City of Kingston
420 Broadway • Kingston, NY 12401

Combined Sewer Overflow Long Term Control Plan

October 2010

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Acronyms Used in the Report

BOD	Biological Oxygen Demand
BWWF	Base Wastewater Flow
CBOD5	Carbonaceous Biological Oxygen Demand (5 day)
CEPT	Chemically Enhanced Primary Treatment
cfs	Cubic Feet per Second
cfu	Colony-Forming Unit
CSS	Combined Sewer System
CSO	Combined Sewer Overflow
DO	Dissolved Oxygen
FEMA	Federal Emergency Management Agency
fps	Feet per Second
GIS	Geographic Information System
GWI	Groundwater Infiltration
HDPE	High Density Polyethylene
HRT	High Rate Treatment
I/I	Infiltration and Inflow
LTCP	Long-Term Control Plan
MG	Million Gallons
mgd or MGD	Million Gallons per Day
mg/L	Milligrams per Liter
mL	Milliliters
MPN	Most Probable Number
NELAC	National Environmental Laboratory Accreditation Conference
NLCD	National Land Coverage Database
NYS DEC	New York State Department of Environmental Conservation
NYS ELAD	New York State Environmental Laboratory Accreditation Program
O&M	Operations and Maintenance
QA/QC	Quality Assurance / Quality Control
RAS	Return Activated Sludge
RTC	Real Time Control
SCADA	Supervisory Control and Data Acquisition
SPDES	State Pollution Discharge Elimination System
SWD	Side Wall Depth
SWMM	Storm Water Management Model
TKN	Totak Kjeldahl Nitrogen
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
UOD	Ultimate Oxygen Demand
USGS	United States Geological Survey
UV	Ultraviolet
WASP	Water Quality Analysis Simulation Program
WI/PWL	Waterbody Inventory/Priority Waterbodies List
WWTF	Wastewater Treatment Facility
WQS	Water Quality Standard
$XM	Million Dollars

Executive Summary

This Combined Sewer Overflow Long-Term Control Plan (CSO LTCP) Study was performed to evaluate whether the City of Kingston's combined sewer system meets the requirements of the USEPA CSO Control Policy and if additional CSO control measures are necessary, to develop and evaluate CSO control alternatives to achieve compliance with the policy. Kingston's Combined Sewer System (CSS) is a high performing system. The system captures for treatment 89 percent of wet weather flows for full treatment at the Wastewater Treatment Facility (WWTF), exceeding the USEPA CSO Policy criteria of 85 percent capture. The CSS has four (4) CSOs:

- Wilbur: Outfall No. 11;
- Hunter: Outfall No. 7;
- Broadway: Outfall No. 6; and
- Hasbrouck: Outfall No. 5.

Previously the CSS had 14 outfalls, but during the 1980's and 1990's 10 of these overflows were eliminated. The CSS utilizes a system of siphons to deliver flow to the WWTF. The CSOs and the WWTF discharge to Rondout Creek near the confluence with the Hudson River. This section of the Creek through Kingston is subject to tidal influences of the Hudson River.

Of the system's four overflows, three discharge infrequently and in small volumes. Only the Hasbrouck overflow chronically discharges to the Rondout Creek. Table ES-1-1 shows that the Hasbrouck CSO generates 92 percent of the 29.1 MG discharged in a typical year under baseline conditions.

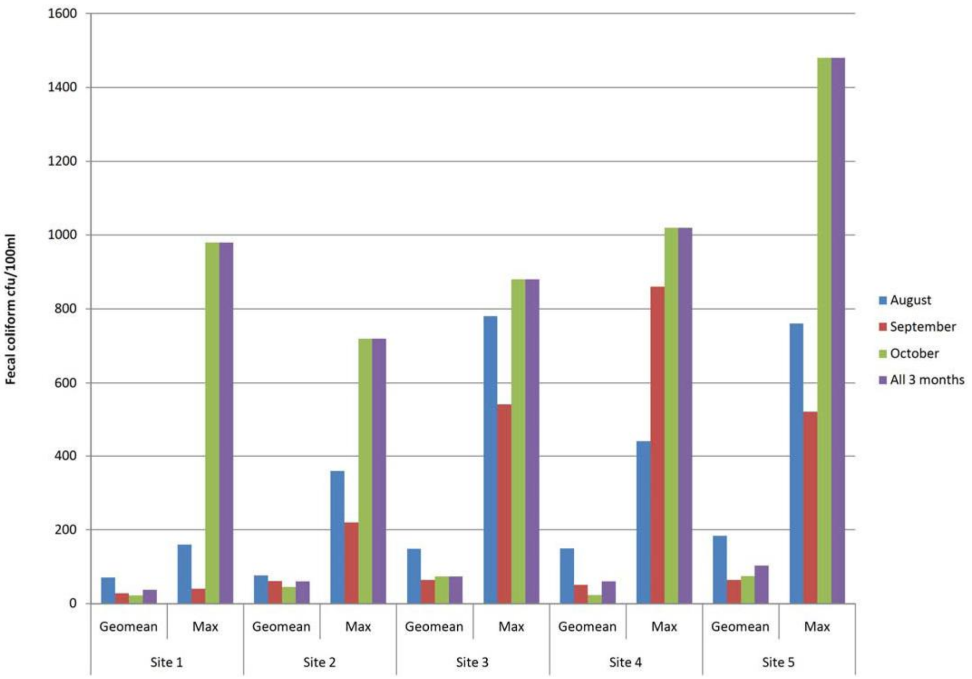
Water quality sampling was performed in 2007 to evaluate whether the Kingston CSOs preclude the Rondout Creek from attaining Water Quality Standards (WQS). The sampling showed that Fecal Coliform is the parameter of concern. Fifteen samples were collected over three (3) months at five locations along Rondout Creek. As shown in Figure ES-1-1, geomean values were within the 200 cfu/100 mL
NYS DEC standard for all months and all locations. The value of this data in interpreting the effect of the CSOs on water quality is somewhat limited due to the relatively small data set and the lack of complimentary data, such as whether the CSOs had activated. Based on available data, it appears the CSO discharges do not preclude compliance with WQS.

Table ES-1-1:

Kingston CSO System Performance (Baseline Conditions)

Typical Year Period				
CSO No.	Total Overflow Volume (MG)	Total Overflow Duration (hours)	Overflow Peak Flow (MGD)	Number of Activations[1]
Hasbrouck	26.93	423	22.46	59
Broadway	0.21	13	1.35	9
Hunter	0.12	23	0.61	12
Wilbur	1.81	18	7.41	5
Total	29.07	-	-	-
Typical 5-Year Period				
CSO No.	Total Overflow Volume (MG)	Total Overflow Duration (hours)	Overflow Peak Flow (MGD)	Number of Activations[1]
Hasbrouck	121.10	1889	27.93	296
Broadway	0.95	76	2.57	38
Hunter	0.52	108	1.03	50
Wilbur	8.81	60	8.72	21
Total	131.38	-	-	-
1) 12 hour interevent time, 0.01 cfs threshold				

Figure ES-1-1: 2007 Rondout Creek Fecal Coliform Sampling and Geomeans



Another important consideration in the development of the CSO LTCP was the performance of the Hasbrouck system during dry weather and small wet weather events. Flow monitoring data indicated that the Hasbrouck system was subject to overflows during dry weather periods. While the dry weather overflows have not been witnessed directly, City personnel have responded to the information with daily maintenance of the regulator to ensure that the trash rack and orifice connecting to the siphon system is clear and open as the system was prone to debris accumulation. During small events, flow monitoring data also indicated that the Hasbrouck regulator continued to overflow when flows to the WWTF had fallen below peak rates.

Flow monitoring data also identified sediment related flow restrictions in the Wilbur and Hunter regulators. City crews responded by cleaning the Wilbur regulator and modifying the Hunter regulator to eliminate these flow restrictions.

Being a small community, as defined by USEPA CSO Policy, the City has selected the presumptive compliance approach. Two most commonly used presumptive approach criteria from USEPA CSO Control Policy are 85 percent capture of wet weather flows or four to six overflows per year. The CSS already meets the 85 percent capture presumptive criterion; however, the number of annual activations is currently greater than four to six overflows per year. This is not uncommon, CSO LTCP efforts for many communities have shown that the four to six overflows per year is a more stringent criterion than the 85 percent capture. Since the water quality evaluation results from the small data set appear to meet WQS, it is unclear at present time whether or not additional control of the CSOs is required.

Consequently, the recommended CSO LTCP utilizes a staged approach that includes post-construction monitoring after modifying the CSS to determine the effect of the CSOs on attainment of WQS. The monitoring will be used to determine if the performance is sufficient to meet WQS. If not, the system will be reassessed to refine the size and type of additional CSO control required.

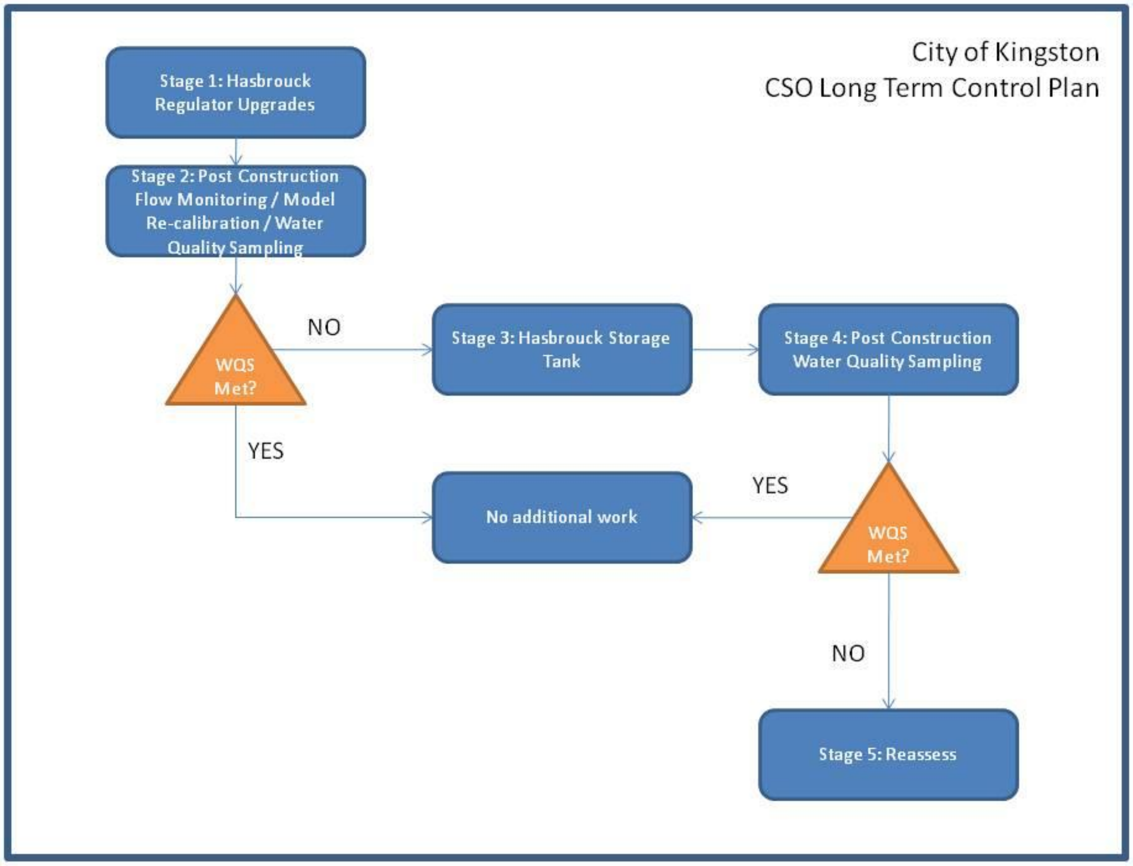
The recommended CSO LTCP implements a staged approach that focuses on improving the performance of the Hasbrouck system. The stages of the CSO LTCP are depicted in the flow chart of Figure ES-2. The initial stage upgrades the regulator to eliminate the need for daily maintenance in the prevention of dry weather overflows, provide direct measurement of CSO discharges, and modulate the wet weather discharge to maximize flow to the WWTF. Post-construction monitoring will be performed to update the characterization of the Hasbrouck system and re-evaluate water quality in Rondout Creek. If the water quality sampling shows that Rondout Creek is meeting WQS or that the CSOs are not precluding compliance with WQS, no additional capital work will be undertaken.

If the monitoring shows that CSO remaining activations appear to cause a WQS violation, additional CSO control measure will be implemented. Based on the estimated costs, the additional CSO control measure is expected to be tank storage. The final size of the tank will be determined based on the updated hydraulic model of the Hasbrouck system and the water quality sampling data. The update of the hydraulic model should also include the updating and refinement of capital costs. If markets or technologies change, such that treatment or separation becomes more cost-effective than storage, the City may elect to implement the most cost-effective solution.

Once the tank or other CSO Control Measure is operational, the post construction water quality monitoring program will be initiated to confirm compliance with WQS in Rondout Creek.

Although it is not anticipated, in the event the post construction water quality sampling shows that the CSOs are clearly the cause of WQS violations, the City will undertake additional study to determine appropriate steps to further reduce impacts.

Figure ES-1-2: Kingston CSO Long Term Control Plan



Storage for Hasbrouck is sized to reduced discharges to five (5) overflows in the typical year under baseline conditions. This would reduce the annual discharge volume from Hasbrouck CSO 24.08 MG, from 26.9 MG in the typical year to 2.82 MG and increase the systemwide percent capture to 98.0 percent. The estimated costs for the CSO LTCP are provided in Table ES-2. The post construction monitoring included water quality sampling and analysis that the City may elect to self perform. The total cost of the program may be as low as $0.99M if post construction monitoring confirms water quality standards are not precluded.

Costs ranging from $0.99M to $5.14M fall within the low burden range for the City of Kingston. The implementation schedule reflects this, with the schedule based on the time required to correctly and competently perform the required work. A schedule reflecting the full implementation of the CSO stages shows related work and post construction monitoring complete by summer 2018 (see Figure ES-3).

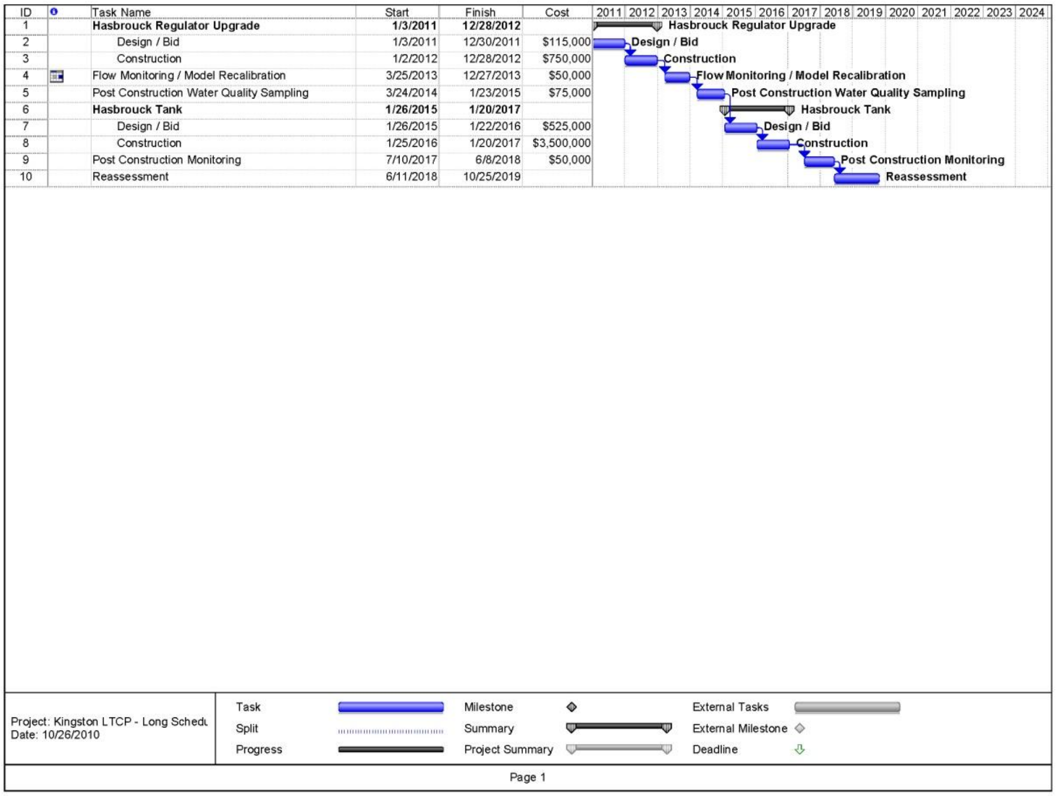
Table ES-1-2:

CSO LTCP Estimated Cost

Stage	Description	Construction Cost	Engineering Cost [1]	Sampling / Monitoring / Analysis Cost	Total
1	Hasbrouck Regulator Upgrade	$ 750,000	$115,000		$ 865,000
2	Hasbrouck Flow Monitoring and Model Re-calibration			$50,000	$ 50,000
2	Post Construction Water Quality Sampling			$75,000	$ 75,000
3	Hasbrouck Storage Tank	$ 3,500,000	$525,000		$4,025,000
4	Post Construction Monitoring			$ 75,000	$ 75,000
5	Re-assessment			$ 50,000	$ 50,000
Totals		$ 4,250,000	$ 640,000	$ 250,000	$5,140,000

[1] Engineering costs are estimated to be 15 percent of the construction costs.

Figure ES-1-3: Kingston CSO LTCP Implementation Schedule (Long Schedule)



ID	Task Name	Start	Finish	Cost
1	**Hasbrouck Regulator Upgrade**	**1/3/2011**	**12/28/2012**	
2	Design / Bid	1/3/2011	12/30/2011	$115,000
3	Construction	1/2/2012	12/28/2012	$750,000
4	Flow Monitoring / Model Recalibration	3/25/2013	12/27/2013	$50,000
5	Post Construction Water Quality Sampling	3/24/2014	1/23/2015	$75,000
6	**Hasbrouck Tank**	**1/26/2015**	**1/20/2017**	
7	Design / Bid	1/26/2015	1/22/2016	$525,000
8	Construction	1/25/2016	1/20/2017	$3,500,000
9	Post Construction Monitoring	7/10/2017	6/8/2018	$50,000
10	Reassessment	6/11/2018	10/25/2019	

Project: Kingston LTCP - Long Schedu
Date: 10/26/2010

1. Description of Kingston System

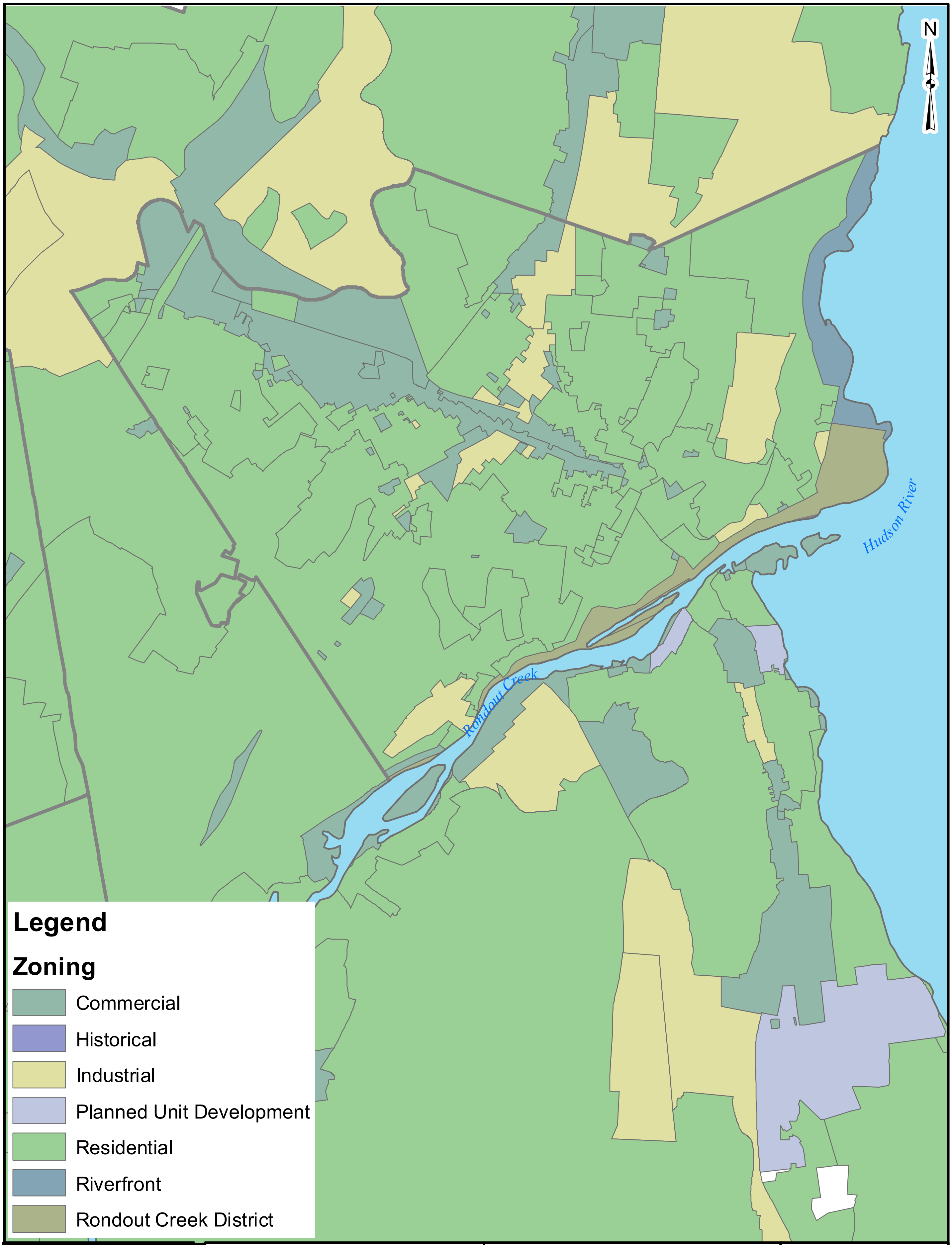
This section of the CSO LTCP presents a summary of the known information about the configuration and performance of the CSS. The purpose of collecting and analyzing this information is to understand, to the degree possible, the reasons for and consequences of the activation of the combined sewer overflows, such that the solutions developed to manage the wet weather discharge are technically appropriate. The intent of this section of the CSO LTCP is to define the existing system conditions for both the City, NYS DEC, and the public.

The data and information presented herein were acquired from several sources including:

- City of Kingston mapping, record drawings and historic information;
- Desktop Capacity Evaluation, dated December 2008;
- NYSERDA Energy Conservation Study, dated April 2007;
- Combined Sewer System Characterization, Monitoring and Modeling Plan, dated July 2007;
- Model Calibration and Validation Technical Memorandum, dated April 2010;
- 2009 Flow Monitoring;
- 2006 & 2007 Water Quality Sampling;
- NYS DEC Waterbody Index/Priority Waterbodies List;
- FEMA Flood Maps;
- National Resource Conservation Services (NRCS) Soil Survey;
- 2006-2008 American Community Survey.

1.1. City of Kingston

The City of Kingston is home to approximately 25,000 residents and is the seat of Ulster County. The majority of the historic City's seven and a half square miles drain to the Rondout Creek, which borders the City immediately to the southeast, prior to the confluence with the Hudson River. The City is organized around the downtown business district, with general business and residential housing surrounding. Land uses, as maintained within GIS, are shown in Figure 1-1.



MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

CITY OF KINGSTON
ZONING MAP

MALCOLM PIRNIE, INC.

OCTOBER 2010

FIGURE 1-1

Primarily residential, the commercial and industrial businesses are focused along a corridor through the center of the city. In recent years, economic conditions have adversely affected the population. In an effort to stave off diminishing tax revenues, the city desires to grow the tax base by actively promoting commercial and residential development. The city has manufacturing and retail businesses and potentially two new housing developments.

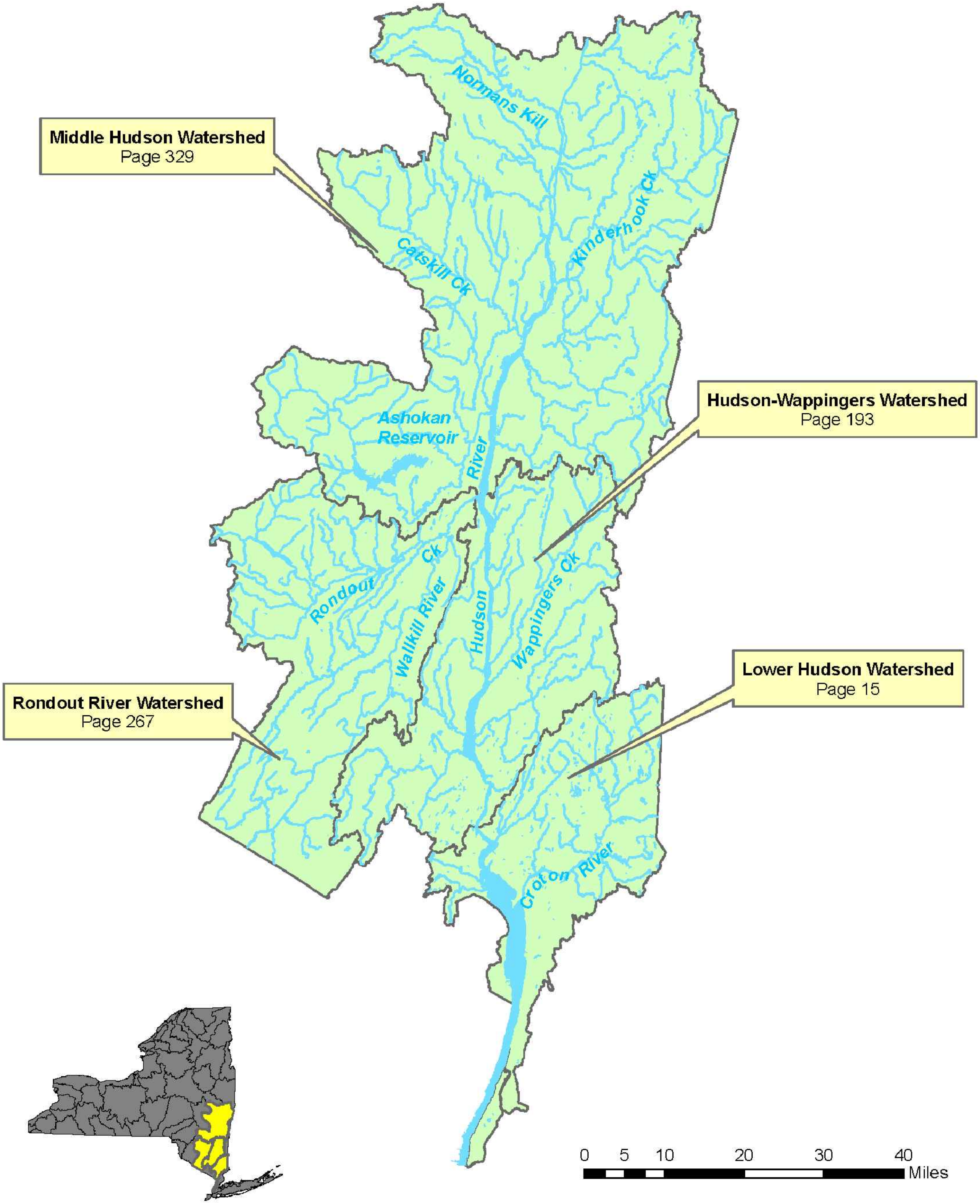
The 2006-2008 American Community Survey estimated the following demographics:

- Total Population: 25,245
  - Male/Female: 53.0 percent
- Age 18 and over: 75.7 percent
  - Age 65 and over: 13.1 percent
- Average household size: 2.31
- Average family size: 3.15
- In labor force: 69.5 percent

1.2. Rondout Creek and Tributary Area

Kingston is located at the mouth of Rondout Creek, which is a tributary to the Hudson River. Rondout Creek is a NYS DEC Class C waterbody. Class C waterbodies can be used for recreation and fishing but are not suitable for water supply. The best available information on the overall evaluation of the creek comes from the "Lower Hudson River Basin Waterbody Inventory/Priority Waterbodies List Report"; August 2008 (WI/PWL Report). Figure 1-2 shows the location of the Rondout Creek watershed within the greater Lower Hudson River watershed as provided in the WI/PWL Report. (Note: page numbers refer to the WI/PWL Report.)

The NYS DEC "must provide regular, periodic assessments of the quality of the water resources in the state, and their ability to support specific uses". These assessments reflect monitoring and water quality information drawn from a number of programs and sources, both within and outside NYS DEC. This information has been compiled by NYS DEC Division of Water and merged into an inventory database of all waterbodies in New York State. The database is used to record current water quality information, characterize known and/or suspected water quality problems and issues, and track progress toward their resolution. This inventory of water quality information is the division's WI/PWL." The WI/PWL is used in the Division of Water's Comprehensive Assessment Strategy, in other programs and in compliance with the Clean Water Act.



User: Lewandowski Spec: PIRNIE STANDARD File: I: \ACAD\PROJ\5744016\Figures\FIGURE 1-2.DWG Scale: 1:1 Date: 10/26/2010 Time: 15:55 Layout: Layout1

MALCOLM PIRNIE	CITY OF KINGSTON CSO LONG TERM CONTROL PLAN	LOWER HUDSON RIVER WATERSHEDS	MALCOLM PIRNIE, INC. OCTOBER 2010 FIGURE 1-2

1.2.1. Soil Survey

The City of Kingston sits atop soils that are a mix of shallow silt loams and loamy sands. Figure 1-3 shows the complicated mix of soils in the Kingston area. Approximately half of the City has soils that are classified as soil groups A or B. These soils have moderate to high infiltration rates. The balance of the City is a mixture of soils that are classified as soil groups C and D, which have slow to very slow infiltration rates. The soils generally impede the downward movement of water and, consequently, are subject to higher rates of run-off. The better draining soils are in the high land areas while the poorly draining soils are along the Hudson River and along the southwest edge of the city. The soils are typically shallow with lithic bedrock underlying. The depth of the soil varies but typically ranges from 10 to 40 inches.

1.2.2. Topography and Floodplain

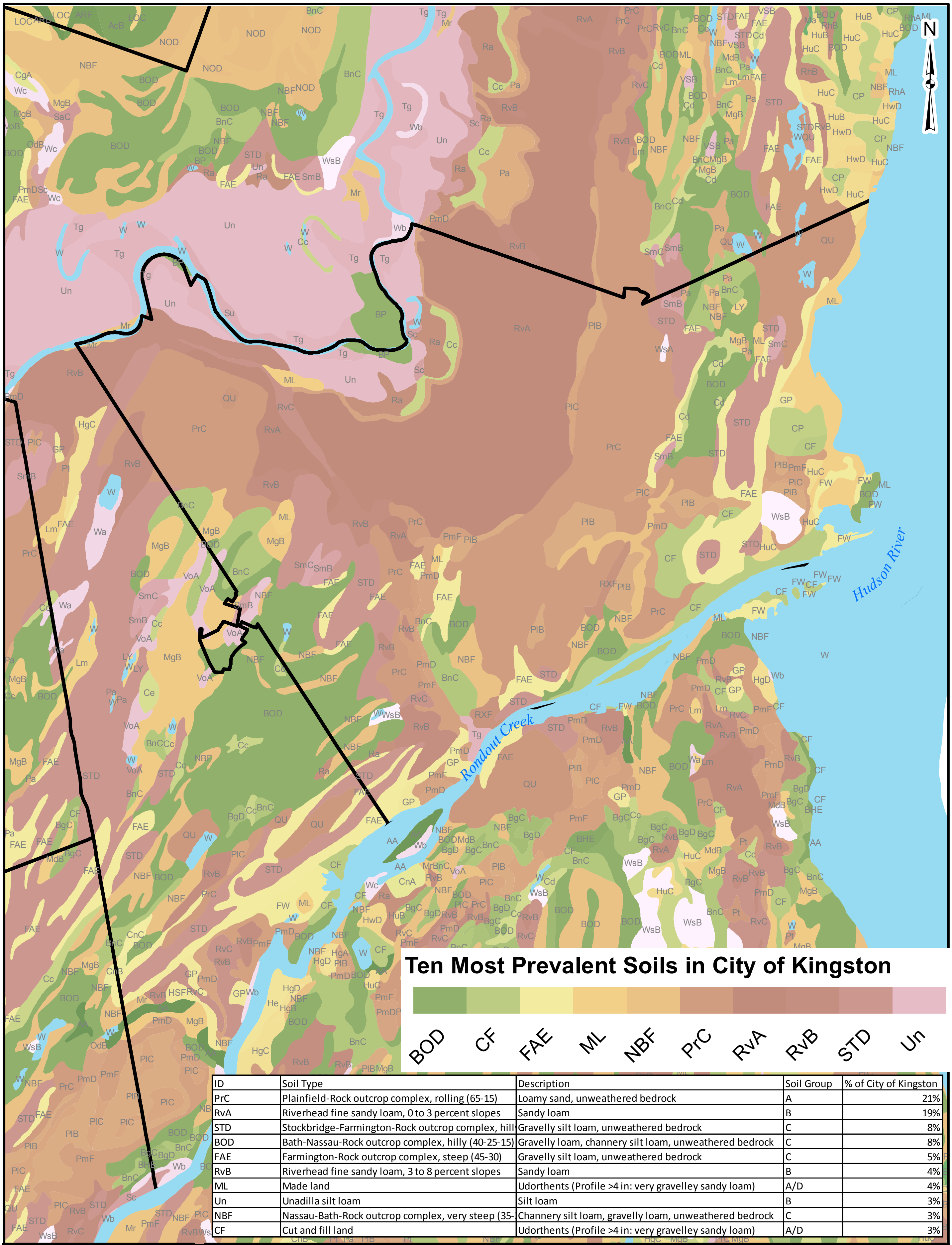
The majority of the City drains southeasterly to Rondout Creek, with a small portion draining to Esopus Creek. The upper areas are gently sloping down to the top of a bluff, where the land drops quickly and significantly down to the creek, as shown in Figure 1-4. The steep topography protects the vast majority of the City from the flooding influence of the Hudson River and Rondout Creek. The Federal Emergency Management Agency (FEMA) Flood Maps for the City are provided in Appendix A.

1.3. Collection System

The collection system for the City of Kingston is a combined sewer system that is regulated at four locations. The Wilbur, Hunter, Broadway, and Hasbrouck regulators direct dry weather flows and those portions of the wet weather that are less than approximately 10.25 mgd to the WWTF through a series of siphons. Wet weather flows that exceed the WWTF’s capacity are discharged to the Rondout Creek. Figure 1-5 shows the configuration of the regulators and the WWTF.

The pipe network connecting the regulators to the WWTF are pressure sewers driven by the elevational head of the regulators. These pipes are referred to as “siphons” because of the pressurized nature. Two 16-inch siphons connect the largest sewershed, Wilbur, directly to the WWTF. A single 24-inch siphon serves the three remaining sewersheds, Hunter, Broadway, and Hasbrouck, as well as several low lying customers along Rondout Creek. Three small forcemains serve other low lying customers along Rondout Creek, and the Hamlet of Port Ewen in the Town of Esopus, a satellite community.

Around the combined sewer system there are areas of separate sanitary sewer. An estimated 40 percent of the total sewer system is separate sanitary sewer, with much of it tributary to the Wilbur system. Past projects in specific areas have redirected run-off from roadways to a storm sewer system, leaving private property connected to the combined sewer.



Ten Most Prevalent Soils in City of Kingston

ID	Soil Type	Description	Soil Group	% of City of Kingston
PrC	Plainfield-Rock outcrop complex, rolling (65-15)	Loamy sand, unweathered bedrock	A	21%
RvA	Riverhead fine sandy loam, 0 to 3 percent slopes	Sandy loam	B	19%
STD	Stockbridge-Farmington-Rock outcrop complex, hill	Gravelly silt loam, unweathered bedrock	C	8%
BOD	Bath-Nassau-Rock outcrop complex, hilly (40-25-15)	Gravelly silt loam, channery silt loam, unweathered bedrock	C	8%
FAE	Farmington-Rock outcrop complex, steep (45-30)	Gravelly silt loam, unweathered bedrock	C	5%
RvB	Riverhead fine sandy loam, 3 to 8 percent slopes	Sandy loam	B	4%
ML	Made land	Udorthents (Profile >4 in: very gravelley sandy loam)	A/D	4%
Un	Unadilla silt loam	Silt loam	B	3%
NBF	Nassau-Bath-Rock outcrop complex, very steep (35-	Channery silt loam, gravelly loam, unweathered bedrock	C	3%
CF	Cut and fill land	Udorthents (Profile >4 in: very gravelley sandy loam)	A/D	3%

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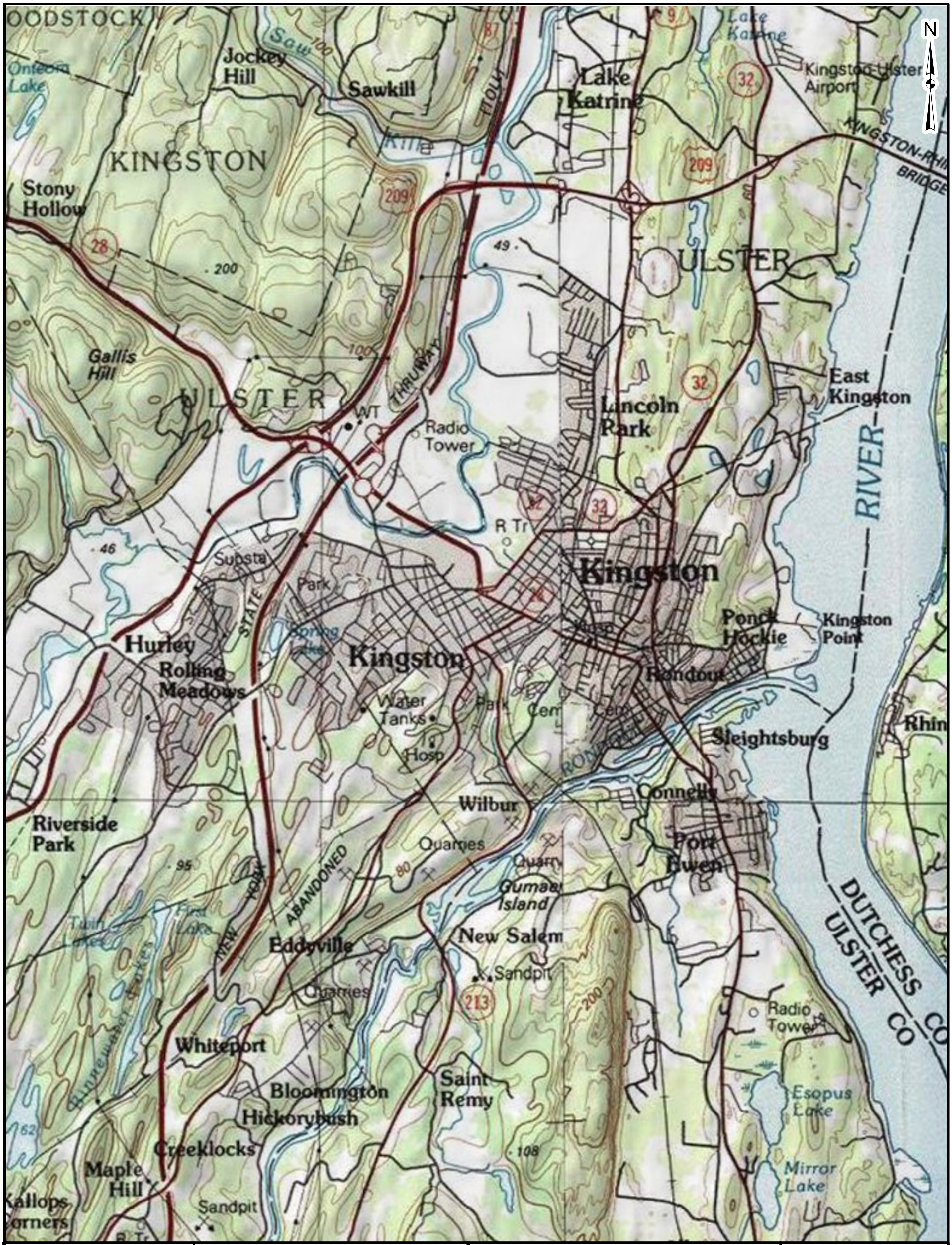
FIGURE 1-3



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TOPOGRAPHY

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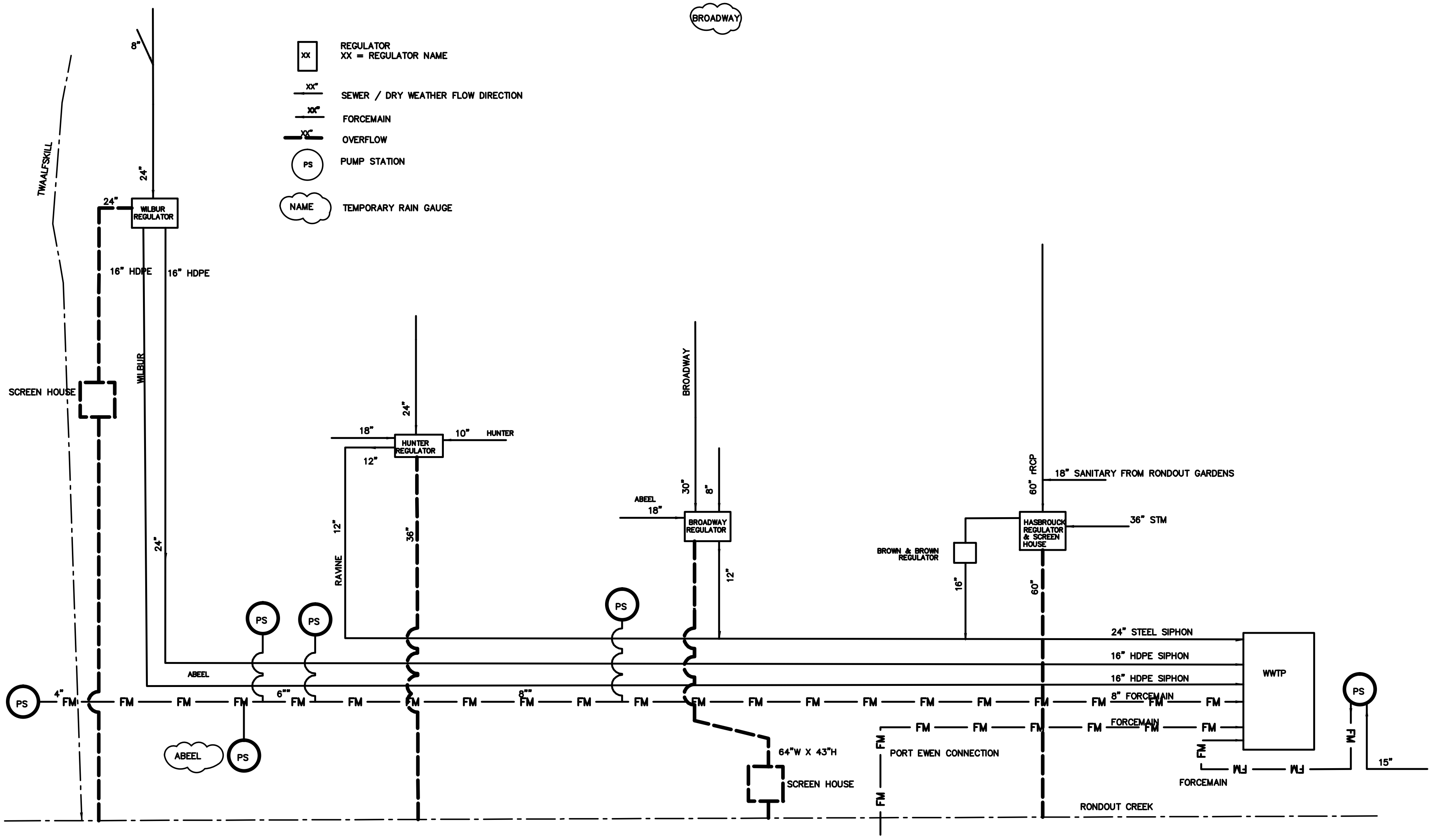
FIGURE 1-4

User: Lewandowski Spec: PIRNIE STANDARD File: I:\ACAD\PROJ\5744016\Figures\FIGURE 1-5.DWG Scale: 1:1 Date: 10/26/2010 Time: 15:54 Layout: G-XXX



CITY OF KINGSTON

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COLLECTION SYSTEM SCHEMATIC

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FIGURE 1–5

All of the City's regulators use leaping weirs to control dry weather flows and allow overflows to occur during wet weather events. The Hasbrouck sewershed is also outfitted with a Brown & Brown orifice regulator that restricts flow into the siphon system.

Because of the shallow rock, the collection system was constructed with two levels. The higher elevation service sewers collect and convey flows from adjacent properties and the roadway. The service sewers discharge into trunk sewers that were constructed deeper and often in the rock. This configuration allowed the majority of the sewer system to be constructed without the expense of excavating rock and yet maintain a gravity flow system.

The following sections contain descriptions of the individual sewersheds and regulators. In describing the collection system, the following terms are used:

Influent sewer or influent pipe: A pipe coming into a structure, such as a manhole, regulator or WWTP influent pump station.

Dry weather pipe: In a regulator, the dry weather pipe is the path normally taken by low flows.

Dry weather flow: From a regulator, the flow coming out of a dry weather pipe. During wet weather, this flow will include some rainfall-derived flows.

Wet weather pipe: In a regulator, the wet weather pipe is the path taken by high flows. May also be referred to as the overflow pipe.

Combined sewer overflow: Flow leaving the system and being discharged to Rondout Creek through a designated combined sewer overflow point.

Regulator: A structural device use to direct and/or divide flows within the collection system.

1.3.1. Wilbur System

The Wilbur sewershed is the largest sewershed, encompassing approximately 2,300 acres. The Wilbur regulator is located on Wilbur Road and is a facility that was constructed during the 1990s to pump flows through dedicated siphons directly to the WWTF. Typically, the pumps are not used; instead, flow is pushed into the siphon by the elevational head. The facility was constructed with a divided wet well, that provides storage, screening and grinding facilities. The 24-inch dry weather flow pipe enters a screen house where a bar screen and grinder removes large debris from the flow before entering the wet wells. There divided wet well has a total effective capacity of 161,500-gallons and is connected to an overflow chamber.

Twin 16-inch density polyethylene (HDPE) siphons run from the Wilbur regulator approximately 9,900 feet to the WWTF. The elevation difference is approximately 30-feet. The overflow pipe is 24-inches in diameter and overflows to the Twaalfskill Creek, which is tributary to Rondout Creek. Overflows pass through a second screen house for floatable control before being discharged. It shows the components of the regulator and the relative position to the WWTF.

1.3.2. Hunter Basin

The Hunter regulator is located in a residential area of the City on Hunter Street east of Ravine Street. The Hunter regulator receives flow from a 600-acre combined sewershed. Some roadway run-off has been removed from the combined sewer in this sewershed. The influent pipe to the Hunter regulator is very steep, having a slope of 0.05 feet per foot (ft/ft) or 5 percent.

The regulator chamber consists of three influent pipes and two effluent pipes, as shown in the sketch in provided in Appendix B. The 36-inch effluent pipe is the wet weather overflow. The 12-inch siphon, transitions to 24-inch siphon and runs to the WWTF. The overflow weir is the control point at the Hunter regulator. The weir is not level, as can been seen in Figure 1-6.

Figure 1-6: Hunter Overflow Weir

1.3.3. Broadway Basin

The Broadway sewershed is combined and is approximately 300 acres, making it the smallest of the four regulator sewersheds. The Broadway regulator is a complex regulator that has two chambers, as shown in Appendix B. One chamber has an 8-inch influent sewer and a 12-inch siphon effluent. The second chamber has a 30-inch influent pipe. A 9-inch high weir separates the 30-inch influent flow from the 60-inch overflow pipe. The two chambers are connected by a 12-inch opening in the common wall. The weir and the opening direct dry weather flows from the 30-inch pipe to the dry weather chamber. The 60-inch overflow pipe goes through a screen facility for floatables control prior to discharge to Rondout Creek. The 12-inch siphon carrying dry weather flow connects to the shared 24-inch siphon that carries flows to the WWTF.

1.3.4. Hasbrouck Basin

The Hasbrouck regulator is located nearest to the WWTF in the apartment complex accessed from the East Strand. As shown in Appendix B, this regulator has both a weir that controls flow into the overflow screen house, a Brown & Brown type regulator that limits the amount of flow to the shared 24-inch siphon and an adjustable orifice. The position of the orifice was originally intended to limit flows through the regulator to 1.1 cfs (0.7 mgd). Flow monitoring data fluctuated but generally showed the actual maximum flow rate through the regulator is 2.5 mgd.

The Hasbrouck influent sewer is 60-inches in diameter. Compared to the other regulators, the Hasbrouck influent sewer has a comparatively flat grade of 0.01 ft/ft (1.0 percent). Flow from the influent pipe approaches an 11-inch weir, which directs low flows into an 18-inch sewer that connects through the Brown & Brown regulator to the effluent siphon. If the depth of flow in the influent pipe exceeds the weir, the overflow enters the screen house where it passes through a bar screen for floatables control before exiting through a 60-inch pipe to Rondout Creek. A 36-inch storm sewer also connects into the screen house downstream of the screen. This pipe serves a multi-family residential development adjacent to the regulator.

1.4. Wastewater Treatment Plant

The City of Kingston's WWTF operates under the New York State Pollution Discharge Elimination System (SPDES) Permit Number NY 002 9351, as regulated by the NYS DEC. The plant currently treats domestic wastewater from the City and neighboring satellite communities. The WWTF, as it currently exists, was upgraded in the early 1970s to treat sewage using a conventional activated sludge process. During that time, the WWTF was designed for an average flow of 4.8 million gallons per day (mgd) through the aeration and secondary clarification processes. Modifications to the WWTF included the addition of a fourth primary clarifier in the early 1980s and the construction of a third aeration tank and a fourth secondary clarifier in the early 1990s.

The current SPDES permit limits the average flow to 6.8 mgd on a 12-month rolling average. Nominal peak flow capacity through is controlled by the settled sewage pumps, which have a capacity of 10.25 mgd.

1.4.1. Effluent Requirements

Effluent limitations and monitoring requirements have been established by the NYS DEC as part of the SPDES permit program. A copy of the current SPDES permit is attached as Appendix C. The permit was last revised in September 2005. The final SPDES effluent limitations that impact the analysis of the aeration system are summarized in Table 1-1. The effluent limits of most significance with respect to the aeration system are the five-day carbonaceous biochemical oxygen demand ($CBOD_5$) and the ultimate oxygen demand (UOD). The conditions of the SPDES permit do not require the WWTF to provide nitrification. However, the SPDES permit requires WWTF operational personnel to monitor the plant effluent for both Total Kjeldahl Nitrogen (TKN) and ammonia (as NH_3). The TKN is included in the UOD limit, which is seasonal in the summer months.

Table 1-1:
Kingston SPDES Permit Limits

Parameter	Limit	Units	Limit	Units	Notes
Flow	6.8	mgd			12 month rolling average
$CBOD_5$	25	mg/l	1,400	lbs/d	Monthly average
$CBOD_5$	40	mg/l	2,300	lbs/d	7 day average
UOD(1)			4,900	lbs/d	Monthly average
TSS(2)	30	mg/l	1,700	lbs/d	Monthly average
TSS	45	mg/l	2,600	lbs/d	7 day average
Disinfection required					All year
pH	6.0-9.0	SU			Range
Solids, Settable	0.3	ml/l			Daily maximum

Notes:

(1) UOD = 1.5 x $CBOD_5$ + 4.5 x TKN
(2) TSS = Total suspended solids

Limit is seasonal from June 1st to October 31st

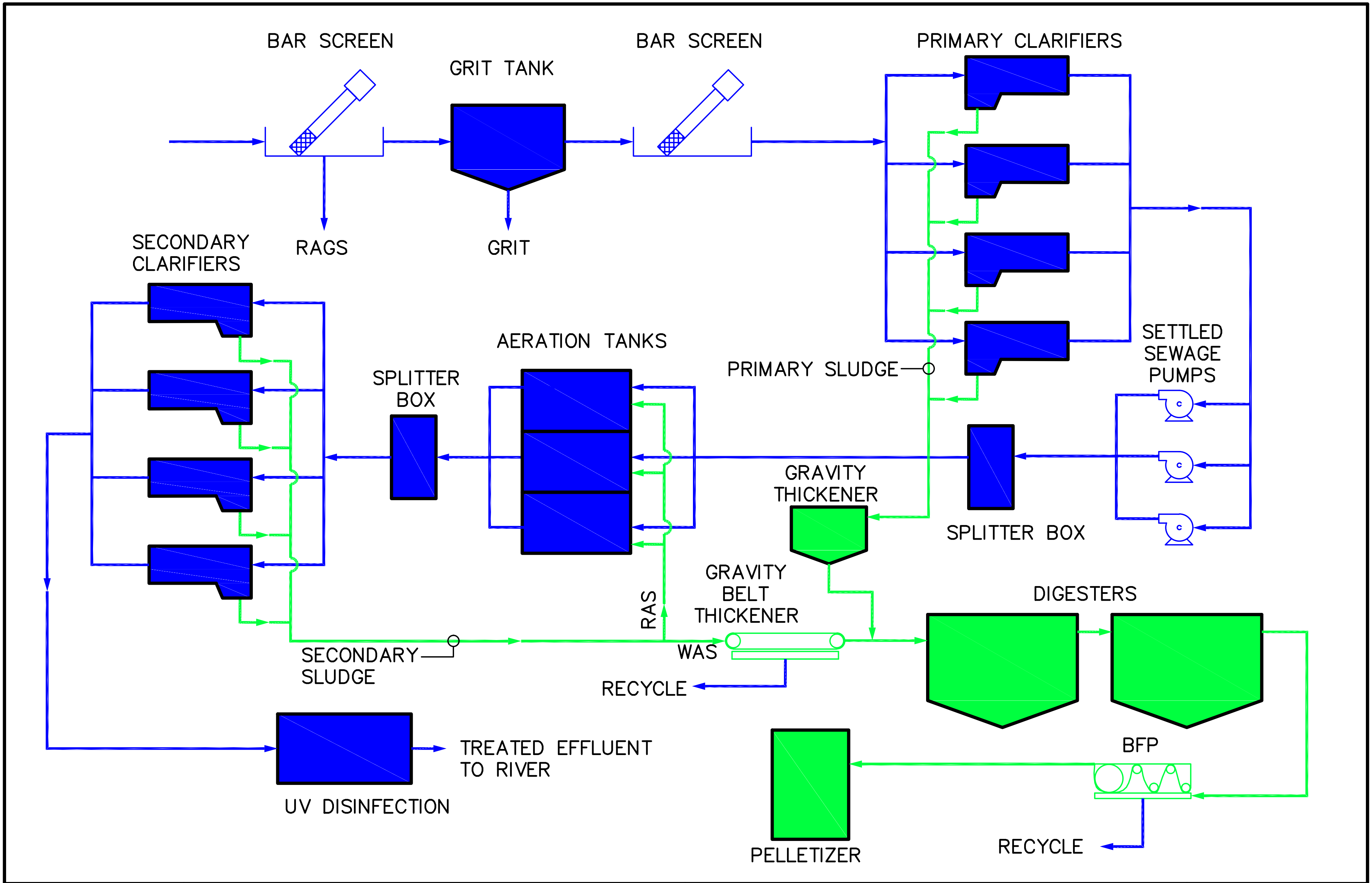
Source: September 2005 SPDES Permit – NY 002 9351

1.4.2. Facility Description

The WWTF liquid stream is comprised of two mechanical bar screens, a vortex grit chamber, four primary clarifiers, three aeration tanks, four secondary clarifiers and ultraviolet (UV) disinfection. Refer to Figure 1-7 for a process flow schematic of the facility.

The solids processing unit operations consist of gravity belt thickening, anaerobic digestion, belt filter press dewatering and sludge cake pelletization. Flow enters the WWTF at the entrance channel that is housed in the screening building prior to the vortex grit chamber. Flow enters the channel from three siphons and a forcemain prior to screening for large debris and rag removal. The flow is then directed to the vortex grit chamber that is weir controlled. After grit removal, flow then enters the head house through a 24 inch closed conduit and is screened a second time.

The flow is then split and directed into one of the four primary clarifiers. Primary sludge is pumped to a gravity thickener and primary effluent flows by gravity to the settled sewage pump station wet well. The settled sewage pump station is comprised of a wet well and three dry pit pumps, each with a rated capacity of 6.3 mgd at 29-feet of head. The primary effluent is pumped to a splitter box prior to flowing by gravity to one of the three aeration tanks. Each aeration tank has a capacity of 392,000-gallons and the return activated sludge (RAS) is returned to each aeration tank. The facility operators currently operate the aeration tanks in a plug flow configuration; however, prior to wet weather flows they change the mode of operation to contact stabilization in an attempt to reduce solids washout during high flows. Mixed liquor from the aeration tanks flows by gravity to a splitter box and then to one of four secondary clarifiers. Clarified secondary effluent is disinfected by ultraviolet (UV) irradiation and sludge is either returned to the aeration tanks or wasted and pumped to the gravity belt thickener.



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KINGSTON WWTF
FLOW SCHEMATIC

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FIGURE 1-7

2. Monitoring and Modeling of the Combined Sewer System

A hydraulic model was constructed for use as a tool to characterize the performance of the system, which included estimating the annual volume of combined sewage discharged from the Kingston collection system, to understand the performance of the collection system under various rainfall conditions and to predict changes in system performance, including CSO volume, from modifications of the collection system. This section presents the approach to the development of the model and the calibration and verification results.

2.1. Monitoring Plan and Data Analysis

The hydrologic elements of a hydraulic model simulate the effects of rainfall on the combined sewer system. In order to properly construct the hydrologic model, information on the depth and velocity of flows within the collection system was collected during a flow monitoring period. Complementary rainfall data was also collected. A Flow Monitoring and Rain Gauging work plan was developed. This living document was used and updated throughout the flow monitoring period. The final version is provided as Appendix D.

2.2. Precipitation Data

Two rain gauges were installed at locations in downtown Kingston at Broadway and Abeel Streets. Both gauges were tipping bucket gauges, programmed to measure in five-minute intervals. The precipitation data was used during the flow decomposition process to identify dry weather flow days and to initially identify potential calibration and validation events.

2.3. Flow Monitor Data

The 2009 flow monitoring effort collected depth and velocity readings at nine monitors in Kingston. The distribution of the flow monitors in the Kingston collection system is illustrated on Figure 2-1. Data was collected in five-minute intervals. The flow monitoring data was used for direct comparison with model results during calibration and validation. The flow monitoring data was also used during the model calibration process to guide in the development of model parameters to mimic the observed dry weather and wet weather events.

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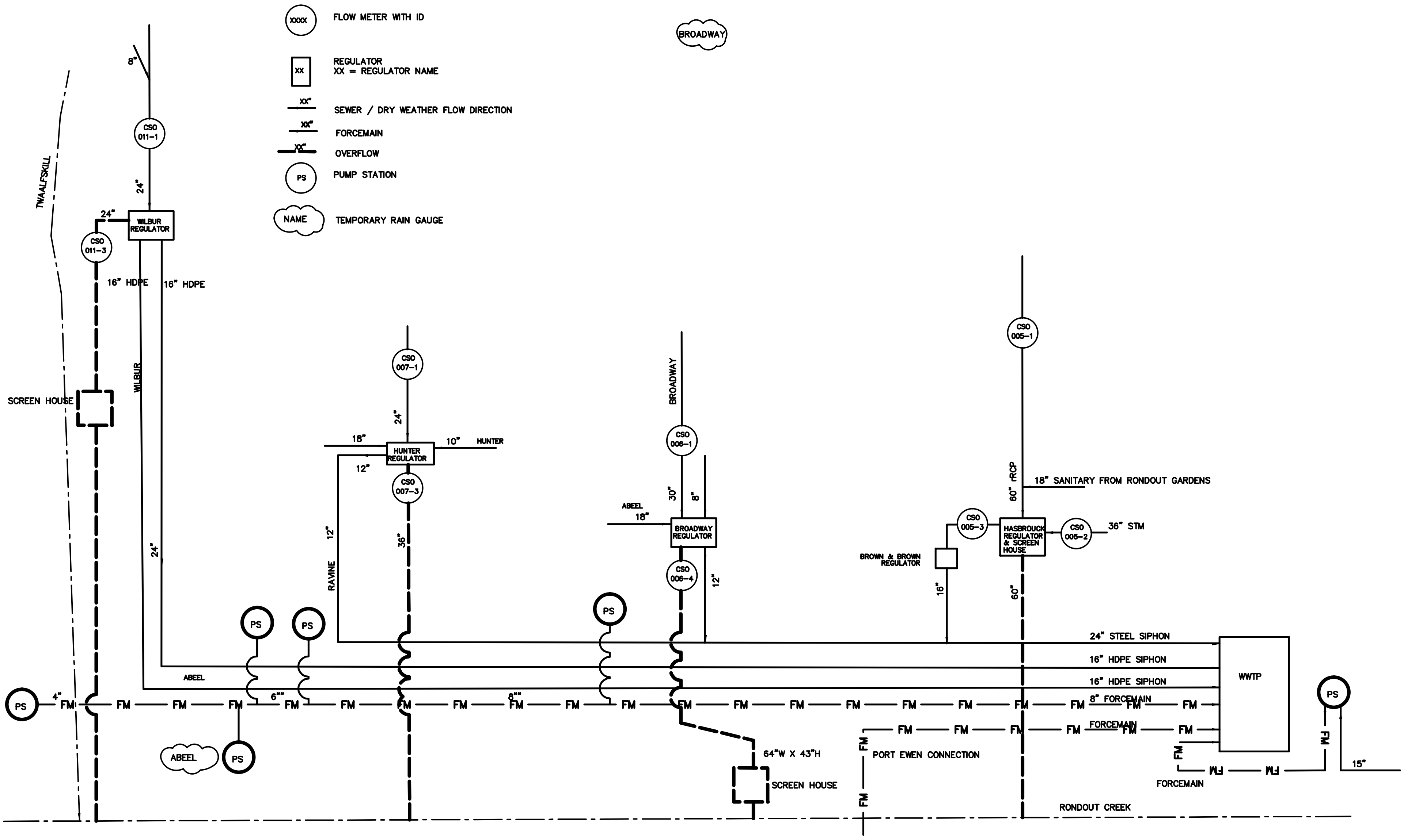

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CONTROL PLAN

SYSTEM SCHEMATIC WITH FLOW MONITORING LOCATIONS

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FIGURE 2-1

The nine flow meters were located at influent and effluent points at the four CSO regulators. The Wilbur regulator had two flow meters, one on the influent 24-inch pipe as well as one on the overflow pipe. The Hunter regulator also had two flow meters, with one on the influent 30-inch by 40-inch line and another on the overflow weir. The Broadway regulator had a similar configuration. The first flow meter was located on the primary 30-inch influent pipe and there was also a meter on the 60-inch overflow pipe. The three remaining flow meters were located on two influent lines to the Hasbrouck regulator, 60 and 36-inch, and on the 60-inch overflow pipe.

The WWTF has a Parshall flume that measures influent flows. Flows are recorded on a circular chart. During the flow monitoring period, a data logger was attached to the Parshall flume system to record total flow rates entering the plant.

2.4. Modeling Approach

The hydraulic model is the primary tool used in the analysis of the combined sewer system and control of the CSOs. As such, the modeling approach and the assumptions included there in, are important to understand. This section contains detailing information on the methods used to simulate the sewer system of the Kingston CSS.

2.4.1. Software

The model was developed using InfoWorks CS v 9.5, and was updated to the latest version, InfoWorks CS v 10.5 during the course of the project.

2.4.2. Hydraulic Model

In the model, the Kingston sewer system was represented as a series of nodes connected by links. Nodes include such elements as:

- Manholes;
- “Blind” pipe/conduit junctions (pipe junctions where manholes do not physically exist in the system);
- Non-conveyance storage elements (wet wells, etc);
- Each upstream terminal point in the system;
- Each outfall and discharge point where flow leaves the system;
- Upstream and downstream of structures required to simulate pump stations, storage, or diversion structures;
- Each significant change in pipe size, shape, slope or invert elevations.

Links include:

- Gravity sewers, siphons, and force mains;
- Storage elements with conveyance capacity;

- Control structures such as weirs, pumps, orifices and gates.

The Kingston system included a number of hydraulic structures. Examples of structures include weirs, junction chambers, diversion structures, and pumping stations. Table 2-1 presents a summary the modeled network hydraulic characteristics.

Table 2-1:

Summary of Network Components

# of Manholes	# of Pipes	Pipe Length (mi)	Flow Meters	Pump Stations	Rain Gauges	CSOs
91	98	3.6	9	1	2	4

2.4.3. Hydrologic Model

The hydrologic model provides flow inputs into the hydraulic network. The Kingston collection system is predominantly a combined sewer system. During the calibration process, wet weather responses in all modeled sewersheds within the system were reviewed and the most appropriate modeling approach was selected for representing performance of each sewershed. Typical urban run-off combined sewer system modeling approach, as described in Section 2.4.3.1, was used for most sewersheds, which exhibited fast response to precipitation events. At the same time, it was observed that the Wilbur sewershed wet weather response more resembled inflow and infiltration (I/I) than a typical urban run-off response. Some sewer separation work has occurred in pockets in the Wilbur sewershed. Because of the system response characteristics, the Wilbur sewershed was modeled using a hybrid approach that allowed for the simulation of wet weather responses representative of both combined and separate sewer systems. This section briefly describes the urban hydrology concepts that were applied in the model.

2.4.3.1. Combined Sewer System Approach

A combined sewer collection system conveys wastewater generated by residential, commercial and industrial users as well as stormwater generated from surface run-off. The relationship between run-off rates, conveyance capacities, and storage in a combined sewer system determines CSO frequency and volume characteristics. In a typical CSS, the capacity of the combined sewers is far greater than that of the interceptor sewers or treatment systems. Flow in excess of the interceptor and/or WWTF capacity is discharged to the receiving water with little or no treatment or storage for later treatment.

The combined sewer system modeling approach applies urban hydrologic methods to sewersheds, the flows generated from which are connected to and routed through the hydraulic model. The first step in the application of a hydrologic model to a combined sewer collection system is the delineation of the sewer watershed (sewershed) areas to be simulated. In the combined sewer service area, sewersheds are typically delineated to each regulator in the system. (A regulator is any device that splits the flow between the two systems, such as an interceptor and receiving water.) Because many combined sewer systems include regulators that intercept wastewater from sewersheds of widely varying sizes, larger sewersheds may be further delineated to develop smaller subbasins of relatively homogenous size and development conditions (land use).

2.4.3.2. Wilbur Sewer System Approach

The modeling approach used for the Wilbur sewersheds parallels the combined sewer system approach, using a predictive hydrologic approach that connects infiltration and inflow and routes it through the hydraulic model.

As with the run-off approach, the first step in the application of a hydrologic model to the Wilbur sewer system was the delineation of the sewershed areas to be simulated. The Wilbur system sewersheds were delineated based on the characteristics of the sewershed. In general, subbasins of relatively homogenous size and development conditions (land use) were used. The larger sewersheds within the Wilbur subbasin generally followed the development boundaries (e.g., lot lines) and did not include open spaces.

2.4.4. Flow Generation

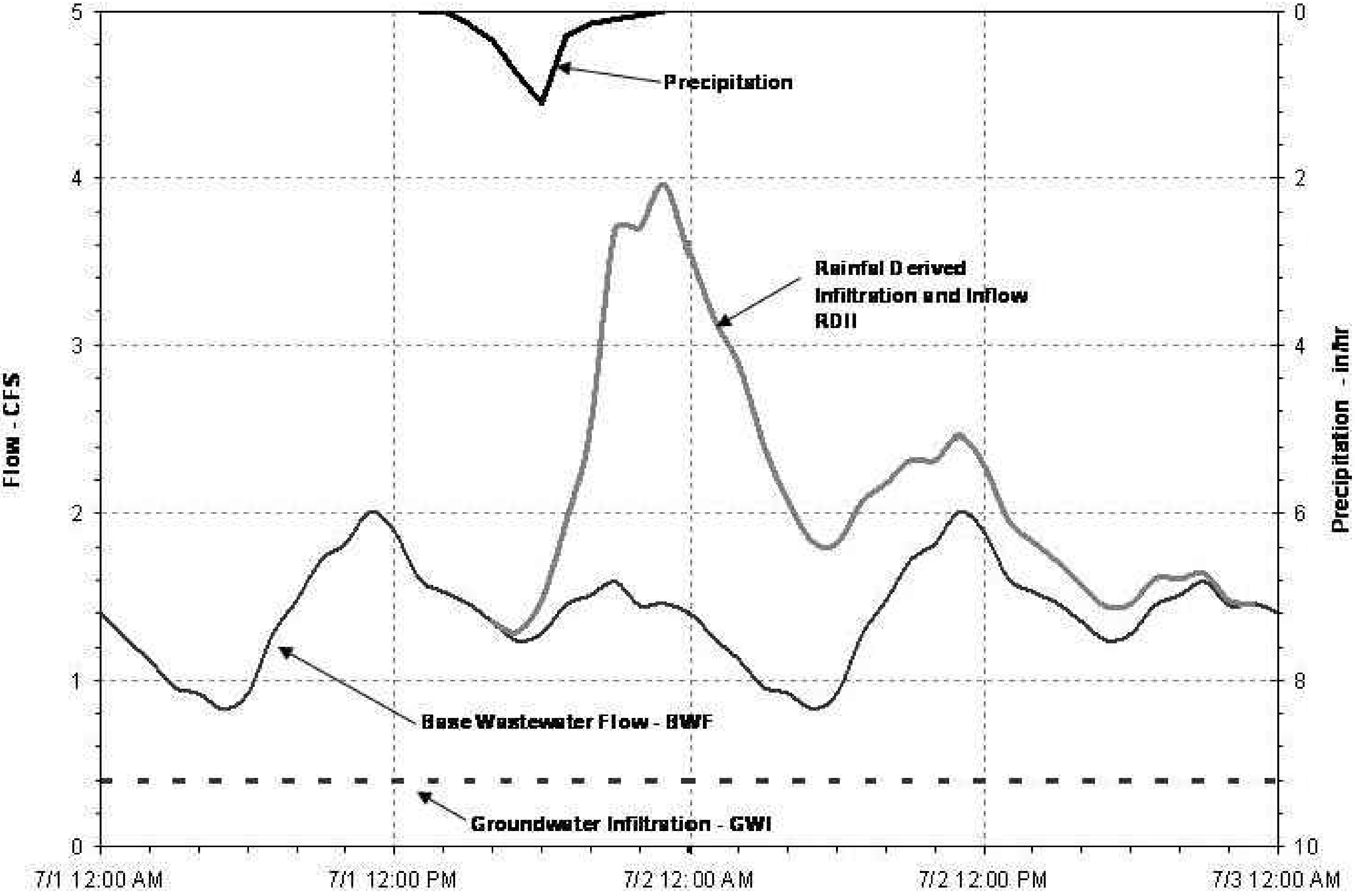
For modeling purposes, it was useful to further define the components of flow in wastewater collection systems. Figure 2-2 displays a typical two-day wastewater flow hydrograph with the effects of the rainfall derived rainfall. Flow is plotted against the Y-axis on the left side of the plot and precipitation intensity is plotted against the inverted Y-axis on the right side of the plot. The wastewater flow hydrograph can be broken into three basic components:

Groundwater Infiltration (**GWI**) enters a sewer system typically through sewer service connections when groundwater infiltrates at defective pipes, pipe joints, connections, or manhole walls. GWI may have seasonal variations but is usually treated as constant over the duration of a single precipitation event.

Base wastewater Flow (**BWWF**) enters the collection system through direct connections, and represents the sum of the domestic, commercial, and industrial waste flows.

Wet Weather Flow is the portion of the sewer flow hydrograph above the normal dry weather flow pattern; it is the sewer flow response to rainfall or snowmelt in a sewershed.

Each of the major components of dry weather flow was input to the model as an average flow, with an appropriate time varying pattern applied. The sanitary BWWF and GWI for each sewershed were estimated by evaluating the flow monitoring data. The monitoring period was unusually wet and the number of pure dry weather flow days was limited. The dry weather flow days measured by each flow monitor were determined by identifying periods where flows were clearly not influenced by rainfall. The identified dry weather flow days are shown in Figure 2-3.



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TYPICAL WASTEWATER FLOW WITH RAINWATER DERIVED RUNOFF HYDROGRAPH

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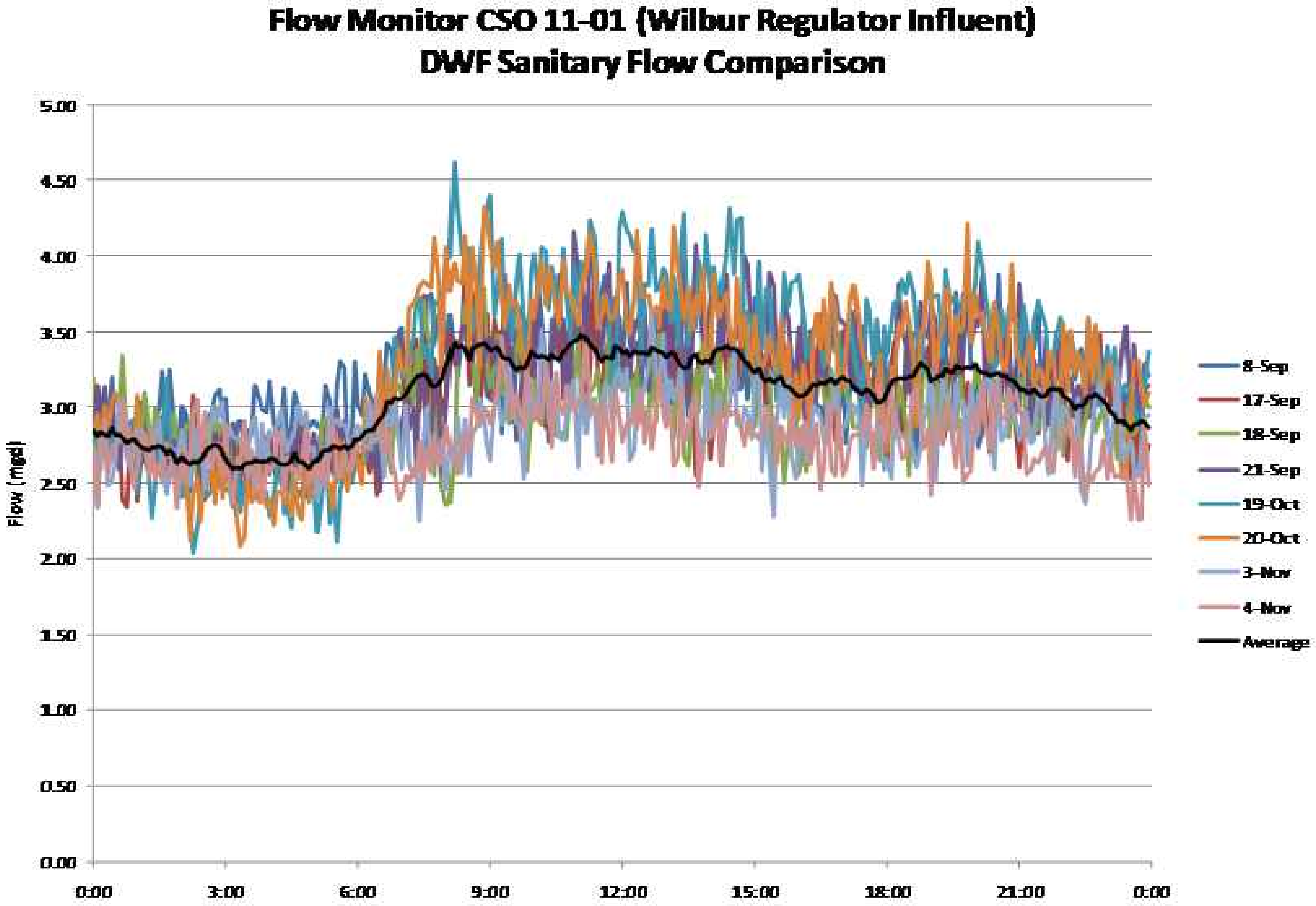
FIGURE 2–2



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DRY WEATHER FLOW
DAY COMPARISON

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FIGURE 2-3

2.4.4.1. Groundwater Infiltration

During the overnight hours the sanitary flow typically drops to a nighttime minimum. At this low period it was assumed that most of the flow present in the system is the result of GWI. In typical residential areas, 15 percent of this low flow was defined as wastewater, with the balance representing groundwater infiltration.

2.4.4.2. Base Wastewater Flows

Subtracting each month's GWI from the total sanitary flow leaves the base wastewater flow BWWF hydrograph. The BWWF hydrographs were divided into weekdays and weekends. The identified dry weather flow days were evaluated to develop a typical dry weather flow hydrograph. Using the average BWWFs a diurnal pattern was developed for each monitor.

To apply the BWWF to the model, the population in each subbasin was computed using the subbasin delineation and the most current U.S. Census data (2000 Census Blocks for Ulster County New York). Starting with an initial assumption of 80 gallons per capita per day the total residential flow in each sewershed was calculated. The sum of the residential, commercial, and industrial BWWFs for each sewershed was loaded into the model and assigned a diurnal pattern. Figure 2-4 provides weekday and weekend diurnal patterns for the sewershed upstream of meter CSO 05-01.

2.4.5. Wet Weather Flow: Combined Sewer Systems

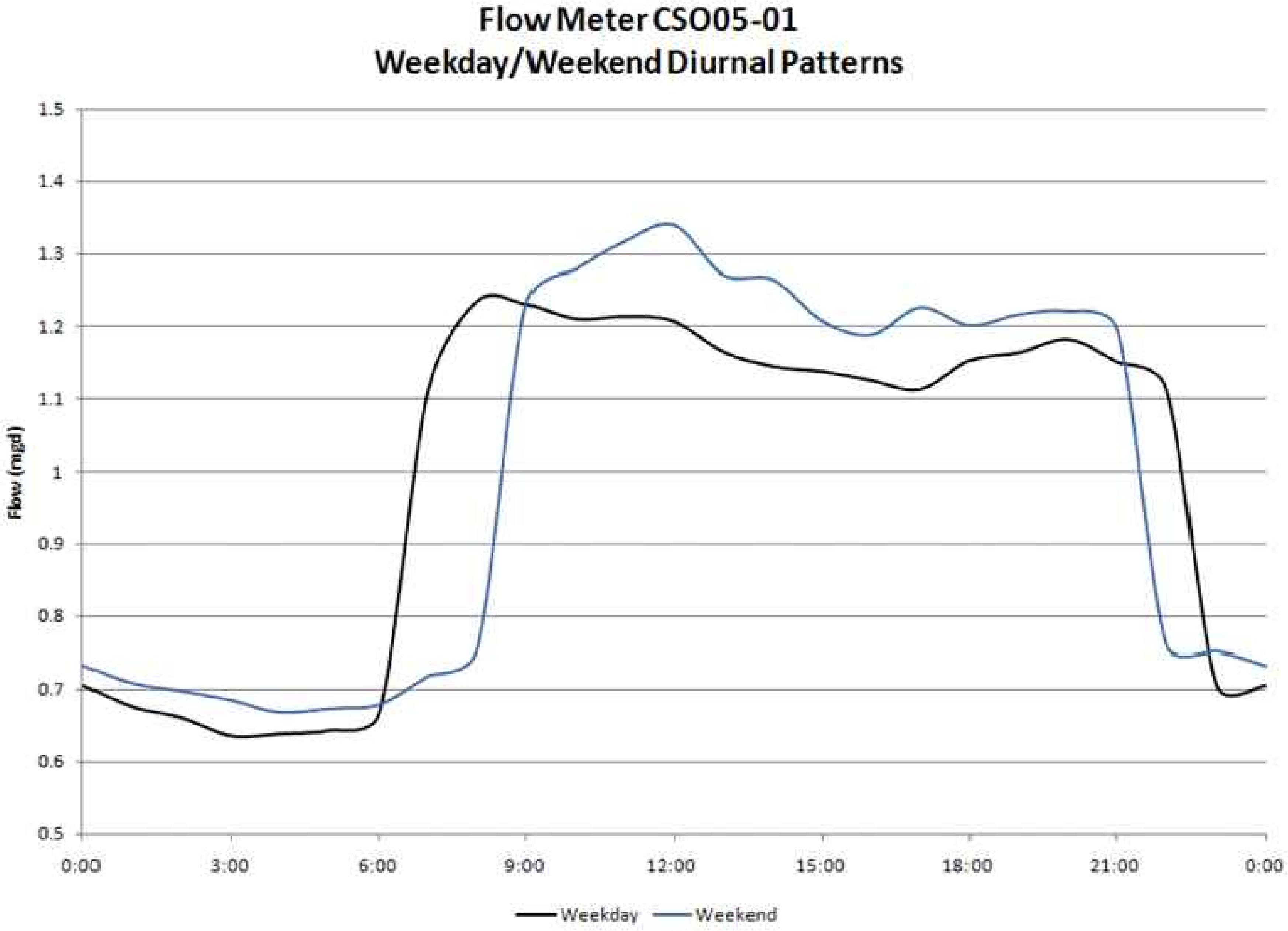
In a combined system, the run-off is driven by the impervious surface of the modeled subbasin. Excess rainfall that neither infiltrates nor is captured by surface depressions travels into the combined system via gutters and stormwater inlets or directly enters a stream via overland flow. Stormwater can also enter through roof drains, manhole covers, and other inlets. The delineated sewersheds were characterized to develop surface parameters that would drive the run-off into the combined sewer systems.

2.4.6. Wet Weather Flow: Wilbur Sewer System

There are a number of approaches available for developing model flows that represent I/I in sewer systems. For the Kingston model, the predictive hydrologic method of simulating I/I, included in the InfoWorks model, was used. Hydrologic routines used traditional surface hydrology methods to mimic the I/I response, and provided a flexible model capable of representing the desired wide range of wet-weather conditions necessary for this system.

2.4.7. Boundary Conditions

Boundary Conditions explain the way the CSS is connected to adjacent systems. Boundary conditions are inputs or constraints and can be simple and constant or complex and vary over time. The Kingston hydraulic model had two boundary conditions: Rondout Creek stage and operations at the WWTF.



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CONTROL PLAN

WEEKDAY AND WEEKEND
DIURNAL PATTERNS

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OCTOBER 2010

FIGURE 2-4

2.4.7.1. Rondout Creek Stage

Rondout Creek stage information was used to determine the outfall boundary condition. A comparison of the river stage data with the outfall pipe inverts determined that although the outfall pipes are submerged during the high tide boundary condition, the river stage never rises above the crest height of the overflow weirs. The river does not reach a level high enough to breach the regulators and therefore has no impact on the operation of the regulators or the pipes upstream. River stage data was collected at a permanent USGS river gauging station located upstream of the Wastewater Treatment Plant at Frank Koenig Boulevard and the Rondout Creek. This gauge collects real-time gage height, temperature, and velocity data.

2.4.7.2. Kingston WWTF

Collection system flow is delivered to the Kingston WWTF via a series of parallel siphons. The satellite community of Port Ewen is connected directly to the WWTF via force main. The satellite community consists of separate sanitary sewers and was modeled according to the sanitary sewer system approach. The boundary condition at the plant was established based upon a review of the existing operating profile. The flow entering the WWTP was limited by a 10.3 ft elevation weir at the grit chamber. The influent satellite community flow transported via separate force mains was limited to the capacity of the pump stations upstream.

2.5. Model Development

2.5.1. Hydraulic Model

Model building is the process of developing a refined representation of the City’s collection system starting with the existing model. The model was developed within InfoWorks CS using the hydraulic system data in the AutoCAD map, survey data, and other information from the City, including the 1978 Sewer System Evaluation Survey. Model extents were determined based upon the sewer system network available in AutoCAD and surveyed over a two week period by Praetorius and Conrad, P.C. The survey collected manhole and pipe information such as rim elevations, pipe inverts, pipe dimensions, shape, and material.

2.5.1.1. Control Structures

With Kingston’s need to develop a long-term control plan to manage combined sewer overflows, consistent and accurate representation of hydraulic structures is important. Control structures were modeled based on a combination of record information and regulator site inspections performed as part of the flow monitoring.

2.5.1.1.1. Orifices

Orifices were used to represent gates and constrictor plates. Table 2-2 lists the typical parameters populated for each orifice link. The adjustable gate at the Hasbrouck Brown

& Brown regulator was modeled using the real time control option available within InfoWorks CS.

Table 2-2:
Typical Orifice Model Parameters

Field	Description	Typical Value/Input
Name	Orifice ID (ORI + 3 letters of Location + .1)	ORIHAS.1
Inlet	Element ID of upstream junction	ORIHAS
Outlet	Element ID of downstream junction	HASREG
Type	Location of orifice relative to flow	SIDE or BOTTOM
Shape	Shape of orifice	CIRCULAR or RECTANGULAR
Crest	Offset of orifice from junction invert (ft)	0.5
Coefficient	C in orifice equation	0.6

2.5.1.1.2. Weirs

Weirs were used to represent weir wall and diversion dams. Elevated pipes were not modeled as weirs, but instead as a normal conduit with an elevated upstream invert. Table 2-3 lists the typical parameters populated for a weir link.

Table 2-3:
Typical Weir Model Parameters

Field	Description	Typical Value/Input
Name	Weir ID	WEIRHAS.1
Inlet	Element ID of upstream junction	WEIRHAS
Outlet	Element ID of downstream junction	HAS1
Type	Location of weir relative to flow	TRANSVERSE or SIDEFLOW
Weir Length	True length of weir (ft)	4.0
Crest	Offset of weir crest from junction invert (ft)	1.5
Coefficient	C in weir equation	2.8
Flap Gate	Presence of flap gate should be noted	Y/N

2.5.1.1.3. Pump Stations

The Kingston collection system contains one pump station relevant to overflow hydraulics but it is not currently in operation. The grinder, wet wells, and overflow structure at Wilbur Pump Station were incorporated into the model based on the available as built drawings. The effluent siphons were modeled as pressure pipes. In the future the pumps could be incorporated into the model using the Dynamic Head pump option in InfoWorks CS.

2.5.1.2. Sediment

Based on available information, sediment was present to varying degrees surrounding diversion structures and was modeled as needed using the “Sediment Depth” option function in InfoWorks CS.

For the Wilbur system, the sediment in the wet well structure was high enough to effectively reduce the delivery capacity of the dual siphons. For this system, the effect of the sediment was simulated by reducing the capacity of the effluent pipes to match actual performance.

2.5.1.3. Manning’s Roughness Coefficients

Roughness coefficients of conduits were adjusted during the model calibration as necessary to replicate observed conditions such as deteriorating pipe or channel conditions.

2.5.2. Hydrologic Model

Application of a hydrologic model to a sewer system required the delineation of the combined sewer areas to be simulated. These areas became the basis for dry and wet weather flow generation within the model. This section describes the model representation of sewersheds and their characteristics.

2.5.2.1. Input Data Sources

The available data for generating dry weather and wet weather flow was reviewed during the process of creating the flow generating portion for the model. The data sources reviewed include, but were not limited to:

- County-provided GIS data sets;
- City-provided mapping;
- Current flow monitoring data.

2.5.2.2. Sewershed Delineation

The City of Kingston service area encompasses approximately 3,900 acres. The service area was divided into sewersheds based on regulators and flow monitors. Sewersheds were further subdivided into 25 modeled subbasins each with an average size of

160 acres. Sewersheds were delineated to each flow monitor based on the Kingston's existing AutoCAD mapping, as illustrated on Figure 2-5. These boundaries were necessary for the accurate review and analysis of the flow monitoring data as well as to assist the model calibration effort. The flow monitoring sewersheds served as the starting point for the collection system model delineations. Table 2-4 summarizes the model subbasin characteristics.

Table 2-4:
Summary of Hydrologic Model Detail

Hydrological Parameter	Model Value
Total Combined Sewer Area (acres)	4,134
Number of Combined Subbasins	25
Average Size of Combined Subbasins (acres)	165
Range of Combined Sewer Subbasins (acres)	1 to 2,260

2.5.2.3. Model Subbasin Delineation Approach

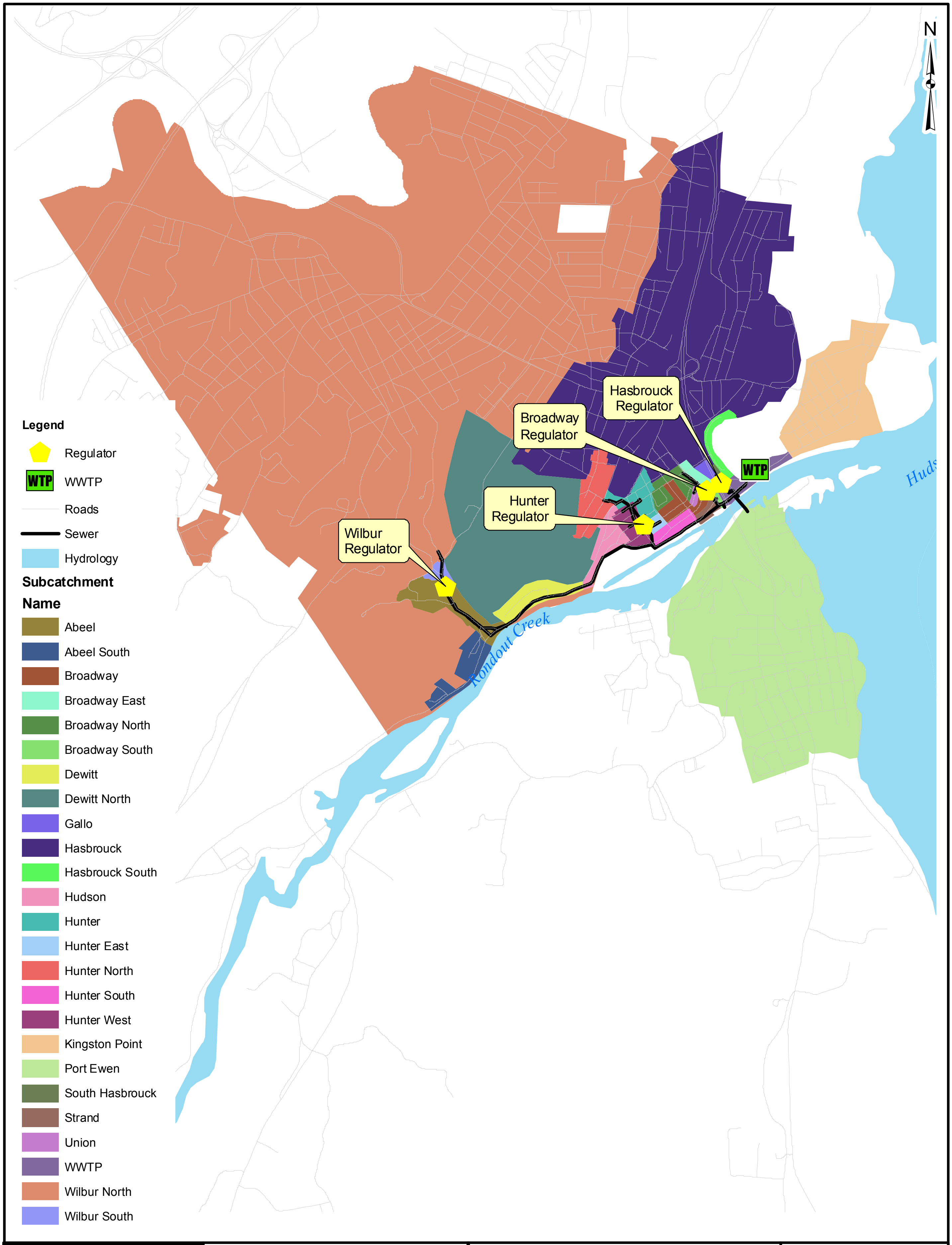
The sewersheds were subdivided to create model subbasins. Beginning in the upstream portion of the system to be modeled, subbasins were delineated based on the collection system sewer network and land use in the combined sewered areas. An effort was made to create subbasins that were of relatively homogenous land use and size. Figure 2-5 illustrates the basins as delineated to each regulator.

For each subbasin, a load point manhole was identified to assign the residential flows for modeling purposes. Model load points were assigned to best represent the effect of flows entering system.

2.5.3. Dry Weather Flow Development

Dry weather flow includes sanitary sewer and infiltration from all sewer users (residential, commercial and industrial, etc.). The dry weather flow was decomposed to create GWI and BWWF components.

This process was repeated resulting in GWI and BWWF values for each monitored sewershed. Flows and patterns developed at the monitoring locations were distributed to sewersheds upstream of the monitor.



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CITY OF KINGSTON
CSO LONG TERM
CONTROL PLAN

KINGSTON SEWERSHED DELINEATION

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OCTOBER 2010

FIGURE 2-5

2.5.4. Wet Weather Flow Development

Although the same process for decomposing dry weather flow was used for all sewer basins, the method for generating wet weather flow varied greatly between the combined system and Wilbur basin approaches. The urban run-off approach applied to the combined system relies on physical characteristics of the sewer basin to account for the routing of rainfall to the sewer system.

To account for I/I in sewer basins in the Wilbur sewershed a modified hydrologic method (using up to three surface types) was used. Hydrologic routines use traditional surface hydrology methods to mimic the I/I response, and provide a flexible model capable of representing the desired wide range of wet-weather conditions necessary for this project. The hydrologic method also provides a much better platform for the long-term simulations as they better simulate the seasonal groundwater level variations encountered in most regions (hydrologic methods better account for antecedent conditions).

