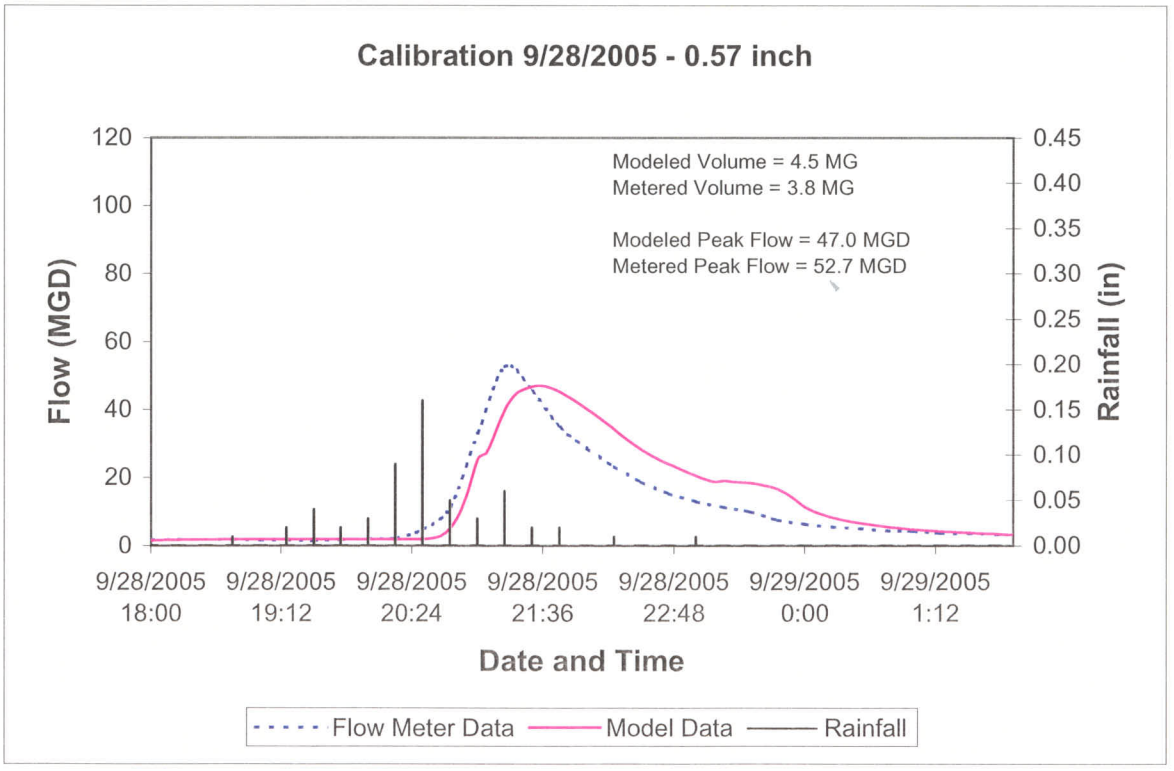


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Figure 2-10
D/S Flow Meter 09
CSO Area 007 - Walnut St.

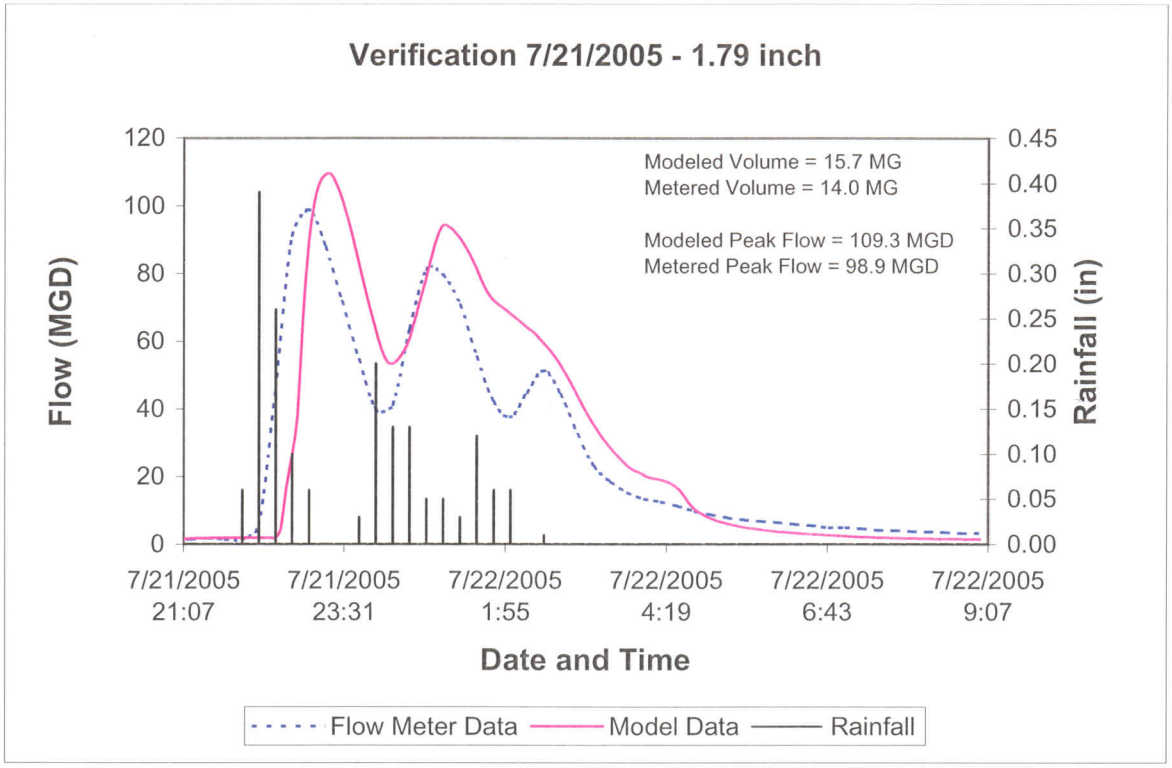
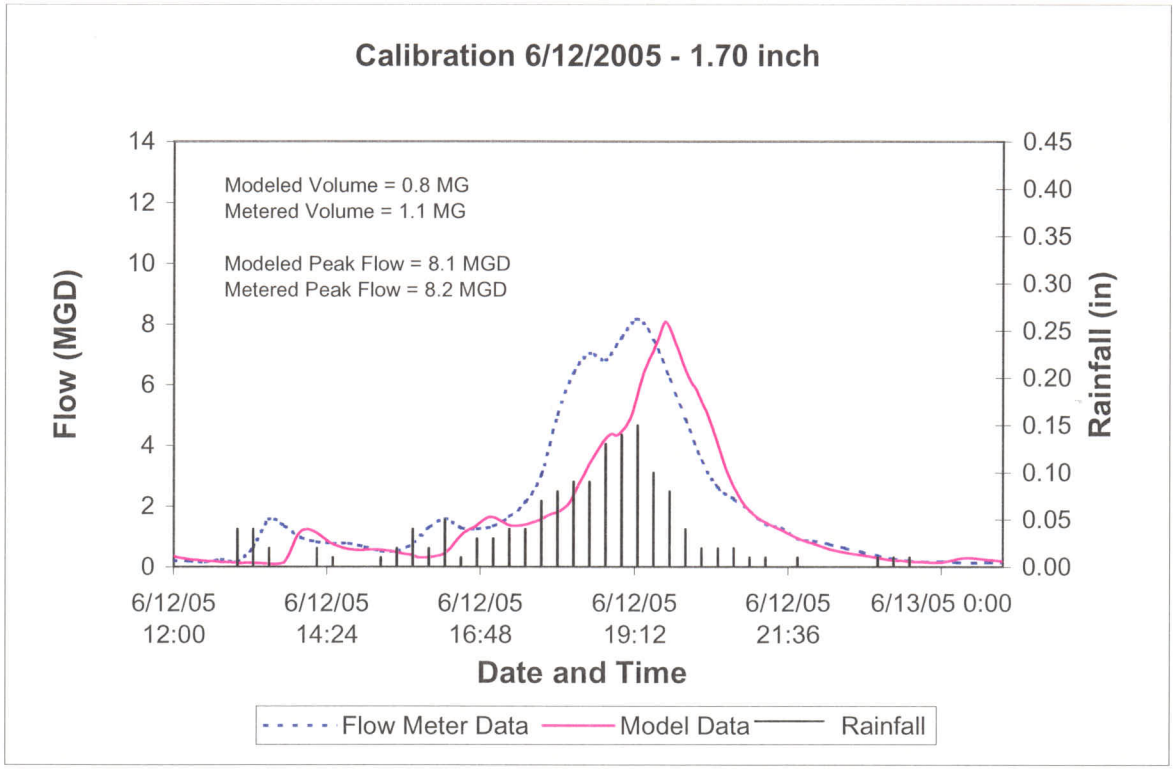


Figure 2-11
U/S Flow Meter 13
CSO Areas 004 and 011 - Hulman and Idaho St.



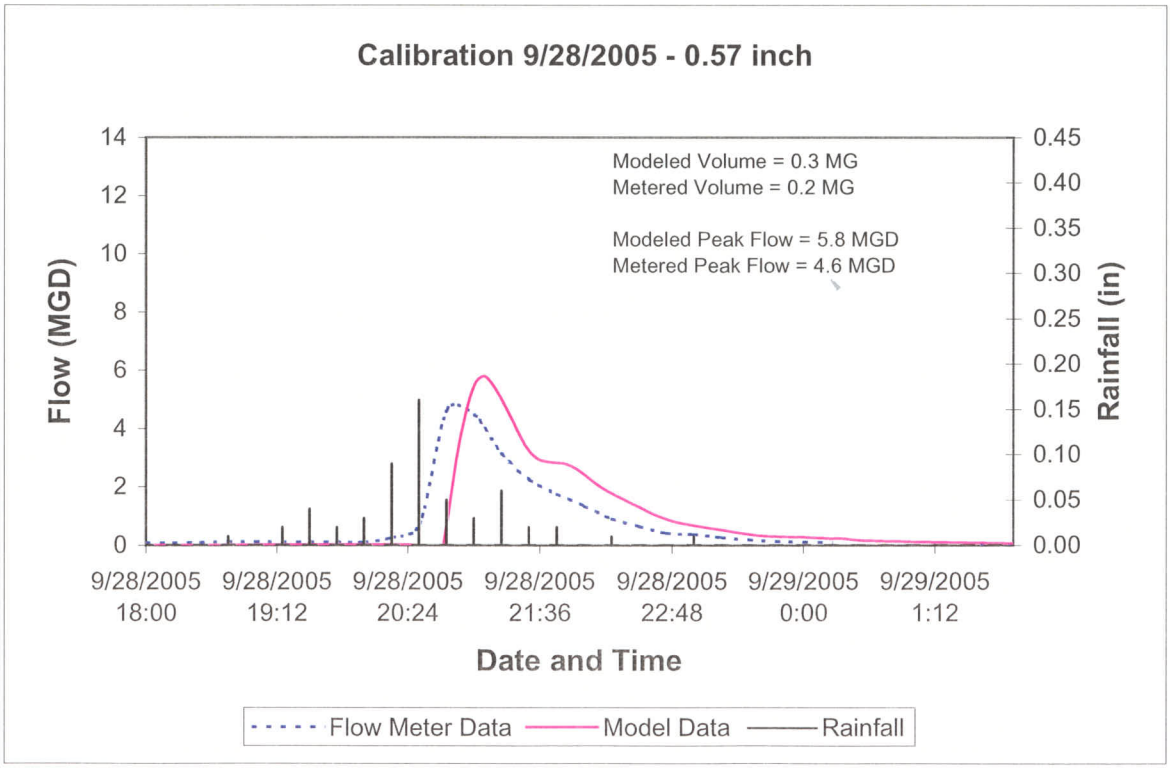


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Figure 2-11
U/S Flow Meter 13
CSO Areas 004 and 011 - Hulman and Idaho St.