Once the limits of the model were defined (via the sewershed delineation described above), each sewershed was assigned parameters that would allow the model to generate flows for input into the modeled sewer network. The sewersheds were defined by the following parameters:

- Area;
- Width (based on overland flow length);
- Imperviousness;
- Ground Slope;
- Infiltration Parameters;
- Overland flow routing coefficients;
- Depression storage.

In order to build the run-off portion of the combined sewered basins, available GIS data was processed to determine physical parameters and soil properties for each sewershed.

2.5.4.1. Area

Area was directly calculated from the GIS mapping. This parameter was not varied during the calibration unless model results indicated that the original area calculation was incorrect or that the delineation did not include areas that actually did contribute to the flow monitor.

2.5.4.2. Width

Sewershed width is a key calibration parameter, one of the few that can significantly alter the hydrograph shape (timing of the peak flow rates), rather than just run-off volume. Initial widths for each sewershed were determined using GIS mapping to develop overland flow lengths.

2.5.4.3. Imperviousness

InfoWorks simulates wet weather from a modeled basin via impervious and pervious run-off. Impervious run-off represents that portion of flow generated from paved surfaces (e.g., parking lots, roads, driveways) and from other connected surfaces such as roof drains. The percent imperviousness of a basin is a good indicator of the level of development of the basin. Pervious run-off represents that portion of flow generated from the open surfaces in a subbasin—those surfaces where surface run-off is not generated until after the soil becomes saturated. Most combined sewer systems are highly urbanized (i.e., highly impervious) and most storms which produce CSOs are small storms where the run-off contribution from pervious surfaces is very small. Therefore, impervious surface run-off was in most cases a large percent of both peak flows and total run-off volumes in the collection system.

Total imperviousness is generally related to the area land use. Table 2-5 presents ranges of total imperviousness based on historical studies performed on highly urbanized collection systems.

Table 2-5:

Typical Imperviousness by Land Use

Land use	Total Imperviousness (%)
Low Density Residential	20 – 35
Medium Density Residential	30 – 50
High Density Residential	40 – 60
Commercial	60 – 90
Light Industrial	40 – 70
Heavy Industrial	60 – 90
Institutional/Public	50 – 70
Parks/Green Spaces	0 - 10

Impervious areas must be hydraulically (directly) connected to the drainage system to contribute run-off to the sewer system. For example, rooftops draining onto adjacent pervious areas should not be included in the effective (directly connected) impervious area estimates. This is particularly true for the smaller, more frequent rainfall events:

run-off from impervious surfaces not directly connected is generally low during these storms and lags after the peak response from the other connected impervious surfaces.

For this model, the percent imperviousness of each sewershed was calculated using the National Land Cover Database. This national database contains imperviousness values on a 30 meter grid or pixel throughout the United States. Each pixel contains a number from 0 to 100 to represent the measured imperviousness. Using GIS the pixel information was spatially applied to compute an average percent impervious value for each subbasin. The NLCD database method of calculating imperviousness was appropriate for this model because there were large subbasins with multiple land uses.

2.5.4.4. Ground Slope

The sewershed slope should reflect the average along the overland flow path(s) estimated using GIS tools. Elevation differences were determined from the contours of the subbasin. The ground slopes were not modified during model validation.

2.5.4.5. Infiltration

As stated above, pervious run-off is typically an insignificant portion of the wet weather flow contributing to a combined sewer system, especially when the system is analyzed using single events. However, when performing continuous simulations for the development of annual overflow statistics at the CSO locations, antecedent moisture conditions have a more significant impact in the performance of the sewer system. The antecedent conditions are dependent upon the infiltration parameters selected.

The Horton method of modeling infiltration was applied to simulate the pervious run-off from sewersheds that were slow to affect the sewer system. Horton infiltration algorithms are empirically based and describe the familiar exponential decay of infiltration capacity evident during heavy storms. However, the program uses the integrated form to avoid an unwanted reduction in infiltration capacity during periods of light rainfall. In addition, a parameter to regenerate infiltration capacity is required for continuous simulation. Initial ranges for these parameters were:

■ Maximum Infiltration Rate:	0.001 – 1.0 (in/hr)
■ Minimum Infiltration Rate:	0.001 – 0.15 (in/hr)
■ Decay Rate of Infiltration:	0.001 - 0.00115 (1/sec)

2.5.4.6. Overland Flow Manning's Roughness Coefficients

Overland flow Manning's roughness coefficients indicate how quickly run-off can flow over the ground. Typical Manning's roughness coefficients for overland flow are shown in the Table 2-6**.** Overland flow values applied in the Kingston model were developed based on a combination of land use classification, soil types, and aerial photos, and refined during the model calibration process.

Table 2-6:
Typical Overland Flow Roughness Coefficients

Ground Cover	Typical n	Typical Range
Concrete or Asphalt	0.011	0.01-0.013
Bare Sand	0.01	0.01-0.016
Graveled Surface	0.02	0.012-0.03
Grass/Sod	0.20	0.10-0.48

2.5.4.7. Detention storage

Detention storage represents the volume, in inches, that must be filled prior to the occurrence of run-off. It represents the initial loss or "abstraction" caused by such phenomena as surface ponding, surface wetting, interception and evaporation. Depression storage may be treated as a calibration parameter, particularly to adjust run-off volumes. Separate depression storage values are required for pervious and impervious areas. Initial values for depression storage are as follows:

- Impervious areas: 0.005 inches to 0.06 inches
- Pervious areas: 0.06 inches to 0.25 inches

Initial values were adjusted as required for calibration.

2.5.4.8. Response Type

The response observed in the Wilbur basin was modeled using a hybrid approach that applies the infiltration model described to different response types that comprise a typical hydrograph. A wet weather hydrograph is generally composed by multiple types of responses to rainfall, each representing a different mechanism that generates flow into the sewer system. A fast response is one in which the time lag between the start of the rainfall and the response of the collection system is short, often on the order of 5 to 10 minutes. This type of response is common in combined sewer systems because of the direct connections (e.g. catch basins, roof leaders, etc.) prevalent in these systems. Responses can also be driven by processes more characteristic of inflow and infiltration (I/I) responses observed in sanitary sewer systems. I/I responses can be characterized as fast (direct inflow connections), medium, or slow. Medium responses may be associated with inflow points located farther away from the monitoring point or reflect a longer flow path into the collection system, as well as with cracks in pipes/manholes or major deterioration of the infrastructure. Slow responses are often associated with infiltration through the ground into the collection system, and are typically more influenced by very wet ground conditions that happen in back to back events or after significant rainfalls. In order to develop a complete wet weather hydrograph for the Wilbur basin, which is primarily combined but has pockets of the system that are separate sewers, the Wilbur sewersheds were simulated using up to three response types.

2.5.4.9. Model Parameter Values

Through the calibration process, the parameters described in the previous sections were adjusted as described in Section 2.6. The final parameter values for the calibrated Kingston model are provided in Table 2-7. Note that the table presents the values by groups with common values. For most groups, there is more than one subbasin with the model that contains the parameters shown.

2.6. Model Calibration

Model calibration consisted of adjusting sewershed and collection system attribute information within reasonable ranges to obtain simulated results that closely replicate actual field monitored flows and depths for a set of monitored storm events. Model calibrations also entailed comparing simulated results with existing historical operational records. This process ensured that the model was representative of the Kingston collection system and would:

- Reasonably predict monitored flows and depths; and
- Provide a tool for predicting system performance under both long-term hydrologic conditions and design storm events.

The calibration process used monitored flow and rainfall data and proceeded generally as follows:

- Upstream monitors were calibrated first. These monitors represent flows from areas that can be uniquely defined. Upstream monitor calibration allows for adjustment of attributes; and
- Moving downstream, subbasins were calibrated to the monitored data.

Model parameters were adjusted carefully. If the process required that parameters be stretched outside of acceptable ranges the model configuration, parameters were re-evaluated.

2.6.1. Defining Calibration Events

The model was calibrated to three events from the summer/fall 2009 monitoring period, consisting of large, medium, and small wet weather events. In addition, all calibration events included a peak intensity of at least 0.25 inches/hour and two calibration events captured 0.8 – 1.2 inches of rain. The third event measured 1.8 inches of rainfall. The wet weather events recorded during the monitoring period are listed in Table 2-8. The events on August 22, October 23, and October 27 were identified as calibration periods as indicated on the right column. Following calibration, the August 28 and September 11 events were used to validate model performance.

Table 2-7:
Subbasin Model Parameters

Subbasin Group	Area (ac)	% Run-off	Response Type	Average Overland Slope	Run-off Routing Value	Run-off Method	Initial Loss Value (ft)	Horton Initial (in/hr)	Horton Limiting (in/hr)	Horton Decay (1/hour)
Broadway	15.6	2.0%	Impervious	0.1	1	Fixed	0.001	-	-	-
		50.0%	Pervious	0.1	1	Horton	0.001	0.2	0.05	3
Hasbrouck	702.2	7.3%	Impervious	0.045	0.03	Fixed	0.008	-	-	-
		0.7%	Pervious	0.045	0.05	Horton	0.017	1	0.01	3
Hasbrouck East	9.4	25.0%	Impervious	0.18	0.001	Fixed	0.008	-	-	-
		10.0%	Pervious	0.18	0.05	Horton	0.017	1	0.01	3
Hunter	45.5	1.5%	Impervious	0.1485	0.001	Fixed	0.008	-	-	-
		5.0%	Pervious	0.1485	0.05	Horton	0.008	1	0.05	3
Port Ewen/Kingston Point	884.6	0.1%	Pervious	0.0535	0.05	Horton	0.008	1	0.05	3
		0.1%	Impervious	0.0535	0.03	Fixed	0.008	-	-	-
Wilbur	2263.3	0.5%	Pervious - Fast	0.5	0.2	Horton	0.008	0.0001	0.0001	3
		1.0%	Pervious - Medium	0.03	0.8	Horton	0.008	0.5	0.05	3
		1.0%	Pervious - Slow	0.003	1	Horton	0.029	0.8	0.01	3

Table 2-8:
Monitoring Period Events and Selected Periods for Calibration and Validation

Event No.	Date-Time	Duration (hrs)	Volume (in)	Max Intensity (in/hr)	Approx. Return Period	Calibration or Validation
1	8/21/2009 14:50	6.1	1.49	1.42	50-yr	
2	8/22/2009 2:05	9.5	0.27	0.15	3-mo	
3	8/22/2009 20:30	5.3	0.78	1.04	2-yr	Calibration
4	8/23/2009 17:50	1.0	1.54	1.54	50-yr	
5	8/28/2009 14:50	24.0	1.56	0.33	4-mo	Validation
6	8/29/2009 23:00	0.8	0.11	0.16	2-wk	
7	9/11/2009 11:55	28.8	0.58	0.23	1-mo	Validation
8	9/12/2009 14:50	1.3	0.11	0.13	2-wk	
9	9/26/2009 23:05	25.2	0.86	0.12	1-mo	
10	10/7/2009 0:10	12.6	0.36	0.15	2-wk	
11	10/9/2009 23:05	4.6	0.27	0.19	2-wk	
12	10/15/2009 14:15	6.8	0.23	0.08	2-wk	
13	10/23/2009 19:30	27.0	1.78	0.25	6-mo	Calibration
14	10/27/2009 16:00	24.0	1.19	0.26	3-mo	Calibration

2.6.2. Calibration Process

The calibration process has two distinct steps: dry weather and wet weather. The dry weather calibration focused on the simulation of the components of wastewater flow. The dry weather calibration process ensured that the model adequately simulated the base flows as a platform for wet weather simulations. For the Kingston modeling effort, monitored rainfall hyetographs developed from the observed precipitation data was applied to the InfoWorks CS model to generate wet weather inflows at each modeled load point.

The model was calibrated to three rainfall events. It is accepted throughout the industry that the antecedent conditions can play a significant role in the way a system responds to a rainfall event. To account for an antecedent condition, the entire flow monitoring period was run as a continuous simulation with the review of the system focusing on the three selected calibration events. However, the model run time for continuous simulations can be long. To optimize the process, the three events were run individually, i.e. discretely, to allow the modeling team to quickly evaluate the wet weather parameters and bring peak flow statistics into range. The continuous simulation was then used to calibrate for antecedent conditions, volume and refined peak.

2.6.2.1. Discrete Event Simulations

A sub-set of the recorded storms was evaluated to allow the modeling team to quickly refine parameters that affect the prediction of peak flow rates. Three events were simulated as follows:

- Recorded flow and depth data from each monitoring site for each major rainfall event was converted into a file format to enable a direct comparison with the model-simulated results;
- Based upon the graphical comparisons of recorded and simulated data for all of the calibration storms, factors such as imperviousness, width, and depression storage in each combined sewer subbasin were adjusted; and
- Following the adjustments to the modeled subbasins, the storms were re-simulated, the results compared again, and further fine tuning adjustments made to the subbasin hydrologic factors.

This process was repeated until a single set of hydrologic factors was finalized for every subbasin upstream of a flow monitor.

2.6.2.2. Continuous Simulations

Once a reasonable prediction of peak flows has been developed, the modeling team refined the calibration using continuous simulations. The primary purpose of continuous simulations was to:

- Ensure the parameters developed using discrete events are suitable for the range of events that occur during the monitoring period; and
- Refine model parameters to better account for antecedent conditions and variations that affect model volumetric predictions and that would ensure that CSO frequency/volume estimates was reasonable.

The primary method for assessing the reasonableness of the continuous simulations was graphical comparisons of simulated results and observed data. Best-fit line slopes and intercepts were also evaluated to ensure the model parameter suitably predicted the observed responses for the range of storms.

2.6.3. Calibration Results

Model calibration is not typically measured as a mathematical fit between two curves. A large number of reasons can be found for differences between modeled and observed data that cannot be allowed for in a simple mathematical test. A graphical comparison between the observed and the model predicted data serves as the primary method of measuring the reasonableness of the calibration. Model calibration can be considered a judgment based process that is successful when the end users are comfortable applying the model for its intended purpose. As stated in Section 7.4.2 of the “CSO Guidance for Monitoring and Modeling”(USEPA):

> *"…Common practice employs both judgment and graphical analysis to assess a model's adequacy."*

In addition, the Guidance also states:

> *"…the [model] results are compared to the field measurements collected concurrently with these rainfall data. If the results are suitably close, the model is considered to be validated."*

There is, however, a measure of fitness that is gaining acceptance and widespread application that can better quantify the model calibration. This method consists of applying a range of tolerances to specific parameters, and for the Kingston modeling effort, the model calibration goals were developed as guidance during the calibration process. The criteria provide a range of acceptable performance at each of the flow monitors, but care must be used when applying these statistical ranges. This presupposes a good degree of confidence in the comparative information, the observed flow and depth data, and the rainfall data. The reason for using a minimum of three calibration events is partly intended to address this aspect.

2.6.3.1. Dry Weather Calibration

The model base flow was calibrated to a four day dry weather period in mid-September. Model parameters were adjusted as needed to achieve matching monitored and simulated flows, depths, and volumes. The dry weather calibration was also evaluated statistically. The dry weather calibration was complete when the model peak flow, volumes, and depths were within the expected range of tolerances. The dry weather flow was higher in the summer than in the fall, as the groundwater levels dropped, so it was necessary to vary the groundwater monthly. The period of monitored flows in mid-September were selected because they had an average amount of groundwater.

2.6.3.2. Wet Weather Calibration

The model wet weather calibration proceeded from upstream to downstream, beginning with the Wilbur sewershed farthest upstream, continuing to Hunter and Broadway sewershed, and ending at the Hasbrouck sewershed. Finally the unmonitored subbasins were adjusted in order to match the influent flow to the WWTF. Wet weather flow plots comparing the meter data to the modeled results are provided in Appendix E. The following sections provide an overview of the calibration.

2.6.3.2.1. Wilbur Sewershed Calibration

The Wilbur regulator receives flow from the largest sewershed within the City and encompasses approximately 2,300 acres. The pumps within the pump station are not in operation. Instead, flow is driven through the effluent siphon purely by head. The calibration of Wilbur regulator revealed that the parallel 16-inch siphons leading to the plant were not functioning at optimal capacity. Field investigation found a considerable amount of sediment within the Wilbur Pump Station. It is likely that some of the wet well debris is partially blocking a portion of the siphon between the pump station and the plant. With the siphon appropriately restricted, the influent and overflow points calibrated reasonably, as shown in Figure 2-6 for the October 23 and October 27 events. The timing of the rising and falling limbs matches well, as do the magnitude of the peaks. The extended depth recorded on the flow meter for the October 23 event was a temporary condition, suspected to be caused by blinding into the Wilbur regulator.

2.6.3.2.2. Hunter Sewershed Calibration

The Hunter regulator is located at the upstream end of a separate 24-inch siphon located east of Wilbur regulator. The Hunter regulator receives flow from a 600 acre combined sewershed. The calibration of this regulator was more typical than that of Wilbur. The roughness coefficient of the influent channel was adjusted to account for the irregular surface of the stone tunnel. The combined sewer modeling approach fit the flow data well, resulting in a good calibration, as shown in Figure 2-7. The model overflows matched the timing of the monitored overflow data, but were reduced in volume.

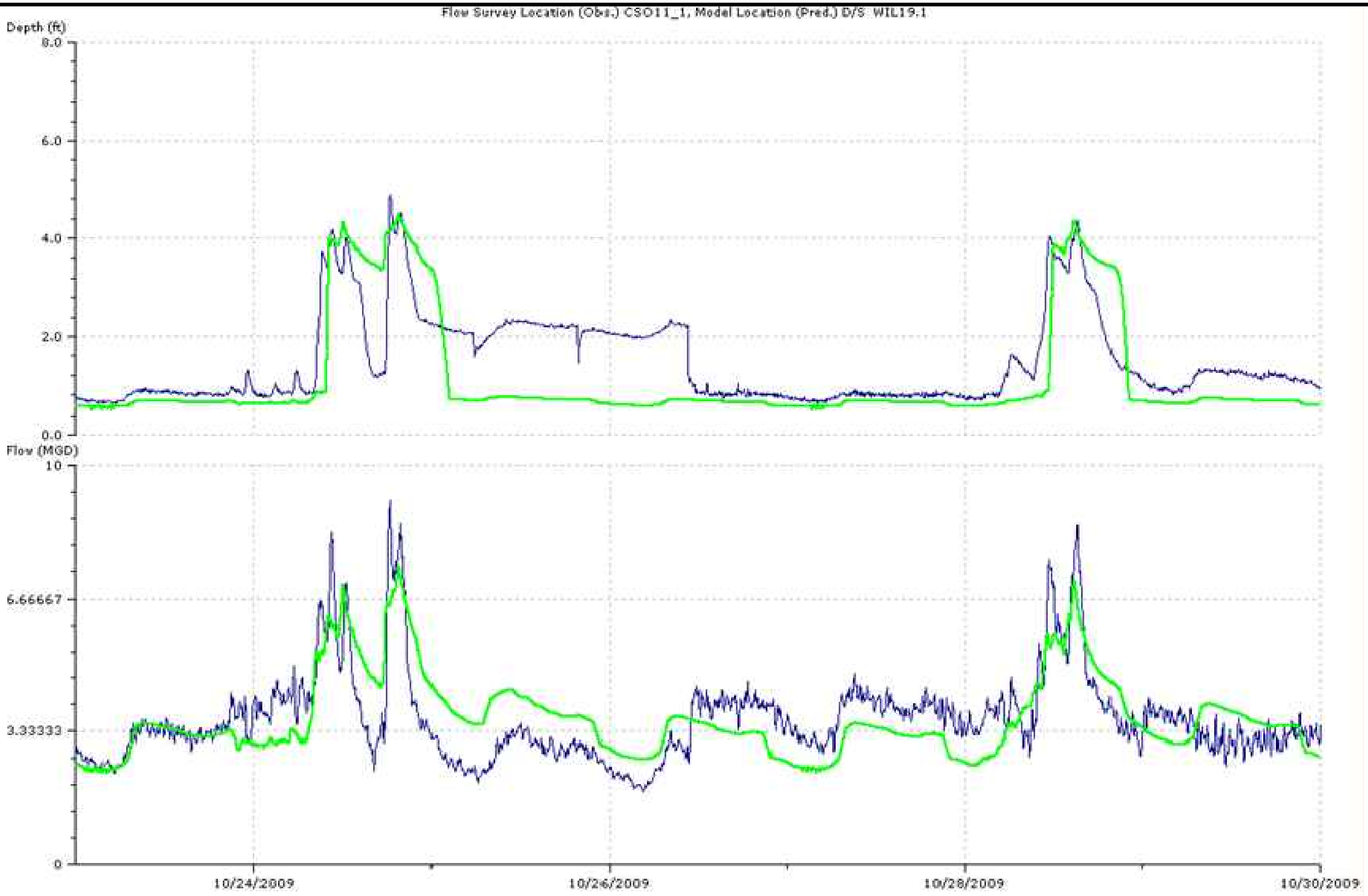
2.6.3.3. Broadway Sewershed Calibration

The Broadway regulator is located downstream of the Hunter regulator. The sewershed is combined and approximately 300 acres, making it the smallest of the four regulator sewersheds. As shown in Figure 2-8, a good calibration was achieved for the influent flow meter by adjusting the infiltration and subbasin parameters to match the peak flows and depths. The calibration also included the overflow meter. The model overflow timing and volumes matched that of the monitored data.

2.6.3.4. Hasbrouck Sewershed Calibration

The Hasbrouck regulator is nearest to the treatment plant. It has a Brown & Brown type regulator that limits the amount of flow to the siphon during wet weather. The regulator position was originally intended to limit flows through the regulator to 1.1 cfs (0.7 mgd). Flow monitoring data fluctuated but generally showed the actual flow through rate as approximately 2.5 mgd. This limit was modeled using a real time control setting on the influent sluice gate and an orifice plate was modeled at the exit. The overflow weir located farther upstream and the bar screen at the overflow chamber were also included in the model configuration. All three of the metering sites calibrated well. The calibration for the influent flow meter is provided as a sample in Figure 2-9. There was not a meter on the overflow at Hasbrouck because it was inaccessible.

User: Lewandowski Spec: PIRNIE STANDARD File: I:\ACAD\PROJ\5744016\Figures\FIGURE 2-6.DWG Scale: 1:1 Date: 10/27/2010 Time: 10:16 Layout: G-XXX



		Depth (ft)		Flow (MGD)		
		Min	Max	Min	Max	Volume (US Mgal)
Obs.	───	0.632	4.883	1.858	9.116	25.494
>Kingston>Run Group>2-166>CalibEvents	───	0.556	4.467	2.363	7.447	25.474
>Kingston>Run Group>1-166>CalibEvents	- - - -	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

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WILBUR CALIBRATION SAMPLE: INFLUENT FLOW METER 10/23 AND 10/27

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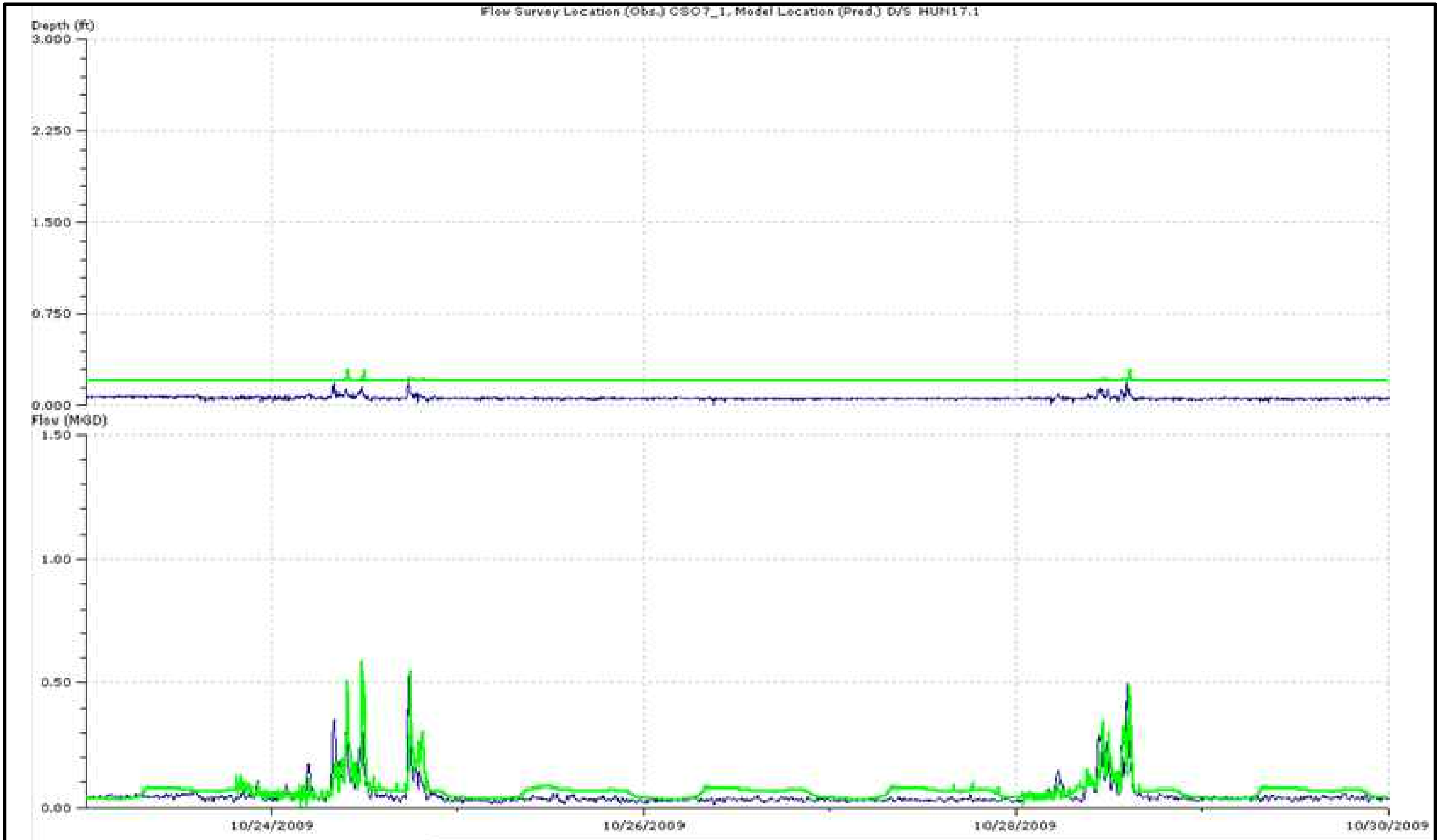
FIGURE 2-6



		Depth (ft)		Flow (MGD)		
		Min	Max	Min	Max	Volume (US Mgal)
Obs.	━━━━	0.000	0.230	0.013	0.526	0.362
>Kingston>Run Group>2-166>CalibEvents	━━━━	0.202	0.299	0.035	0.550	0.484
>Kingston>Run Group>1-166>CalibEvents	- - - - -	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

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CSO LONG TERM
CONTROL PLAN

HUNTER CALIBRATION SAMPLE:
INFLUENT FLOW METER 10/23 AND 10/27

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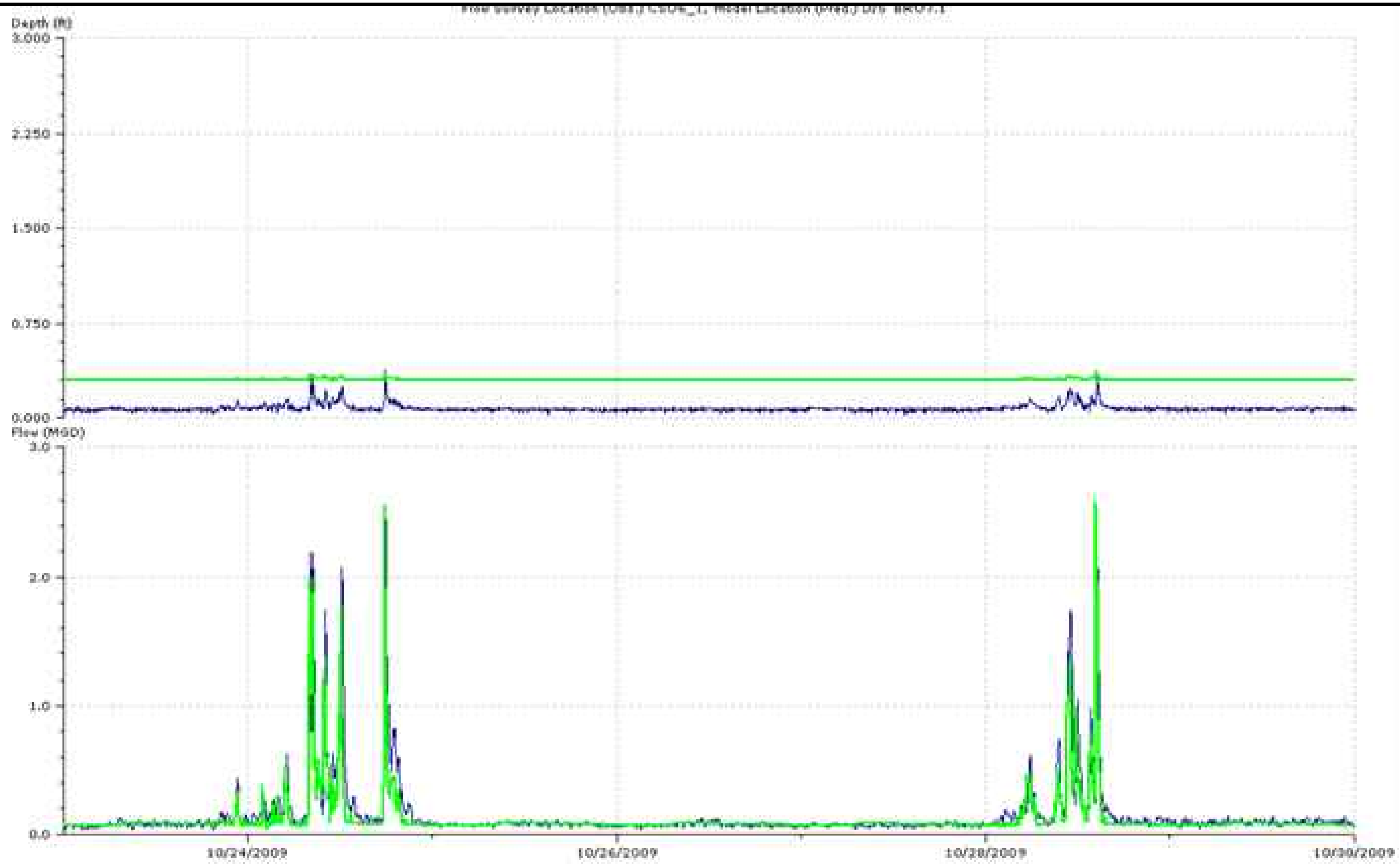
FIGURE 2–7



		Depth (ft)		Flow (MGD)		
		Min	Max	Min	Max	Volume (US Mgal)
Obs.	——	0.021	0.376	0.036	2.443	1.009
>Kingston>Run Group>2-166>CalibEvents	——	0.302	0.358	0.062	2.564	0.837
>Kingston>Run Group>1-166>CalibEvents	- - - - -	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

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CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

BROADWAY CALIBRATION SAMPLE: INFLUENT FLOW METER 10/23 AND 10/27

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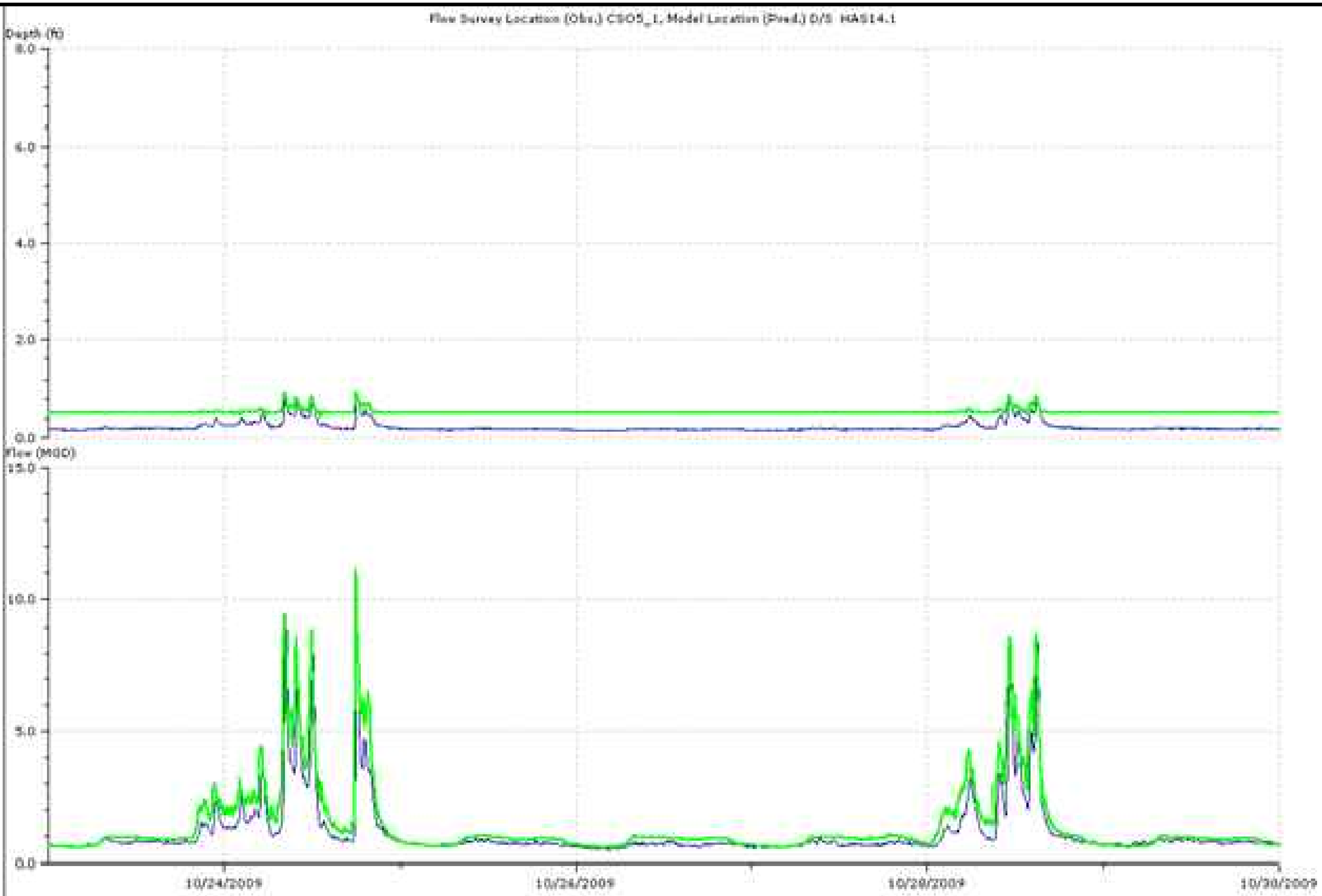
FIGURE 2–8

User: Lewandowski Spec: PIRNIE STANDARD File: I:\ACAD\PROJ\5744016\Figures\FIGURE 2-9.DWG Scale: 1:1 Date: 10/27/2010 Time: 10:19 Layout: G-XXX



		Depth (ft)		Flow (MGD)		
		Min	Max	Min	Max	Volume (US Mgal)
Obs.	▬	0.142	0.923	0.500	9.301	8.022
>Kingston>Run Group>2-166>CalibEvents	🟩	0.499	0.946	0.530	10.830	9.981
>Kingston>Run Group>1-166>CalibEvents	┅	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

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CONTROL PLAN

HASBROUCK CALIBRATION SAMPLE:
INFLUENT FLOW METER 10/23 AND 10/27

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FIGURE 2-9

2.6.4. Model Validation

Once the model was calibrated, the model was validated to two events not previously evaluated. Two validation events were selected that could provide a range of storm volumes and intensities to test model performance. The August 21 event lasted 24 hours and received 1.6 inches of rainfall while the smaller September 11 event was similar in duration and received only 0.6 inches of rainfall. Table 2-8 provided the detailed statistics of the rain events.

The model was determined to be validated based upon graphical evaluation of the timing, shape, and visual fit of the modeled response to the monitored response. The plots of modeled versus monitored peak flows, volumes, and depths for both validation events are included in Appendix F.

The validated model can now be used to estimate the annual overflow volume, to understand the performance of the collection system under various rainfall conditions, and to predict changes in system performance, including CSO volume, from modification of the collection system.

2.7. Baseline Conditions

Baseline Conditions represent the operational and configuration changes that occurred or after the end of the flow monitoring period (November 2009) through spring 2010 or are planned for the near future with a high level of certainty. The following changes to the system were simulated in the Baseline model:

- Wilbur Siphon sediment removal and capacity restoration;
- Hunter street sediment removal;
- Hasbrouck storm sewer separation; and
- Addition of future flows from the Hudson Landing and Sailor’s Cove development projects.

The model calibration found that the flows delivered through the Wilbur system to the WWTF was less than expected. Inspection of the system found sediment build up on the wet wells reduced the effective capacity of the system from two 16-inch siphons to one 16-inch siphon. Since the identification of the condition, work has been completed to remove the debris and reinstate the siphon capacity. Baseline conditions represent an open Wilbur system that operates at full capacity.

The Hunter regulator was known to be prone to sediment deposition in the effluent line. Since the completion of the flow monitoring, the concrete slab that was located over the effluent pipe has been removed, allowing for better cleaning of the deposition. Baseline condition represents this change in the regulator. The change had little effect on the results of the model. The regulator did not calibrate well, understating the overflows. It is likely that the real system now more closely matches the model results.

The 36-inch storm sewer that discharges into the Hasbrouck screen house was modeled as a separate discharge. This removed the storm water volume from the calculation of CSO volume.

Previously identified growth and development plans were incorporated in the hydraulic model. The build out of flows are long-term, with some flow likely not to be realized until 2020. The following are the areas and added flows incorporated into the baseline condition:

- Town of Esopus 0.276 mgd (with current forcemain) – Port Ewen;
- Town of Ulster 0.075 mgd – Hasbrouck;
- East Kingston 0.15 mgd – East Kingston (east of the plant);
- Hudson Landing 0.444 mgd – East Kingston (east of the plant);
- Sailor’s Cove 0.59 mgd– East Kingston (east of the plant); and
- Parking Garage Development 0.059 mgd (Uptown) – Wilbur.

3. Combined Sewer System Characterization

The System Characterization defines the performance of the CSS during dry and wet weather. The performance of the Kingston CSS is based on the data collected during the flow monitoring period, hydraulic modeling, and institutional knowledge held by City staff that manages the system. The hydraulic modeling utilized a typical five-year period that had within it a typical year period to assess the performance of the CSO system under baseline conditions.

3.1. Typical Year Periods

The typical five-year period was developed to assess the performance of the collection system under average conditions. A typical year period was selected from within the typical five-year period. The typical period approach was utilized to best capture the dynamic nature of rainfall and, consequently, the response of the system to rainfall. While design storms have a role to play in wet weather simulations, the typical period with a continuous simulation was preferred to better simulate the overflow resulting from back to back events and varying antecedent conditions. The use of a typical five-year period versus a single typical year period allows the inclusion of a larger number of events of varying duration and intensity. The Technical Memorandum documenting the selection of the typical periods is provided in Appendix G.

3.2. Dry Weather Flow

The collection system effectively and efficiently transports dry weather flows to the WWTF for treatment. For the purposes of defining the performance of the collection system, dry weather flow conditions are defined as those flows that are not influenced by rainfall and/or rainfall run-off.

3.2.1. Overall

During the flow monitoring period, the average dry weather flow to the WWTF was approximately 4.5 mgd. The distribution of flows from the sewersheds is provided in Table 3-1. Nearly 90 percent of the dry weather flow originates from the Wilbur and Hasbrouck Sewer Systems.

Table 3-1: **Dry Weather Flow Distribution**

	Total WWTF	Wilbur	Hunter	Broadway	Hasbrouck	Satellite
Flow (mgd)	4.51	3.1	0.06	0.10	0.89	0.40
% of Total	100.0%	68%	1%	2%	20%	9%

3.2.2. Wilbur Sewer System

The Wilbur Sewer System delivers dry weather flows to the WWTF without dry weather overflows or other undesirable conditions. The screen and grinder at the head of the regulator create backwater that affects the influent several hundred feet upstream of the regulator, as shown in Figure 3-1, the scattergraph of the influent. This condition likely allows sediment to settle out but does not cause other problems, such as odors.

Through the model calibration process, it was determined that the effluent capacity of the Wilbur regulator was diminished. Subsequent inspection by City personnel found sediment build up in the wet wells that was obstructing flow into the siphons. Consequently, the system was functionally operating as though there were only one siphon barrel. Since the situation was identified, measures have been taken to remove the material and reinstate the effluent capacity. This condition did not cause dry weather overflows.

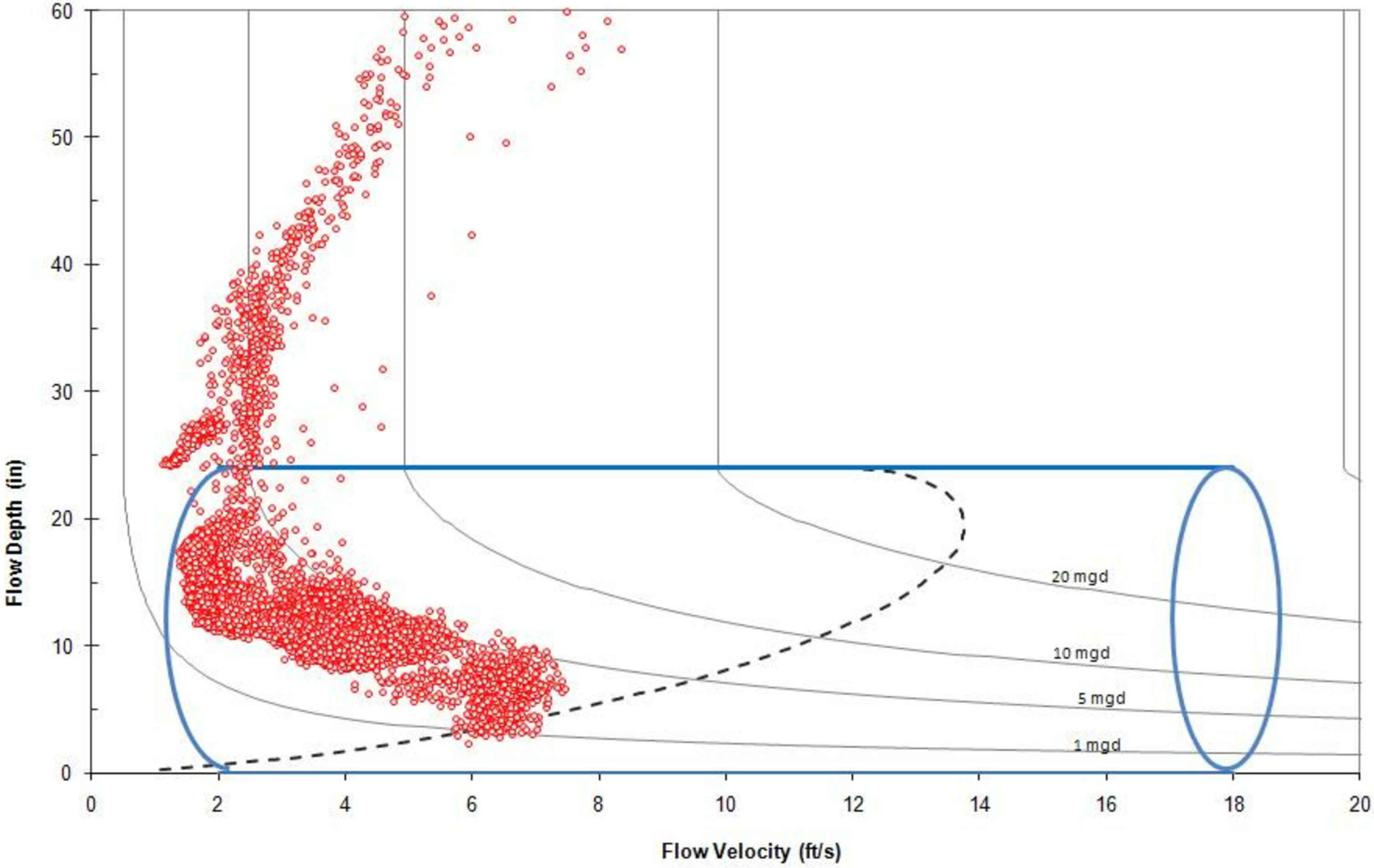
3.2.3. Hunter Sewer System

The influent flows to the Hunter regulator follow normal open-channel flow patterns with good velocities, as shown in Figure 3-2. However, the configuration of the Hunter Regulator, with a 90-degree turn to get into the dry weather effluent pipe, means that it is susceptible to sedimentation. Sedimentation in the regulator has the potential to cause dry weather overflows. Consequently, City personnel actively and aggressively maintain this regulator. In 2010, City personnel have removed a concrete shelf from within the regulator that was significantly hampering access to parts of the chamber, enabling even better management of the system.

3.2.4. Broadway Sewer System

The Broadway Sewer System conveys dry weather to the WWTF well and without any undesirable conditions. As shown in Figure 3-3, the influent sewer to the Broadway Regulator operates under open channel conditions that match well with the Manning’s curve. Under dry weather flow conditions, the collection system:

- Does not experience overflows;
- Does not experience depths of flow outside of normal ranges;
- Exhibits normal, open-channel flow patters within the trunk sewers; and
- Does not release problematic odors.



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CONTROL PLAN

WILBUR INFLUENT SEWER
SCATTERGRAPH

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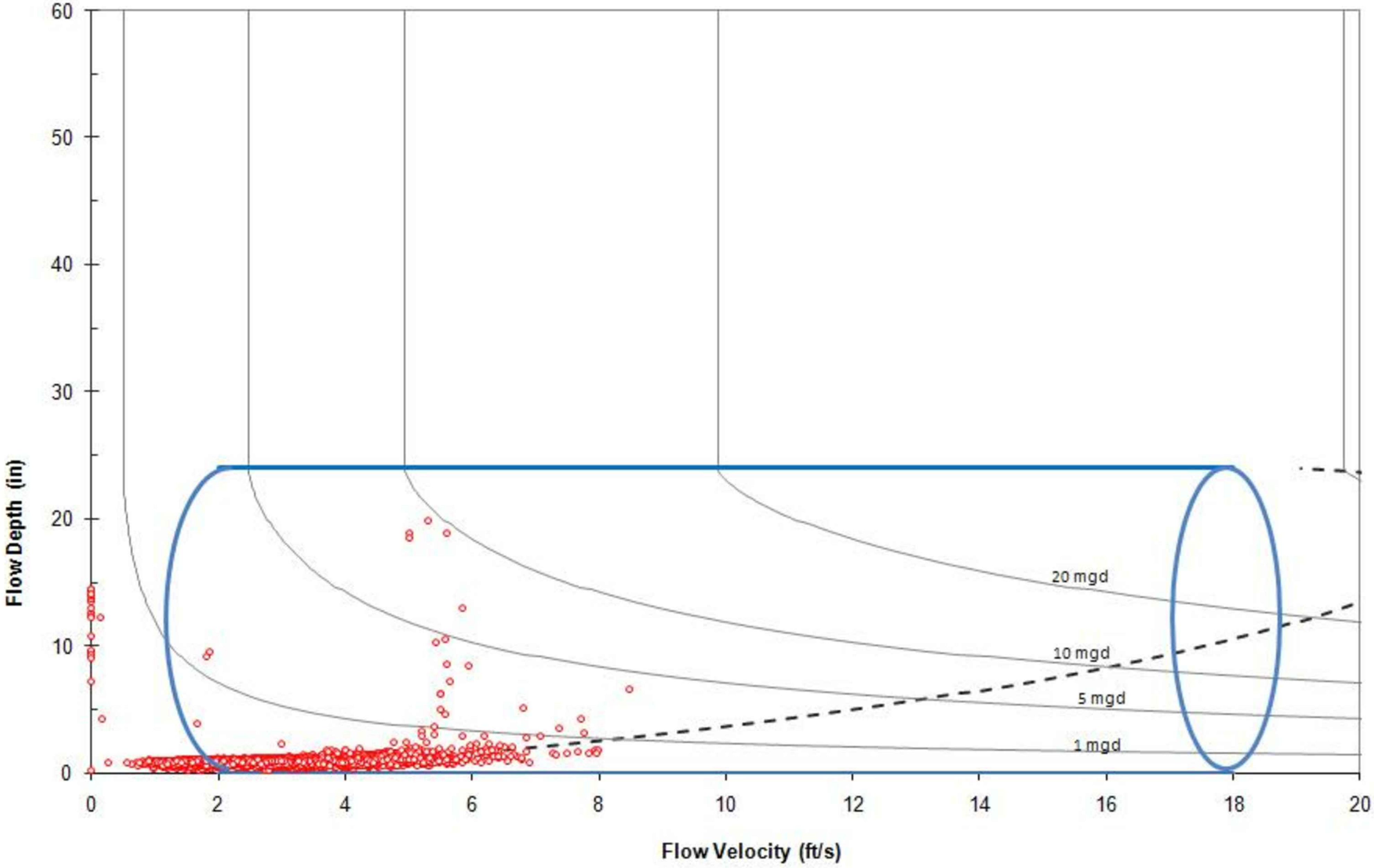
FIGURE 3-1



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CSO LONG TERM
CONTROL PLAN

HUNTER INFLUENT SEWER
SCATTERGRAPH

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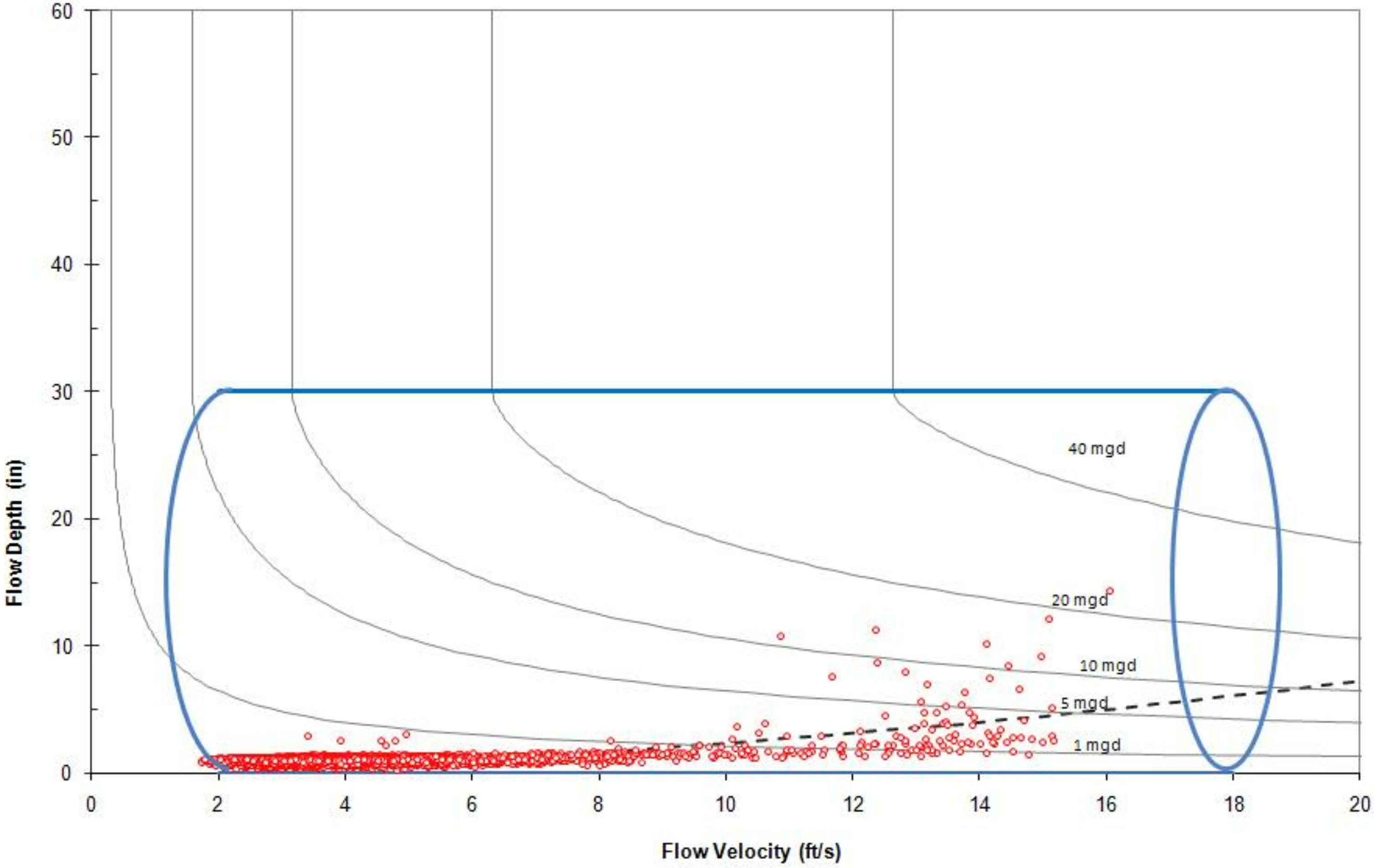
FIGURE 3–2



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CSO LONG TERM
CONTROL PLAN

BROADWAY INFLUENT SEWER SCATTERGRAPH

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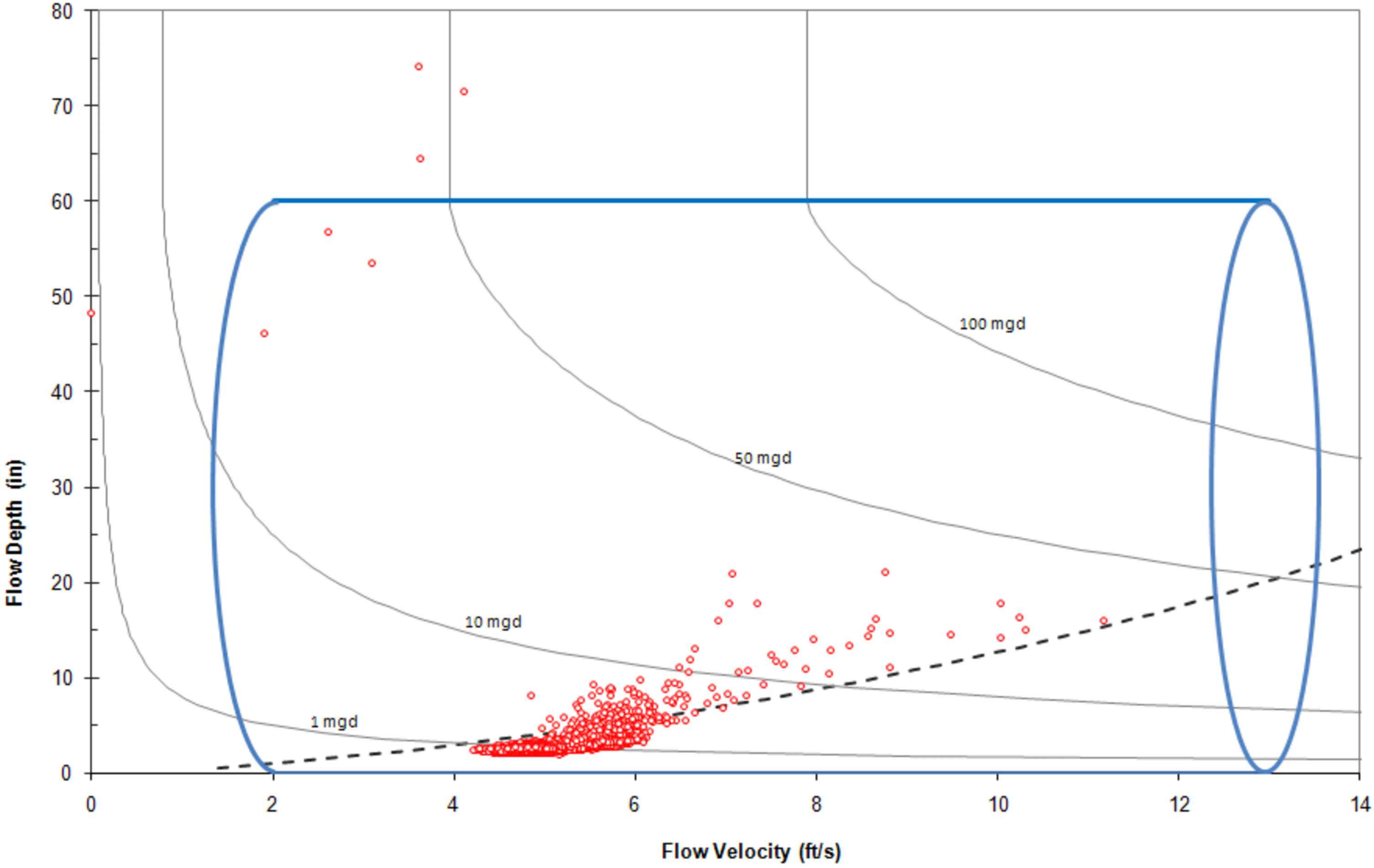
FIGURE 3-3



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CSO LONG TERM
CONTROL PLAN

HASBROUCK INFLUENT SEWER
SCATTERGRAPH

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FIGURE 3-4

3.2.5. Hasbrouck Sewer System

The influent system to the Hasbrouck regulator operates under normal, open channel flow conditions during dry weather, as shown by the scattergraph in Figure 3-4. However, a detailed review of the dry weather effluent system identified an operation condition that resulted in dry weather overflows. The scattergraph for the 18-inch effluent, provided in Figure 3-5, shows that once flows reach about 1.5 mgd, the system goes into backwater. This was not unexpected as the Brown & Brown regulator, by design, limits flow into the siphon system. It was not expected, however, that flows would back up during dry weather. As shown in Figure 3-6, the Hasbrouck effluent went into backwater on September 2, 2009, and generated sufficient depths as to overtop the weir. The activations were dynamic and transient in nature. A detailed review of the flow monitoring data found:

- Activations were not triggered by flows influent to the WWTF;
- The Broadway Regulator, which has a lower weir crest than Hasbrouck, did not overflow; and
- Time, frequency and duration of activation did not appear to have a pattern.

Based on the available information, the overflows are suspected as being caused by a blinding or malfunction of the Brown & Brown regulator. The City has investigated this condition and is performing weekly inspection of the regulator to minimize impacts due to debris causing the overflow to activate in dry weather conditions.

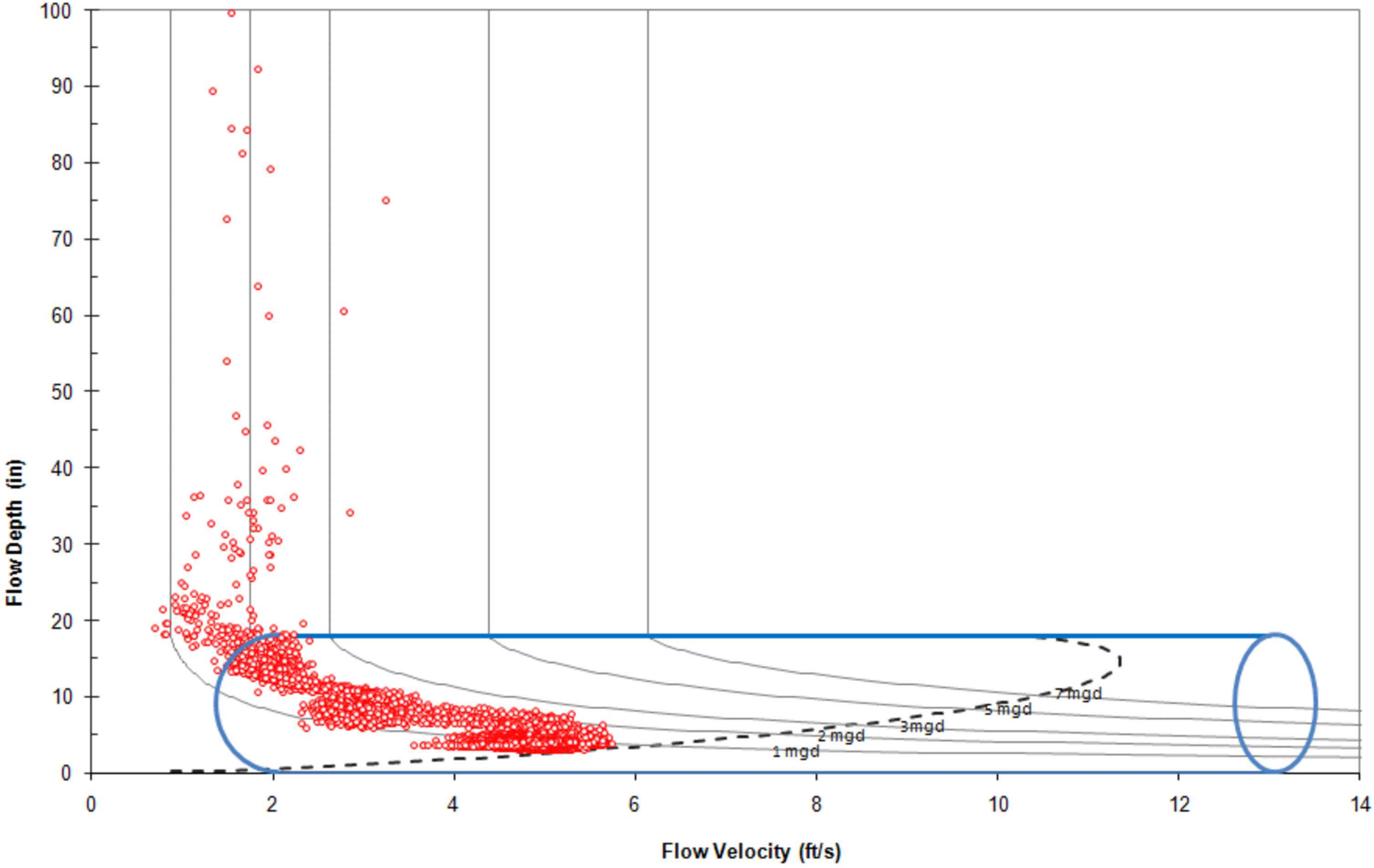
3.3. Wet Weather Flows

During wet weather events, the combined system delivers up to approximately 10.5 mgd to the WWTF. The peak flow rate delivered is based on two controls:

- Siphon capacity/head losses; and
- Local controls.

In many collection systems, the flow from the collection system to the WWTF is set by a hydraulic control at the WWTF, such as an influent gate or an effluent weir for a grit tank. In the Kingston system, the primary controls of flow delivery to the WWTF are the friction and minor losses of the siphon. However, this alone is not enough to maintain peak wet weather flows to within the WWTF capacity. The Brown & Brown regulator at Hasbrouck restricts flows to the WWTF to protect the treatment processes.

As depicted in Figure 3-7, each of the four sewersheds of the Kingston system acts as an independent system. Flow into each of the regulators is determined by the individual characteristics of the sewershed i.e. slope, soil system, rainfall distribution. But, as three of the sewer systems (Hunter, Broadway and Hasbrouck) are connected to a common header, they must share the header pipe capacity.



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HASBROUCK EFFLUENT SEWER
SCATTERGRAPH

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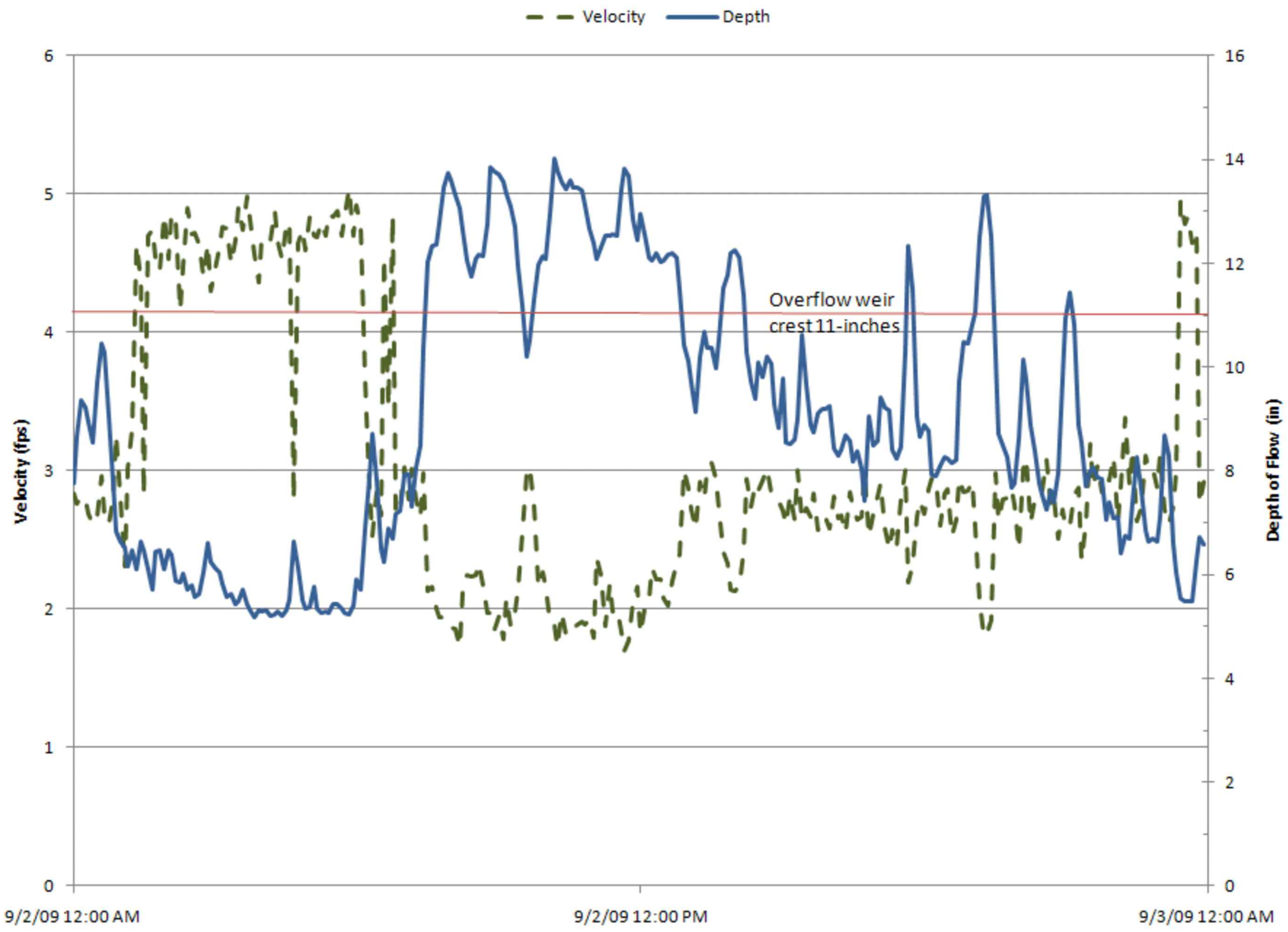
FIGURE 3-5



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HASBROUCK DRY WEATHER BACKWATER EXAMPLE

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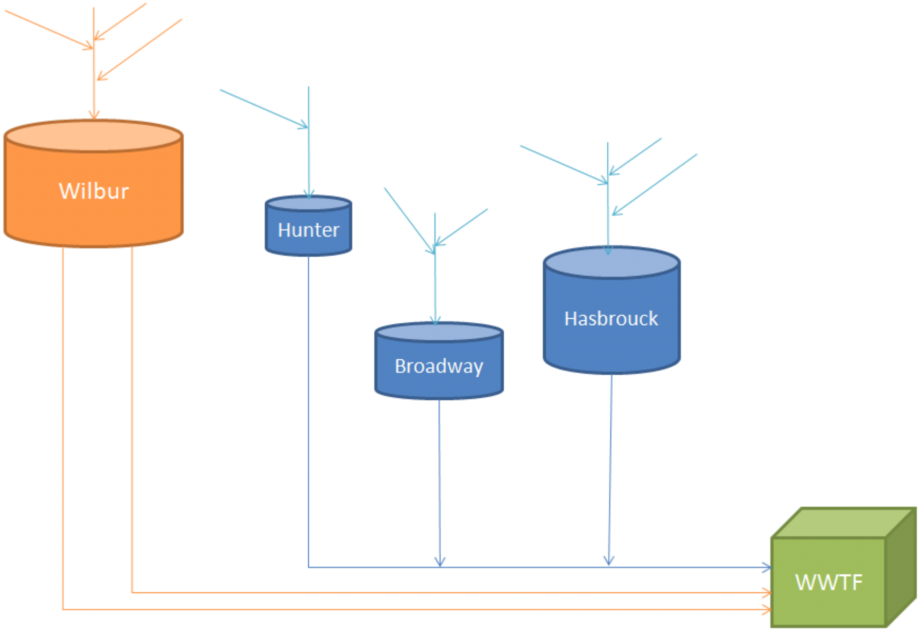
FIGURE 3-6

Figure 3-7: Kingston Sewer Systems with Common Header



The determination of the "share" of the capacity is determined by head and, for Hasbrouck, the set position of the Brown & Brown regulator.

Wilber is in a slightly different situation as it is served by two, dedicated siphons and does not share the discharge capacity with the rest of the system.

3.3.1. Wilbur Sewer System

The overflow of the Wilbur Sewer System is determined by the difference between the flow capacity of the effluent siphons and the influent flow rate from the gravity system. The wet well provides up to 161,500 gallons of storage capacity.

The instantaneous peak measured flow into the Wilbur Regulator during the flow monitoring period, which included two 50-year events, was 16.6-mgd. Most events were less than or equal to 5-mgd, as indicated by the iso-flow lines shown in the scattergraph in Figure 3-1. For the typical five-year period, the projected peak flow rate is 9-mgd. By comparison, the peak carring capacity of the 16-inch siphons is 3.5-mgd each or 7-mgd together.

The CSO system is triggered when the influent flow rate exceeds the effluent flow rate and the storage volume is filled. Most events are fully contained within the wet wells.

The storage capacity available in the wet well varies based on the amount of time between wet weather events, also referred to as the interevent time. Assuming a full tank volume of 161,500 gallons and an influent dry weather flow rate of 3.1-mgd, the wet wells take approximately one hour to empty after a rain event. In application, the influent flow rate remains elevated above dry weather flow for some extended period of time after the end of a rain event. Modeling indicates that dewatering the wet wells generally takes on the order of six to eight hours to empty.

3.3.2. Hunter Sewer System

The overflow of the Hunter Sewer System is determined by the difference between the flow allocation to Hunter in the shared siphon and the influent flow rate. The peak flow rate observed during the flow monitoring period was 9.5-mgd. Because of the steep grade, the influent 24-inch sewer water level did not rise above quarter pipe, but did attain velocities of 8 fps. These responses were, again, in response to 50-year storm events. The majority of events produced peak flow rates below 1-mgd, as indicated by the iso-flow lines shown on the scattergraph in Figure 3-2. For the typical period, flow rates are projected to peak at 1-mgd.

3.3.3. Broadway Sewer System

The overflow of the Broadway Sewer System is again determined by the difference between the flow “allocation” to Broadway in the shared siphon and the influent flow rates. The Broadway Regulator has two influent pipes, only one of which was monitored. In that pipe, the peak observed flow rate was 24-mgd. The majority of events produced peak flow rates of less than 5-mgd, as shown by the iso-flow lines on the scattergraph in Figure 3-3. The influent pipe operated under shallow and fast flows, the depths generally below six inches in the 30-inch pipe and velocities reaching 14 to 16 fps. During the typical period, the peak flow rate for the Broadway system is projected to be 3-mgd.

The overflow weir is nine inches high. Consequently, the Broadway system overflows for relatively small rain events and in spite of the influent pipe being 75 percent empty.

3.3.4. Hasbrouck Sewer System

The Hasbrouck Sewer System has the most complex wet weather system as overflow is controled by three factors:

- The difference between the shared siphon capacity allocated to Hasbrouck and the influent flow rate;
- The overflow weir with a height of 18-inches; and
- The Brown & Brown Regulator.

During the flow monitoring period, the peak observed influent flow rate was 65-mgd. The majority of events produced flows less than 10-mgd, as shown in the iso-flow lines on the scattergraph in Figure 3-4. The 60-inch influent pipe also is steeply sloped. The flow in the pipe generally was below 12-inches, or 20 percent of the pipe diameter and velocities on the order of 8 fps. During the typical period, peak flow rates are projected to reach 23-mgd.

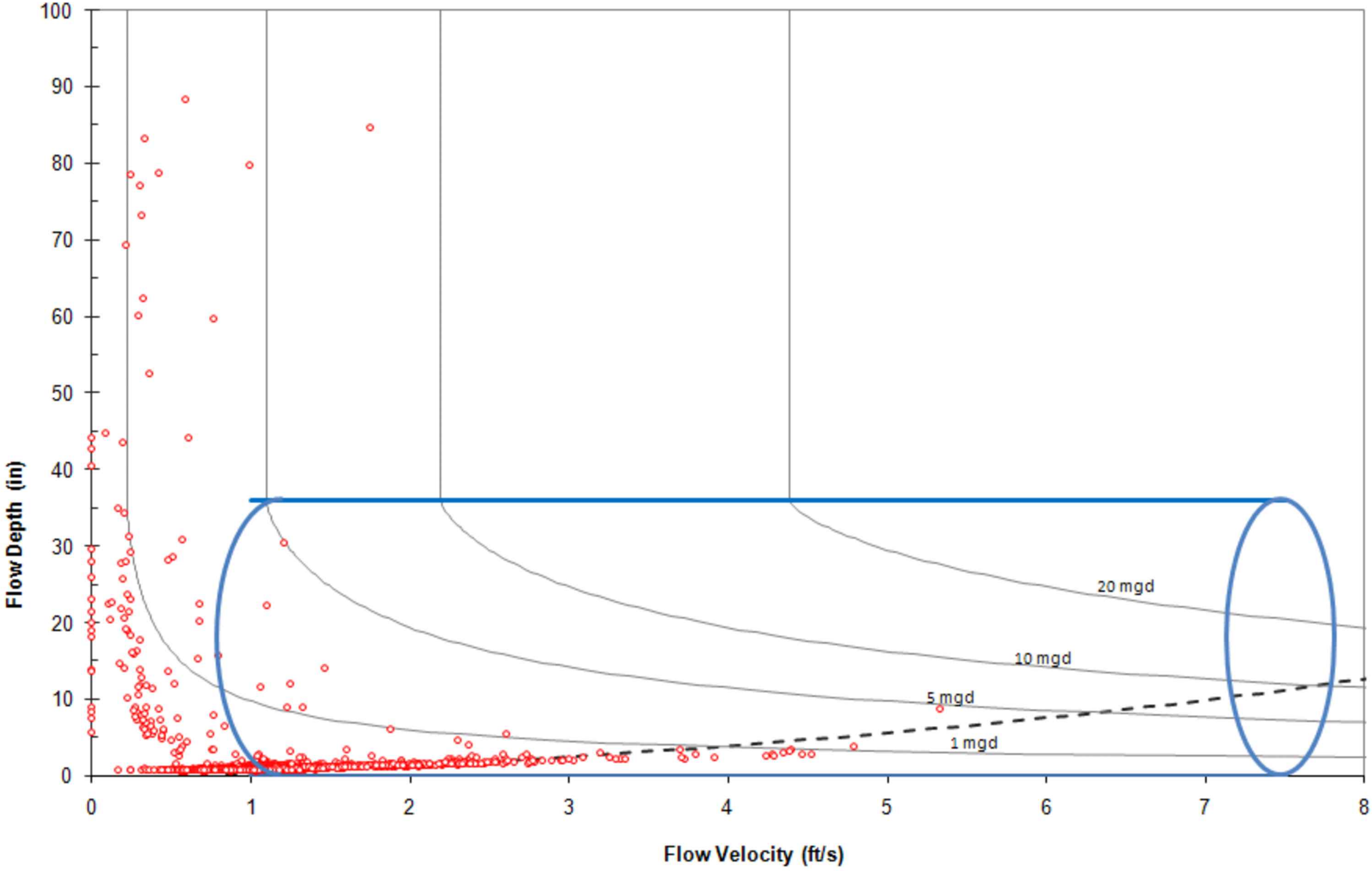
The 36-inch storm sewer that connects into the Hasbrouck screen house activates only during wet weather. Flows in the pipe did not rise above 1-mgd and operated under backwater conditions during several events, as shown in Figure 3-8. It is suspected that the relative small storm flows are not competitive with the combined sewer overflows, which range up to 7.5-mgd during normal wet conditions and significantly higher under severe wet conditions.

3.3.5. WWTF Influent Flows

Peak wet weather flows during the flow monitoring period exceeded 10-mgd on four occasions, with 10.8-mgd being the largest peak recorded. The recorded values were consistent with the reported peak flows of the WWTF. The hydrograph for the WWTF flows is shown on Figure 3-9.

3.4. Combined Sewer System Performance

The performance of the baseline combined sewer system was assessed using a five-year typical period of rainfall, with a typical year period identified within. As shown in Table 3-2, the CSO system discharges 131 MG of combined sewage to the Rondout Creek during the typical five-year period and 29 MG during the typical year period.



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HASBROUCK STORM PIPE
SCATTERGRAPH

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FIGURE 3-8

Table 3-2:
Baseline Condition Typical Period Overflow Performance Statistics

Typical Year Period				
CSO No.	Total Overflow Volume (MG)	Total Overflow Duration (hours)	Overflow Peak Flow (MGD)	Number of Activations[1]
Hasbrouck	26.93	423	22.46	59
Broadway	0.21	13	1.35	9
Hunter	0.12	23	0.61	12
Wilbur	1.81	18	7.41	5
Total	29.07	-	-	-
Typical 5-Year Period				
CSO No.	Total Overflow Volume (MG)	Total Overflow Duration (hours)	Overflow Peak Flow (MGD)	Number of Activations[1]
Hasbrouck	121.10	1889	27.93	296
Broadway	0.95	76	2.57	38
Hunter	0.52	108	1.03	50
Wilbur	8.81	60	8.72	21
Total	131.38	-	-	-
1) 12 hour interevent time, 0.01 cfs threshold				

The volume treated during the typical year period is approximately 1,779 MG, based on the typical year simulation. The volume treated during wet weather events is estimated at 221 MG. Wet weather was defined as periods with flow exceeding the average annual dry weather flow to the WWTF by five percent or more. Consequently, the system is operating at a typical year capture rate of 221 MG / (221 MG + 29 MG) or 88.4 percent.

Hasbrouck is the most frequently activated overflow and generates the largest overflow volume. During the typical five-year and one-year periods, overflow from Hasbrouck represents 92 percent of the total system discharge. Broadway and Hunter activate 9 and 12 times per year, respectively and both produce small overflow volumes. Wilbur activates with the same order of magnitude, five times per year but produces 1.81 MG.

The 36-inch storm sewer that connects into the Hasbrouck screen house activates 103 times in a typical year, discharging 3.7 MG. The storm water currently discharges into Rondout Creek through the CSO outfall pipe. The storm volume and peak flow rate discharged are small compared to the Hasbrouck CSO components but the storm system activates more frequently and for a longer duration than the CSO components.

3.5. Rondout Creek Water Quality

The City of Kingston, in response to NYS DEC permit conditions, collected samples and observations at several sites on Rondout Creek. Six sites were sampled in 2006 and five sites were sampled in 2007 at locations shown in Figure 3-10. The Sampling included measurements of Dissolved Oxygen, Fecal Coliform, TSS (2007 only) and visual observation of floatables in the creek. In 2006, samples were collected on six different dates four of which were associated with rain events. Data on specific timing of occurrence of CSOs concurrent with the sample collection is not available. In 2007 samples were collected on 15 different days, three of which were noted as days where rain occurred concurrently with sampling. Samples were collected between August 15 and October 30.

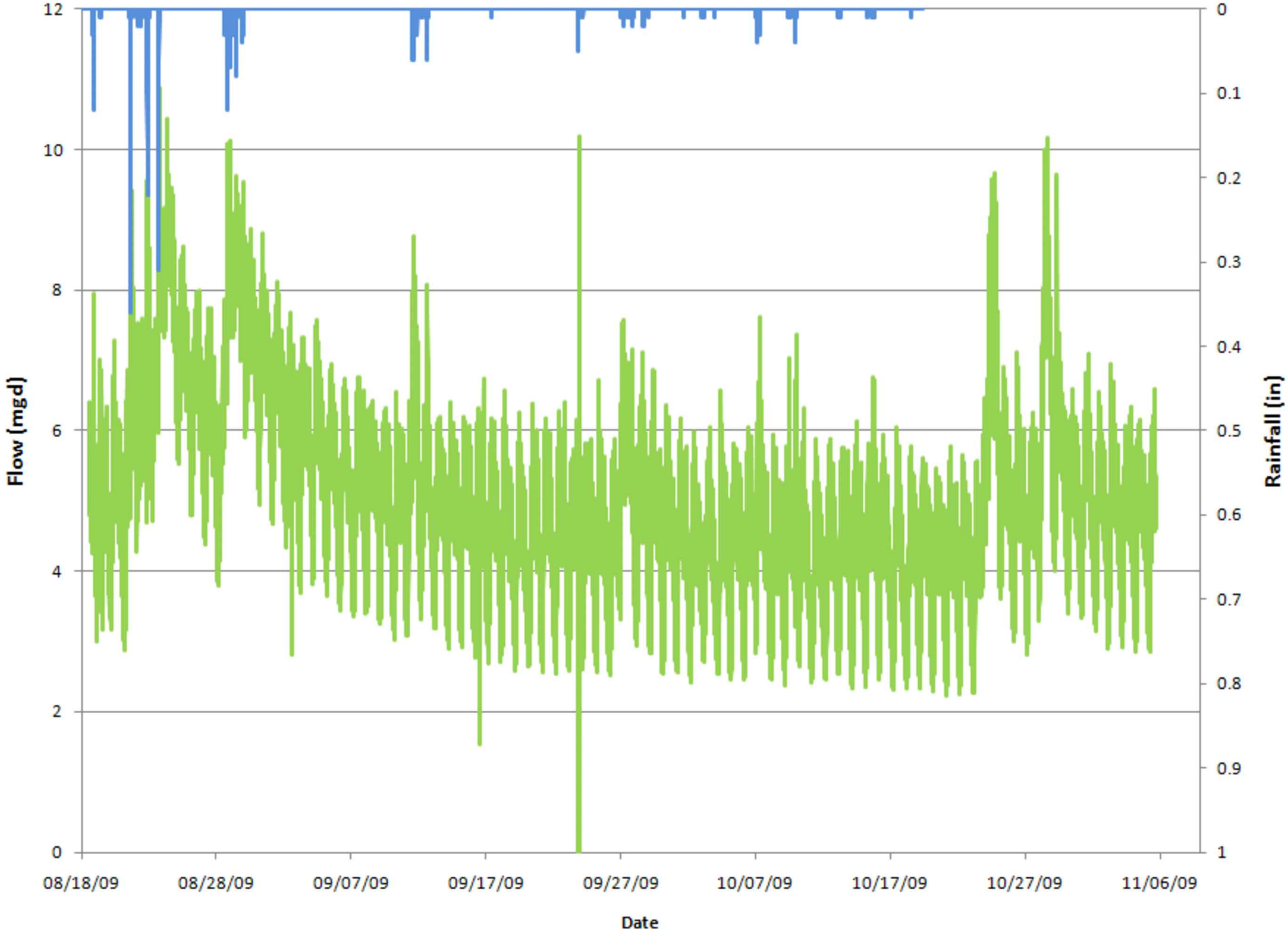
3.6. Dissolved Oxygen Measured

The DO readings do not indicate any samples that show a violation of New York State Water quality criteria. Readings were above six milligram per liter (mg/l) in most samples and only one sample (collected upstream of possible CSO) was measured below five mg/l. Figure 3-11 and Figure 3-12 illustrates the 2006 and 2007 DO data, respectively, plotted against rainfall.

3.7. Fecal Coliform Sampling

Fecal coliform samples were collected at the same dates and times as the DO measurements. During some of the sampling events fecal coliform was measured at concentrations that could indicate a potential violation of water quality standards. The 2006 fecal coliform data is shown plotted against rainfall in Figure 3-13 and the 2007 data is shown on Figure 3-14. Since no information was provided on the occurrence of CSO during these sampling events it is difficult to make observations about any possible relationship of high fecal bacteria readings and combined sewer system overflows.

As plotted against rainfall, some of the samples, such as those in June of 2006 and a few samples in 2007 seem to indicate a wet weather response in fecal coliform concentrations. Figure 3-15 shows the 2007 fecal sampling results plotted against USGS river flow data. This graph suggests that the late October elevated fecal coliform concentrations may be due to a combination of upstream influence and local rainfall as in the previous figure. The 2007 data has several samples where the most downstream site shows the highest fecal bacteria concentrations, however the pattern is neither consistent nor statistically verifiable.



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WWTF INFLUENT FLOWS

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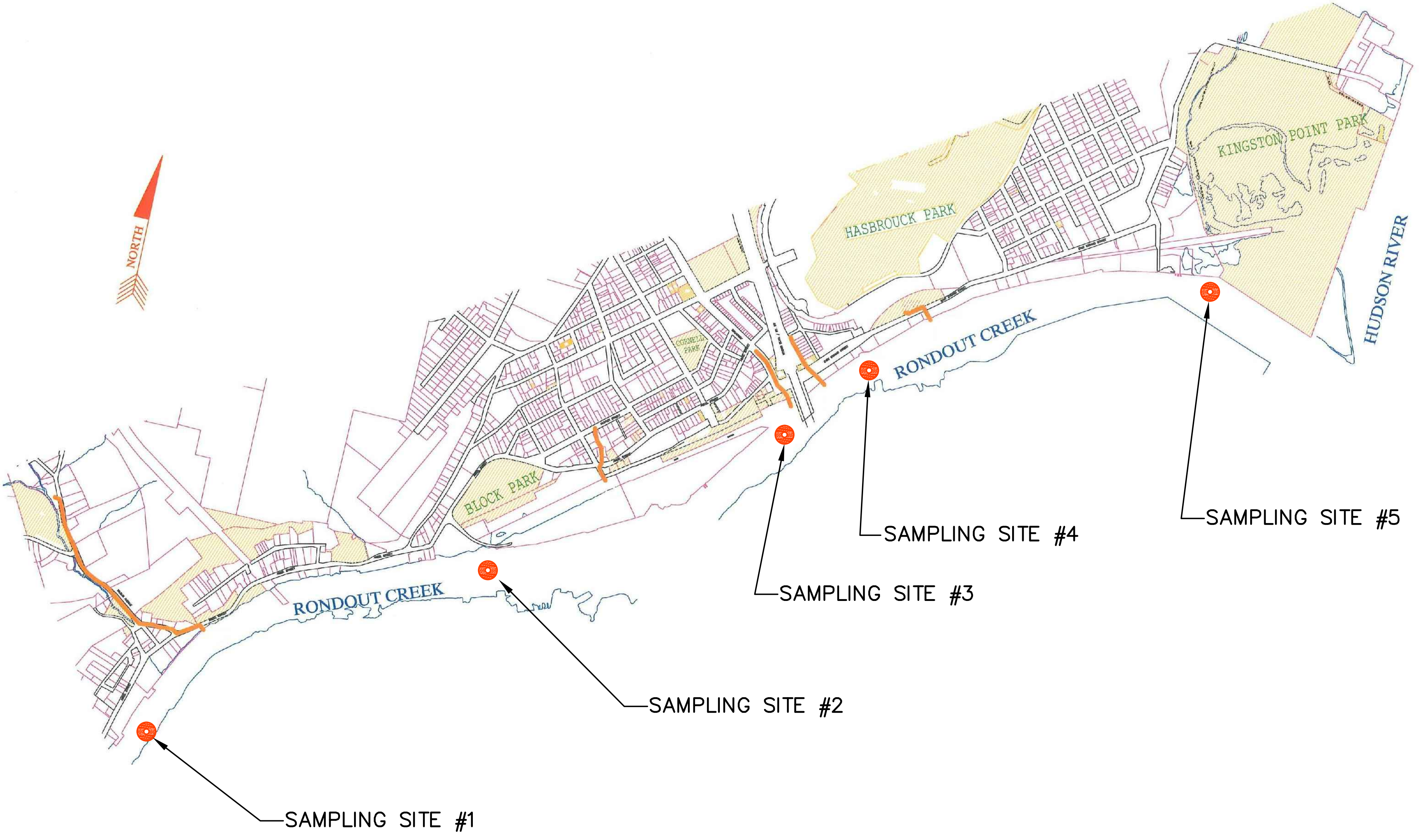
FIGURE 3-9

XREFS: IMAGES: H:\PROJECT\5744004\FILE\CSS Characterization Plan\fig_1_new.JPG

User: Lewandowski Spec: PIRNIE STANDARD File: I:\ACAD\PROJ\5744016\Figures\FIGURE 3-10.DWG Scale: 1:1 Date: 10/26/2010 Time: 15:51 Layout: Layout1



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CSO LONG TERM
CONTROL PLAN

2006 & 2007 WATER QUALITY
SAMPLING SITES
SCALE: NO SCALE

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FIGURE 3–10

In 2007 sufficient samples were collected to evaluate whether five samples taken in a 30 day period exceed the geometric mean standard set by NYS DEC. Most of the individual samples from 2007 are below the geometric mean standard and the geometric means of all months sampled, as listed in Table 3-3, are less than the 200 cfu/100ml standard in each of the three months sampled. The monthly maximums and geomeans are shown graphically on Figure 3-15: 2007 Fecal Coliform vs. River Flow.

Based on the available 2007 data, it appears that the CSOs do not preclude the Creek from meeting WQS.

Table 3-3:
Geometric Mean of 2007 Fecal Coliform Samples

	Site 1	Site 2	Site 3	Site 4	Site 5
August	71	77	149	150	184
September [1]	28	61	64	51	64
October	22	46	73	23	75

[1] Only four samples were collected in September 2007.

3.8. TSS Sampling

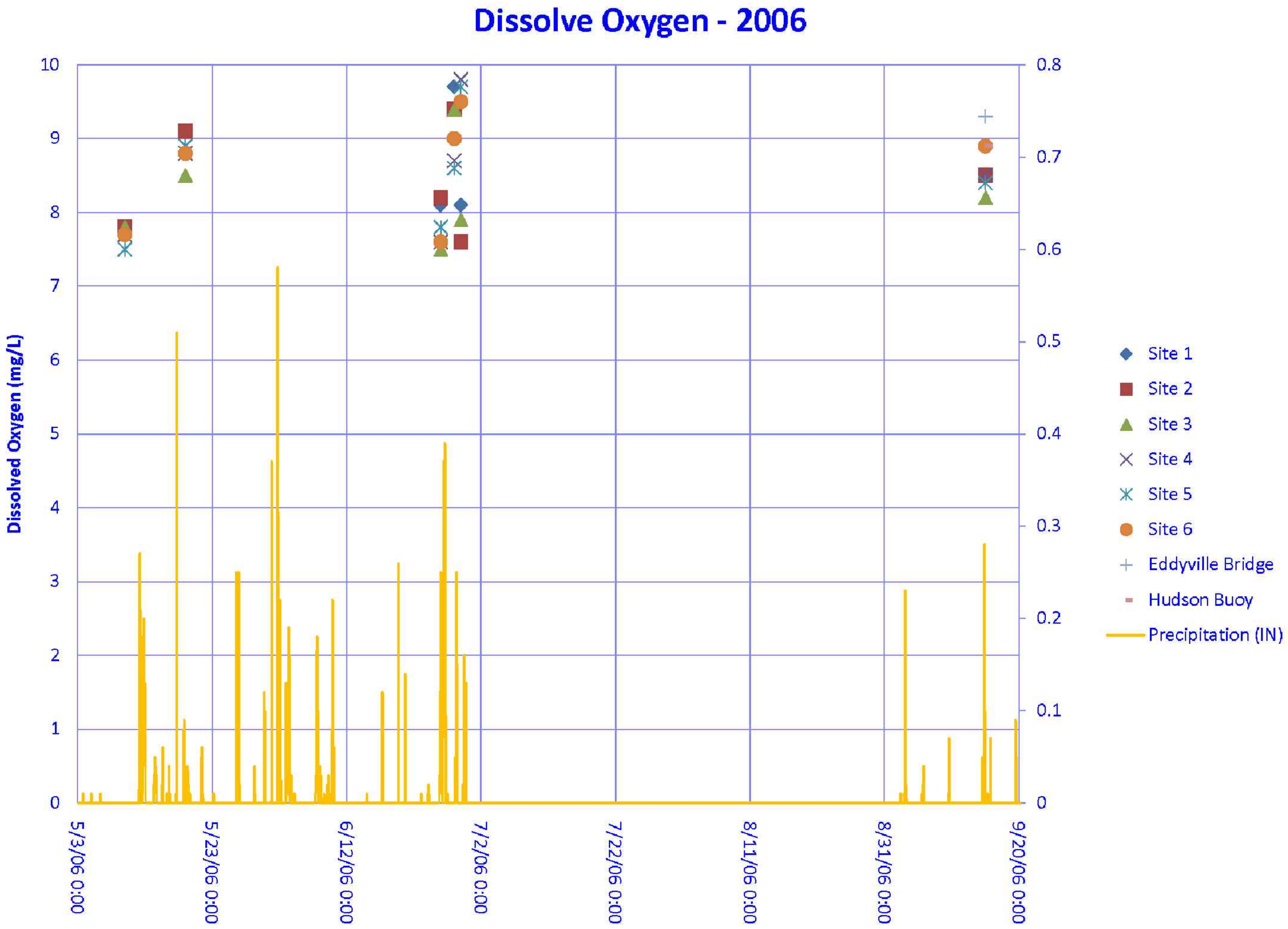
TSS were sampled concurrently with DO and fecal coliform in 2007. Figure 3-17 illustrates the measured TSS in relation to rainfall as in the earlier figures. There does not appear to be an apparent relationship between suspended solids and rainfall. A second plot of TSS against river flow shown on Figure 3-18 indicates that the elevated readings of TSS observed in late October 2007 seem to be related to the preceding high flow period rather than to a specific local rain event.

3.9. Floatables

Observations for floatables were made by City of Kingston Staff during the 2006 sampling. The reported data indicate no observations of floatables during the entire sampling period. The Wilbur, Broadway, and Hasbrouck outfalls are fitted with screens to catch floatables and material half inch and larger.

3.10. QA/QC

The absence of field data sheets makes assessment of field QA/QC difficult. It is not clear from reviewing the available data what the specific relationship between rainfall, CSO and sample collection was. The data seems to be internally consistent and comparison of field duplicates for fecal coliforms as shown in Figure 3-19 shows reasonable correspondence from collocated samples. Future sampling programs should develop a higher level of field documentation and include a more detailed effort to relate sampling events to wet (or dry) weather and overflow events.



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CSO LONG TERM
CONTROL PLAN

2006 DISSOLVED OXYGEN
DATA

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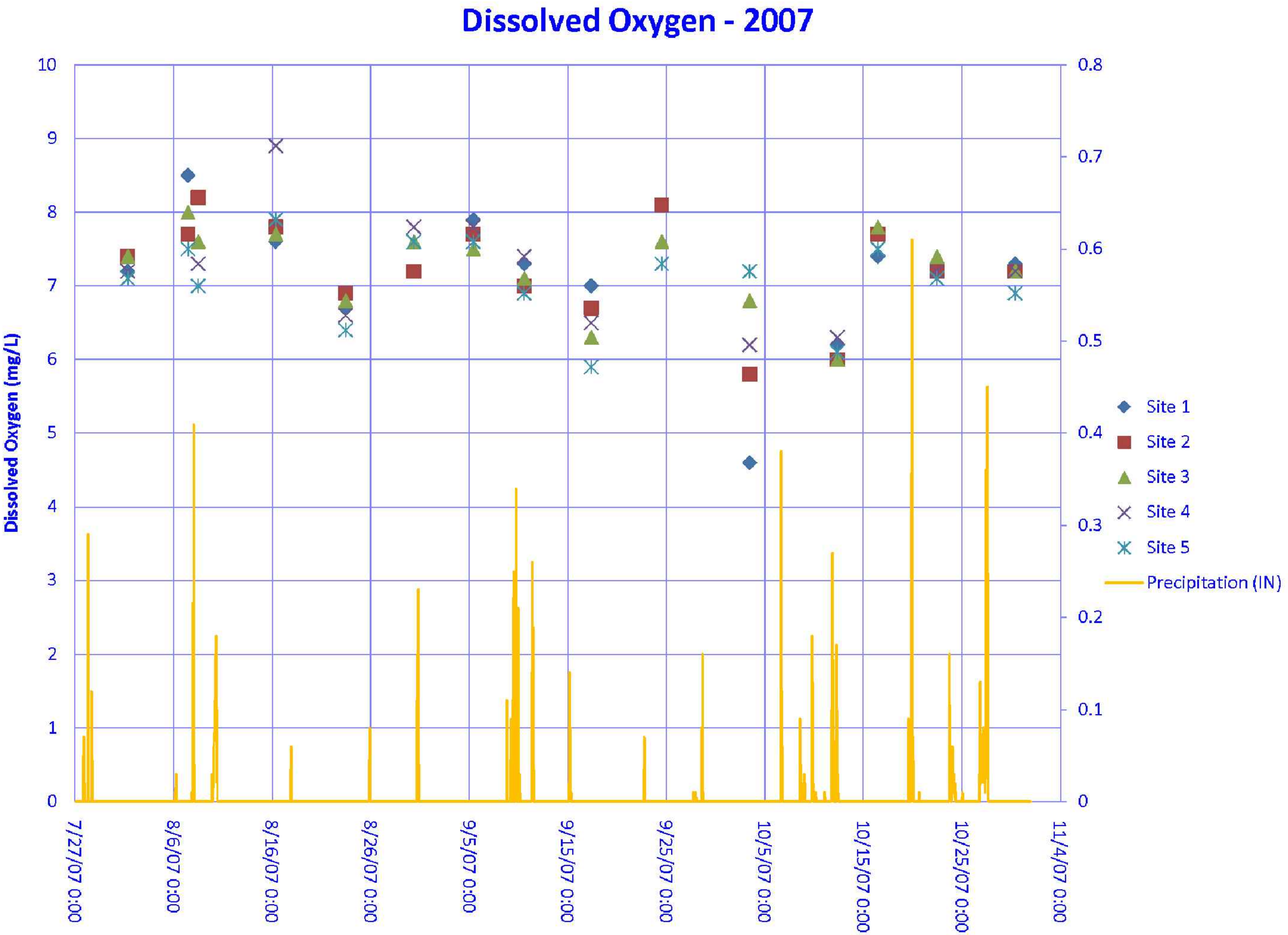
FIGURE 3-11



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2007 DISSOLVED OXYGEN
DATA

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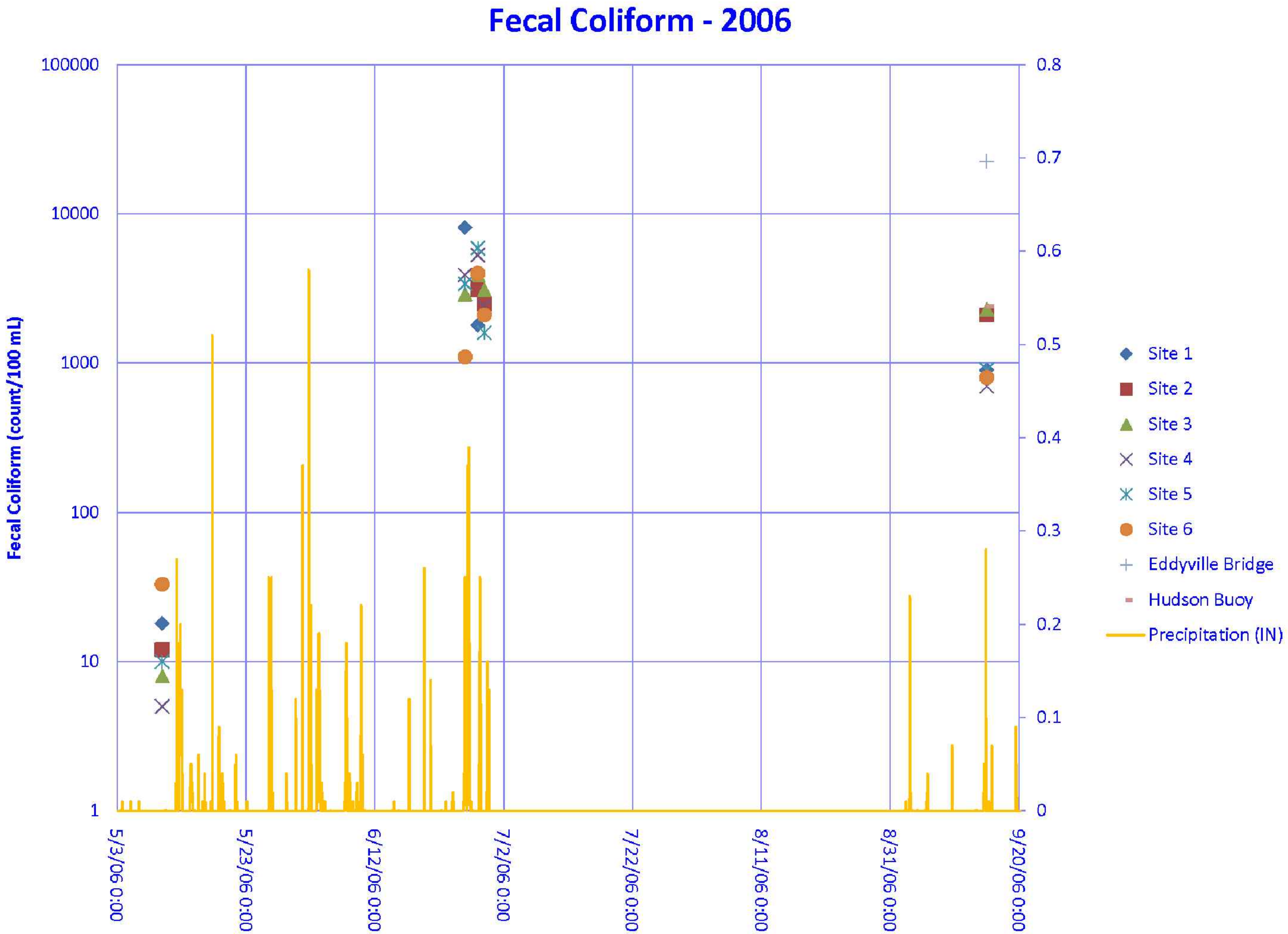
FIGURE 3-12



MALCOLM PIRNIE

CITY OF KINGSTON

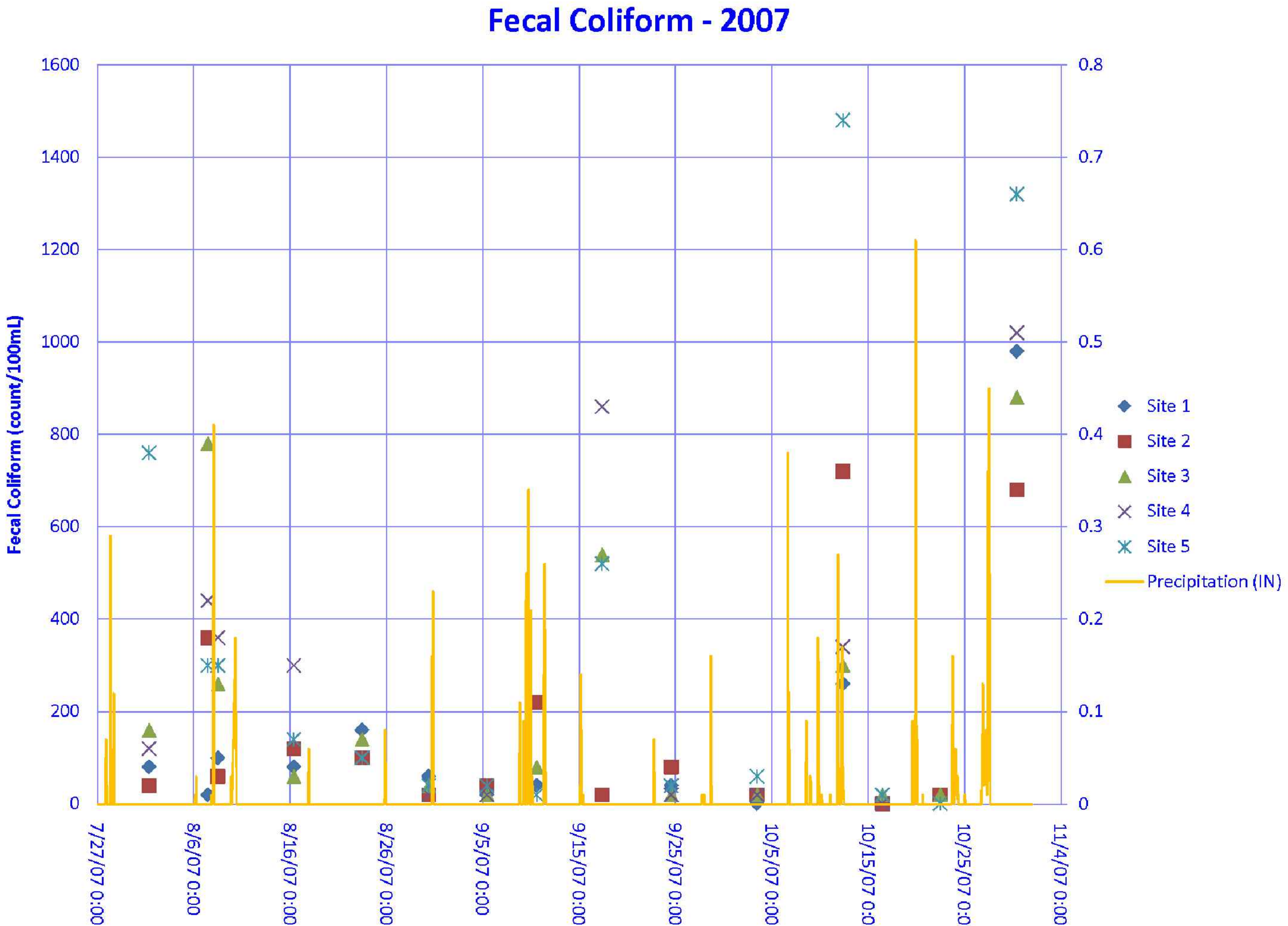
CSO LONG TERM
CONTROL PLAN

2006 FECAL COLIFORM DATA

MALCOLM PIRNIE, INC.

OCTOBER 2010

FIGURE 3–13



MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

2007 FECAL COLIFORM
DATA

MALCOLM PIRNIE, INC.

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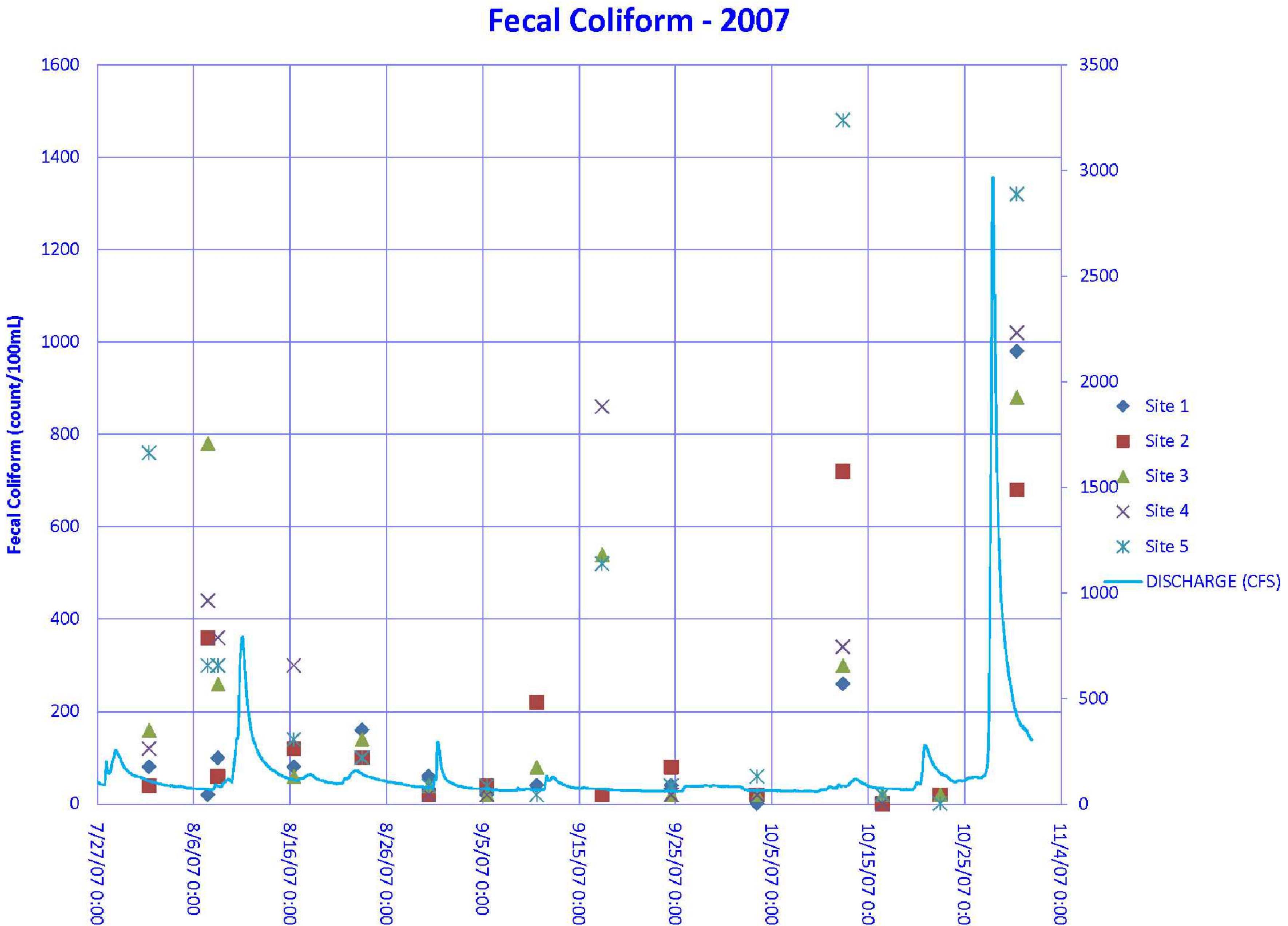
FIGURE 3–14



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CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

2007 FECAL COLIFORM
vs RIVER FLOW

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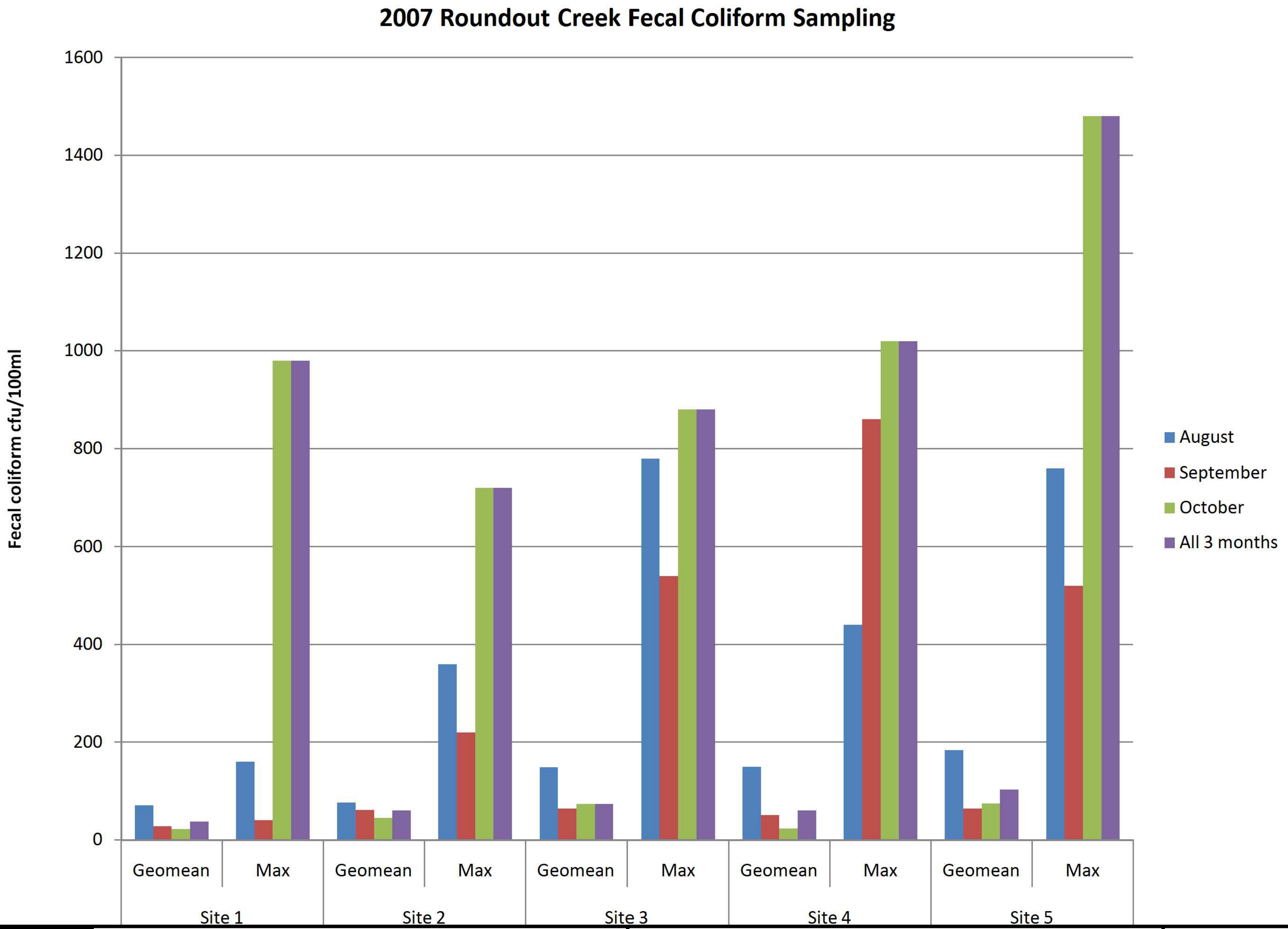
FIGURE 3-15



MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

FECAL COLIFORM
MONTHLY GEOMEANS

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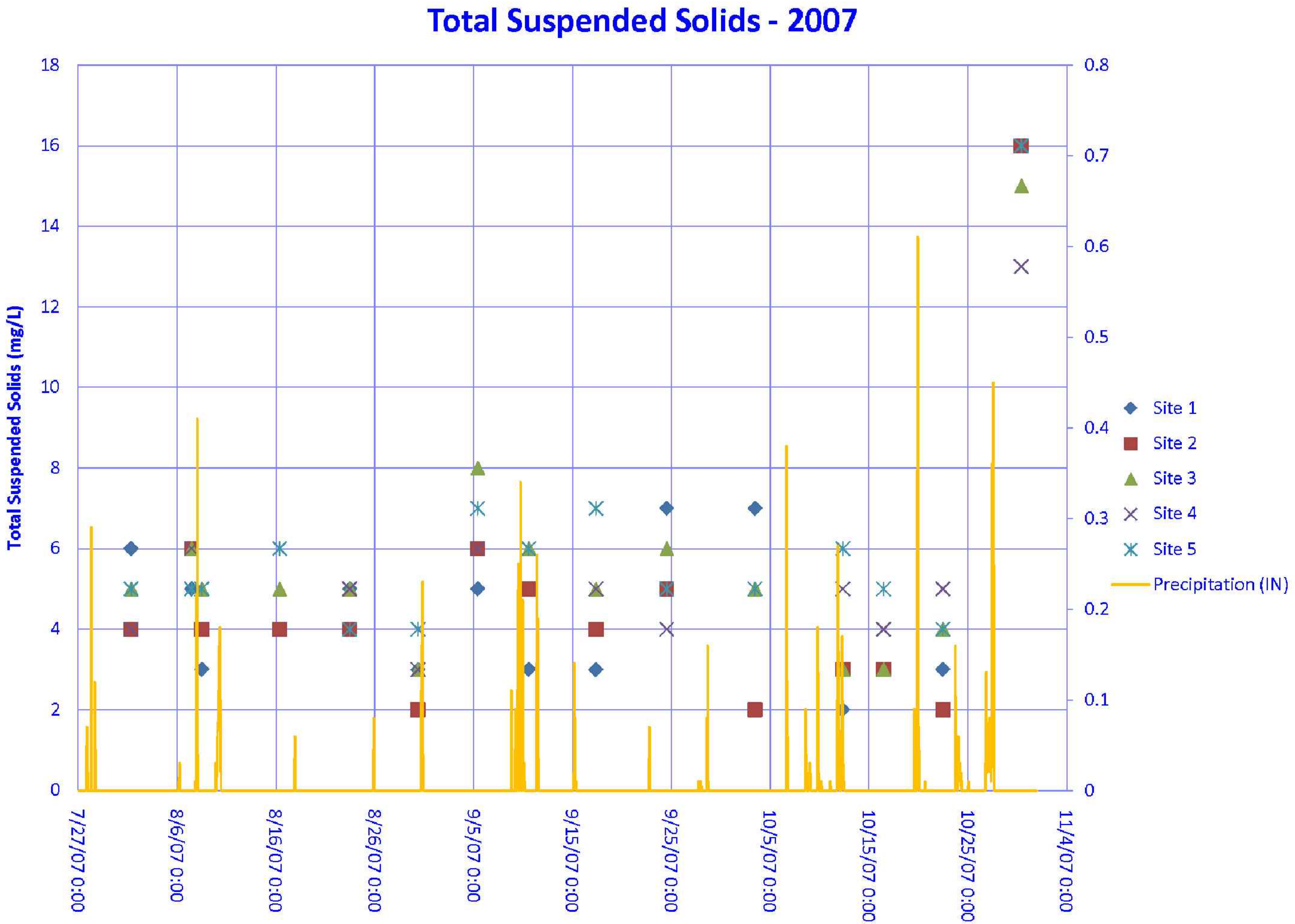
FIGURE 3-16



MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

2007 TOTAL SUSPENDED
SOLIDS DATA

MALCOLM PIRNIE, INC.

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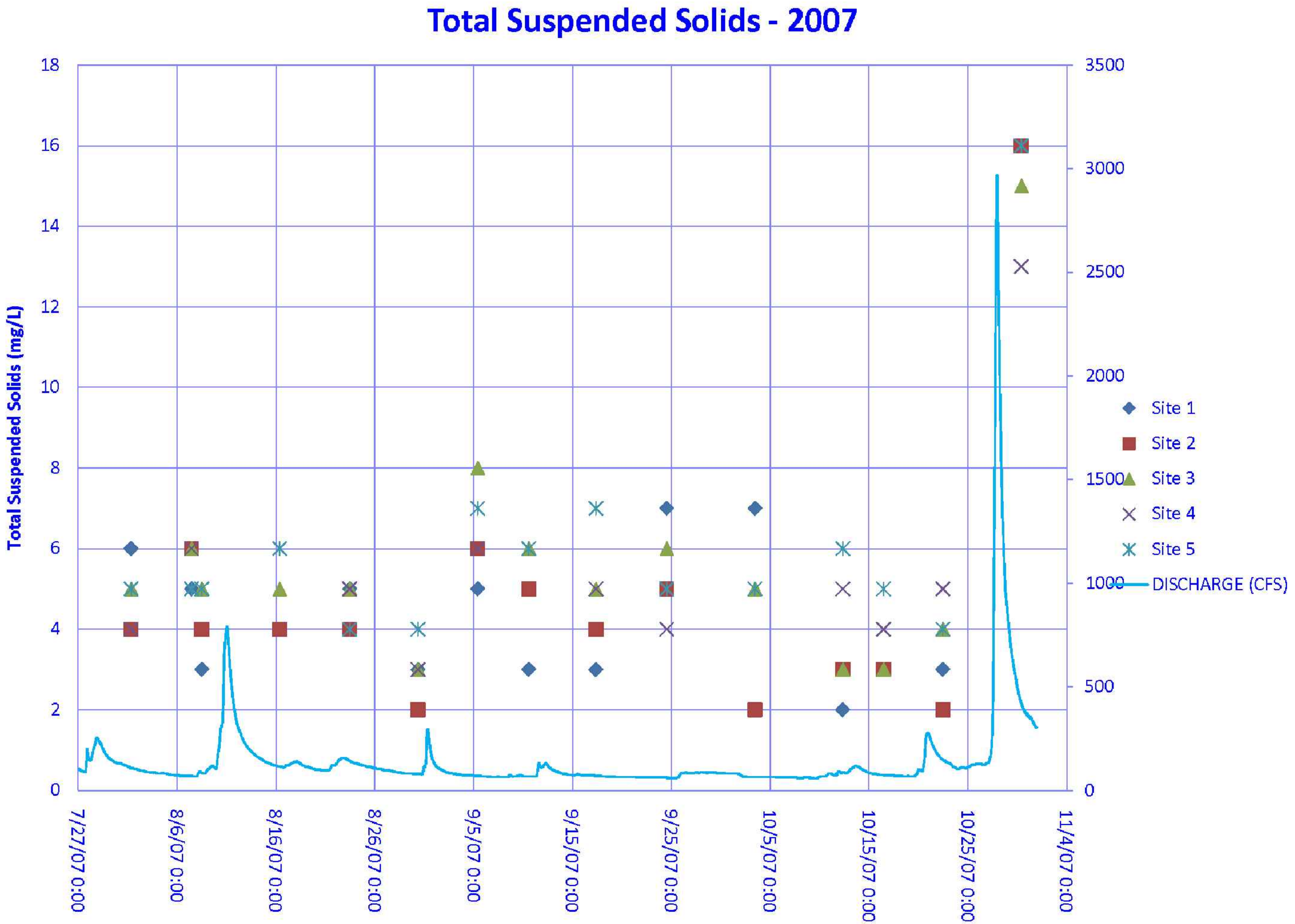
FIGURE 3–17



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CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

2007 TSS vs RIVER FLOW

MALCOLM PIRNIE, INC.

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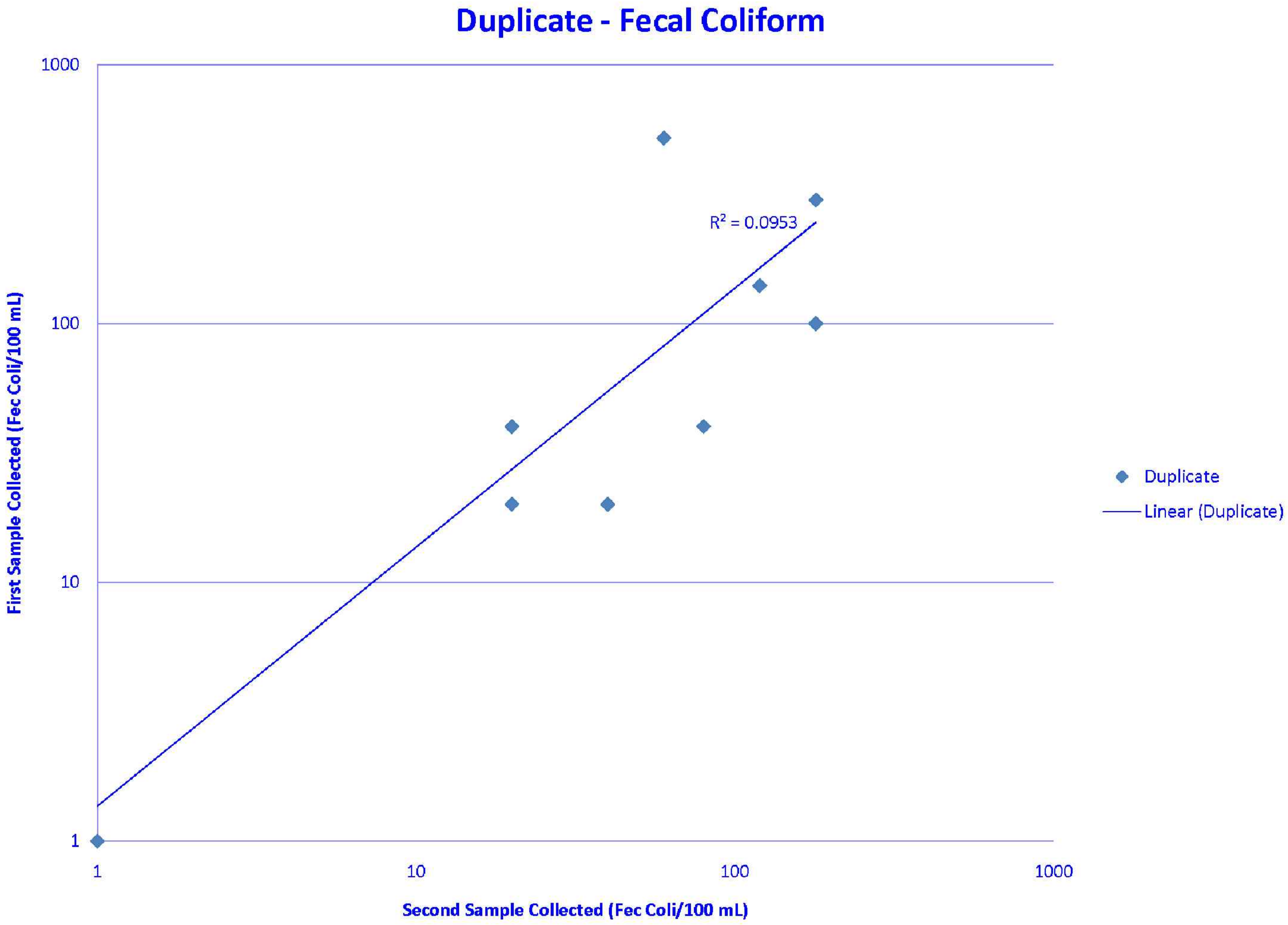
FIGURE 3-18



MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

DUPLICATE FECAL
COLIFORM SAMPLES

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FIGURE 3–19

4. Development and Evaluation of Alternatives

The goal of this CSO LTCP is to evaluate whether the City of Kingston's combined sewer system meets the requirements of the USEPA CSO Control Policy and if additional CSO control measures are necessary, to develop and evaluate CSO control alternatives to achieve the compliance with the policy. Being a small community, as defined by USEPA CSO policy, the City has selected a presumptive compliance approach. Two most commonly used presumptive approach criteria from USEPA CSO Control Policy are 85 percent capture of wet weather flows or four to six overflows per year without impacting WQS. As demonstrated in Section 3, the City's CSS already meets the 85 percent capture presumptive criterion; however the number of annual activations is currently greater than four to six overflows per year. This is not uncommon, since CSO LTCP efforts for many communities have shown that the four to six overflows per year is a more stringent criterion than the 85 percent capture.

The water quality evaluation results presented in Section 3 appear to show that water quality samples from Rondout Creek met NYS DEC WQS with the current operation of the CSOs. Further receiving stream water quality sampling and evaluations may be necessary to determine the extent of additional system improvements. Therefore, the evaluations presented in this section of the report provide a range of CSO control alternatives from no action to the improvements required to reduce the annual number of CSO activations to four to six overflows per year. The latter will serve as a "benchmark" for the extent of the City's system improvements that may become necessary to meet the receiving steam water quality standards.

In developing alternatives to meet this goal, several objectives were identified as critical:

- Technically feasible facilities;
- Operationally sound system;
- Value-added benefits; and
- Highest cost or effectiveness.

Any solutions considered must pass a basic requirement of being technically feasible, that is capable of being constructed and operated given limitation of land availability, flow rates, hydraulic heads, and other construction and operation parameters. To be successful, the solution must be operationally compatible with the size of the City of Kingston and the operational staff levels and skill sets.

The solution should provide value added benefits for residents and staff that advance the City of Kingston as a desirable location for families and businesses. Finally, the solution should recognize and respect the investment made by residents through rates by providing the highest levels of benefits for the cost.

4.1. Consideration of Sensitive Areas

Kingston Point Park, as shown in Figure 4-1, is located on the Hudson River, on the eastern shore north of the confluence of the Hudson River and Rondout Creek. The configuration of the breakwaters controlling the discharge of the Rondout into the Hudson and forming the park cove protects the park from the influence of the CSOs. During low tides, water from the Rondout Creek entering the Hudson River flows to the south, away from the beach. During high tides, waters in the Hudson River create a backwater condition on the flow coming from Rondout Creek. At these times, the beach is insulated from the Creek by the shape of the land. Consequently, for both sections of the park, areas with primary contact recreation are protected from receiving the direct flow of Rondout Creek by the shape of the land and/or the configuration of the breakwalls.

Kingston’s neighbor across the Rondout Creek and satellite customer community, Town of Esopus, draws drinking water from the Hudson River approximately three miles south of the confluence of the Rondout Creek and the Hudson River. The Village of Rhinebeck, Dutchess County Water and Wastewater Authority Hyde Park System, Town of Lloyd, and the City of Poughkeepsie also draw water from the Hudson River. It is the primary source of water for the Village of Rhinebeck, Town of Esopus, and the City of Poughkeepsie, while the Town of Lloyd has upland reservoirs and wells as primary sources of water. Figure 4-2 shows the relative location of the drinking water intakes to the City of Kingston.

Based on a review of each entity’s Annual Drinking Water Quality Report for 2009, total coliform, as a surrogate to fecal coliform, is not currently impacting the raw water quality for each water supply. All total coliform sampling results reviewed are below the NYS DOH MCL of 5 percent positive. The Village of Rhinebeck, with the closet raw water intake reported that there were no positive samples for microbiological contaminants for 2009.

Therefore, it appears that the City’s CSOs do not directly impact any of the sensitive areas discussed herein based on the data presented.

4.2. Nine Minimum Controls

The City actively implements the Nine Minimum Controls. The goal in implementing the goals is to capture and direct the maximum volume of wastewater to the treatment

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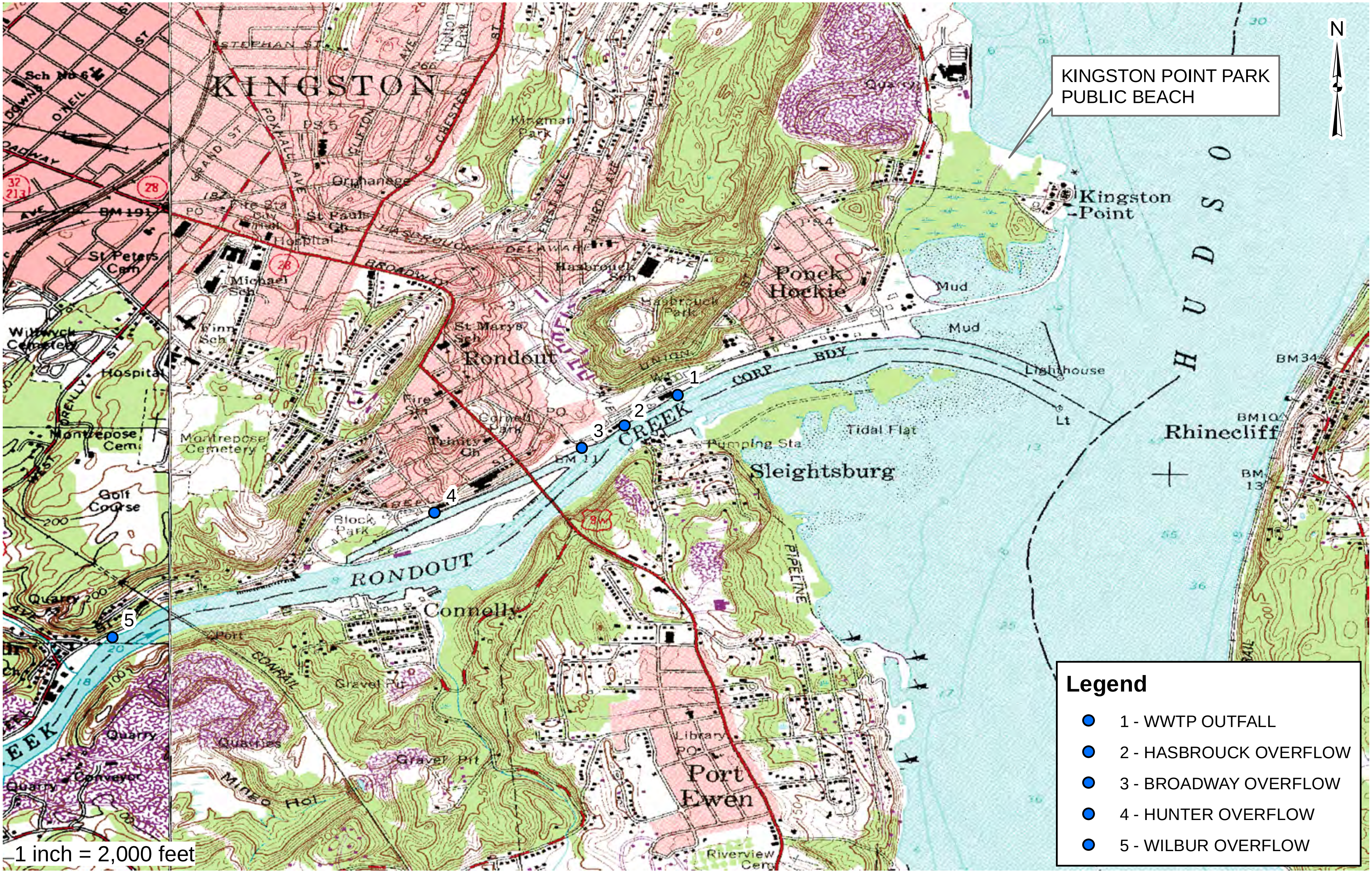


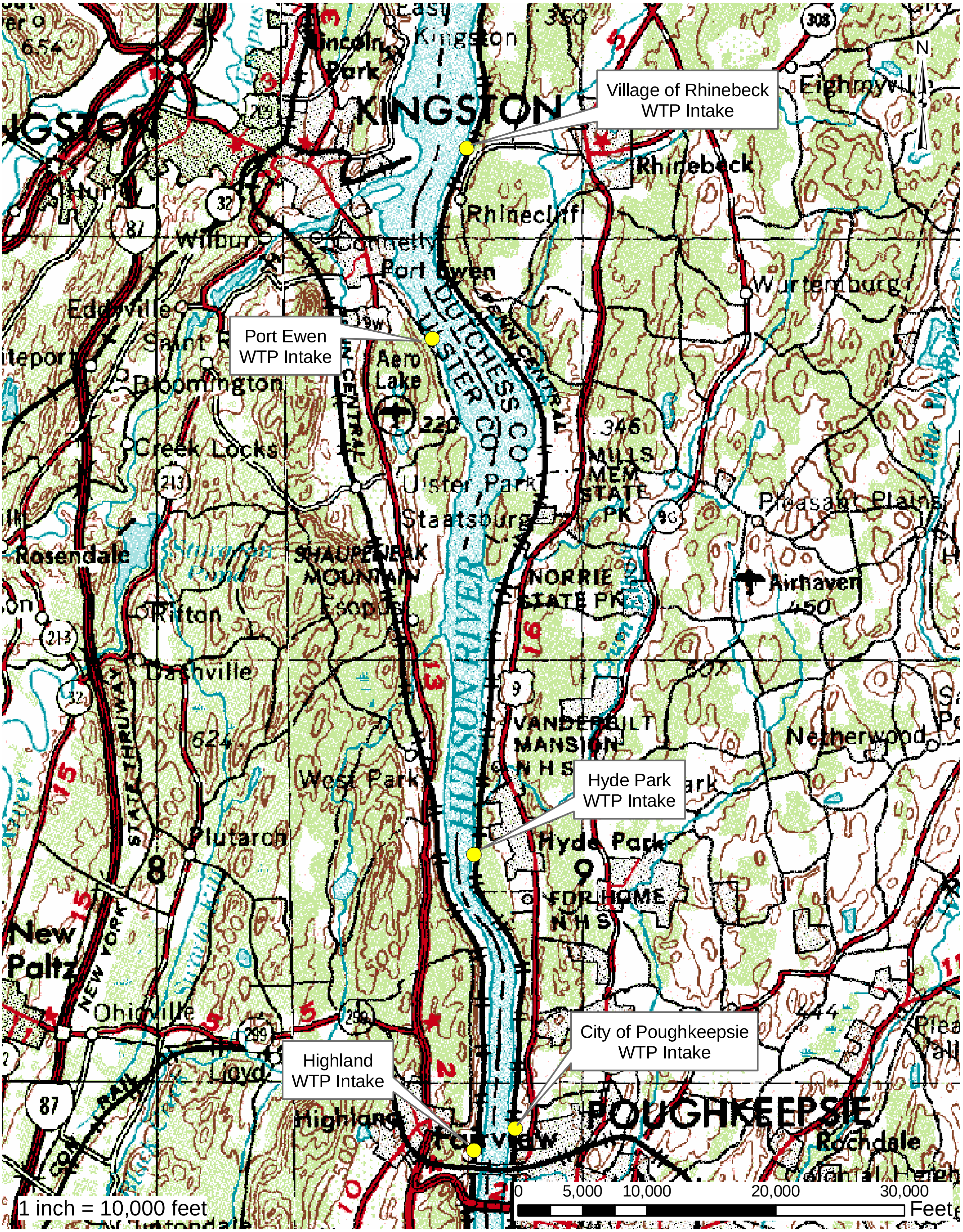
MALCOLM PIRNIE

CITY OF KINGSTON
CSO LONG TERM
CONTROL PLAN

SENSITIVE AREA
KINGSTON POINT PARK

MALCOLM PIRNIE, INC.

OCTOBER 2010
FIGURE 4-1



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MALCOLM PIRNIE

CITY OF KINGSTON
CSO LONG TERM
CONTROL PLAN

DRINKING WATER
INTAKE LOCATIONS

MALCOLM PIRNIE, INC.

OCTOBER 2010

FIGURE 4-2

plant by maximizing the flow through the WWTF. There is a continuous effort to reduce the storm water contributions of the I/I during periods of wet weather. The City submits annual reports on the CSO Best Management Practices (BMPs). The most recent report is provided in Appendix H.

4.3. CSO Control Goals and Water Quality Standards

As previously stated, the City’s CSS already meets the presumptive approach criterion of 85 percent capture. However, the ultimate goal of the CSO LTCP is to enable Rondout Creek to meet water quality standards. Since the number of annual activations is currently 58 (greater than four to six overflows per year), additional improvements to the collection system may be necessary to meet this goal.

Three levels of improvements and associated levels of CSO control have been evaluated for the City of Kingston CSS as applicable to each CSO location:

- No Action;
- Regulator Optimization/Real-time control operation; and
- Additional system improvements as necessary to reduce number of CSO activations to four to six events per year.

The evaluations are discussed separately for two groups of CSOs:

- Wilbur, Hunter and Broadway; and
- Hasbrouck.

The analysis of the water quality sampling data showed the parameter of concern is bacteria but that it appears the CSOs did not cause a violation of the bacteria WQS. Moving forward from that observation, it is projected that one to two discharges from the Kingston CSOs within a 30-day period will not preclude meeting water quality standards.

CSO control goals focus on the Hasbrouck regulator as discharges from the Hasbrouck system are the primary source of the overflow volume (92 percent) and have a high frequency of activation. With total discharge volumes of 2.1 MG combined, the infrequent activations from the Wilbur, Hunter, and Broadway overflows do not appear likely to exceed the fecal coliform standard.

A review of the discharges during the typical year, baseline conditions, from the Hasbrouck CSO, the most frequently activating CSO in the Kingston system, was performed to determine the control level needed to reduce activation to about two in a 30-day period. The summer months of June, July, and August has the highest density of large rain events. Controlling overflows to 1.30 MG will reduce the June activations to one event, July activation to three, and eliminate August activations. All activations remaining above the control level are substantially reduced from baseline conditions. With background fecal concentrations and Rondout Creek volumes as recorded during the 2007 sampling, the 30-day geomean standard is expected to not be exceeded. Considering the top events during the typical year under baseline conditions, as shown in Table 4-1, controlling Hasbrouck to the 1.30 MG of the August 11 event reduces the overflow activations to five in a typical year.

Table 4-1:
Hasbrouck Typical Year Top Ten Events

Event Ranking	Date	CSO Discharge Volume (MG)	
		Systemwide	Hasbrouck
1st	19-Oct	3.05	2.36
2nd	9-Jun	2.68	2.04
3rd	10-Jul	2.35	1.91
4th	27-Jul	1.75	1.51
5th	5-Jul	1.56	1.50
6th	11-Aug	1.30	1.30
7th	1-May	1.29	1.28
8th	30-Mar	1.11	1.11
9th	13-Jun	0.96	0.96
10th	5-May	0.90	0.90

4.4. Initial Screening of CSO Technologies

A wide range of technologies exists for CSO control, including the following main groups:

- Source controls;
- Green solutions;
- Sewer system optimization;
- Sewer separation;
- Storage;
- Primary treatment; and
- Disinfection.

While each CSO control group may include a number of various CSO control technologies, many of these technologies are project or condition-specific and may not be applicable or feasible for the City. A two-step CSO control technologies screening process was used for this project to streamline the selection of potentially feasible technologies for further evaluations. During the first step, a preliminary list of CSO control technologies were screened based on knowledge of the Kingston collection and treatment systems, Rondout Creek water quality objectives, and nationwide experience on similar projects. This initial list of the potentially applicable technologies is summarized in Table 4-2.

During the second step, the list of screened technologies was applied to the specific performance and site conditions of the four CSO regulators and developed into alternatives. This section includes a brief summary of the preliminary CSO control technologies considered in this project, including identification of the advantages and disadvantages of each. The rationale for including or excluding the alternatives from further evaluations is also presented and a description and evaluation of the system-specific CSO control alternatives is presented in Sections 4.5 and 4.6.

4.4.1. Source Controls

Source controls are methods of reducing overflow volume, floatables, BOD, suspended solids, and other parameters by controlling wet weather flows and loadings at their source. Source control methods include:

- Public education programs: This measure involves the implementation of programs to educate the public on initiatives such as litter control (with information regarding associated fines and penalties), illegal disposal, and the link between litter and CSO impacts. Public notification typically includes postings in public places, radio and television advertisements, and letter notification to residents and commercial entities.
- Street sweeping: This measure involves cleaning of street litter by mechanical or manual street cleaning. The USEPA recommends that street cleaning be done as often as once or twice per week and after each storm. However, street sweeping performed at such a high frequency may not be feasible due to O&M costs incurred and logistical difficulties in large urban areas.
- Catch basin cleaning: This measure typically involves cleaning of catch basins by maintenance crews using a vacuum truck.
- Industrial pretreatment: This measure involves reducing potential contaminants in CSO discharges by controlling industrial discharges to the sewer system.

The primary advantage of the use of source controls is low capital cost.

Table 4-2: Preliminary Screening of CSO Technologies

CSO Control Technology	Effectiveness		Comments
	CSO Volume	Pollutant Reduction	
Source Control			
Public Education	None	Low	Cannot reduce the volume, frequency, or duration of CSO occurrences
Street Sweeping	None	Low	Effective at floatables removal; cost-intensive O&M; ineffective at reducing CSO volume, bacteria, and fine particulate pollution
Catch Basin Cleaning	None	Very Low	Labor intensive
Industrial Pretreatment	Very Low	Low	The City has an NYS DEC approved program in place
Green Solutions			
Rain Barrels	Low	Low	Good for residential areas, minimal capture of total run-off volume, low-cost, requires emptying barrels after storm and interaction with home and business owners
Infiltration Trenches/ Catch Basins	Medium	Medium	Site-specific, relatively low-cost, good for residential areas, widespread participation required to be effective
Rooftop Greening	Medium	Low	Site-specific, cost-intensive, non-intrusive construction, other benefits to city, requires widespread application to be effective, used for larger buildings with flat roofs
Permeable Pavements	Medium	Medium	Site-specific, cost-intensive, increased O&M costs
Sewer System Optimization			
Optimize Existing System	Medium	Medium	Optimization has already been considered for NMC activities
Real Time Control	Medium	Medium	Highly automated system, increased O&M, increased potential for backups, applicable to larger interceptors with available storage capacity
Sewer Separation			
Complete Separation	High	Medium	Disruptive to affected areas, cost-intensive, potential for increased stormwater pollutant loads, requires homeowner participation
Partial Separation	Medium	Medium	Disruptive to affected areas, cost-intensive, potential for increased stormwater pollutant loads. The City is identifying inflow sources and will further investigate the potential for removal
Rain Leader Disconnection	Low	Low	Relatively low-cost, requires home and business owner participation, potential for increased stormwater pollutant loads

Storage			
Tanks	High	High	Requires large space, disruptive to area, cost-intensive, may require cover and odor control depending on location
Storage Pipelines/Conduits	High	High	Disruptive to affected areas, potentially expensive in congested urban areas, aesthetically acceptable, provides storage and conveyance
Vertical Shafts	High	High	Less disruptive than tanks or conduits, capital-intensive, provides storage in smaller area, pump station required to lift stored flow out of shaft
Tunnels	High	High	Least disruptive storage technology, capital-intensive, provides storage and conveyance, pump station required to lift stored flow out of tunnel
Primary Treatment			
Retention/Treatment	Low	Medium	Reduced tank size compared to storage. Allows permitted discharge of flows
Vortex Separator (includes Swirl Concentrators)	None	Low	Inconsistent pollutant removal performance. Depending on available head, may require sewer flows to be pumped, increased O&M costs
Chemically Enhanced Primary Treatment	None	Medium	Reduced tank size requirements and increased solids removal efficiency, requires chemical addition, requires chemical storage and high O&M costs
High Rate Physical/Chemical Treatment	None	Medium	Deep sidewall tanks likely to require rock excavation, adding to high unit costs
Expansion of WWTP processes	High	High	WWTF is land locked with limited opportunities to expand peak treatment capacity
Disinfection			
Chlorination/dechlorination	Low	High	Requires a minimum of 5 minutes contact time, chemical storage and high O&M costs, limited space at WWTP and CSO location, possibility to be combined with primary sedimentation and/or vortex facilities
Ultraviolet	None	High	Typically more expensive than chlorination/dechlorination, requires higher level of solids removal and startup time

The primary disadvantage of source controls is their inability to address the CSO impacts, if they exist, on water quality standards for DO, TSS, and fecal coliform. An additional disadvantage includes increased O&M costs required for cleaning streets and inlets.

Due to the nature of these kinds of controls, numerical estimation of their effects on conveyance system and receiving water body responses is not feasible. Therefore, they were not considered in the development of CSO control alternatives for the City. Source controls are considered additive and complimentary to the City’s CSO control alternatives.

4.4.2. Green Solutions

“Green solutions” is a broad term covering a range of techniques offering the potential to reduce peak storm overflow rates. The goal of green solutions is to develop techniques that store, infiltrate, evaporate, and detain run-off. Green solutions have the potential to reduce both the volume of stormwater generated by a site and the peak overflow rate.

Common green solutions techniques are described below:

- Rain barrels: Barrels placed at the end of roof downspouts to capture and hold run-off from roofs. The water in the barrel must be manually emptied onto the ground, or it can be put to beneficial use to water vegetation. The barrel top typically has a protective screen to inhibit mosquitoes.
- Infiltration trenches: Excavated trenches backfilled with stone to create subsurface basins that provides storage for water and allow infiltration.
- Rooftop greening: The practice of constructing pre-cultivated vegetation mats on rooftops to capture rainfall, thereby reducing run-off and CSO.
- Permeable pavement: A type of surface material that reduces run-off to the combined sewer drainage system by allowing precipitation to infiltrate through the paving material and into the earth.
- Rain Gardens: A specialized garden that features native plantings to capture water so it has a chance to slowly filter into the ground rather than run-off to the combined sewer drainage system.

Green solutions must be applied over a large area in order to achieve any significant reduction in run-off volume and/or flow rate to the combined sewer system. In urban areas, it is not cost-effective to demolish existing infrastructure for the purpose of green solutions applications alone. It is generally accepted that green solutions become cost-effective when redevelopment is under construction simultaneously within an urban area. This is because the streets and sidewalks have already been dug up, allowing substantial construction cost savings. In the case of rooftop greening and rain barrels, significant participation and cooperation of business and private property owners is required.

Furthermore, rooftop greening may require an evaluation and possibly revisions to the Building Code, which can be a lengthy process.

4.4.3. Sewer System Optimization

This CSO control involves making the best use of existing system facilities to reduce overflows. This may be accomplished by modifying the regulators to mitigate the conditions that trigger overflow events or adding real-time controls that change the operating conditions of the system in response for flows.

4.4.3.1. Regulator Modifications

Reduction in volume and frequency of overflows at regulators can be accomplished by modification of the existing hydraulic control features of the regulator – i.e., raising the elevation of weirs, modifications to orifice area, etc. These types of modifications are regulator-specific and feasible only if existing excess interceptor capacity is available and the resulting hydraulic gradient upstream of the regulator can be reestablished at a safe elevation to prevent flooding of basements or increase of other overflows. This type of conveyance system control can be advantageous for regulators with high frequencies but low discharge volumes.

4.4.3.2. Real-Time Control

Real-time control is any response, manual or automatic, to changes in the sewer system condition. An example is the measurement of sewer levels or flow in “real time” at key points in the system in order to operate control components (such as adjustable weirs, gates or inflatable dams) to maximize use of the existing sewer system and reduce overflows. This kind of real-time control adjusts the regulator controls in response to system conditions.

The primary advantage of regulator modifications is their low cost. The primary disadvantages are that regulator modifications by themselves typically are insufficient for complete CSO control, result in increased O&M needs, and create the potential for significant surcharging.

4.4.4. Sewer Separation

Sewer separation involves the installation of additional sewers, typically to convey stormwater alongside the existing combined sewer system. Typically, the existing sewers are left in place to convey sanitary sewage to the WWTF, since sanitary laterals are already connected and the existing sewer goes directly to the wastewater plant; however, constructing new sanitary sewers and retaining the existing combined sewers for stormwater drainage can be also considered. Separation can be an effective method of removing stormwater flows from the sanitary sewer systems and reducing CSO volume. There are two degrees of sewer separation: complete separation and partial separation. Partial separation is typically limited to stormwater inflow removal.

4.4.4.1. Complete Separation

Complete separation involves the separation of the combined sewer area tributary to any overflow point or regulator. The removal of stormwater leaves the existing system with enough capacity to carry sanitary flow and reduces overflows. Complete separation requires the installation of new storm sewers in combined sewer areas and the removal of any roof leader, foundation drain, and sump pump connections to the present combined system. Even after all direct inflow sources from private properties are disconnected, leaky service laterals may still contribute significant wet weather flows to the sewer system.

4.4.4.2. Partial Separation (Stormwater Inflow Removal in Existing Rights of Way)

Stormwater inflow removal is accomplished by installing new storm sewers in local, discrete areas within combined sewer subbasins to reduce direct stormwater input to the existing combined sewer system. Inflow removal is considered viable and potentially cost-effective in areas where gravity discharge of collected stormwater could be accomplished through relatively short outfalls to the receiving water or to a storm sewer with excess capacity.

4.4.4.3. Roof Leader (Gutters and Downspouts) and Sump Pump Disconnection

Roof leaders and sump pumps are disconnected from the combined sewer system with stormwater redirected to a dry well, lawn, or storm sewer.

4.4.5. Storage

Satellite storage facilities are tanks located within the collection system that are sized to provide the storage volume associated with the selected level of control. After wet weather flows subside, the basin and settled solids are dewatered back to the collection system. It is assumed that dewatering would be accomplished with pumps capable of dewatering the basin within 24 hours in order to avoid septicity and to increase the likelihood that storage will be available when needed.

Examples of storage control facilities include:

- Storage tanks: Closed or open concrete tanks that may include odor control and grit removal systems.
- Storage pipelines/conduits: These structures require a small construction right of way; however, a relatively large-diameter pipeline or conduit typically is needed to provide the required storage volume.
- Vertical shafts: Closed or open concrete shafts that may include odor control and grit removal systems. The vertical shafts have an advantage of requiring less surface area to store large volumes of flow.

- Tunnels: Storage is provided by the mining of storage tunnels below grade, and if possible, in bedrock. Tunnels have an advantage of causing minimal surface disruption. The storage tunnel stores flow, then conveys it to a dewatering station.

The primary advantage of storage is that captured flows are returned to the collection system for full treatment at the WWTF.

As with conveyance system controls, the primary disadvantage of this technology is its high capital cost. Additional disadvantages include increased O&M costs for pumping, the need for adequate construction sites and the potential for disruption of adjoining sites or neighbors during construction, and operation.

Given the shallow rock, significant grade change in the area of the regulators and relatively small volumes to be controlled, vertical shafts, tunnels and pipeline storage are not appropriate storage technologies for the Kingston system. Traditional storage tanks remain a viable control technology.

4.4.6. Treatment

Treatment is another method of reducing untreated CSO overflow volume and frequency. Treatment typically involves some form of solids (and associated BOD) removal and/or disinfection.

Examples of treatment control methods include primary sedimentation, vortex separators, high rate physical/chemical treatment, and chemically enhanced primary treatment. These methods are described below.

4.4.6.1. Retention/Treatment

The objective of retention/treatment is gravitational settling of suspended particles in a smaller volume tank combined with disinfection for the legal discharge of treated flows. This is the simplest method for treating and discharging combined sewer overflows.

4.4.6.2. Chemically Enhanced Primary Treatment (CEPT)

Chemically enhanced primary treatment involves adding chemicals (polymers and coagulants) to primary sedimentation basins to cause the suspended particles to clump together through coagulation and flocculation. The floc particles settle faster, enhancing treatment efficiency. As a result, primary treatment can be accomplished at higher surface overflow rates and in smaller tanks as compared to the conventional primary clarification process.

The advantage of this technology is a smaller footprint and typically better performance than a primary sedimentation facility. The primary disadvantage of this technology is the increased O&M costs for chemical handling and disinfection facilities as well as chemical costs.

4.4.6.3. High-Rate Physical/Chemical Treatment (HRT)

High-rate physical/chemical treatment is a traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance. The pretreatment requirement for HRT is fine screening and sometimes grit removal. The first stage of HRT is coagulant addition, where ferric chloride, alum, or a similar coagulant is added and rapidly mixed into solution. The coagulation stage is followed by a flocculation stage where polymer is added and mixed to form floc particles that will settle in the following stage. Also in this stage, recycled sludge or micro sand from the settling stage is added back in to improve the flocculation process. Finally, the wastewater enters the gravity settling stage that is enhanced by lamella tubes or plates. Disinfection, which is not part of the HRT process, typically is completed after treatment to the HRT effluent. Sludge is collected at the bottom of the clarifier and either pumped back to the flocculation stage or wasted periodically when sludge blanket depths become too high.

The primary advantages of the HRT processes are that they typically have the smallest footprint and best performance as compared to most if not all other primary treatment technologies. The main disadvantages of this technology are high capital and O&M costs as well as startup time requirements and with the Kingston topography, the likely requirement of bedrock removal.

4.4.7. Disinfection

The major objective of disinfection is to control the discharge of pathogenic microorganisms in receiving waters. The disinfection methods commonly considered for CSO discharges are chlorination and UV .

Each disinfection method has advantages and disadvantages with regard to chemical toxicity, stability, interaction with extraneous material, penetration, availability, and cost.

4.4.7.1. Chlorination

Chlorination can be accomplished by adding chlorine gas, sodium hypochlorite, chloramines, or chlorine dioxide to wastewater and providing sufficient contact time for required pathogen destruction. The most commonly used chlorination agents are chlorine gas and sodium hypochlorite.

Chlorine gas historically has been the most common chlorination reagent; however, over the past decade many utilities have switched from chlorine gas to sodium hypochlorite liquid (hypochlorite) because of the greater inherent risk of chlorine gas to personnel health and safety as compared to hypochlorite. While substantially safer than chlorine gas, hypochlorite can still present a moderate safety concern to personnel working in the area. Sodium hypochlorite can also be corrosive, necessitating additional maintenance of associated chemical feed equipment and piping.

One of the disadvantages of using hypochlorite as opposed to chlorine gas is that the hypochlorite solution degrades over time. However, the strength of the solution can be monitored in order to accurately calculate the required dose when the system needs to be operated. The rate of degradation increases with solution strength and varies with temperature.

Chlorination can be implemented with moderate capital cost; however, space requirements for chlorine contact tanks may be considerable. Traditional disinfection with any form of chlorine typically requires a five-minute contact time. Contact tanks with adequate baffling and volume to prevent short circuiting and the recommended detention time are required.

To reduce the space and cost requirements for chlorine contact facilities, high-rate disinfection is commonly used for CSO treatment. High-rate disinfection is defined as the application of a higher-than-normal concentration of disinfectant in combination with high-rate mixing to achieve the desired level of bacterial kill over a shorter contact time. Typical chlorine doses range from 4 mg/L to maximum doses of 25 to 30 mg/L, and sufficient contact time. High-rate disinfection has been used successfully on a number of wet weather disinfection applications to provide a minimum of 5 minutes of contact time instead of the standard 15 minutes.

For discharge to surface waters, dechlorination following chlorination may be required to remove any remaining chlorine residual prior to discharge to minimize any adverse effect to receiving waters. Liquid sodium bisulfite is the most commonly used dechlorination agent applied in conjunction with sodium hypochlorite. The contact time for sodium bisulfite is much less than for chlorine; the goal is to provide only enough time for complete mixing of the bisulfite solution into the chlorinated wastewater flow.

4.4.8. UV Disinfection

UV disinfection is gaining popularity in the disinfection of wastewater and CSO discharges. Despite its higher capital and O&M costs (due to higher power consumption), the main advantage of UV is the much smaller footprint required as opposed to other disinfection methods. While the chlorine-based compounds and ozone require contact tanks large enough to provide required minimum contact times, UV disinfection does not have a required contact time, and therefore the UV units may be installed in existing channels. Because chemicals are not used, UV disinfection ensures that no chemical residuals are discharged in the effluent.

The primary disadvantages of UV systems are high capital cost and startup time requirements. Additionally, the effectiveness of UV disinfection is sensitive to effluent quality. Higher TSS concentrations can interfere with UV's ability to disinfect, requiring much higher doses and providing much lower efficiency. UV systems also require a reliable backup power source to ensure the continuance of disinfection during power outages.

4.5. CSO Control Alternatives: Wilbur, Hunter and Broadway

Because the number of CSO activations at the Wilbur, Hunter, and Broadway regulators is already at or close to single-digit events, per the evaluations for these locations were focused on relatively low cost improvements to optimize the system performance and further reduce a number of overflows. Therefore, only two levels of improvements were evaluated for these locations - No Action and Regulator Optimization.

4.5.1. No Action

No Action indicates that no new work is required. It leaves the system as-is. There is no capital cost incurred for no action. Operation and maintenance costs remain the same as existing O&M costs. No action is a viable alternative, as the Wilbur, Hunter, and Broadway overflows low discharge frequency and low discharge volumes are unlikely to cause a WQS violation in Rondout Creek.

4.5.2. Regulator Optimization

Regulator optimization is the raising of the weirs to maximize flow to the WWTF and minimize overflow without adverse side effects such as surcharging or basement flooding. The location of these three regulators on steep inclines means water levels can be raised without endanger connections.

Optimizing regulators directs more flow to the WWTF. Hydraulic modeling shows that by optimizing flow at the regulators, the wet weather capacity of the WWTF will be exceeded during peak events. The projected peak flow rate of 15.6 mgd exceeds the current capacity of 10.25 mgd. Upgrades to the WWTF to remove hydraulic limitations and/or an excess peak flow storage facility would be required. The cost for removing the hydraulic limitations to increase capacity to 13.6 mgd was estimated at $5.9M (2008 dollars). The WWTF is land locked. Expansion beyond the 13.6 mgd is not technically feasible, as the City would require an investment up to $65M to convert the existing WWTF to a wet weather pump station and equalization facility and construct a larger WWTF in another location.

As shown in Table 4-3, Broadway is fully contained under a typical year and Hunter is reduced to two overflows. The net decrease in overflow volume is only 0.21 MG. This reduction is too small to affect the annual percent capture of the system and is not likely to measurably improve water quality in Rondout Creek.

As the “No Action” alternative is viable given the low frequency and discharges and that the costs associated with optimizing the regulators far outway benefits, no action is selected as the approach for the Wilbur, Hunter and Broadway regulators.

Table 4-3:
Wilbur, Hunter, Broadway Optimized vs Baseline Conditions

Regulator	**Overflow Volume (MG)**	**Overflow Duration (hours)**	**Overflow Peak Flow (MGD)**	**Number of Activations**
	Optimized Conditions			
Broadway	0	0	0	0
Hunter	0.01	6	0.2	2
Wilbur	1.8	18	7.4	5
	Baseline Conditions			
Broadway	0.21	13	1.3	9
Hunter	0.12	23	0.6	12
Wilbur	1.81	18	7.4	5

4.6. CSO Control Alternatives: Hasbrouck

Removal, storage and treatment alternatives were considered to reduce the frequency and volume activations to meet WQS. Costs were developed using:

1. Bid tabulations from past Kingston projects
2. Cost curves developed for CSO LTCP work in other upstate New York communities

4.6.1. No Action

No Action indicates that no new work is required. It leaves the system as-is. There is no capital cost incurred for no action. Operation and maintenance costs remain the same as existing O&M costs. No action may not be a viable alternative, with 58 activations at the Hasbrouck overflow. The WWTF are not maximized before and after peak events and, with the high frequency of discharge, the WQS for fecal coliform may be challenging to meet.

4.6.2. Regulator Modifications

Modification to the Hasbrouck regulator will upgrade the structural, mechanical and instrumentation and control to eliminate the need for daily maintenance to protect against dry weather overflows. This concept will also allow flows from the Hasbrouck sewershed to be directed to the WWTF when there is available capacity instead of statically limiting the flow at the regulator. A detailed review of the regulator will need to be performed to determine the final configuration. The review will consider, at a minimum:

- Replacement of the Brown & Brown regulator with a SCADA controlled pinch valve or knife gate which will continue to protect the WWTF from high flows and also maximize the conveyance of flows before and after peak conditions.
- Replacement of the ½" mechanical bar screen
- Raising the weir in the screen house
- Refurbishing/replacement of the overflow flow monitoring system
- Relocation of 36-inch stormsewer connection to downstream of the regulator beyond the monitoring point.

A total of $750,000 is budgeted for the Hasbrouck Regulator Modifications capital improvements. Engineering at 15 percent of construction is budgeted at $115,000.

Regulator modification will have a significant effect on the performance of Hasbrouck during dry weather and small wet weather events. Table 4-4 shows the modeled predicted results of added real time control to Hasbrouck that sets the orifice size based on WWTF capacity. In addition to the 28 percent reduction in annual CSO volume and 24 percent reduction in activations, the percent capture of the system increases from 88 percent to 92 percent. Despite all the benefits, regulator modifications may or may not be sufficient for meeting (or not precluding the attainment) the water quality standards in the receiving stream. Post-construction monitoring would be required to verify the system performance and associated water quality benefits. Additional CSO control alternatives for further reducing CSOs at Hasbrouck are further evaluated below should additional improvements become necessary as a result of the PCM. Modifications will not continue to limit discharges from Hasbrouck to the WWTF to stay within peak flow rates.

A review of the model-predicted discharges from the Hasbrouck CSO was performed to determine the flows and volumes that need to be handled to reduce activation to about 4-6 events per year.

Table 4-4:
Hasbrouck Performance: RTC v Baseline

	Total Overflow Volume (MG)	Overflow Duration (hours)	Peak Flow (MGD)	Number of Activations	Percent Capture (%)
Real Time Control	18.7	213	21.9	45	91
Baseline	26.9	423	22.5	59	89

4.6.3. Separation: Partial Separation

Partial Separation is the removal of surface run-off from the combined sewer system. Catch basins and inlets are routed to a new, dedicated storm water pipe. Foundation drains and other storm water features outside of the public roadway remain as currently connected. The estimated cost to partially separate an urban combined sewer system is $50,000 per acre. This assumes the separation work occurs in the soft ground, above the bedrock. At this rate, the 702 acre Hasbrouck Sewershed would cost an estimated $35.1M.

4.6.4. Separation: Green Infrastructure

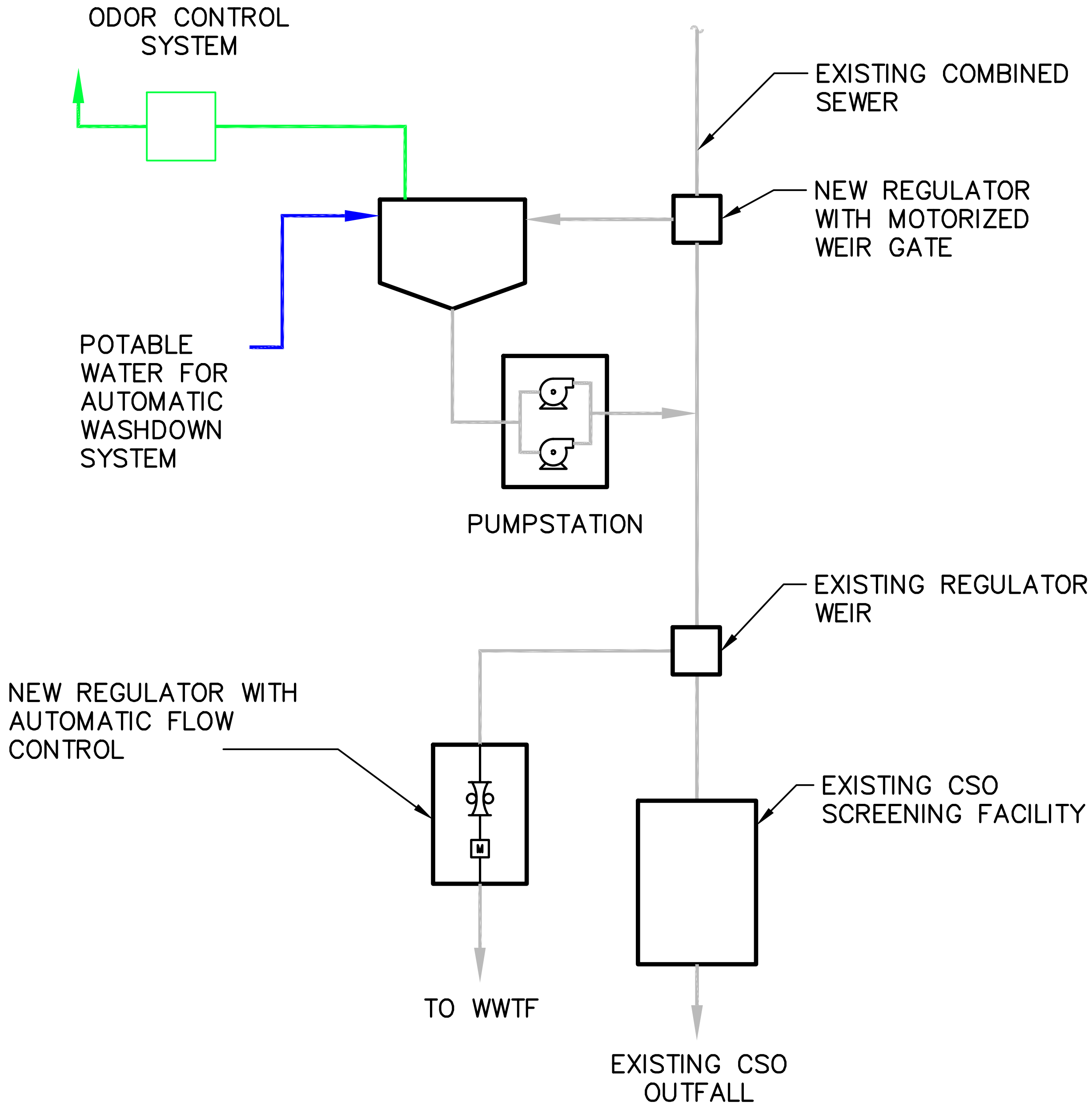
Separation with Green Infrastructure means using engineered systems that mimic nature to filter, detain and potentially remove overland run-off from the combined sewer system. Green Infrastructure uses a network of small facilities to locally manage the run-off.

With the shallow rock elevations, it is reasonable that infiltration of the storm water into the ground is not going to be feasible broadly through the Hasbrouck sewershed. As a result, most green infrastructure facilities will require an underdrain with a connection to either a dedicated storm water pipe or back into the combined sewer. A connection to a storm water pipe effectively separates the surface system from the combined sewer where a connection back to the combined sewer will delay the arrival of the flows, providing some benefit to the CSOs.

Green Infrastructure can play a positive role in reducing peak flow rates into the Hasbrouck system, but is not likely to control enough run-off to reduce Hasbrouck overflows to the 4 to 6 events per year used as a target for these evaluations.. Pilot testing of green infrastructure facilities, including pre-and post construction monitoring, would be needed to determine flow reduction from individual facility. It is expected that the net effect at the regulator will be nominal during the large control events.

4.6.5. Storage: Tank

Three locations were identified as potential sites for a storage tank. Site 1 is a tennis court upstream of the regulator, which is owned by the City. Sites 2 and 3 are downstream of the regulator on Abeel and are private property. At all sites, the tank would required screening, cleaning and pump back facilities. To provide the requisite 1.3 MG of storage, an AWWA D110 Type III Pre-stressed Concrete Tank with the dimensions of 146-ft in diameter and 10-ft side wall depth would be needed.
Costs for the storage tank were estimated using tank pricing provided by Natgun and other local projects. The construction cost is estimated at $3.5M and includes the tank, flushing system, pump station and piping. Property acquisition costs are not included. Refer to Figure 4-3 for a conceptual Schematic of the improvements.



<u>NOTE:</u>

1. WWTF FLOWS WILL BE MONITORED AND TRANSMITTED VIA TELEMETRY TO THE HASBROUCK REGULATOR. NEW CONTROL SYSTEM WILL MODULATE AN AUTOMATIC VALVE TO REGULATE FLOW TO THE WWTF. THE ELEVATION OF THE NEW WEIR GATE IN THE NEW REGULATOR WILL BE CONTORLLED BY COMBINED SEWAGE ELEVATION IN THE EXISTING REGULATOR AT HASBROUCK.

MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

CSO STORAGE TANK
SCHEMATIC

MALCOLM PIRNIE, INC.

OCTOBER 2010

FIGURE 4-3

4.6.6. Treatment: Disinfection

Disinfection directly addresses the primary concern regarding overflows: bacteria. Disinfection assumes the construction of a sodium hypochlorite / sodium bisulfite chlorination/dechlorination system and a contact tank to provide 15 minute contact time at the design flow through rate. A dewatering pump is also included to return capture flows to the WWTP. The estimated capital cost of constructing a disinfection facility is $4.5M for five overflows in a typical year. Annual operation and maintenance costs are estimated at $40,000 and include the cost of chemicals, electricity, and cleaning the facility after each event.

Costs for a disinfection system were developed from cost curves developed for upstate New York. The costs do not include that of a screen as the Hasbrouck overflow has an existing mechanical bar screen. Costs do not include land acquisition, engineering or other non-construction costs.

4.6.7. Treatment: Retention/Treatment Basin.

Retention/Treatment Basin uses a tank to provide for the settling of solids. Tank sizes were developed based on 30-minute holding times for the design flow through rate. Retention/Treatment Basin units include the replacement of the existing screen with mechanical fine screens ahead of the tank and a dewatering pump station. The estimated cost of construction is $9.3M for five overflows in a typical year. Annual operation and maintenance costs are estimated at $27,400 and include the cost of electricity, chemicals, and cleaning the tank after each event.

Costs for a retention/treatment basin were developed from cost curves developed for upstate New York. Costs do not include land acquisition, engineering or other non-construction costs.

4.6.8. Treatment: High Rate Treatment

High Rate Treatment is the use of a deep tank with the addition of chemical additives to effectively achieve equivalent primary treatment within a shortened period of time. HRT units include mechanical fine screens, one or more treatment units, and a dewatering pump station. A small equalization tank is commonly used to accommodate the facility start up time and to attenuate sharp peaks. The estimated cost of construction is $9.7M for five overflows in a typical year. Annual operation and maintenance costs are estimated at $28,000 and include the cost of electricity, chemicals, and cleaning the tank after each event.

5. CSO Long-Term Control Plan

The goal of this CSO LTCP was to evaluate whether the City of Kingston's combined sewer system meets the requirements of the USEPA CSO Control Policy and if additional CSO control measures are necessary, to develop and evaluate CSO control alternatives to achieve the compliance with the policy. Being a small community, as defined by USEPA CSO policy, the City has selected a presumptive compliance approach.

As demonstrated in Section 3, the City's CSS already meets the 85 percent capture presumptive criterion and the water quality sampling data appears to show the CSOs do not preclude Rondout Creek from attaining WQS; however the number of annual activations is currently greater than four to six overflows per year. Since the results presented in Section 3 of this report are not entirely conclusive, it is unclear at present time whether or not the remaining CSO discharges meet or do not preclude the attainment of the WQ standards.

Consequently, the recommended CSO LTCP utilizes a staged approach that include post-construction monitoring after modifying the CSS to determine the effect of the CSOs on attainment of WQS and reassess the size and type of additional CSO control required.

5.1. Recommended CSO LTCP

The recommended CSO LTCP implements a staged approach that focuses on improving the performance of the Hasbrouck system. The stages of the CSO LTCP are depicted in the flow chart of Figure 5-1. The initial stage upgrades the regulator to eliminate the need for daily maintenance in the prevention of dry weather overflows, provide direct measurement of CSO discharges and modulate the dry weather discharge to maximize flow to the WWTF.

The second stage performs post construction monitoring on the regulator system and updates the calibration of the hydraulic model to re-characterize the activation of the Hasbrouck CSO. Water quality sampling will be performed to capture sufficient water quality data to determine compliance with water quality standards.

If the second stage water quality sampling shows that Rondout Creek is meeting WQS or that the CSOs are not precluding compliance with water quality standards, no additional capital work will be undertaken by the City.

If the monitoring shows that CSO activations remain likely to cause a WQS exceedence, additional CSO control measures (third stage) will be implemented. Based on the costs presented in Section 4, the additional CSO control alternatives are expected to be tank storage. The final size of the tank will be determined based on the updated hydraulic model of the Hasbrouck system and the water quality sampling data. The update of the hydraulic model should also include the updating and refinement of capital costs. If markets or technologies change, such that treatment or separation become more cost-effective than storage, the City may elect to implement the most cost-effective solution.

Once the tank or other CSO Control Measure is operational, the water quality sampling program (fourth stage) will be initiated to confirm compliance with WQS in Rondout Creek.

Although it is not anticipated, in the event the post construction water quality sampling shows that the CSOs are clearly the cause of WQS violations, the City will undertake additional study to determine appropriate steps to further reduce impacts (fifth stage).

Figure 5-1: Kingston CSO LTCP

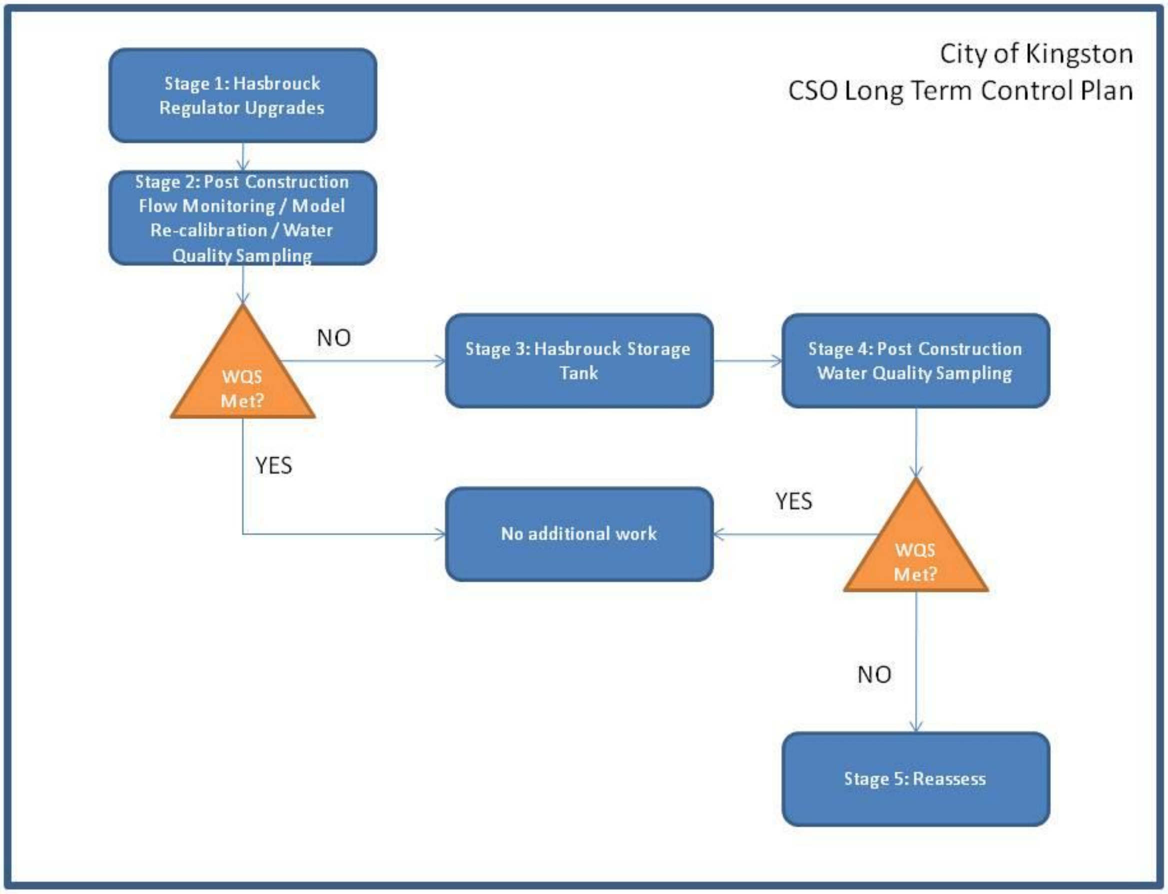


Table 5-1:

CSO LTCP Costs by Stage

Stage	Description	Construction Cost	Design Cost	Sampling / Monitoring / Analysis Cost	Total
1	Hasbrouck Regulator Upgrade	$ 750,000	$115,000		$ 865,000
2	Hasbrouck Flow Monitoring and Model Re-calibration			$50,000	$ 50,000
2	Post Construction Water Quality Sampling			$75,000	$ 75,000
3	Hasbrouck Storage Tank	$ 3,500,000	$525,000		$4,025,000
4	Post Construction Monitoring			$ 75,000	$ 75,000
5	Re-assessment			$ 50,000	$ 50,000
Totals		$ 4,250,000	$ 640,000	$ 250,000	$5,140,000

The costs for the stages of the CSO LTCP are provided in Table 5-1. All costs are in 2010 dollars. The total cost for the program will be determined by the results of the post construction monitoring. Sampling and monitoring costs are included for flow monitoring, water quality sampling, and data analysis. The City may elect to self perform these tasks and save the expenses.

At the low end, the LTCP will cost $0.99M for:

- Hasbrouck Regulator Upgrade;
- Post Construction Flow Monitoring and Model Re-Calibration; and
- Post Construction Water Quality Sampling.

At the high end, the LTCP will cost $5.14M for:

- Hasbrouck Regulator Upgrade;
- Post Construction Flow Monitoring and Model Re-Calibration;
- Post Construction Water Quality Sampling;
- Hasbrouck Storage Tank;
- Post Construction Monitoring; and
- Re-assessment.

5.2. Affordability Analysis

The City's CSO LTCP is an element of the City's SPDES permit requirements. As part of the LTCP, a financial capability assessment was completed to determine the financial impact of the capital projects that may need to be implemented in accordance with the US EPA document "CSO Guidance for Financial Capability Assessment and Schedule Development" (US EPA, 1997). The US EPA recognizes that the implementation and scheduling of a LTCP directly impacts a community's ability to afford the proposed remediation activities. The financial capability assessment measures the impact that the LTCP will have on both the current and future financial capability of the community.

5.2.1. Financial Capability Assessment Methodology

Affordability has many dimensions and requires multiple perspectives to adequately arrive at a reasonably acceptable definition of an affordable solution from the community's perspective. Therefore, this analysis explores the financial capability of the community to fund the LTCP based on two perspectives:

1. The method outlined in the 1997 US EPA guidelines, which outlines a two-phase process for assessing the ability to fund a CSO LTCP. Phase I of the analysis assesses residential customer affordability as measured by the cost as a percentage of median household income (MHI). If the costs are at or above one percent of the median household income, a Phase II analysis is completed. The Phase II analysis assesses community financial capacity (i.e., financial strength and financing capacity) to afford the program. (For this study, a Phase II analysis was not completed, since the projected residential costs were below one percent of the median household income).
2. An additional method that evaluates the financial capability and the need for sewer rate increases through time on a year-by-year basis. This analysis considers and incorporates the conceptual construction schedule for anticipated future capital projects and associated O&M impacts, and estimates the proposed year-by-year rate increases and residential indicator for each community, and the resulting potential "rate shock" that may occur as result of the need for significant rate increases.

5.3. Calculation of the Residential Indicator

The US EPA financial capability assessment guideline outlines a two-phase process for assessing the ability to fund a CSO LTCP. Phase I of the analysis assesses residential customer affordability as measured by the cost as a percentage of MHI. The Residential Indicator is calculated by first determining the total cost of wastewater treatment (including wastewater treatment, collection and LTCP-related costs). A portion of the total cost is then allocated to residential customers based on the percentage of total flow generated from these customers. Finally, the total residential cost is allocated amongst the total number of households in the community to determine the wastewater treatment and LTCP cost per household. Once the cost per household is determined, the Residential Indicator is calculated by dividing the cost per household by the MHI of the community, and is compared to the US EPA criteria for classifying the financial impact as “low,” “mid-range,” or “high.” Table 5-2 shows the US EPA’s criteria for classifying the financial impact based on the calculated Residential Indicator.

Table 5-2:
US EPA Residential Indicator Financial Impacts

Financial Impact	**Residential Indicator (Cost as a % of MHI)**
Low	Less than 1% of MHI
Mid-Range	1% – 2% of MHI
High	Greater than 2% of MHI

5.3.1. Identification of Wastewater Treatment Costs

The existing and projected costs for wastewater treatment operations were used to determine the Residential Indicator, and were estimated as described below. Appendix I presents supporting US EPA guidance worksheets and documentation of the financial capability assessment for the City.

5.3.1.1. Current Wastewater Treatment Costs

The US EPA defines current wastewater treatment costs as the current annual operation and maintenance (O&M) expenses (excluding depreciation) plus current annual debt service payments (principal and interest). These costs are intended to represent the cash expenditures of current wastewater treatment operations.

Table 5-3:
Actual FY 2009 O&M Expenses

Description	**Amount**
Administration	$ 586,551
Sanitary Sewers	794,661
Pumping Stations	288,239
Wastewater Treatment	1,566,383
Other Miscellaneous	7,033
Total	$ 3,242,866

Capital Expenses

Capital expenses, including debt service and capital outlay, are considered in the assessment since they represents a cash cost associated with the wastewater system. A summary of the anticipated debt service and capital outlay in FY2010 for the City is presented in Table 5-4.

Table 5-4:
Projected FY2010 Capital Expenses

Description	Amount
Sewer Bond Debt Service	$ 732,910
Sewer Lease Payments	270,597
Total	$ 1,003,507

5.3.1.2. Projected Wastewater Treatment and LTCP Costs

Estimates of projected wastewater treatment costs are made up of annual debt service payments (principal and interest) associated with future wastewater treatment, collection, and LTCP projects, and incremental O&M expenses associated with implementing the projected treatment and control projects.

Projected Capital Costs of Wastewater Treatment and Collection Projects

Estimates of future wastewater treatment and collection system capital costs were made based on capital improvement plan information provided by the City. The City provided future capital plans for the 2011 fiscal year. The City plans to implement a LTCP-related project for the 2011 fiscal year, which could have an ultimate total estimated cost of approximately $5,140,000 if all phases are required to be constructed. Therefore, the City's projected capital need was estimated to be $5,140,000 for this assessment.

5.3.2. Annual Residential Cost Per Household

The current and projected wastewater treatment costs for the City were then proportioned to the City's residential customers based on flow and number of residential accounts, to estimate the residential share of the costs. The cost per household was then determined by dividing the residential cost by the number of residential customers. The total estimated cost per household calculated for this assessment is summarized in Table 5-5.

Table 5-5:
Annual Residential Cost per Household

Description	Amount
Current Annual Costs	
Operation & Maintenance Expense	$ 3,242,866
Capital Expenditures	1,003,507
Total Current Annual Costs	$ 4,246,373
Amortized LTCP Capital Costs[1]	463,847
Total Annual Cost	$ 4,710,220
Residential Cost Share[2]	$ 2,494,969
Residential Accounts	6,816
Residential Cost per Household	$366.05

[1] Included $5,140,000 in Phase I and Phase II LTCP costs, amortized over 20 years at an interest rate of 5.0 percent. Future costs exclude any system rehabilitation/replacement expenditures that may be required to maintain or improve the condition of the system.

[2] Total costs apportioned to inside-city residential customers based on estimates of residential flow as a percentage of the total system flow.

5.3.3. Median Household Income

Multiple statistical sources were evaluated for MHI data within the Kingston region. Data were reviewed from the U.S. Census Bureau 2000 census and the U.S. Census Bureau American Community Survey (ACS). However, the U.S. Census Bureau 2006-2008 American Community Survey 3-Year Estimates information, adjusted to 2010, was utilized because it was the most recent data available from the U.S. Census Bureau. The 2008 MHI value of $45,066 was adjusted to the 2010 value of $47,600 by applying an annual inflation factor of 2.8 percent to the ACS census information.

The average Consumer Price Index (CPI) during the past ten years (1999 through 2008) for the Northeast Urban region was used as the annual inflation factor.[1] The ten-year average CPI for this region was calculated and found to be 2.8 percent. The following equation was used to inflate the MHI data and corresponding statistics to 2010 dollars.

$$\mathrm{MHI}_{2010} = \mathrm{MHI}_{2008} * (1 + \mathrm{CPI})^{(2010-2008)}$$

The 2010 MHI value was estimated to be $47,600 as shown in Table 1-5.

5.3.3.1. Residential Indicator

The Residential Indicator was calculated for the City by dividing the cost per household by the MHI. The results of this calculation are shown in Table 5-6.