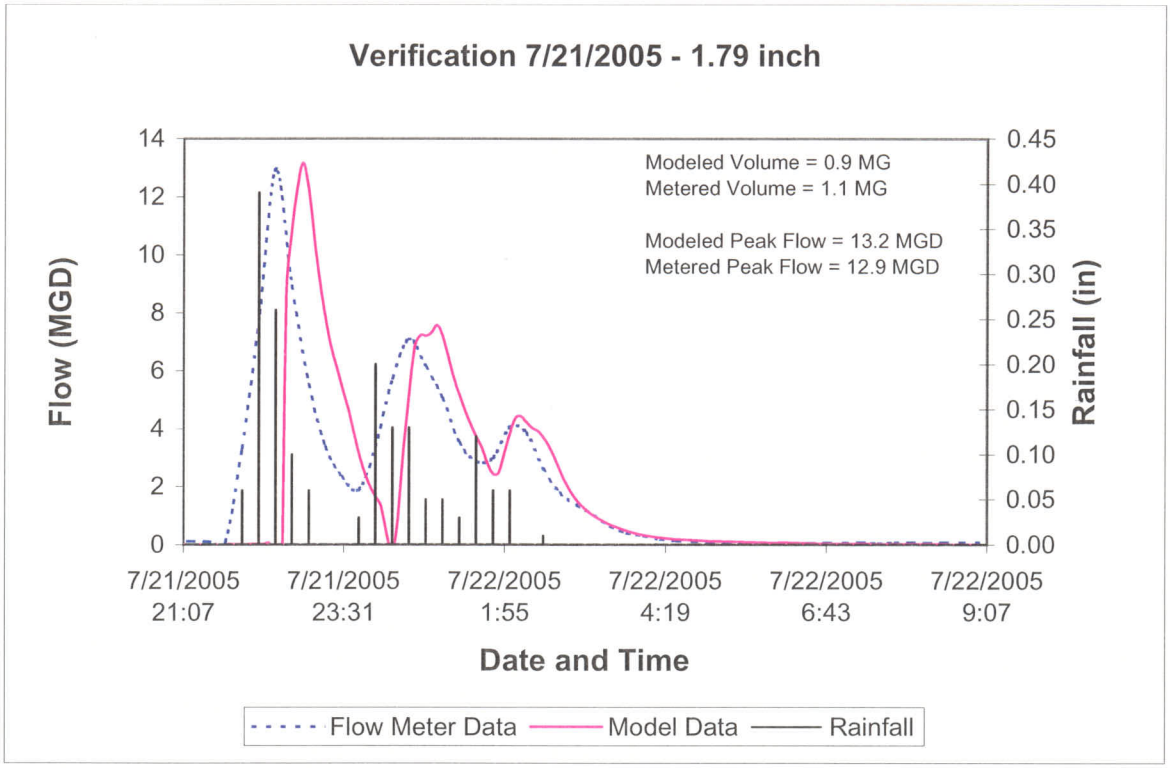
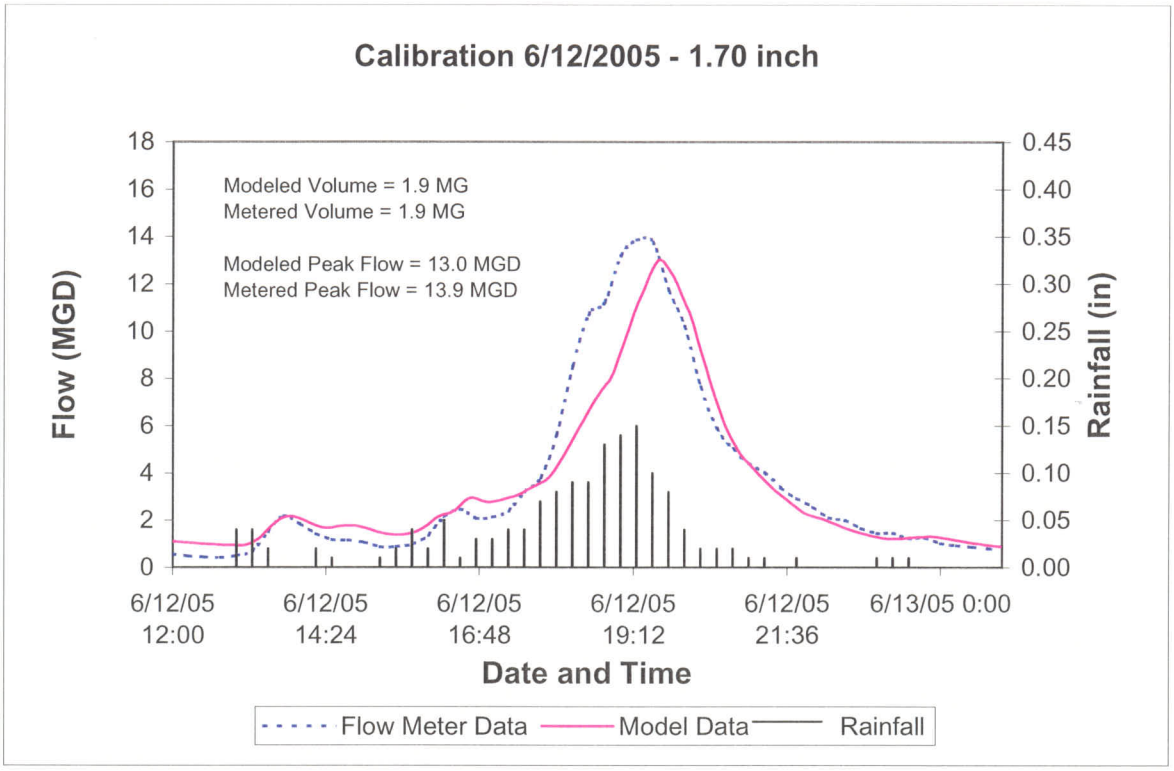


Figure 2-12
U/S Flow Meter 14
CSO Service Area 004 and 011 - Hulman and Idaho St.



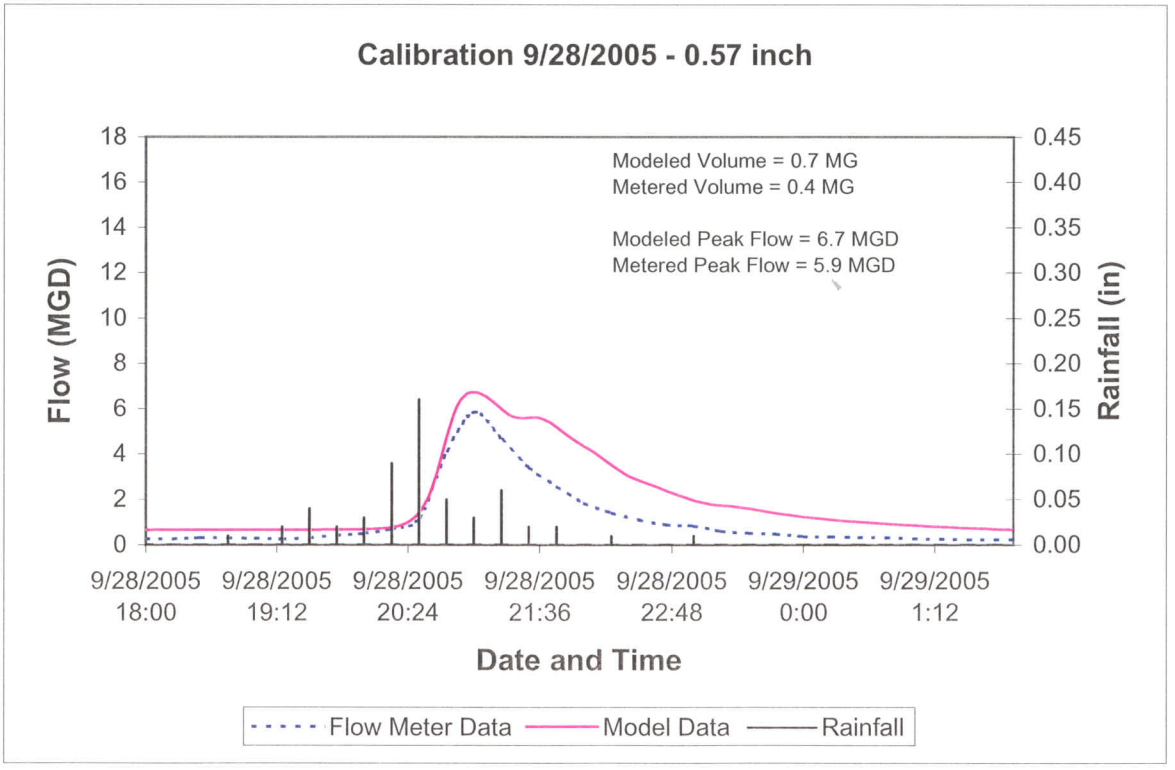


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Figure 2-12
U/S Flow Meter 14
CSO Service Area 004 and 011 - Hulman and Idaho St.

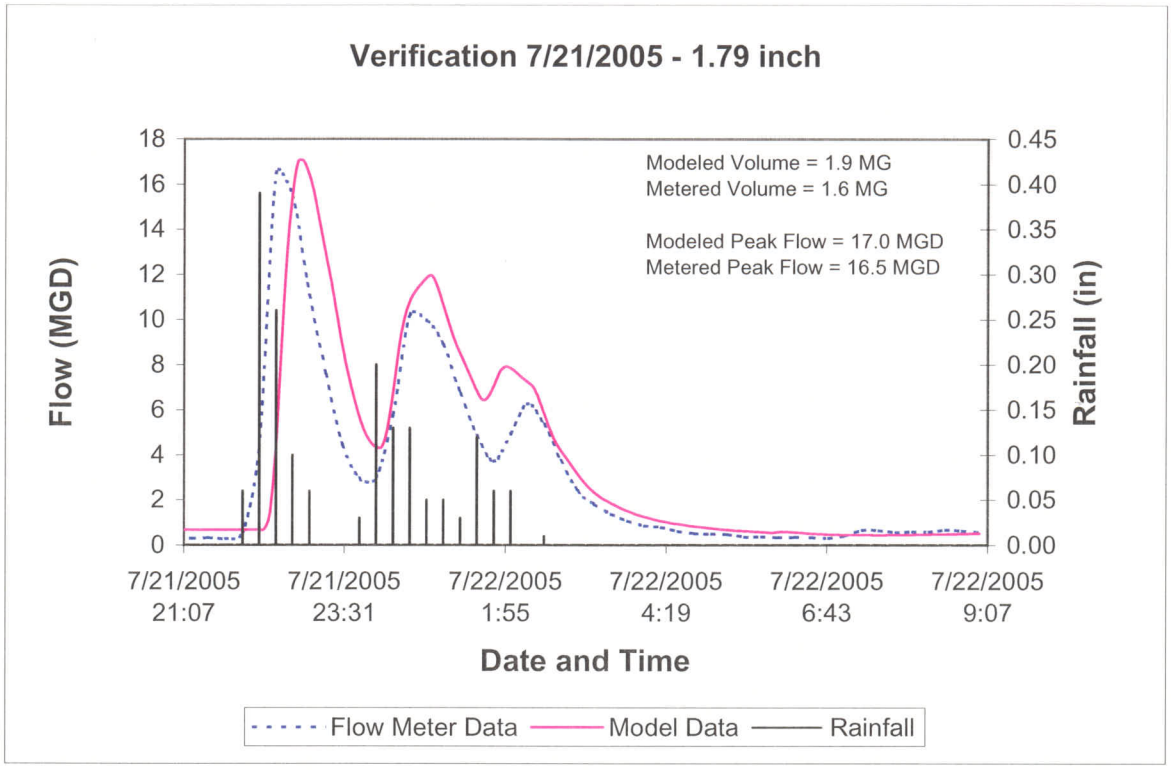
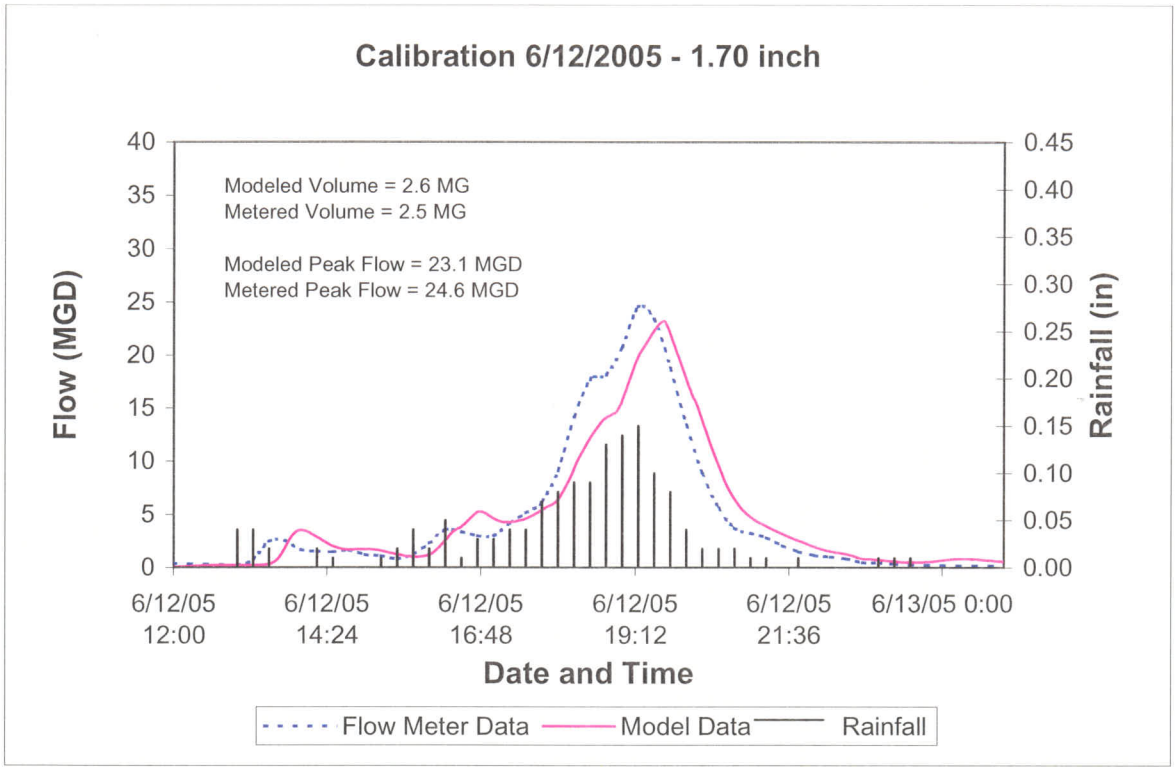


Figure 2-13
U/S Flow Meter 15
CSO Area 004 and 011 - Hulman and Idaho St.



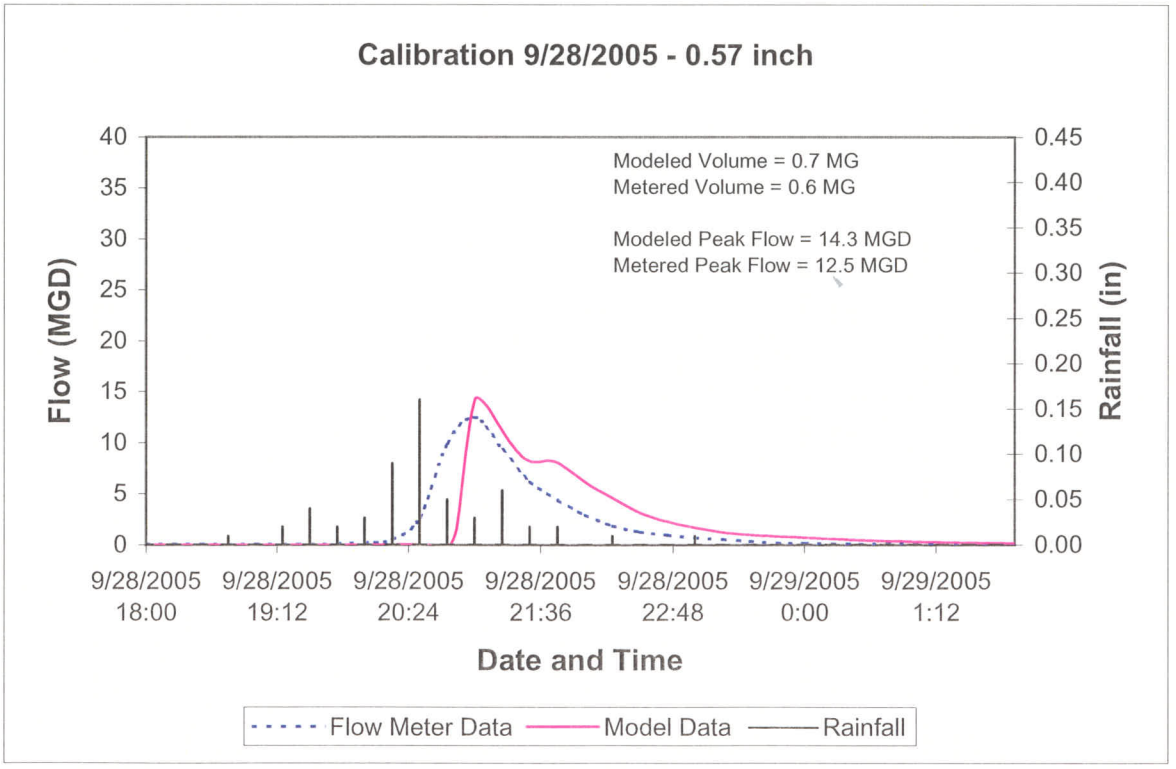


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Figure 2-13
U/S Flow Meter 15
CSO Area 004 and 011 - Hulman and Idaho St.

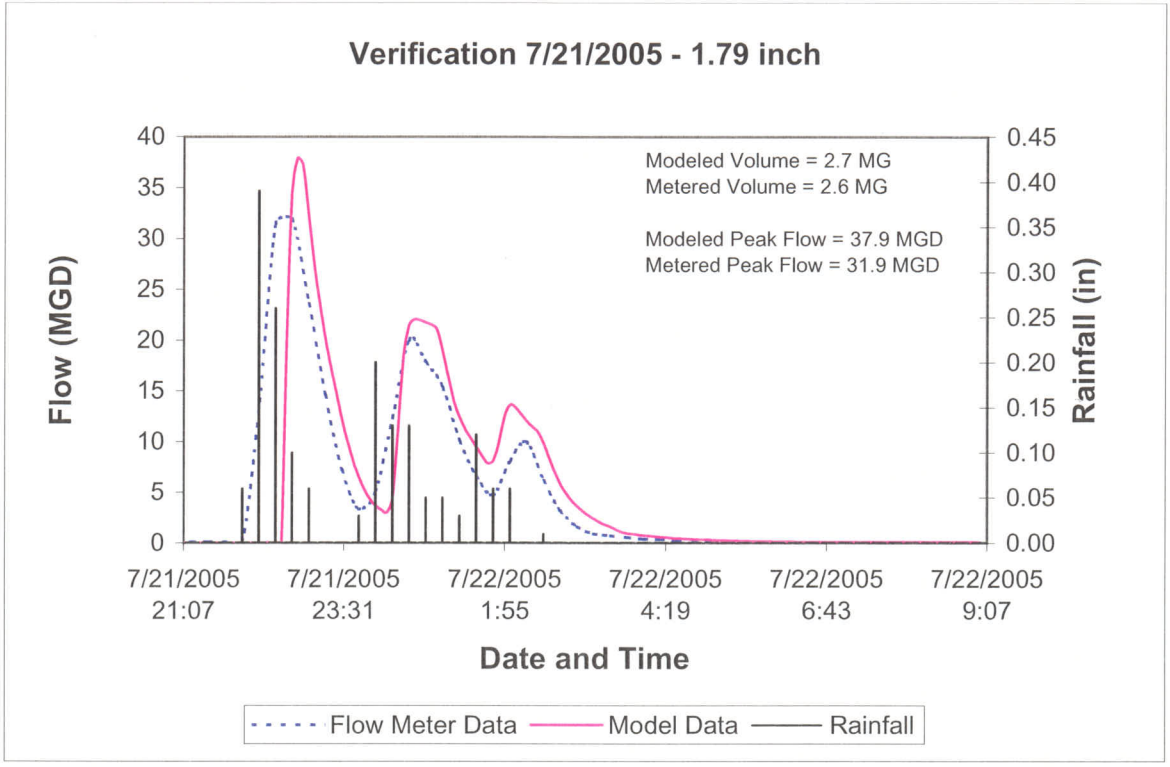
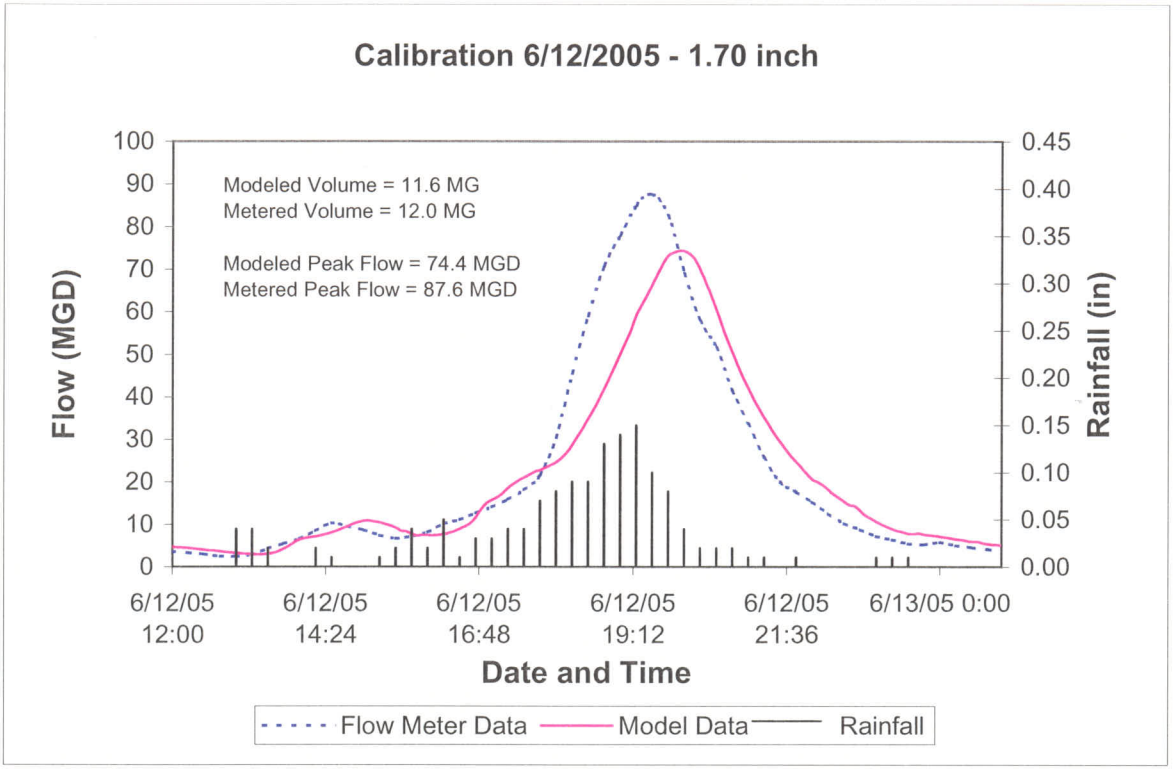


Figure 2-14
D/S Flow Meter 11
CSO Area 011 - Idaho St.



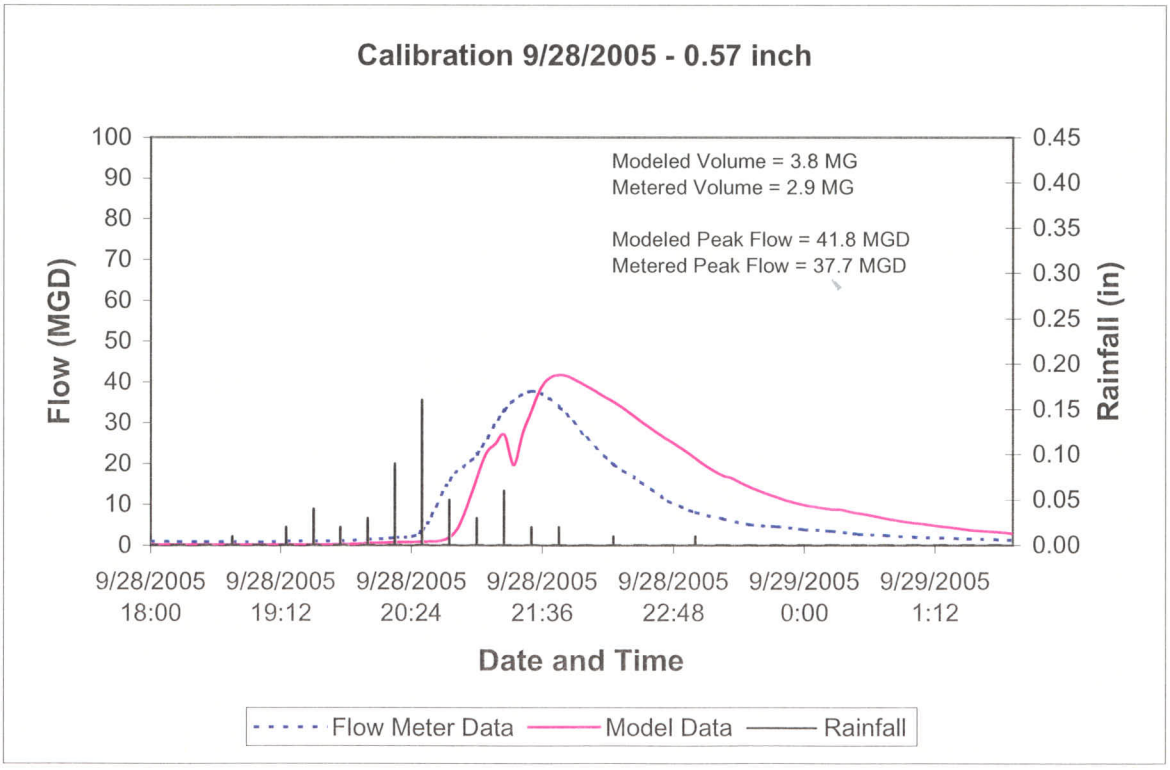


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Figure 2-14
D/S Flow Meter 11
CSO Area 011 - Idaho St.