Table 5-6:
Residential Cost and % of MHI (the Residential Indicator)

Description	Residential Cost per Yr	Estimated 2010 MHI	Cost as % of MHI	EPA Impact Range
City of Kingston	$366	$47,600	0.77%	Low Range

The Residential Indicator was estimated to be approximately 0.77 percent. This result was compared to EPA financial impact ranges documented in the EPA guidance document to assess the financial impact that may be placed on the City's residential customers. The comparison indicates that the financial impact of current and projected wastewater collection and treatment costs, including planned LTCP costs is in the "Low" range, as shown below:

Financial Impact	Residential Indicator (Cost per household as % of MHI)
Low	Less than 1.0 Percent of MHI
Mid-Range	1.0 – 2.0 Percent of MHI
High	Greater than 2.0 Percent of MHI

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[1] US Department of Labor, Bureau of Labor Statistics (ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt

5.4. Potential Annual Financial Impact Analysis

This section provides an alternative assessment using additional information relevant to assessing financial capability in addition to the US EPA Financial Capability Assessment method. The method used in this section examines the annual wastewater rate increases that would be required to pay for the capital program, as well as the cost of wastewater services as a percentage of MHI. In this analysis, annual rate increase needs were estimated based on the City's estimated annual revenue requirements. The total annual wastewater cost per customer was then divided by the estimated MHI to project the change in the Residential Indicator over time.

The same financial capability threshold of wastewater utility costs equal to 2.0 percent of the median household income of the service area was employed (based on the 2.0 percent guideline set by the US EPA in 1997 for the purpose of assessing the financial capability of the proposed wastewater treatment and LTCP. However, it is important to note that using a community-wide financial capability threshold does not imply that all customers within each community will be able to "afford" wastewater utility service if the costs (or rates) are below the 2.0 percent threshold. Rather, the threshold is used as a means to assess the community's ability to afford the programs as a whole.

The EPA guidance document correlates the financial impact range with the general time period allowed for scheduling the implementation of CSO controls. In general, a City scoring in the "Low Burden" category would be expected to implement CSO control projects based on a normal engineering and construction schedule.

5.4.1. Rate Impacts and Affordability

Historical sewer fund revenues and expenses were reviewed along with the wastewater treatment and proposed LTCP cost information to develop a long-term cash flow and rate revenue requirements forecast. These revenue requirements were then used to estimate future sewer rates for residential customers. The annual financial impact analysis was based on the following assumptions:

- Operating expenses were projected to increase by approximately 3.0 to 4.0 percent per year, including escalation of labor costs at 2.5 percent per year, fringe benefits at 4.0 percent per year, energy costs at 4.0 percent per year, and other costs at a general inflation rate of 2.8 percent per year.
- The rate of future customer growth was estimated to increase by approximately 0.06 percent each year over the forecast period.
- The projected capital projects were assumed to be funded with General Obligation bonds. General Obligation bond financing assumptions consisted of a repayment period of 20 years and an interest rate of 5.0 percent. It was also assumed that a debt issuance cost of 1.5% of the revenue bond issuance amount would be incurred. A

debt service coverage requirement of 1.0 was assumed for General Obligation bond debt.

- The MHI for the City was assumed to increase at a rate of approximately 2.8 percent, based on historical trends in the consumer price index. To the extent that the MHI for the City increases more slowly, the residential cost as a percentage of MHI will be higher.

The projected annual residential costs over the 10-year forecast period was estimated based on the assumptions described above, and the results are shown in Table 1-6 and Figure 1-1. The results indicate that relatively moderate rate increases (in the range of 0 percent to 4 percent per year) would be needed to generate sufficient revenues to cover operation and maintenance costs, pay the existing and projected debt service obligations, and pay for the debt service associated with the LTCP.

The projected annual residential cost as a percentage of MHI over the forecast period is shown in Figure 1-2. The analysis results indicate that the residential cost as a percentage of MHI will likely remain below the high burdened financial capability threshold of 2.0 percent if the City were to implement a LTCP project with costs equal to $5,140,000 in the 2011 fiscal year. The results indicate that the City would not likely experience a high financial burden (as defined by the US EPA guidance document) as a result of implementing the LTCP project in the 2011 fiscal year.

Table 5-7:
Anticipated Rate Impact on Residential Customers

City of Kingston, NY
Assuming an average of 8 ccf used per month, per residence

Year	Projected Rate Increase	Rate per ccf	Annual Cost
2010	na	$4.67	$448.32
2011	4.00%	$4.86	$466.25
2012	4.00%	$5.05	$484.90
2013	4.00%	$5.25	$504.30
2014	4.00%	$5.46	$524.47
2015	0.71%	$5.50	$528.20
2016	0.90%	$5.55	$532.93
2017	1.95%	$5.66	$543.32
2018	1.54%	$5.75	$551.67
2019	2.01%	$5.86	$562.78
2020	2.04%	$5.98	$574.29

Therefore, in order for the City to pay for LTCP project, the following would be necessary:

- The City would either need to issue debt to pay for the LTCP (assumed approach), or utilize existing cash reserves to fund the LTCP project.
- The City as a whole would need to accept a few years of moderate wastewater rate increases, which will increase the annual sewer cost to customers.

However, it is important to note that additional capital expenditures will likely be required over the forecast period to rehabilitate or replace aging infrastructure, and these costs have not be included in the analysis. When these costs are incurred, they will increase the annual customer cost and in turn, increase the cost as a percentage of MHI.

Figure 5-2: Projected Annual Residential Sewer Cost

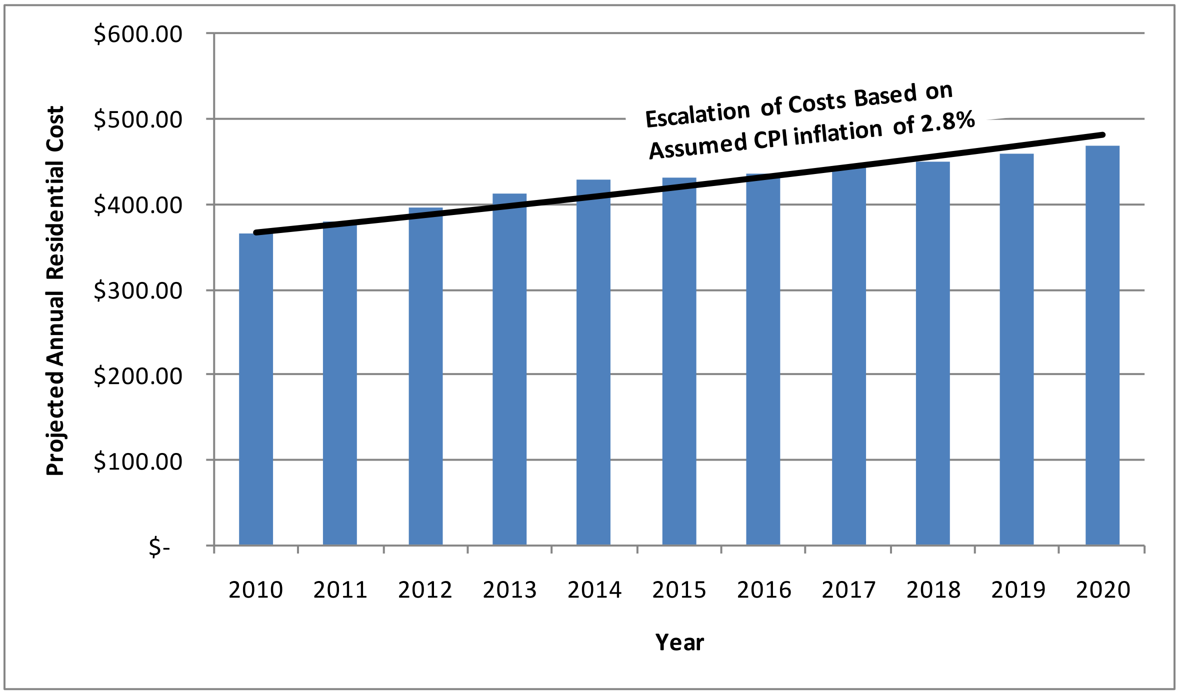
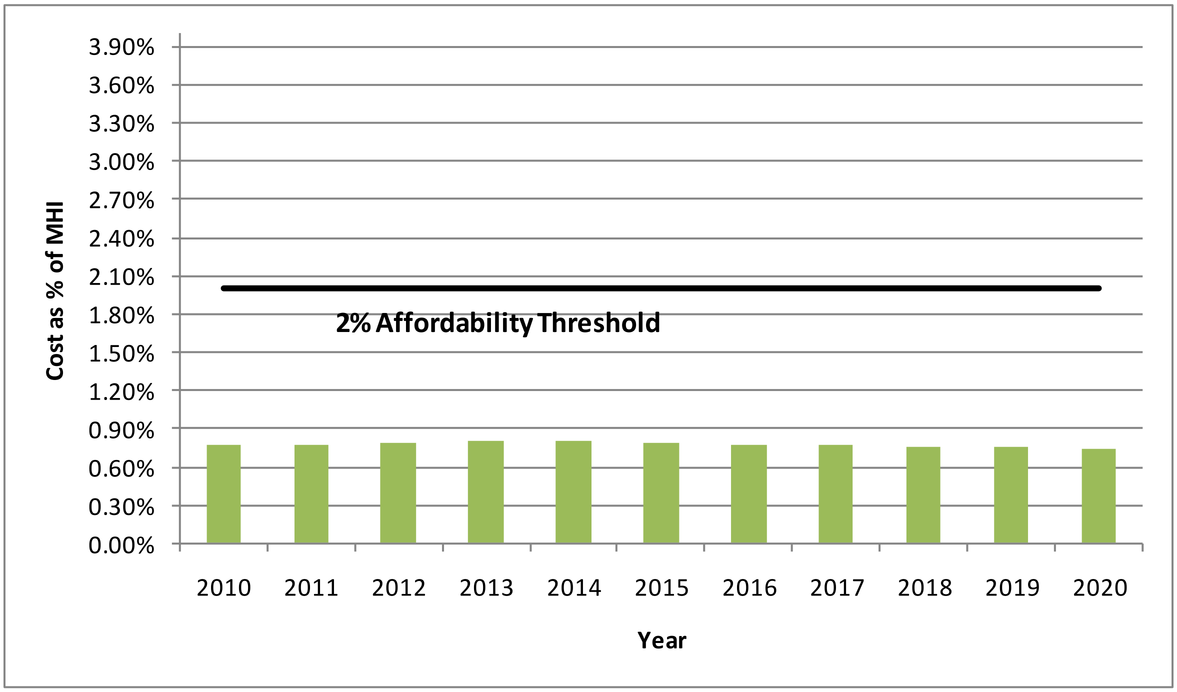


Figure 5-3: Projected Cost as a Percent of MHI



5.5. Implementation Schedule

The implementation schedule begins in 2011 with the design and bid of the Hasbrouck Regulator Upgrades. The construction of the Hasbrouck Regulator follows in 2012 with post-construction flow monitoring and water quality sampling following. As shown in Figure 5-4, schedule is complete at the end of 2014 if water quality conditions are met as outlined in Section 5.1. If water quality conditions are not met, a longer schedule, shown in Figure 5-5, is implemented that allows for the construction of storage, post construction monitoring and reassessment, if required.

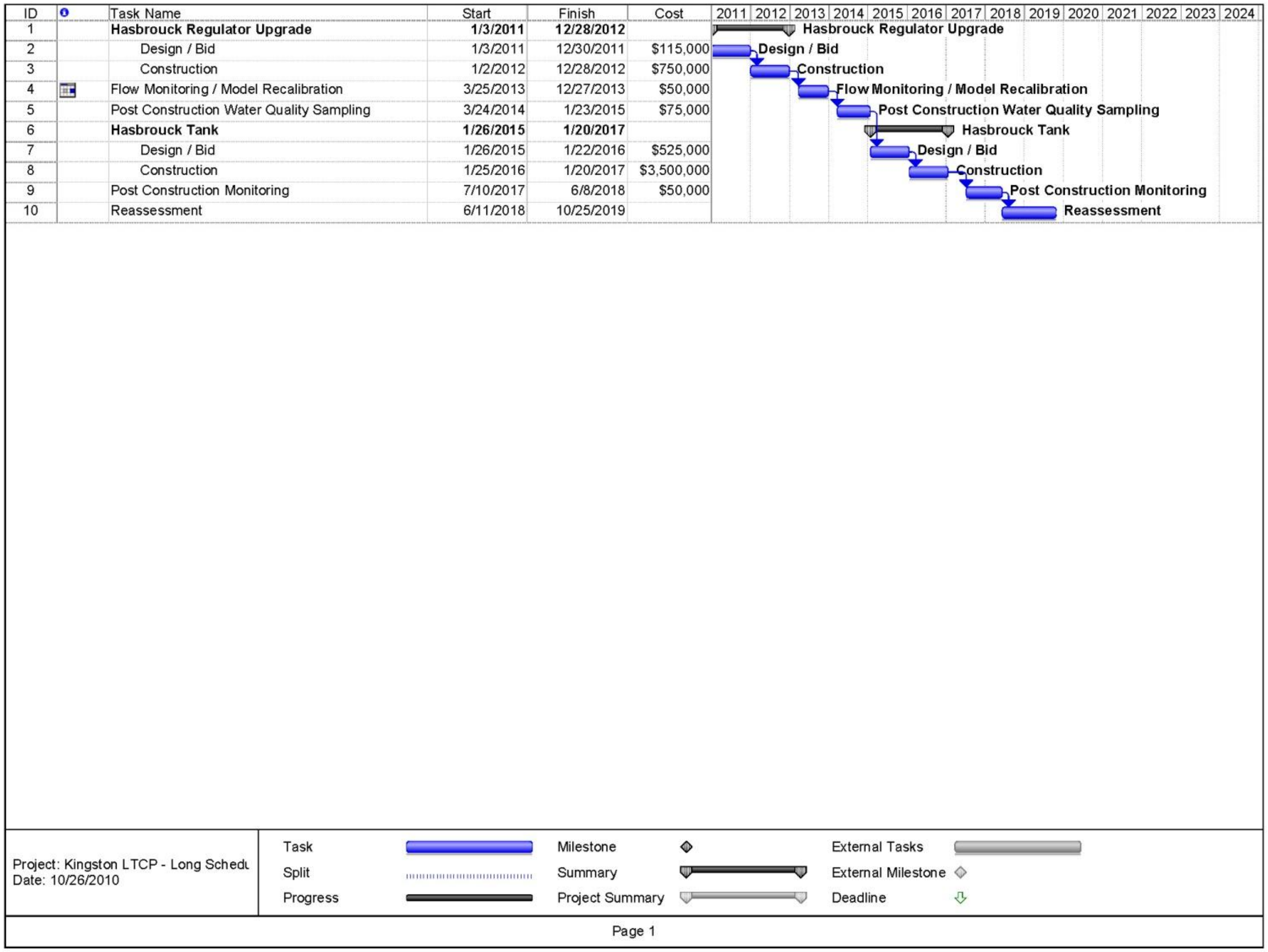
Figure 5-4: Kingston CSO LTCP - Short Schedule

ID	ℹ	Task Name	Start	Finish	Cost
1		**Hasbrouck Regulator Upgrade**	**1/3/2011**	**12/28/2012**	
2		Design / Bid	1/3/2011	12/30/2011	$115,000
3		Construction	1/2/2012	12/28/2012	$750,000
4	▦	Flow Monitoring / Model Recalibration	3/25/2013	12/27/2013	$50,000
5		Post Construction Water Quality Sampling	3/24/2014	12/26/2014	$75,000

Project: Kingston LTCP - Short Sched
Date: 10/26/2010

Page 1

Figure 5-5: Kingston CSO LTCP - Long Schedule



ID	ℹ	Task Name	Start	Finish	Cost
1		**Hasbrouck Regulator Upgrade**	**1/3/2011**	**12/28/2012**	
2		Design / Bid	1/3/2011	12/30/2011	$115,000
3		Construction	1/2/2012	12/28/2012	$750,000
4	▦	Flow Monitoring / Model Recalibration	3/25/2013	12/27/2013	$50,000
5		Post Construction Water Quality Sampling	3/24/2014	1/23/2015	$75,000
6		**Hasbrouck Tank**	**1/26/2015**	**1/20/2017**	
7		Design / Bid	1/26/2015	1/22/2016	$525,000
8		Construction	1/25/2016	1/20/2017	$3,500,000
9		Post Construction Monitoring	7/10/2017	6/8/2018	$50,000
10		Reassessment	6/11/2018	10/25/2019	

Project: Kingston LTCP - Long Schedu
Date: 10/26/2010

Page 1

5.6. Post Construction Monitoring

Post Construction Monitoring as described in this section is the method used to assess whether the steps taken to control discharges from the Combined Sewer System comply with the USEPA CSO Policy and, further, whether in complying with the Policy the Rondout Creek meets or is not precluded from meeting Water Quality Standards. This Post Construction Monitoring plan utilizes and updates the Sampling and Monitoring Plan approved by NYS DEC in 2007 and used by the City of Kingston to collect the sampling data that is the basis for this CSO LTCP.

5.6.1. Receiving Water Monitoring Plan

5.6.1.1. Intent

The intent of the receiving water sampling effort will be to characterize the existing water quality during both dry and wet weather events, to assess the background pollution levels, to assess if Rondout Creek meets WQS and to assess whether the Kingston CSOs preclude meeting those standards.

5.6.1.2. Methodology and Scope

A minimum of five sampling events will be conducted per month at the five sampling points located upstream and downstream from the four CSO discharge sites and the WWTF. The sampling events will be conducted weekly, with one additional sampling event to be conducted within two to four hours of a precipitation event commencing that would most likely result in an overflow. The four monthly samples will be taken once a week during dry weather no earlier than 72 hours after rainfall events. During excessively wet months, the remaining three samples can be taken at least 24 hours after rainfall events. To take advantage of the existing 30-day geomean based water quality standards for fecal coliform concentration in the receiving stream, the City reserves the right to increase the sampling frequency and/or develop a simplified one-dimensional water quality model to approximate a geomean from 30 daily samples.

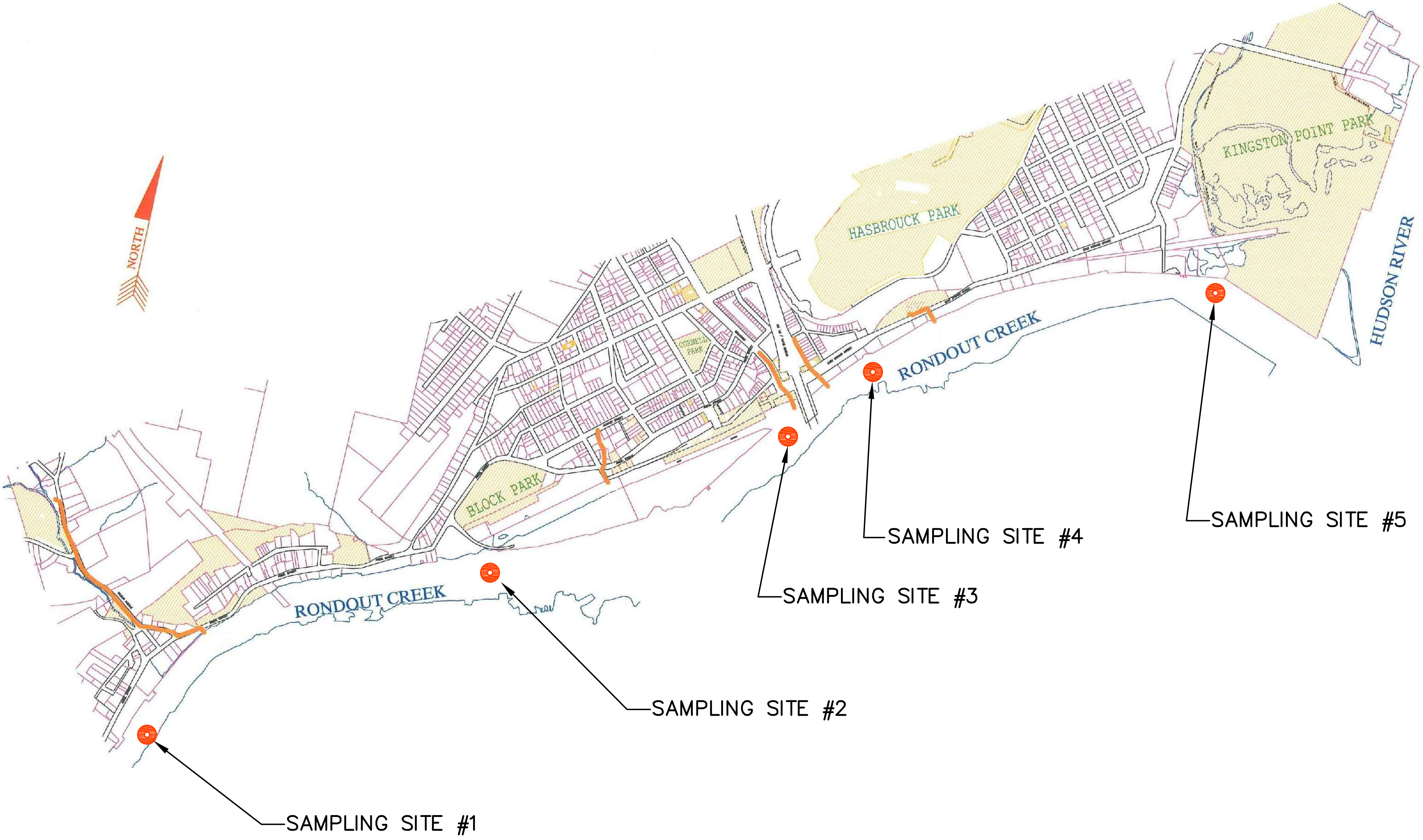
Grab samples collected will be collected at the water surface and will be analyzed for:

- Total suspended solids;
- Settleable solids;
- Fecal coliform;
- Dissolved oxygen (DO); and
- Floatables.

Sampling events will no earlier than April 1 and will conclude no later than October 31. The sampling locations in the Rondout Creek are shown on Figure 5-6 and are to be consistent with the locations used in 2007.

XREFS: IMAGES: H:\PROJECT\5744004\FILE\CSS Characterization Plan\fig_1_new.JPG

User: Lewandowski Spec: PIRNIE STANDARD File: I:\ACAD\PROJ\5744016\Figures\FIGURE 5-6.DWG Scale: 1:1 Date: 10/29/2010 Time: 14:49 Layout: Layout1



MALCOLM PIRNIE

CITY OF KINGSTON

CSO LONG TERM
CONTROL PLAN

POST CONSTRUCTION MONITORING
CREEK SAMPLING SITES
SCALE: NO SCALE

MALCOLM PIRNIE, INC.

OCTOBER 2010

FIGURE 5-6

5.6.2. Quality Assurance/Quality Control Plan

The water quality sampling QA/QC Plan will be ascertained through the following actions:

- All sampling personnel shall be familiar with the goals and objectives of this sampling program, sampling locations, equipment, and protocol;
- All sampling holding times shall be in full compliance with the requirements set forth in applicable EPA-approved methods published in "*Standard Methods for the Examination of Water and Wastewater*";
- Chains of custody reports shall be completed for all samples and field blanks;
- All analytical work, with the exception of the field measured parameters (Dissolved Oxygen and floatables) shall be performed by a contract laboratory having a New York State Environmental Laboratory Accreditation Program (ELAP) certification (in accordance with the National Environmental Laboratory Accreditation Conference (NELAC) Institute);
- The contract laboratory shall provide a copy of its approved standard operating procedures and protocols for analytical work and QA/QC procedures for each parameter or parameter group in full compliance with applicable EPA-approved methods published in "*Standard Methods for the Examination of Water and Wastewater*"; and
- All equipment to be used for the field measurements shall be in good working order and properly calibrated as per manufacturer's recommendations.

5.6.2.1. Field Work

The field work QA/QC program will be comprised of the following components:

- Equipment blanks;
- Duplicate samples; and
- Laboratory blanks.

5.6.2.1.1. Equipment Blanks

Equipment blanks (rinsate blanks) are defined as samples that are generated by rinsing representative sampling equipment with laboratory analyte-free water and then analyzing the rinsate in a similar fashion as regular samples. Equipment blanks are used to assess the cleanliness of equipment used for sampling and the adherence to equipment cleaning practices. Equipment blanks will be collected from sampling equipment immediately before initiation of each sampling event (dry or wet weather). Each sampling crew that mobilizes to perform sampling for a given event will collect equipment blanks from one sampling jar and from one grab sampling device. Each crew will use laboratory analyte-free water to prepare equipment blanks by rinsing one sampling jar, and one grab sampling device, individually with enough volume to take samples of each of the parameters of concern included in this project. Thus, each sampling crew will have two sets of equipment blank samples: one representative of a sampling jar and the other representative of a grab sampling device. All equipment blanks will be acquired from sampling equipment before sampling crews depart to perform sampling.

5.6.2.1.2. Duplicate Samples

Duplicates samples are defined as a second, or duplicate, set of samples that are obtained from the study matrix which are prepared and analyzed alongside regular samples. Duplicate samples are used to assess the precision of the entire sampling activity. Collecting duplicate samples translates to the collection and additional large grab sample from a given location. For the additional sampling event, the sampling event leader will designate one of the sampling crews to obtain an additional sample volume from their sampling location. The designated crew will collect a duplicate sample.

5.6.2.1.3. Laboratory Blanks

Laboratory blanks are defined as samples of laboratory analyte-free water that are put through similar preparatory and analytical procedures as regular samples. Laboratory blanks are used to assess the accuracy of laboratory analytical procedures. Laboratory blanks will be prepared by contract laboratory personnel in accordance with established QA/QC procedures. Guidelines for laboratory blank preparation and analytical results reporting by contract laboratory will be determined based on correspondence and contract development between the sampling contractor and the contract laboratory. A copy of the contract should be submitted to Malcolm Pirnie for review prior to program initiation.

5.6.2.1.4. Field Documentation During Sampling

Sampling personnel will complete a sample log sheet for each sampling location during the additional sampling event. The log will include documentation of the following during sampling at each location:

- Time of sampling;
- Date of sampling;
- Weather conditions;
- Storm discharge flow/hydraulic conditions (standing water/moving flow, etc.);
- Dissolved Oxygen; and
- Physical Observations:
  - Presence of grease;
  - Presence of floatables;
  - Presence of atypical smells; and
  - Color.

Any other comments regarding additional observations deemed relevant should be recorded. The log will be completed by the sampler and given to the sampling leader upon completion of the sampling event.

Each container for grab sampling of the receiving water will be labeled on its cover with the name of the sample location.

5.7. Combined Sewer System Monitoring

It is the intent of the City of Kingston to replace metering equipment in the overflow chambers located at two of the existing CSOs, place an insert area-velocity meter downstream of the diversion chamber at Hunter Street, and place a level transducer in the equalization tank of the Wilber Avenue. These meters will allow the City to collect a minimum of one year of data pertaining to the frequency, duration, and volume of overflows throughout the City.

5.7.1. Methodology

One of the conditions to be met for compliance with the Ninth Minimum Control is the monitoring of the frequency of the overflow events at each CSO, where feasible. For the purposes of this post-construction monitoring, the City will install automatic metering equipment and data loggers at any regulator that does not have flow monitors installed and in working order to accurately assess the frequency, duration, and volume of the overflow discharges as discussed herein.

5.7.2. Rainfall Data

The rainfall gauge at the WWTF will be inspected every day to see if any measurable rainfall has occurred in the last 24 hours. If so, the rainfall amount, date, and approximate duration will be recorded. During periods of dry weather, outfalls will be inspected at least once per week.

5.7.3. Rondout Creek Stage, Flow and Volume

Rondout Creek stage, flow and volume will be acquired from the USGS for use in the data analysis.

5.7.4. Water Quality Evaluations

The data will be reviewed for trends during dry and wet weather conditions. Figures and tables will be developed to illustrate the changes in water quality parameters tested during the monitoring period. Dry weather and wet weather baseline conditions will also be summarized for use in preliminarily evaluating water quality in comparison to the receiving stream water quality standards.

Estimated pollutant loadings from each CSO will be developed by utilizing the flow frequency, duration and volume data developed through the CSS monitoring discussed in Section 4. Typical pollutant values for CSOs presented in the Report to Congress, *Impacts and Control of CSOs and SSOs*, dated August 2004, will be utilized for the estimation of the pollutant loadings to the receiving stream.

Further evaluations will be performed to estimate whether the CSO discharges from the City result in exceeding or preclude from the attainment of the receiving stream water quality standards.

The extent of the water quality evaluations necessary for assessing the impact from the City's CSOs on the Rondout Creek will be determined upon collecting and evaluating the CSO discharge flow data and the receiving stream water quality data. As stated before, to take full advantage of the existing water quality standards, the City may decide to increase a number of samples during a 30-day period or to develop a one-dimensional water quality model to further support the water quality evaluations.

6. Public Participation

Throughout the development of this Long-Term Control Plant, input has been provided from a focused team of stakeholders that have worked to see that the recommendation put forward in this CSO LTCP are consistent with the priorities, resources and physical layout of the City of Kingston. The stakeholder team consisted of:

- James Sottile, Mayor
- Charles Landi, Alderman
- John Tuey, Comptroller
- Ralph Swenson, PE, City Engineer
- Alan Adin, Engineering Technician
- Michael Schupp, Superintendant of Public Works
- Allen Winchell, Waste Treatment Plant
- Ed Herwig, Wastewater Treatment Plan
- Robert Cacchio, CAMO Pollution Control

Workshop sessions were held with the stakeholder team at key points throughout the CSO LTCP process including:

- Completion of flow monitoring: initial dissemination of performance results;
- System Characterization: key triggers to CSO activations; and
- Alternatives Development: CSO technology and feasibility.

Key exchanges from the workshop sessions included:

- Preference for simple, storage systems over complex treatment facilities;
- Requirement to protect adjacent customers from high water levels;
- Emphasis on access for maintenance;
- Preference for the investigation and possible use of green infrastructure;
- Requirement to keep expenditures reasonable until economy recovers; and
- Priority to continue to serve satellite and growth customers as a revenue base.

With the drafting of the LTCP, workshops are planned for a broader stakeholder base to explore the details of the projects presented in this plan. A November 2010 stakeholder workshop will focus on Rondout Water Quality Standards and the LTCP as planned in phase.

A second series of stakeholder workshops will be hosted after the implementation of the regulator modifications and post construction monitoring. The workshops will focus on the results of the sampling and, if additional controls are requirement, the technology and locations of facilities.

1652

City of Kingston
420 Broadway • Kingston, NY 12401

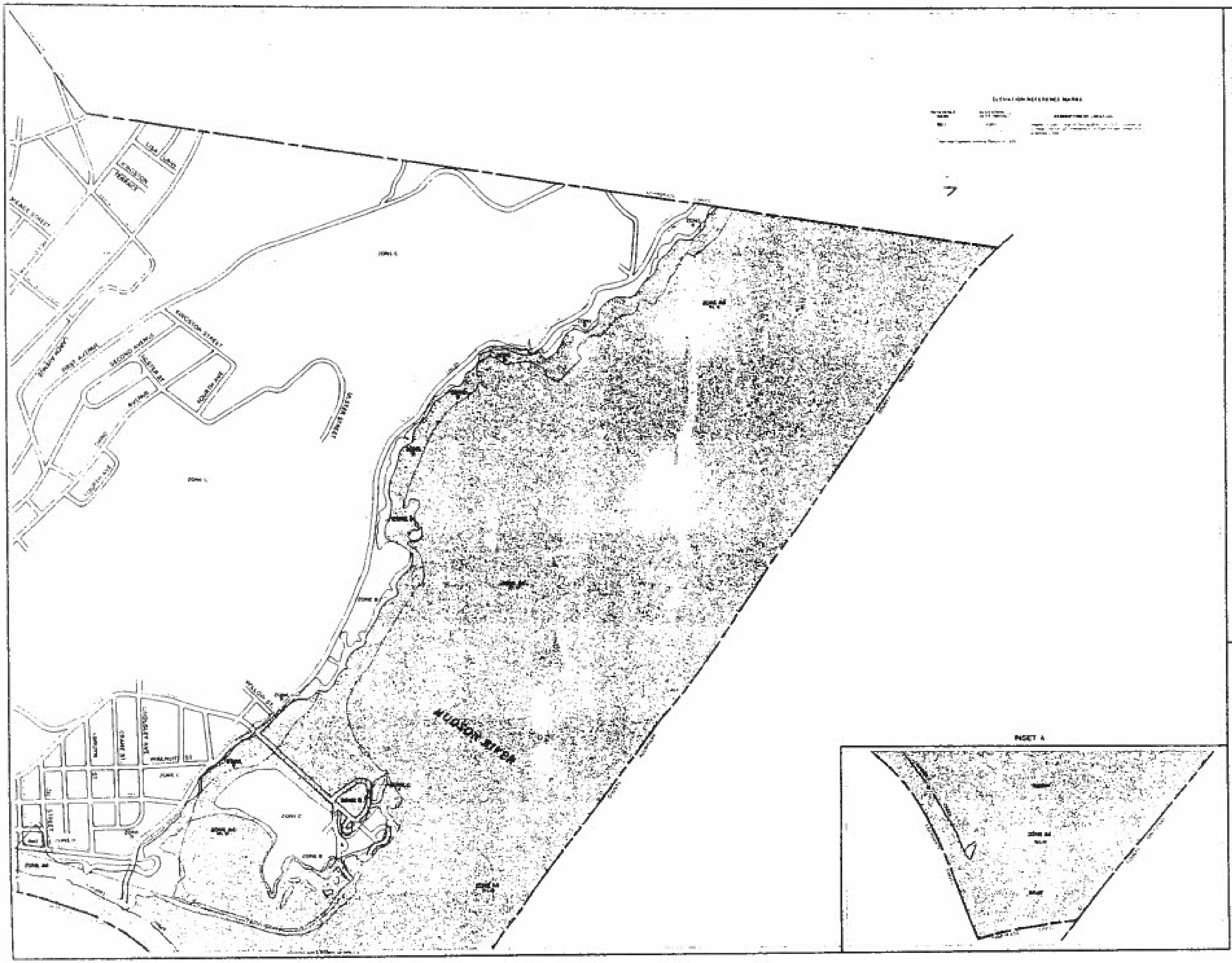
APPENDIX

A

FEMA Maps

4098046

MALCOLM
PIRNIE



FIRM
FLOOD INSURANCE RATE MA

CITY OF
KINGSTON,
NEW YORK
ULSTER COUNTY

PANEL 3 OF 3

COMMUNITY-PANEL NUMBE

EFFECTIVE DAT

City of Kingston
420 Broadway • Kingston, NY 12401

APPENDIX

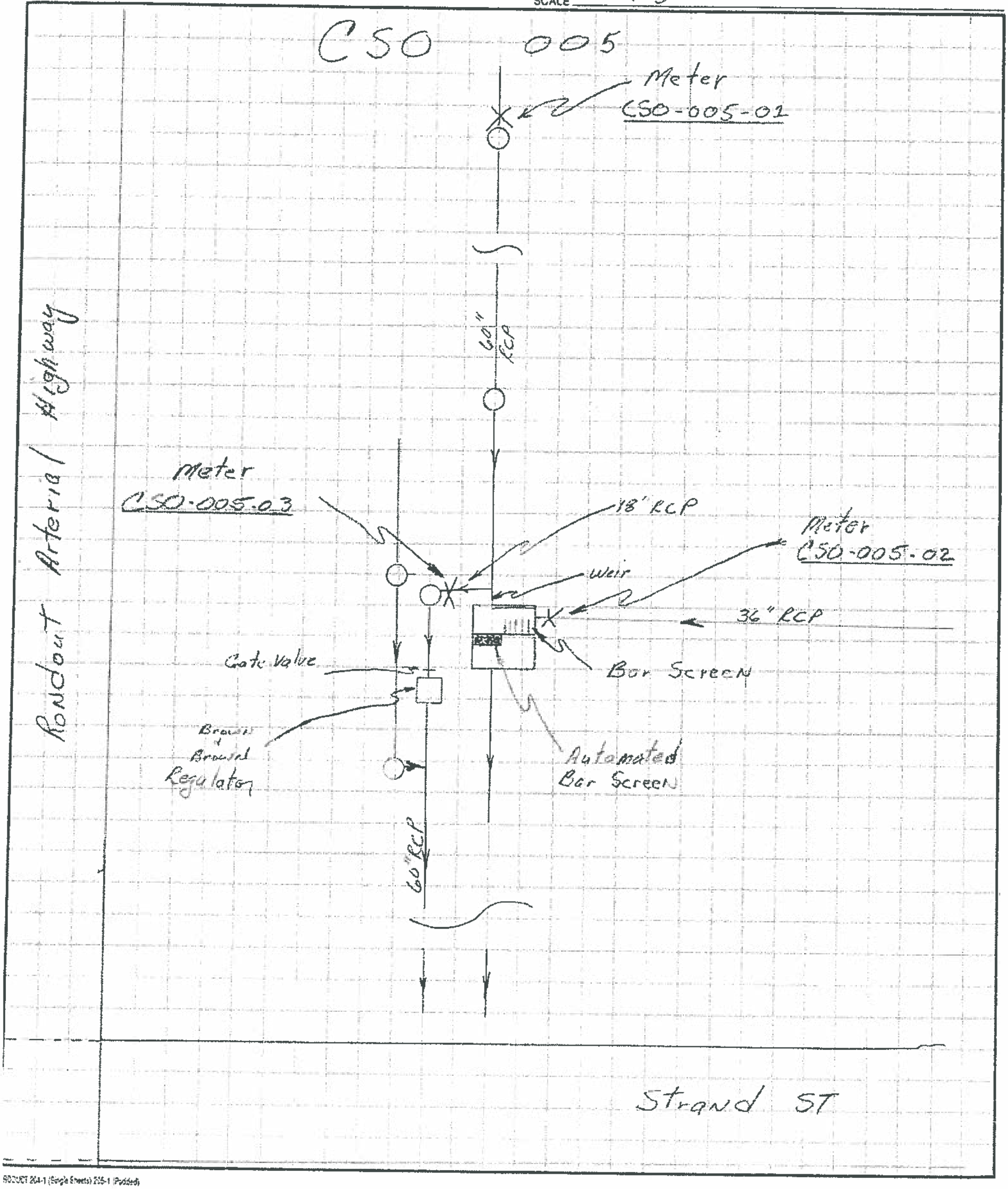
B

Regulator Sketches

MALCOLM PIRNIE

Flow Assessment
SERVICES LLC
19 Harvey Road, Suite 22
Bedford, NH 03110
(603) 656-9799

SHEET NO. ______ OF ______
CALCULATED BY ______ DATE 8-11-05
CHECKED BY ______ DATE ______
SCALE NTS

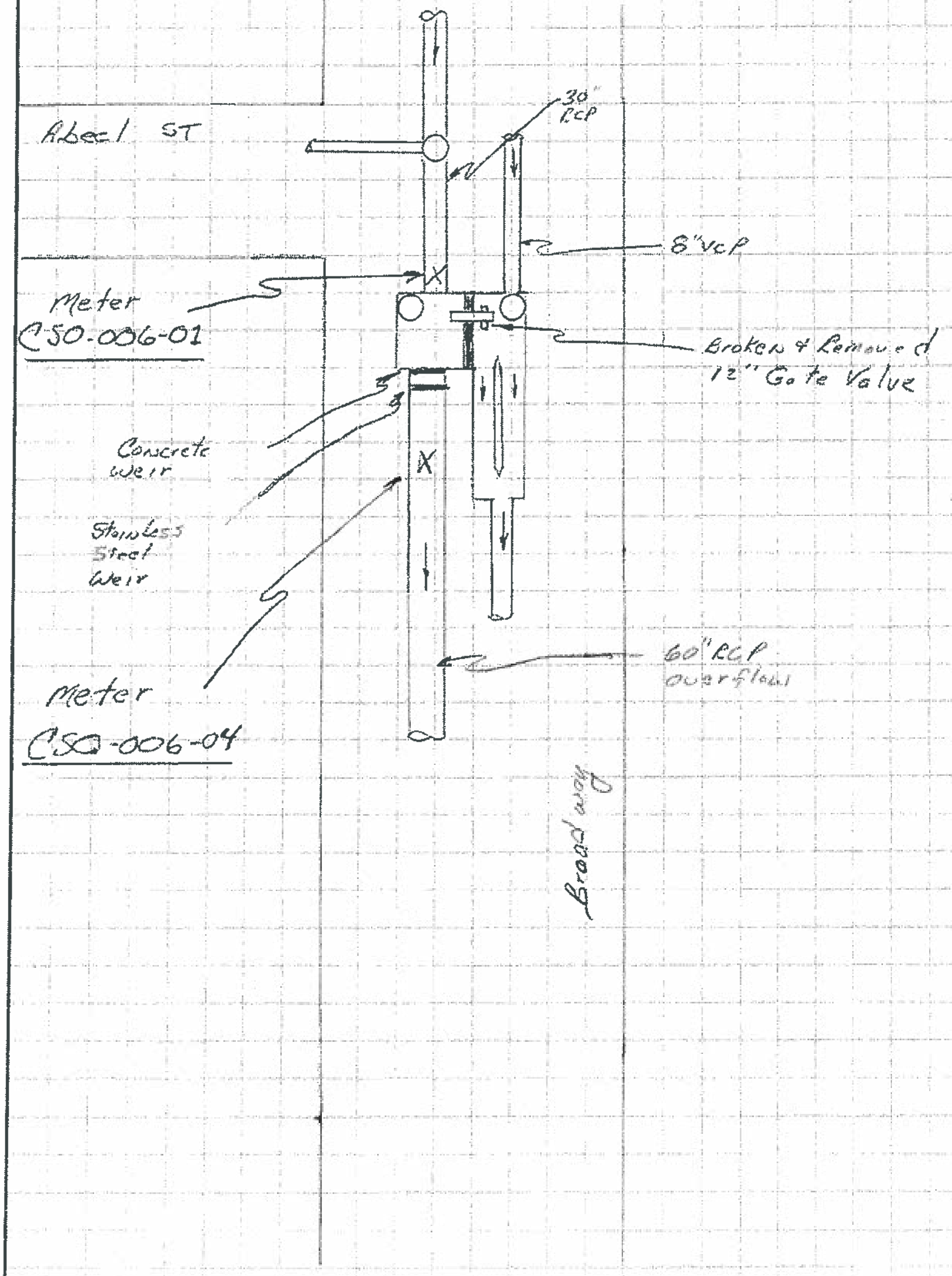


[illegible] 204-1 (Single Sheets) 205-1 (Padded)

FLOW Assessment
SERVICES LLC.
19 Harvey Road, Suite 22
Bedford, NH 03110
(603) 656-9799

JOB [illegible]
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE 8-11-09
CHECKED BY ____ DATE ____
SCALE NTS

CSO 006



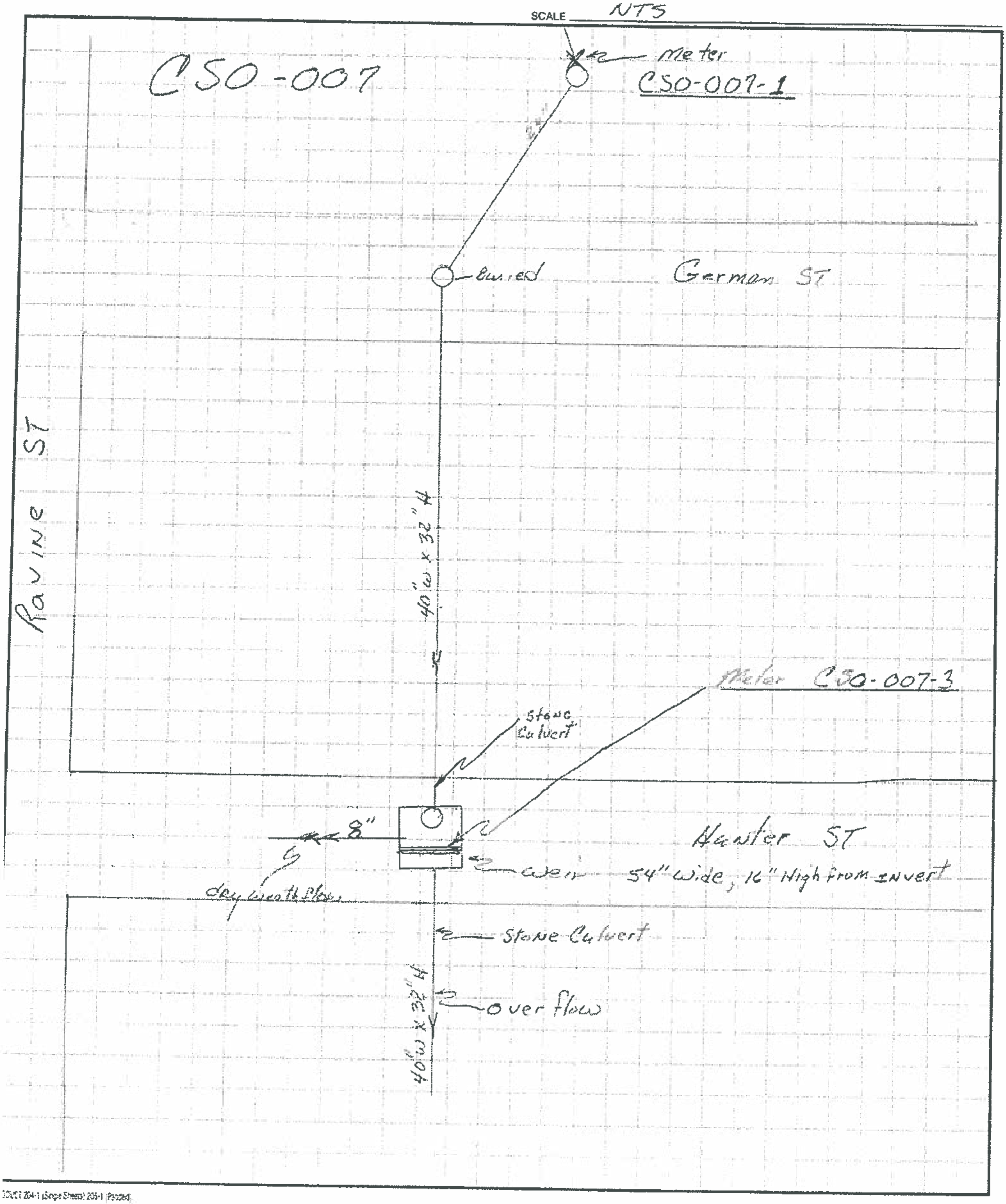
Flow Assessment Services LLC
19 Harvey Road, Suite 22
Bedford, NH 03110
(603) 656-9799

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE 08-12-09

CHECKED BY ______ DATE ______

SCALE NTS

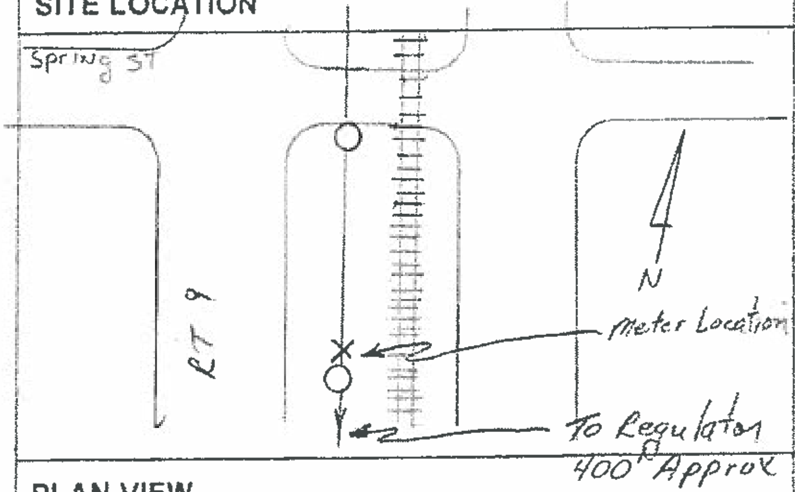


[illegible] 204-1 (Single Sheets) 205-1 (Padded)

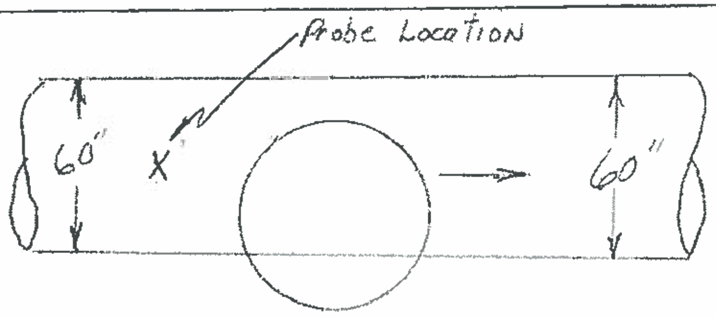
FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

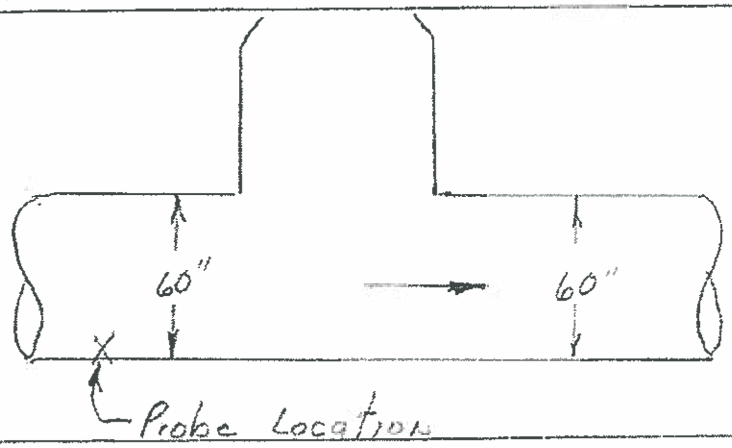
SITE LOCATION



PLAN VIEW



PROFILE VIEW



PROJECT: Kingston NY

LOCATION: R/W off Rt 9

MH#: 29

#: CSO-005-01

DATE: 8-11-09

TIME:

REGULATOR#

LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	60	60	
MATERIAL	RCP	RCP	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	12'8"	12'8"	

(Please see back for additional lines)

WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

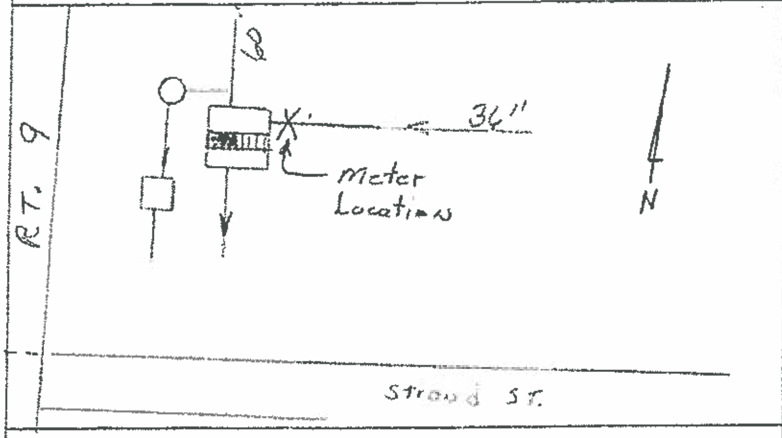
~~OVERFLOW OCCURS~~ @

Photo 131

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: R/w off Strand ST, in Apt Complex

~~[illegible]~~: Meter CSO - 005-02

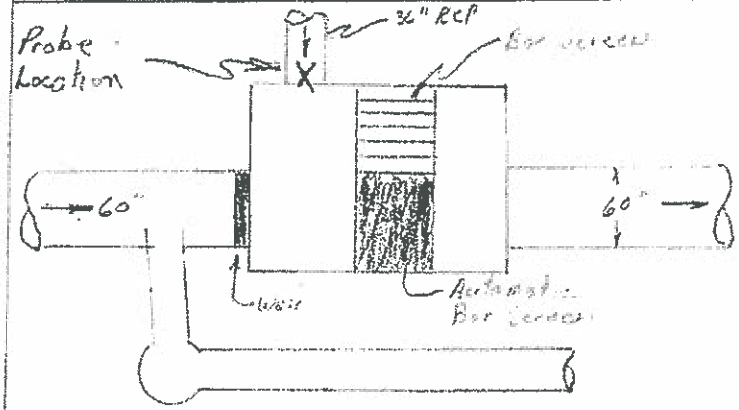
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

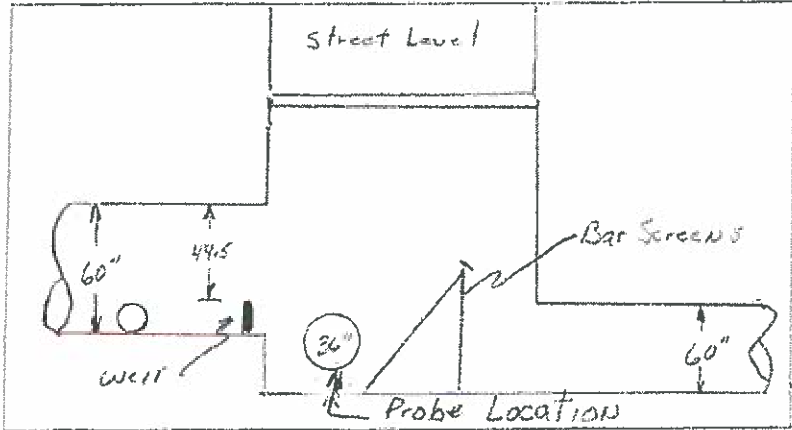


LINE DESCRIPTIONS

	INCOMING	~~OUTGOING~~ Weir	OVERFLOW
SIZE	36"		60"
MATERIAL	RCP	Stainless Steel	RCP
DEBRIS	0	0	0
SHAPE	Round	—	Round
DEPTH	12'6"	9'0"	13'9"

(Please see back for additional lines) Depth To ground Level of Building

PROFILE VIEW



WEIR

LENGTH

BREADTH 125

LEVEL [✓ YES] NO

HEIGHT ABOVE WEIR

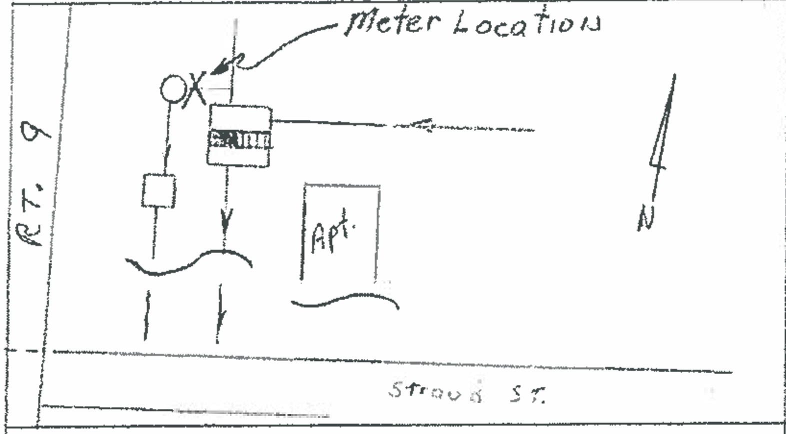
OVERFLOW OCCURS @ 15.5

Photo 126, 125

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: R/w off Strand ST in Apt Comp

MH#: Meter CSO-005-3

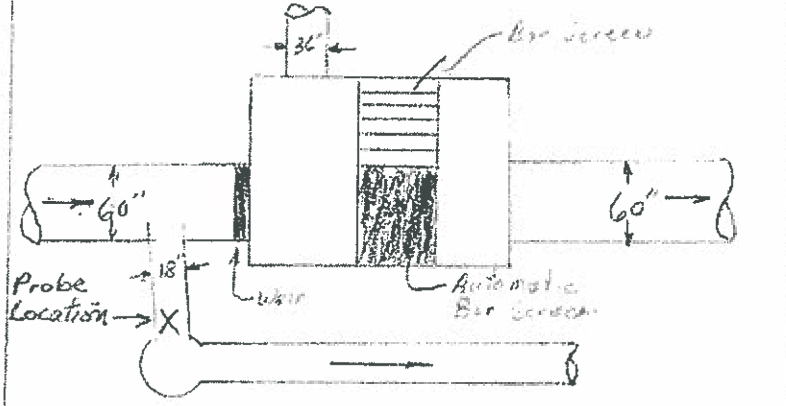
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

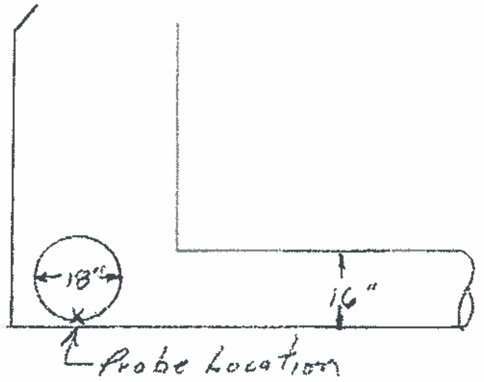


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	18"	16"	
MATERIAL	RCP	RCP	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	12'1"	12'2"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

~~OVERFLOW OCCURS~~ @ 15.5

Photo 124

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

PROJECT: Kingston NY.

LOCATION: Broadway + Abeel ST

meter CSO-006-01

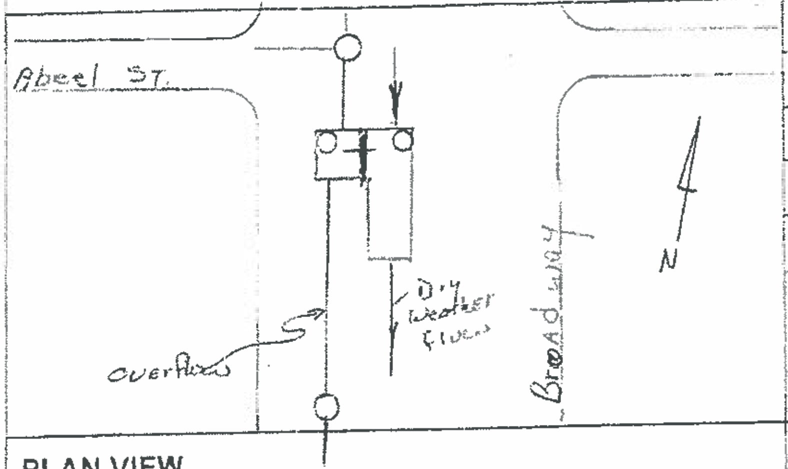
MAP#

DATE: 8-11-09

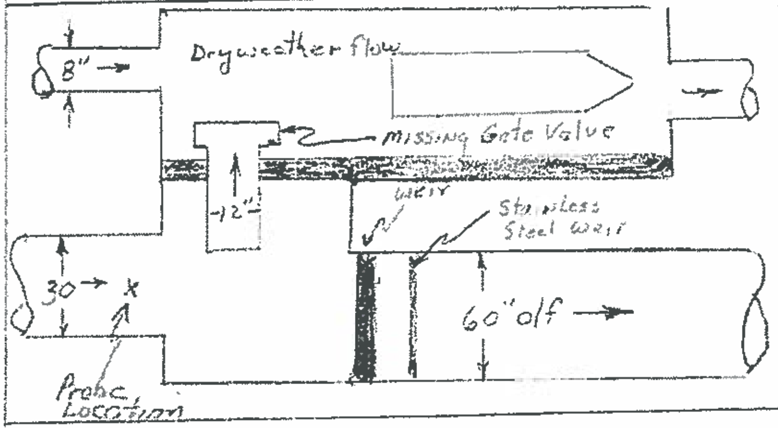
TIME:

REGULATOR#

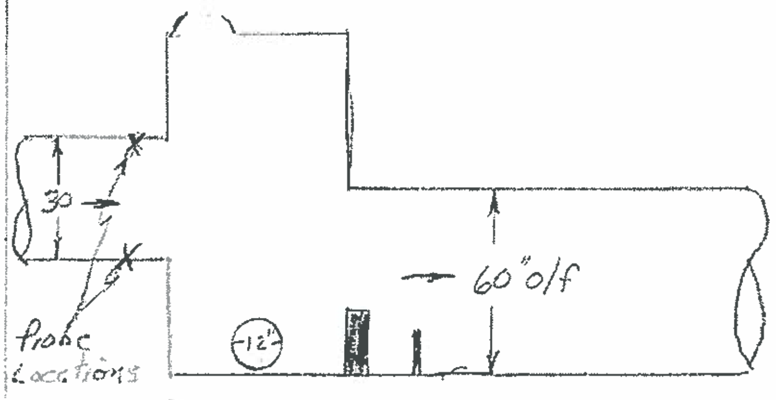
SITE LOCATION



PLAN VIEW



PROFILE VIEW



LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	30"	12"	60
MATERIAL	RCP	CIP	RCP
DEBRIS	0	0	0
SHAPE	Round	Round	Round
DEPTH	9'4"	11'8"	11'0"

(Please see back for additional lines)

WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

OVERFLOW OCCURS @

Photo 130

FLOW Assessment SERVICES LLC.

DETAILED SITE INVESTIGATION

PROJECT: Kingston NY.

LOCATION: Broadway & Abeel ST

Meter CSO-006-04

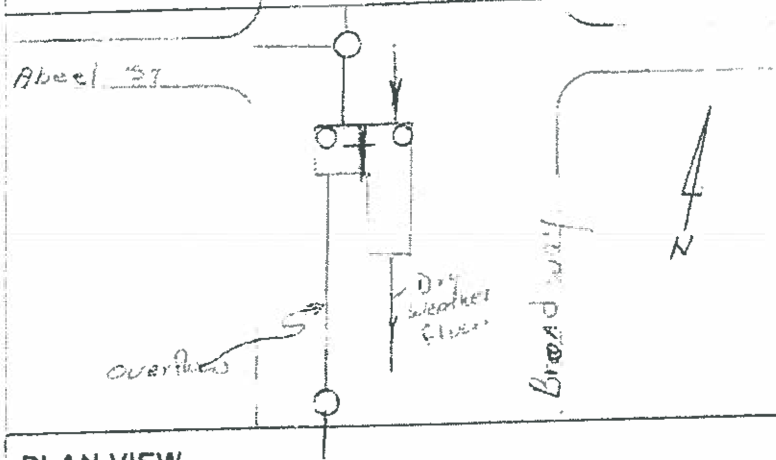
MAP#

DATE: 8-11-09

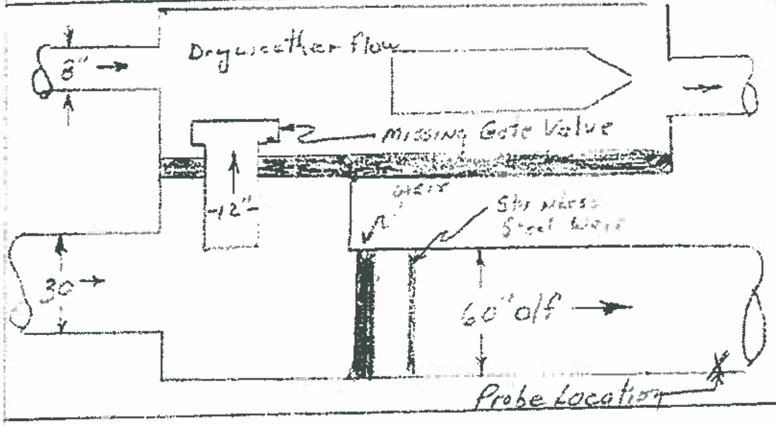
TIME:

REGULATOR#

SITE LOCATION



PLAN VIEW

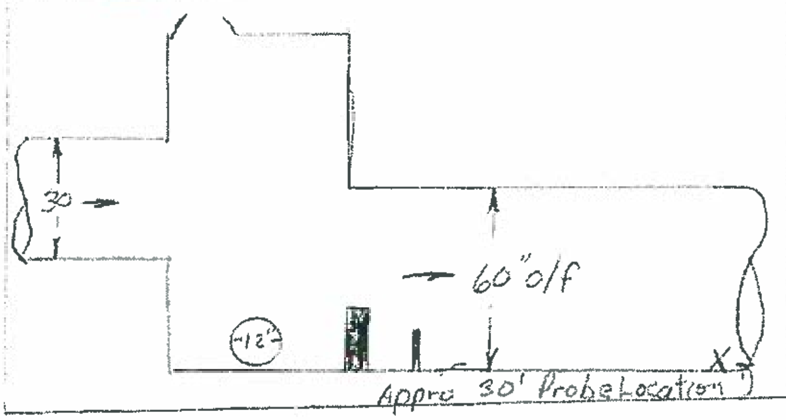


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	30"	12"	60
MATERIAL	RCP	CIP	RCP
DEBRIS	0	0	0
SHAPE	Round	Round	Round
DEPTH	9'4"	11'8"	11'0"

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH 45

BREADTH 8

LEVEL YES/[✓ NO]

HEIGHT ABOVE WEIR 51

~~OVERFLOW OCCURS~~ @ 9"

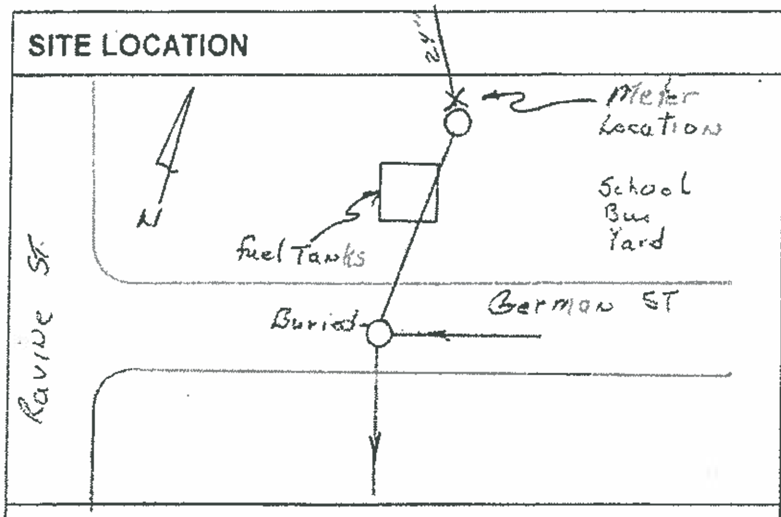
Weir is more an obstruction Than Weir.

Photo 126, 128, 127

FLOW Assessment
SERVICES L.L.C.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY.

LOCATION: R/w off German ST

MH# Meter CSO 007-1

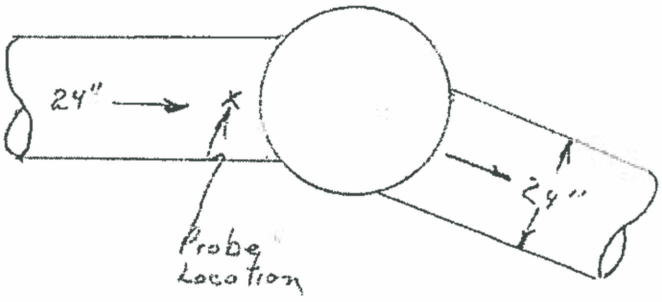
MAP#

DATE: 8-12-09

TIME:

REGULATOR#

PLAN VIEW

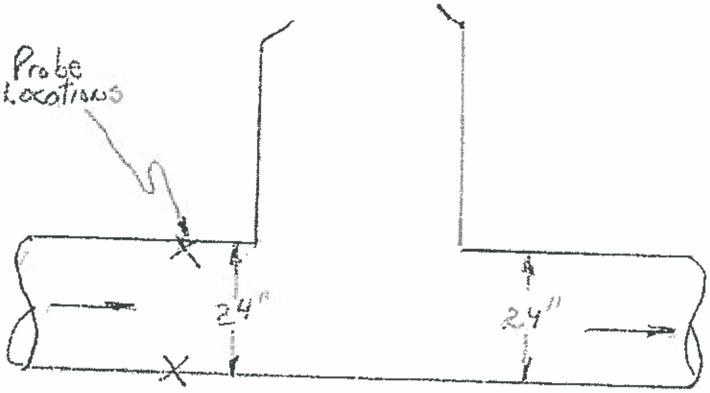


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	24"	24"	
MATERIAL	PVC	PVC	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	4'2	4'3"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

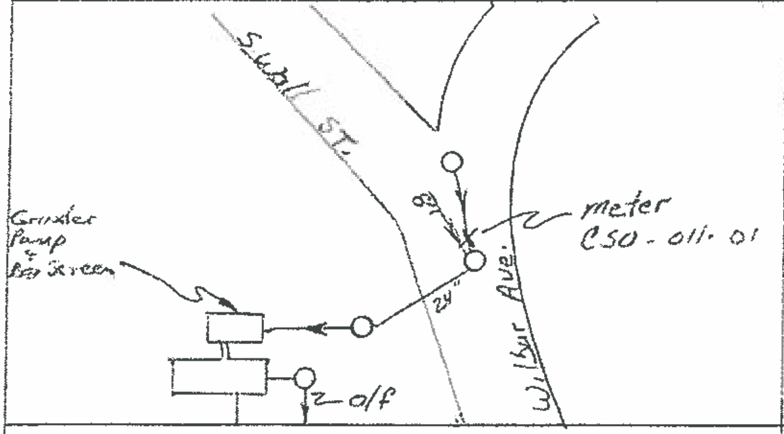
OVERFLOW OCCURS @

Photo 132

FLOWAssessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: Wilbur Ave

[illegible]: meter CSO 011-01

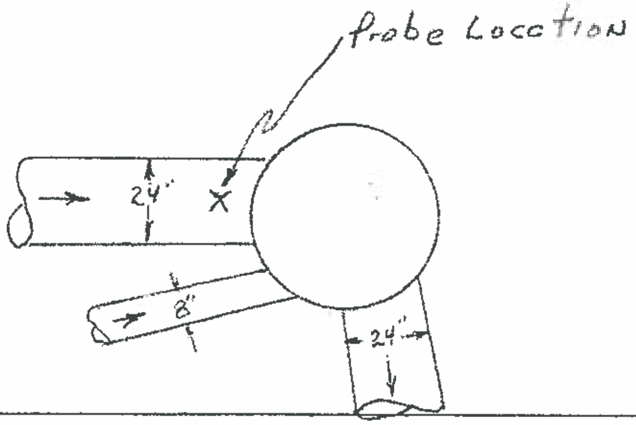
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

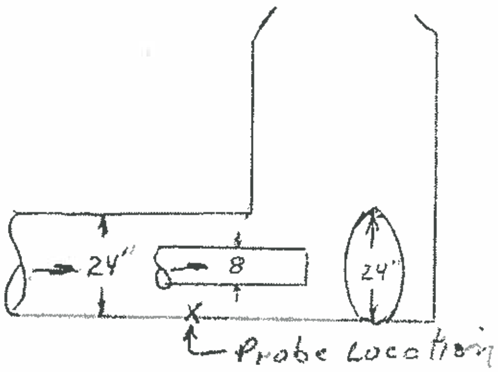


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	24"	24"	
MATERIAL	PVC	PVC	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	7' 1"	7' 1"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

~~OVERFLOW [illegible]~~ @ Photo 121

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

PROJECT: Kingston NY

LOCATION: Wilbur Ave

[illegible] CSO 011-03

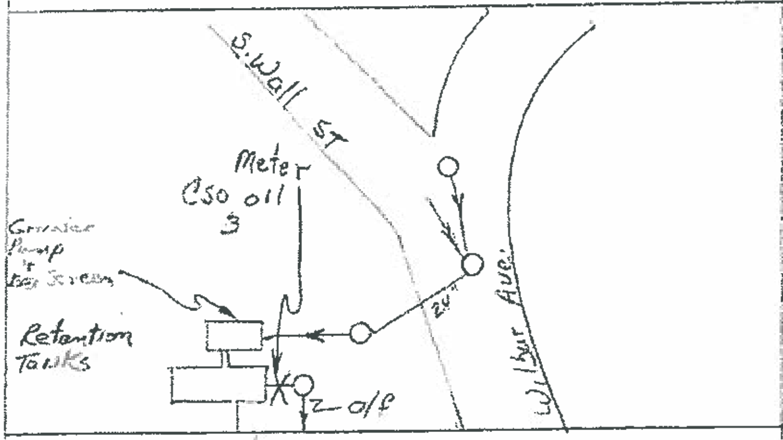
MAP#

DATE: 8-11-09

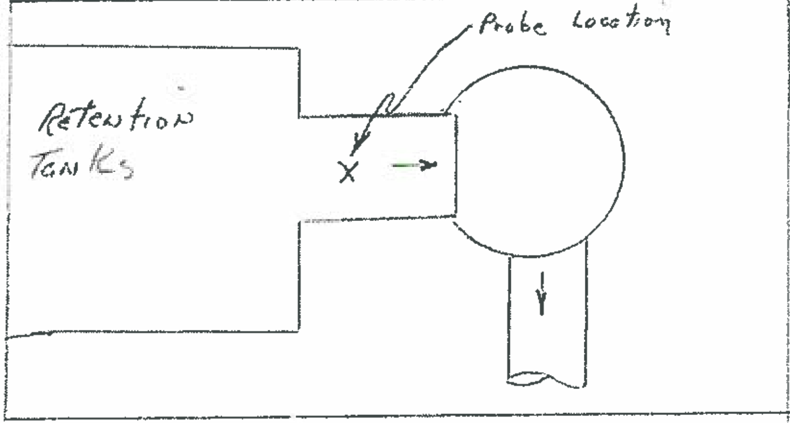
TIME:

REGULATOR#

SITE LOCATION



PLAN VIEW

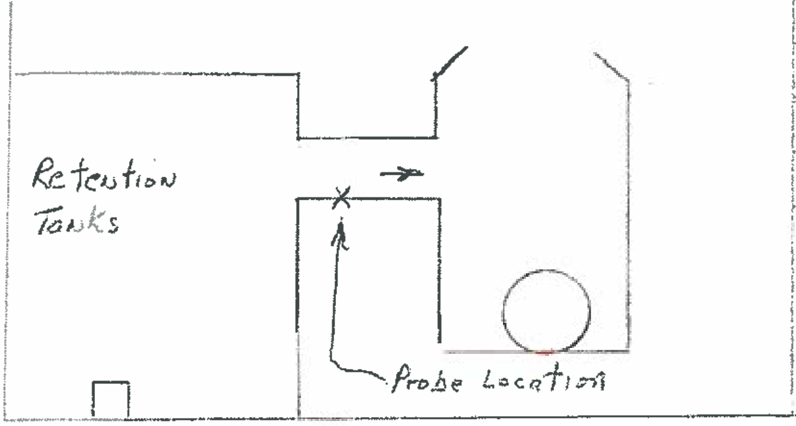


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	47.5W x 11.75H		24"
MATERIAL	StainLess		PVC
DEBRIS	0		0
SHAPE	Rect.		Round
DEPTH	3'6"		8'4"

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

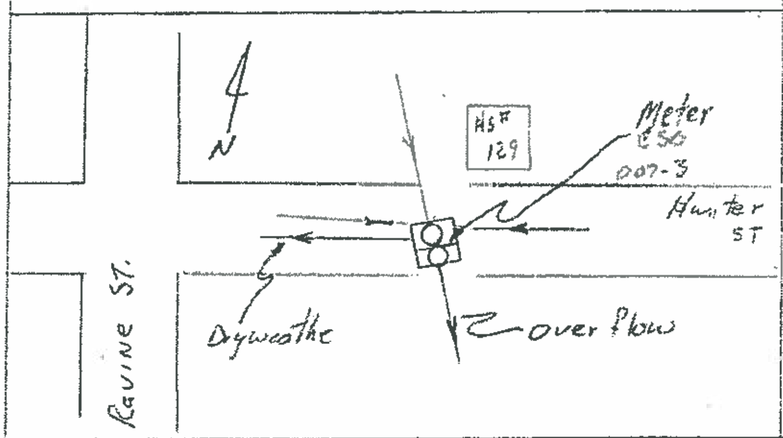
HEIGHT ABOVE WEIR

[illegible]S @
Photo 118 + 120

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: 129 Hunter ST

Meter CSO-007-3

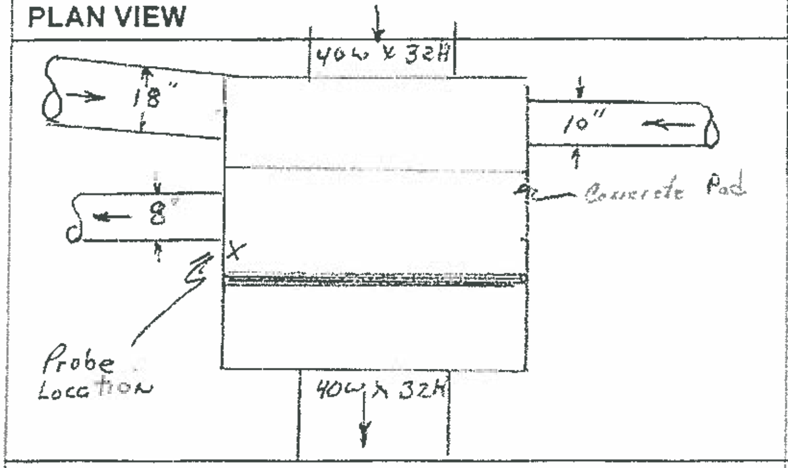
MAP#

DATE: 8-12-09

TIME:

REGULATOR#

PLAN VIEW

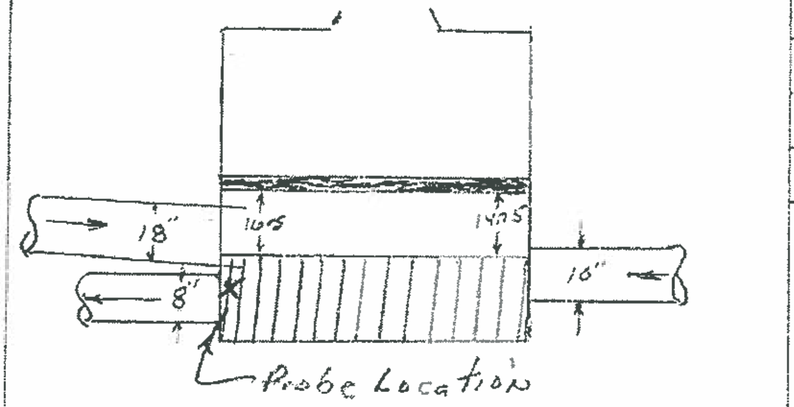


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	42"w x 32"H	8"	40"w x 32"H
MATERIAL	Stone	VCP	Stone
DEBRIS	6"	3"	0"
SHAPE	Rect	Round	Rect
DEPTH	8' 11"	?	8' 11"

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH 54"

BREADTH 2"

LEVEL YES [✓ NO]

HEIGHT ABOVE WEIR 16.5 Left Side 14.75 Right

OVERFLOW OCCURS @

Photo 123, 122

1652

City of Kingston
420 Broadway • Kingston, NY 12401

APPENDIX

C

SPDES Permit

MALCOLM PIRNIE

New York State Department of Environmental Conservation
Division of Environmental Permits, Region 3
21 South Putt Corners Road, New Paltz, New York 12561-1620
Phone: (845) 256-3000 • **FAX:** (845) 255-3042
Website: www.dec.state.ny.us

Alexander B. Grannis
Commissioner

July 13, 2009

James Sottile, Mayor
City of Kingston
420 Broadway
Kingston, NY 12401

RE: Kingston Wastewater Treatment Plant
DEC No. 3-5108-00044/00003
SPDES No. NY-002 9351
<u>Notice of Permit Modification</u>

Dear Mayor Sottile:

The N.Y.S. Department of Environmental Conservation (DEC) did not receive any objections from the City in response to the June 23, 2009 letter notifying you of DEC`s intent to modify the permit referenced above. Therefore, the proposed changes identified in the draft permit provided with our June 23rd notice have been included in a permit modification issued today. The modified permit is enclosed.

If you have any questions, I can be reached at (845) 256-3041.

Respectfully,

Alexander F. Ciesluk, Jr.

Alexander F. Ciesluk, Jr.
Deputy Regional Permit Administrator

enc.
cc: J. Sansalone, DEC w/enc
E. Zicca, DEC w/enc
C. Webber, DEC (3505) w/enc
M. Josilo, EPA Reg. II w/enc
NYS EFC w/enc
Ulster Co. DOH w/enc.
~~R. Swenson, C. Eng w/enc~~

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

State Pollutant Discharge Elimination System (SPDES) DISCHARGE PERMIT

Firs:3 99

Industrial Code: **4952**
Discharge Class (CL): **05**
Toxic Class (TX): **T**
Major Drainage Basin: **13**
Sub Drainage Basin: **06**
Water Index Number: **H-139**
Compact Area:

SPDES Number: NY- 0029351
DEC Number: 3-5108-00044/00003
Effective Date (EDP): 05/01/2008
Expiration Date (ExDP): 04/30/2013
Modification Dates:(EDPM) 02/03/2009; 7/13/09

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the Clean Water Act, as amended, (33 U.S.C. §1251 et.seq.)(hereinafter referred to as "the Act").

PERMITTEE NAME AND ADDRESS

Name: **City of Kingston**
Attention: **Mayor**
Street: **420 Broadway**
City: **Kingston**
State: **NY** Zip Code: **12401**

is authorized to discharge from the facility described below:

FACILITY NAME AND ADDRESS

Name: **Kingston Wastewater Treatment Plant**
Location (C,T,V): **Kingston (City)**
County: **Ulster**
Facility Address: **91-129 East Strand Avenue**
City: **Kingston**
NY Zip Code: **12401**
NYTM -E:
NYTM - N:
From Outfall No.: **002** at Latitude: **41** ° **55** ' **12** " & Longitude: **73** ° **58** ' **42** "
into receiving waters known as: **Rondout Creek** Class: **C**

and; (list other Outfalls, Receiving Waters & Water Classifications)

Additional discharges are listed on page 2 of the permit.

in accordance with: effluent limitations; monitoring and reporting requirements; other provisions and conditions set forth this permit; and 6 NYCRR Part 750-1.2(a) and 750-2.

DISCHARGE MONITORING REPORT (DMR) MAILING ADDRESS

Mailing Name: **City of Kingston**
Street: **91-129 East Strand Avenue**
City: **Kingston**
State: **NY** **12401**
Responsible Official or Agent: **George B. Cacchio**
Phone: **(845) 331-2490**

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or extended pursuant to law. To be authorized to discharge beyond the expiration date, the permittee shall apply for permit renewal not less than 180 days prior to the expiration date shown above.

DISTRIBUTION:

C.O. BWP – Permit Coordinator (3505)
J. Sansalone, DEC
RWE- E. Zicca, White Plains
C. Webber, DEC (3505)
EPA Region II - Michelle Josilo

Ulster co. Health Dept.
NYS EFC
R. Swenson, C. Kingston

Permit Administrator: Alexander F. Ciesluk, Jr.

Address: 21 South Putt Corners Road
New Paltz, NY 12561

Signature: Alexander F. Ciesluk Jr.

Date: 07/13/09

7/13/09

PERMIT LIMITS, LEVELS AND MONITORING DEFINITIONS

OUTFALL	WASTEWATER TYPE	RECEIVING WATER	EFFECTIVE	EXPIRING
	This cell describes the type of wastewater authorized for discharge. Examples include process or sanitary wastewater, storm water, non-contact cooling water.	This cell lists classified waters of the state to which the listed outfall discharges.	The date this page starts in effect. (e.g. EDP or EDPM)	The date this page is no longer in effect. (e.g. ExDP)

PARAMETER	MINIMUM	MAXIMUM	UNITS	SAMPLE FREQ.	SAMPLE TYPE
e.g. pH, TRC, Temperature, D.O.	The minimum level that must be maintained at all instants in time.	The maximum level that may not be exceeded at any instant in time.	SU, °F, mg/l, etc.		

PARA-METER	EFFLUENT LIMIT	PRACTICAL QUANTITATION LIMIT (PQL)	ACTION LEVEL	UNITS	SAMPLE FREQUENCY	SAMPLE TYPE
	Limit types are defined below in Note 1. The effluent limit is developed based on the more stringent of technology-based standards, required under the Clean Water Act, or New York State water quality standards. The limit has been derived based on existing assumptions and rules. These assumptions include receiving water hardness, pH and temperature; rates of this and other discharges to the receiving stream; etc. If assumptions or rules change the limit may, after due process and modification of this permit, change.	For the purposes of compliance assessment, the analytical method specified in the permit shall be used to monitor the amount of the pollutant in the outfall to this level, provided that the laboratory analyst has complied with the specified quality assurance/quality control procedures in the relevant method. Monitoring results that are lower than this level must be reported, but shall not be used to determine compliance with the calculated limit. This PQL can be neither lowered nor raised without a modification of this permit.	Type I or Type II Action Levels are monitoring requirements, as defined below in Note 2, that trigger additional monitoring and permit review when exceeded.	This can include units of flow, pH, mass, Temperature, concentration. Examples include µg/l, lbs/d, etc.	Examples include Daily, 3/week, weekly, 2/month, monthly, quarterly, 2/yr and yearly.	Examples include grab, 24 hour composit and 3 gra samples collected over a 6 hour period.

Note 1: DAILY DISCHARGE: The discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for the purposes of sampling. For pollutants expressed in units of mass, the 'daily discharge' is calculated as the total mass of the polluta discharged over the day. For pollutants with limitations expressed in other units of measurement, the 'daily discharge' is calculated as the average measurement of the pollutant over the day. DAILY MAX: The highest allowable daily discharge. DAILY MIN: The lowest allowable daily discharg MONTHLY AVG (daily avg): The highest allowable average of daily discharges over a calendar month, calculated as the sum of each of the daily discharges measured during a calendar month divided by the number of daily discharges measured during that month. RANGE: The minimum and maximum instantaneous measurements for the reporting period must remain between the two values shown. 7 DAY ARITHMETIC MEAN (7 day average): The highest allowable average of daily discharges over a calendar week. 12 MRA (twelve month rolling avg): The average of the most recent twelve month's monthly averages. 30 DAY GEOMETRIC MEAN (30 d geo mean): The highest allowable geometric mean of daily discharges over a calendar month, calculated as the antilog of : the sum of the log of each of the daily discharges measured during a calendar month divided by th number of daily discharges measured during that month. 7 DAY GEOMETRIC MEAN (7 d geo mean): The highest allowable geometric mean of dail discharges over a calendar week.

Note 2: ACTION LEVELS: Routine Action Level monitoring results, if not provided for on the Discharge Monitoring Report (DMR) form, shall b appended to the DMR for the period during which the sampling was conducted. If the additional monitoring requirement is triggered as noted below, the permittee shall undertake a short-term, high-intensity monitoring program for the parameter(s). Samples identical to those required for routine monitoring purposes shall be taken on each of at least three consecutive operating and discharging days and analyzed. Results shall be expressed in terms of both concentration and mass, and shall be submitted no later than the end of the third month following the month when the additional monitoring requirement was triggered. Results may be appended to the DMR or transmitted under separate cover to the same address. If levels higher than the Action Levels are confirmed, the permit may be reopened by the Department for consideration of revised Action Levels or effluent limits. Th permittee is not authorized to discharge any of the listed parameters at levels which may cause or contribute to a violation of water quality standards. TYPE I : The additional monitoring requirement is triggered upon receipt by the permittee of any monitoring results in excess of the stated Action Level. TYPE II: The additional monitoring requirement is triggered upon receipt by the permittee of any monitoring results that show the stated actio level exceeded for four of six consecutive samples, or for two of six consecutive samples by 20 % or more, or for any one sample by 50 % or more.

7/13/09

ADDITIONAL OUTFALLS

Outfall No.	**Description**	**Latitude/Longitude**	**Receiving Stream/Class**
005	Old Hasbrouck Avenue CSO	41°54'35"/73°58'57"	Rondout Creek/C
006	Broadway CSO	41°54'34"/73°58'59"	Rondout Creek/C
007	Hunter Street CSO	41°54'25"/73°59'22"	Rondout Creek/C
011	Wilbur Avenue CSO	41°54'06"/74°00'08"	Rondout Creek/C

PERMIT LIMITS, LEVELS AND MONITORING

OUTFALL No.	LIMITATIONS APPLY:	RECEIVING WATER	EFFECTIVE	EXPIRING
002	All year unless otherwise noted	Rondout Creek	ExDP	ExDP

PARAMETER	EFFLUENT LIMIT					MONITORING REQUIREMENTS				FN
								Location		
	Type	Limit	Units	Limit	Units	Sample Frequency	Sample Type	Inf.	Eff.	
Flow	Monthly Avg	Monitor	mgd			Continuous	Recorder		X	
Flow	12 Month Rolling Average	6.8	mgd			1/month	Calculated		X	
CBOD$_5$	Monthly Avg	25	mg/l	1400	lbs/d	2/week	24 hr. Comp	X	X	(1)
CBOD$_5$	7 Day avg	40	mg/l	2300	lbs/d	2/week	24 hr. Comp		X	
UOD (June 1 – Oct 31)	Monthly Avg			4900	lbs/d					(2)
Solids, Suspended	Monthly Avg	30	mg/l	1700	lbs/d	2/week	24 hr. Comp	X	X	(1)
Solids, Suspended	7 Day Avg	45	mg/l	2600	lbs/d	2/week	24 hr. Comp		X	
Solids, Settleable	Daily Max	0.3	ml/l			3/day	Grab		X	
Nitrogen, TKN (as N) (June 1 – Oct 31)	Daily Max	Monitor	mg/l			2/week	24 hr. Comp		X	(3)
Nitrogen, Ammonia (as NH3)	Daily Max	Monitor	mg/l			1/month	24 hr. Comp		X	
Copper, Total	Daily Max			2.0	lbs/d	1/month	24 hr. Comp		X	
Lead, Total	Daily Max			0.45	lbs/d	1/month	24 hr. Comp		X	
Zinc, Total	Daily Max			Monitor	lbs/d	1/quarter	24 hr. Comp		X	
Temperature	Daily Max	Monitor	Deg F			3/day	Grab		X	
pH	Range	6.0 – 9.0	SU			3/day	Grab		X	
Effluent Disinfection required: [X] All Year [ ] Seasonal from ___________ to										
Coliform, Fecal	30 Day Geometric Mean	200	No./ 100 ml			2/week	Grab		X	
Coliform, Fecal	7 Day Geometric Mean	400	No./ 100 ml			2/week	Grab		X	
Chlorine, Total Residual	Daily Max	0.9	mg/l			3/day	Grab		X	(4)

FOOTNOTES:

(1) and effluent shall not exceed 15% and 15% of influent concentration values for CBOD$_5$ and TSS respectively.

(2) Ultimate Oxygen Demand shall be computed as follows: UOD = 1.5 X CBOD$_5$ + 4.5 X TKN (Total Kjeldahl Nitrogen)

(3) Samples for CBOD$_5$ and TKN are to be collected at the same time.

(4) Monitoring of TRC is only required when chlorine is used for disinfection.

7/13/09

SCHEDULE OF COMPLIANCE

The permittee shall comply with the following schedule:

a) **Long-Term Control Plan (LTCP):**

Outfall Number(s)	Compliance Action	Due Date
ALL	Install flow monitoring devices on the combined sewer system	7/15/09
	Retain a consultant to evaluate water quality during the summer of 2009 and to develop an approvable LTCP. Submit the LTCP in accordance with the LTCP requirements in this permit.	11/1/10

The above compliance actions are one time requirements. The permittee shall comply with the above compliance actions to the Department's satisfaction once. When this permit is administratively renewed by NYSDEC letter entitled "SPDES NOTICE/RENEWAL APPLICATION/PERMIT," the permittee is not required to repeat the submission(s) noted above. The above due dates are independent from the effective date of the permit stated in the letter of "SPDES NOTICE/RENEWAL APPLICATION/PERMIT."

b) The permittee shall submit a written notice of compliance or non-compliance with each of the above schedule dates no later than 14 days following each elapsed date, unless conditions require more immediate notice as prescribed in 6 NYCRR Part 750-1.2(a) and 750-2. All such compliance or non-compliance notification shall be sent to the locations listed under the section of this permit entitled RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS. Each notice of non-compliance shall include the following information:

1. A short description of the non-compliance;
2. A description of any actions taken or proposed by the permittee to comply with the elapsed schedule requirements without further delay and to limit environmental impact associated with the non-compliance;
3. A description or any factors which tend to explain or mitigate the non-compliance; and
4. An estimate of the date the permittee will comply with the elapsed schedule requirement and an assessment of the probability that the permittee will meet the next scheduled requirement on time.

c) The permittee shall submit copies of any document required by the above schedule of compliance to NYSDEC Regional Water Engineer at the location listed under the section of this permit entitled RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS and to the Bureau of Water Permits, 625 Broadway, Albany, N.Y. 12233-3505, unless otherwise specified in this permit or in writing by the Department.

SPECIAL CONDITIONS:

DISCHARGE NOTIFICATION REQUIREMENTS - *Sign Maintenance:* The permittee shall periodically inspect the outfall identification sign(s) in order to ensure they are maintained, are still visible, and contain information that is current and factually correct. Signs that are damaged or incorrect shall be replaced within 3 months of inspection. *Data Retention:* The permittee shall retain records for a minimum period of 5 years in accordance with 6NYCRR Part 750-1.12(b)(2) and Part 750-2.5(c)(1). These records, which include discharge monitoring reports (DMRs) and annual reports, must be retained at a repository accessible to the public. This repository shall be open to the public, at a minimum, during normal daytime business hours. The repository may be the business office, wastewater treatment plant, village, town, city, or county clerk's office, the local library, or other location approved by the Department.

7/13/09

TOXICITY TESTING PROGRAM, TIER 2 - CHRONIC TEST

Effluent Toxicity Monitoring Requirements

Outfall Number	Effluent Parameters (Units)	Reason for Testing Requirement	Sample Frequency	Sample Type
002	Toxicity (% Effluent)	Existing pretreatment program. STP > 1.0 MGD	Quarterly, for a period of one year, in years ending in 1 and 6.	24 hr. Composite/ static renewal

(a) The effluent toxicity monitoring program shall begin 5/1/09.

(b) The results of each toxicity test shall be submitted no later than 60 days following the end of each test period. These reports sha be submitted to the NYS DEC Regional Water Engineer at 100 Hillside Ave, Suite 1W, White Plians, NY 10603-2860 and to th Toxicity Testing Unit, Bureau of Watershed Assessment and Research, 625 Broadway, Albany, NY 12233-3502.

(c) Effluent toxicity shall mean the toxicity of the effluent in chronic static renewal tests as specified in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms,* Third Edition, EPA/600/4-91/002 (1994), the EPA Chronic Manual for Marine Organisms (EPA/600/4-91/003(1994), or the most recent editions (herein referred as the EPA Chronic Manuals). Both a vertebrate and invertebrate species shall be used for the tests. Where the outfall being tested discharges to estuarine or ocean waters, marine organisms shall be tested. Where the outfall being tested discharges to fre waters, freshwater organisms shall be tested. Each test run shall be 'bracketed' with a test of pure effluent and a test of effluent diluted sufficiently such that at least one diluted sample shows no toxic effects. Appropriate dilutions between the endpoints sh be tested to allow calculation of the Maximum Allowable Waste Concentration. Dilution water shall be collected according to t EPA Chronic Manuals. Receiving water shall be used as dilution water unless the Department approves a different source. Effluent sampling and holding shall be done as outlined in of the EPA Chronic Manuals. Any deviation from procedures in the EPA Chronic Manuals requires prior written approval by the Department.

(d) The Maximum Allowable Waste Concentration (MAWC) in % Effluent, for both a vertebrate and an invertebrate species, shall determined and reported. The MAWC in % Effluent shall be compared to the calculated Instream Waste Concentration (IWC) the effluent. The IWC in % Effluent shall be determined using the daily average effluent flow at the time of sampling and a critical receiving water flow of 33.2 cubic feet per second for Rondout Creek.

(e) Where practicable, monitoring of chemical and physical parameters limited in this permit shall be coordinated so that the resulti analysis is also representative of the samples used for toxicity testing.

(f) Discharges which use chlorination as part of the waste treatment process for disinfection should be dechlorinated prior to toxicit testing or samples shall be taken immediately prior to the chlorination system.

(g) In accordance with NYSDEC guidance, the Department may require the permittee to conduct additional toxicity testing. If suc additional testing is necessary, the permittee shall be notified in writing by the NYS DEC Regional Water Engineer. The writte notification shall include the reason(s) why such testing is required.

TOXICITY REDUCTION EVALUATION COMPLIANCE SCHEDULE

(a) In accordance with Department guidance on whole effluent toxicity monitoring and control, the Department will evaluate the results of acute and/or chronic toxicity testing of discharges authorized by this permit. Based on this evaluation, the Department may require the permittee to perform a Toxicity Reduction Evaluation (TRE). Should a TRE be required, the permittee shall be notified in writing by the NYS DEC Regional Water Engineer. The written notification shall include the reasons why the TRE is required.

(b) Within 60 days of the date of the written notification from the NYS DEC Regional Water Engineer in (a), the permittee shall submit an approvable proposal for Toxicity Reduction Evaluation to the Bureau of Watershed Assessment and Research, 625 Broadway, Albany, NY 12233-3502. The TRE proposal shall be directed towards identifying the source of the toxicity, describing procedures to reduce the toxicity to an acceptable level, identifying monitoring parameters suitable for insuring control of the toxicity, and proposing a schedule for completing the TRE.

(c) Within 14 days of receipt of written approval of the TRE proposal from the DEC Regional Water Engineer, the permittee shall implement the approved TRE proposal in accordance with the approved schedule.

(d) The completed TRE, including data findings and recommendations for corrective action, permit limits, and proposed self-monitoring requirements shall be submitted to the Bureau of Watershed Assessment and Research at the address noted in (b) on this page. The Department will review the TRE and <u>may</u> modify the permit, in accordance with applicable law & regulation, to incorporate one or more of the following: substance specific numerical limits, toxicity limits, monitoring requirements, and/or a schedule of compliance that will ensure acceptable toxicity levels of the effluent.

PRETREATMENT PROGRAM IMPLEMENTATION REQUIREMENTS

A. DEFINITIONS. Generally, terms used in this Section shall be defined as in the General Pretreatment Regulations (40 CFR Part 403). Specifically, the following definitions apply to terms used in this Section (PRETREATMENT PROGRAM IMPLEMENTATION REQUIREMENTS):

1. Categorical Industrial User (CIU)- an industrial user of the POTW that is subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N;

2. Local Limits - General Prohibitions, specific prohibitions and specific limits as set forth in 40 CFR 403.5.

3. The Publicly Owned Treatment Works (the POTW) - as defined by 40 CFR 403.3(q) and that discharges in accordance with this permit.

4. Program Submission(s) - requests for approval or modification of the POTW Pretreatment Program submitted in accordance with 40 CFR 403.11 or 403.18 and approved by letter dated 10/27/99.

5. Significant Industrial User (SIU) -

   a. CIUs;

   b. Except as provided in 40 CFR 403.3(v)(3), any other industrial user that discharges an average of 25,000 gallo per day or more of process wastewater (excluding sanitary, non-contact cooling and boiler blowdown wastewater) to the POTW;

   c. Except as provided in 40 CFR 403.3(v)(3), any other industrial user that contributes a process wastestream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant;

   d. Any other industrial user that the permittee designates as having a reasonable potential for adversely affecting the POTW's operation or for violating a pretreatment standard or requirement.

6. Substances of Concern - Substances identified by the New York State Department of Environmental Conservation Industrial Chemical Survey as substances of concern.

B. IMPLEMENTATION. The permittee shall implement a POTW Pretreatment Program in accordance 40 CFR Part 403 and as se forth in the permittee's approved Program Submission(s). Modifications to this program shall be made in accordance with 40 CF 403.18. Specific program requirements are as follows:

1. Industrial Survey. To maintain an updated inventory of industrial dischargers to the POTW the permittee shall:

   a. Identify, locate and list all industrial users who might be subject to the industrial pretreatment program from th pretreatment program submission and any other necessary, appropriate and available sources. This identification and location list will be updated, at a minimum, every five years. As part of this update the permittee shall collect a current and complete New York State Industrial Chemical Survey form (or equivalent from each SIU.

   b. Identify the character and volume of pollutants contributed to the POTW by each industrial user identified in B.1.a above that is classified as a SIU.

   c. Identify, locate and list, from the pretreatment program submission and any other necessary, appropriate and available sources, all significant industrial users of the POTW.

2. Control Mechanisms. To provide adequate notice to and control of industrial users of the POTW the permittee shall:

   a. Inform by certified letter, hand delivery courier, overnight mail, or other means which will provide written acknowledgment of delivery, all industrial users identified in B.1.a. above of applicable pretreatment standards and requirements including the requirement to comply with the local sewer use law, regulation or ordinance and any applicable requirements under section 204(b) and 405 of the Federal Clean Water Act and Subtitles C and D of the Resource Conservation and Recovery Act.

b. Control through permit or similar means the contribution to the POTW by each SIU to ensure compliance with applicable pretreatment standards and requirements. Permits shall contain limitations, sampling frequency and type, reporting and self-monitoring requirements as described below, requirements that limitations and conditions be complied with by established deadlines, an expiration date not later than five years from the date of permit issuance, a statement of applicable civil and criminal penalties and the requirement to comply with Local Limits and any other requirements in accordance with 40 CFR 403.8(f)(1).

3. Monitoring and Inspection. To provide adequate, ongoing characterization of non-domestic users of the POTW, the permittee shall:

a. Receive and analyze self-monitoring reports and other notices. The permittee shall require all SIUs to submit self-monitoring reports at least every six months unless the permittee collects all such information required for the report, including flow data.

b. The permittee shall adequately inspect each SIU at a minimum frequency of once per year.

c. The permittee shall collect and analyze samples from each SIU for all priority pollutants that can reasonably be expected to be detectable at levels greater than the levels found in domestic sewage at a minimum frequency of once per year.

d. Require, through permits, each SIU to collect at least one 24 hour, flow proportioned composite (where feasible) effluent sample every six months and analyze each of those samples for all priority pollutants that can reasonably be expected to be detectable in that discharge at levels greater than the levels found in domestic sewage. The permittee may perform the aforementioned monitoring in lieu of the SIU except that the permittee must also perform the compliance monitoring described in 3.c.

4. Enforcement. To assure adequate, equitable enforcement of the industrial pretreatment program the permittee shall:

a. Investigate instances of noncompliance with pretreatment standards and requirements, as indicated in self-monitoring reports and notices or indicated by analysis, inspection and surveillance activities. Sample taking and analysis and the collection of other information shall be performed with sufficient care to produce evidence admissible in enforcement proceedings or in judicial actions. Enforcement activities shall be conducted in accordance with the permittee's Enforcement Response Plan developed and approved in accordance with 40 CFR Part 403.

b. Enforce compliance with all national pretreatment standards and requirements in 40 CFR Parts 406 - 471.

c. Provide public notification of significant non-compliance as required by 40 CFR 403.8(f)(2)(viii).

d. Pursuant to 40 CFR 403.5(e), when either the Department or the USEPA determines any source contributes pollutants to the POTW in violation of Pretreatment Standards or Requirements the Department or the USEPA shall notify the permittee. Failure by the permittee to commence an appropriate investigation and subsequent enforcement action within 30 days of this notification may result in appropriate enforcement action against the source and permittee.

5. Record keeping. The permittee shall maintain and update, as necessary, records identifying the nature, character, and volume of pollutants contributed by SIUs. Records shall be maintained in accordance with 6 NYCRR Part 750-2.5(c).

6. Staffing. The permittee shall maintain minimum staffing positions committed to implementation of the Industrial Pretreatment Program in accordance with the approved pretreatment program.

C. SLUDGE DISPOSAL PLAN. The permittee shall notify NYSDEC, and USEPA as long as USEPA remains the approval authority, 60 days prior to any major proposed change in the sludge disposal plan. NYSDEC may require additional pretreatment measures or controls to prevent or abate an interference incident relating to sludge use or disposal.

D. REPORTING. The permittee shall provide to the offices listed on the Monitoring, Reporting and Recording page of this permit and to the Chief-Water Compliance Branch; USEPA Region II; 290 Broadway; New York, NY 10007; a periodic report that briefly describes the permittee's program activities over the previous year. This report shall be submitted to the above noted offices within 60 days of the end of the reporting period. The reporting period shall be annual, with reporting period(s) ending c February 28th.

The periodic report shall include:

1. Industrial Survey. Updated industrial survey information in accordance with 40 CFR 403.12(i)(1) (including any NYS Industrial Chemical Survey forms updated during the reporting period).

2. Implementation Status. Status of Program Implementation, to include:

    a. Any interference, upset or permit violations experienced at the POTW directly attributable to industrial users.

    b. Listing of significant industrial users issued permits.

    c. Listing of significant industrial users inspected and/or monitored during the previous reporting period and summary of results.

    d. Listing of significant industrial users notified of promulgated pretreatment standards or applicable local standards who are on compliance schedules. The listing should include for each facility the final date of compliance.

    e. Summary of POTW monitoring results not already submitted on Discharge Monitoring Reports and toxic loadings from SIU's organized by parameter.

    f. A summary of additions or deletions to the list of SIUs, with a brief explanation for each deletion.

3. Enforcement Status. Status of enforcement activities to include:

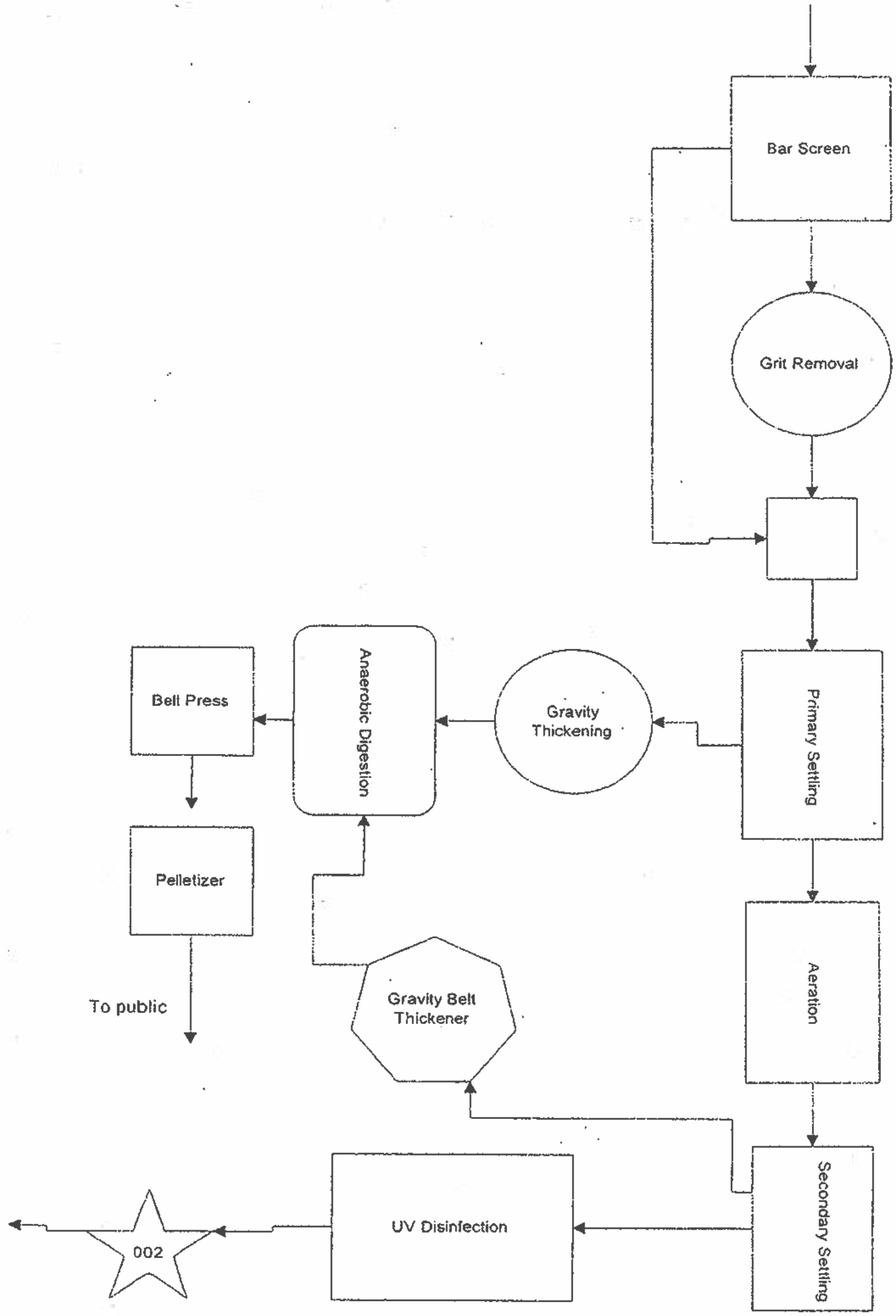
    a. Listing of significant industrial users in Significant Non-Compliance (as defined by 40 CFR 403.8(f)(2)(viii)) with federal or local pretreatment standards at end of the reporting period.

    b. Summary of enforcement activities taken against non-complying significant industrial users. The permittee shall provide a copy of the public notice of significant violators as specified in 40 CFR Part 403.8(f)(2)(viii).

7/13/09

MONITORING LOCATIONS

The permittee shall take samples and measurements, to comply with the monitoring requirements specified in this permit, at the location(s) specified below:



7/13/09

BEST MANAGEMENT PRACTICES FOR COMBINED SEWER OVERFLOWS

The permittee shall implement the following Best Management Practices (BMPs). These BMPs are designed to implement operation & maintenance procedures, utilize the existing treatment facility and collection system to the maximum extent practicable, and implement sewer design, replacement and drainage planning, to maximize pollutant capture and minimize water quality impacts from combined sewer overflows. The BMPs are equivalent to the "Nine Minimum Control Measures" required under the USEPA National Combined Sewer Overflow policy. The EPA's policy is available at http://cfpub.epa.gov/npdes/cso/cpolicy.cfm?program_id=5.

1. CSO Maintenance/Inspection - The permittee shall develop a written maintenance and inspection program for all CSOs listed on page 2 of this permit. This program shall include all regulators tributary to these CSOs, and shall be conducted during periods of both dry and wet weather. This is to insure that no discharges occur during dry weather and that the maximum amount of wet weather flow is conveyed to the POTW for treatment. This program shall consist of inspections with required repair, cleaning and maintenance done as needed. This program shall consist of weekly inspections.

   Inspection reports shall be completed indicating visual inspection, any observed flow, incidence of rain or snowmelt, condition of equipment and work required. These reports shall be in a format approved by the Regional Office and submitted to the Region with the monthly operating report (Form 92-15-7).

2. Maximum Use of Collection System for Storage - The permittee shall optimize the collection system by operating and maintaining it to minimize the discharge of pollutants from CSOs. It is intended that the maximum amount of in-system storage capacity be used (without causing service backups) to minimize CSOs and convey the maximum amount of combined sewage to the treatment plant in accordance with Item 4 below.

   This shall be accomplished by an evaluation of the hydraulic capacity of the system but should also include a continuous program of flushing or cleaning to prevent deposition of solids and the adjustment of regulators and weirs to maximize storage.

3. Industrial Pretreatment - The approved Industrial Pretreatment Program shall consider CSOs in the calculation of local limits for indirect discharges. Discharge of persistent toxics upstream of CSOs will be in accordance with guidance under (NYSDEC Division of Water Technical and Operational Guidance Series **(TOGS) 1.3.8 New Discharges to POTWs**. (http://www.dec.ny.gov/regulations/2652.html). For industrial operations characterized by use of batch discharge, consideration shall be given to the feasibility of a schedule of discharge during conditions of no CSO. For industrial discharges characterized by continuous discharge, consideration must be given to the collection system capacity to maximize delivery of waste to the treatment plant. Non-contact cooling water should be excluded from the combined system to the maximum extent practicable. Direct discharges of cooling water must apply for a SPDES permit.

   To the maximum extent practicable, consideration shall be given to maximize the capture of nondomestic waste containing toxic pollutants and this wastewater should be given priority over residential/commercial service areas for capture and treatment by the POTW.

4. Maximize Flow to POTW - Factors cited in Item 2. above shall also be considered in maximizing flow to the POTW. Maximum delivery to the POTW is particularly critical in treatment of "first-flush" flows. The treatment plant shall be capable of receiving and treating: the peak design hydraulic loading rates for all process units; i.e., a minimum of **10.5** MGD through the plant headworks; a minimum of **10.5** MGD through the primary treatment works and disinfection works, if applicable; and a minimum of **10.2** MGD through the secondary treatment works during wet weather. The collection system and headworks must be capable of delivering these flows during wet weather.

5. Wet Weather Operating Plan - The permittee shall maximize treatment during wet weather events. This shall be accomplished by having a wet weather operating plan containing procedures so as to operate unit processes to treat maximum flows while not appreciably diminishing effluent quality or destabilizing treatment upon return to dry weather operation. The wet weather operations plan shall be developed in accordance with the DEC guidance, Wet Weather Operating Practices for POTWs With Combined Sewers, (http://www.dec.ny.gov/docs/water_pdf/wwtechtran.pdf .

   The submission of a wet weather operating plan is a one time requirement that shall be done to the Department's satisfaction once. However, a revised wet weather operating plan must be submitted to the Regional Office and the Bureau of Water Permits, 625 Broadway, Albany, NY 12233-3505 for review and approval whenever the POTW

and/or sewer collection system is replaced or modified. When this permit is administratively renewed by NYSDEC letter entitled "SPDES NOTICE/RENEWAL APPLICATION/PERMIT", the permittee is not required to repeat the submission. The above due dates are independent from the effective date of the permit stated in the letter of "SPDES NOTICE/RENEWAL APPLICATION/PERMIT".

6. Prohibition of Dry Weather Overflow - Dry weather overflows from the combined sewer system are prohibited. The occurrence of any dry weather overflow shall be promptly abated and reported to the NYSDEC Regional Office in accordance with 6 NYCRR Part 750-2.7.

7. Control of Floatable and Settleable Solids - The discharge of floating solids, oil and grease, or solids of sewage origin which cause deposition in the receiving waters, is a violation of the NYS Narrative Water Quality Standards contained in Part 703. As such, the permittee shall implement best management practices in order to eliminate or minimize the discharge of these substances. All of the measures cited in Items 1, 2, 4 & 5 above shall constitute approvable "BMPs" for mitigation of this problem. If aesthetic problems persist, the permittee should consider additional BMP's including but not limited to: street sweeping, litter control laws, installation of floatables traps in catch basins (such as hoods), booming and skimming of CSOs, and disposable netting on CSO outfalls. In cases of severe or excessive floatables generation, booming and skimming should be considered an interim measure prior to implementation of final control measures. Public education on harmful disposal practices of personal hygienic devices may also be necessary including but not limited to: public broadcast television, printed information inserts in sewer bills, or public health curricula in local schools.

8. Combined Sewer System Replacement - Replacement of combined sewers shall not be designed or constructed unless approved by NYSDEC. When replacement of a combined sewer is necessary it shall be replaced by separate sanitary and storm sewers to the greatest extent possible. These separate sanitary and storm sewers shall be designed and constructed simultaneously but without interconnections to maximum extent practicable. When combined sewers are replaced, the design should contain cross sections which provide sewage velocities which prevent deposition of organic solids during low flow conditions.

9. Combined Sewer/Extension - Combined sewer/extension, when allowed should be accomplished using separate sewers. These sanitary and storm sewer extensions shall be designed and constructed simultaneously but without interconnections. No new source of storm water shall be connected to any separate sanitary sewer in the collection system.

   If separate sewers are to be extended from combined sewers, the permittee shall demonstrate the ability of the sewerage system to convey, and the treatment plant to adequately treat, the increased dry-weather flows. Upon a determination by the Regional Water Engineer an assessment shall be made by the permittee of the effects of the increased flow of sanitary sewage or industrial waste on the strength of CSOs and their frequency of occurrence including the impacts upon best usage of the receiving water. This assessment should use techniques such as collection system and water quality modeling contained in the 1999 Water Environment Federation Manual of Practice FD-17 entitled, Prevention and Control of Sewer System Overflows, 2nd edition.

10. Sewage Backups - If, there are documented, recurrent instances of sewage backing up into house(s) or discharges of raw sewage onto the ground surface from surcharging manholes, the permittee shall, upon letter notification from DEC, prohibit further connections that would make the surcharging/back-up problems worse.

11. Septage and Hauled Waste - The discharge or release of septage or hauled waste upstream of a CSO is prohibited.

12. Control of Run-off - It is recommended that the impacts of run-off from development and re-development in areas served by combined sewers be reduced by requiring compliance with the New York Standards for Erosion and Sediment Control and the quantity control requirements included in the New York State Stormwater Management Design Manual. (http://www.dec.ny.gov/chemical/8694.html).

13. Public Notification – The permittee shall maintain identification signs at all CSO outfalls owned and operated by the permittee. The permittee shall place the signs at or near the CSO outfalls and ensure that the signs are easily readable by the public. The signs shall have **minimum** dimensions of eighteen inches by twenty four inches (18" x 24") and shall have white letters on a green background and contain the following information:

7/13/09

N.Y.S. PERMITTED DISCHARGE POINT
(wet weather discharge)
SPDES PERMIT No.: NY__________

OUTFALL No. :____

For information about this permitted discharge contact:

Permittee Name:

Permittee Contact:

Permittee Phone: ( ) - ### - ####

OR:

NYSDEC Division of Water Regional Office Address :

NYSDEC Division of Water Regional Phone: ( ) - ### -####

The permittee shall implement a public notification program to inform citizens of the location and occurrence of CSO events. This program shall include a mechanism (public media broadcast, standing beach advisories, newspaper notice etc.) to alert potential users of the receiving waters affected by CSOs. The program shall include a system to determine the nature and duration of conditions that are potentially harmful to users of these receiving waters due to CSOs.

14. Characterization and Monitoring - The permittee shall characterize the combined sewer system, determine the frequency of overflows, and identify CSO impacts in accordance with Combined Sewer Overflows, Guidance for Nine Minimum Controls, EPA, 1995, Chapter 10. These are minimum requirements, more extensive characterization and monitoring efforts which may be required as part of the Long Term Control Plan.

15. Annual report - The permittee shall submit an annual report summarizing implementation of the above best management practices (BMPs). The report shall list existing documentation of implementation of the BMPs and shall be submitted by January 31st of each year to the Regional office listed on the Recording, Reporting and Additional Monitoring page of this permit and to the Bureau of Water Permits, 625 Broadway, Albany, NY 12233-3505. Examples of recommended documentation of the BMPs are found in Combined Sewer Overflows, Guidance for Nine Minimum Controls (NMC), EPA, 1995. The permittee may obtain an electronic copy of the NMC guidance at http://www.epa.gov/npdes/pubs/owm0030.pdf. For guidance on developing the annual report, a BMP checklist is available from DEC on-line at http://www.dec.ny.gov/docs/water_pdf/csobmp.pdf. The permittee must submit a completed copy of this checklist along with the annual report. The actual documentation shall be stored at a central location and be made available to DEC upon request.

7/13/09

LONG TERM CONTROL PLAN

The permittee shall develop a Long-Term Control Plan in accordance with the 1994 National CSO Control Policy and the Guidance for Long-Term Control Plan, EPA, September, 1995, which will address the elements contained in Sections A through D below:

I. Phase I

A. Public Participation

The permittee shall prepare and implement a public participation plan that outlines how the permittee will ensure participation of the public throughout the LTCP development process.

B. CSS Characterization

The permittee shall develop and implement a plan that will result in a comprehensive characterization of the Combined Sewer System (CSS), including the interceptor sewer system, developed through records review, monitoring, modeling, and other means as appropriate to establish the existing baseline conditions, evaluate the effectiveness of the CSO technology-based controls (BMPs), and determine the baseline conditions upon which the LTCP will be based. The characterization shall adequately address the response of the CSS to various precipitation events; identify the number, location, frequency, and characteristics of CSOs; and identify water quality impacts that result from CSOs.
To complete the characterization, the permittee shall employ the following methods:

1. Rainfall Records Review - The permittee shall examine the complete rainfall records for the geographic areas of the CSS and evaluate the flow variations in the receiving water body to correlate between the CSOs and receiving water conditions.

2. CSS Records Review - The permittee shall review and evaluate all available CSS records and undertake field inspections and other necessary activities to identify the number, location, and frequency of CSOs and their location relative to sensitive areas and to pollution sources, such as significant industrial users, in the collection system.

3. CSO and Water Quality Monitoring - The permittee shall develop a monitoring program that measures the frequency, duration, flow rate, volume, and pollutant concentration of CSOs and assesses the impact of the CSOs on receiving waters. Monitoring shall be performed at a representative number of CSOs for a representative number of events. The monitoring program shall include CSOs and ambient receiving waterbody monitoring and, where appropriate, other monitoring protocols, such as biological assessments, toxicity testing, and sediment sampling.

4. Identification of Sensitive Areas - The permittee shall identify sensitive areas to which its CSOs occur. These areas shall include waters with threatened or endangered species and their designated critical habitat, waters with primary contact recreation, public drinking water intakes or their designated protection areas and any other areas identified by the permittee or permitting authority, in coordination with appropriate State or Federal agencies.

5. CSS and Receiving Water Modeling - The permittee may employ models, which include appropriate calibration and verification with field measurements, to aid in the characterization. If models are used, they shall be identified by the permittee along with an explanation of why the model was selected and used in the characterization.

C. CSO Control Alternatives

1. a. Demonstrative Approach - The permittee shall develop a range of CSO control alternatives that would meet EPA's requirements for the demonstrative approach. The alternatives should demonstrate each of the following: (1) the planned control program is adequate to meet WQS and protect designated uses, and (2) the CSO discharges remaining after implementation of planned control programs will not preclude the attainment of WQS or the receiving waters designated uses or contribute to impairment, and (3) the planned control program will provide the maximum pollution reduction benefits reasonably attainable, and (4) the planned control program is designed to allow cost effective expansion or retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

b. Presumptive Approach - Alternatively, the permittee shall develop a range of CSO control alternatives that would meet one of EPA's criteria for the presumptive approach. These criteria consist of: (1) no more than 4-6 overflow events per year that do not receive minimum treatment; or (2) the elimination or capture for minimum treatment of no less than 85% by volume of the combined sewage collected during precipitation events on a system-wide annual average basis; or (3) the elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment during the characterization, monitoring, and modeling effort. Minimum treatment for (1) and (2) above is defined as: primary clarification to remove floatables and settleable solids, solids and floatables disposal, and disinfection of effluent, if necessary, to meet water quality standards (WQS) according to 6NYCRR Part 703.

2. Evaluation of CSO Control Alternatives - The permittee shall evaluate each of the alternatives developed in accordance with C.1 a. or b. to select the CSO controls that will ensure compliance with CWA requirements. The permittee shall consider expansion of the POTW treatment plant(s) secondary and primary capacity as one alternative.

3. Cost/Performance Considerations - The permittee shall develop and submit cost/performance curves that demonstrate the relationship among the set of CSO control alternatives that correspond to the ranges identified in C.1 a. or b. above.

4. Identification of the Selected CSO Control Alternatives - The permittee shall submit a description of the alternatives that were considered, the chosen alternative(s) that will be implemented and the reasoning behind the selection.

5. Schedule - The permittee shall submit a schedule for design and construction of the selected CSO control facilities and/or implementation of other measures. The schedule may be phased based on the relative importance of the adverse impacts on water quality standards and on the permittee's financial capability.

D. Subsequent Requirements

1. Operational Plan - The wet weather operating plan that is required in the treatment plant's CSO Best Management Practices shall be required to be updated as a result of modifications to the CSS made during the implementation of the LTCP.

2. Post-Construction Compliance Monitoring Program - The permittee shall develop and submit a post-construction monitoring program that (a) is adequate to ascertain the effectiveness of the CSO controls and (b) can be used to verify attainment of water quality standards. The program shall include a plan that details the monitoring protocols to be followed, including CSO and ambient monitoring and, where appropriate, other monitoring protocols, such as biological assessments, whole effluent toxicity testing, and sediment sampling.

II. LTCP Compliance Dates

All submittals shall be delivered to the Regional Water Engineer and the Bureau of Water Permits, 625 Broadway, Albany, NY 12233-3505. See the LTCP Compliance Schedule in this permit.

III. Phase II

Upon DEC approval of the Phase I LTCP, the construction and implementation schedule shall become part of, and enforceable under, this permit.

7/13/09

RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS

a) The permittee shall also refer to 6 NYCRR Part 750-1.2(a) and 750-2 for additional information concerning monitoring and reporting requirements and conditions.

b) The monitoring information required by this permit shall be summarized, signed and retained for a period of five years from the date of the sampling for subsequent inspection by the Department or its designated agent. **Also, monitoring information required by this permit shall be summarized and reported by submitting;**

☒ (if box is checked) completed and signed Discharge Monitoring Report (DMR) forms for each __1__ month reporting period to the locations specified below. Blank forms are available at the Department's Albany office listed below. The first reporting period begins on the effective date of this permit and the reports will be due no later than the 28th day of the month following the end of each reporting period.

☐ (if box is checked) an annual report to the Regional Water Engineer at the address specified below. The annual report is due by February 1 and must summarize information for January to December of the previous year in a format acceptable to the Department.

☐ (if box is checked) a monthly "Wastewater Facility Operation Report..." (form 92-15-7) to the:
☐ Regional Water Engineer and/or ☐ County Health Department or Environmental Control Agency specified below

Send the DMRs with **original signatures** to:

Department of Environmental Conservation
Division of Water
Bureau of Water Compliance Programs
625 Broadway
Albany, New York 12233-3506

Phone: (518) 402-8177

Send a **copy** of each DMR page to:

Department of Environmental Conservation
Regional Water Engineer
100 Hillside Ave, Suite 1W
White Plains, NY 10603-2860

Phone: (914) 428-2505

Send an **additional copy** of each DMR page to:
Ulster County Health Department
300 Flatbush Avenue
Kingston, NY 12401

c) Noncompliance with the provisions of this permit shall be reported to the Department as prescribed in 6 NYCRR Part 750-1.2(a) and 750-2.

d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

e) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculations and recording of the data on the Discharge Monitoring Reports.

f) Calculation for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

g) Unless otherwise specified, all information recorded on the Discharge Monitoring Report shall be based upon measurements and sampling carried out during the most recently completed reporting period.

h) Any laboratory test or sample analysis required by this permit for which the State Commissioner of Health issues certificates of approval pursuant to section five hundred two of the Public Health Law shall be conducted by a laboratory which has been issued a certificate of approval. Inquiries regarding laboratory certification should be sent to the Environmental Laboratory Accreditation Program, New York State Health Department Center for Laboratories and Research, Division of Environmental Sciences , The Nelson A. Rockefeller Empire State Plaza, Albany, New York 12201.

1652

City of Kingston
420 Broadway • Kingston, NY 12401

APPENDIX

D

Flow Monitoring Plan

MALCOLM PIRNIE

City of Kingston CSO Long-Term Control Planning

420 Broadway • Kingston, New York 12401

Draft Flow Monitoring and Rain Gauging Work Plan

September 2009

Report Prepared By:

Malcolm Pirnie, Inc.

855 Route 146
Suite 210
Clifton Park, New York 12065
518-250-7300

5744015

MALCOLM PIRNIE

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1. Overflow Structure Record Drawings
2. Flow Monitor Specifications
3. Site Location and Installation Sketches
4. August 11-24, 2009 Scattergraphs and Hydrographs

1. Background

The City of Kingston, New York (City) is located in Ulster County, on the Hudson River. The City is located on approximately 7-1/2 square miles of land and is home to 23,456 people (US Census Bureau, 2000 Census). The City's collection system is a combined sewer system having four permitted, combined sewer overflows (CSOs) that discharge to Rondout Creek, a tributary to the Hudson River.

There are four distinct sewer sheds, each with a regulator and a permitted discharge point. The sewersheds are referred to by the regulator location:

- Wilbur (CSO 011).
- Hunter (CSO 007).
- Broadway (CSO 006).
- Hasbrouck (CSO 005).

A sketch of the control and interceptor portion of the collection system is shown on Figure 1-1. The flow from each of these gravity systems is conveyed to the WWTP through a pressure pipe, referred to as a siphon. The steel pipe is routed along Rondout Creek. The pipe is pressurized by the head differential between the gravity systems and the steel pipe. There are approximately five connections to the steel pipe, which includes the four connections from the combined sewer system. There are no manholes or other access points along the steel siphon. Available record drawings for the overflows are included as Attachment 1.

The City is undertaking a planning study to develop long-term solutions to the discharge of CSOs to Rondout Creek and the Hudson River. The first step in this process is the characterization of the combined sewer system through hydraulic modeling and water quality analysis. To be valid, the characterization must reflect the conditions in, and performance of, the collection system under a variety of conditions. The basis for this characterization, then, is the flow monitoring, rain gauging, river stage, and water quality data collected as described in this Work Plan.

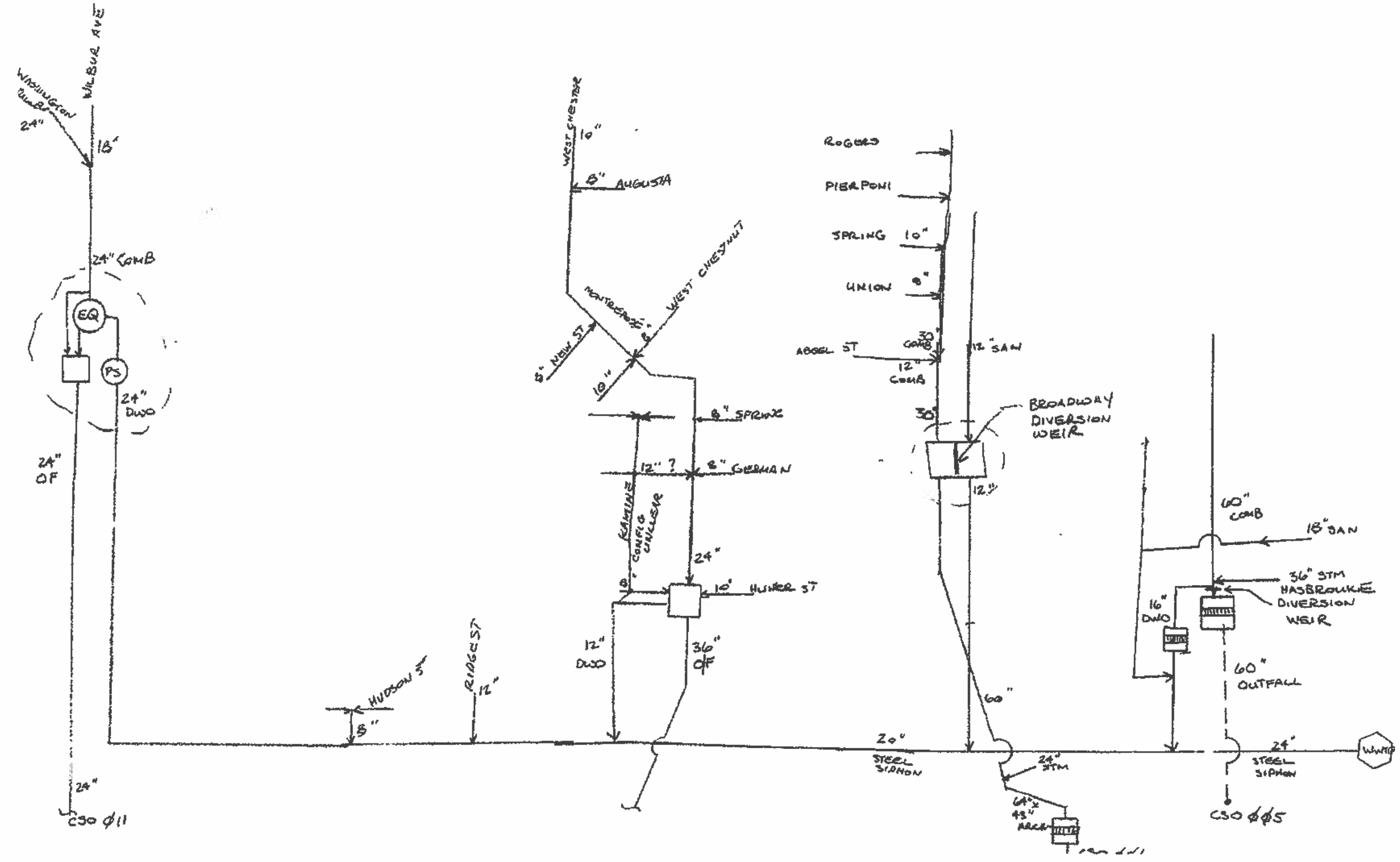


Figure 1-1: City of Kingston Collection System Sketch

2. Program Overview

The objective of the Flow Monitoring and Rain Gauging Program (Program) is to collect data adequate to understand the response of the collection system to a variety of weather conditions and the characteristics of the overflows. While much of this understanding will result from the analysis of the hydraulic model results, it is predicated upon a sufficient quality and quantity of data. This Program will collect flow monitoring data at 10 locations associated with the four overflow points and rainfall data at two locations;

The Program is scheduled for an 8-week collection period, commencing on August 11, 2009. The collection period is tentative and may be shortened or extended, based on the capture of the targeted number sampling events and quality rainfall events. This Program is dynamic and should be expected to change in response to actual conditions.

2.1. Dry Weather Conditions

One goal of the Program is the collect adequate dry weather flow data to characterize the contribution of sanitary waste flow, industrial flow, and groundwater infiltration. Dry weather flow conditions exist when the flow is unencumbered by ongoing or previously occurring rainfall. The number of dry weather days required to meet this goal will be evaluated based on the monitoring data and will vary with the size and duration of rainfall events.

2.2. Wet Weather Conditions

As the CSO Policy references the performance of the collection system in an average year, another goal of the Program is to collect flow and rainfall across a range of storm events representative of an average year. It is not possible to define formal requirements for storm events, as the actual experienced events are dependent on future weather patterns.

2.3. Average Year

The average year of rainfall is a defining performance condition for the long-term control of CSOs. The average rainfall totals, as provided by Climatology of the United States, No. 81, were reviewed for the closest rain gauge, Poughkeepsie, New York. This rain gauge is approximately 20 miles south of Kingston. Table 2-1 shows the monthly average rainfall totals from 1971 to 2000.

Table 2-1:

Monthly Average Rainfall Totals, Poughkeepsie, New York

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rain	3.19	2.53	3.59	3.79	4.73	3.73	4.72	3.83	3.69	3.56	3.53	3.23	44.12

3. Rain Gauging Program

Rainfall in the City of Kingston is largely front driven. There are no topographic features, such as mountains or lakes that lead to multiple weather patterns occurring simultaneously in the City. Consequently, two rain gauges will be used to capture and verify rainfall. The rain gauges will be located at Beel Street and Broad Street.

3.1. Data Quality Control

Quality control of the rain data is provided for by utilizing two rain gauges. Based on the size and weather patterns of the City, one rain gauge is adequate to measure the characteristics of the rainfall events; however, the second rain gauge provides an additional level of redundancy against the failure of the primary rain gauge by providing an additional data source that allows the measurement and recording of the surviving device to be verified.

As available, the hourly rainfall data reported by the national weather service at the Poughkeepsie, Dutchess County Airport (NWS reporting station KPOU) will be collected and compared to the rain gauge data as an additional data quality check.

4. Flow Monitoring Program

The flow monitoring program will be performed by Flow Assessments under the management of Malcolm Pirnie, Inc. (Malcolm Pirnie). Flow Assessments will be responsible for providing all equipment and staff necessary to accurately collect the required data. Flow Assessments will be responsible for the quality of the flow monitoring data, including the selection of viable monitoring sites, proper calculation of flow in non-standard pipes, and accuracy of data under low and extreme high flow conditions.

The goal of the flow monitoring program is to capture level and velocity data at key points in the collection system to describe the system performance in dry-weather and under various wet-weather conditions. This data will be primarily used to calibrate and verify a hydraulic model of the collection system.

4.1. Monitoring Program

The monitoring program consists of the installation of 10 temporary flow meters by Flow Assessments. The flow meters will be ISCO Model 2150 or SIGMA 920. Information for this monitor is provided as Attachment 2. The monitors will be set up to collect data at 5-minute intervals and will be coordinated with the timing on the rain gauges. The locations of the flow meters are listed in Table 4-1 and shown graphically on Figures 4-1, 4-2 and 4-3.

Table 4-1:

Flow Monitoring Locations

Meter #	Location description	Pipe Diameter
CSO11-1	Upstream, Wilbur diversion chamber	24”
CSO11-3	Wilbur dry weather pipe	24”
CSO07-1	Upstream, Hunter diversion chamber	24”
CSO07-3	Overflow weir, Hunter diversion chamber	N/A
CSO06-1	Comb influent, Broadway diversion chamber	30”
CSO06-4	Overflow, Broadway diversion chamber	60”
CSO05-1	Comb influent, Hasbrouke diversion chamber	60”
CSO05-2	Storm influent, Hasbrouke diversion chamber	36”
CSO05-3	Hasbrouke dry weather pipe	18”
WWTP	WWTP Influent meter - recorder	N/A

Figure 4-1: Wilbur Regulator Flow Monitoring Locations

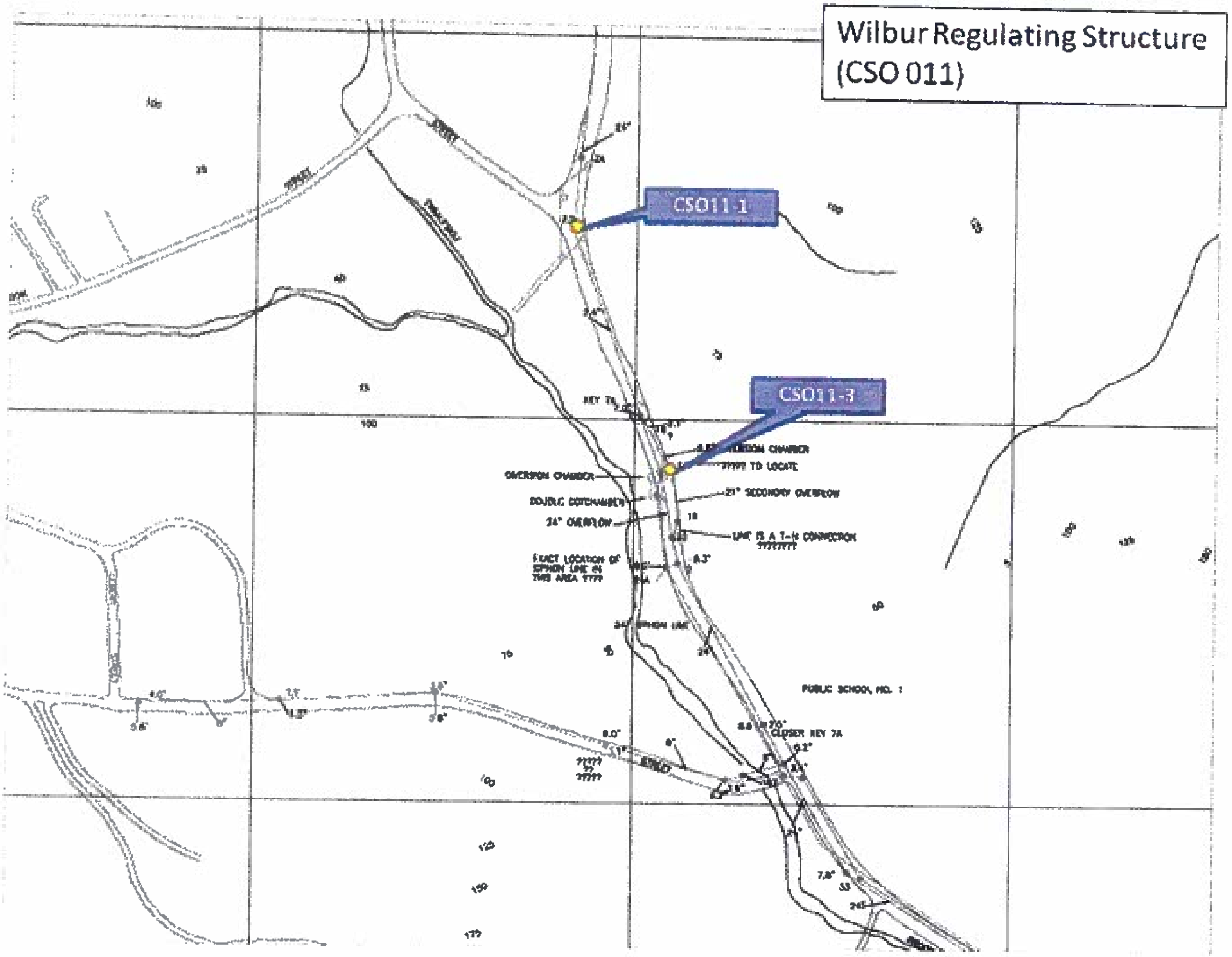


Figure 4-2: Hunter Regulator Flow Monitoring Locations

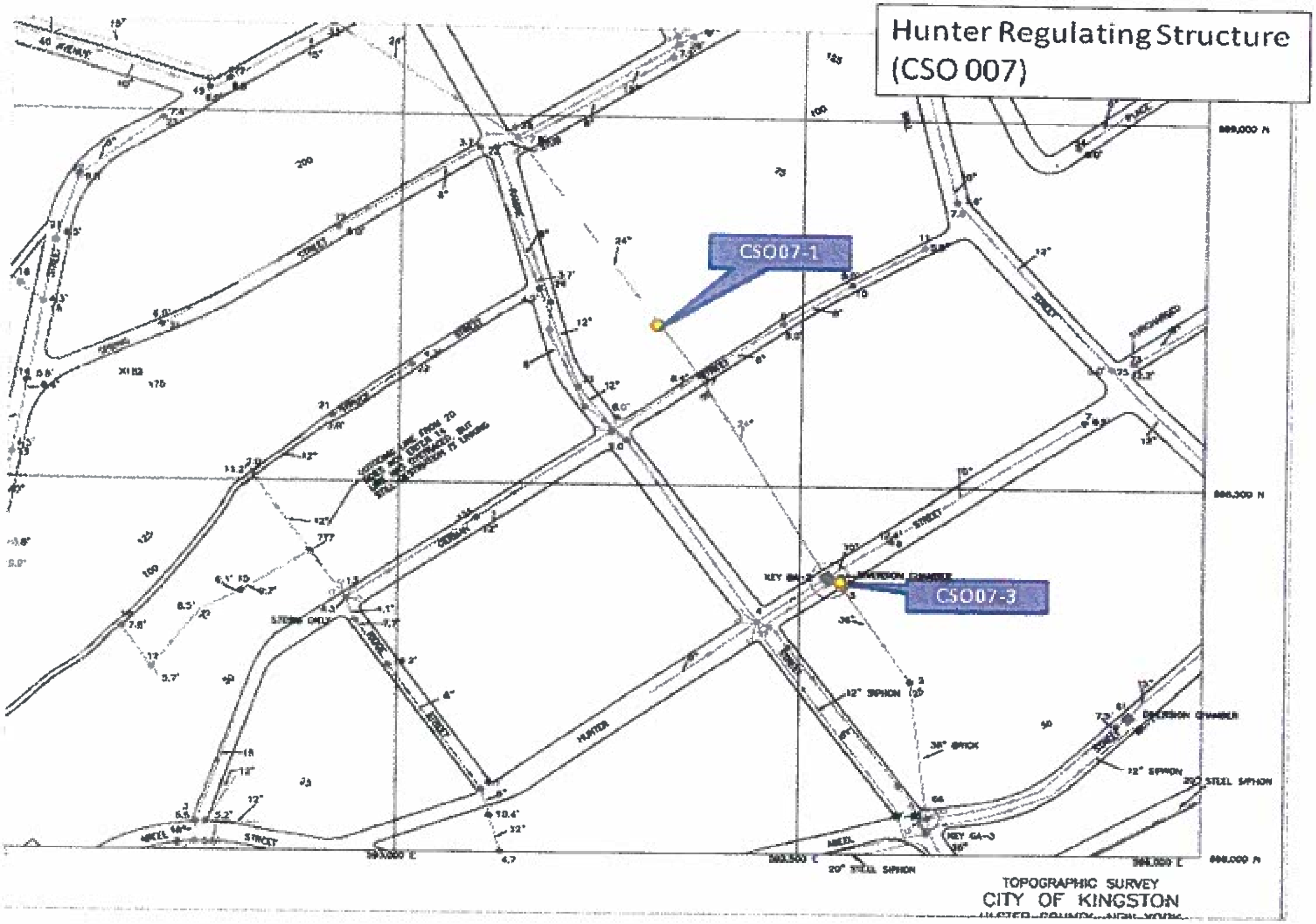
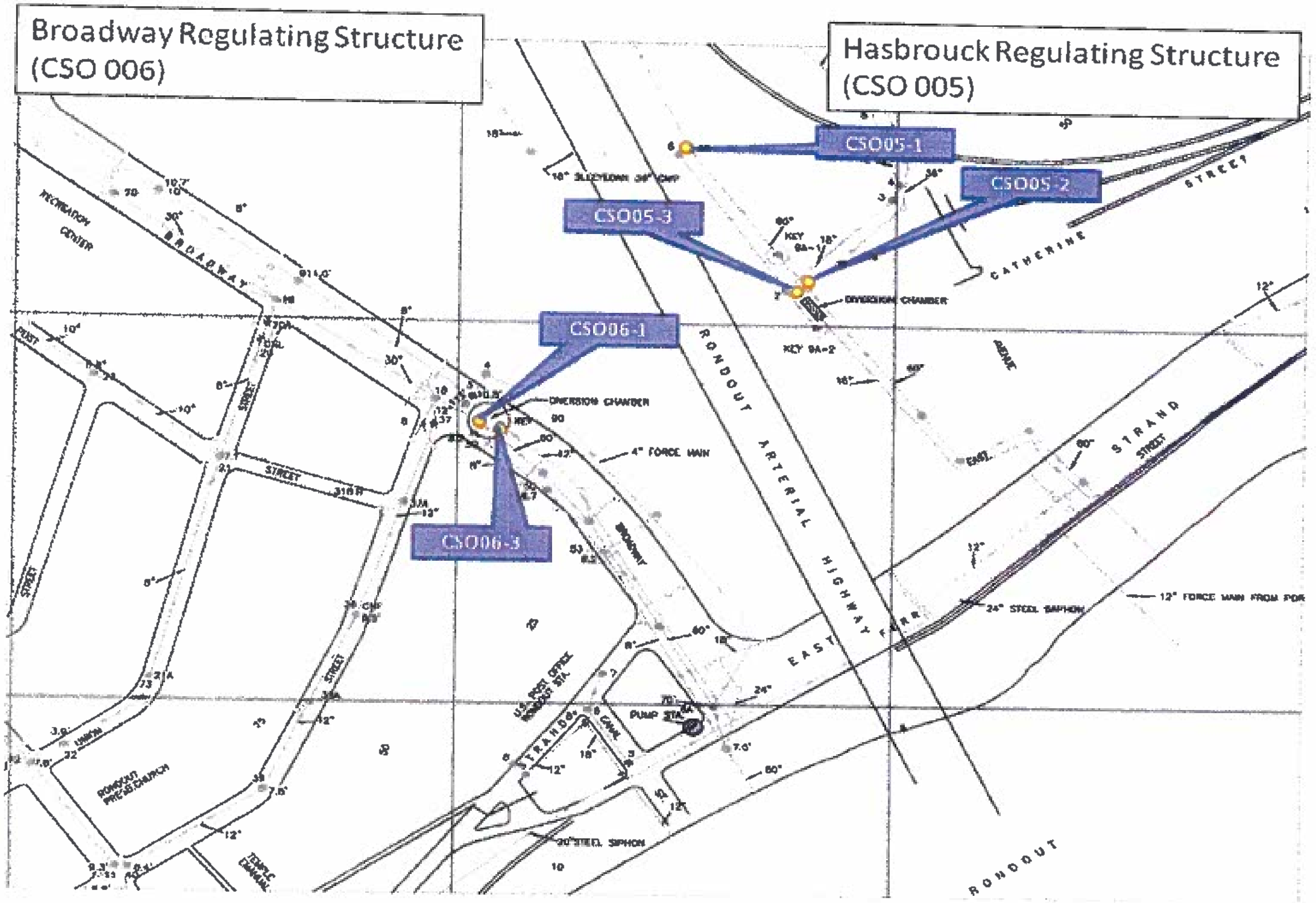


Figure 4-3: Broadway and Hasbrouck Regulator Flow Monitoring Locations



The flow monitoring locations were selected to calibrate and verify a hydraulic model. While the flow monitoring data will be reviewed for direct assessment of performance, the primary use the flow monitoring data in the pipe system is to develop a hydraulic model that reasonably represents the performance of the collection system in an average year. As such, flow meters are not located directly on CSO outfalls. Instead, flow meters are located within the trunk sewer system, both on the influent side of the regulators and on the dry-weather outlet side of the regulators. Direct subtraction and the hydraulic model will be used to mathematically calculate the overflow volumes.

4.2. Flow Monitor Installation

Flow Assessments will supply and install depth and velocity sensors capable of hard-wired communication, with data loggers that can record flow every 5 minutes. Flow Assessments will follow their standard rigorous installation protocols, including but not limited to the following:

- Initial site reconnaissance to establish monitoring configuration.
- Installation with initial field calibration for both depth and velocity.
- Detailed installation notes, specifying:
    - Detailed sketch of location showing all influent and effluent piping.
    - Specific location and physical depth of all depth and velocity probes.
    - Digital photographs of every probe installation.

Based on preliminary site inspections, adjustments were made in the location and equipment used. Site locations and installation sketches are included as Attachment 3.

4.3. Flow Monitor Maintenance

Flow Assessment will ensure monitors are kept in working order and free of debris. Flow Assessment staff will be responsible for all system maintenance, including changing batteries, cleaning and calibrating sensors, as well as communications and data and report maintenance. Field calibration of the monitors will be performed at installation. Flow Assessment will maintain two valid confirmations throughout the monitoring period. Flow monitors are required to have a minimum % up time of 90%.

4.4. Flow Data Collection and Access

The flow meter will be programmed to record the level and velocity and calculate flow at 5-minute interval. Flow Assessment will download and Quality Assurance/Quality Control (QA/QC) data on a weekly basis. Reviewed data will be available via the internet. The first data will be posted three weeks after installation and updated every two weeks thereafter.

4.5. Data Quality Control

Data quality control began with the development of this Field Data Collection Program. Flow monitoring sites were prescreened for suitability prior to field personnel entering a site based on information learned through previous monitoring work. During data collection period, Flow Assessment will perform in-house data quality checks. This will be followed by a final data quality review performed by Malcolm Pirnie.

4.5.1. Collected Data Quality Assessment

Following receipt of the data from Flow Assessment, additional data review and analysis will be performed by Malcolm Pirnie staff. The purpose of the Malcolm Pirnie review is to identify any data issues as quickly as possible (and initiate corrective action by Flow Assessment), and prepare the data for use in a subsequent hydraulic model.

Malcolm Pirnie's data review and analysis will use the following four categories of data screening procedures, or checks:

1. **Check for data accuracy:** This procedure reviews data to determine if one or more sensors (depth and/or velocity) behaved inconsistently during an event. Scattergraphs are an important tool used in performing this check. After collection of the first round of data, a depth versus velocity scattergraph will be developed. Based upon a review of the data, it will be determined whether the site has hydraulic characteristics conducive to meeting the objectives of the study. If appropriate, a recommendation will be made to change the monitoring configuration, equipment, or location.

   This check will be performed promptly as each weekly dataset is obtained. The scattergraph of the data obtained since the last download will be plotted and overlaid on the scattergraph of the previous data. Data problems associated with sensor fouling or drift will be identified and the field maintenance crew alerted for appropriate action.

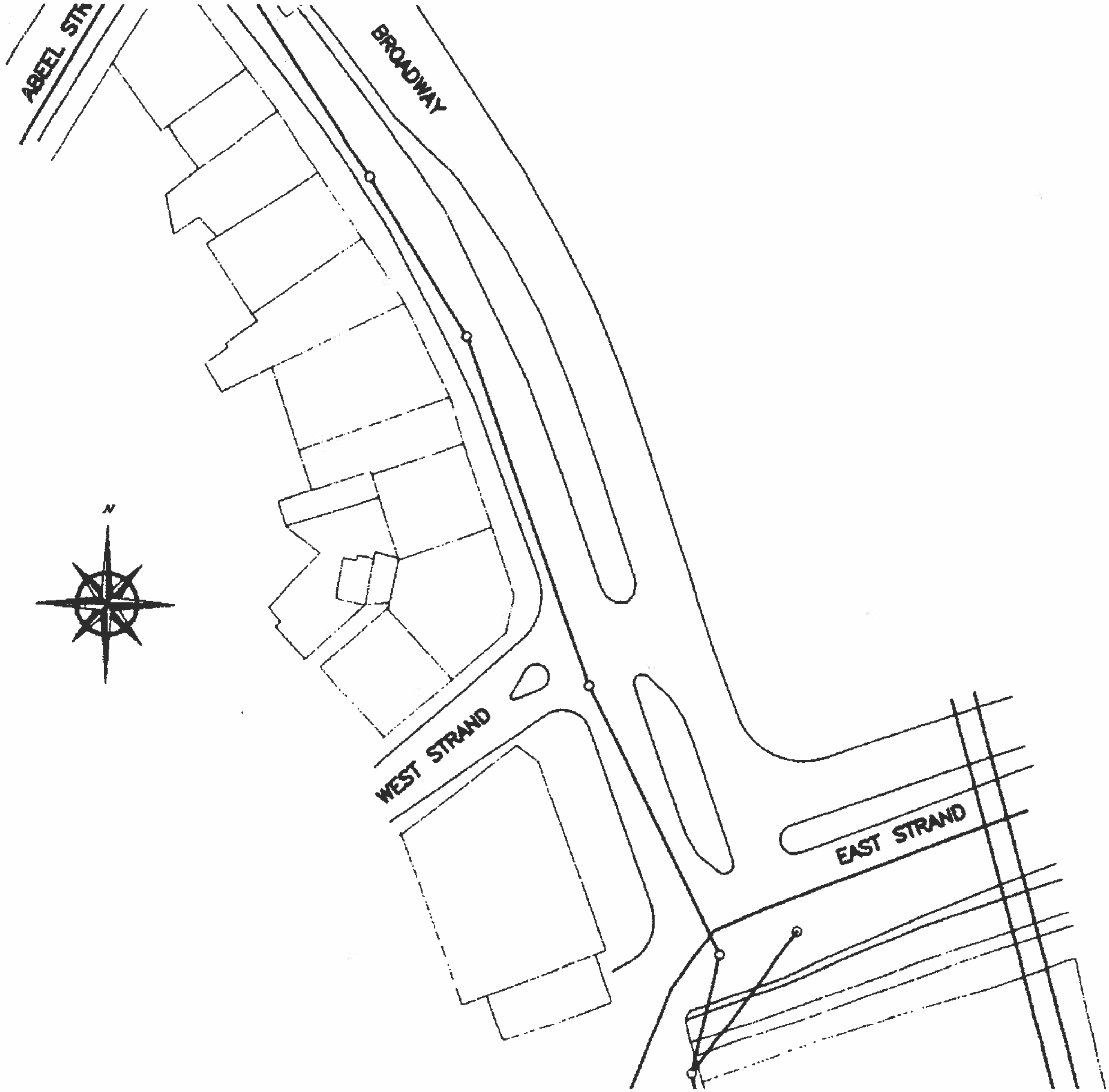
2. **Check for flow balance:** This is a fundamental conservation of mass check. For dry weather, the flow balance requires that the movement of the water mass be continuous and increasing from upstream to downstream. Table 4-2 shows the flow balance equations based on the proposed flow monitoring sites.

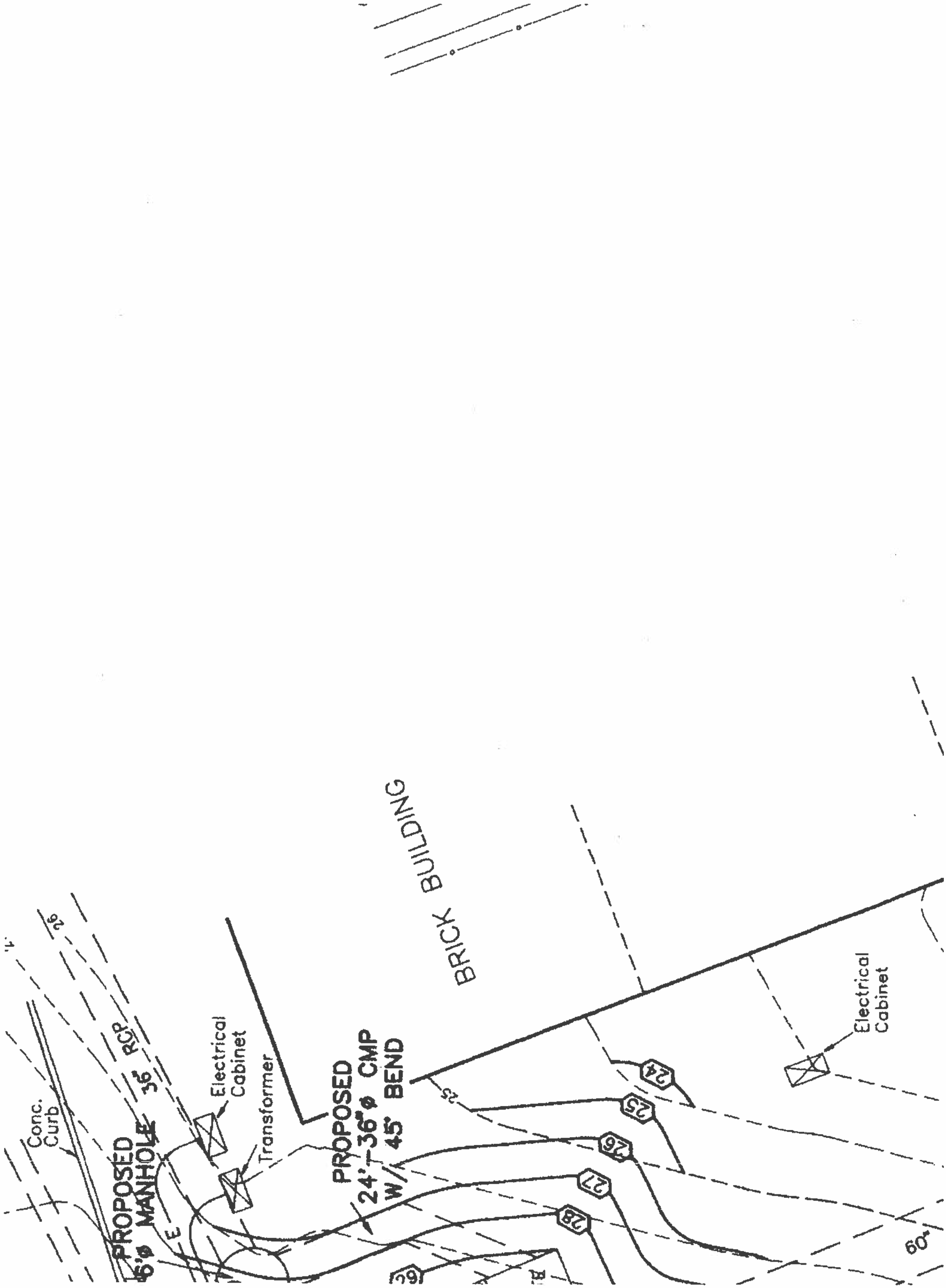
ATTACHMENT

1

Overflow Structure Record Drawings

MALCOLM
PIRNIE


ABEEL ST
BROADWAY
N
WEST STRAND
EAST STRAND


BRICK BUILDING
PROPOSED 24'-36"Ø CMP W/ 45° BEND
PROPOSED 6'Ø MANHOLE
36" RCP
Conc. Curb
Electrical Cabinet
Transformer
Electrical Cabinet
E
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27
28
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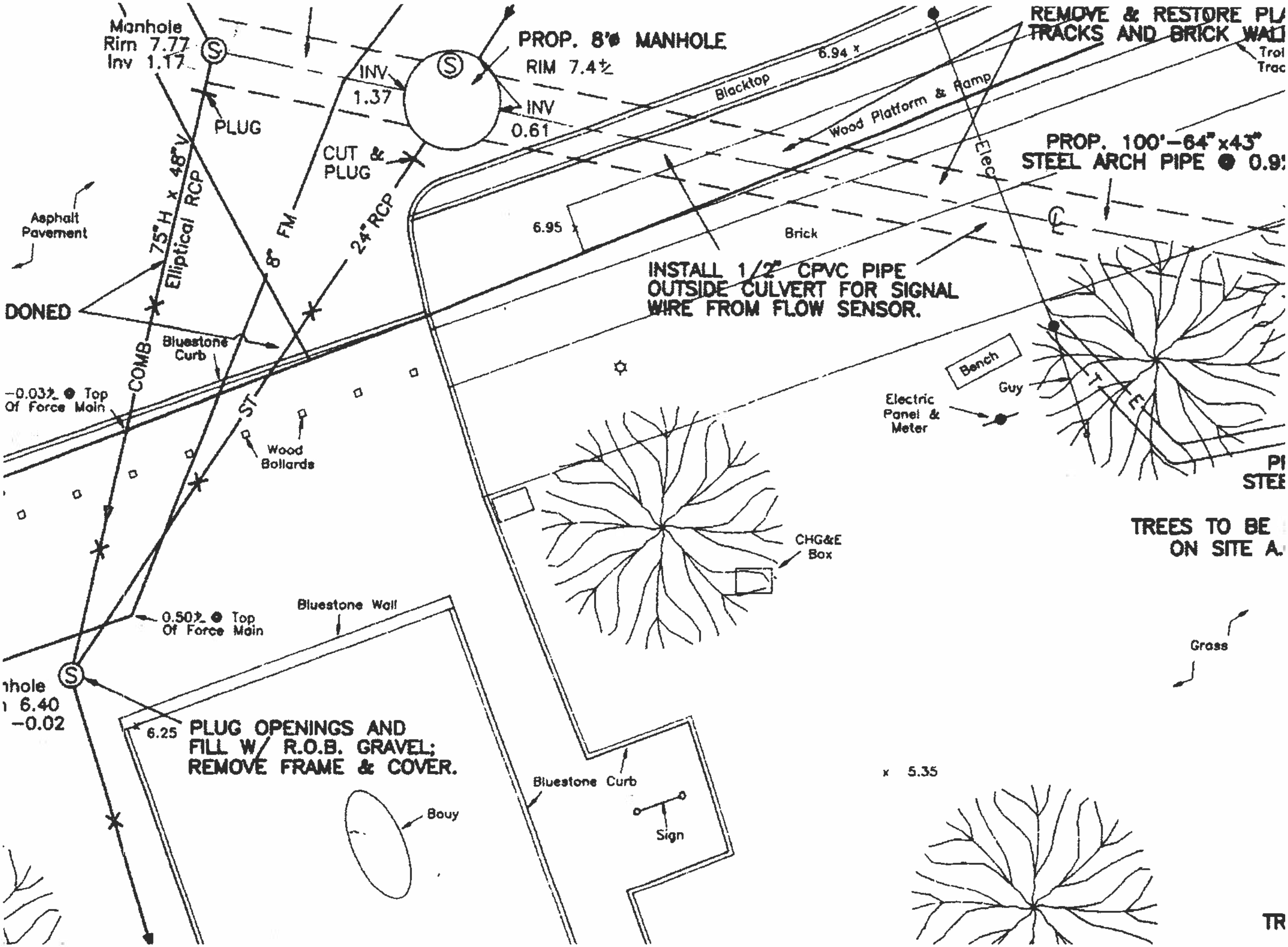
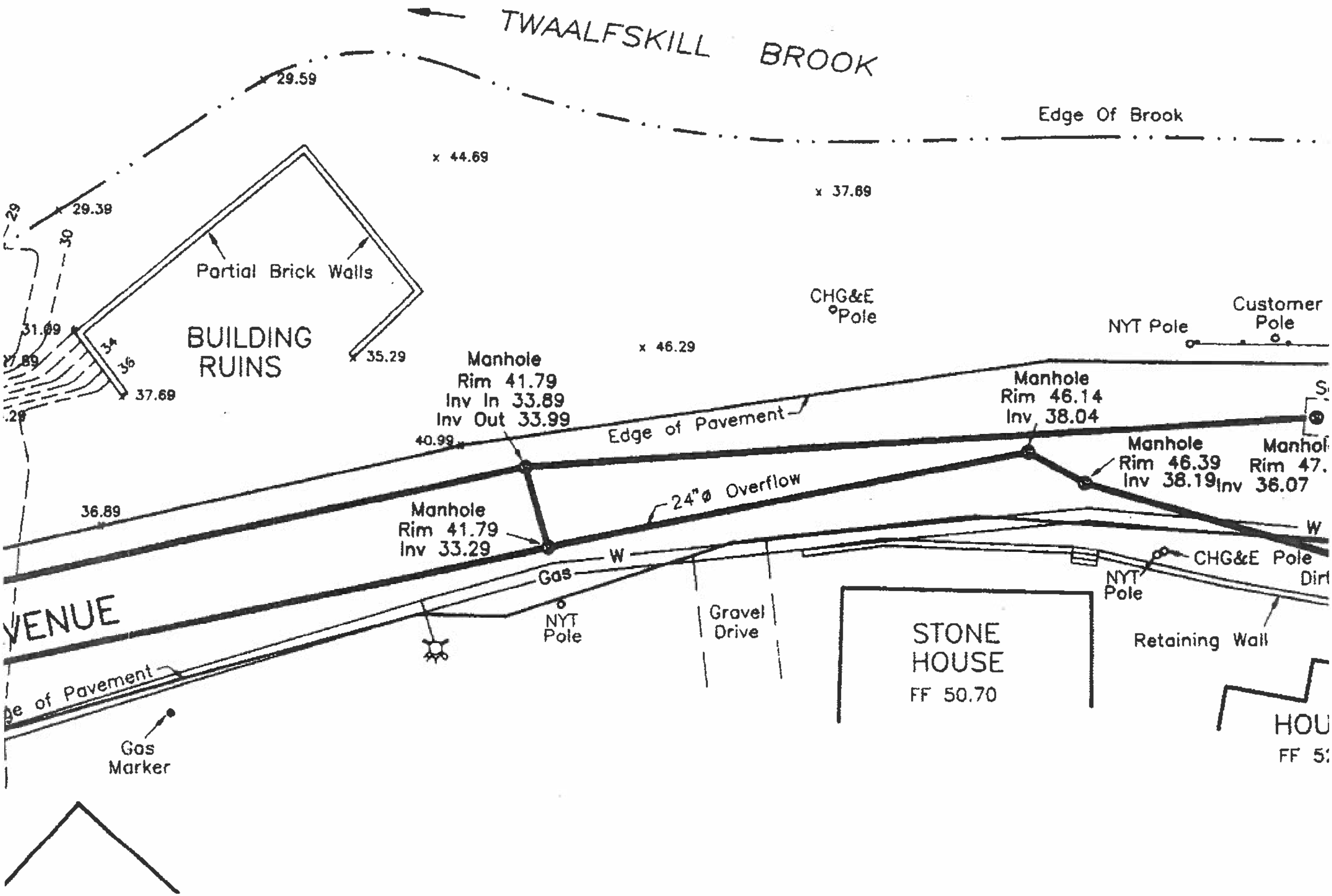
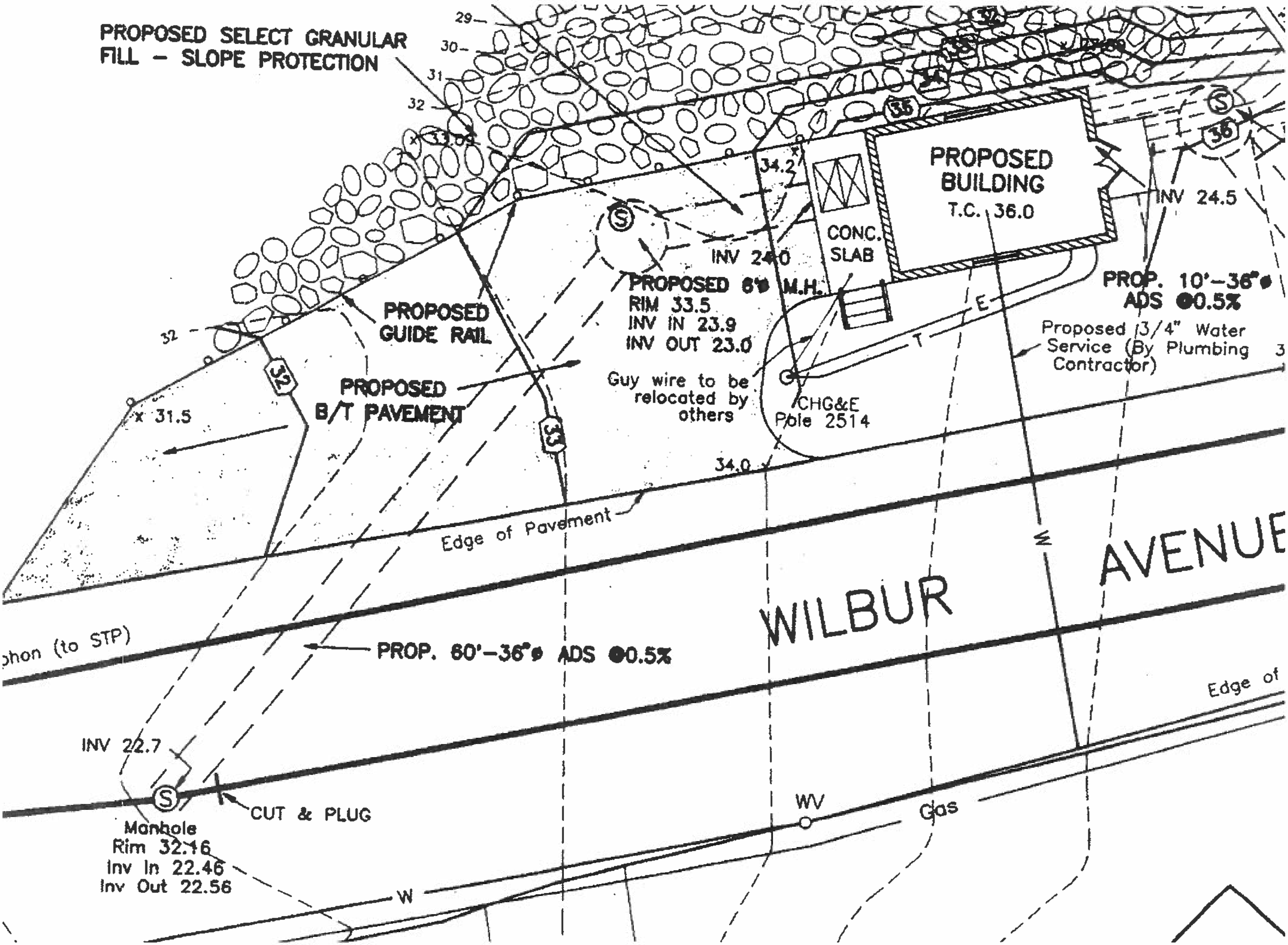
26
60"


Manhole
Rim 7.77
Inv 1.17
PROP. 8'Ø MANHOLE
RIM 7.4±
INV
1.37
INV
0.61
PLUG
CUT &
PLUG
REMOVE & RESTORE PL
TRACKS AND BRICK WAL
Trol
Trac
6.94 x
Blacktop
Wood Platform & Ramp
Elec
PROP. 100'–64"x43"
STEEL ARCH PIPE @ 0.9
℄
75"H x 48"V
Elliptical RCP
8" FM
24" RCP
Asphalt
Pavement
DONED
6.95
Brick
INSTALL 1/2" CPVC PIPE
OUTSIDE CULVERT FOR SIGNAL
WIRE FROM FLOW SENSOR.
Bluestone
Curb
COMB
ST
−0.03± @ Top
Of Force Main
Wood
Bollards
Bench
Guy
Electric
Panel &
Meter
T
E
PI
STEE
TREES TO BE
ON SITE A.
CHG&E
Box
Bluestone Wall
0.50± @ Top
Of Force Main
hole
6.40
−0.02
6.25
PLUG OPENINGS AND
FILL W/ R.O.B. GRAVEL;
REMOVE FRAME & COVER.
Grass
Bouy
Bluestone Curb
Sign
x 5.35
TR


TWAALFSKILL BROOK
Edge Of Brook
29.59
29.39
29
30
44.69
37.69
Partial Brick Walls
BUILDING RUINS
31.69
34
36
37.69
35.29
CHG&E Pole
NYT Pole
Customer Pole
46.29
Manhole
Rim 41.79
Inv In 33.89
Inv Out 33.99
40.99
Edge of Pavement
Manhole
Rim 46.14
Inv 38.04
Manhole
Rim 46.39
Inv 38.19
Manhole
Rim 47.
Inv 36.07
24"ø Overflow
36.89
Manhole
Rim 41.79
Inv 33.29
W
W
Gas
NYT Pole
Gravel Drive
STONE HOUSE
FF 50.70
NYT Pole
CHG&E Pole
Retaining Wall
HOU
FF 5
VENUE
Edge of Pavement
Gas Marker


PROPOSED SELECT GRANULAR FILL – SLOPE PROTECTION
29
30
31
32
x 33.09
32
35
34
36
PROPOSED BUILDING
T.C. 36.0
INV 24.5
CONC. SLAB
34.2
INV 24.0
PROPOSED 6'ɸ M.H.
RIM 33.5
INV IN 23.9
INV OUT 23.0
PROP. 10'–36"ɸ ADS @0.5%
Proposed 3/4" Water Service (By Plumbing Contractor)
E
T
PROPOSED GUIDE RAIL
32
x 31.5
PROPOSED B/T PAVEMENT
33
Guy wire to be relocated by others
CHG&E Pole 2514
34.0
Edge of Pavement
W
WILBUR AVENUE
phon (to STP)
PROP. 60'–36"ɸ ADS @0.5%
Edge of
INV 22.7
S
CUT & PLUG
Manhole
Rim 32.16
Inv In 22.46
Inv Out 22.56
WV
Gas
W

City of Kingston CSO Long-Term Control Planning
Draft Flow Monitoring and Rain Gauging Work Plan

ATTACHMENT

2

Flow Monitor Specifications

5744015 / ALB

MALCOLM PIRNIE

Isco 2150 Area Velocity Flow Module

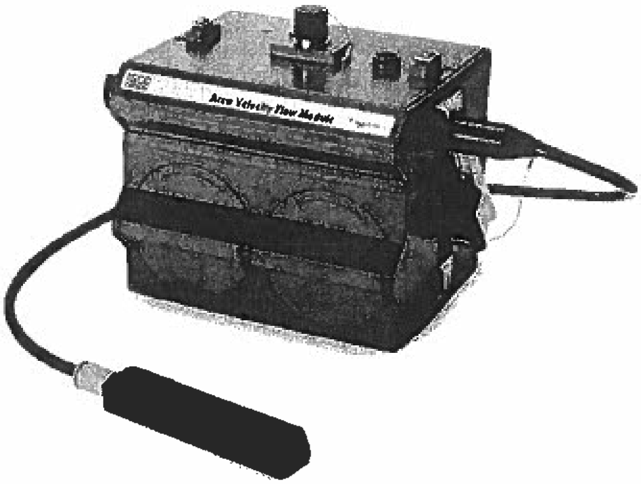
The 2150 Flow Module uses continuous wave Doppler technology to measure mean velocity. The sensor transmits a continuous ultrasonic wave, then measures the frequency shift of returned echoes reflected by air bubbles or particles in the flow.

The 2150's "smart" area velocity probe is built on digital electronics, so the analog level is digitized in the sensor itself to overcome electromagnetic interference. The probe is also factory-calibrated for 10-foot (3 meter) span at different temperatures. This built-in calibration eliminates drift in the level signal, providing long-term level stability that reduces recalibration frequency and completely eliminates span recalibration.

In field use, the 2150 is typically powered either by two alkaline, or Isco Rechargeable Lead-acid batteries, within a 2191 Battery Module. Highly efficient power management extends battery life up to 15 months at 15-minute data storage intervals. Other power options (including solar) are available.

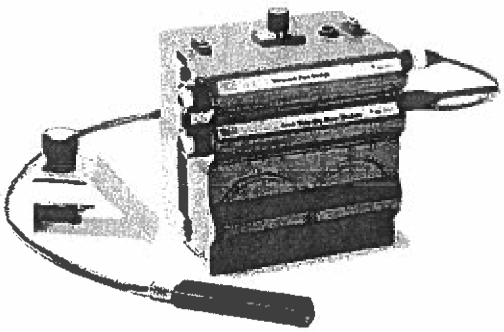
Applications

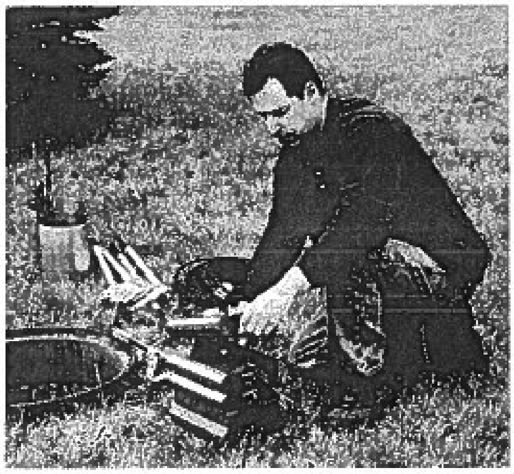
- Portable and permanent-site AV flow monitoring for inflow and infiltration, capacity assessment, sewer overflow, and other sewer studies.
- Measuring shallow flows in small pipes. Our low-profile area velocity sensor minimizes flow stream obstruction and senses velocity in flows down to 1 inch (25 mm) in depth.



Standard Features

- Rugged, submersible enclosure meets NEMA 4X, 6P (IP68) environmental specs.
- Chemically resistant epoxy-encapsulated sensor withstands abuse, resists oil and grease fouling, and eliminates the need for frequent cleaning.
- Replaceable high-capacity internal desiccant cartridge and hydrophobic filter protect sensor reference from water entry and internal moisture.
- Pressure transducer vent system automatically compensates for atmospheric pressure changes to maintain accuracy.
- The quick-connect sensor can be easily removed and interchanged in the field without requiring recalibration.
- Up to four 2100 Series flow modules can be networked by stacking and/or extension cables.

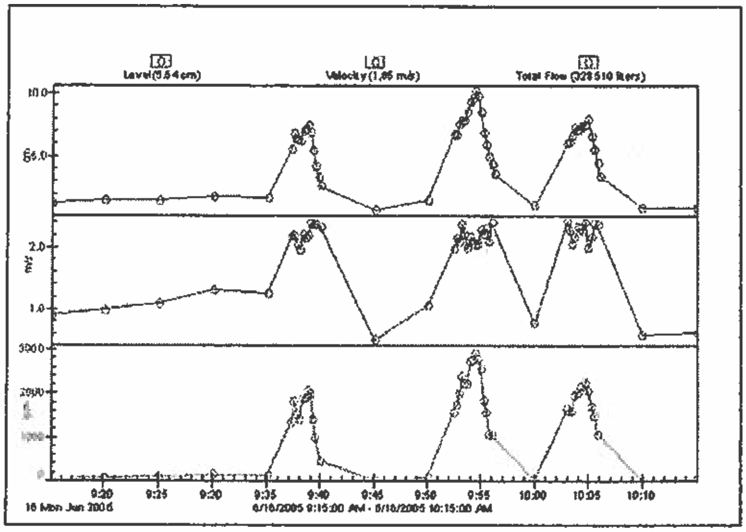




Above left: Additional modules can be added for redundant or multi-stream measuring (Isco 2110 Ultrasonic Module shown). Right: Optional mounting rings provide quick, secure sensor installation in round pipes from 6 to 80 inches (150 to 2000 mm).

Software Features

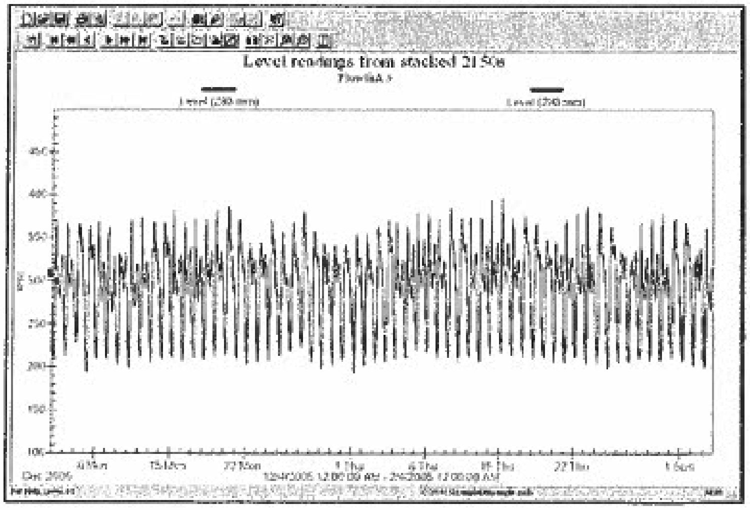
- Secure data storage. All data are continuously stored in flash memory to protect against loss in case of power failure
- Easy to upgrade. New operating software can be downloaded into non-volatile flash memory, without affecting stored program and data.
- Records and stores input voltage and temperature data.
- Variable rate data storage lets you change the data storage interval when programmed conditions occur. This feature assures maximum information about an exceptional event – such as an overflow – while conserving power and data capacity during normal conditions.
- 38,400 bps communication provides speedy setup and data retrieval.



Variable rate data storage

The 2150 flow module has the ability to automatically switch data storage rates based on varying conditions.

In the example at left, the 5-minute data storage rate automatically changed to 30 seconds when the flow rose above a programmed level.



Level stability

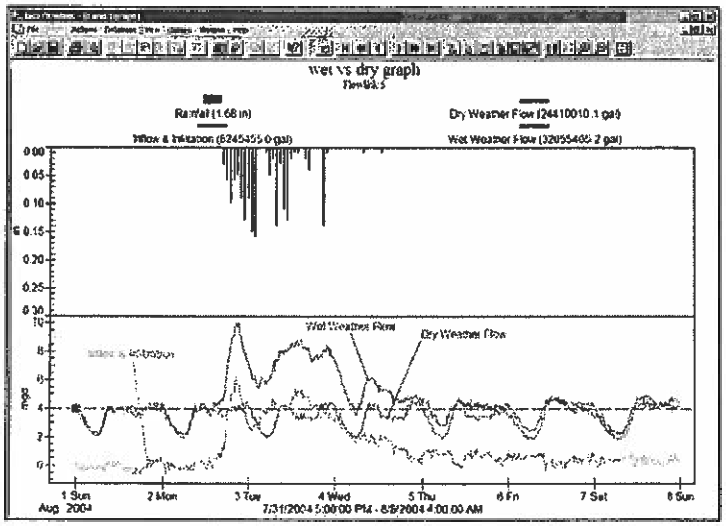
Frequent multipoint level recalibration is a requirement with other area velocity flow meters. Isco's exclusive "smart" sensor design in the area velocity probe yields exceptionally low drift in the level signal.

The 2150's factory-calibrated 3-meter span totally eliminates the need for cumbersome span recalibration in the field.

In the example at left, two area velocity probes were installed at the same site. The level readings from both sensors track closely without any drift, over an 8-week period.

Flowlink® Data Analysis

Isco Flowlink® Software is a powerful tool for analyzing flow and water quality data. It provides site setup, data retrieval, and comprehensive data analysis, as well as advanced reporting and graphing. See separate datasheets for details on Flowlink and Flowlink Pro software.



The Flowlink screen shown above gives a comparison of dry and wet weather flows, plus rainfall typical of an inflow & infiltration study

Information Delivery

Isco 2100 Series Flow Modules offer a wide variety of communication and retrieval options, to minimize the need for expensive on-site visits and confined space entry. These include:

Isco 2103 Land-line Modem Module
Reliable two-way dial-up communication between down-hole 2100 Flow Modules and your desktop computer, equipped with Isco Flowlink Software. A dial-out feature enables the system to transmit a text message alarm to your digital cell phone or pager.

Isco 2103c Cellular Modem Module
All the features of the 2103 Modem with the convenience of cell phone access. And the 2103c can automatically send data via the Internet to a designated server running Flowlink Pro software, using economical 1xRTT packet-switched data transmission.

Isco 2108 Analog Output Module
Provides current outputs for use with Isco 2100 Series Area Velocity and Ultrasonic Flow Modules. It allows easy interface with SCADA/DCS or other secondary instrument systems.

Modbus
2100 Series Flow Modules provide digital RS 232 Modbus output that can be used to interface with external communication modules, SCADA systems, or other devices.

On-site Data Retrieval

Isco Flowlink Software
Download and process data on-site. Enjoy unmatched data management capability, advanced data editing and analysis, powerful reporting and presentation choices, and a variety of downloading and data handling options.

Isco 2101 Field Wizard
A durable, weatherproof module for on-site data retrieval. Don't risk damage to your fragile notebook PC. The 2101 Field Wizard provides on-site display of current readings, information about stored data, diagnostics, and more.

Interrogate all 2100 Series Flow Modules in the stack at one time, and store more than 14 days' data from up to 20 modules!

Isco 2102 Communication Module
Connect with your Isco 2100 Series Flow Modules from the safety and convenience of your vehicle.

Digital spread-spectrum radio signals enable "drive-up" data retrieval, system configuration, and level calibration, with minimum power consumption. "Plug and Play" setup – no interfacing needed.

Specifications

2150 Flow Module

Size (HxWxD):	2.9 x 11.3 x 7.5 in (74 x 287 x 191 mm)
Weight:	2.0 lb (0.9 kg)
Materials of construction:	High-impact polystyrene, stainless steel
Enclosure (self-certified):	NEMA 4X, 6P (IP68)
Temperature Range:	-40° to 140° F (-40° to 60° C) operating and storage
Power Required:	12 VDC nominal (7.0 to 16.6 VDC), 100 mA typical, 1 mA standby
Power Source:	Typically, an Isco 2191 Battery Module, containing 2 alkaline or 2 rechargeable lead-acid batteries. (Other power options are available; ask for details.)
Typical Battery Life:	Using 15-minute data storage interval Energizer® Model 529 alkaline - 15 months Isco rechargeable lead-acid - 2.5 months
Program Memory:	Non-volatile programmable flash; can be updated using PC without opening enclosure; retains user program after updating.