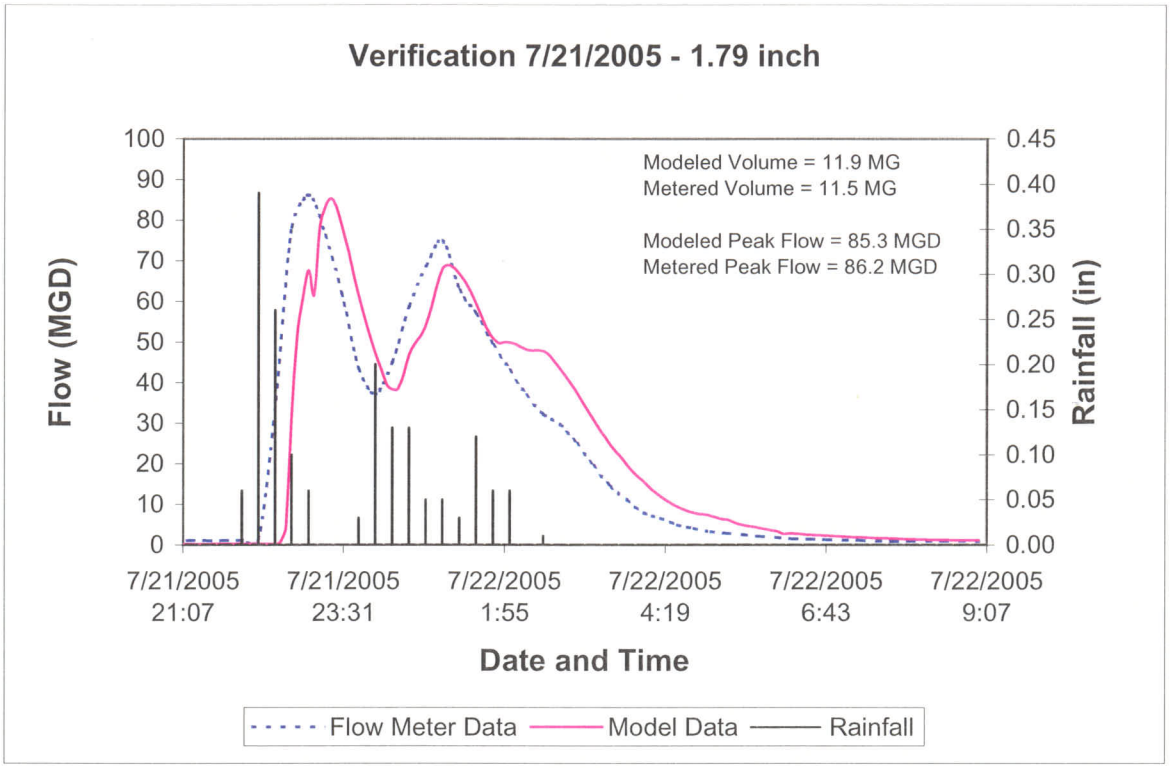
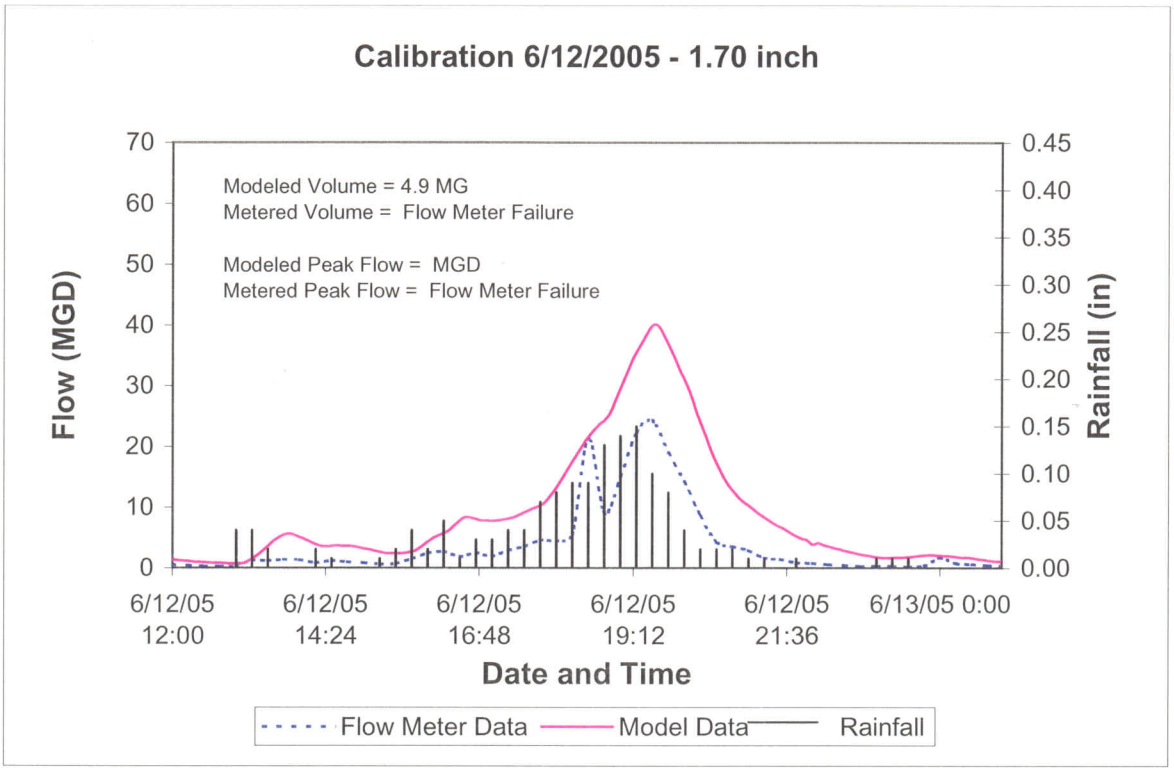


Figure 2-15
D/S Flow Meter 12
CSO Area 004 - Hulman St.



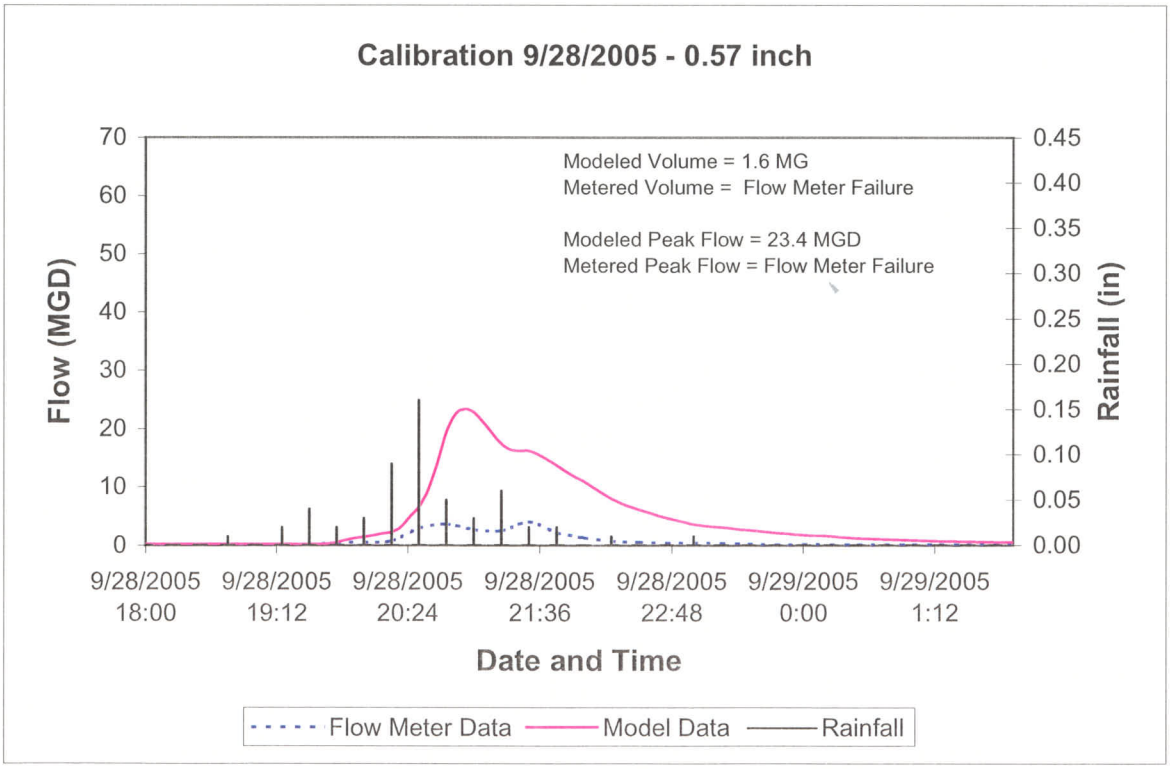


Figure 2-15
D/S Flow Meter 12
CSO Area 004 - Hulman St.