Built-in Conversions

Flow Rate Conversions:	Up to 2 independent level-to-area conversions and/or level-to-flow rate conversions.
Level-to-Area Conversions:	Channel Shapes - round, U-shaped, rectangular, trapezoidal, elliptical, with silt correction; Data Points - Up to 50 level-area points.
Level-to-Flow Conversions:	Most common weirs and flumes; Manning Formula; Data Points (up to 50 level-flow points); 2-term polynomial equation
Total Flow Calculations:	Up to 2 independent, net, positive or negative, based on either flow rate conversion

Data Handling and Communications

Data Storage:	Non-volatile flash; retains stored data during program updates. Capacity 395,000 bytes (up to 79,000 readings, equal to over 270 days of level and velocity readings at 15-minute intervals, plus total flow and input voltage readings at 24-hour intervals)
Data Types:	Level, velocity, flow rate 1, flow rate 2, total flow 1, total flow 2, input voltage, temperature
Storage Mode:	Rollover; 5 bytes per reading.
Storage Interval:	15 or 30 seconds; 1, 2, 5, 15, or 30 minutes; or 1, 2, 4, 12, or 24 hours Storage rate variable based on level, velocity, flow rate, total flow, or input voltage
Data Retrieval:	Serial connection to PC or optional 2101 Field Wizard module; optional modules for spread spectrum radio; land-line or cellular modem; 1xRTT. Modbus and 4-20 mA analog available.
Software:	Isco Flowlink for setup, data retrieval, editing, analysis, and reporting
Multi-module networking:	Up to four 2100 Series Flow Modules, stacked and/or remotely connected. Max distance between modules 3300 ft (1000 m).
Serial Communication Speed:	38,400 bps

2150 Area Velocity Sensor

Size (HxWxD):	0.75 x 1.3 x 6.0 in (19 x 33 x 152 mm)
Cable (Length x Diameter):	25 ft x 0.37 in (7.6 m x 9 mm) standard. Custom lengths available on request.
Weight (including cable):	2.2 lbs (1 kg)
Materials of construction:	Sensor - Epoxy, chlorinated polyvinyl chloride (CPVC), stainless steel Cable - Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC)
Operating Temperature:	32° to 140° F (0° to 60° C)
Level Measurement:	Method - Submerged pressure transducer mounted in the flow stream Transducer Type - Differential linear integrated circuit pressure transducer Range (standard) 0.033 to 10 ft (0.010 to 3.05 m); (optional) up to 30 ft (9.15 m). Maximum Allowable Level 34 ft (10.5 m) Accuracy ±0.01 ft from 0.033 to 10 ft, (±0.003 m from 0.01 to 3.05 m,) Long-Term Stability ±0.023 ft/yr (±0.007 m/yr) Compensated Range 32° to 122°F (0° to 50°C)
Velocity Measurement:	Method - Doppler ultrasonic, frequency 500 kHz Typical Minimum Depth 0.08 ft (25 mm) Range -5 to +20 ft/s (-1.5 to +6.1 m/s) Accuracy (in water with uniform velocity profile, speed of sound = 4850 ft/s, for indicated velocity range) ±0.1 ft/s from -5 to 5 ft/s (±0.03 m/s from -1.5 to +1.5 m/s) ±2% of reading from 5 to 20 ft/s (1.5 to 6.1 m/s)
Temperature Measurement:	Accuracy ±3.6° F (±2° C)

2191 Battery Module

Size (HxWxD):	6.0 x 9.6 x 7.6 in (152 x 244 x 193 mm)
Weight (without batteries):	3.2 lb (1.4 kg)
Materials of construction:	High-impact polystyrene, stainless steel
Enclosure (self certified):	NEMA 4X, 6P, (IP68)
Batteries:	Two 6-volt Energizer Model 529* alkaline (25 Ahrs capacity) or Isco Rechargeable Lead-acid (5 Ahrs capacity) recommended. *Note – Energizer 529 ER does not give specified life.

2150 Ordering Information

Contact your Teledyne Isco representative for complete ordering details and information on other 2100 Series Modules.

Description	Part No.
2150 with AV sensor, 2191 Battery Module, and Handle	68-2050-002
2150 Module with AV sensor (only)	68-2050-001
Isco Flowlink® 5 Software	68-2540-200
Energizer® Model 529 Alkaline Lantern Battery (2 required)	340-2006-02
Isco Rechargeable Lead-acid Battery (2 required)	60-2004-041
Charger for Lead-acid Batteries (holds 2 batteries)	60-2004-040

ISCO®

Water is life. Protect it.

Teledyne Isco, Inc.
4700 Superior Street
Lincoln NE 68504 USA
Tel: (402) 464-0231
USA and Canada: (800) 228-4373
Fax: (402) 465-3022
E-Mail: iscoinfo@teledyne.com
Internet: www.isco.com

Certified ISO 9001

DATA SHEET

Hach Sigma 910 Portable Area Velocity Flow Meter

Flow

The design and weight makes it one of the best choices for temporary flow monitoring projects. Use it to log level and velocity data for more than 60 days without changing the battery. Its sealed design provides superior system protection against surcharge conditions.

Features and Benefits

WW

IW

C

Simple and Reliable Flow Measurement

The compact and lightweight Hach Sigma 910 Portable Area Velocity Flow Meter measures average velocity directly, without the need for time-consuming and costly flow profiling. Hach's exclusive Submersible Area Velocity Sensor assures accuracy and reliability for unsurpassed versatility, even in the harshest open-channel applications.

Ideal for Harsh Environments

The 910 Flow Meter is NEMA 6P sealed to withstand submergence and prolonged surcharge conditions. Its compact size makes it easily portable and provides for easy storage and fit in a variety of applications such as sewer and storm water monitoring.

Advanced Technology for Accuracy

The technology used in the Hach Sigma 910 flow meter automatically corrects for temperature effects on level measurement for a higher level of accuracy. The patented* "Drawdown Correction" feature corrects the effects of velocity on accurate level measurement. Advanced, ultrasonic one-MHz Doppler technology avoids signal dropouts and ensures high levels of accuracy in low-flow, full-pipe, or reversed-flow conditions. The hydrodynamic body and side-mounted cable also maintains accuracy by reducing turbulence along the sensor body.

**Patent number U55691914*

Easy Installation and Maintenance

The 4.5-inch diameter of the Hach Sigma 910 flow meter means it can be installed almost anywhere. It has a low profile for reduced maintenance. The low maintenance sensor is detachable and interchangeable for flexibility. An oil-filled probe greatly reduces sensor fouling and need for regular cleaning schedules. Single point calibration (atmospheric) makes calibration quick and accurate.

Applications

The Sigma 910 Portable Area Velocity Flow Meter is ideal for short-term flow studies and sanitary sewer evaluation studies.

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

HACH®

Be Right™

Specifications*

910 Flow Meter

Units of Measurement

Level: m, cm, ft., in.

Flow: gps, gpm, gph, lps, lpm, lph, mgd, afd, cfs, cfm, cfh, cfd, m^3s, m^3m, m^3h, m^3d

Totalized Flow: L, m^3, ft.^{3}, gal., acre-ft.,

Monitoring Intervals

1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60 minutes

Operating Temperature

-18 to 60°C (0 to 140°F)

Storage Temperature

-40 to 60°C (-40 to 140°F)

Time-Based Accuracy

±1 second per day

User Interface

IBM-compatible PC

Program Memory

Non-volatile programmable flash, can be updated via RS-232 port

Data Storage

Capacity: 90 days of 1 level and 1 velocity reading at 15-minute recording intervals

Data Types: Level and velocity

Storage Mode: Wrap or slate

RAM Memory: 128 K

Communications

Serial connection to IBM-compatible computer with Hach Data Management software

Enclosure Material

PVC

Enclosure Rating

NEMA 6P (IP67)

Power Source

One Energizer EN-529 alkaline 6 Vdc battery

Battery Life

60 days typical (with 15-minute recording interval, 1 level and 1 velocity, data download once per week, at 10°C (50°F), also affected by site conditions)

Dimensions

11.4 cm diameter x 44.8 cm (4.5 in. diameter x 17.625 in.)

Weight

3.54 kg (7.8 lbs.) with battery

Submerged Depth/Velocity (AV) Sensor

VELOCITY MEASUREMENT

Range

-1.52 to 6.10 m/s (-5 to 20 ft./s)

Zero Stability

0.015 m/s (<0.05 ft./s)

Accuracy

±2% of reading

Operating Temperature

-18 to 60°C (0 to 140°F)

Typical Minimum Depth for Velocity

2 cm (0.8 in.)

Method

Doppler ultrasonic

Transducer Type

Twin 1 MHz piezoelectric crystals

DEPTH MEASUREMENT

Range

Standard: 0 to 3 m (0 to 10 ft.)

Extended: 0 to 9 m (0 to 30 ft.)

Accuracy

±0.16% full scale ±1.5% of reading at constant temp (±2.5°C)

±0.20% full scale ±1.75% of reading from 0 to 30°C (32 to 86°F)

±0.25% full scale ±2.1% of reading from 0 to 70 °C (32 to 160°F)

Maximum Allowable Level

Standard: 10.5 m (34.5 ft.)

Extended: 31.5 m (103.5 ft.)

Air Intake

Atmospheric pressure reference is desiccant protected

Method

Pressure transducer with stainless steel diaphragm

GENERAL

Material

Noryl® plastic outer shell with epoxy potting

Cable

Standard: 9, 15, 23, and 30.5 m (30, 50, 75 and 100 ft.)

Custom: greater than 30.5 m (100 ft.)

Maximum: 76 m (250 ft.)

Cable Diameter

0.91 cm (0.36 in.)

Sensor Dimensions

2.3 x 3.8 x 13.5 cm (0.9 x 1.5 x 5.3 in.)

**Specifications subject to change without notice.*

Engineering Specifications

910 Flow Meter

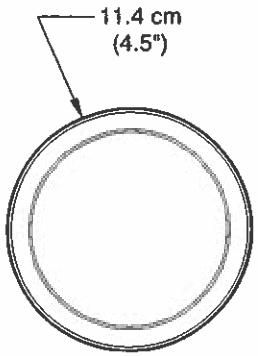
1. The flow meter system shall consist of a flow meter and a submerged depth/velocity sensor.
2. The sensor shall be equipped with level drawdown correction to compensate for the effects of velocity in depth measurement accuracy.
3. The flow meter housing shall be made of NEMA 6P (IP67) PVC sealed to withstand submergence and prolonged surcharge conditions.
4. The flow meter shall be capable of reporting in the following units:
   a. Level; m, cm, ft., in.
   b. Flow; gps, gpm, gph, lps, lpm, lph, mgd, afd, cfs, cfm, cfh, cfd, m^3s, m^3m, m^3h, m^3d.
   c. Totalized flow; L, m^3, $ft.^3$, gal., acre-ft.
5. The flow meter shall monitor at 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60-minute intervals.
6. The flow meter shall be capable of storing data in non-volatile, programmable flash memory that can be updated via RS232 port.
   a. Capacity shall be 90 days of one depth and one velocity reading at 15-minute recording intervals.
   b. Data types shall be level and velocity.
   c. Storage mode shall be wrap or slate.
7. The flow meter shall have Modbus® and GSM wireless communication functionality.
8. Exterior dimensions shall not exceed 4.5 inches diameter and 17.625 inches length.
9. The flow meter shall be the Sigma Model 910 Portable Area Velocity Flow Meter manufactured by Hach Company.

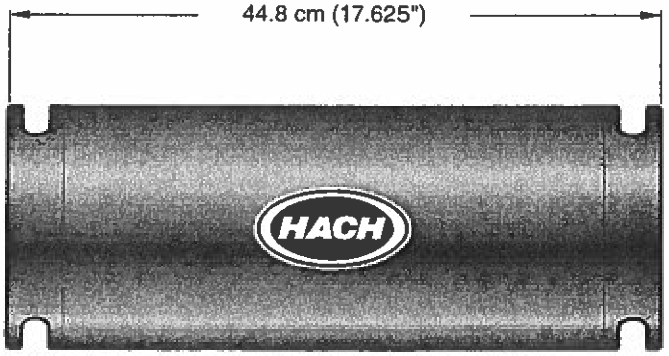
Submerged Depth/Velocity (AV) Sensor

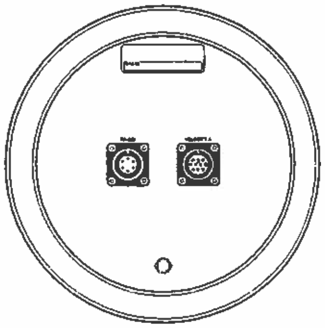
1. The sensor shall be capable of directly measuring average velocity.
2. The method of velocity measurement shall employ transducer type that is twin 1-MHz piezoelectric crystals.
3. The method of depth measurement shall be pressure transducer with stainless steel diaphragm.
4. Velocity range shall be -1.52 to 6.10 m/s (-5 to 20 ft./s)
5. The range of level measurement shall be 0 to 3 m (0 to 10 ft.), standard, and 0 to 9 m (0 to 30 ft.), extended.
6. The body material of the sensor shall be Noryl® plastic outer shell with epoxy potting.
7. The connector of the sensor shall be hard anodized and satisfy Military Spec 5015.
8. Power consumption of the sensor shall be less than or equal to 1.2 W at 12 Vdc.
9. The sensor shall be the Sigma AV Sensor Flow Sensor manufactured by Hach Company

Dimensions

The Hach Sigma 910 Portable Area Velocity Flow Meter should not be used in hazardous locations where combustible gases may be present. Mount the meter so that the connectors face down. When not in use, cover the connectors with their protective caps to prevent corrosion. Always use the appropriate manhole support bracket/spanner bar.







Ordering Information

Flow Meter

4900	Sigma 910 Flow Meter with 6-volt battery

Complete Flow Meter Systems

4900910	Includes Sigma 910 Flow Meter (p/n 4900) standard submerged depth/velocity (AV) sensor (p/n 77065-030) and suspension harness (p/n 4920)

Flow Meter Accessories

4920	Suspension Harness for suspending the flow meter
9542	Manhole Support Bracket/Spanner; 18 in., fits 18- to 28-in. manholes
9557	Manhole Support Bracket/Spanner; 28 in., fits 28- to 48-in. manholes
5713000	Manhole Support Bracket; 18 to 27 in.

Sensors

All sensor are equipped with a connector

Non-oil Filled Standard Submerged Depth/Velocity (AV) Sensors (0 to 10 ft. range)

77065-030	Non-oil Filled Standard Sigma Submerged AV Sensor; 30 ft. cable
77065-050	Non-oil Filled Standard Sigma Submerged AV Sensor; 50 ft. cable
77065-075	Non-oil Filled Standard Sigma Submerged AV Sensor; 75 ft. cable
77065-100	Non-oil Filled Standard Sigma Submerged AV Sensor; 100 ft. cable

Oil Filled Standard Submerged Depth/Velocity (AV) Sensors (0 to 10 ft. range)

77064-030	Oil Filled Standard Sigma Submerged AV Sensor; 30 ft. cable
77064-050	Oil Filled Standard Sigma Submerged AV Sensor; 50 ft. cable
77064-075	Oil-Filled Standard Sigma Submerged AV Sensor; 75 ft. cable
77064-100	Oil-Filled Standard Sigma Submerged AV Sensor; 100 ft. cable

Sensor Mounting Hardware

4939	Submerged AV Mounting Plate, for pipe wall installation
9574	Insertion Tool for Street Level, for use with spring rings only

Spring Rings

1361	Spring Ring for 6-in. dia. pipe
1362	Spring Ring for 8-in. dia. pipe
1363	Spring Ring for 10-in. dia. pipe
1364	Spring Ring for 12-in. dia. pipe

Cables and Interfaces

3513	DTU-to-PC Cable; 115 Vac
3580	DTU-to-PC Cable; 230 Vac
1727	Sampler or Flow Meter to PC Cable
3358	RS232 Extension Cable

Accessories

5254	Insight Software (free of charge)
8764300	Flo-Center Software CD Only
8764500	Flo-Center Software CD with RS232
8764600	Flo-Center Software CD with RS232 and USB
7724700	Silicon Oil; dual 50-ml pack (refills 100 sensors)
7724800	Silicon Oil Refill Kit; includes dispensing tool and oil packs.
7725600	Oil-Filled Submerged AV Sensor Kit
7730000	Retrofit Kit (converts non oil-filled to oil-filled); includes kit Silicon Oil Refill Kit
8713200	Solar Module with 10-Watt panel and Power Regulator Assembly
8713300	Solar Module with 20-Watt panel and power Regulator Assembly

Lit. No. 2545
F63 Printed in U.S.A.

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

Keep it pure.

Make it simple.

Be right.

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

In the United States, Canada, Latin America, sub-Saharan Africa, Asia, Australia/New Zealand, and U.S. exporters, contact:

HACH COMPANY World Headquarters
P.O. Box 389
Loveland, Colorado 80539-0389
U.S.A.
Telephone: 800-227-4224
Fax: 970-669-2932
E-mail: orders@hach.com
www.hach.com

In Europe, the Middle East, and Mediterranean Africa, contact:

HACH LANGE GmbH
Willstätterstraße 11
D-40549 Düsseldorf
GERMANY
Tel: +49 (0) 211 5288-0
Fax: +49 (0) 211 5288-143
E-mail: info@hach-lange.de
www.hach-lange.com

HACH®

Be Right™

City of Kingston CSO Long-Term Control Planning
Draft Flow Monitoring and Rain Gauging Work Plan

ATTACHMENT

3

Site Location and Installation Sketches

5744015 / ALB

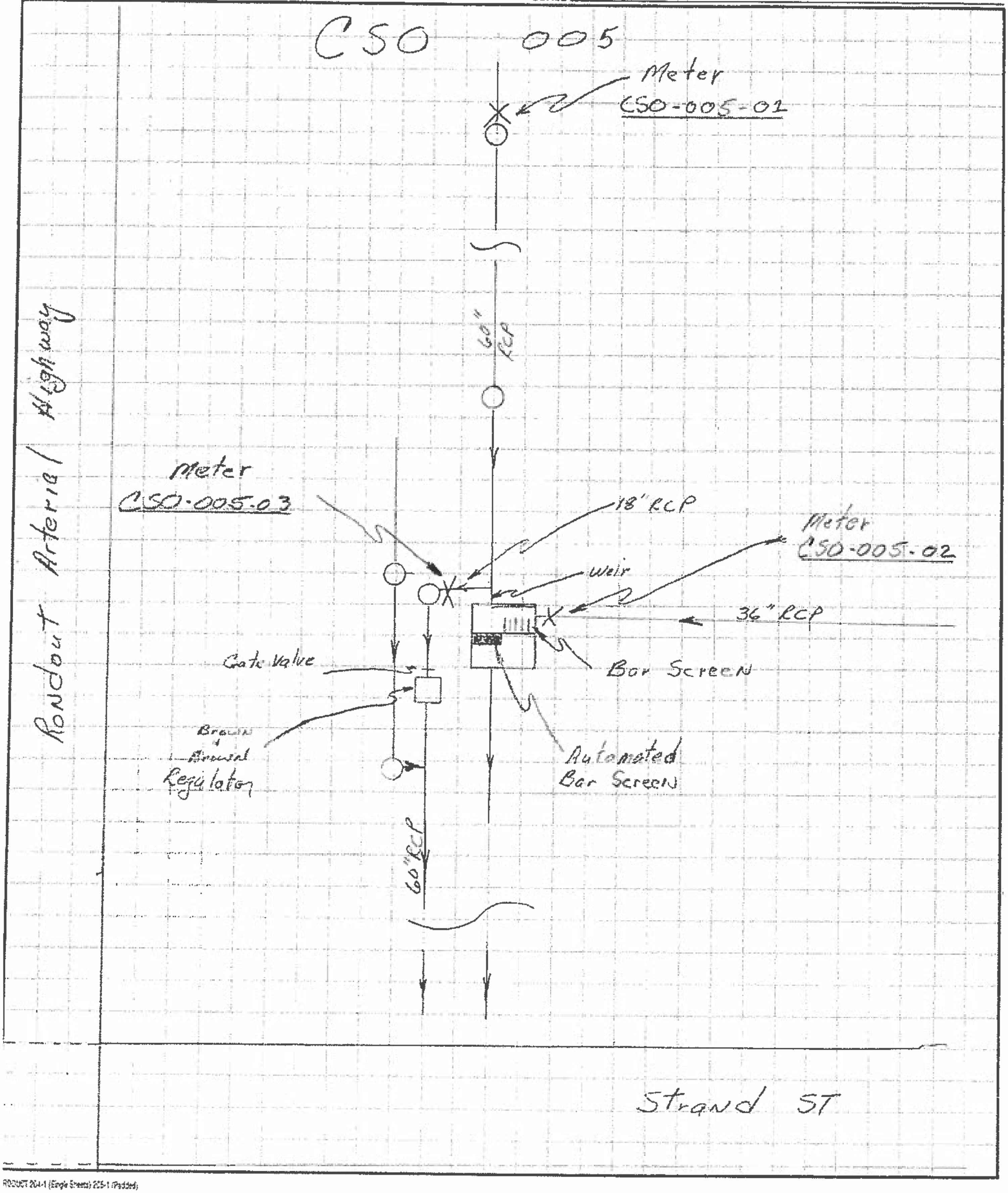
MALCOLM PIRNIE

FLOW Assessment SERVICES LLC

19 Harvey Road, Suite 22
Bedford, NH 03110
(603) 656-9799

JOB Kingston NY
SHEET NO.
OF
CALCULATED BY
DATE 8-11-05
CHECKED BY
DATE
SCALE NTS

CSO 005



FLOW Assessment SERVICES L.L.C.
19 Harvey Road, Suite 22
Bedford, NH 03110
(603) 656-9799

JOB Kingston NY

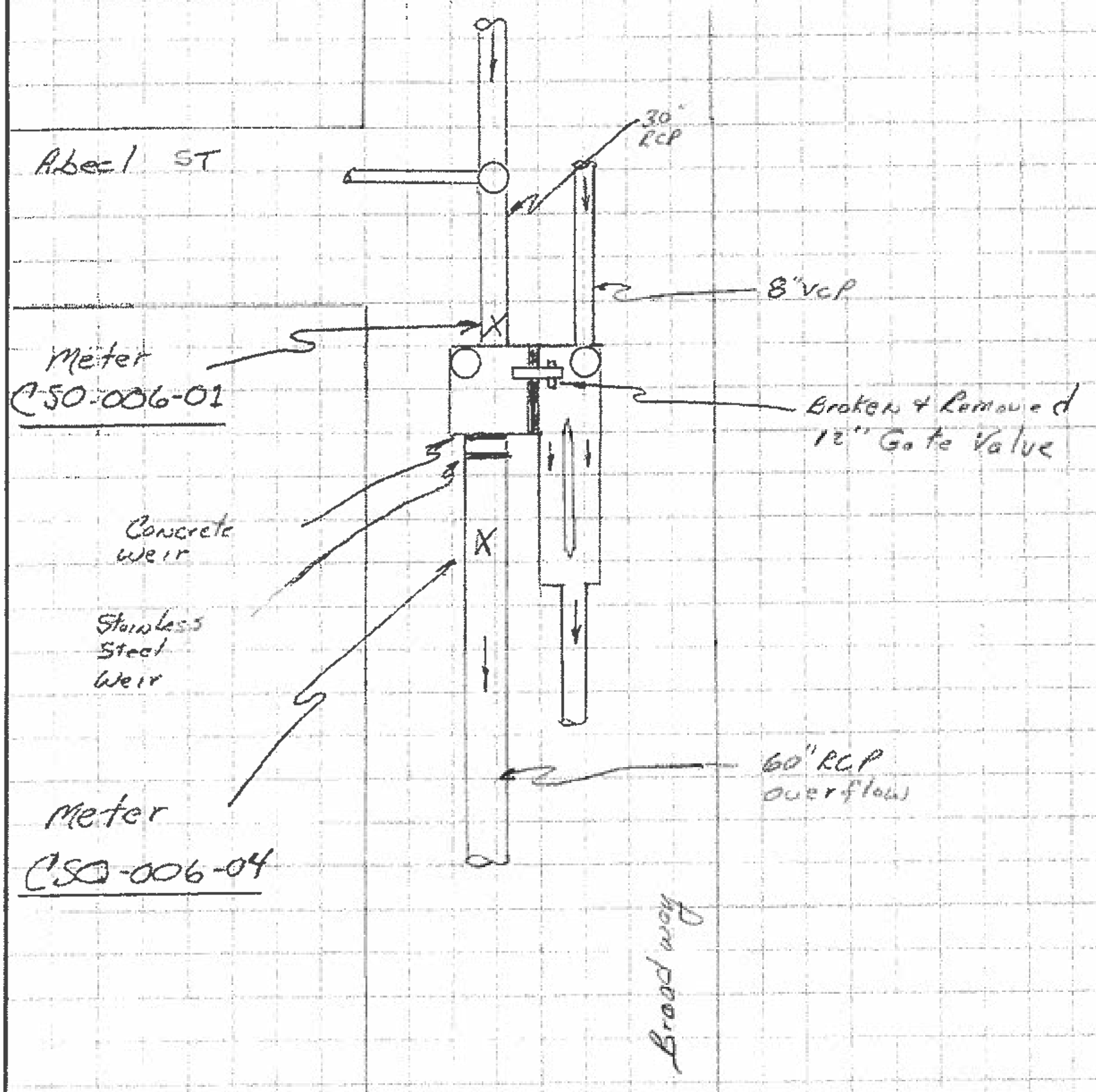
SHEET NO. ______ OF ______

CALCULATED BY ______ DATE 8-11-09

CHECKED BY ______ DATE ______

SCALE NTS

CSO 006



PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

FLOW Assessment SERVICES LLC
19 Harvey Road, Suite 22
Bedford, NH 03110
(603) 656-9799

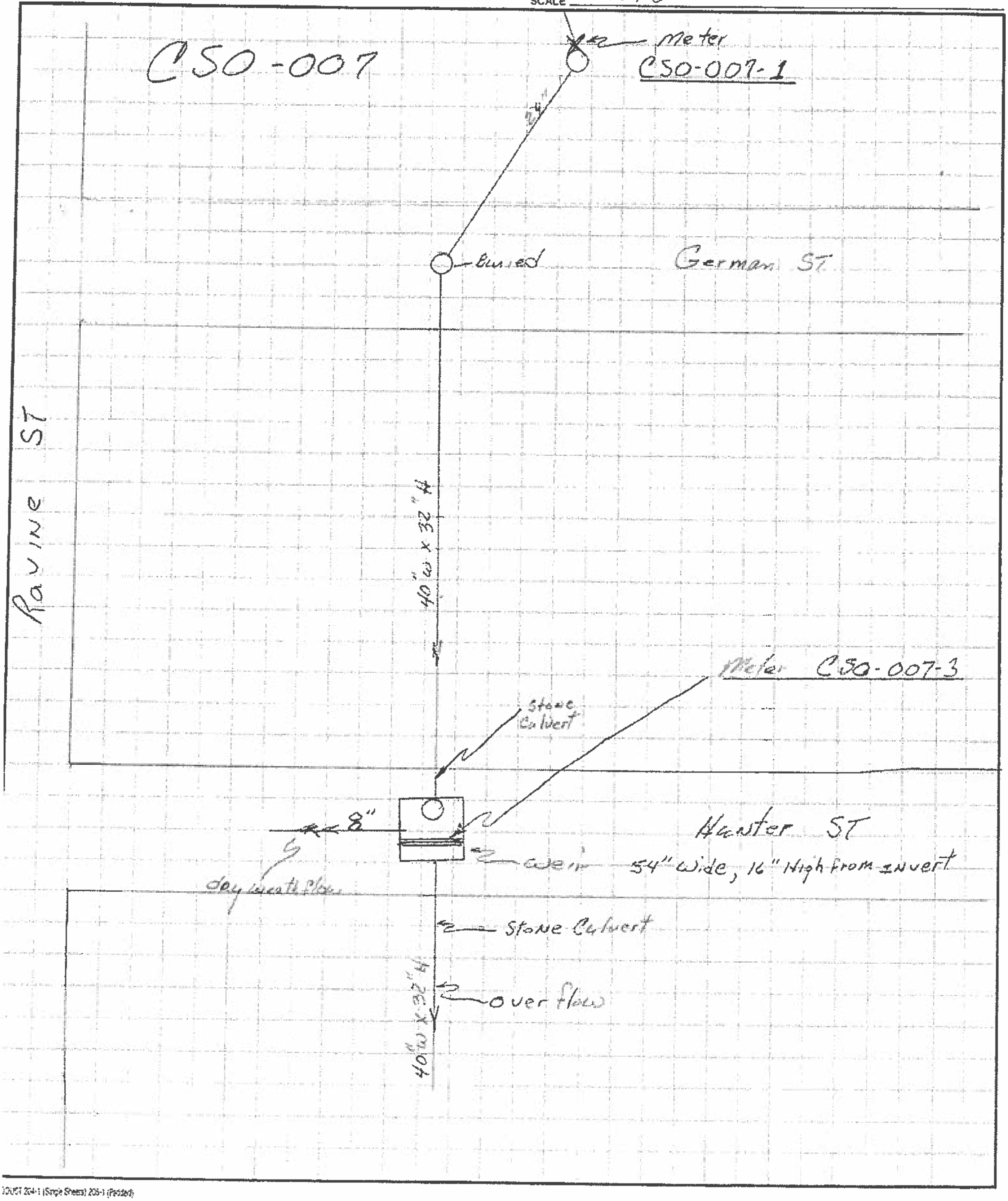
JOB Kingston NY

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE 08-12-09

CHECKED BY ______ DATE ______

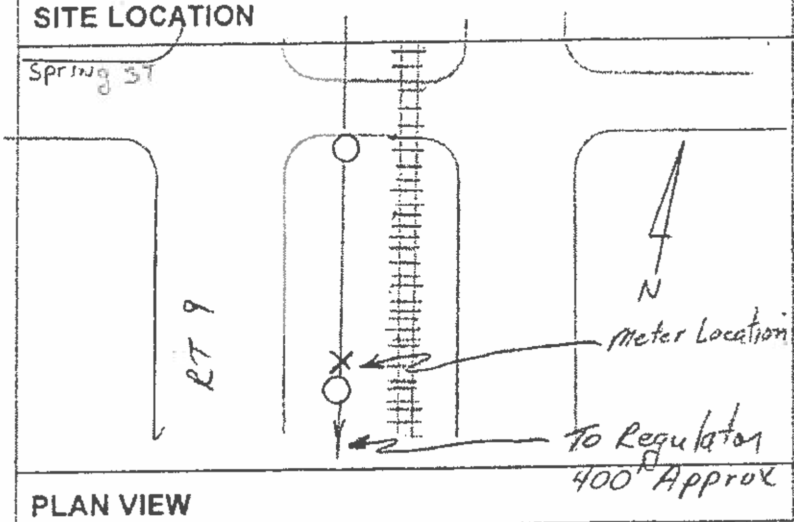
SCALE NTS



FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: R/W off Rt 9

MH#: 29

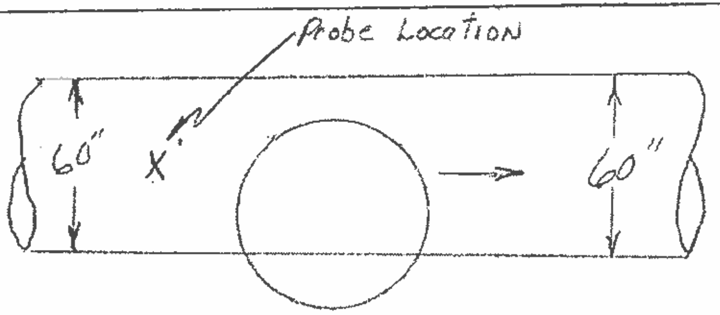
[illegible] CSO-005-01

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

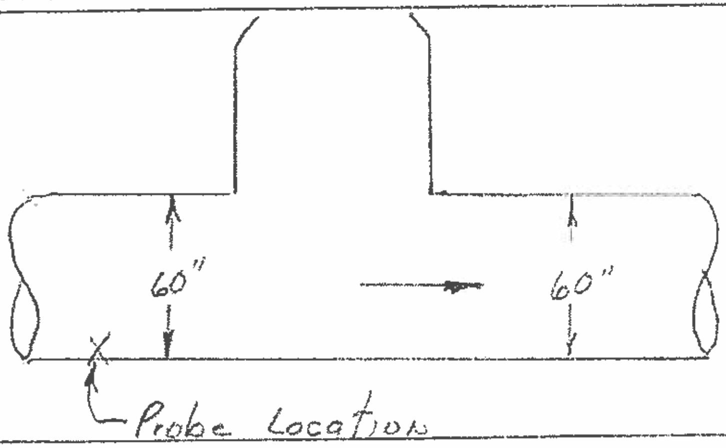


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	60	60	
MATERIAL	RCP	RCP	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	12'8"	12'8"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

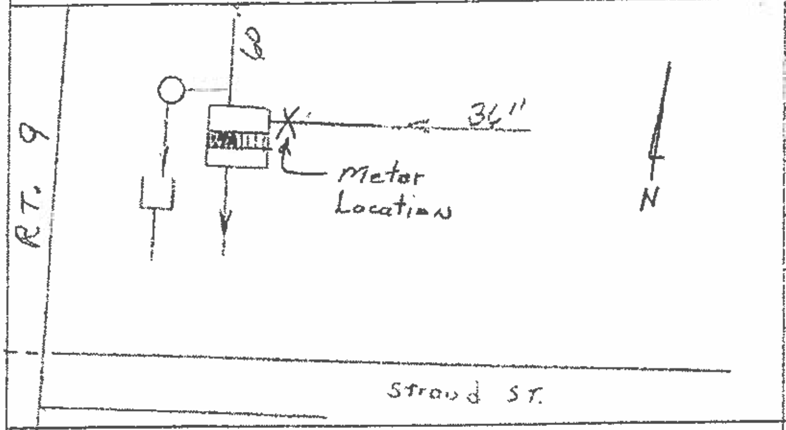
OVERFLOW OCCURS @

Photo 131

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: R/w off Strand ST, in Apt Complex

MH#: Meter CSO - 005-02

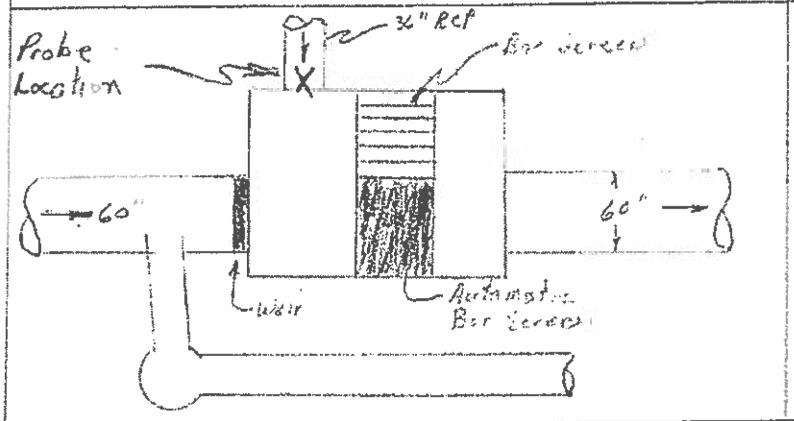
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

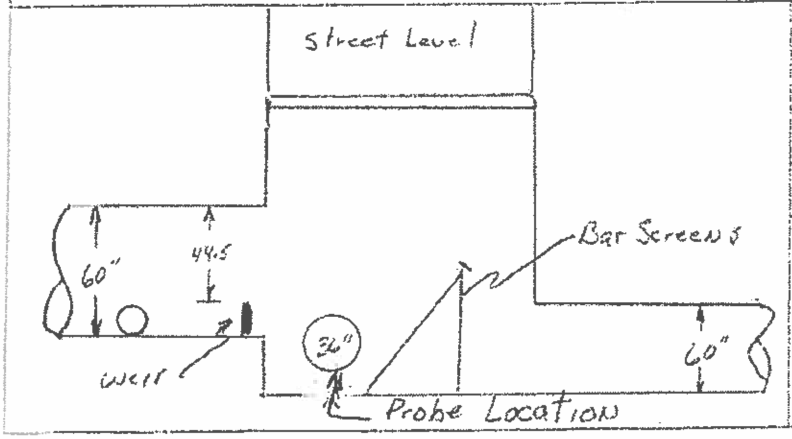


LINE DESCRIPTIONS

	INCOMING	~~OUTGOING~~ Weir	OVERFLOW
SIZE	36"		60"
MATERIAL	RCP	Stainless Steel	RCP
DEBRIS	0	0	0
SHAPE	Round	—	Round
DEPTH	12'6"	9'0"	13'9"

(Please see back for additional lines) Depth To ground Level of Building

PROFILE VIEW



WEIR

LENGTH /

BREADTH .25

LEVEL [✓ YES] NO

HEIGHT ABOVE WEIR

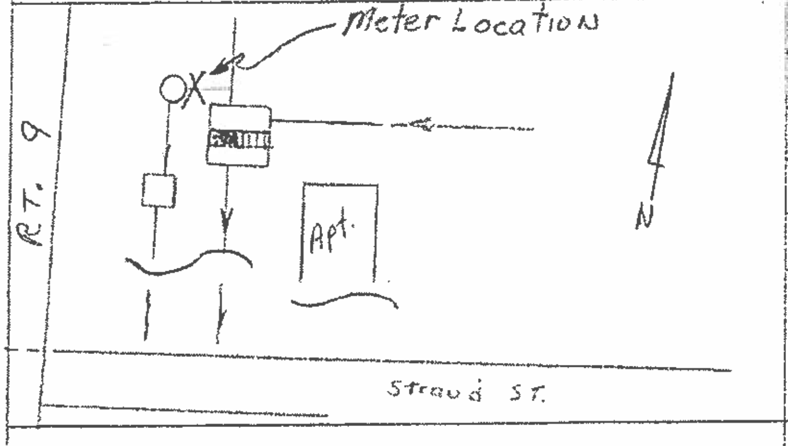
OVERFLOW OCCURS @ 15.5

Photo 126, 125

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: R/w off Strand ST in Apt Comp

MH#: Meter CSO-005-3

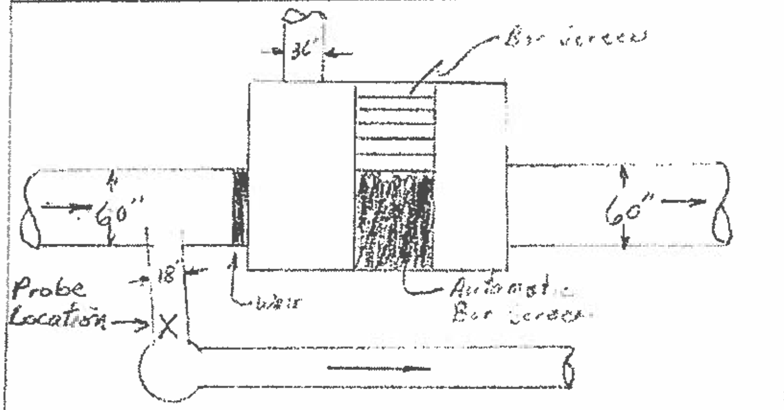
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

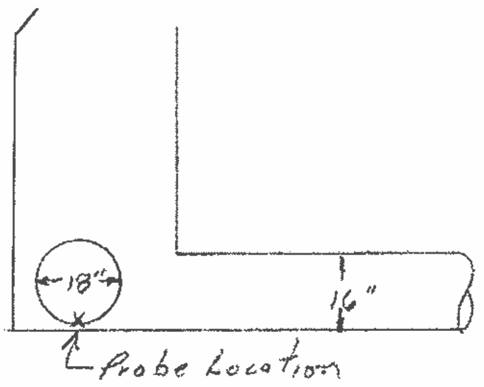


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	18"	16"	
MATERIAL	RCP	RCP	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	12'1"	12'2"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

~~OVERFLOW OCCURS~~ @ 15.5

Photo 124

FLOW Assessment SERVICES LLC.

DETAILED SITE INVESTIGATION

PROJECT: Kingston NY.

LOCATION: Broadway + Abeel ST

Meter CSO-006-01

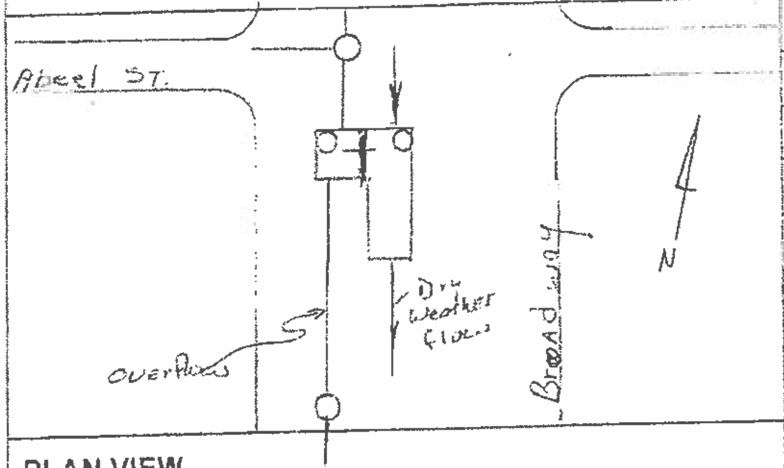
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

SITE LOCATION

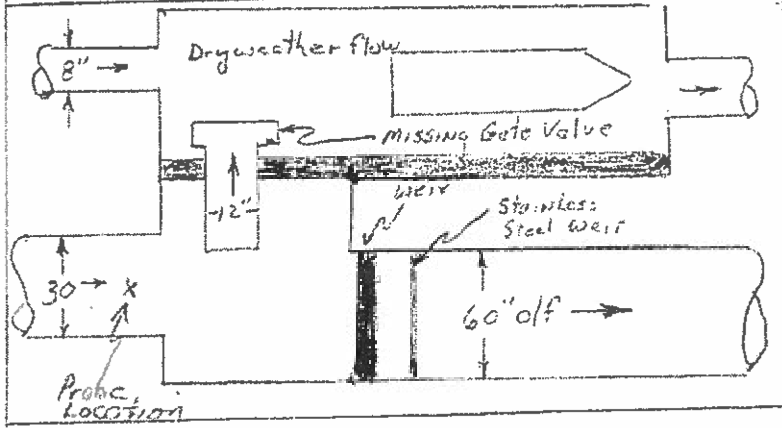


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	30"	12"	60
MATERIAL	RCP	CIP	RCP
DEBRIS	0	0	0
SHAPE	Round	Round	Round
DEPTH	9'4"	11'8"	11'0"

(Please see back for additional lines)

PLAN VIEW



WEIR

LENGTH

BREADTH

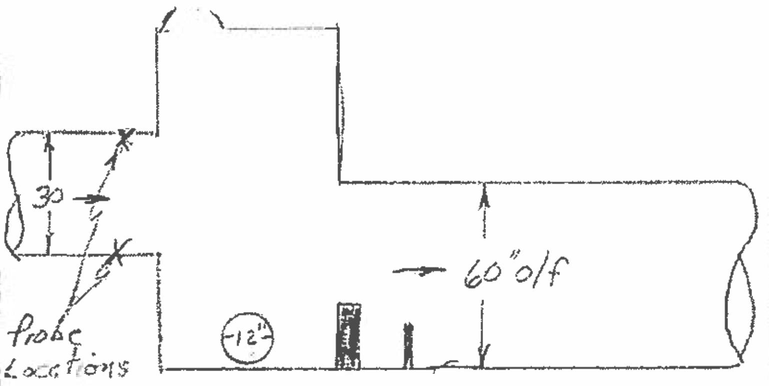
LEVEL YES/NO

HEIGHT ABOVE WEIR

OVERFLOW OCCURS @

Photo 130

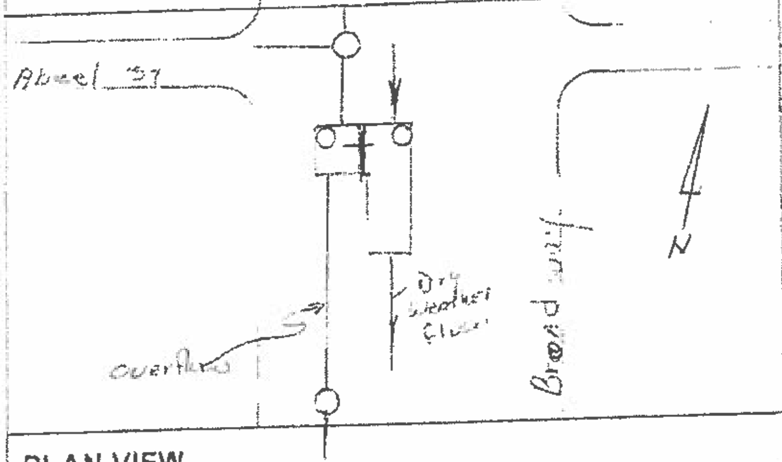
PROFILE VIEW



FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY.

LOCATION: Broadway + Abeel ST

Meter CSO - 006 - 04

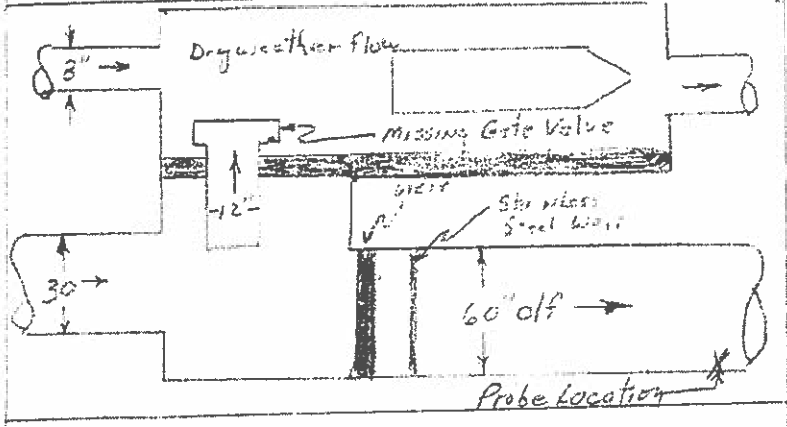
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

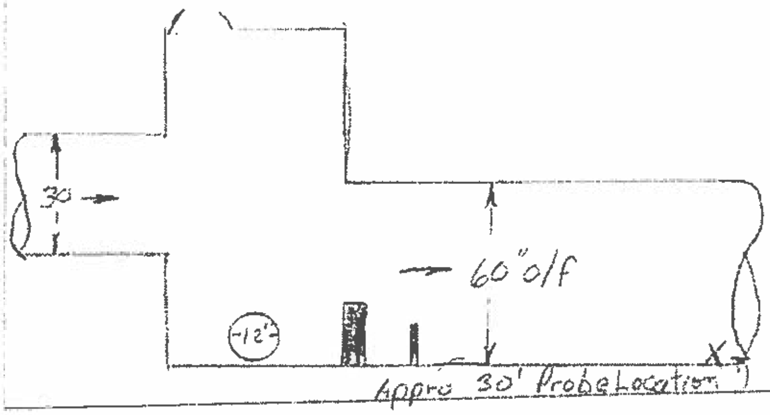


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	30"	12"	60
MATERIAL	RCP	CIP	RCP
DEBRIS	0	0	0
SHAPE	Round	Round	Round
DEPTH	9'4"	11'8"	11'0"

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH 45

BREADTH 8

LEVEL YES/[✓ NO]

HEIGHT ABOVE WEIR 51

~~OVERFLOW OCCURS~~ @ 9"

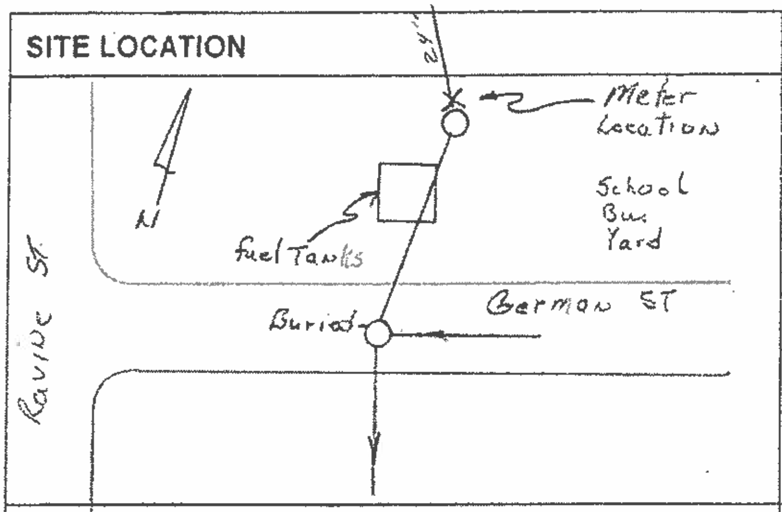
Weir is more an obstruction Than Weir.

Photo 129, 128, 127

FLOW Assessment
SERVICES L.L.C.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: R/W off German ST

[illegible] Meter CSO 007-1

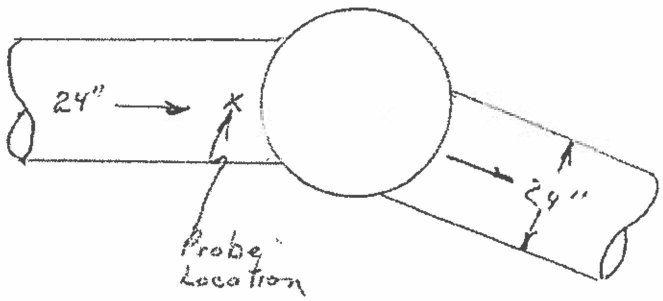
MAP#

DATE: 8-12-09

TIME:

REGULATOR#

PLAN VIEW

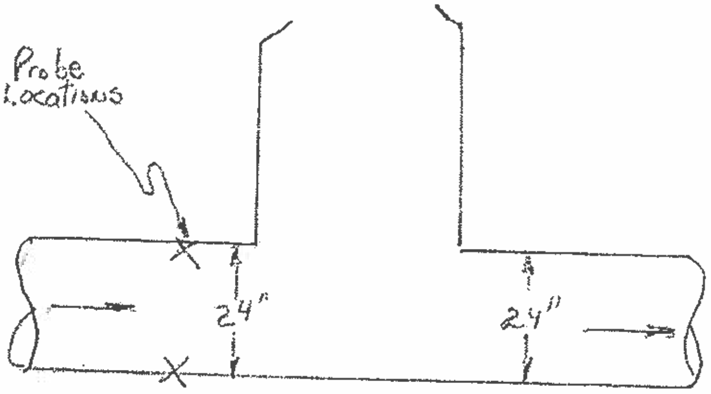


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	24"	24"	
MATERIAL	PVC	PVC	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	4'2	4'3"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

HEIGHT ABOVE WEIR

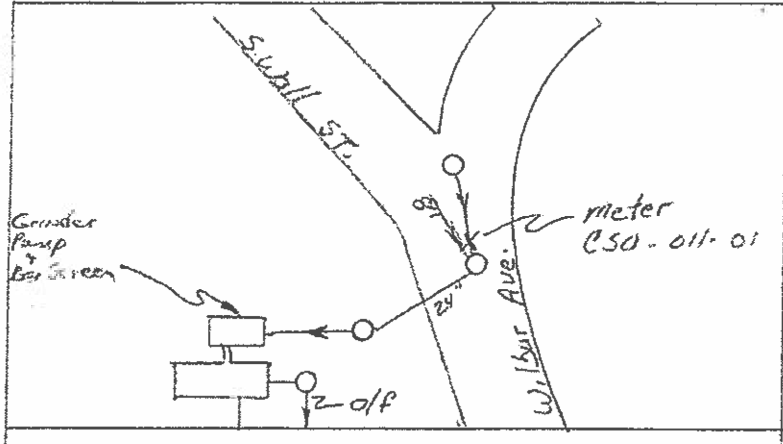
OVERFLOW OCCURS @

Photo 132

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: Wilbur Ave

[redacted]: meter
CSO 011-01

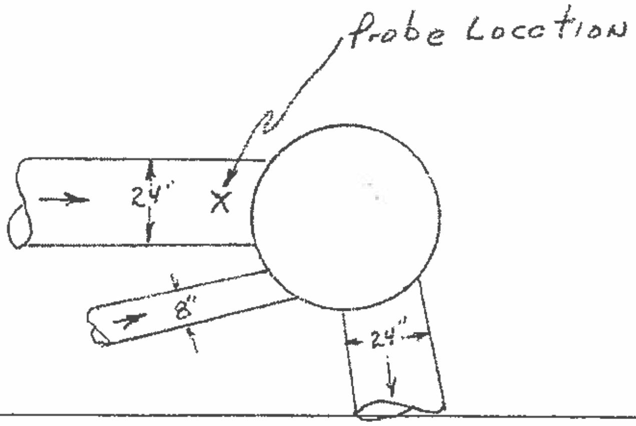
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

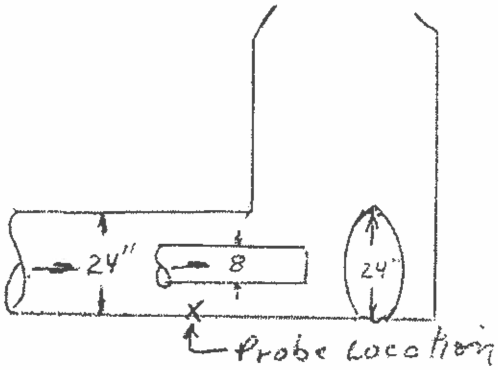


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	24"	24"	
MATERIAL	PVC	PVC	
DEBRIS	0	0	
SHAPE	Round	Round	
DEPTH	7' 1"	7' 1"	

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

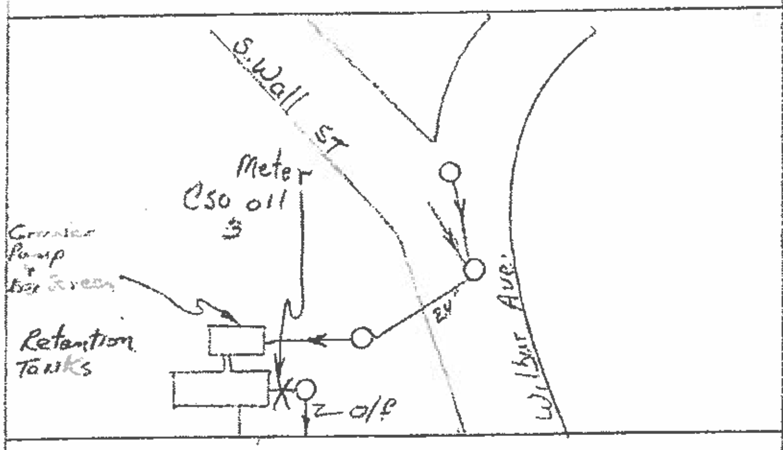
HEIGHT ABOVE WEIR

~~OVERFLOW/CLOSURE~~ @ Photo 121

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: Wilbur Ave

[redacted]: CSO 011-03

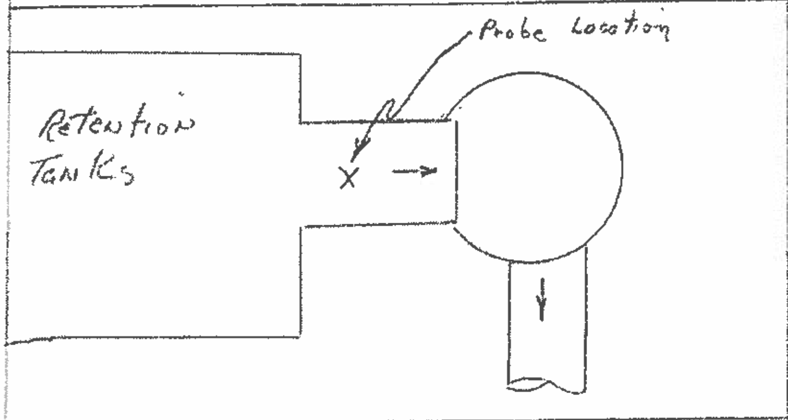
MAP#

DATE: 8-11-09

TIME:

REGULATOR#

PLAN VIEW

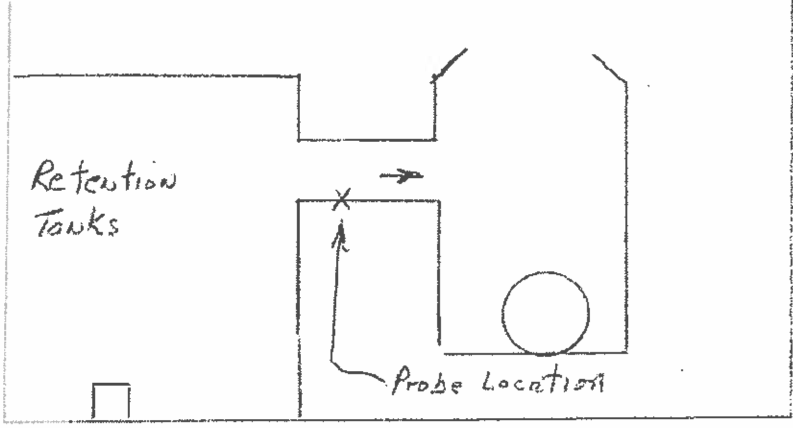


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	47.5W x 11.75H	/	24"
MATERIAL	Stainless	/	PVC
DEBRIS	0	/	0
SHAPE	Rect.	/	Round
DEPTH	3'6"	/	8'4"

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH

BREADTH

LEVEL YES/NO

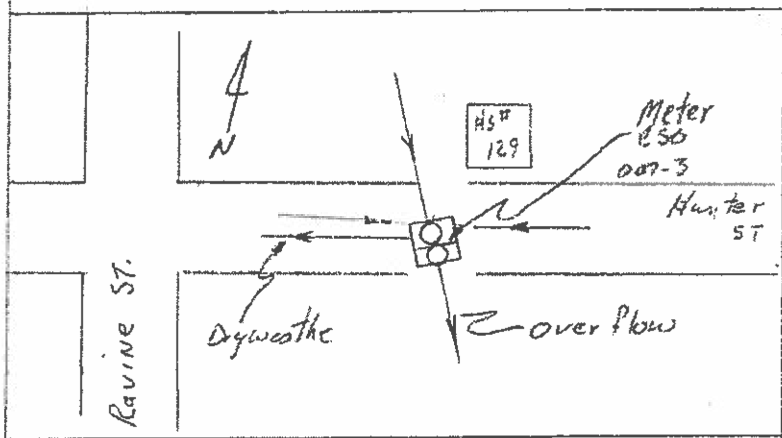
HEIGHT ABOVE WEIR

[redacted]S @
Photo 118 + 120

FLOW Assessment
SERVICES LLC.

DETAILED SITE INVESTIGATION

SITE LOCATION



PROJECT: Kingston NY

LOCATION: 129 Hunter ST

Meter CSO-007-3

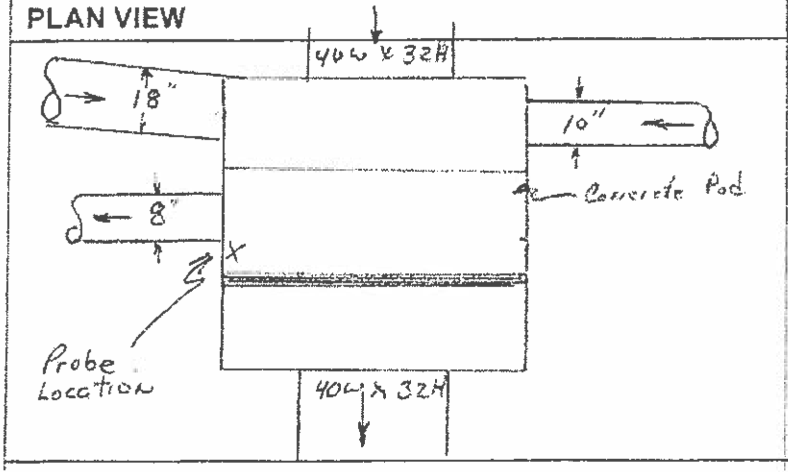
MAP#

DATE: 8-12-09

TIME:

REGULATOR#

PLAN VIEW

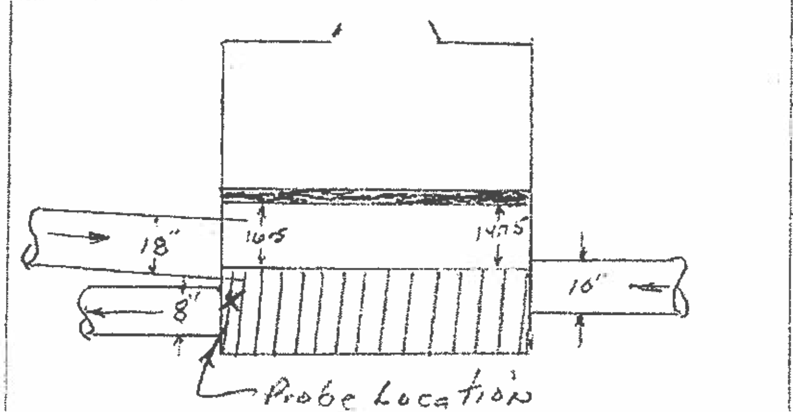


LINE DESCRIPTIONS

	INCOMING	OUTGOING	OVERFLOW
SIZE	42"w x 32"H	8"	40"w x 32"H
MATERIAL	Stone	VCP	Stone
DEBRIS	6"	3"	0"
SHAPE	Rect	Round	Rect
DEPTH	8' 11"	?	8' 11"

(Please see back for additional lines)

PROFILE VIEW



WEIR

LENGTH 54"

BREADTH 2"

LEVEL YES [✓ NO]

HEIGHT ABOVE WEIR 16.5 Left Side 14.75 Right

OVERFLOW OCCURS @

Photo 123, 122

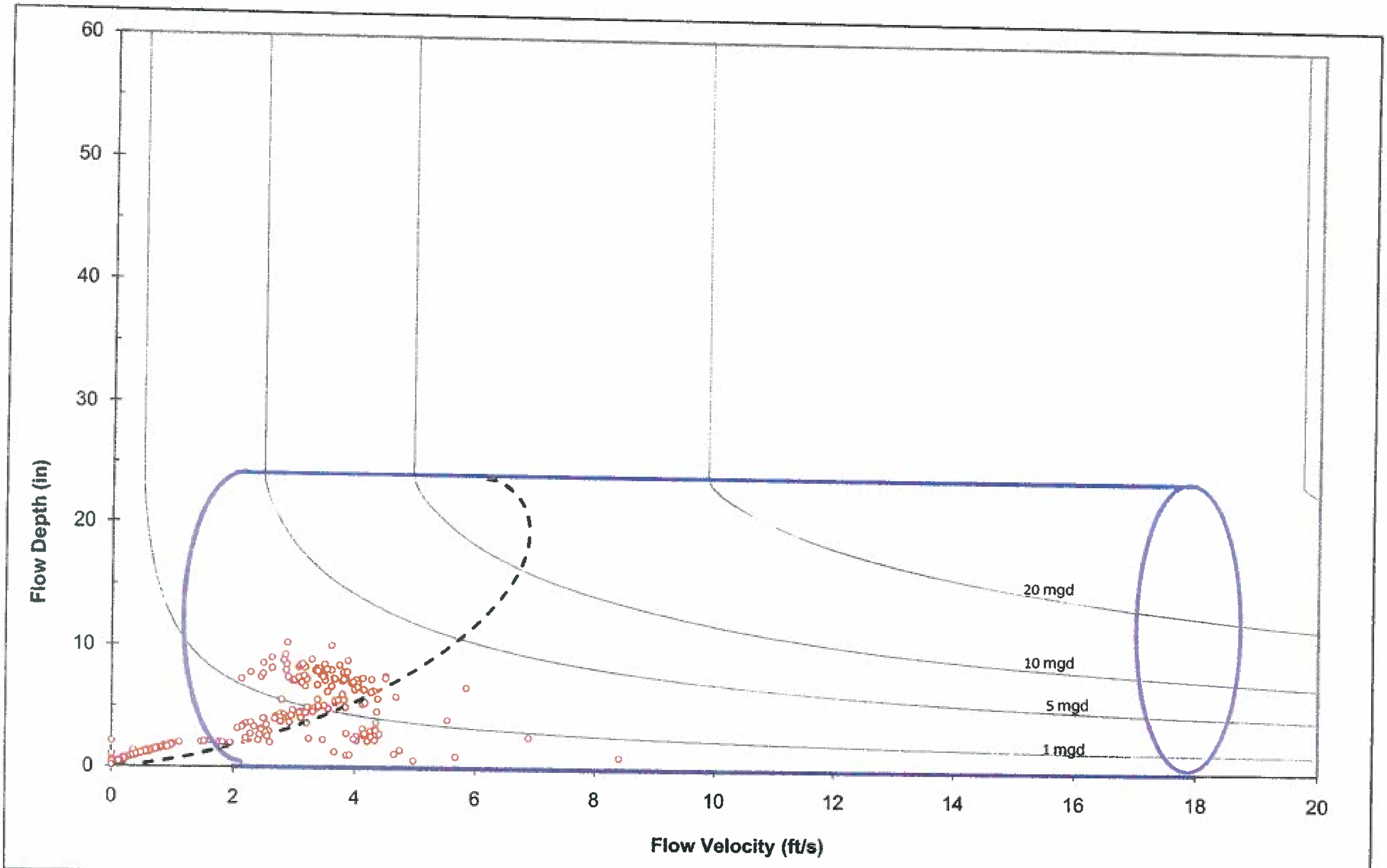
City of Kingston CSO Long-Term Control Planning
Draft Flow Monitoring and Rain Gauging Work Plan

ATTACHMENT

4

August 11-24, 2009 Scattergraphs and Hydrographs

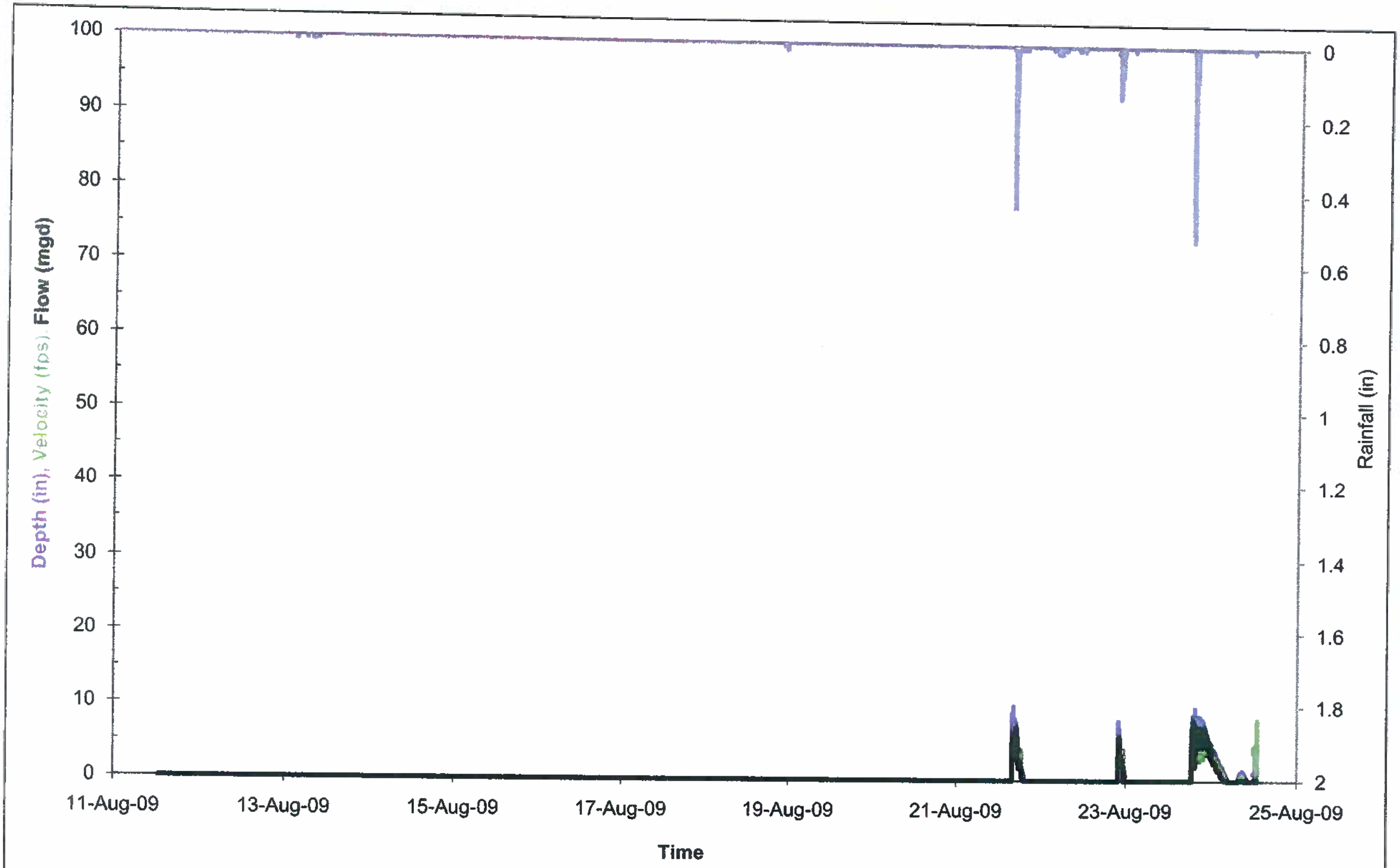
MALCOLM PIRNIE



MALCOLM PIRNIE

City of Kingston
Wilbur Regulator Effluent
Flow Monitoring Program

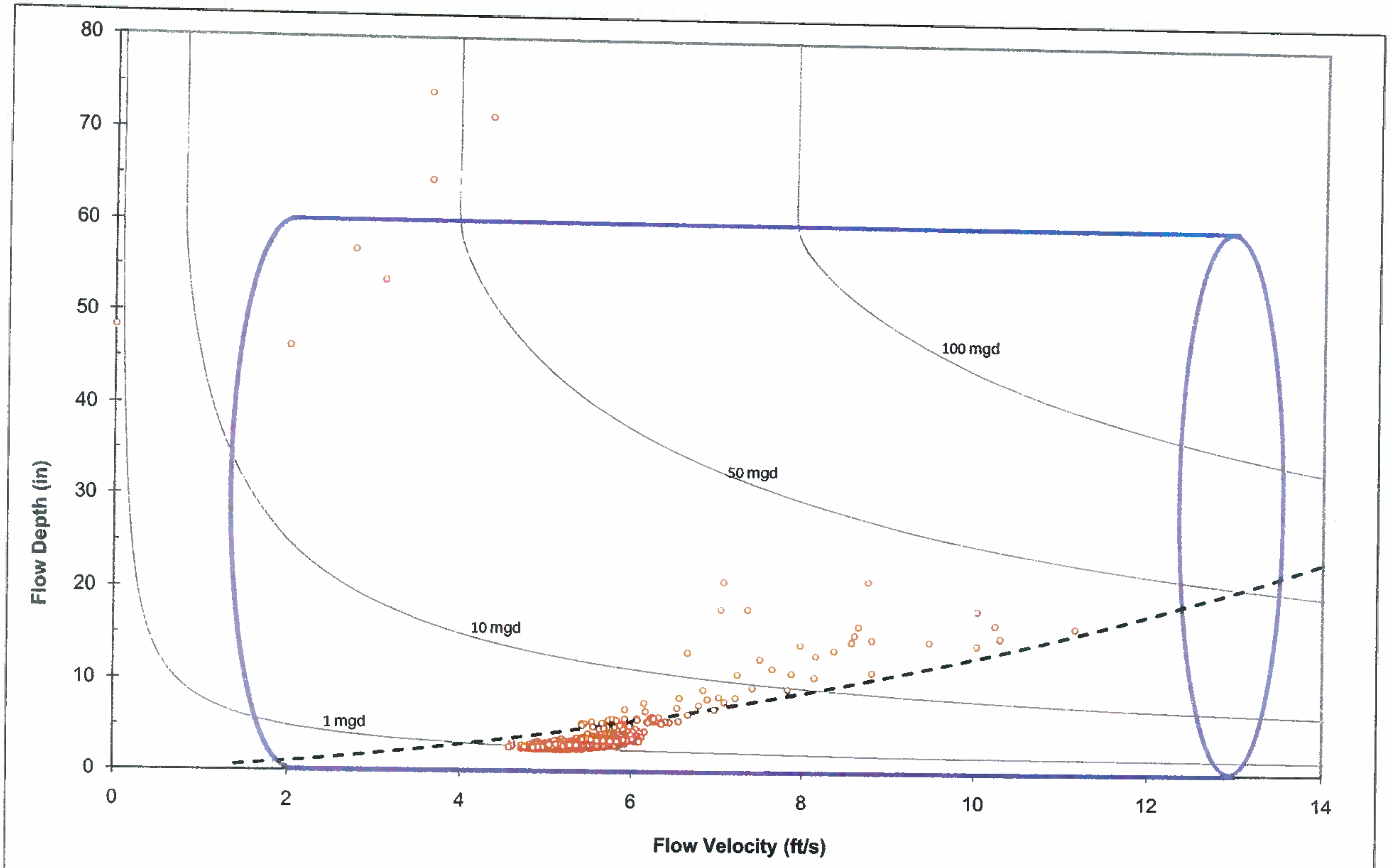
Flow Meter CSO 11-3
Scattergraph



MALCOLM PIRNIE

City of Kingston
Wilbur Regulator Effluent
Flow Monitoring Program

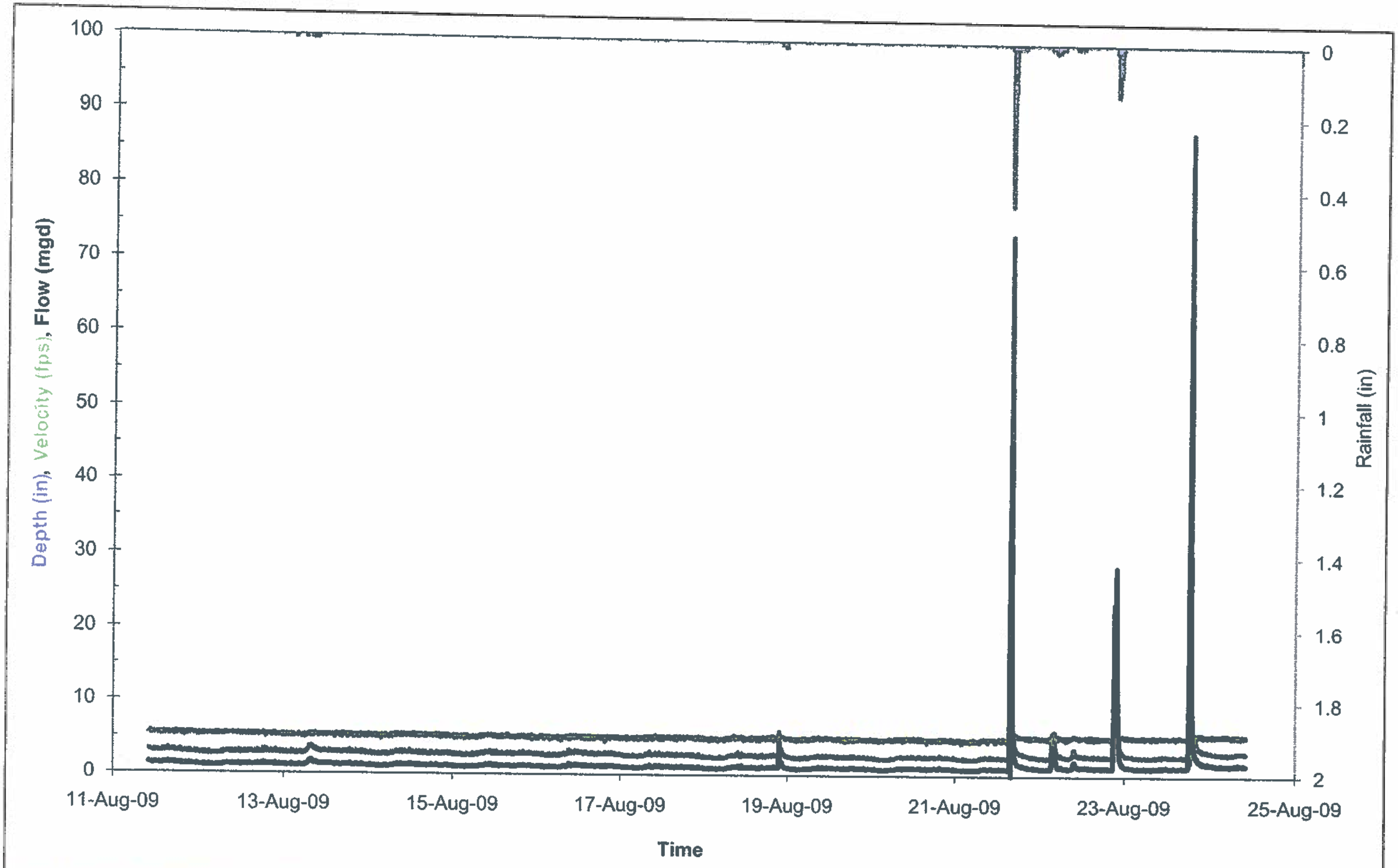
Flow Meter CSO 11-3
Hydrograph



MALCOLM PIRNIE

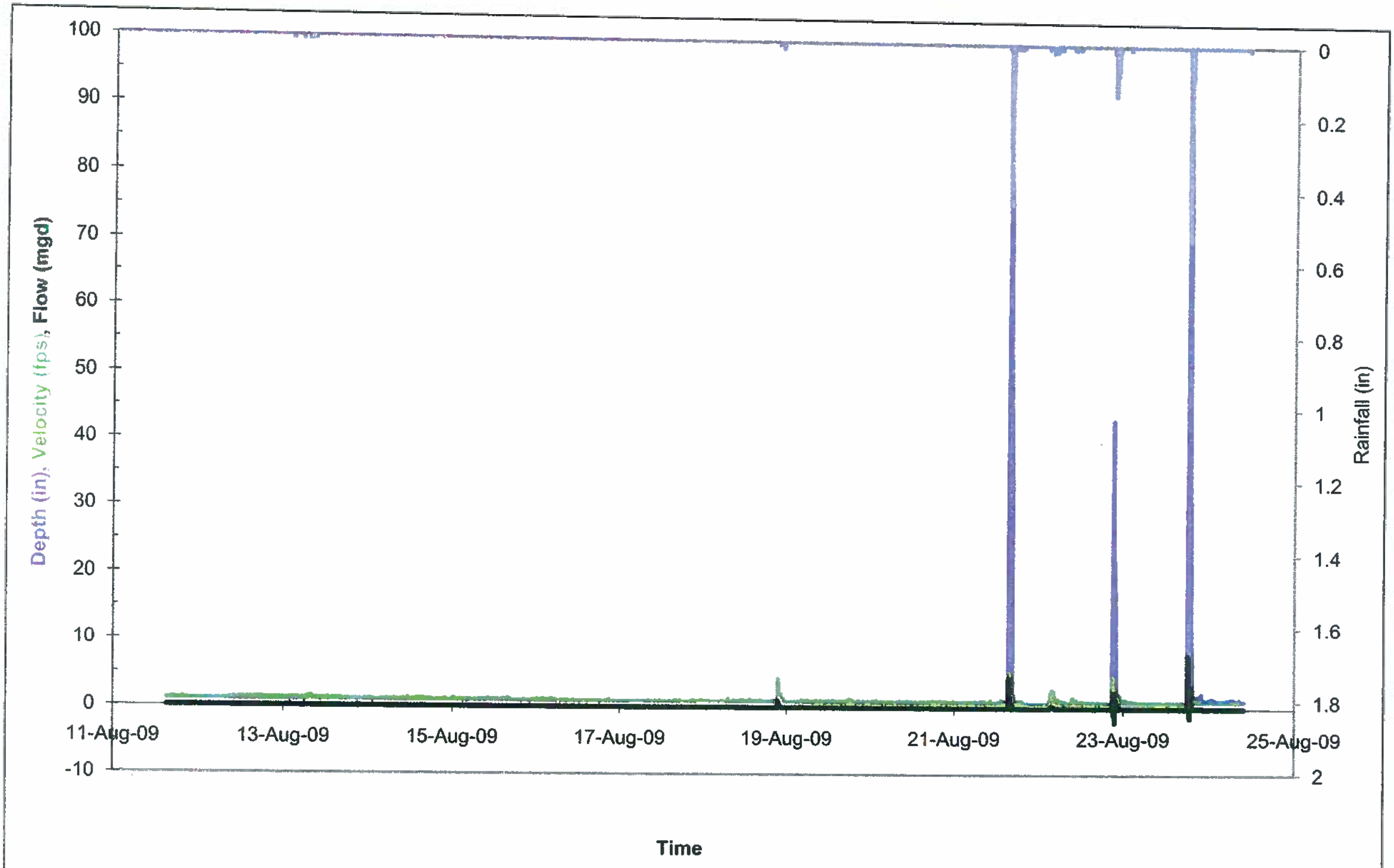
City of Kingston
Hasbrouck Regulator Influent
Flow Monitoring Program