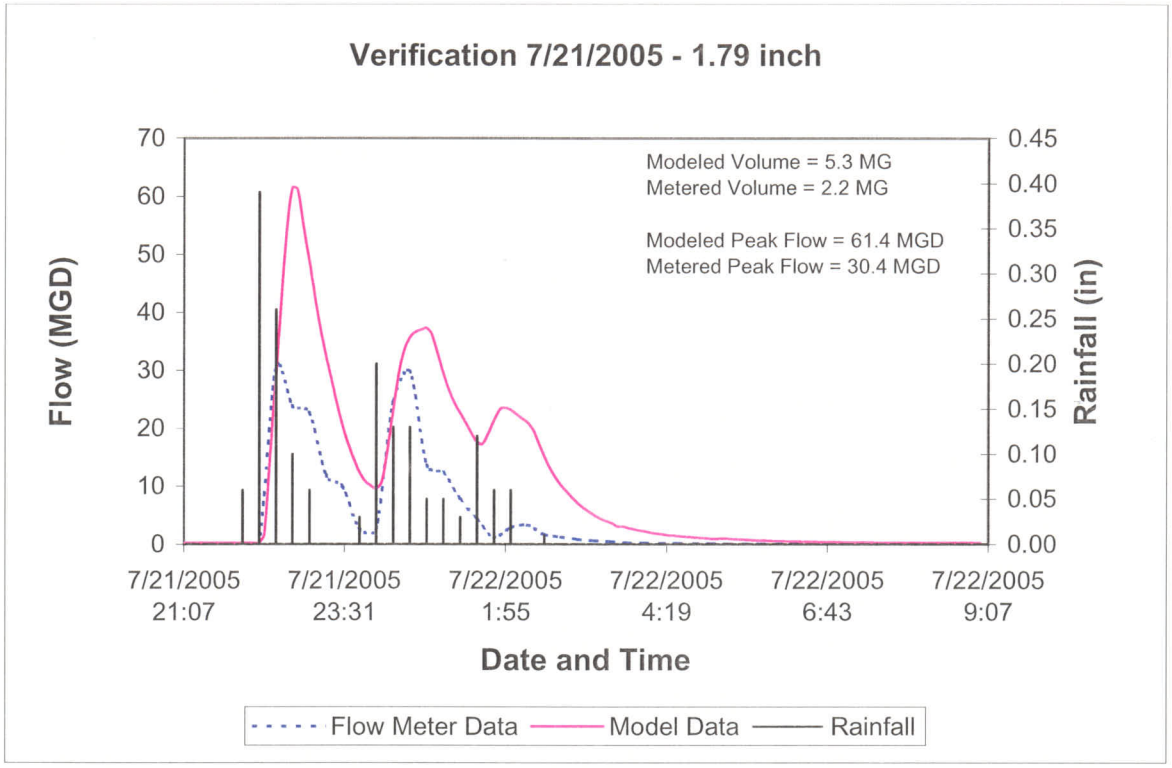


Figure 2-16

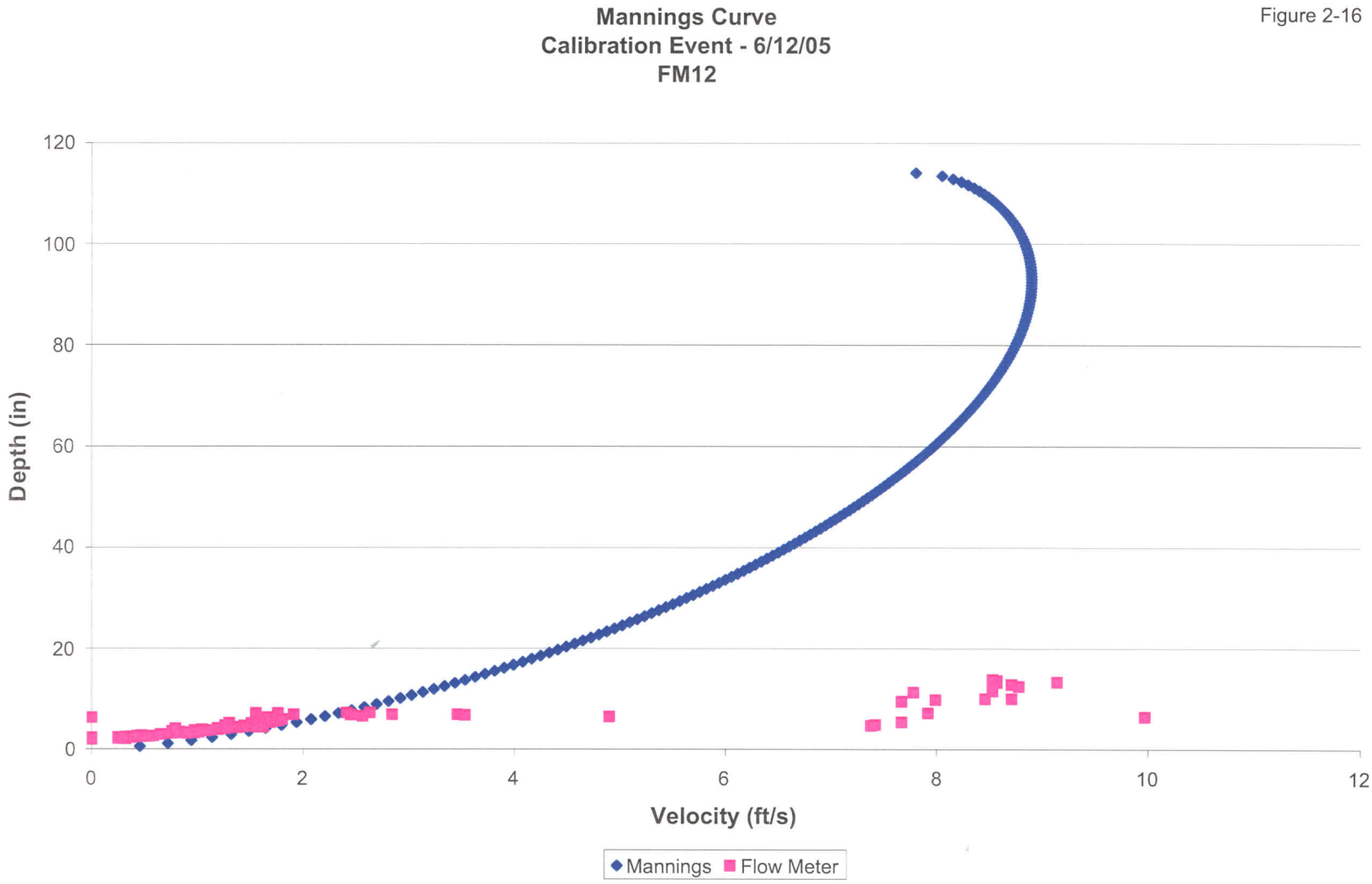

Mannings Curve
Calibration Event - 6/12/05
FM12
120
100
80
60
40
20
0
Depth (in)
0
2
4
6
8
10
12
Velocity (ft/s)
Mannings
Flow Meter

Figure 2-17

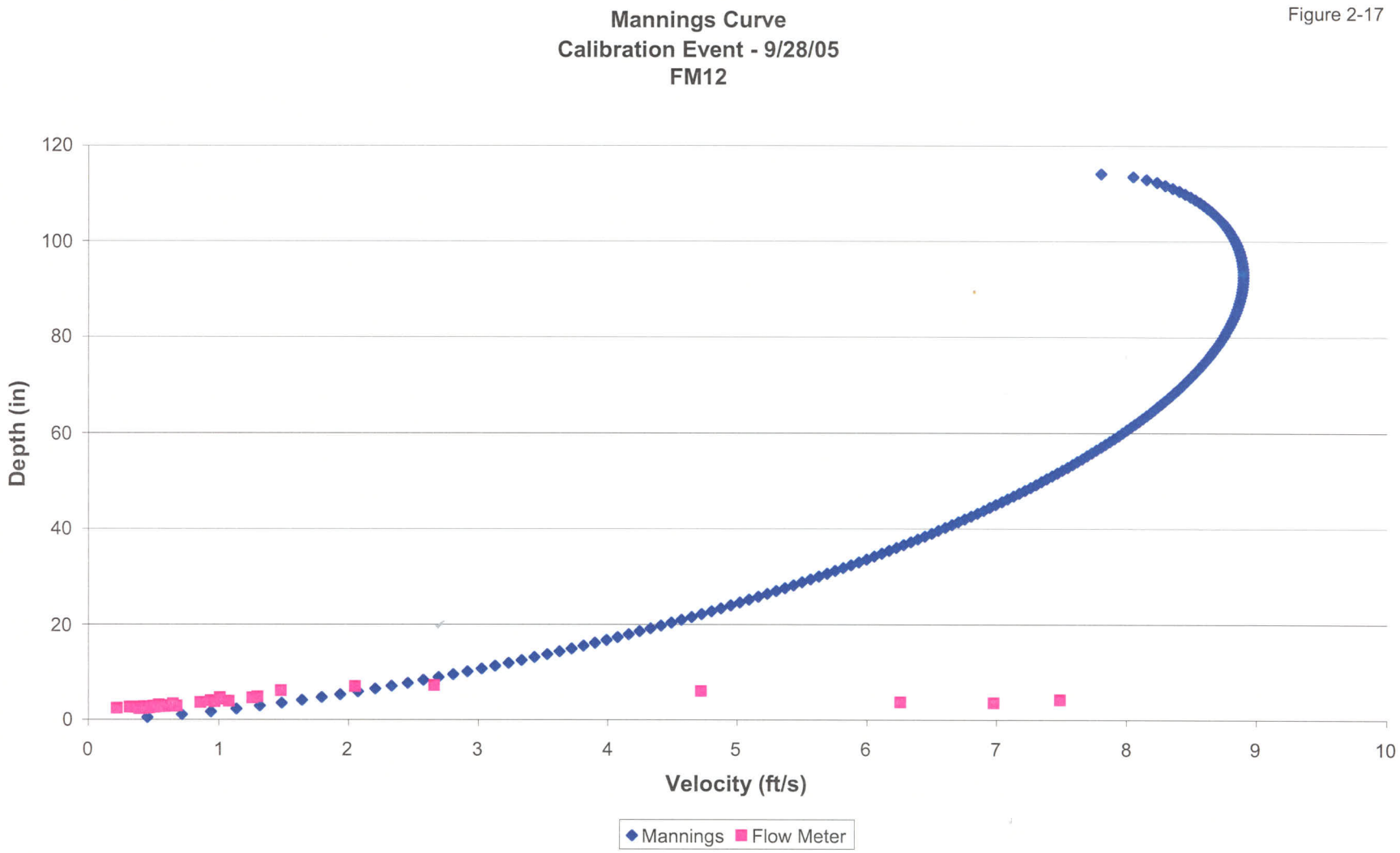
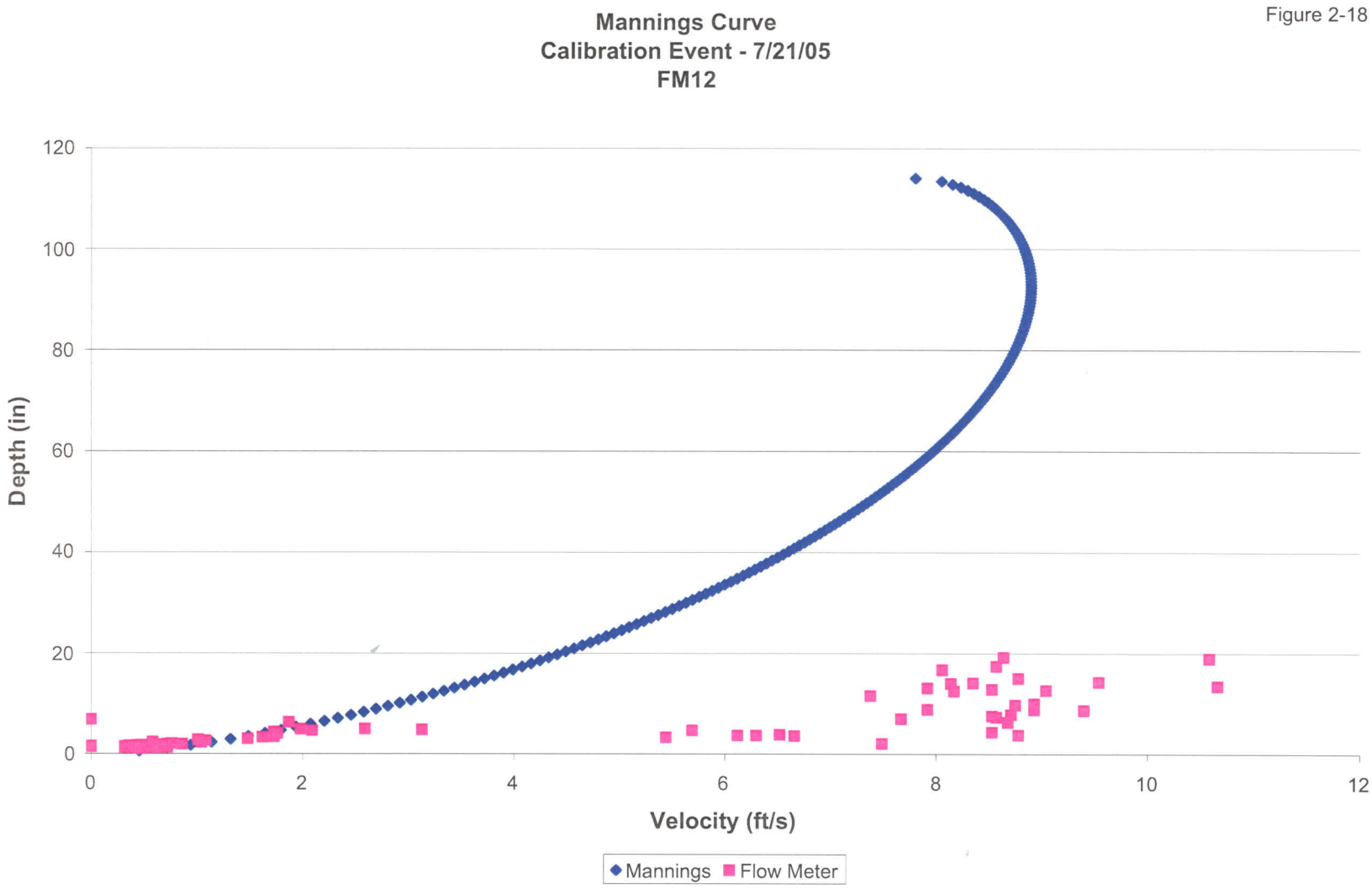

Mannings Curve
Calibration Event - 9/28/05
FM12
Depth (in)
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Velocity (ft/s)
Mannings
Flow Meter

Figure 2-18


Mannings Curve
Calibration Event - 7/21/05
FM12
120
100
80
60
40
20
0
Depth (in)
0
2
4
6
8
10
12
Velocity (ft/s)
Mannings
Flow Meter

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CSO SITE REPORT

Project Name:	Terre Haute 2005
Project Number:	30096.11
Contact Name:	Toni Presnel
Contact Number:	(812) 234-2551

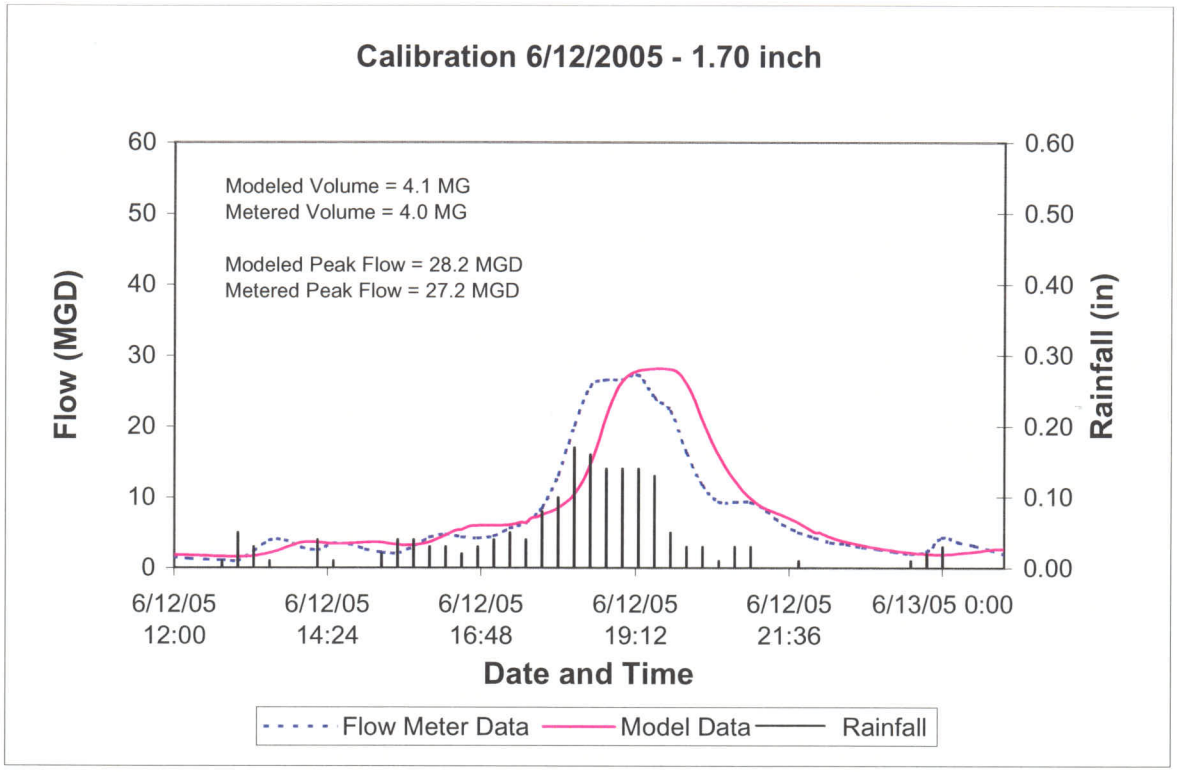
Site Name:	Terre_FM12	Monitor Series:	1506	Monitor S/N:	9537	Map #:	
Address / Location:	At the intersection and Prairieton and Hulman Street			Manhole #:			
				Pipe Diameter:	111 x 113.50 Inches		
Access:	Drive	Traffic Volume:	Light	Communications Number:	NA		

Monitoring Point Information			Manhole Structure Information			
Installation Type:	Doppler Special Installation		Manhole Depth / Cover Notes	20 Feet		
Sensors / Devices:	Pressure depth and Velocity		Manhole Material / Condition:	Concrete		Fair
Monitoring Location:	Downstream		MH Air Quality / Crew Size:	Acceptable		2
Monitor Location:	Manhole		Overflow Type / Dimensions:			
Rain Gauge Zone:	RG1		Onset to Overflow Depth:	Inches		
Installation QC:	Eric Hehmann		Outfall Distance / Gates:		Feet	
Hydraulics / Data Quality Rating:	Very low, slow dry wheather flow.	B	Active Pipe Connections?			
			Pipe Material / Condition:	Concrete		Fair
Negative Velocity Potential	No		Mini System Characteristics:	Other		

Outgoing

Meter Confirmation Information:			Communications and AC Power Information:	
Date/Time:	May 23, 2005	10:15 AM	Telephone Pole #:	N/A
Pipe Diameter:	111 H x 113.50 W Inches		Distance From Manhole:	N/A
Pipe Shape:	Circular		Road Cut Length:	N/A
Depth of Flow (Wet Dof):	3 Inches		Antenna Type / Surface:	
Range (Air Dof):	Inches		AC Power Pole #:	N/A
Ultra. Physical Offset:	Inches		AC Power Trench Length:	N/A
Waves or Ripples (+/-) :	0.25 Inches		**Additional Site Information / Comments:**	
Peak Velocity:	0.5 fps			
Pipe Obstruction / Depth:		Inches		
Pressure Serial # / Range:	36558	5 psi / 0-11.5 ft.		
Confirm Performed By:	Ira Goldfarb			

Figure 2-20
D/S Flow Meter 18
CSO Area 003 - Turner St.



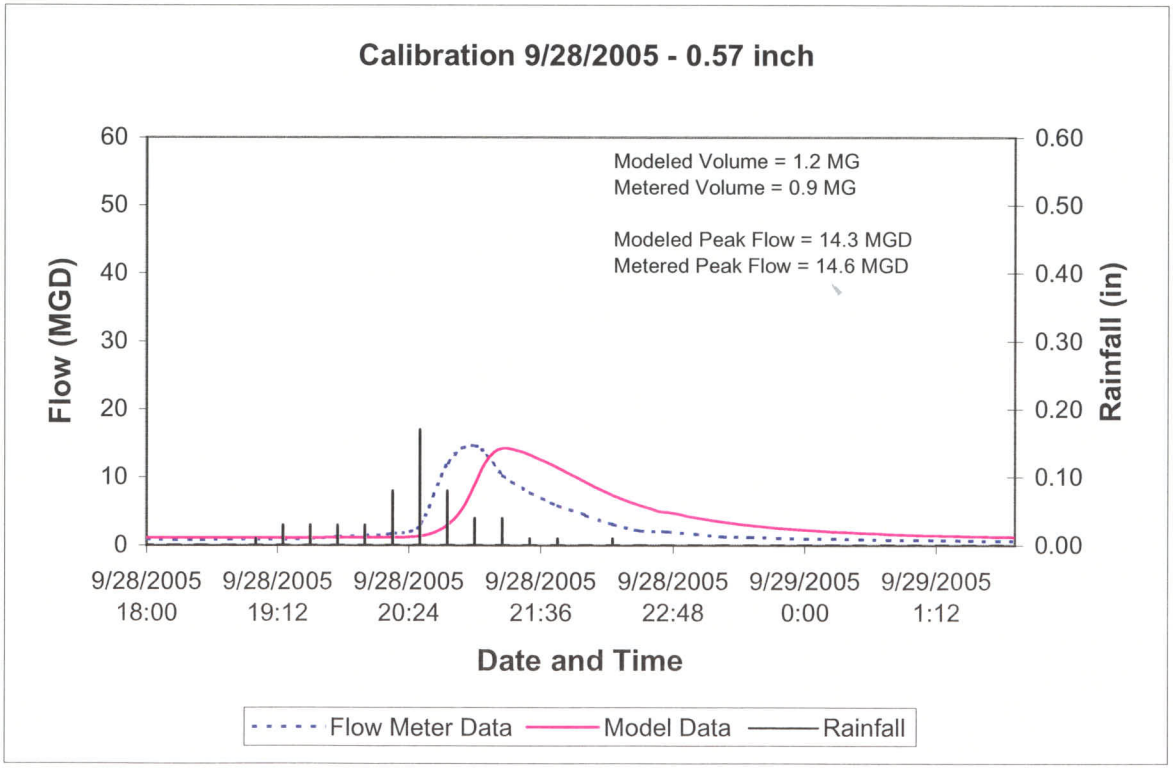


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Figure 2-20
D/S Flow Meter 18
CSO Area 003 - Turner St.

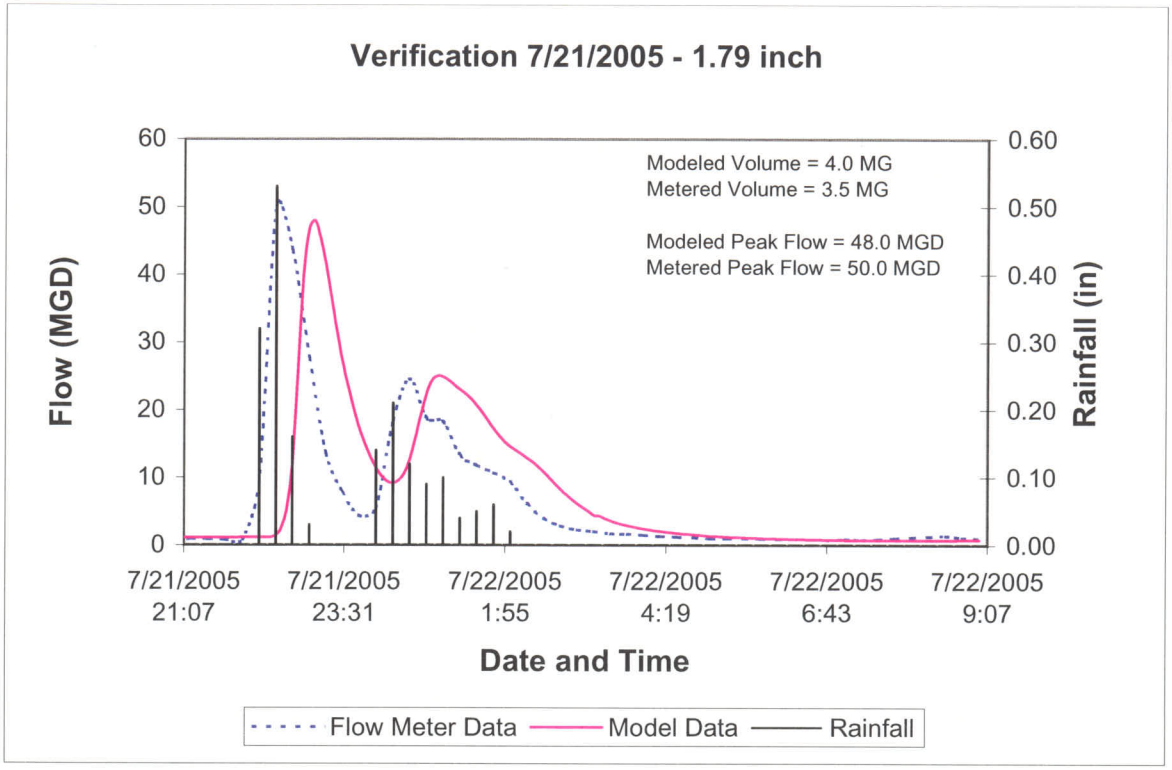
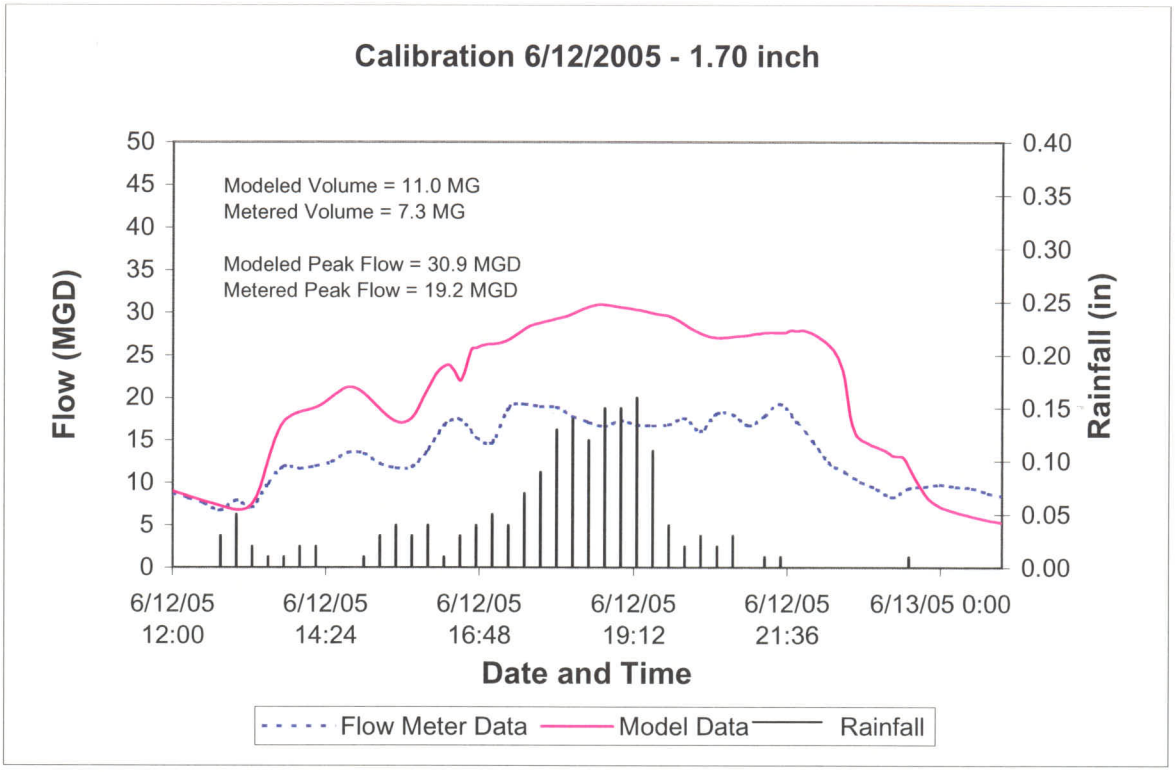