Flow Meter CSO 5-1
Scattergraph



City of Kingston
Hasbrouck Regulator Influent
Flow Monitoring Program

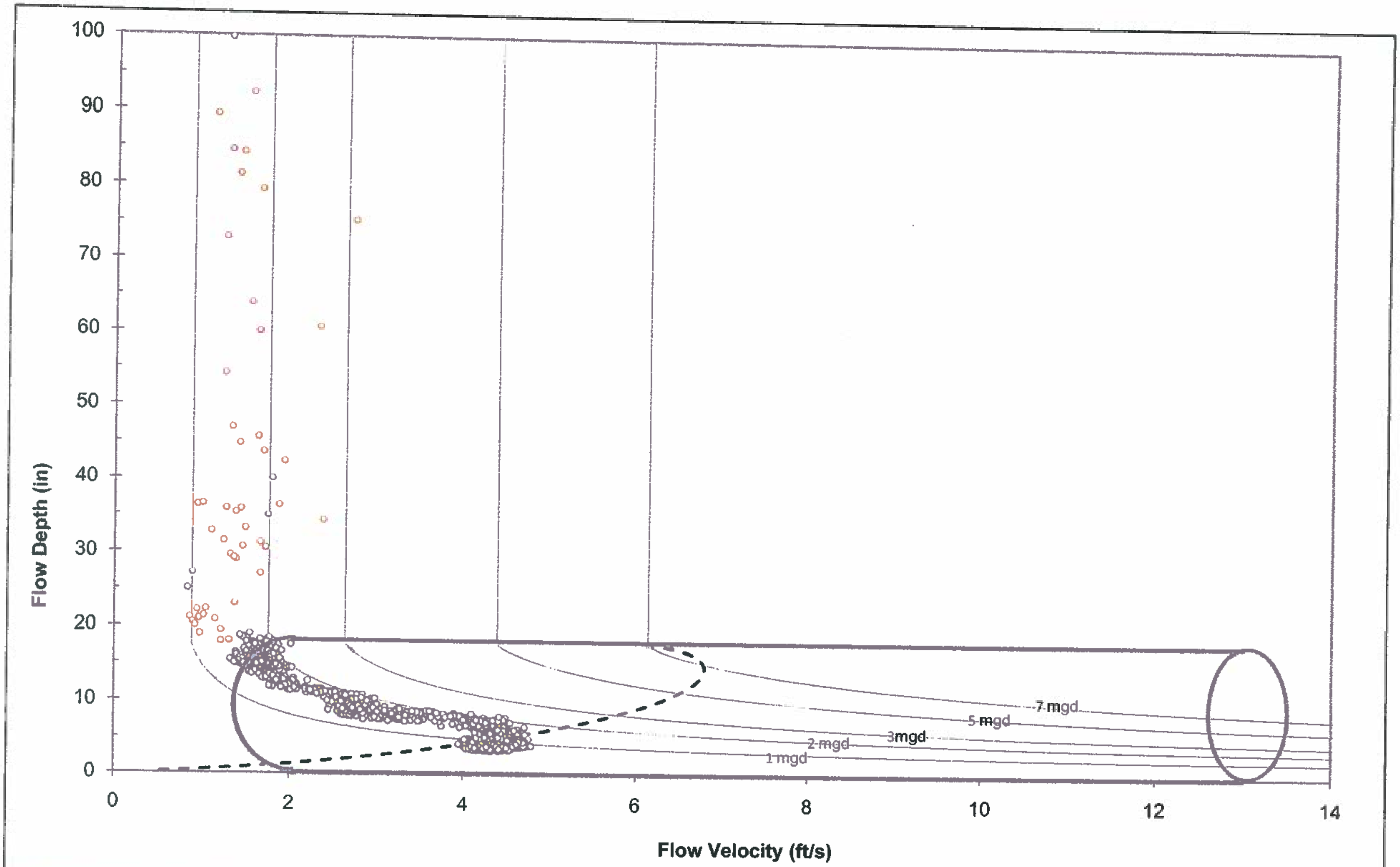
Flow Meter CSO 5-1
Hydrograph



MALCOLM PIRNIE

City of Kingston
Hasbrouck Regulator Storm Pipe
Flow Monitoring Program

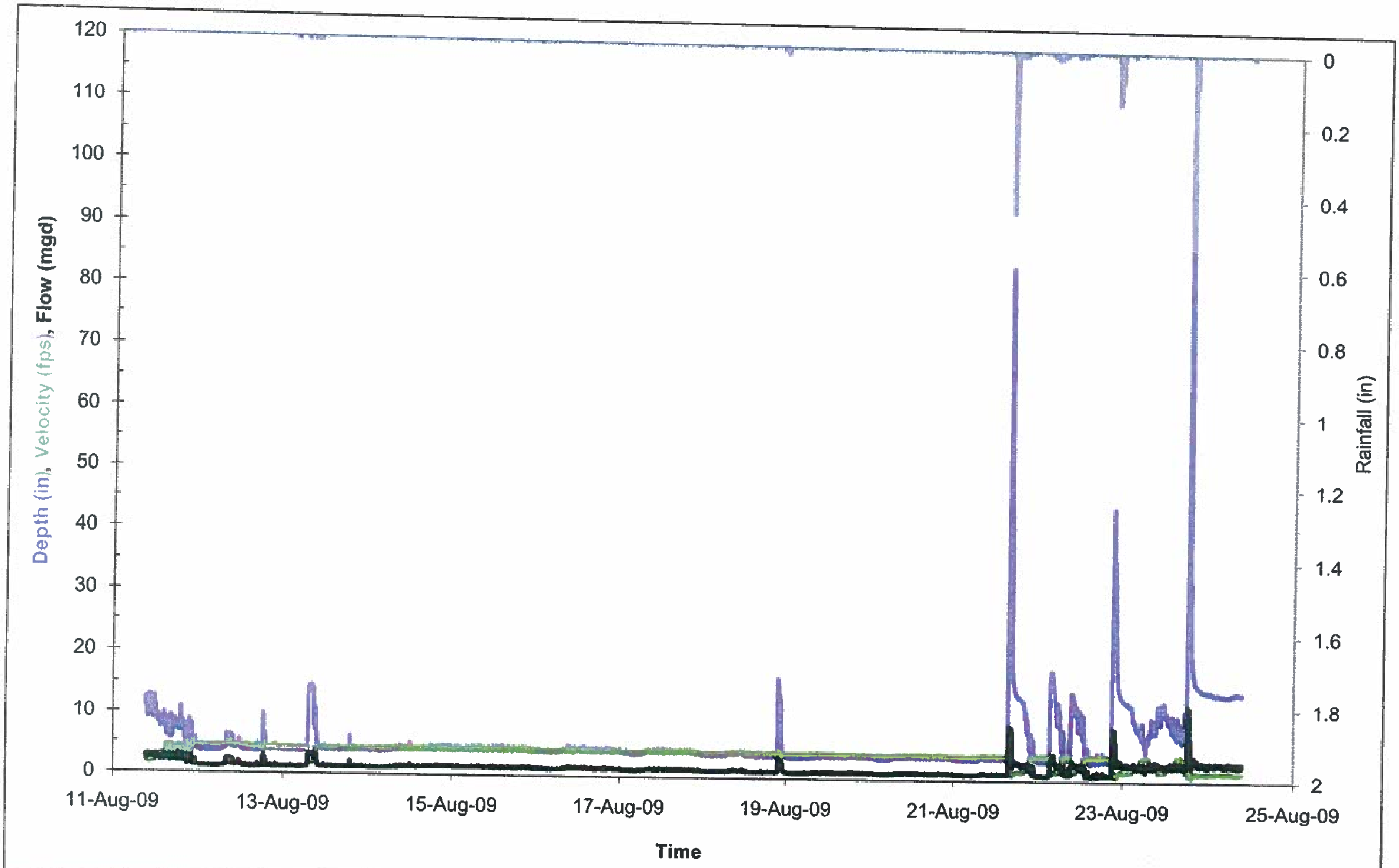
Flow Meter CSO 5-2
Hydrograph



MALCOLM PIRNIE

City of Kingston
Hasbrouck Regulator Effluent
Flow Monitoring Program

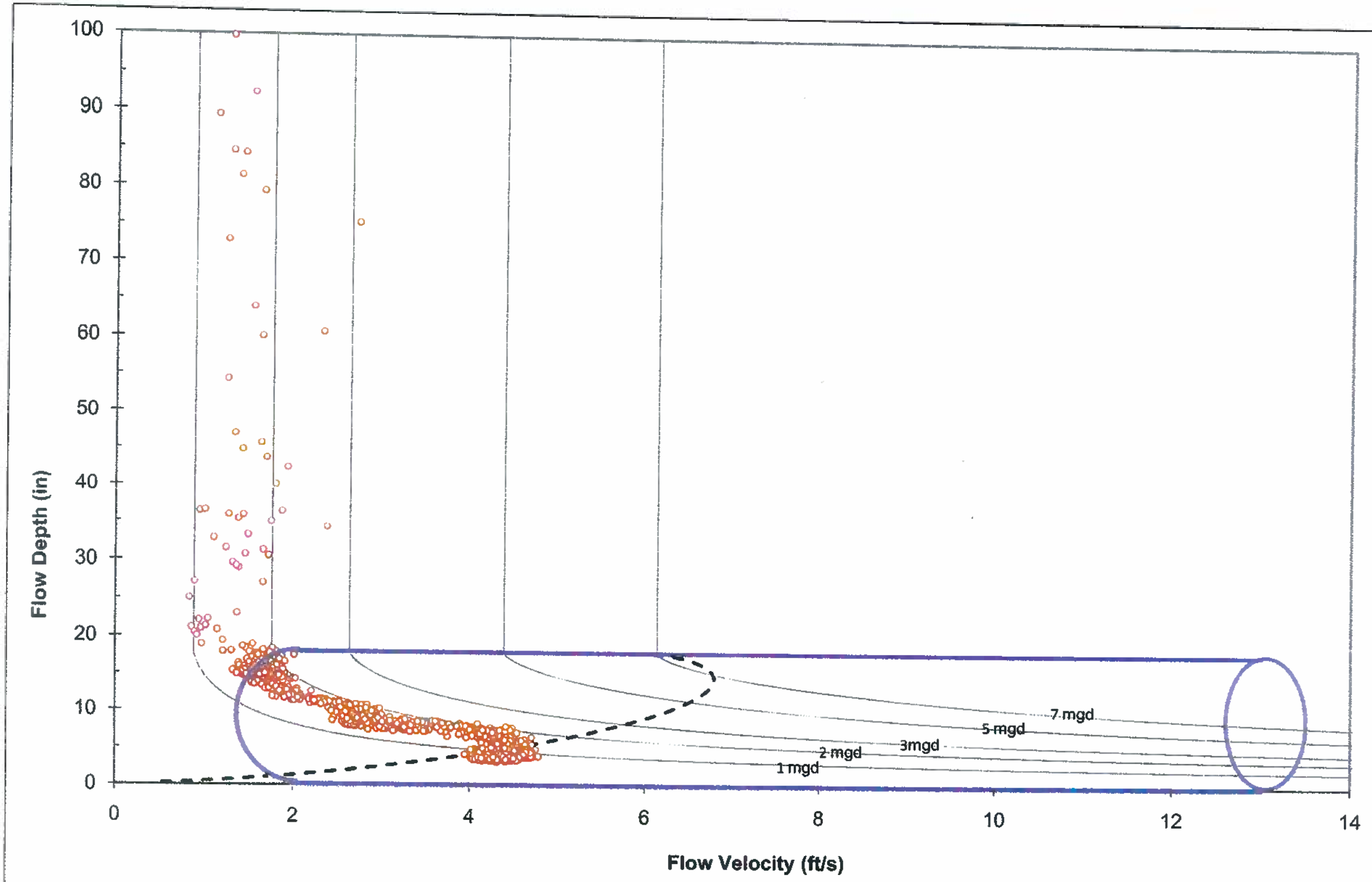
Flow Meter CSO 5-3
Scattergraph



MALCOLM PIRNIE

City of Kingston
Hasbrouck Regulator Effluent
Flow Monitoring Program

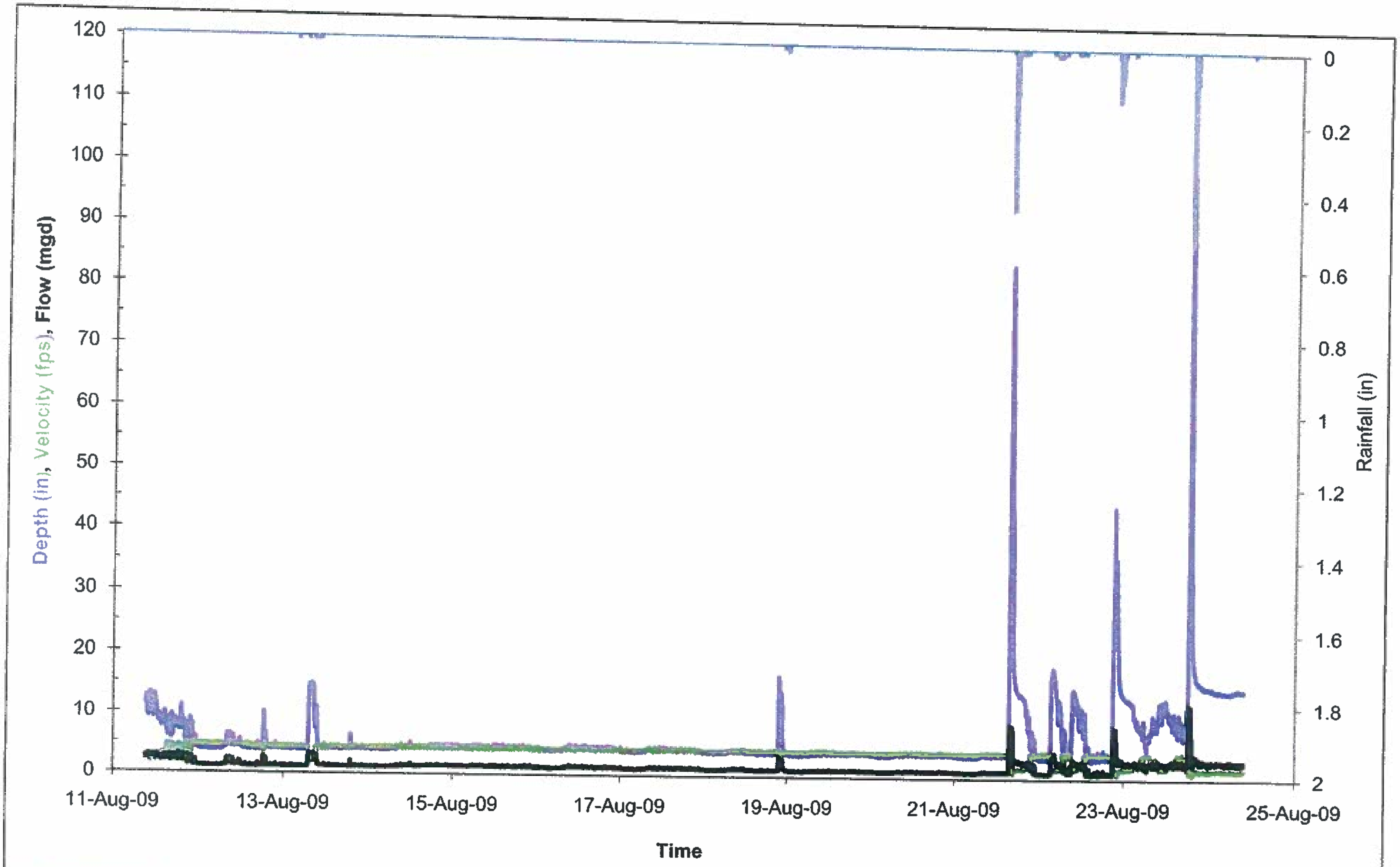
Flow Meter CSO 5-3
Hydrograph



MALCOLM PIRNIE

City of Kingston
Hasbrouck Regulator Effluent
Flow Monitoring Program

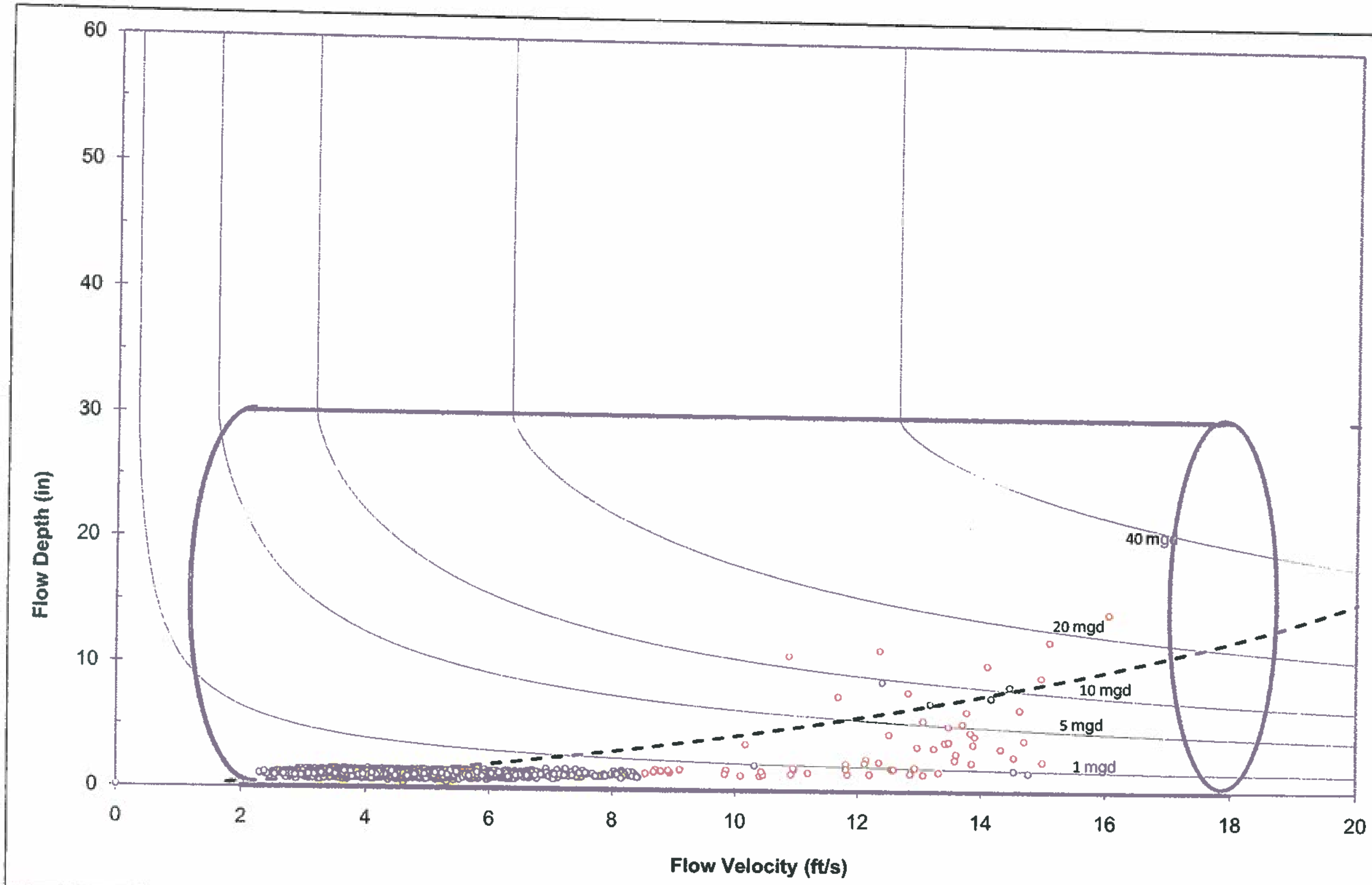
Flow Meter CSO 5-3
Scattergraph



MALCOLM PIRNIE

City of Kingston
Hasbrouck Regulator Effluent
Flow Monitoring Program

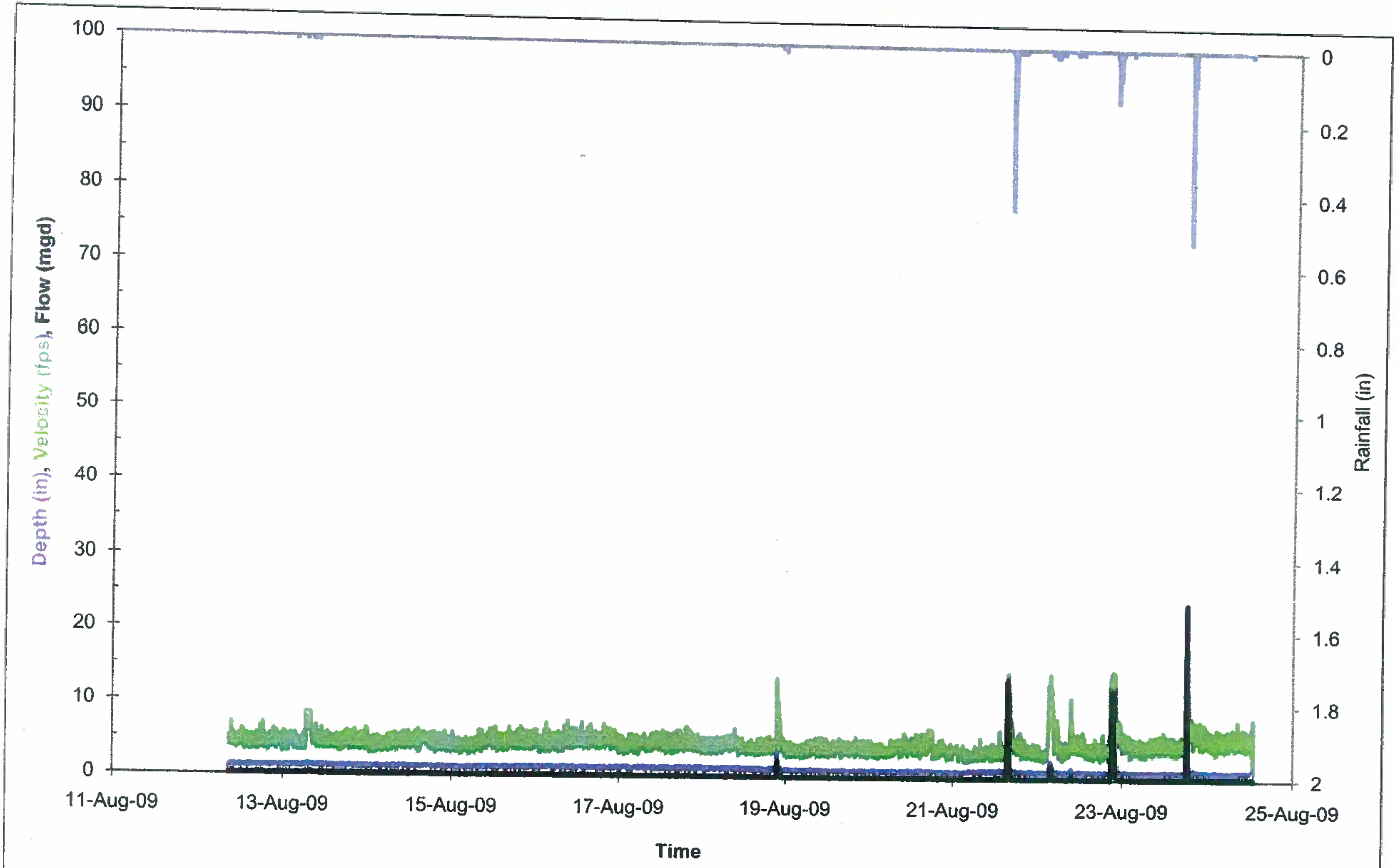
Flow Meter CSO 5-3
Hydrograph



MALCOLM PIRNIE

City of Kingston
Broadway Regulator Influent
Flow Monitoring Program

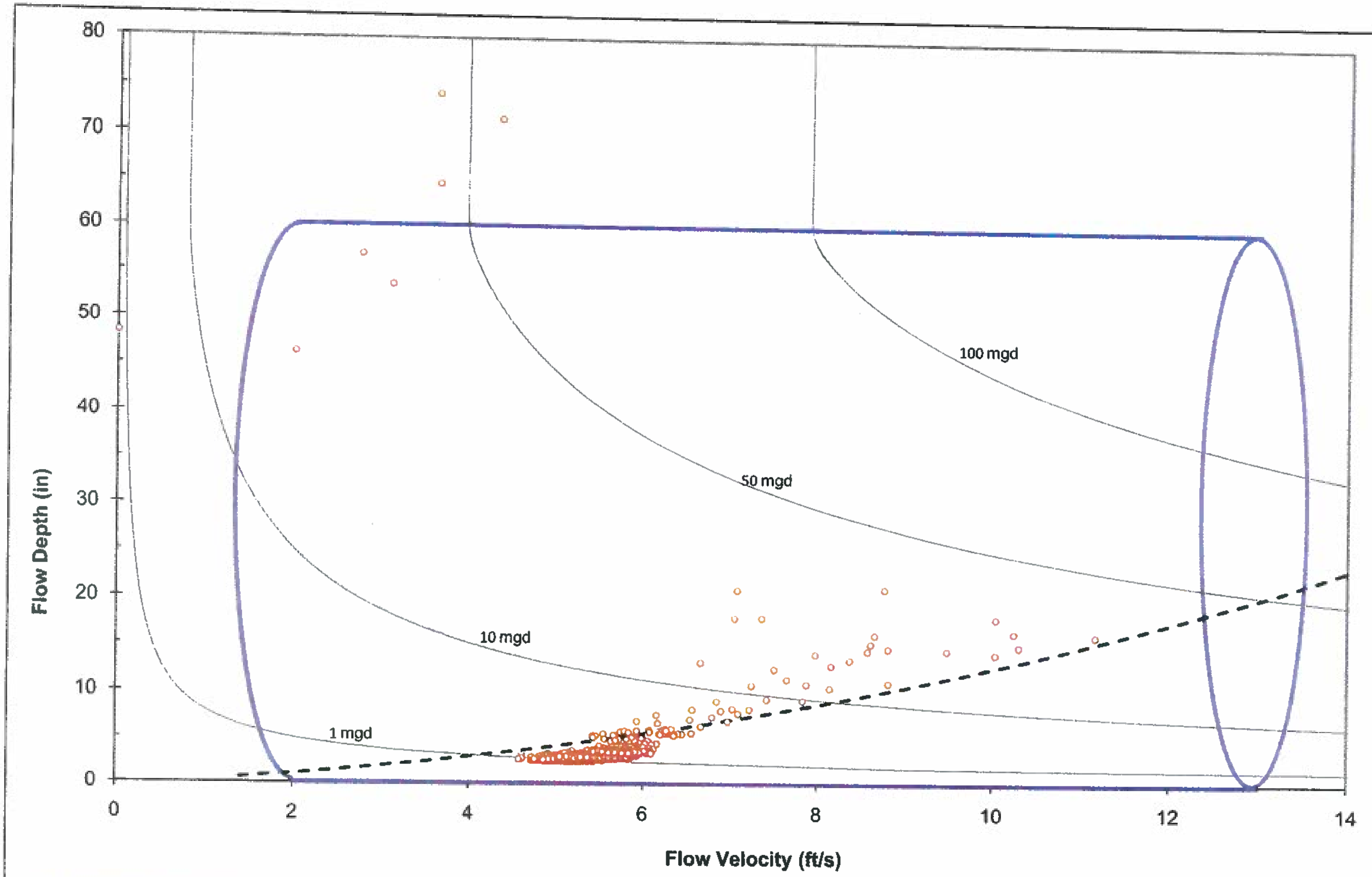
Flow Meter CSO 6-1
Scattergraph



MALCOLM PIRNIE

City of Kingston
Broadway Regulator Influent
Flow Monitoring Program

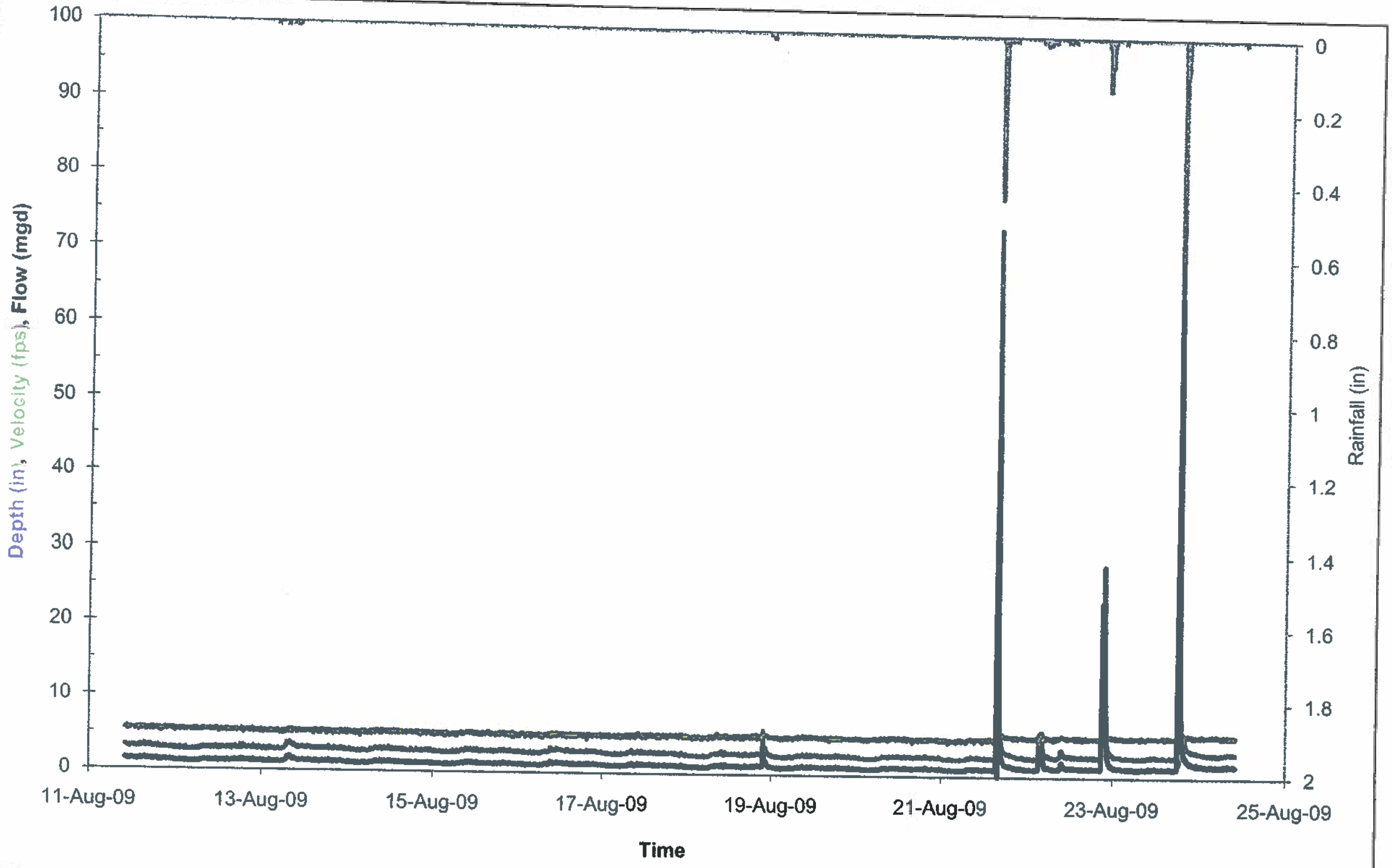
Flow Meter CSO 6-1
Hydrograph



MALCOLM PIRNIE

City of Kingston
Broadway Regulator Overflow
Flow Monitoring Program

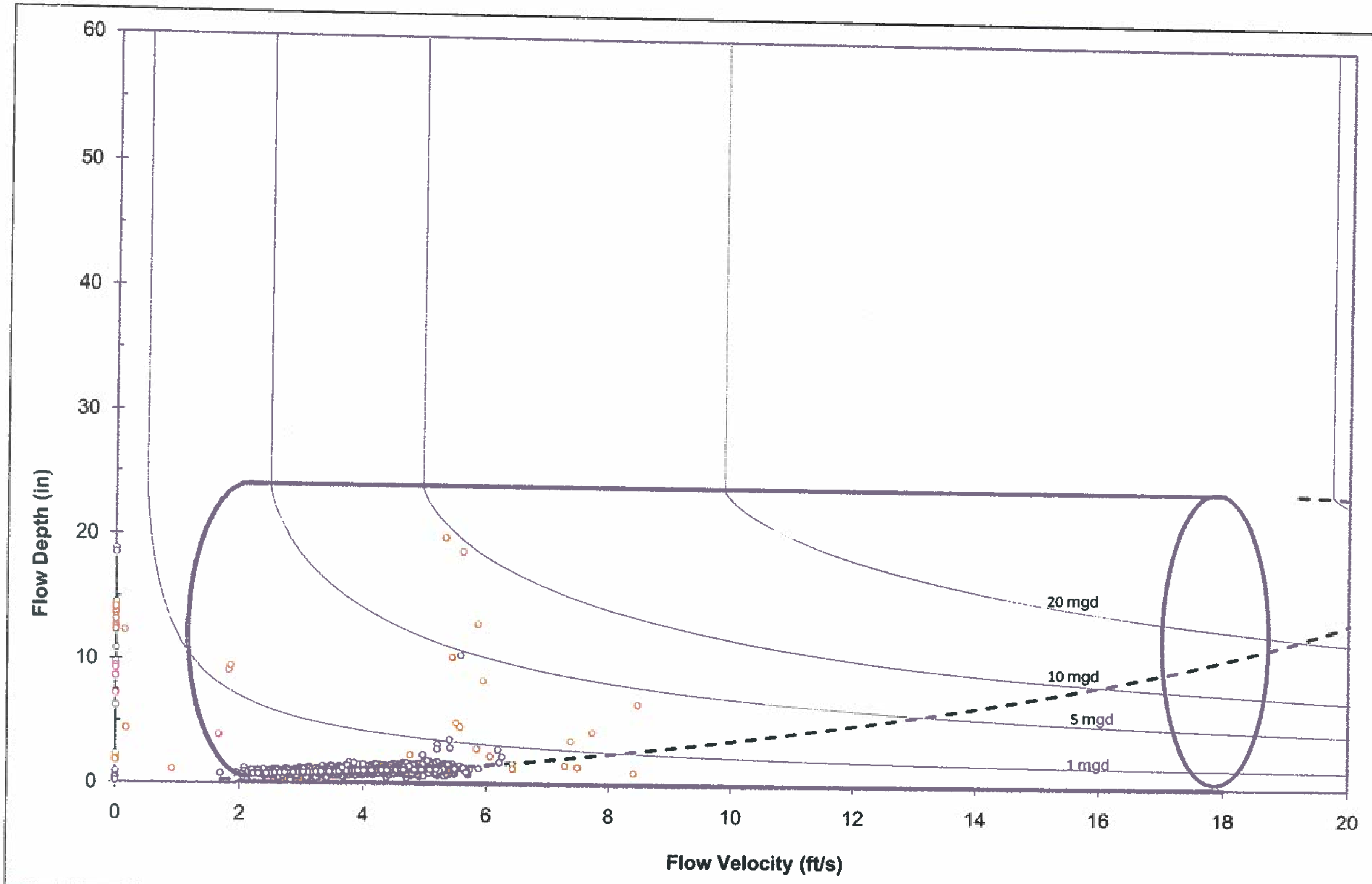
Flow Meter CSO 6-4
Scattergraph



MALCOLM PIRNIE

City of Kingston
Broadway Regulator Overflow
Flow Monitoring Program

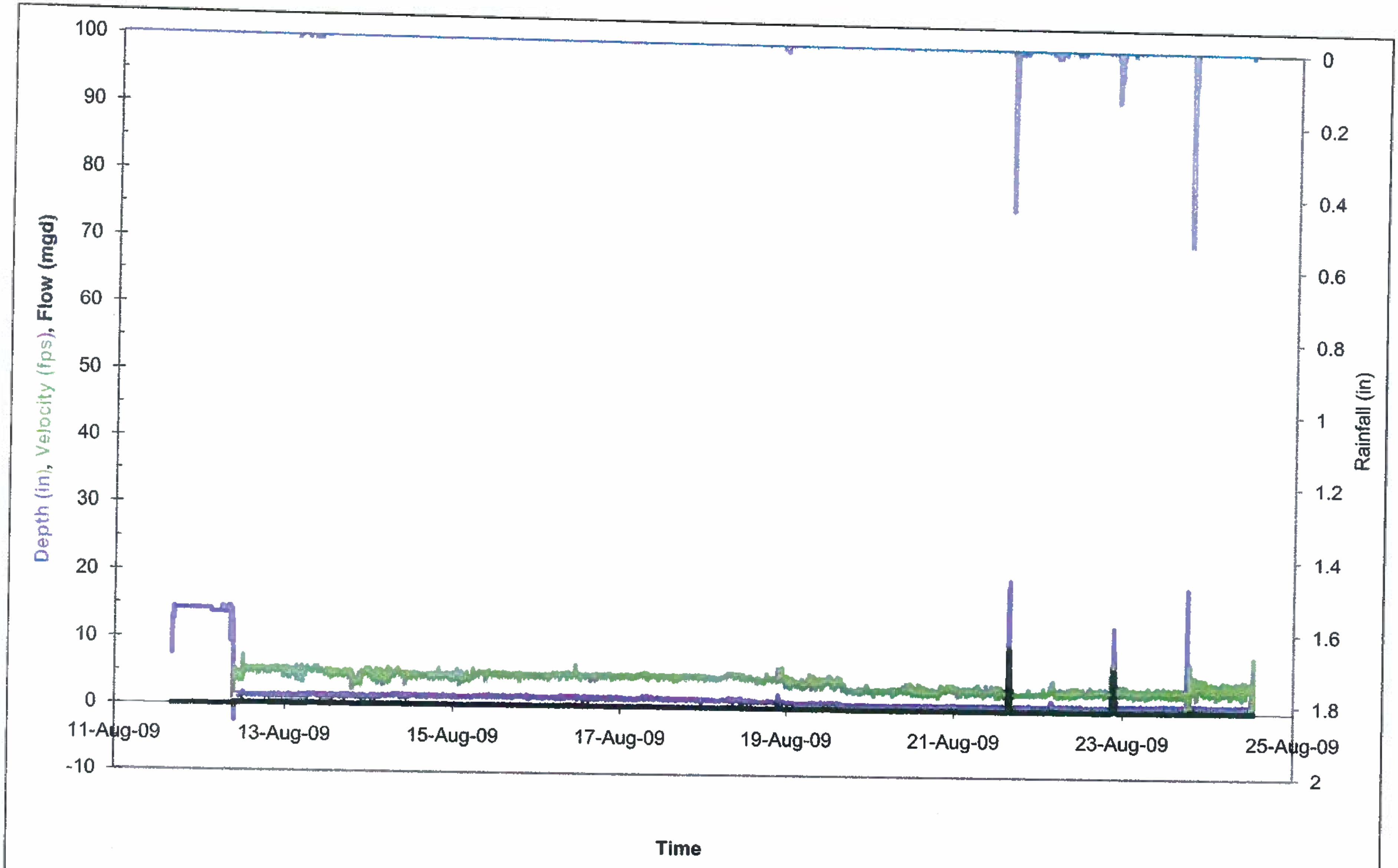
Flow Meter CSO 6-4
Hydrograph



MALCOLM PIRNIE

City of Kingston
Hunter Regulator Influent
Flow Monitoring Program

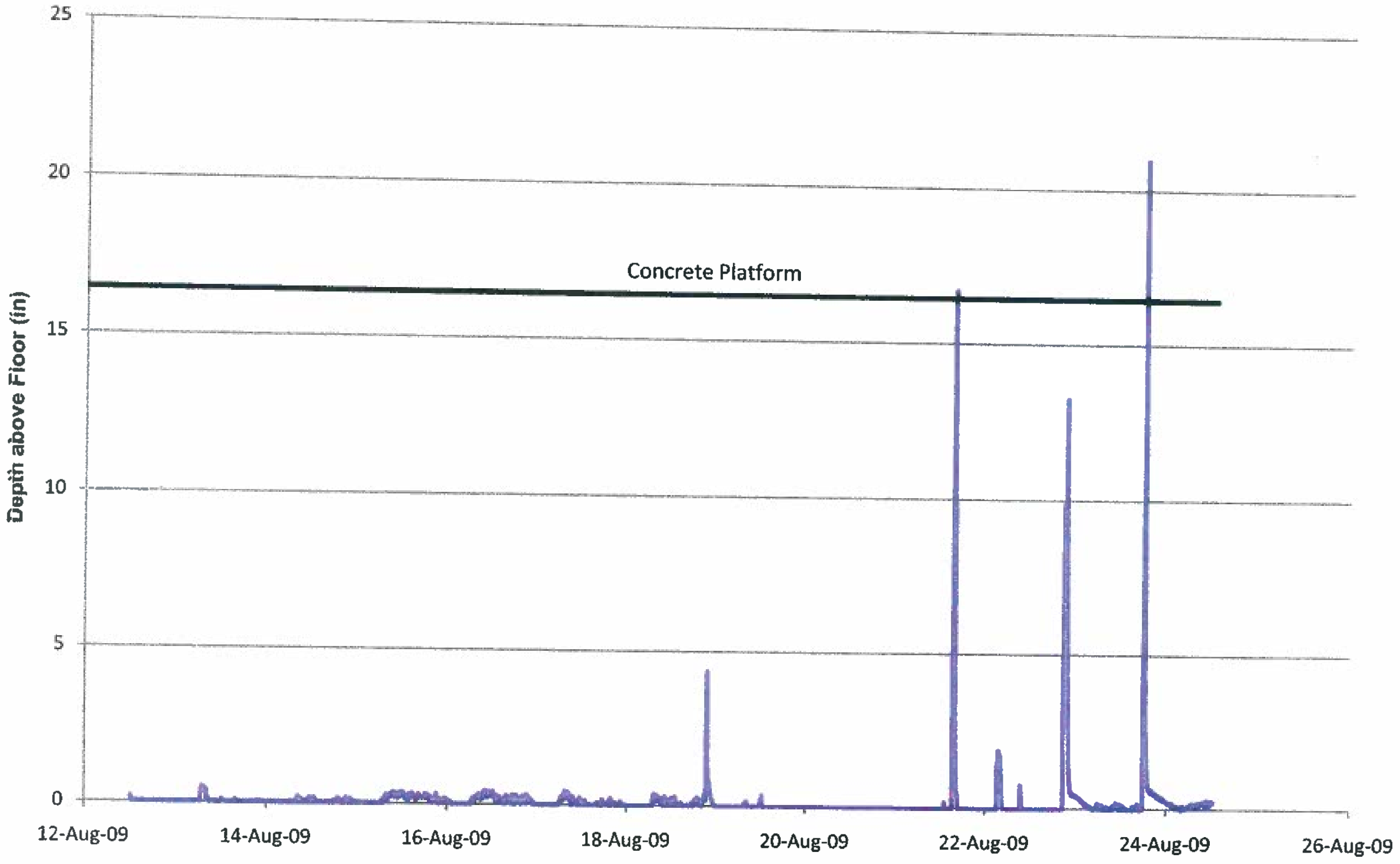
Flow Meter CSO 7-1
Scattergraph



MALCOLM PIRNIE

City of Kingston
Hunter Regulator Influent
Flow Monitoring Program

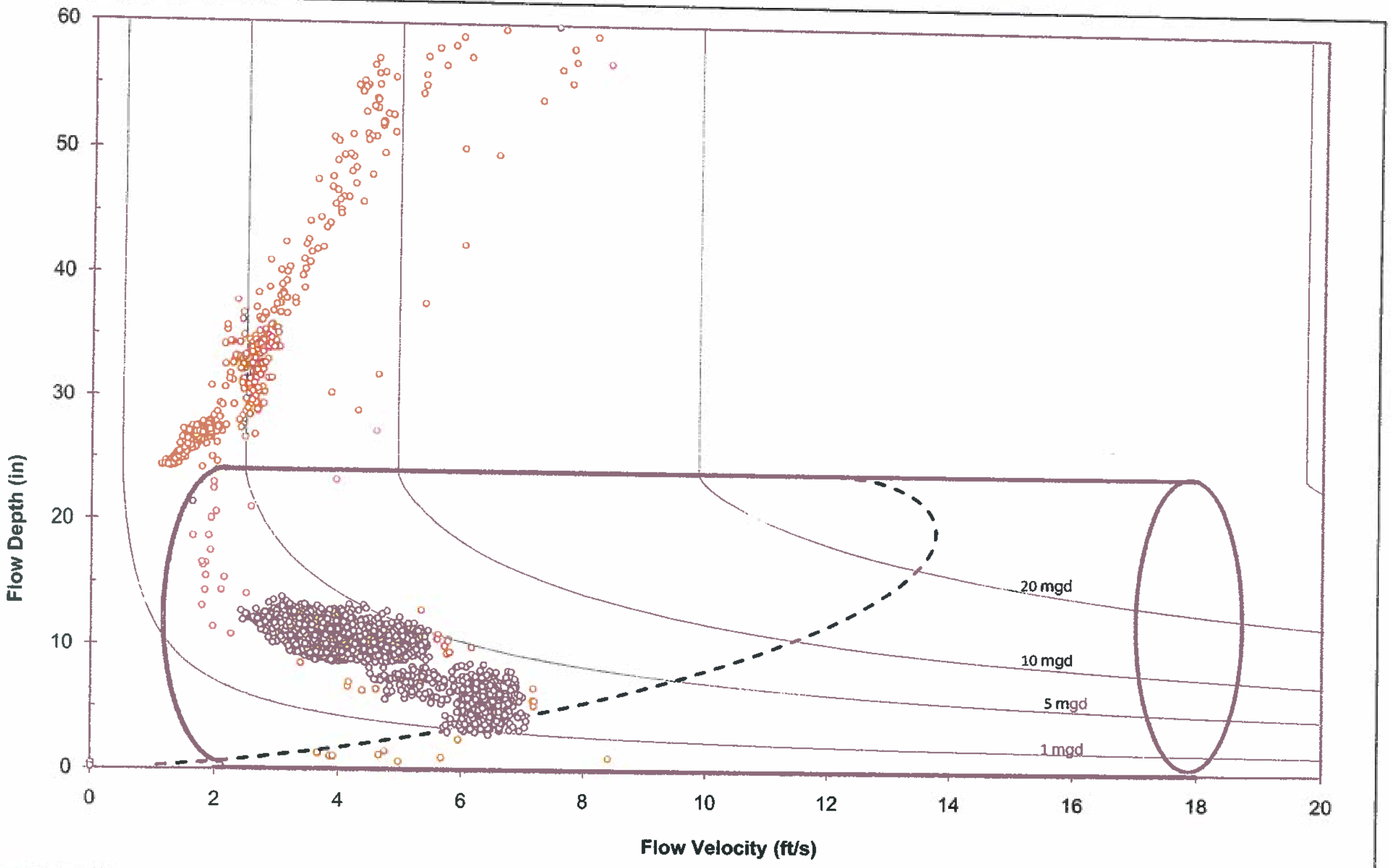
Flow Meter CSO 7-1
Hydrograph



MALCOLM PIRNIE

City of Kingston
Hunter Regulator Overflow
Flow Monitoring Program

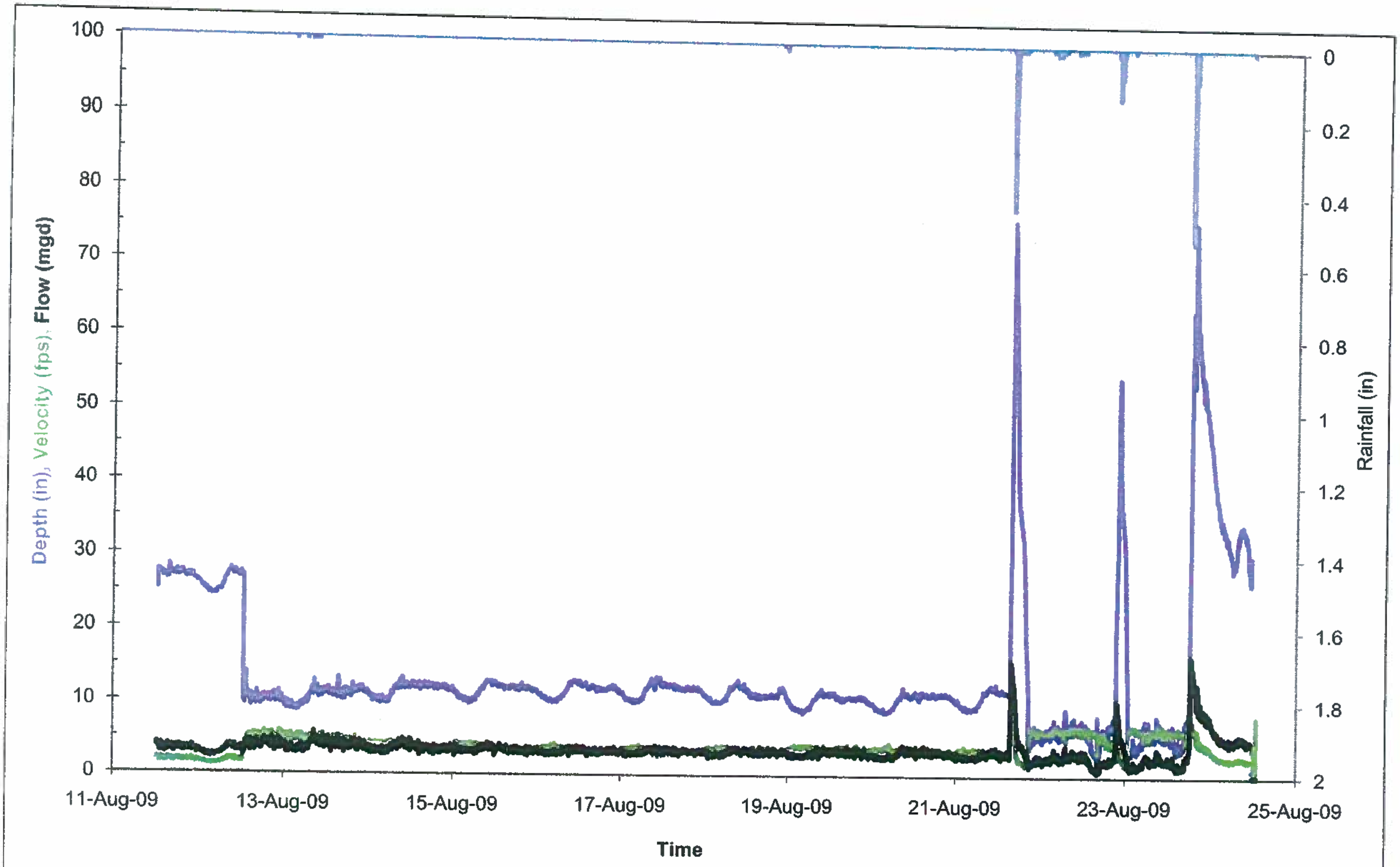
Flow Meter CSO 7-3 Depth Plot



MALCOLM PIRNIE

City of Kingston
Wilbur Regulator Influent
Flow Monitoring Program

Flow Meter CSO 11-1
Scattergraph



MALCOLM PIRNIE

City of Kingston
Wilbur Regulator Influent
Flow Monitoring Program

Flow Meter CSO 11-1
Hydrograph

1652

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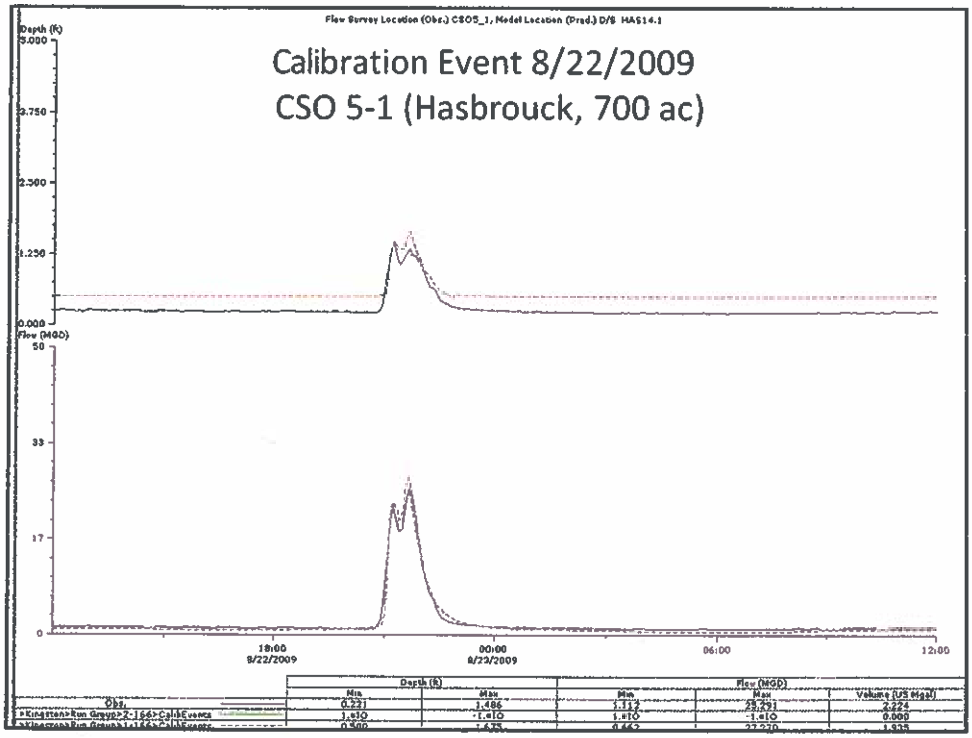
APPENDIX

E

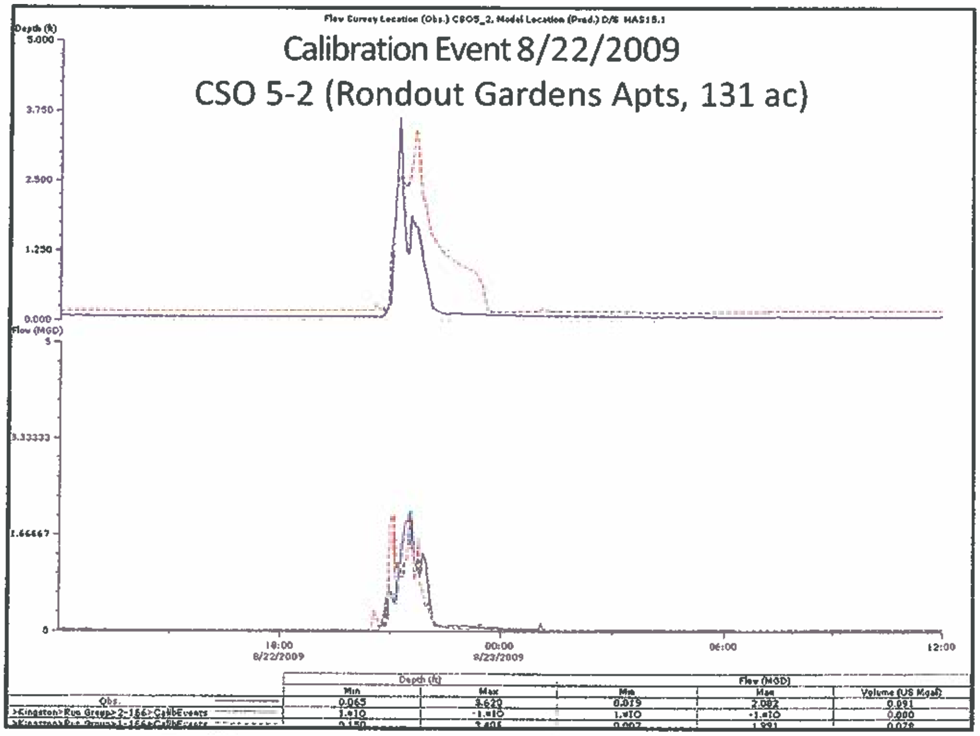
Wet Weather Calibration

MALCOLM
PIRNIE



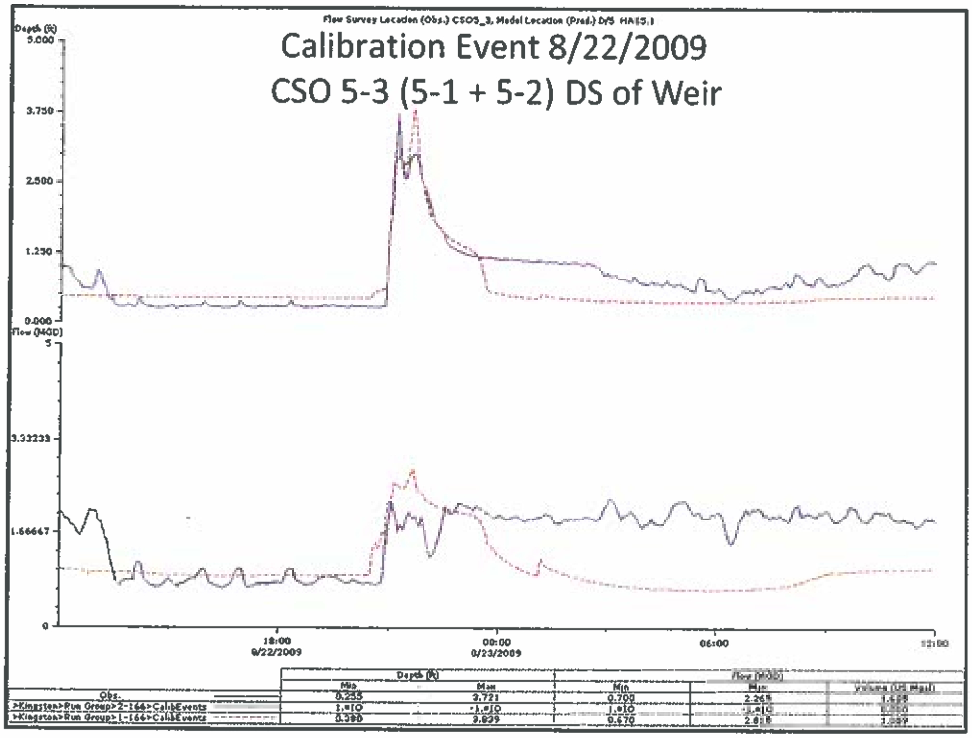
Calibration Event 8/22/2009
CSO 5-1 (Hasbrouck, 700 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.221	1.486	1.112	25.291	2.224
>Kingston>Run Group>2-166>CalibEvents	1.e10	-1.e10	1.e10	-1.e10	0.000
>Kingston>Run Group>1-166>CalibEvents	0.500	1.675	0.662	27.270	1.935



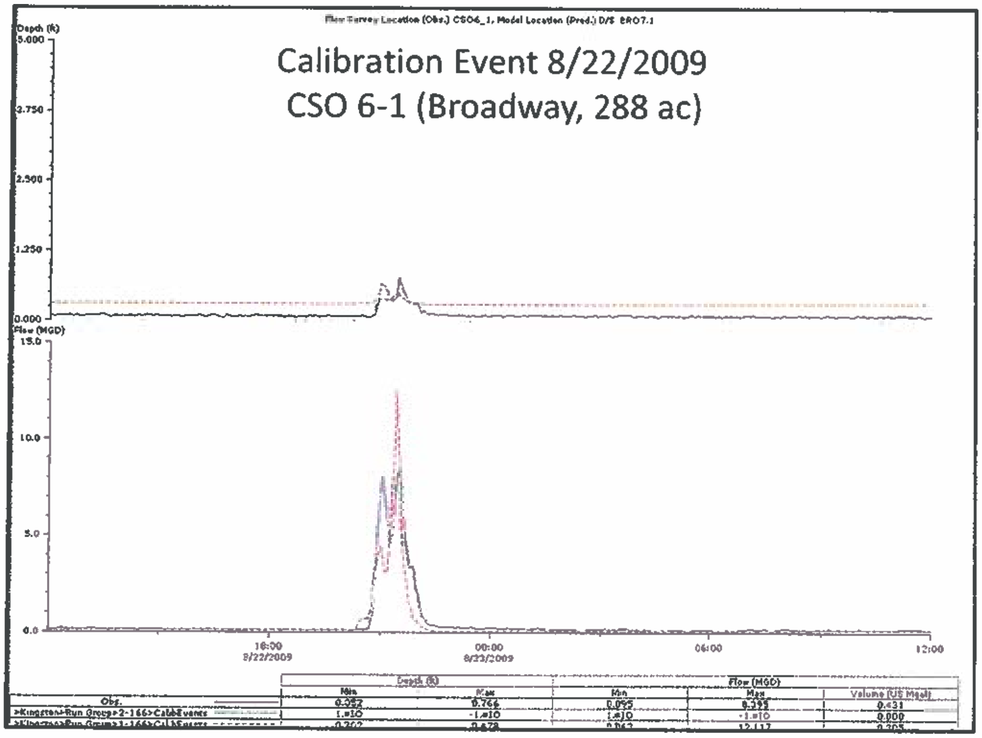
Calibration Event 8/22/2009
CSO 5-2 (Rondout Gardens Apts, 131 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.065	3.620	0.019	2.082	0.091
>Kingston>Run Group>2-166>CalibEvents	1.e10	-1.e10	1.e10	-1.e10	0.000
>Kingston>Run Group>1-166>CalibEvents	0.150	3.405	0.007	1.991	0.079


Flow Survey Location (Obs.) CSO5_3, Model Location (Pred.) D/S HA65.1

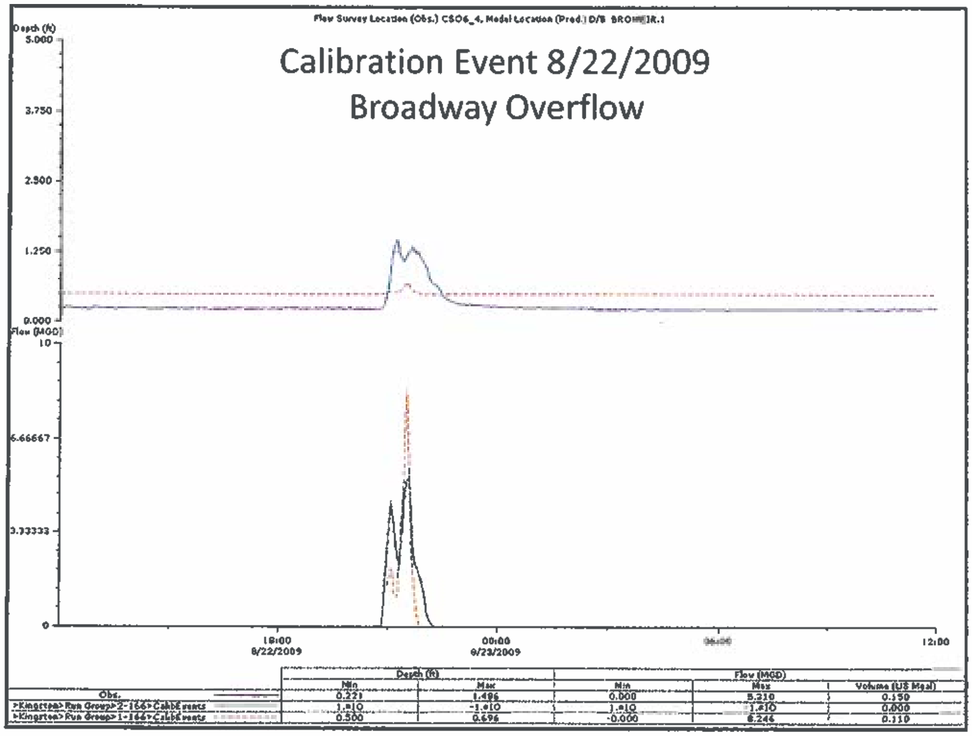
Calibration Event 8/22/2009
CSO 5-3 (5-1 + 5-2) DS of Weir

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.235	3.721	0.700	2.265	1.628
>Kingston>Run Group>2-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000
>Kingston>Run Group>1-166>CalibEvents	0.390	3.839	0.670	2.818	1.089


Flow Survey Location (Obs.) CSO6_1, Model Location (Pred.) D/S BRO7.1

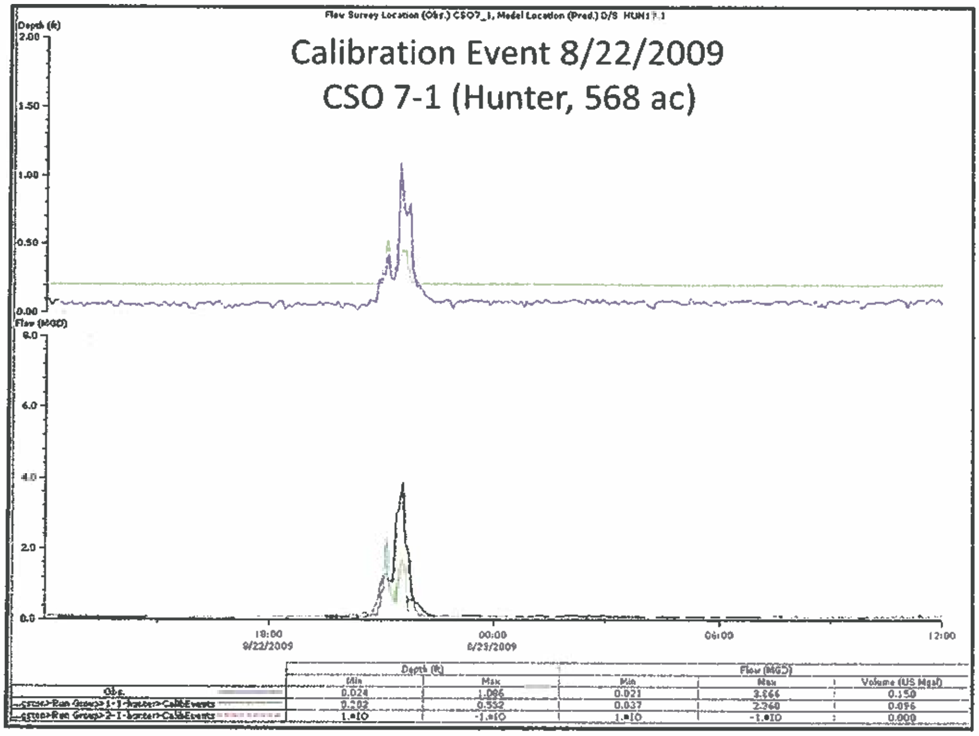
Calibration Event 8/22/2009
CSO 6-1 (Broadway, 288 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.052	0.766	0.095	8.395	0.431
>Kingston>Run Group>2-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000
>Kingston>Run Group>1-166>CalibEvents	0.202	0.478	0.062	12.117	0.205



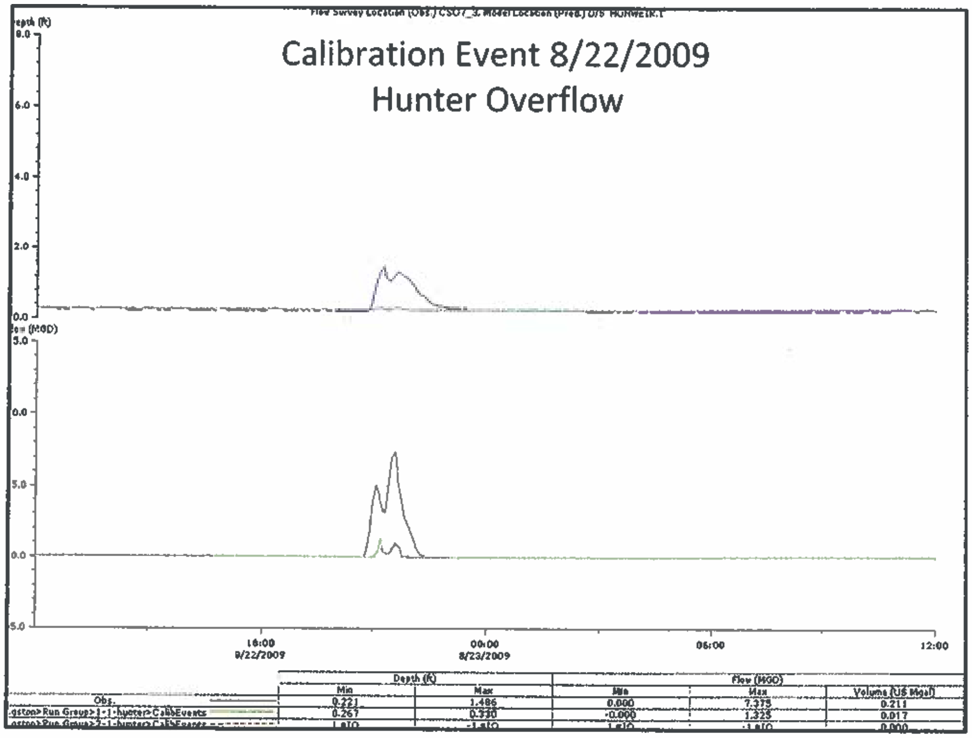
Calibration Event 8/22/2009
Broadway Overflow

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.221	1.496	0.000	5.210	0.150
>Kingston>Run Group>2-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000
>Kingston>Run Group>1-166>CalibEvents	0.500	0.696	-0.000	8.244	0.110



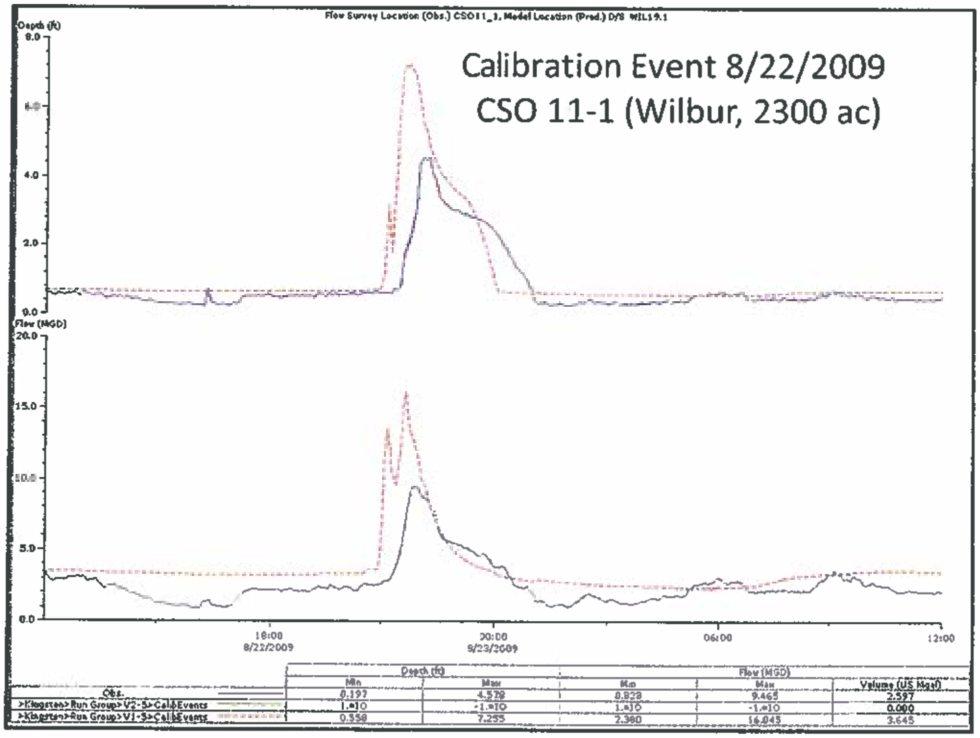
Calibration Event 8/22/2009
CSO 7-1 (Hunter, 568 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.024	1.086	0.021	3.866	0.150
cston>Run Group>1-1-hunter>CalibEvents	0.202	0.532	0.037	2.260	0.096
cston>Run Group>2-1-hunter>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000



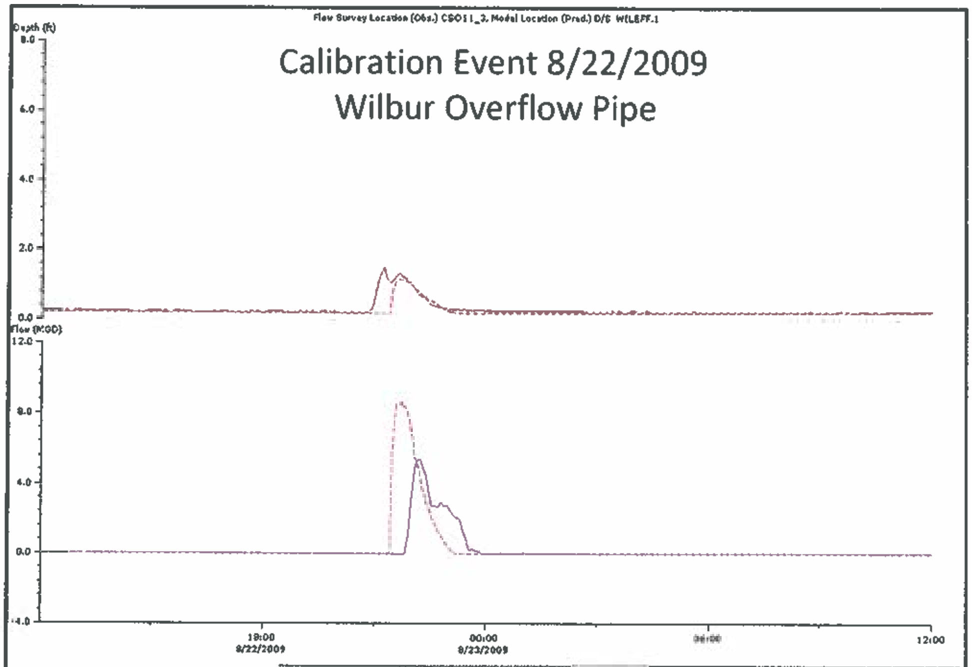
Calibration Event 8/22/2009
Hunter Overflow

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.221	1.486	0.000	7.375	0.211
.gston>Run Group>1-1-hunter>CalibEvents	0.267	0.330	-0.000	1.325	0.017
.gston>Run Group>2-1-hunter>CalibEvents	1.e10	-1.e10	1.e10	-1.e10	0.000



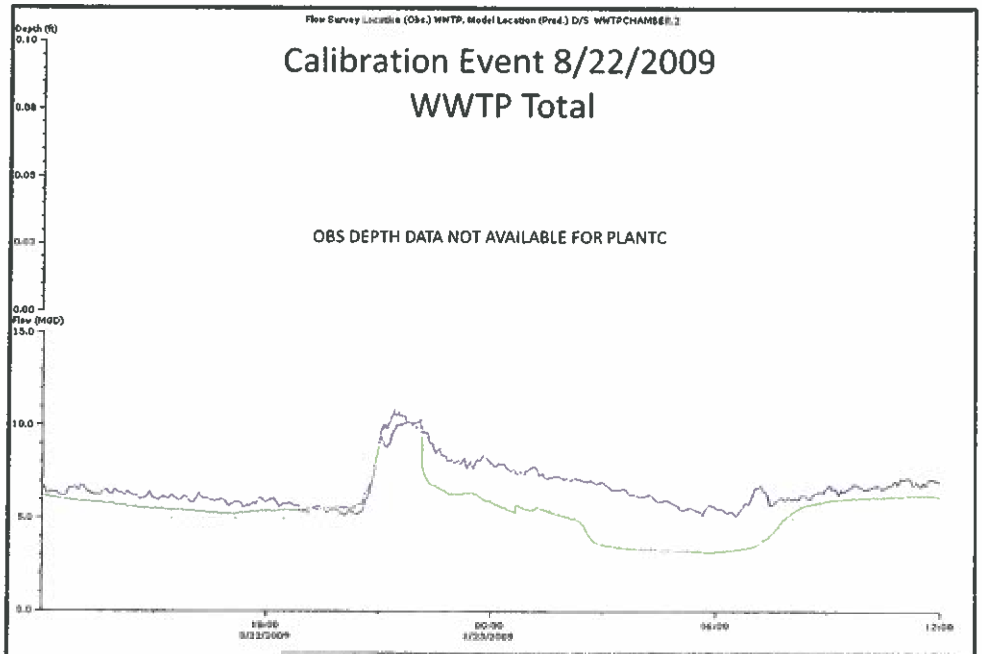
Calibration Event 8/22/2009
CSO 11-1 (Wilbur, 2300 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.197	4.579	0.828	9.465	2.597
>Kingston>Run Group>V2-5>CalibEvents	1.e10	-1.e10	1.e10	-1.e10	0.000
>Kingston>Run Group>V1-5>CalibEvents	0.358	7.255	2.380	16.045	3.645



Calibration Event 8/22/2009
Wilbur Overflow Pipe

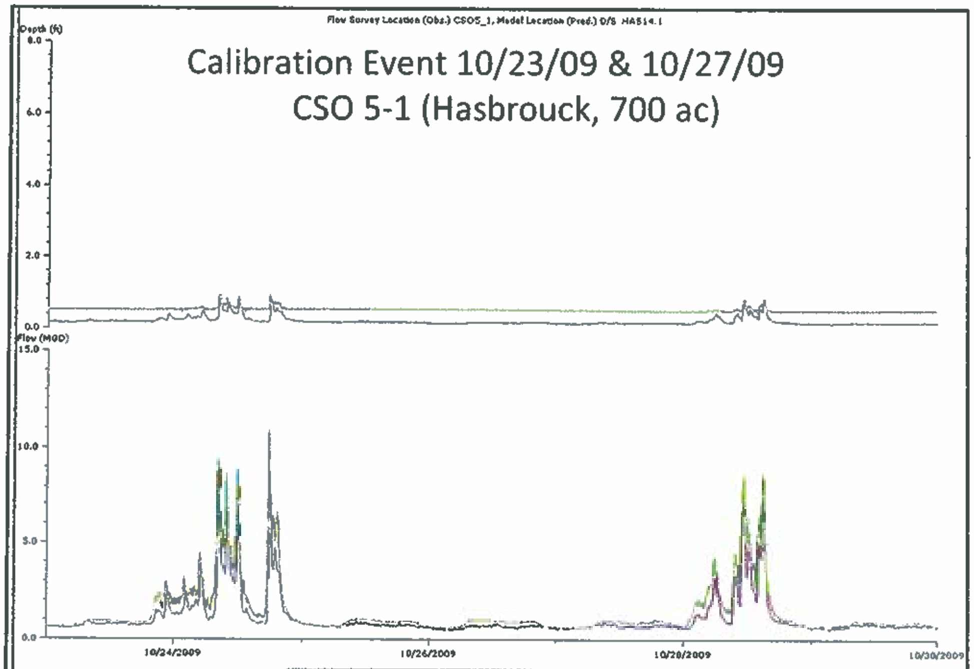
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.221	1.486	0.000	5.436	0.208
>Kingston>Run Group>V2-5>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000
>Kingston>Run Group>V1-5>CalibEvents	0.200	1.156	-0.000	8.609	0.305



Calibration Event 8/22/2009
WWTP Total

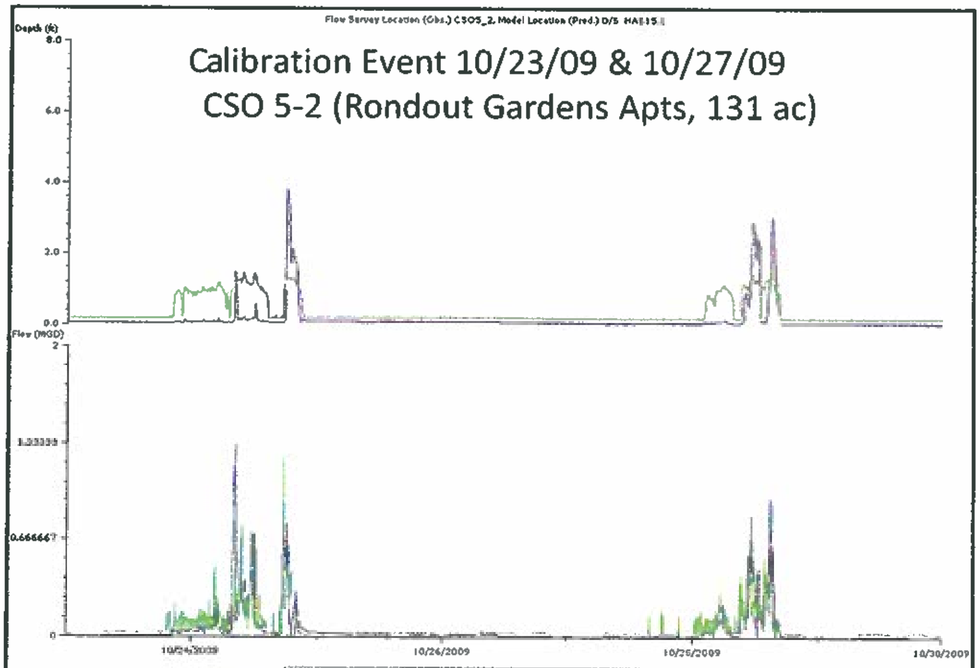
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.221	1.496	5.143	10.175	6.449
>Kingston>Run Group>1-1>CalibEvents	0.512	7.068	3.132	10.740	5.455

WWTP	NA	Data recorder at plant


Flow Survey Location (Obs.) CSO5_1, Model Location (Pred.) D/S HA514.1

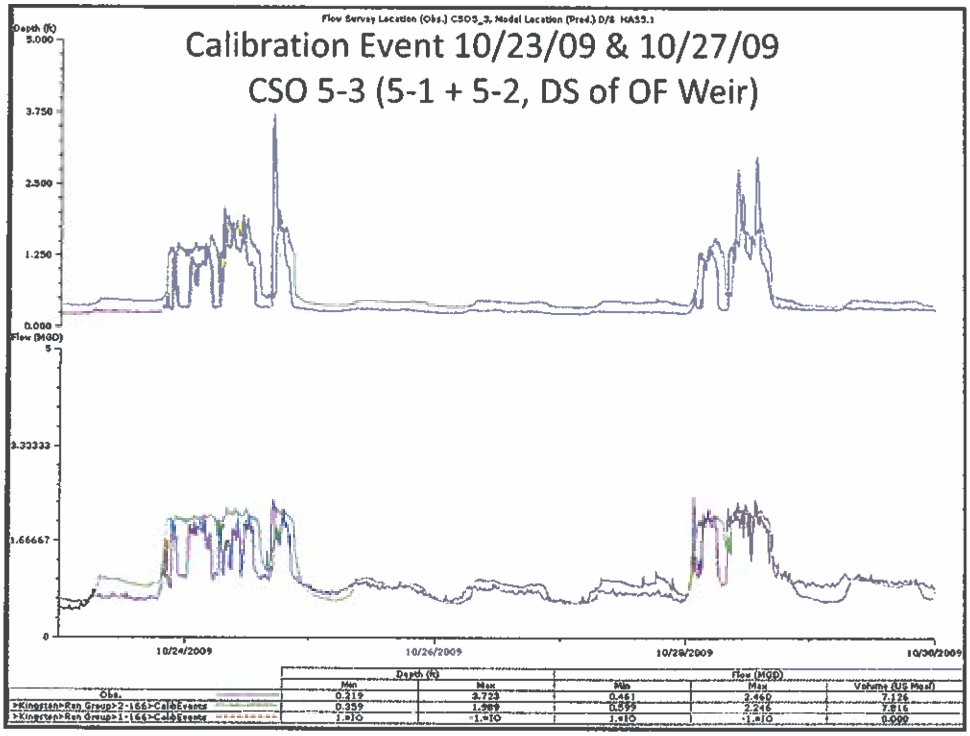
Calibration Event 10/23/09 & 10/27/09
CSO 5-1 (Hasbrouck, 700 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.142	0.923	0.500	9.201	8.022
>Kingston>Run Group>2-166>CalibEvents	0.499	0.946	0.590	10.830	9.981
>Kingston>Run Group>1-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000


Flow Survey Location (Obs.) CSO5_2, Model Location (Pred.) D/S HA515.1

Calibration Event 10/23/09 & 10/27/09
CSO 5-2 (Rondout Gardens Apts, 131 ac)

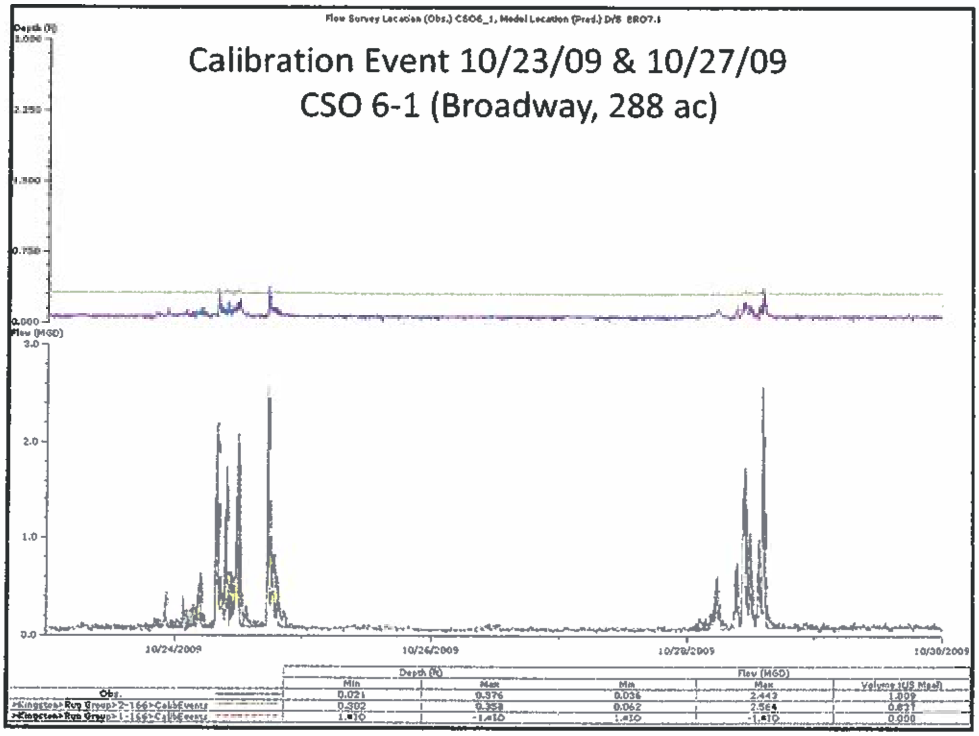
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.037	3.827	0.000	1.320	0.302
>Kingston>Run Group>2-166>CalibEvents	0.150	1.550	-0.038	1.234	0.363
>Kingston>Run Group>1-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000



Calibration Event 10/23/09 & 10/27/09

CSO 5-3 (5-1 + 5-2, DS of OF Weir)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.219	3.723	0.461	2.460	7.126
>Kingston>Run Group>2-166>CalibEvents	0.359	1.989	0.599	2.246	7.816
>Kingston>Run Group>1-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

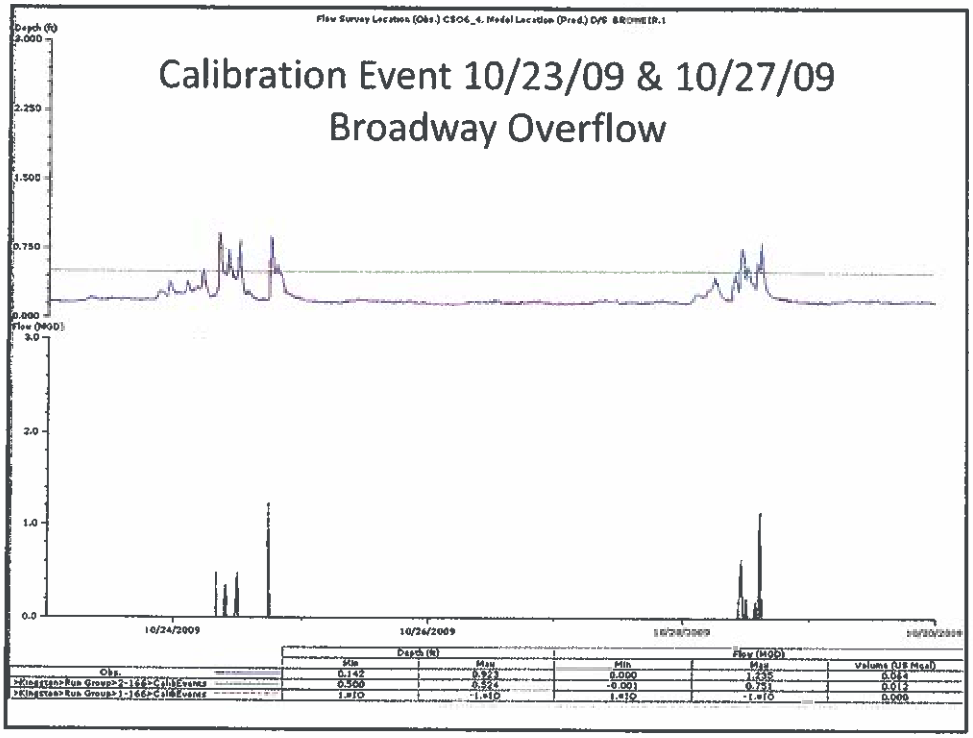


Calibration Event 10/23/09 & 10/27/09

CSO 6-1 (Broadway, 288 ac)

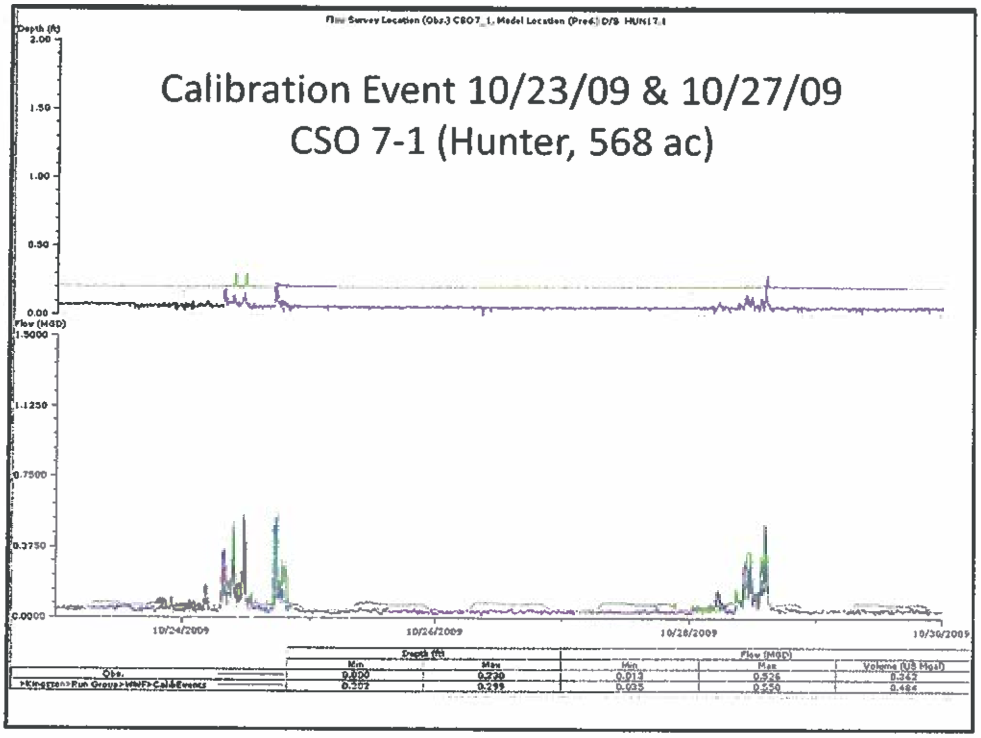
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.021	0.376	0.036	2.443	1.009
>Kingston>Run Group>2-166>CalibEvents	0.302	0.358	0.062	2.564	0.827
>Kingston>Run Group>1-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

Calibration Event 10/23/09 & 10/27/09
Broadway Overflow

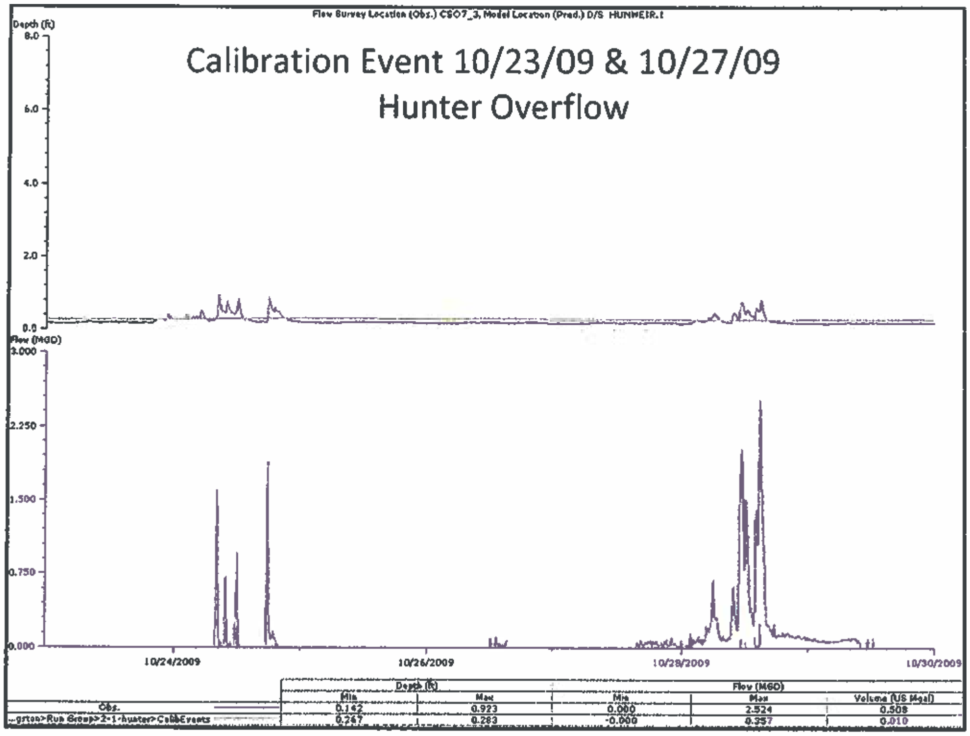


	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.142	0.923	0.000	1.235	0.064
>Kingston>Run Group>2-166>CalibEvents	0.500	0.524	-0.001	0.751	0.012
>Kingston>Run Group>1-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

Calibration Event 10/23/09 & 10/27/09
CSO 7-1 (Hunter, 568 ac)

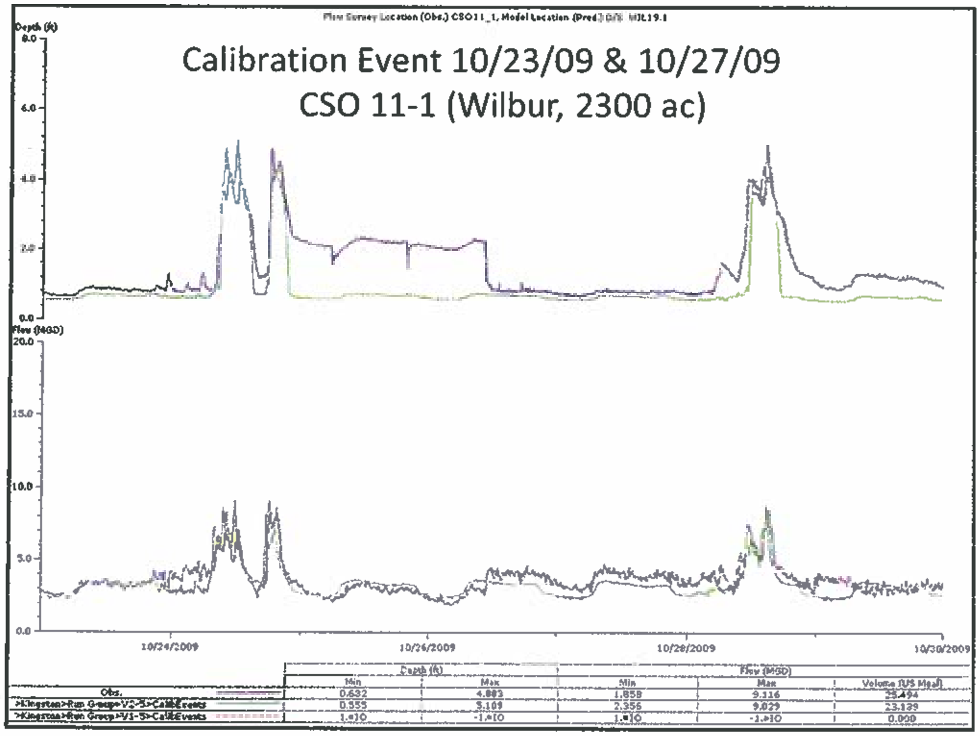


	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.000	0.230	0.013	0.526	0.362
>Kingston>Run Group>WWF>CalibEvents	0.202	0.299	0.035	0.550	0.484



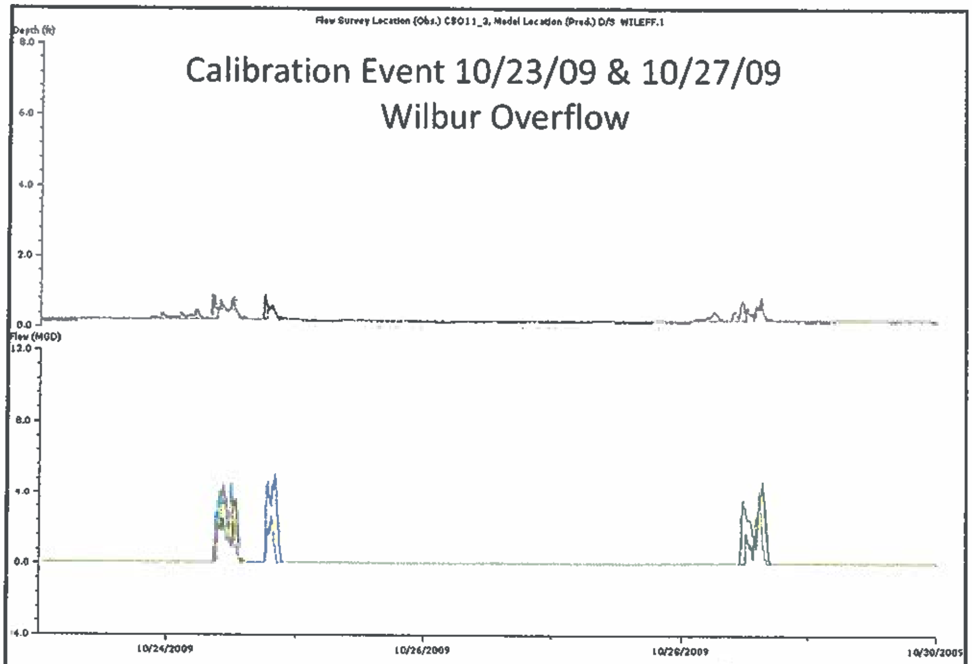
Calibration Event 10/23/09 & 10/27/09
Hunter Overflow

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.142	0.923	0.000	2.524	0.508
...gston>Run Group>2-1-hunter>CalibEvents	0.267	0.283	-0.000	0.357	0.010

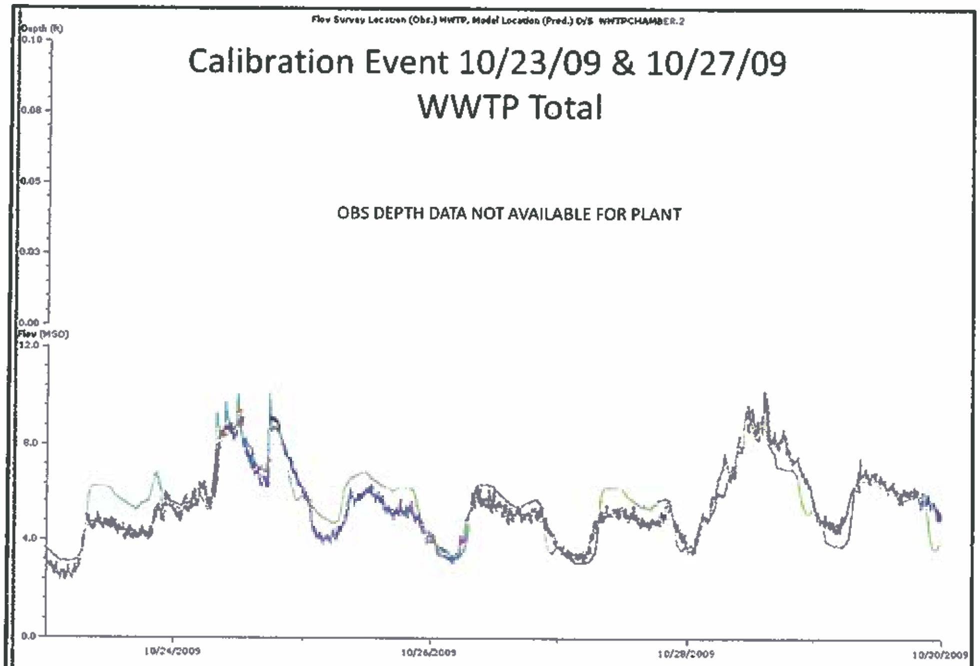


Calibration Event 10/23/09 & 10/27/09
CSO 11-1 (Wilbur, 2300 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.632	4.883	1.858	9.116	25.494
>Kingston>Run Group>V2-5>CalibEvents	0.555	5.109	2.356	9.029	23.139
>Kingston>Run Group>V1-5>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000



	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.142	0.923	0.000	5.031	1.469
>Kingston>Run Group>V2-S>CalibEvents	0.200	0.792	-0.000	4.522	0.782
>Kingston>Run Group>V1-S>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000



	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.142	0.928	2.339	9.985	38.280
>Kingston>Run Group>2-166>CalibEvents	0.609	1.062	3.074	10.294	39.308
>Kingston>Run Group>1-166>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

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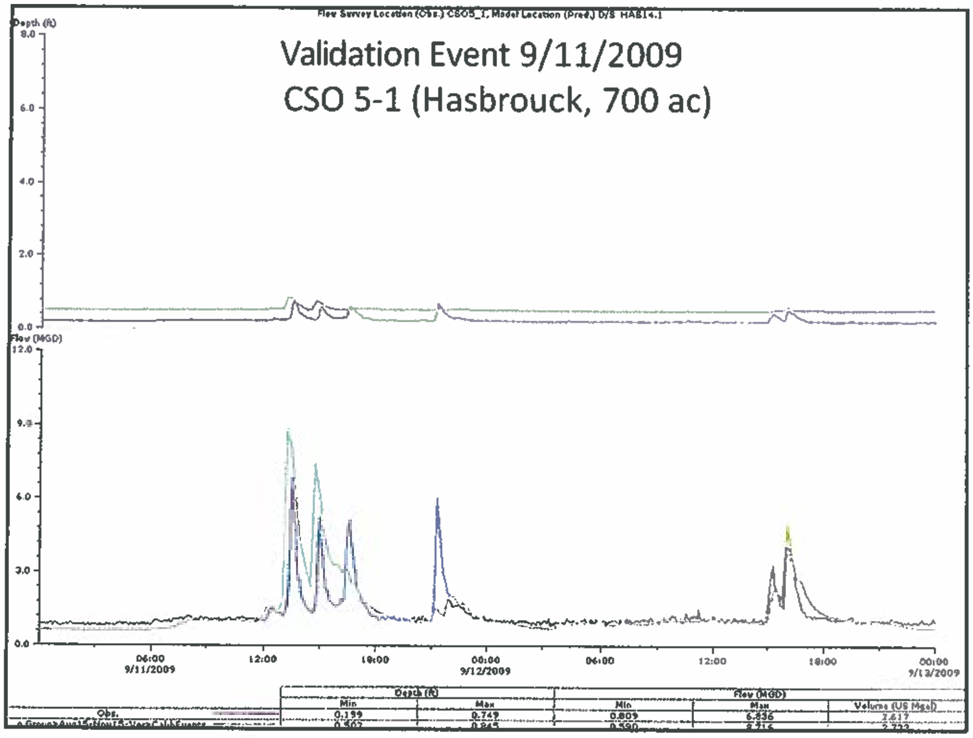
APPENDIX

F

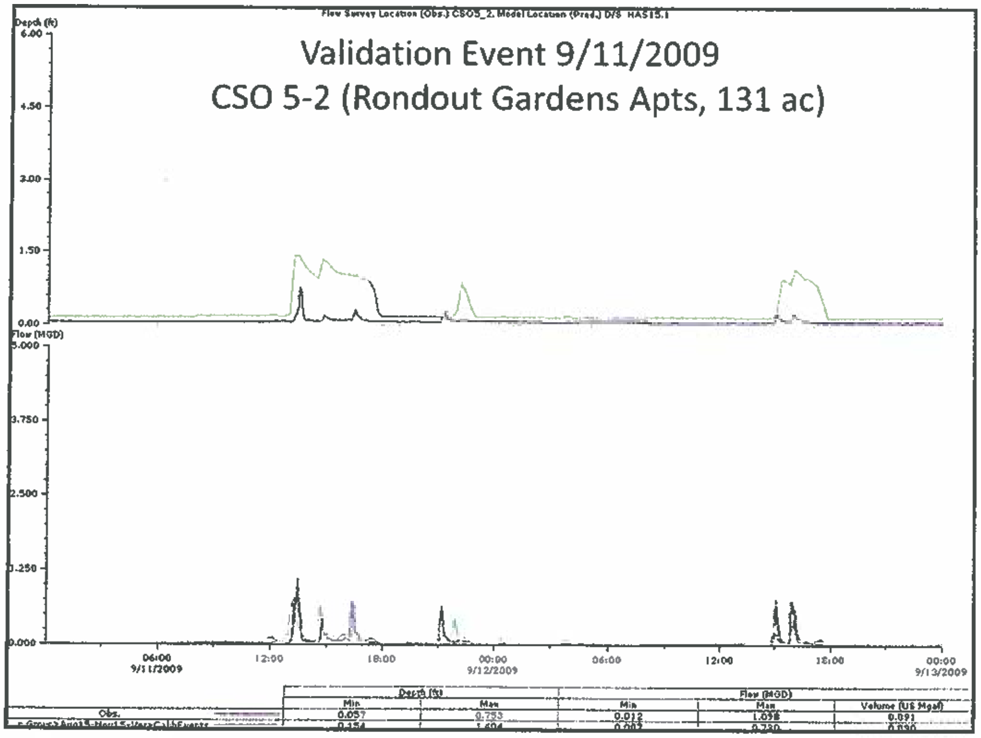
Model Verification

MALCOLM
PIRNIE



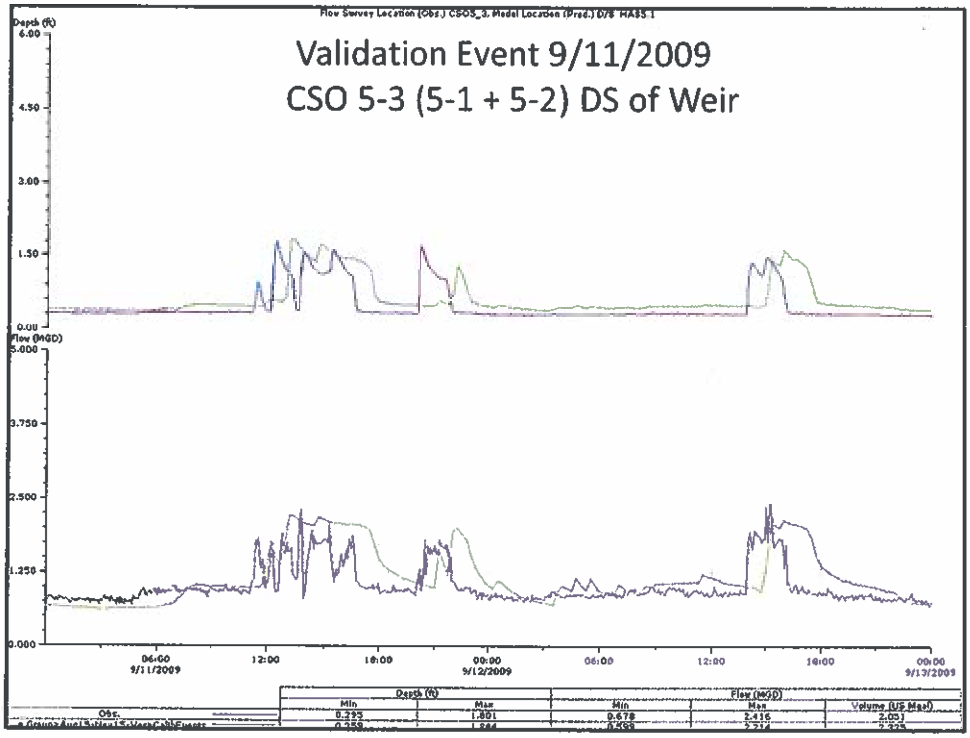
Validation Event 9/11/2009
CSO 5-1 (Hasbrouck, 700 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.199	0.749	0.809	6.836	2.617
[illegible]	0.502	0.845	0.590	8.716	2.722