Figure 2-21
Interceptor Flow Meter 04



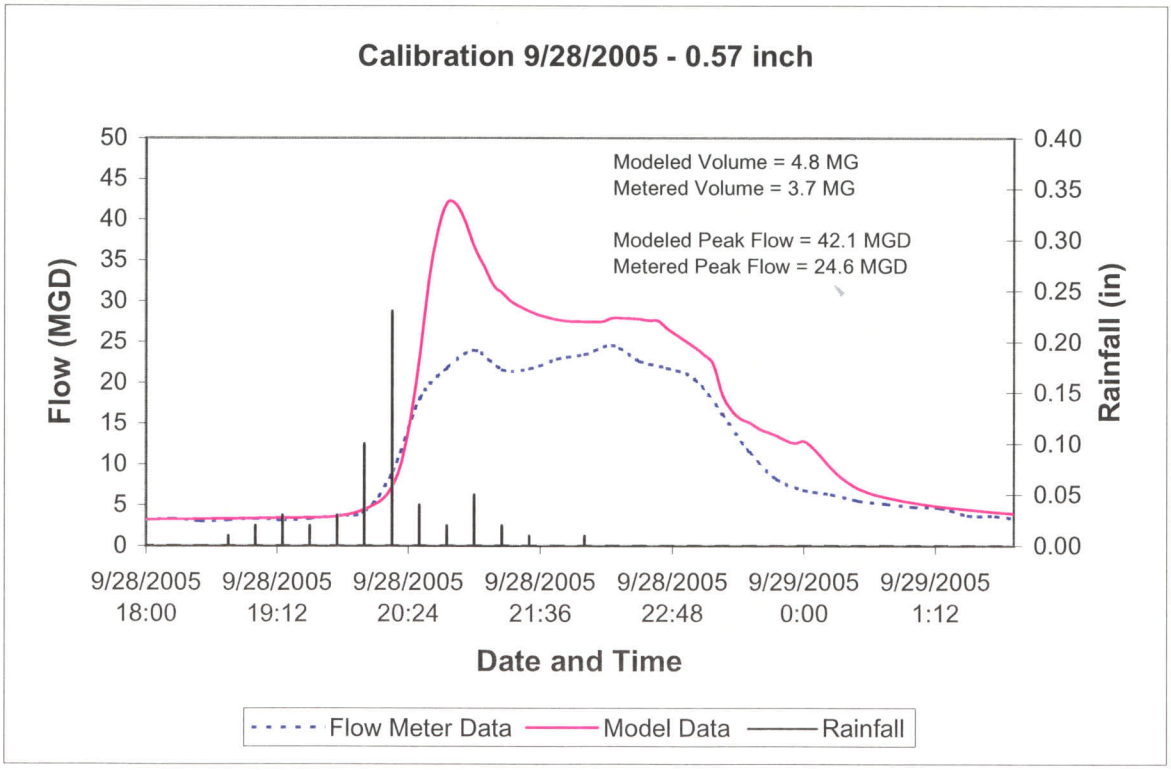


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Figure 2-21
Interceptor Flow Meter 04

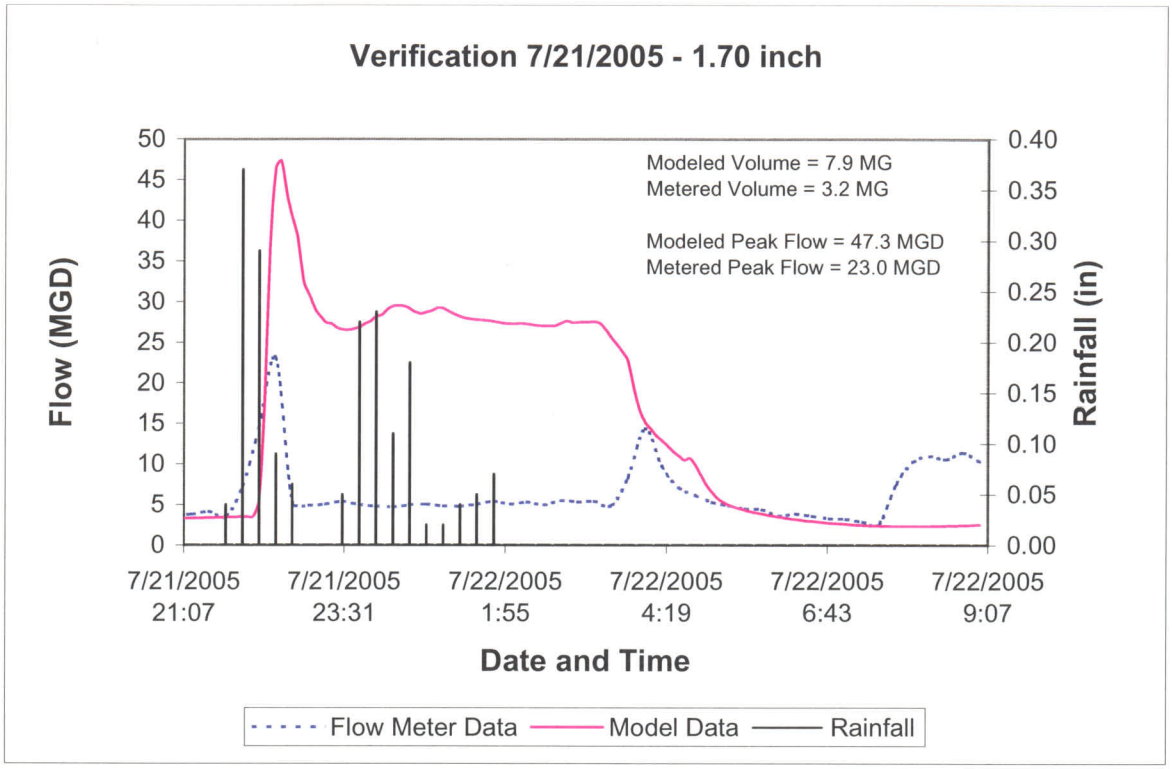

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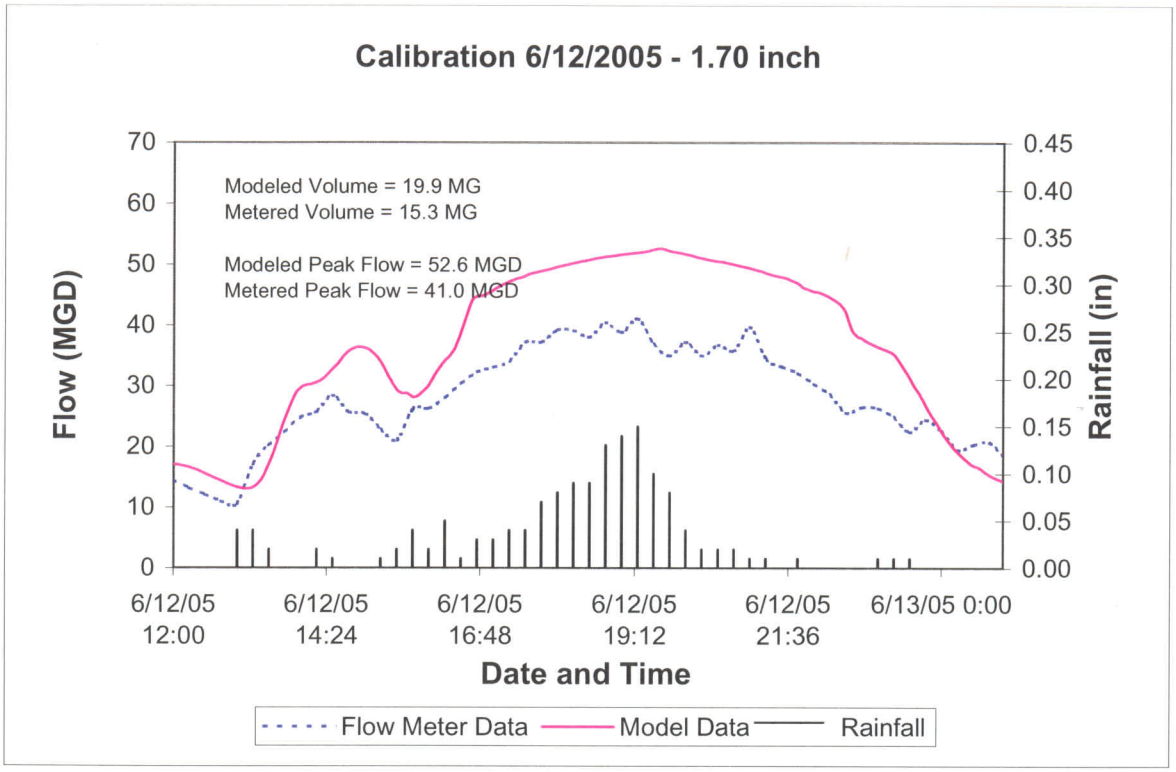
Figure 2-22
Interceptor Flow Meter 10



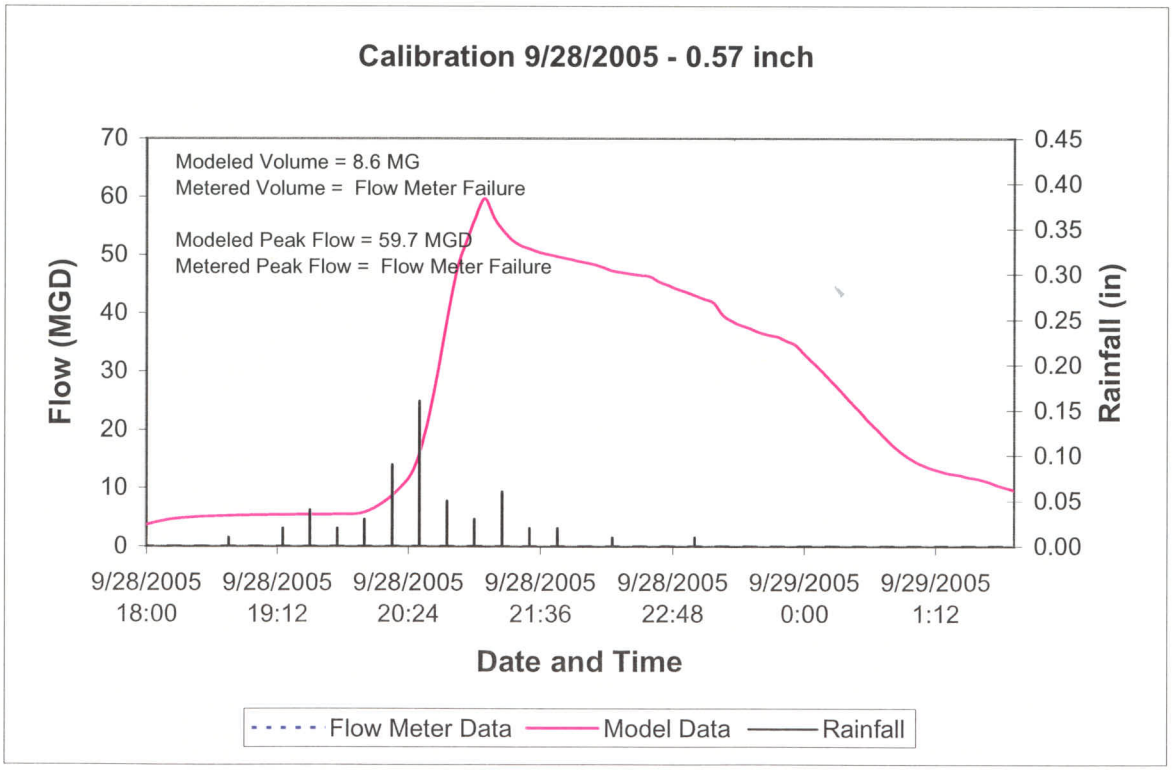


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Figure 2-22
Interceptor Flow Meter 10

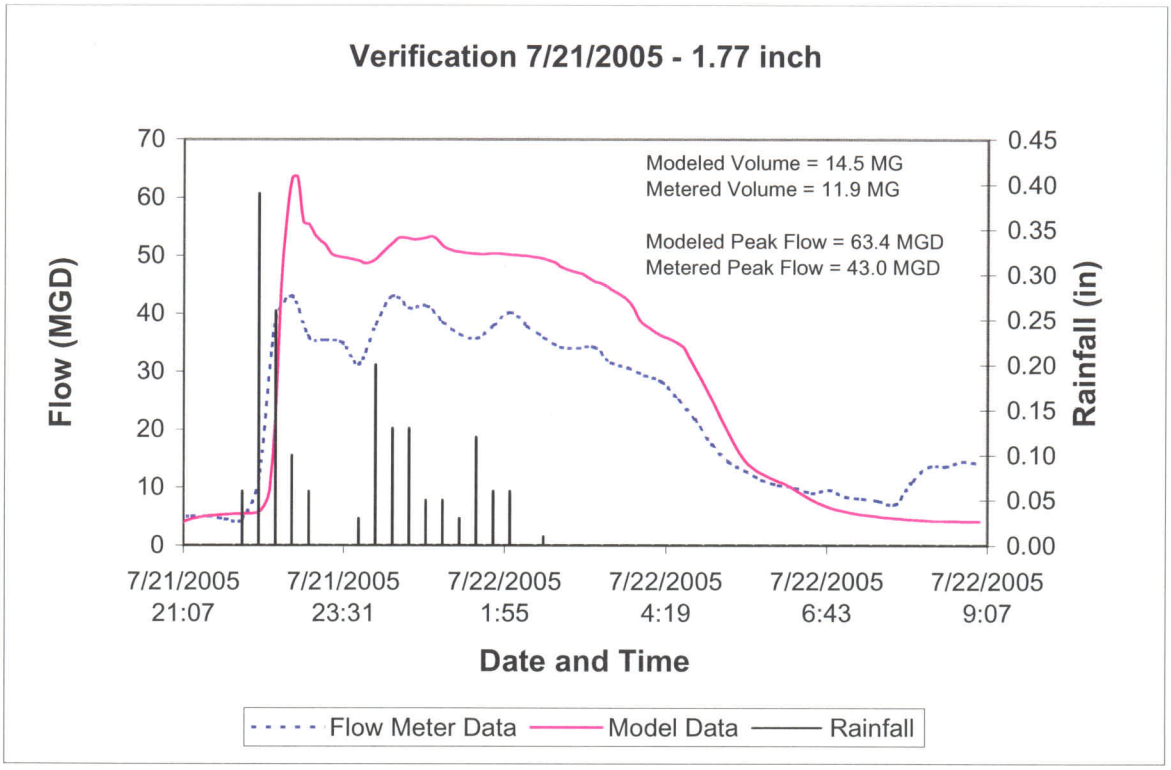

Figure 2-23
Interceptor Flow Meter 16

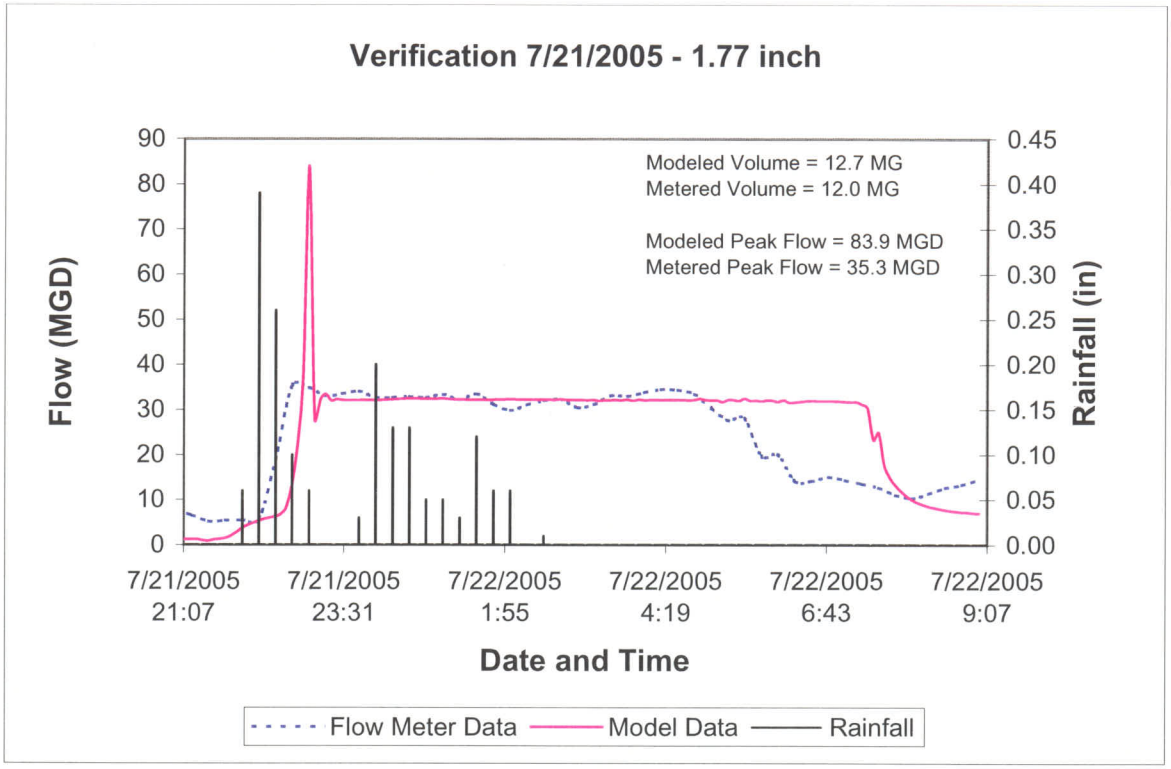

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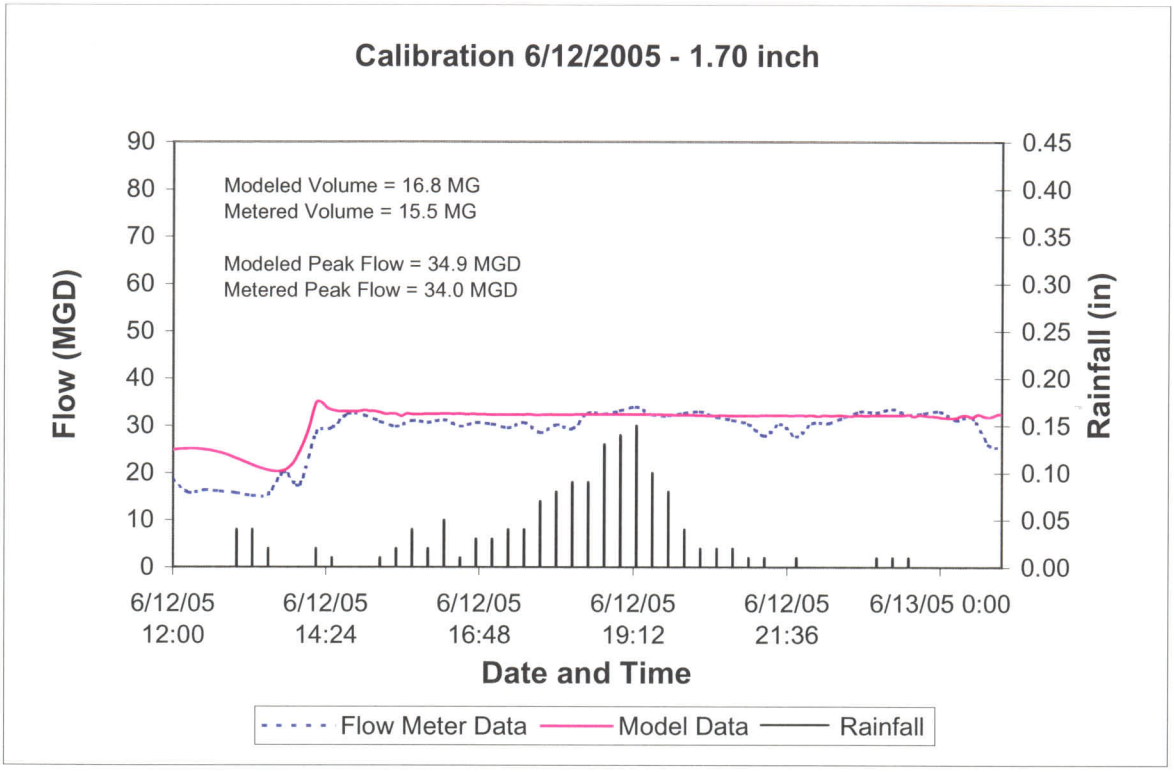
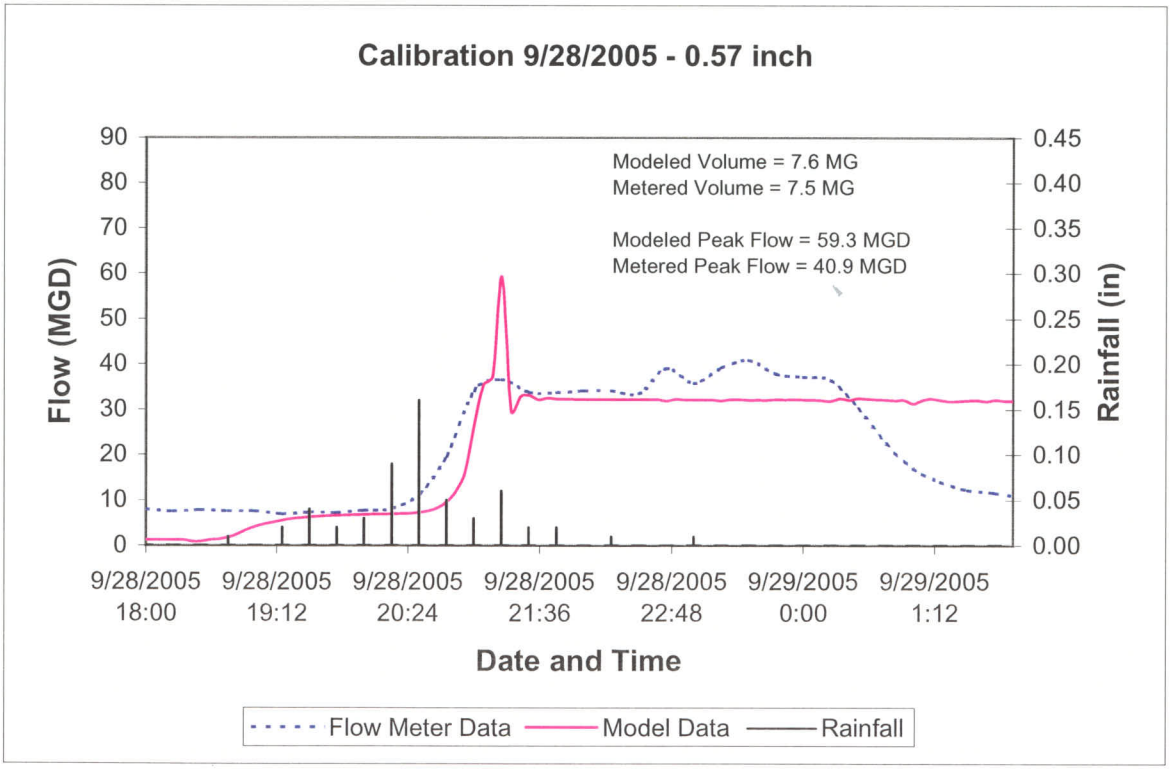
Figure 2-23
Interceptor Flow Meter 16





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