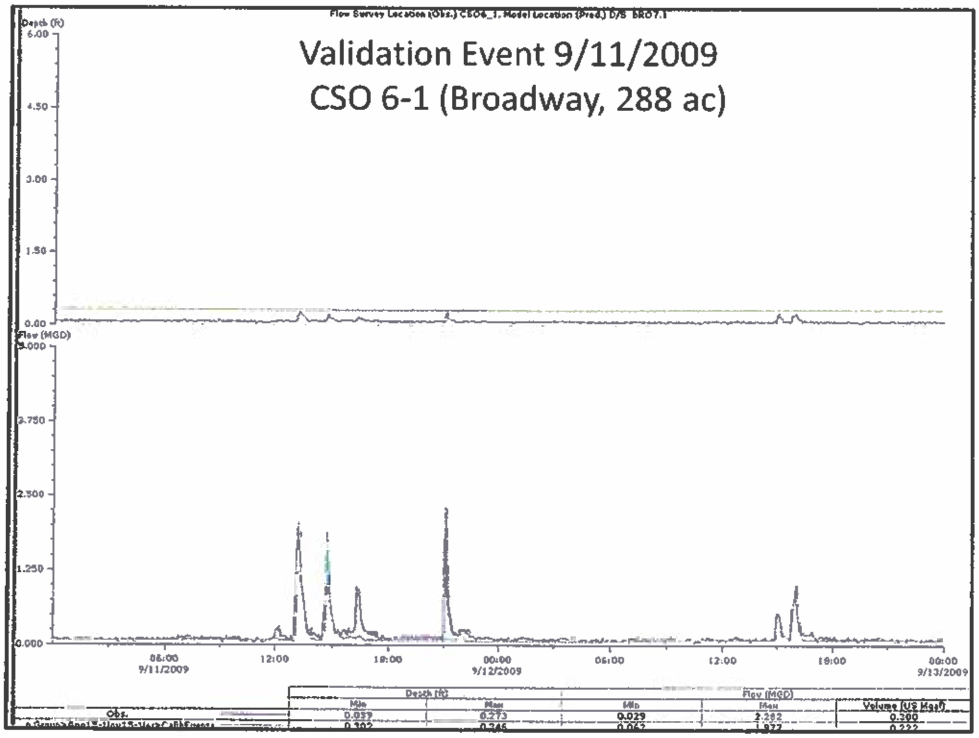


Validation Event 9/11/2009
CSO 5-2 (Rondout Gardens Apts, 131 ac)

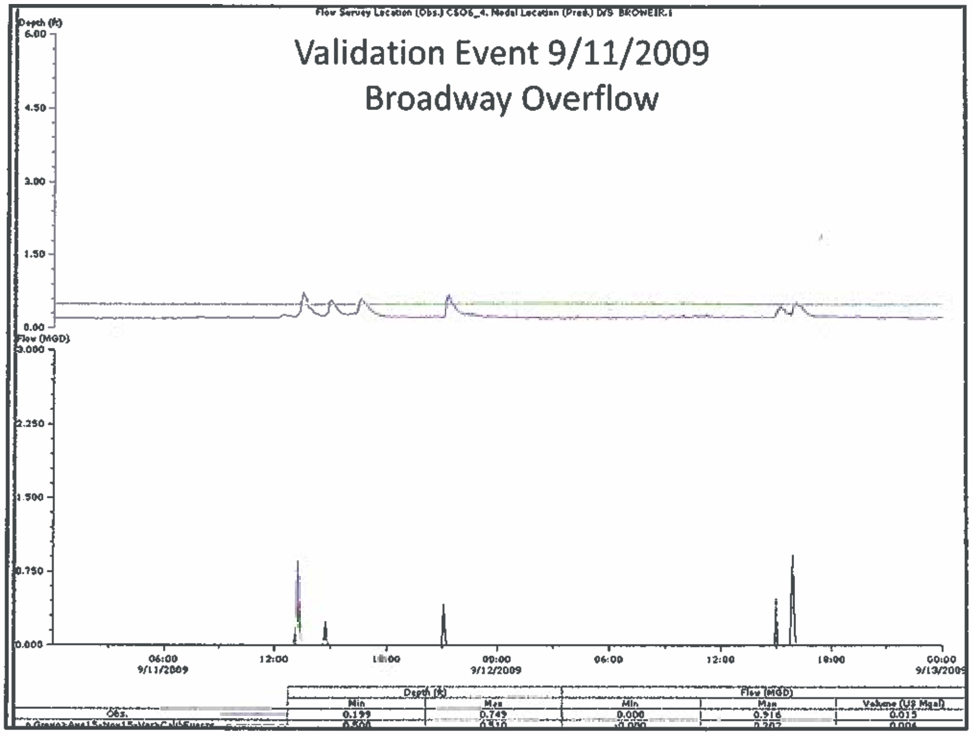
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.057	0.753	0.012	1.098	0.091
[illegible]	0.154	1.404	0.002	0.730	0.090


Validation Event 9/11/2009
CSO 5-3 (5-1 + 5-2) DS of Weir

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.295	1.801	0.678	2.416	2.051
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]


Validation Event 9/11/2009
CSO 6-1 (Broadway, 288 ac)

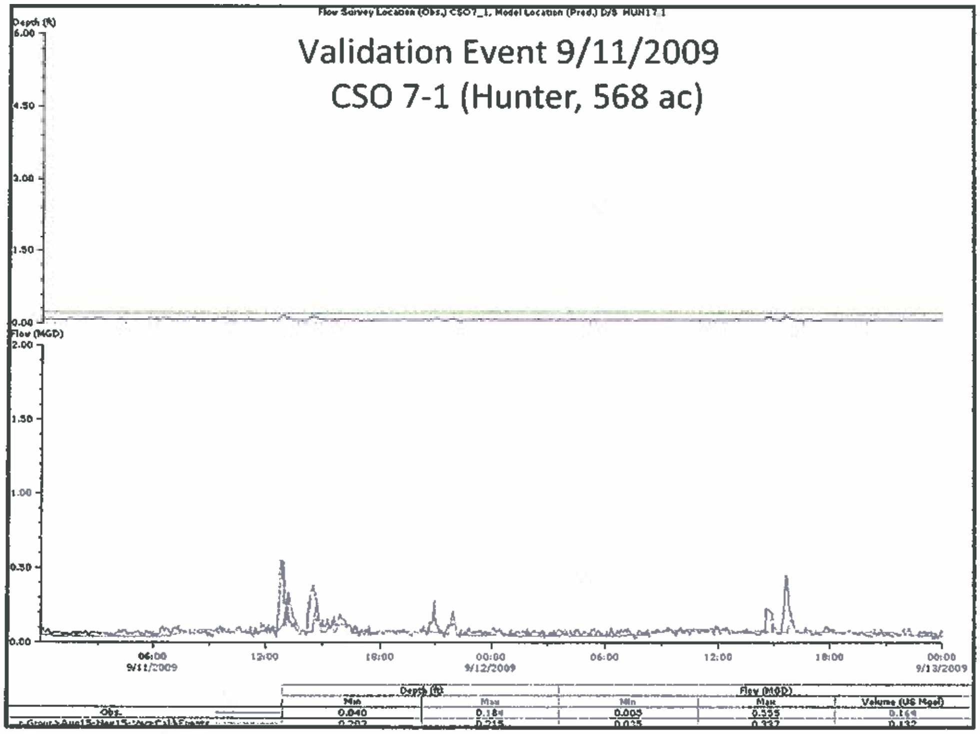
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.039	0.273	0.029	2.282	0.300
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Validation Event 9/11/2009
Broadway Overflow

Flow Survey Location (Obs.) CSO6_4, Model Location (Pred.) D/S BROWEIR.1

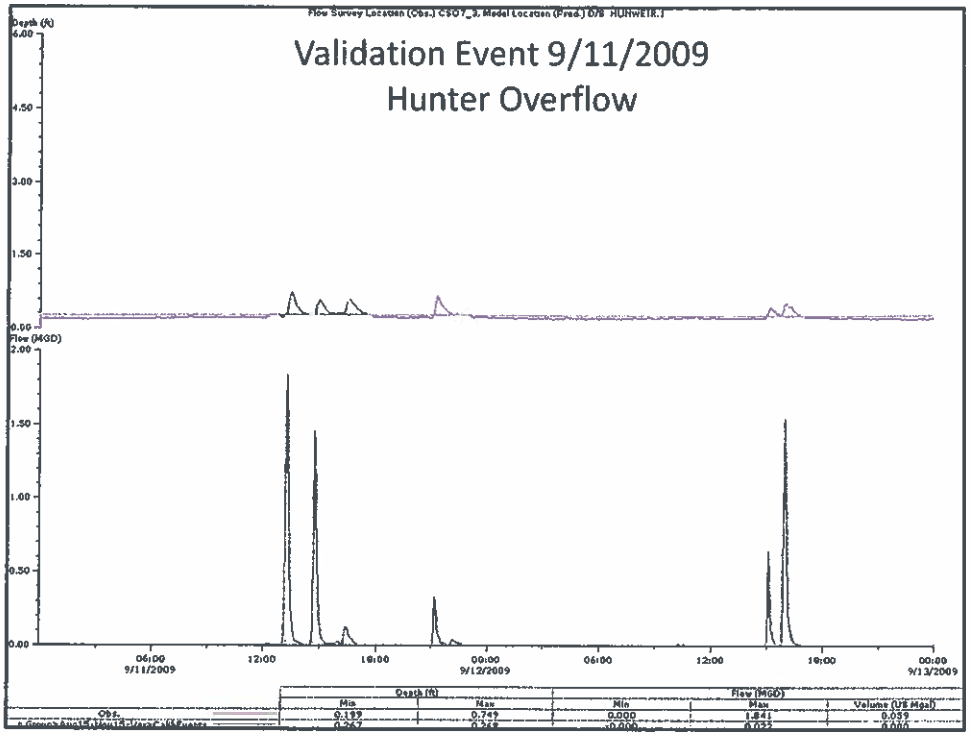
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.199	0.749	0.000	0.916	0.015



Validation Event 9/11/2009
CSO 7-1 (Hunter, 568 ac)

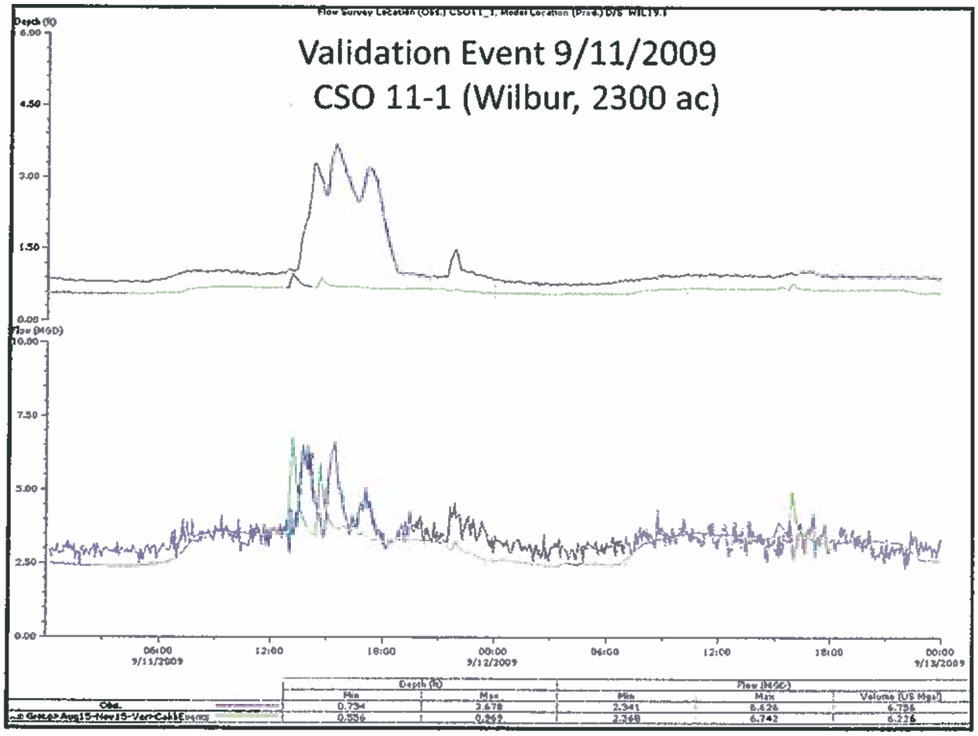
Flow Survey Location (Obs.) CSO7_1, Model Location (Pred.) D/S HUN17.1

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.040	0.184	0.005	0.555	0.164



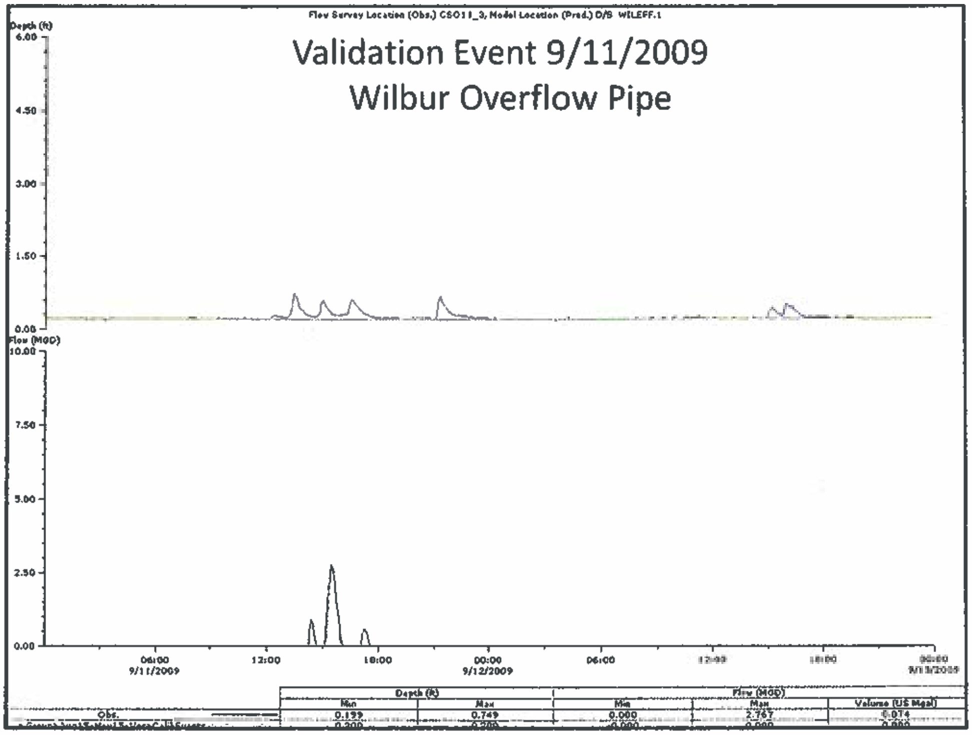
Validation Event 9/11/2009
Hunter Overflow

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.199	0.749	0.000	1.841	0.059
<Group> Aug15-Nov15-Ver-CalibEvents	0.267	0.268	-0.000	0.022	0.000



Validation Event 9/11/2009
CSO 11-1 (Wilbur, 2300 ac)

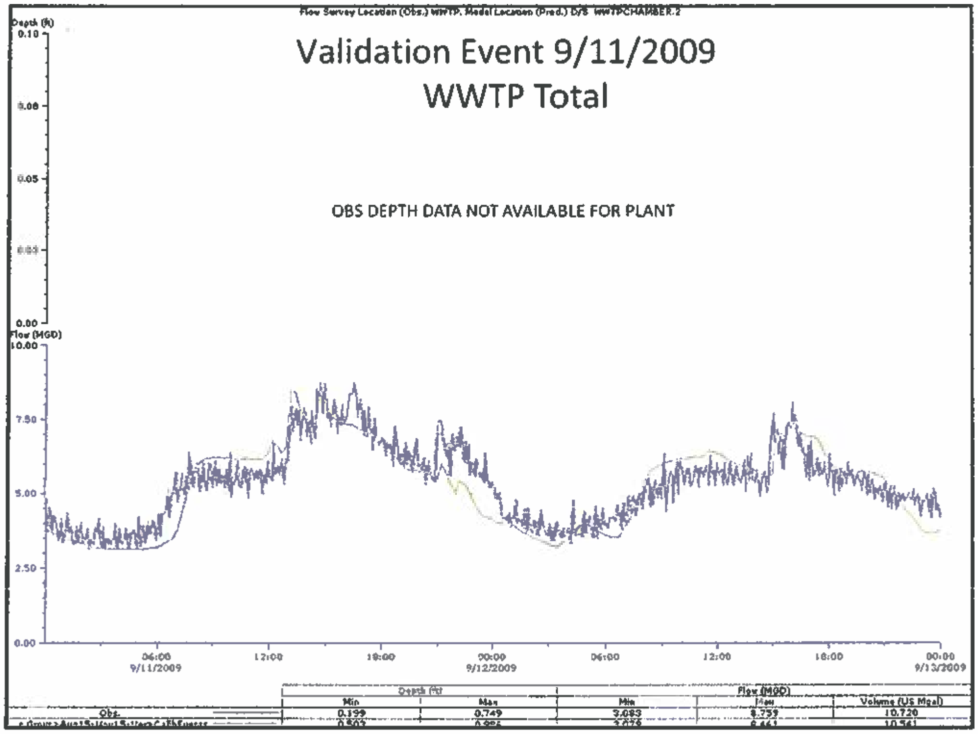
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.734	3.678	2.341	6.626	6.756
<Group> Aug15-Nov15-Ver-CalibEvents	0.556	0.869	2.368	6.742	6.226



Flow Survey Location (Obs.) CSO11_3, Model Location (Pred.) D/S WILEFF.1

Validation Event 9/11/2009
Wilbur Overflow Pipe

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.199	0.749	0.000	2.767	0.074
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

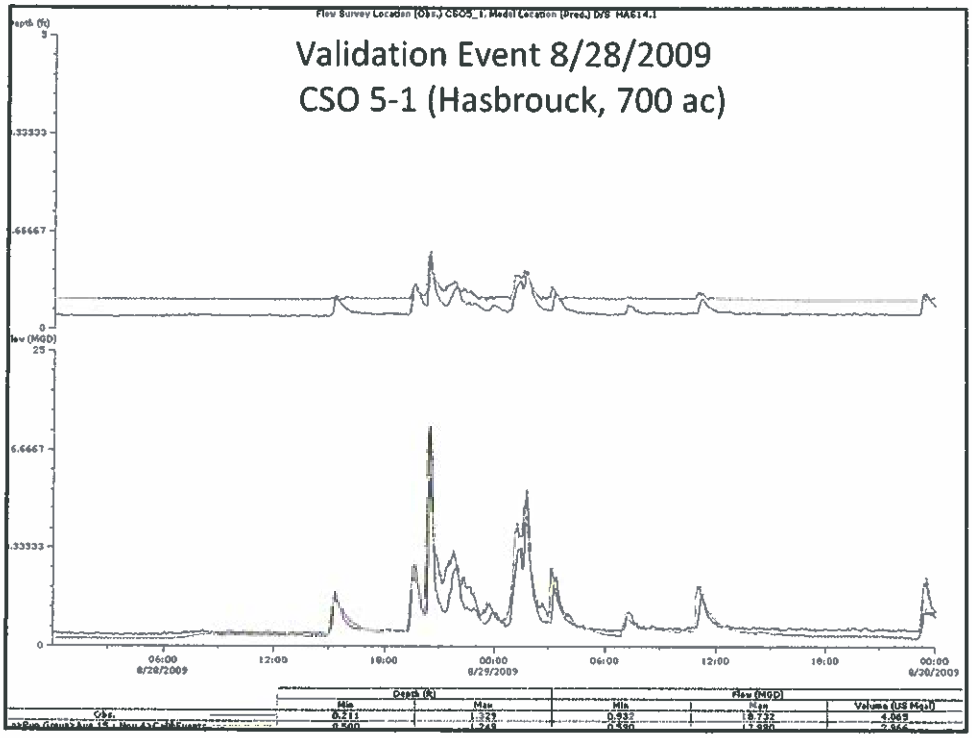


Flow Survey Location (Obs.) WWTP, Model Location (Pred.) D/S WWTPCHAMBER.2

Validation Event 9/11/2009
WWTP Total

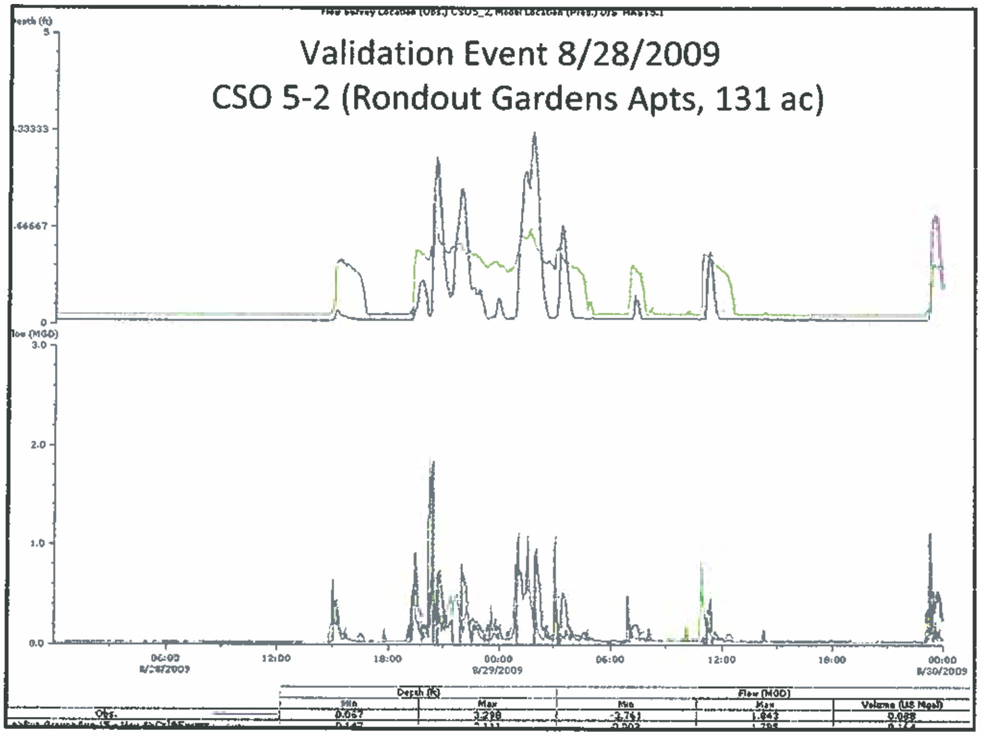
OBS DEPTH DATA NOT AVAILABLE FOR PLANT

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.199	0.749	3.083	8.759	10.720
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



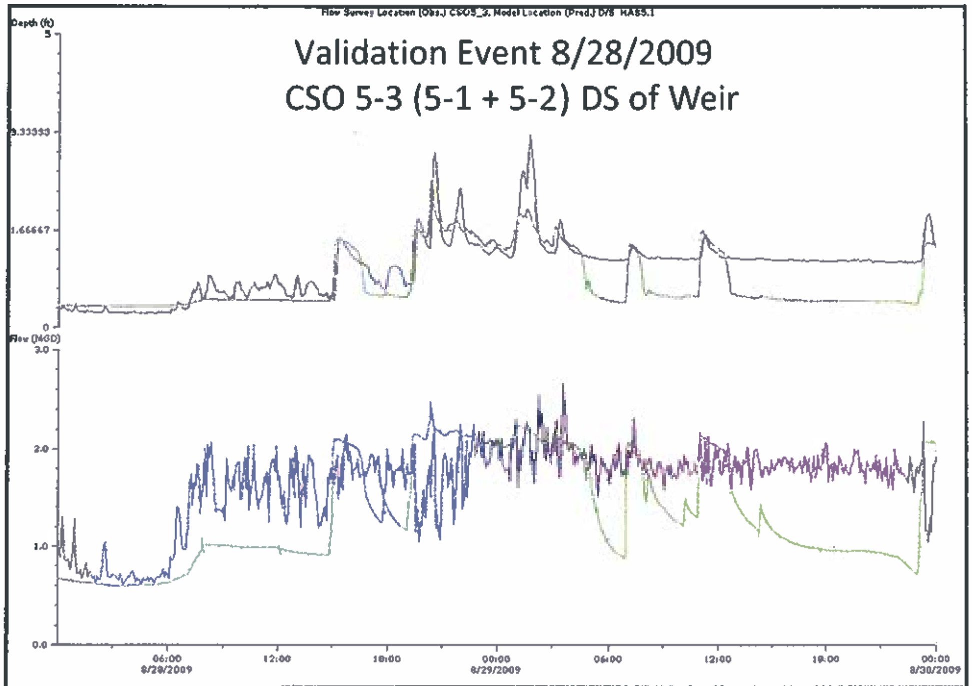
Validation Event 8/28/2009
CSO 5-1 (Hasbrouck, 700 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.211	1.329	0.932	18.732	4.069
[illegible]	0.500	1.249	0.590	17.990	2.966



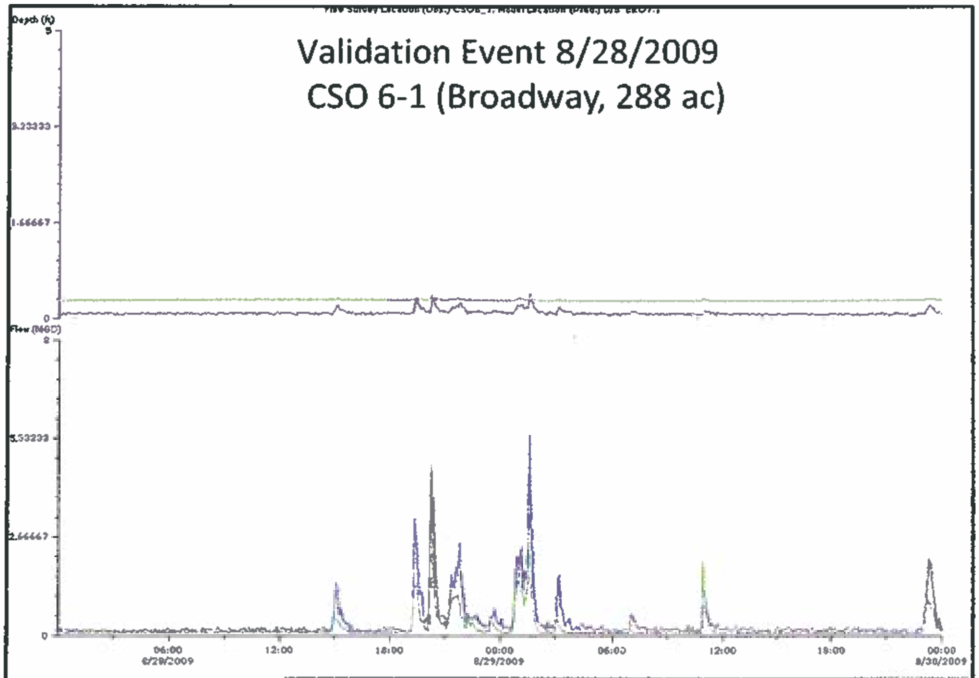
Validation Event 8/28/2009
CSO 5-2 (Rondout Gardens Apts, 131 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.067	3.298	-3.761	1.843	0.088
[illegible]	0.147	[illegible]	[illegible]	[illegible]	[illegible]



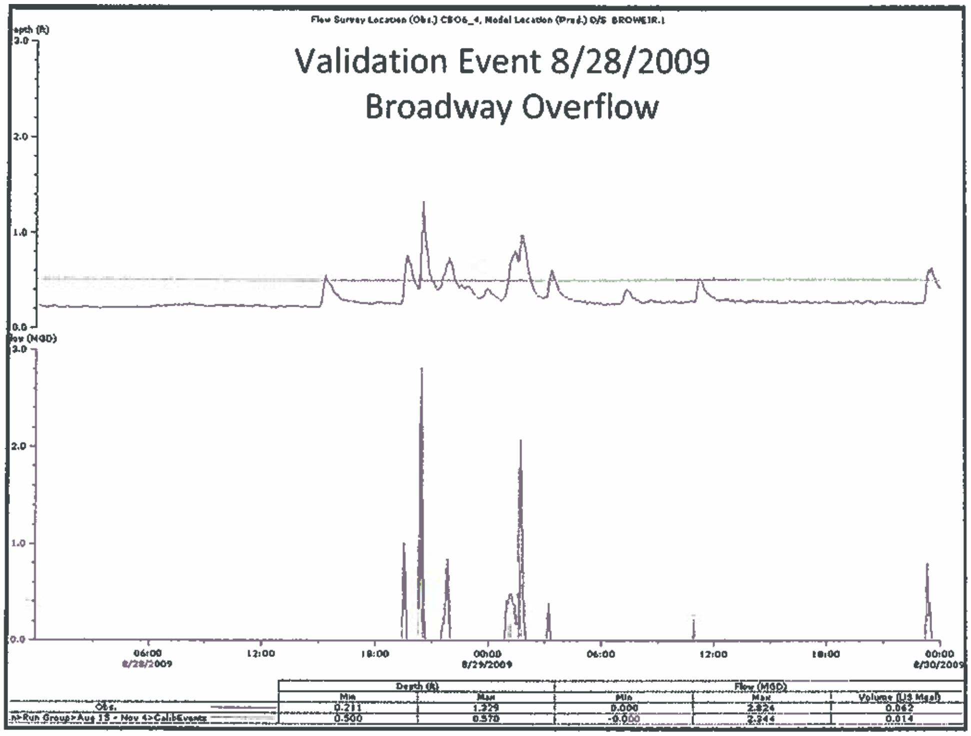
Validation Event 8/28/2009
CSO 5-3 (5-1 + 5-2) DS of Weir

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.249	3.306	0.614	2.674	3.300
...Run Group>Aug 15 - flow 4>CalibEvents	0.259	2.546	0.599	2.472	[illegible]



Validation Event 8/28/2009
CSO 6-1 (Broadway, 288 ac)

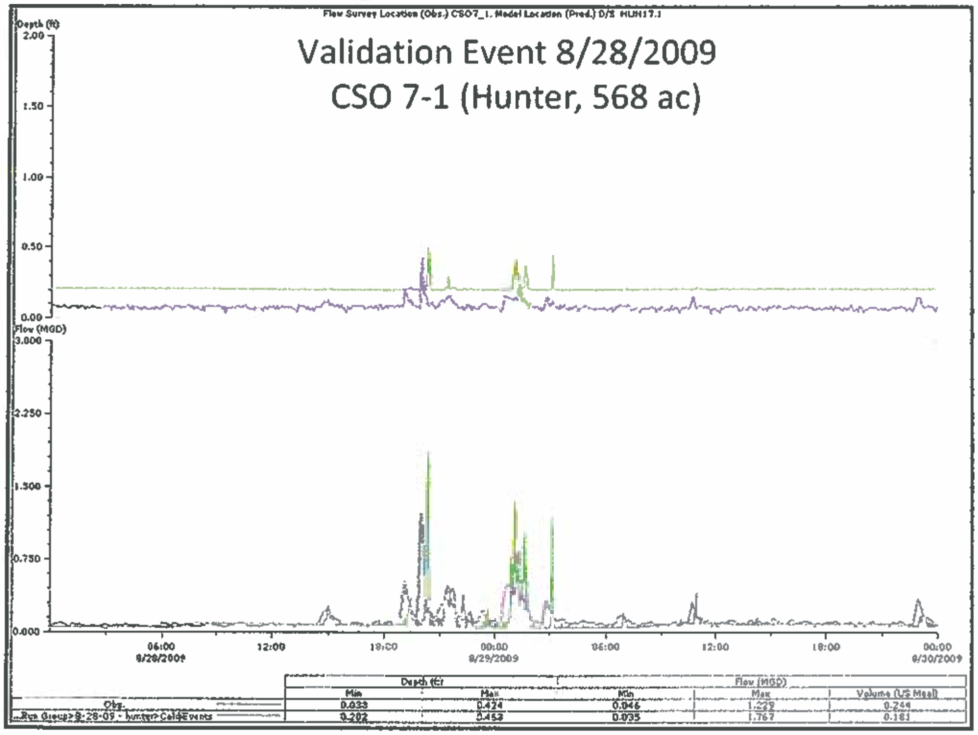
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.044	0.424	0.054	5.399	0.661
->Run Group>Aug 15 - flow 4>CalibEvents	0.302	0.395	0.062	4.669	0.363



Flow Survey Location (Obs.) CSO6_4, Model Location (Pred.) D/S BROWEIR.1

Validation Event 8/28/2009
Broadway Overflow

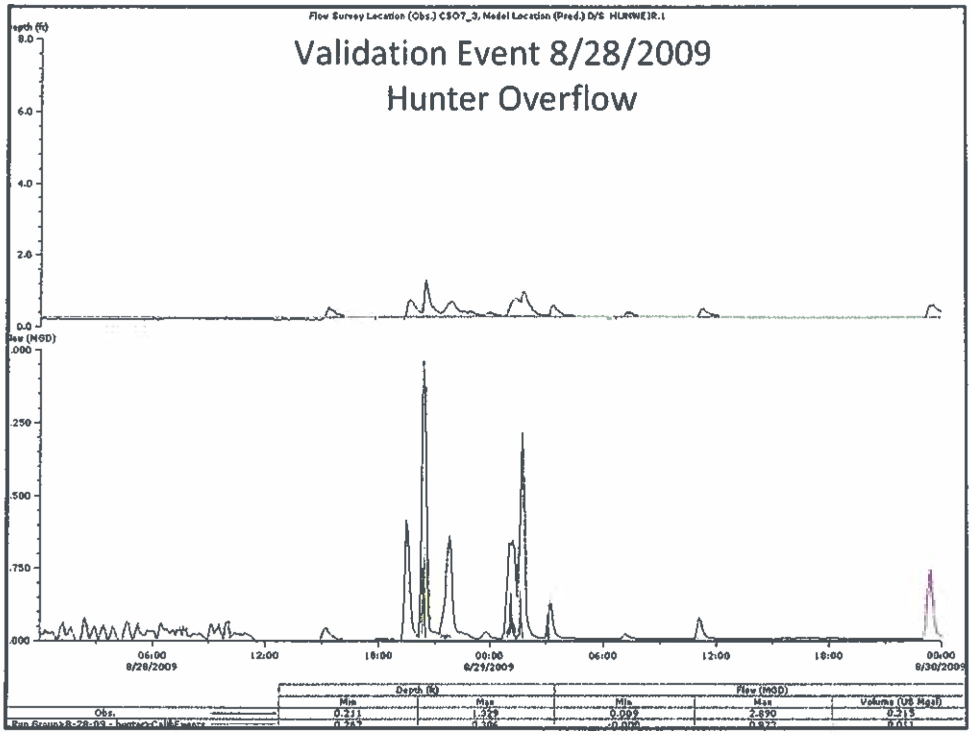
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.211	1.329	0.000	2.824	0.062
n>Run Group>Aug 15 - Nov 4>CalibEvents	0.500	0.570	-0.000	2.344	0.014



Flow Survey Location (Obs.) CSO7_1, Model Location (Pred.) D/S HUN17.1

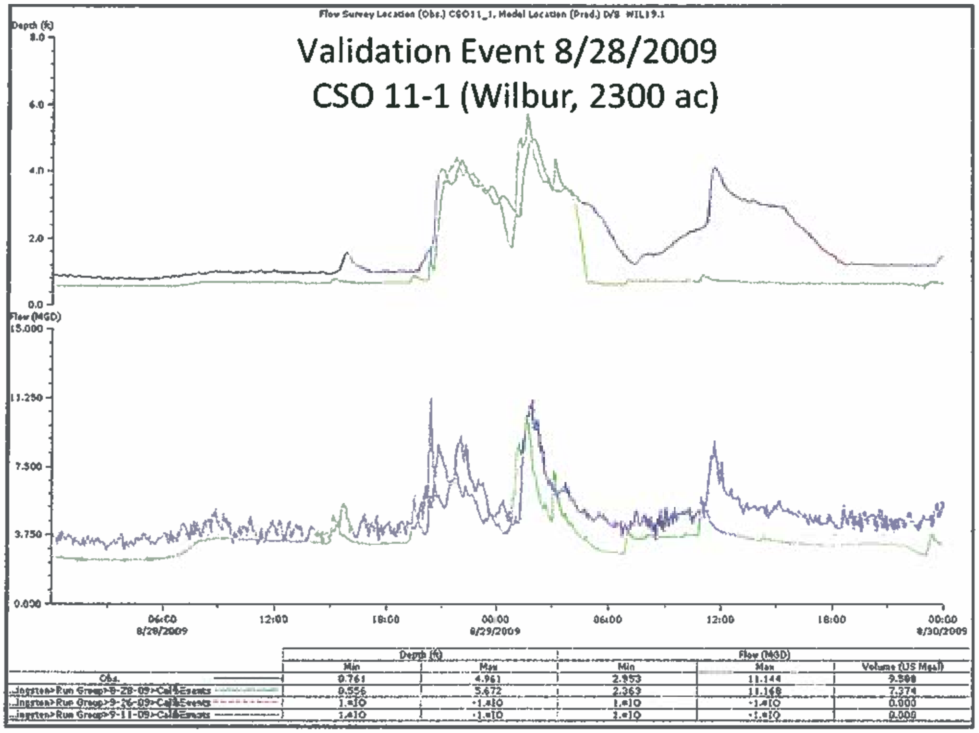
Validation Event 8/28/2009
CSO 7-1 (Hunter, 568 ac)

	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.033	0.424	0.046	1.229	0.244
...Run Group>8-28-09 - hunter>CalibEvents	0.202	0.453	0.035	1.767	0.181



Validation Event 8/28/2009
Hunter Overflow

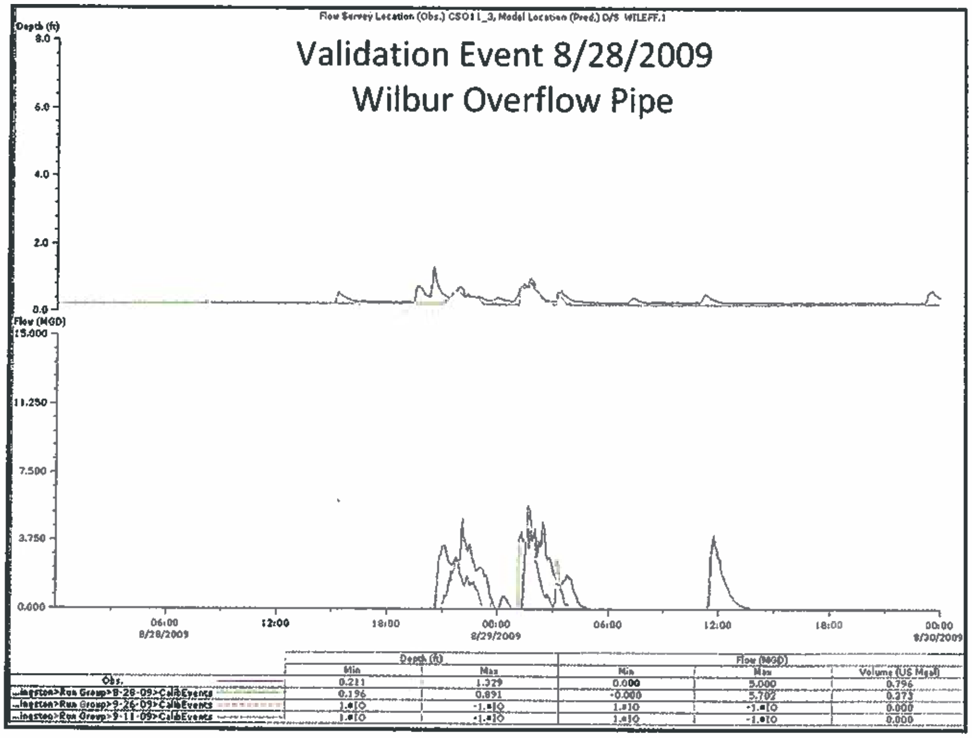
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.211	1.329	0.009	2.890	0.215
Run Group>8-28-09 - hunter>Cal&Events	0.262	0.306	-0.000	0.922	0.011



Validation Event 8/28/2009
CSO 11-1 (Wilbur, 2300 ac)

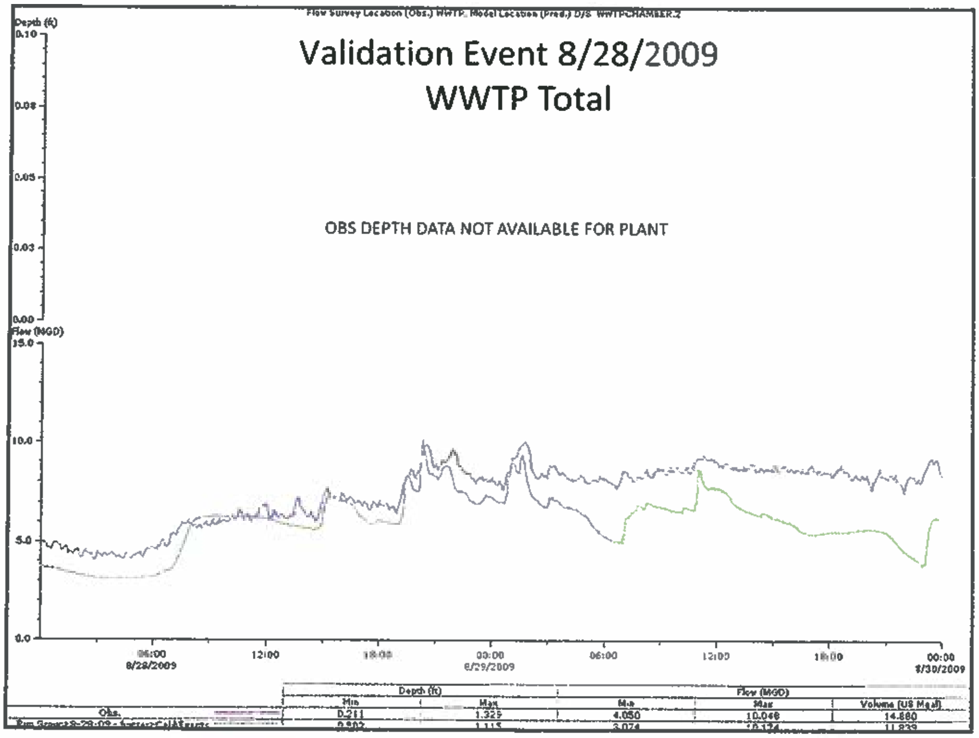
	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.761	4.961	2.953	11.144	9.588
..Jngsten>Run Group>8-28-09>Cal&Events	0.556	5.672	2.363	11.168	7.374
..Jngsten>Run Group>9-26-09>Cal&Events	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000
..Jngsten>Run Group>9-11-09>Cal&Events	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

Validation Event 8/28/2009
Wilbur Overflow Pipe



	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.211	1.329	0.000	5.000	0.796
...ingston>Run Group>8-28-09>CalibEvents	0.196	0.891	-0.000	5.702	0.273
...ingston>Run Group>9-26-09>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000
...ingston>Run Group>9-11-09>CalibEvents	1.#IO	-1.#IO	1.#IO	-1.#IO	0.000

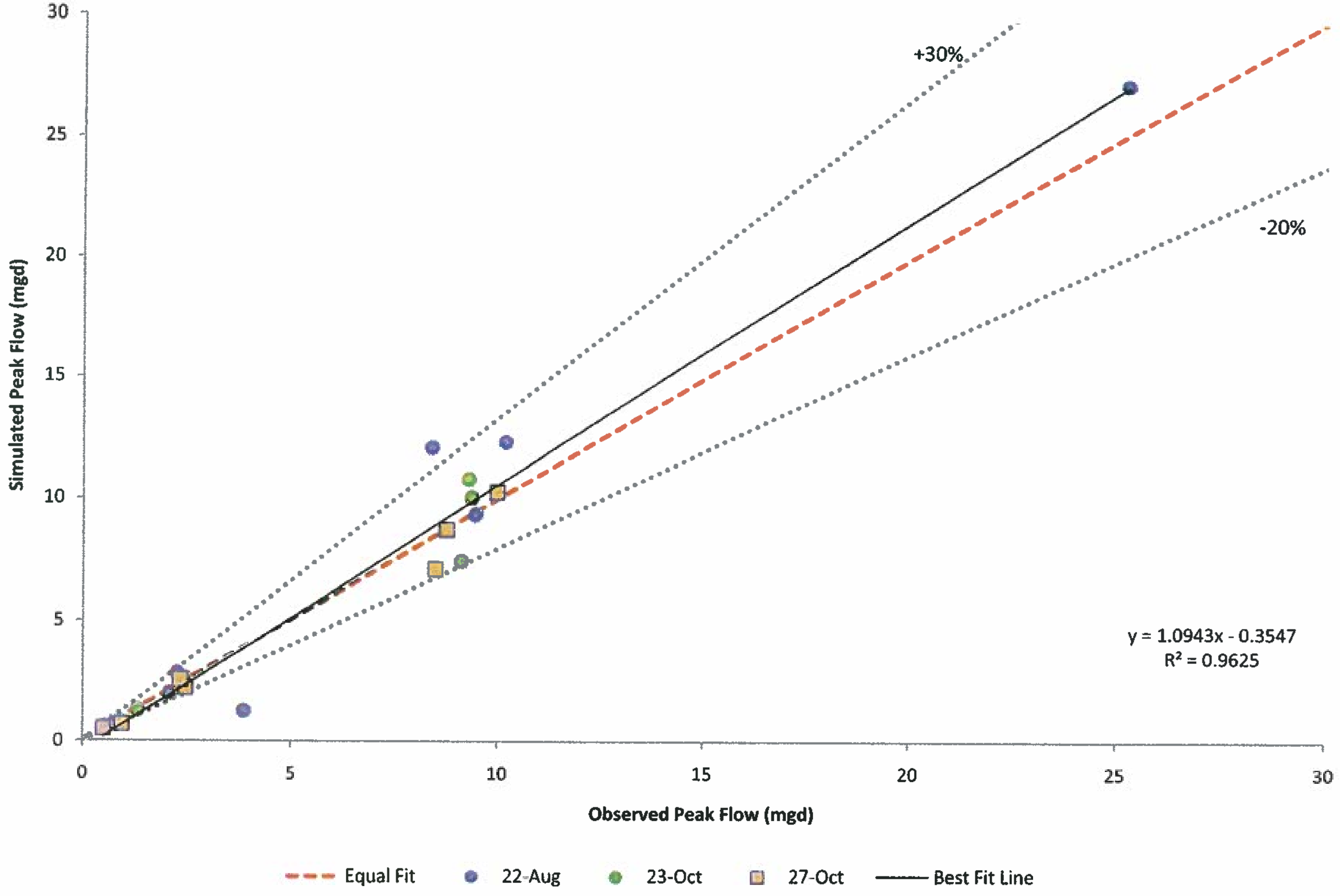
Validation Event 8/28/2009
WWTP Total

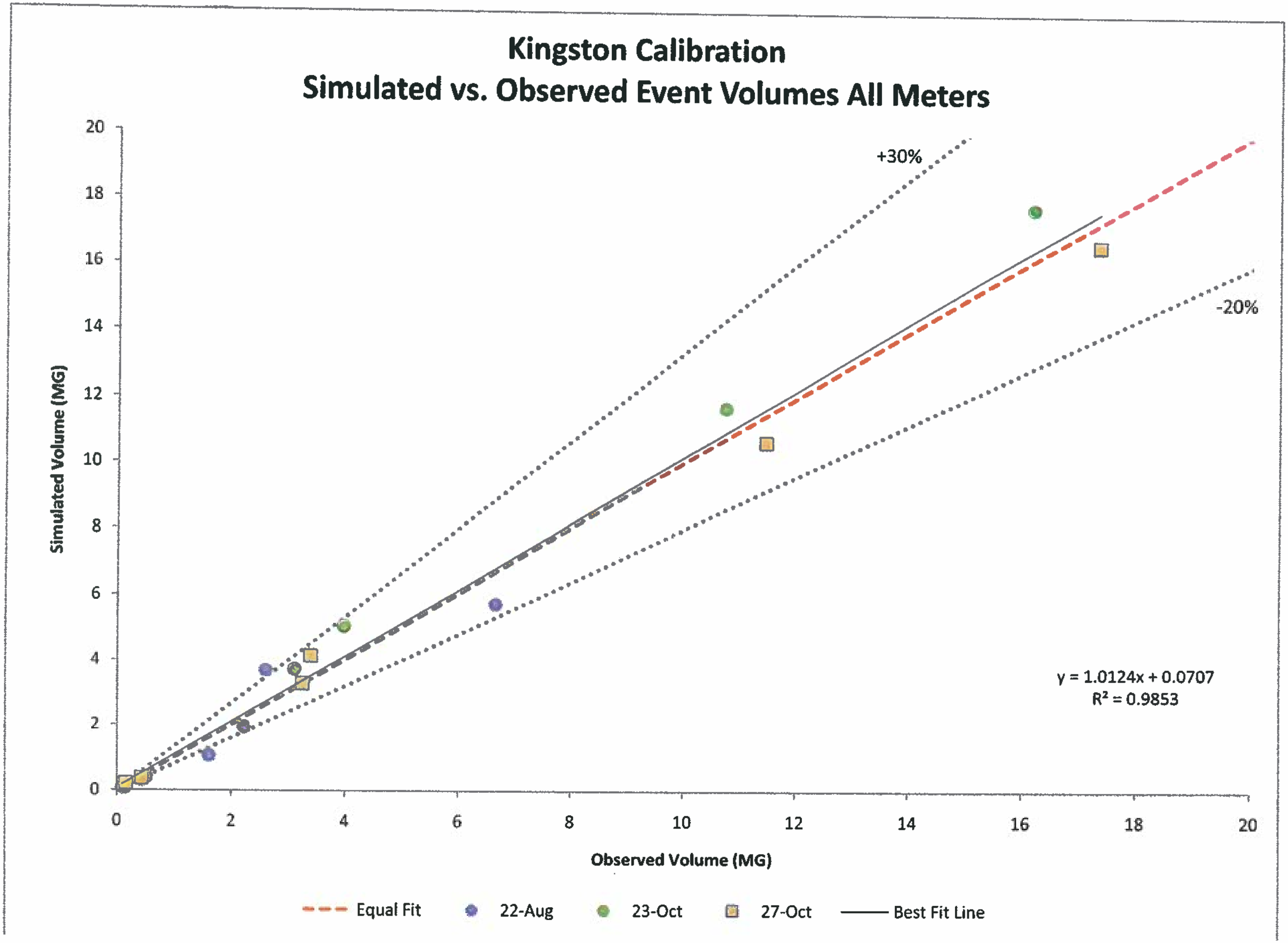


	Depth (ft)		Flow (MGD)		
	Min	Max	Min	Max	Volume (US Mgal)
Obs.	0.211	1.329	4.050	10.048	14.880
Run Group>8-28-09 - ...CalibEvents	0.902	1.115	3.074	10.174	11.839

APPENDIX B
Calibration and Validation Scatter Plots

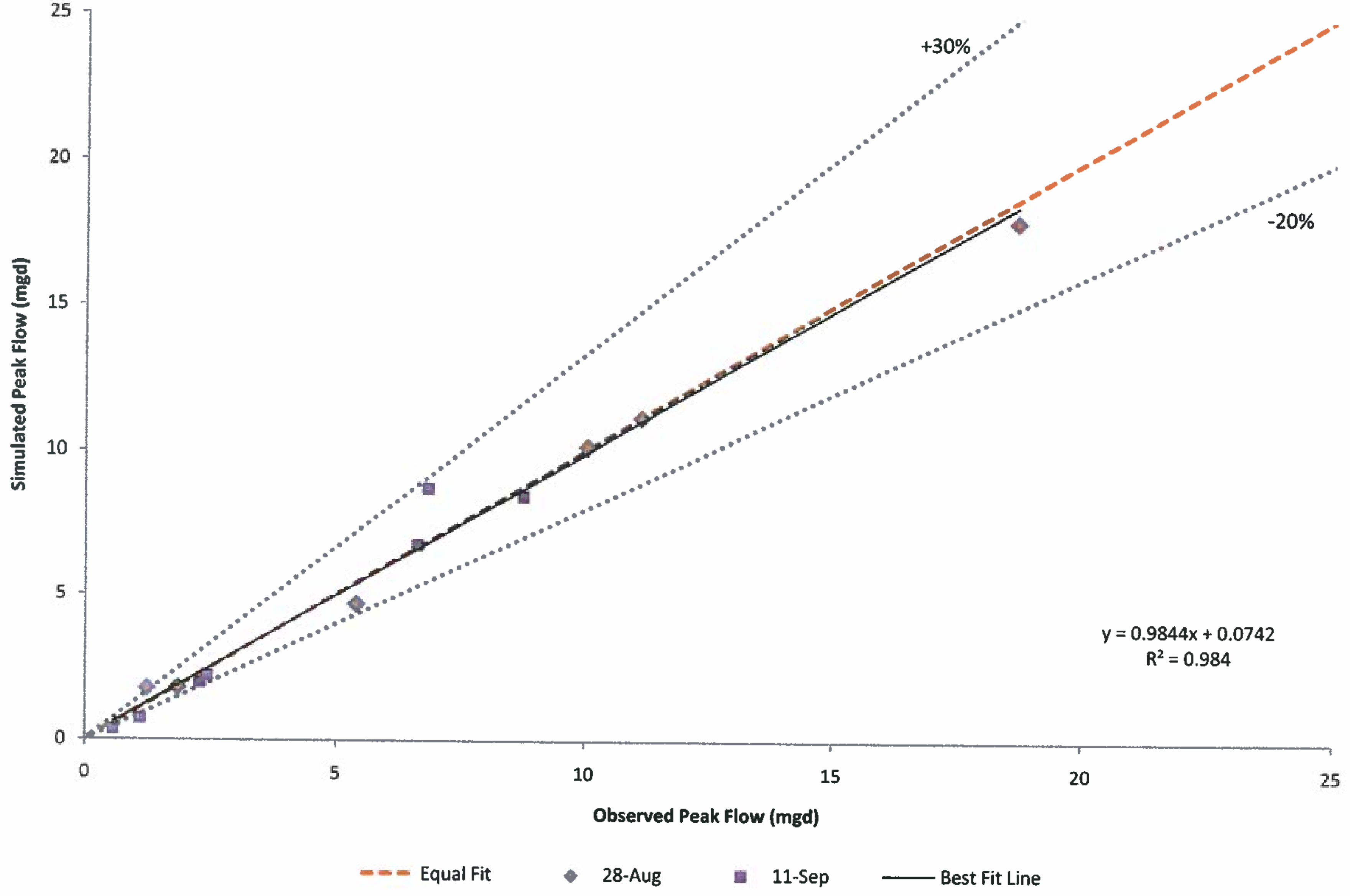
Kingston Calibration
Simulated vs. Observed Event Peak Flows All Meters

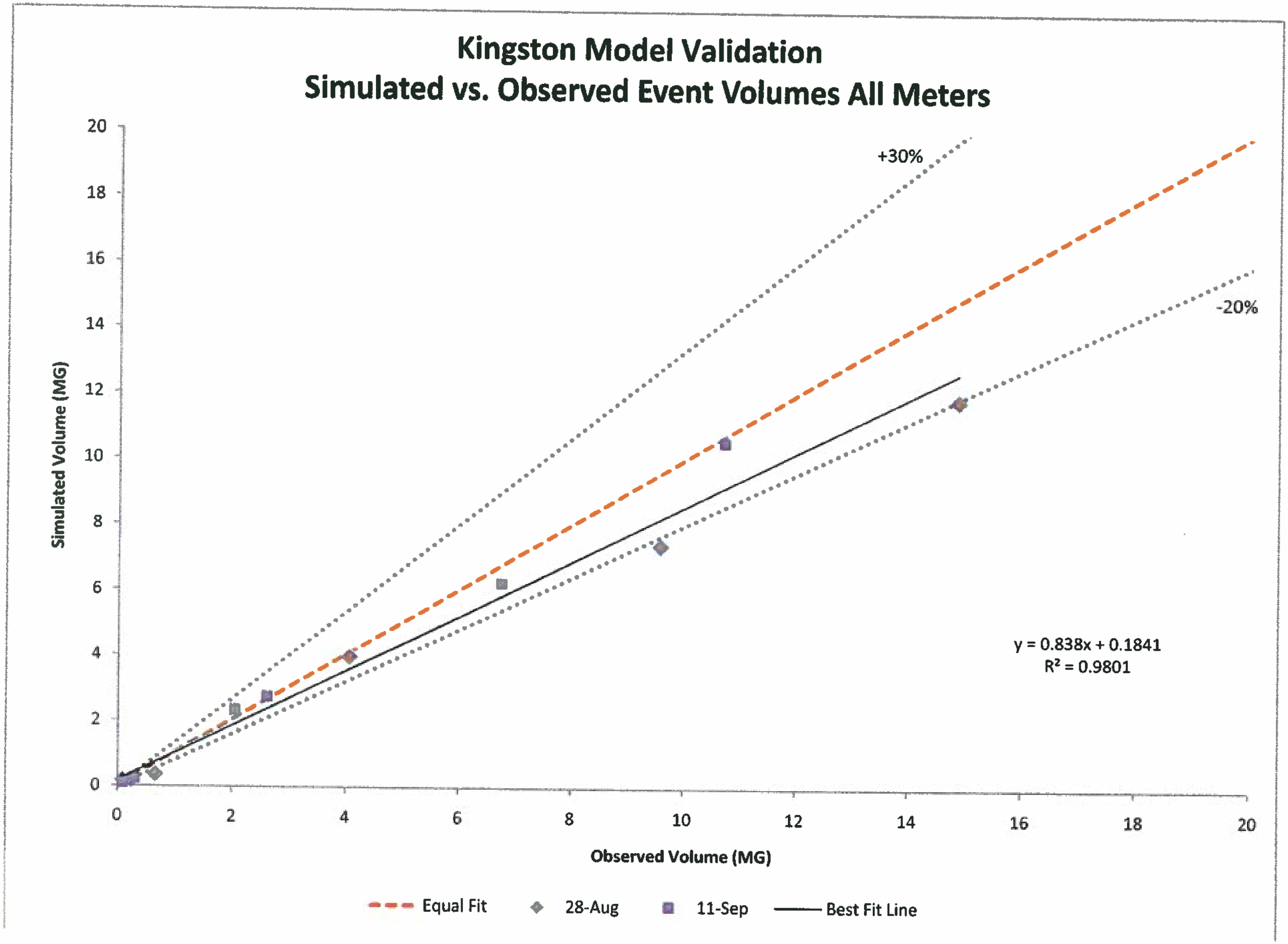




Kingston Calibration
Simulated vs. Observed Event Volumes All Meters

Kingston Model Validaation
Simulated vs. Observed Event Peak Flows All Meters





Kingston Model Validation
Simulated vs. Observed Event Volumes All Meters

City of Kingston
420 Broadway • Kingston, NY 12401

APPENDIX

G

Typical Period Selection Technical Memorandum

MALCOLM PIRNIE

City of Kingston
420 Broadway • Kingston, NY 12401

Typical Period Selection Technical Memorandum

June 2010

Report Prepared By:

Malcolm Pirnie, Inc.

855 Route 146 Suite 210
Clifton Park, NY 12065
518-250-7300

MALCOLM PIRNIE

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1 Methodology

1.1. Typical 5-year and Typical Year Periods

The typical five-year period was developed to assess the performance of the collection system under average conditions. A typical year period was selected from within the typical five year period. The typical period approach was utilized to best capture the dynamic nature of rainfall and, consequently, the response of the system to rainfall. While design storms have a role to play in wet weather simulations, the typical period with a continuous simulation was preferred to better simulate the overflow resulting from back to back events and varying antecedent conditions. The use of a typical five year period versus a single typical year period allows the inclusion of a larger number of events of varying duration and intensity. Also, a simulation which includes a typical five year period allows the statistics to be presented much more simply. A CSO which activates less than one time per year yet greater than once every five years is easier to illustrate over a longer time period. Instead of 0.2 overflows per year, the statistic may be expressed as an average of one overflow over a five year period.

1.2. Precipitation Data Review

Multiple area rain gauges were considered for the historic precipitation analysis before selecting the Albany Airport station. The rain gauge needed to have at least thirty years of hourly rainfall records and ideally would be located at a similar elevation to Kingston (279 ft). The Kingston City Hall rain gauge recorded hourly rainfall but was only in operation from 1948-1984 and sometimes recorded as few as 10-20 days of rainfall a year. The next nearest rain gauge with at least thirty years of rainfall was located at Poughkeepsie. The Poughkeepsie rain gauge was located at an elevation of 50 ft and recorded 58 years of hourly rainfall. However upon further review, the Poughkeepsie was Gauge incomplete and contained many data gaps. See Figures 1-1 and 1-2. Clinton Corners and Hudson Correctional Facility rain gauges were located more closely to Kingston than the Albany Airport rain gauge but those gauges also had significant data gaps. The Albany Airport Rain Gauge was selected because extensive historic precipitation data was available without data gaps and the gauge was located at a similar elevation as Kingston (275 ft versus 279 ft).

Figure 1-1: Annual Total Rainfall at Albany Airport and Poughkeepsie Rain Gauges

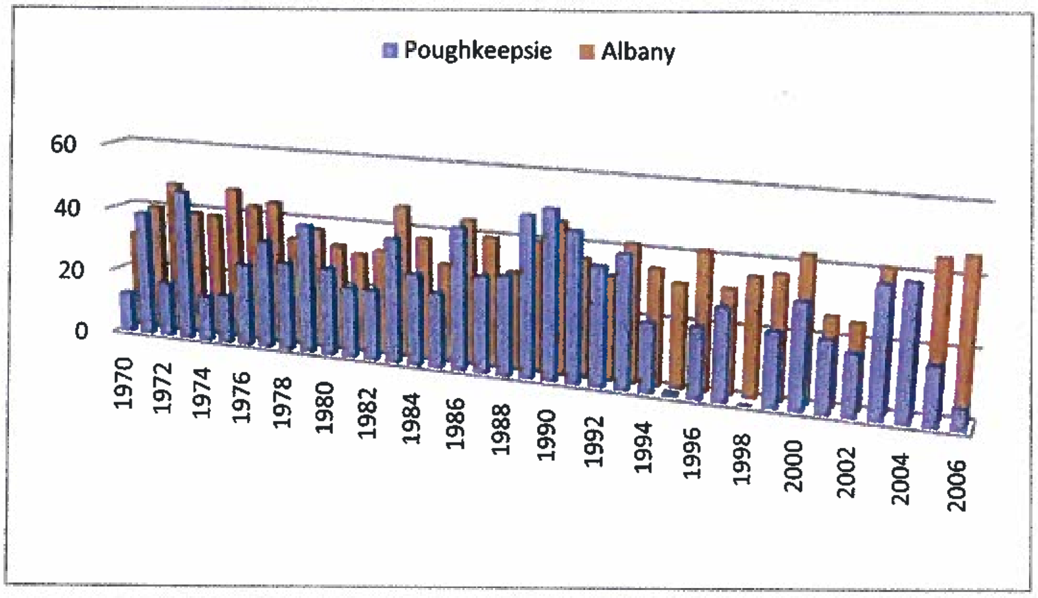
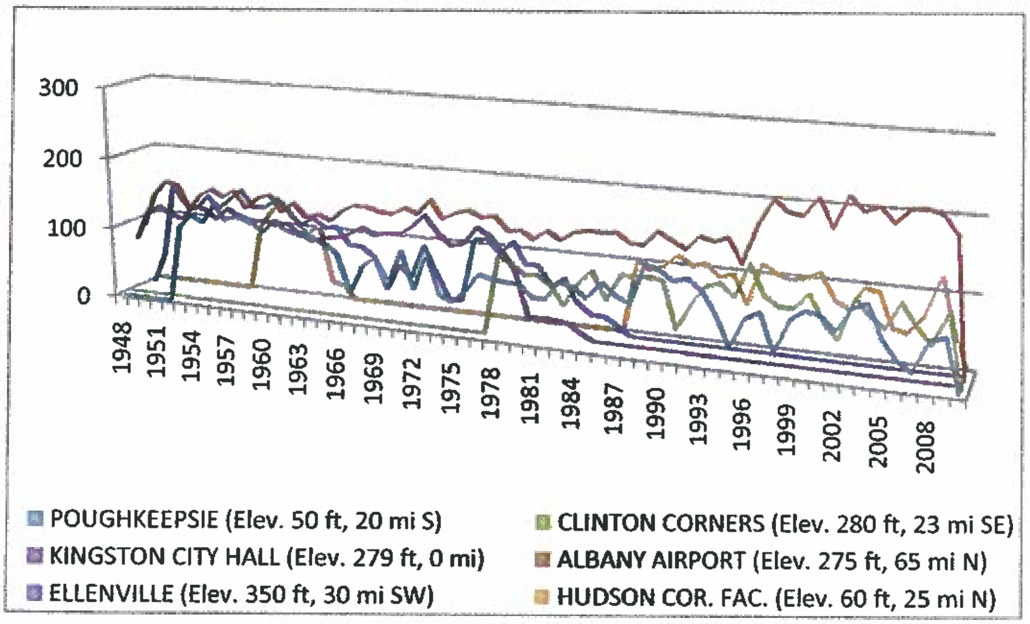


Figure 1-2: Annual Days of Recorded Rainfall



Precipitation Analysis

2.1. Historic Precipitation Data

The representative five year period used for system characterization was a contiguous five year period of observed rainfall. The typical five year period was not modified or adjusted in any way but is actual rainfall that occurred over a five year period. The Albany Airport rain gauge was selected following a review of available area rain gauges and their available recorded data. All rainfall events since 1948 were assigned a recurrence interval based upon the maximum rainfall over a three hour duration. Three hours is approximately the time of concentration for most of the Kingston collection system. The ideal five-year period would have 5 one year events, 10 six month events, 20 three month events, and so forth. The annual average precipitation was compared to the running five year average. The typical five year period was selected based upon a qualitative evaluation of each of these criteria.

Figure 2-1 below is the annual rainfall totals at Albany Airport rain gauge. The average annual rainfall from 1948-2006 was 35.9 inches. Over the past sixty years, the annual rainfall reached a low of 21.6 inches in 1964 and a high of 47.18 inches in 1972. The typical five year period was selected from 1985-1989 because the trending in annual precipitation leveled off between 1980 and 2000. This period was also selected because it contained a distribution of storm sizes which aligned similarly to the long-term average (See Table 2-2).

Figure 2-1: Five Year Average Rainfall 1948-2006

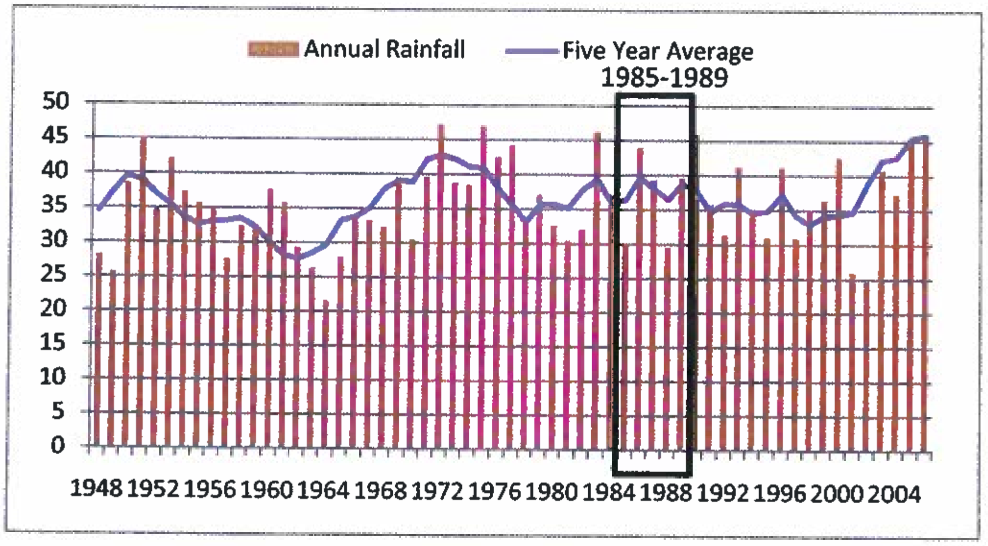


Table 2-1.
Five Year Typical Period Annual Rainfall

Year	Total Rainfall (in)
1985	29.95
1986	43.96
1987	39.34
1988	29.55
1989	39.67
5 Year Average	36.49
1948 - 2006 Average	35.89

1989 was selected as the typical year from the 1985-1989 five year typical period. Both 1987 and 1989 had annual total rainfall similar to the long-term average, but 1987 contained one of the top ten events of the hourly rainfall record. The storm events from 1948-2006 were ranked in order of total rainfall volume. The top ten events by volume, or 'extreme' events, are listed below in Table 2-3. The October 3, 1987 event was ranked number nine in volume. The five year average distribution of rainfall events by total depth aligns well with the long-term distribution. The five year annual average also is very close to the long-term annual average.

Table 2-2.
Annual Storm Events by Total Event Depth

	> 0.0 in	> 0.25 in	> 0.5 in	> 0.75 in	> 1.0 in	> 1.5 in	> 2.0 in
1985	81	13	8	6	4	2	0
1986	61	10	9	3	12	2	3
1987	54	16	6	8	7	0	4
1988	69	14	7	6	6	0	1
1989	67	18	8	7	5	6	1
Five Year Average (1985-1989)	66	14	8	6	7	2	2
Long term average	59	17	9	6	5	2	1

Table 2-3.
Largest Storm Events by Rainfall Volume (1948 - 2006)

Rank	Depth (in)	Date	Duration (hrs)	Max Hourly Depth (in)
1	6.13	9/16/1999 1:00	31	0.7
2	5.8	12/29/1948 11:00	79	0.32
3	4.96	8/31/1950 1:00	37	0.75
4	4.92	9/11/1960 8:00	36	0.41
5	4.84	8/27/1971 4:00	39	0.92
6	4.83	6/28/1973 18:00	37	1.1
7	4.2	10/17/1975 19:00	61	0.34
8	4.17	5/28/1984 7:00	73	0.3
9	3.63	10/3/1987 3:00	35	0.37
10	3.63	10/14/1955 15:00	62	0.37

1652

City of Kingston
420 Broadway • Kingston, NY 12401

APPENDIX

H

Nine Minimum Controls CSO BMP Report

MALCOLM
PIRNIE

CITY OF KINGSTON
ANNUAL REPORT OF CSO BMPs
SPDES NUMBER NY002 9351

I. Introduction

The City of Kingston has a residential population of approximately 23,456 (2000 Census), and is comprised of approximately 7.4 square miles of land area and 3 miles of Rondout Creek Waterfront. Although there are several industries remaining in the City, the City consists largely of commercial and residential development.

II. Baseline Information

A. General System Description

The City of Kingston is served by a WWTF with a permitted flow of 6.8 MGD on a 12-month rolling average with minimum peak design hydraulic loading rates of 10.5 MGD through the plant head-works, primary treatment-works and disinfection-works, and 10.2 MGD through the secondary treatment works during wet weather. Actual sanitary flows range from a low of approximately 3.6 MGD during dry weather, to as much as 13.6 MGD during periods of wet weather. In addition to serving the City of Kingston, the Kingston WWTF also accepts sanitary sewerage from both the Town of Ulster and Town of Esopus. Sanitary flow from the Town of Ulster is regulated via an inter-municipal agreement, and further limited to a small number of individual residences, offered on a case-by-case basis. Sanitary flow from the Town of Esopus is regulated via an inter-municipal agreement, which limits flow to 0.646 MGD with certain stipulations governing overages; however, flow has exceeded 1.8 MGD during a period of extended wet weather conditions in March, 2008.

The sanitary sewerage collection system consisting of approximately 75 miles of collection piping, comprised of clay tile, concrete, cast iron, steel and PVC. As a result of previous efforts to further separate the sanitary sewerage system, the City installed, and continues to operate and maintain 17 pump stations:

Nearly 40% of the City is served by a combined sewerage collection system that includes four (4) Combined Sewer Overflows (CSOs); Old Hasbrouck Avenue, Broadway, Hunter Street, and Wilbur Avenue. As a consequence of the large proportion of combined sewers within the City, and the age of the collection system, wet weather flows through the CSOs are of constant concern. Overflow weirs within each of the CSOs are set such that the WWTF will not be hydraulically overloaded and result in a "washout' of the plant, see **Attachment 'H'** entitled **Kingston CSO's – Balancing of Diversion Chambers**:

Old Hasbrouck Avenue	1.4 MGD (on March 18, 2009 outlet orifice increased from 4.25" to 5.5")
Broadway	0.5 MGD
Hunter Street	0.5 MGD (on April 8, 2010 a new concrete weir was constructed that provides a higher elevation crest and greater weir height adjustment flexibility)
Wilbur Avenue	6.5 MGD

III. Goals of the Annual Report of CSO BMPs

Our goal is to capture and direct the maximum volume of wastewater to the treatment plant through the maximum use of the collection system. There is a continuous effort to reduce the stormwater contributions of inflow and infiltration during periods of wet weather, for instance, the Kingston Building Department is currently conducting targeted block-by-block inspections that will identify illegal stormwater connections such as sump pumps and downspouts; in addition, the Department of Public Works is continually watchful for cross connections, and leaking pipes and manholes during their daily maintenance activities for separation and sealing or replacement.

IV. Development Team

The Annual CSO BMP Plan has been developed by City Forces in conjunction with a contracted WWTF Operations Management Team that includes:

Ralph Swenson, PE	City Engineer
Alan Adin	Engineering Technician
Ed Boyle	Assistant Superintendent of Public Works
Allen Winchell	Senior Plant Operator
Ed Herwig	Senior Plant Operator
George Cacchio	Manager, CAMO Pollution Control
Jim Podeszedik	Plant Operator, CAMO Pollution Control

V. "Maximization of Flow to the POTW for Treatment"

A. Capacity Determination

Maximize Use of the Collection System

The City of Kingston has maximized, to the extent possible, the storage of combined sewer flows within its collection system. The methods employed by the City are as follows:

1. Major Interceptors

Due to the topography of the City, many of the sewers are steeply sloped and therefore provide limited opportunity to store excess capacity. Within each of the four existing CSO's in Kingston, flow is controlled through the adjustment of regulators and weirs; in-line storage is severely restricted, as stated previously; although, during Long-Term Control Plan development, the 60" diameter RCP trunk sewer influent to the Hasbrouck Avenue CSO has been identified as a possible location of future in-line storage opportunity. Maintenance of maximum available storage capacity is maintained through the regular cleaning and inspection of the system by City sewer crews. **Attachment 'A'** entitled **Combined Sewer Overflow Specifications** describes CSO locations, flow directed to the WWTF prior to overflow conditions, and the receiving surface waterbody.

2. Pump Stations

The City of Kingston maintains seventeen (17) pump stations, only five (5) include wet wells of any significance, and that, severely limited. The spreadsheet, **Attachment 'B'** entitled **Pump Station Specifications** describes location, available wet well volume, and pump performance. Pump stations have negligible storage capacity to affect wet weather flows to the WWTF.

VI. Critical Components and Their Operating Guidelines

A. Critical Components

1. Collection System:
    a. Catch Basins (2,000)
    b. Pump Stations (17)
    c. Combined Sewer Overflows (4)
        Hasbrouck CSO - Outfall # 005
        Broadway CSO - Outfall # 006
        Hunter St. CSO - Outfall #007
        Wilber Ave. CSO - Outfall # 011

B. Operating Guidelines

1. **Collection System**:
Approximately 2,000 catch basins related to the CSO'S
Four above ground pump stations

a. Catch basins: Catch basins collect and pretreat surface stormwater, allowing heavy solids to fall out of suspension prior to entering the collection system.

Before Wet Weather Event
Perform routine cleaning as stated in MS4 report (copy attached)
Remove sediment from sump on a rotating annual schedule
Perform any needed repairs

During Wet Weather Event
Keep catch basin grates clear of debris

After Wet Weather Event
Clean any clogged catch basins with Vac-truck

Why do we do this? *To ensure that the maximum amount of street surface stormwater is collected and treated nearest it's source, removing sediment and other heavy debris, keeping such materials from entering our surface waters*
What triggers the change? *Anticipation of wet weather events and "first flush"*
What can go wrong? *The catch basin grates could be "blinded", precluding stormwater from entering the structure, resulting in street flooding, or the sump may be full, precluding primary treatment of surface waters*

Inspection and Maintenance of pump stations is performed as follows:

1. Above Ground Pump Stations

   Inspection: Pump station inspections are performed daily.

   Maintenance: Pump station bar racks are cleaned on a daily basis. Wet wells are degreased on a weekly schedule. Pump equipment is maintained in accordance with the manufacturer's recommendations and intervals. Preventive maintenance is performed semi-annually on emergency generators. Generators are exercised regularly to keep them in good running condition.

2. Below Ground Pump Stations

   Inspection: Pump station inspections are performed daily.

   Maintenance: Wet wells are degreased on a weekly schedule. Pump equipment is maintained in accordance with the manufacturer's recommendations and intervals. Preventive maintenance is performed regularly on portable emergency generators. Generators are exercised regularly to keep them in good running condition.

Hour meters have been installed at all pump stations as a preventative maintenance measure. Hour meters allow maintenance personnel to track pump station operations and identify operational problems before they impact system performance.

Per the SPDES requirements, each of the CSO structures are visually inspected and reported in the monthly DMR's submitted to the NYS DEC.

Emergency Procedures: Emergency procedures are as follows:

a. Emergency call out list is kept by the City dispatcher for the Department of Public Works. If an emergency exists, the DPW is notified and the necessary personnel called to the site of the emergency.
b. Spares of critical mechanical equipment are kept in inventory by the DPW in case an emergency replacement is required.
c. The DPW is equipped to handle routine and out of the ordinary emergencies.

O&M Staff Training:

- The City of Kingston Safety Officer is in charge of training staff for confined space entry and other OSHA requirements.
- There is no formal written training program for O&M tasks. The O&M staff is trained on the job to perform all necessary and emergency tasks as needed.

BMP #2 Maximum Use of Collection System for Storage

The City of Kingston has maximized, to the extent possible, the storage of combined sewer flows within its collection system. The methods employed by the City are as follows:

a. Use of pump station wet wells;
b. Storage of sewage within the sanitary sewerage collection system;
c. Adjustment of regulators and weirs;
d. Collection system inspection and cleaning.

Due to the topography of the City, many of the sewers are very steeply sloped and therefore provide limited storage capacity. Of the four existing CSO's in Kingston, the recently installed Pretreatment Pump Station at Wilbur Avenue, upstream of the Wilbur Avenue CSO, utilizes wet wells for storage of sanitary flows. The wet wells have a combined storage volume of approximately 161,500 gallons and provide a limited level of attenuation; the removal and disposal of nearly 120 tons of accumulated sediment was completed in May, 2010; more regular cleanings will be scheduled in the future to minimize accumulations of sediment and maximize available storage volume.

The City sewer crew performs regular cleaning and inspection of the collection system, removing flow restricting sediment and debris, which helps to identify deficiencies within the system. In addition, crews also monitor regulators and weirs regularly so as to maximize system storage, and also as an indicator of system conditions; it is at this point that the decision to raise a weir is made, balancing hydraulic loads to the WWTF against flows in the collection system that can reasonably be accommodated.

Sewer projects in the City of Kingston recently completed are as follows:

a. Sanitary Manhole sealing at Twin ponds Homeowner's Association

The project consisted of sealing two (2) manholes, each leaking through their wall and at pipe penetrations; leakage estimated at 45,000 GPD, see **Attachment 'M'.**

b. Linderman Avenue Sanitary Sewer Replacement from Tannery Brook Interceptor to Becket Street.

The project consisted of 1,050 LF of 12" Dia. and 2,164 LF of 10" Dia. sanitary sewer replacement including 19 associated manholes and approximately 50 lateral connection replacements. This project lies within mini System 3A with an estimated groundwater infiltration rate of 12,105 GPDIM; see **Attachment 'F'** entitled **Infiltration Rate Summary.**

[(1,050 LF x 12") + (2,164 LF x 10")] / 43,560 LF per Mile x 12,105 GPDIM
= 9,516 GPD

c. Delta Place Sanitary Sewer Replacement from Linderman Avenue to Hewitt Place.

The City of Kingston developed a Sewage Spill Protocol in 2001 specifically to address CSO dry weather overflows. Elements of this protocol follow the requirements as stated in the current SPDES Permit and 6NYCRR Part 750-2.7.

Dry weather overflows have been minimized by following the provisions of the plans listed under items BMP #1, BMP #2, BMP #4 and BMP #5 herein. Currently, the City's collection system does not have any records of normally occurring DWOs with visual verification; however, during routine maintenance signs of a DWO may include outfall deposits or stains, benthic growth on pipe surfaces, and quality of pooling water in the outfall. Any DWOs would be reported in accordance with the protocol listed. Potential DWOs are remediated by normal maintenance procedures such as sediment and debris removal which may accumulate at or near regulator inlets or the repair of weirs damaged during a storm event.

As mentioned under BMP #1 - , the responsible Department and staff which maintain the CSO Facilities in the City of Kingston are now the Wastewater Treatment Plant Facility personnel who are better equipped to deal with the associated regulatory requirements and priorities; a greater emphasis is being placed upon preventive maintenance.

BMP #7 Control of Floatable and Settleable Solids

Three of four existing CSO's at Hasbrouck Street (#005), Broadway (#006), and Wilbur Avenue (#011) have automatic bar screens (trash racks) for removal of floatables and solids. Trash racks have screen spacing of ½", therefore, only small particles pass through during an overflow event. While the Hunter Street CSO (#007) is not equipped with a bar screen, the City is planning to eliminate this CSO in the future; a major portion of this sewer-shed has now been separated and redirected to the 20" OD steel siphon as a result of, and subsequent to, the completion of the Montrepose Sewer Replacement under BMP #2.

Each of the CSO structures are also visually inspected and reported on in the monthly DMR's submitted to the NYS DEC.

The City of Kingston has anti-litter laws in place, and also maintains a Street Sweeping Program which runs annually from April thru October. Streets are swept 3 times per year; only under special circumstances are specific streets swept more often than the normal schedule allows.

BMP #8 Combined Sewer System Replacements

It is the policy of the City of Kingston NOT to replace combined sewers, but to fully separate the sanitary component from the stormwater component when encountered as soon as is practical.

BMP #9 Combined Sewer/Extension

It is the policy of the City of Kingston NOT to extend combined sewers, but to fully separate the sanitary component from the stormwater component when encountered and extend only separated sewers to the point of use as soon as is practical.

There is only one large new development (Hudson Landing) within the City having recently received authorization to proceed to site development, it will discharge to North Street Sewer, and from there be pumped directly to the headworks; it is not tributary to any of the existing CSOs. All other new development under construction or contemplated is either "in fill" or single family residential where the impacts of additional sanitary sewerage loading is negligible.

As a result of the Sanitary Sewer Replacement, Montrepose Avenue and Abeel Street, Contract CK-085, Montrepose Avenue sewers have been further separated; all flows enter the Ravine Street Sewer, which lead to the Block Park Pump Station. In order to relieve pressure on the Block Park Pump Station, the Hunter Street CSO discharge line connected to the existing 20" diameter steel siphon line was "tapped" to receive the Ravine Street Sewer, and in so doing, produced the positive unintended consequence of, we believe, elimination of a partial air lock that may have been contributing to wet weather overflows. Construction of a new concrete weir was also completed at the same time; the new weirs has a crest height approximately equal to the pre-existing weir, but with the added capacity to accept additional weir plates for increased crest heights if deemed necessary in the future.

BMP #10 Connection Prohibitions

On occasion, sanitary sewers backup into residential basements for a variety of reasons; such as residential lateral failures, temporary main-line blockages, hydraulic overloads during extreme wet weather conditions, and during construction operations due to by-pass pump malfunction. Such backups are temporary in nature as corrective action is undertaken immediately.

BMP #11 Septage and Hauled Waste

The City of Kingston does not routinely accept septage, we have, however, been recently contacted by Country Village Apartments / Condominiums representatives requesting that we accept septage from a pump station wet well on an emergency basis only, a final decision has not been made.

BMP #12 Control of Run-off

The City of Kingston is in compliance with all MS4 requirements, being audited last in 2008.

BMP #13 Public Notification

Signs exist at all City of Kingston outfall locations as per requirements of the SPDES permit.

The City of Kingston is required by the SPDES permit modification (EDPM of 9/1/2005) to develop and implement a Public Notification Program to inform the citizens of location and occurrence of CSO events. A draft copy of the required Public Notification Program is attached here for your review; it will be revisited during the further development of our Long Term Control Plan.

BMP #14 Characterization and Monitoring

A Combined sewer System Characterization, Monitoring and Modeling Plan was developed for the City of Kingston by Malcolm Pirnie, dated July 2007. The Plan was submitted to NYSDEC for review and approval; and will be referenced during the development of our LTCP.

BMP #15 Annual Report

SPDES Permit NY0029351 Schedule of Compliance requires that flow monitoring devices be installed at all combined sewer system overflows by July 15, 2009. An Engineering Services Agreement was executed between the City of Kingston and Malcolm Pirnie, Inc. on July 23, 2009 for:

- Flow Monitoring and Rain Gauge Program,
- Collection System Base Mapping, and
- Hydraulic Model Development, Calibration and Validation.

The hydraulic model has been developed, calibrated and validated. SPDES Permit NY0029351 Schedule of Compliance also requires that an approvable Long-Term Control Plan be developed in full compliance with EPA Guidance by November 1, 2010.

Average daily flows at the WWTF have been compared with historic weather data and potable water delivery for the period 2002 through the present. Water supply data indicates a stable water use while WWTF rolling average flows are trending positive, see **Attachment 'K'**. The graph of WWTF rolling averages illustrates the impact of weather and water use, and suggests that sewerage "capture" is increasing, which supports the Draft CSO Long-Term Control Planning Progress Report Dated May 14, 2010.

'A'

Combined Sewer Overflow Specifications

Outfall No.	Description	Location	Address	Latitude/Longitude	Phone No.	CSO Discharge Piping	Flow Prior to Overflow (Assigned)	Receiving Surface Water	Receing Water Classification	Treatment
005	Old Hasbrouck Avenue CSO	Hudson Valley Landing	29-31R H.V.L.	41 ,54',35"/73 ,58',57"	331-2490	16"	1.4 MGD	Rondout Creek	C	Screening
006	Broadway CSO	Broadway	39 Broadway	41 ,54',34"/73 ,58',59"	331-2490	12"	0.5 MGD	Rondout Creek	C	Screening
007	Hunter Street CSO	Hunter Street	131 Hunter Street	41 ,54',25"/73 ,59',22"	331-2490	12"	0.5 MGD	Rondout Creek	C	None
011	Wilbur Avenue CSO	Wilbur Avenue	141 Wilbur	41 ,54',06"/74 ,00',08"	331-2490	2 - 16" Dia.	6.5 MGD	Rondout Creek	C	Screening

Assigned Flows are for planning purposes only, actual flows may differ; see Attachment 'H'.

'B'

Pump Station Specifications

No.	Location	Address	SBL	Phone No.	Wet Well Volume	Pump Capacity	Pump Suction	Pump Discharge	Pump Description	Pump Motor Hp	Pump Motor Power Requirements	On-Site Generators
1	Valley Street	17 Valley Street	56.25-5-20	338-4806	-	0.05 MGD @ 24' TDH	4"	4"	Submersible	2	240V / 3 P	No
2	Harding Avenue	58 Harding Avenue	48.270-3-40	338-5990	5000 Gal.	0.50 MGD @ 33' TDH	6"	4"	Sewage	7.5	230V / 3P	Yes
3	Lincoln Street	94 Lincoln Street	48.82-8-11	338-8466	5000 Gal.	0.50 MGD @ 33' TDH	6"	4"	Sewage	7.5	230V / 3P	Yes
4	North Street	128 North Street	56.28-2-15	338-6810	5000 Gal.	0.50 MGD @ 33' TDH	4"	4"	Sewage	7.5	230V / 3P	Yes
5	Frog Alley	27 Frog Alley	48.314-1-3	338-8492	5000 Gal.	0.60 MGD @ 33' TDH	4"	4"	Sewage	7.5	230V / 3P	Yes
6	Hurley Avenue	305 Hurley Avenue	48.70-1-3.1	338-3699	-		-	4"	Submersible	2	230V / 3P	No
7	Tammany Street	82 Tammany Street	48.75-2-24.2	-	-	0.05 MGD @ 25' TDH	-	-	Grinder	2	230V / 1P	No
8	E. Chester Street	370 E. Chester Street	48.75-7-15	-	-	0.09 MGD @ 28' TDH	-	-	Grinder	2	230V / 3P	No
9	Kingston street	52 Kingston Street	48.75-4-5.1	-	-	0.07 MGD @ 20' TDH	-	-	Grinder	2	230V / 1P	No
10	Fourth Avenue	301 Fourth Avenue	48.75-4-17	-	-	0.05 MGD @ 25' TDH	-	-	Grinder	2	230V / 1P	No
11	North Street	8 North Street	56.36-1-23	-	-	0.05 MGD @ 15' TDH	-	-	Grinder	2	230V / 1P	No
12	Broadway	3 Broadway (East Strand)	56.43-5-40	-	-		-	4"	Submersible	2	230V / 1P	No
13	Abeel Street	304 Abeel Street (Block Park)	56.50-6-12	-	950 Gal.	0.32 MGD @ 80' TDH	-	4"	Submersible	10.5	230V / 3P	No
14	Abeel Street	385 Abeel Street (Hudson Street)	56.50-2-21.11	-	750 Gal.	0.22 GPM @ 90' TDH	-	4"	Submersible	7.5	230V / 3P	No
15	Abeel Street	480 Abeel Street (Davis Street)	56.57-3-11.2	-	670 Gal.	0.22 MGD @ 90' TDH	-	4"	Submersible	10.5	230V / 3P	No
16	Abeel Street	598 Abeel Street (Dunn Street)	56.57-3-10	-	750 Gal.	0.24 MGD @ 10' TDH	-	4"	Submersible	2	230V / 3P	No
17	City of Kingston WWTF	91-129 East strand	56.43-6-8	331-2490	5000 Gal.	#1 Pump @0.35 MGD #2 Pump @ 0.63 MGD	6"	6"	Sewage	15	230V / 3P	Yes
18	Wilbur Avenue Pretreatment Pump Station	141 Wilbur Avenu8e	56.49-1-14.1	-	161,500 Gal.	#1 Pump @ 3.95 MGD #2 Pump @ 3.95 MGD	12"	12"	Sewage	40	460V / 3P	Yes

Pump Stations 2 thru 5 and 17 (shaded) service combined sewer service areas

2 - 16 KW, 1P/3P, Trailer-mounted generators are available for use at all pump station locations as the need arises
  - 1P, 120/240 V, 138 A; 3P, 120/208 V, 115 A
  - 1P, 120/240 V, 146 A; 3P, 120/240 V, 111 A

C

CAUTION: This electro mechanical screen has many moving components. Before performing any maintenance or making any adjustments **LOCKOUT POWER** to the machine.

This manual contains complete instructions for the installation, operation and service of a **FMC Cog Rake Bar Screen**. The life and economical operation of the machine is dependent, to a great extent, on the care taken during installation and subsequent maintenance given to the unit.

Upon receipt of the **Cog Rake Bar Screen** carefully check to determine that all the of the equipment has been received and no parts are damaged. Immediately report any damage or shortages to the transportation company handling the shipment noting the extent of the damage or shortage on the bill and bill of lading.

These instructions have been prepared to be used with the contract drawings furnished by FMC Corporation. The contracts will subsequently be referred to as "the drawings".

INTRODUCTION

The **Cog Rake Bar Screen** will be installed at an incline as shown on the drawings. The drawings and service instructions should be thoroughly reviewed prior to beginning the installation for familiarity with the component assemblies. **Do Not place any grout until a FMC service engineer has inspected and approved the screen installation.**

RECEIVING, HANDLING, STORAGE

Immediately upon delivery, inspect the shipment to assure:

1. Product complies with requirements of the contract documents and reviewed submittals.
2. Quantities are correct.
3. Packages are intact and properly labeled.
4. Products are properly protected and undamaged. Should there be any damage to the unit, immediately notify the engineer, FMC, and the transportation company.

Handling the unit:

1. Provide protection during handling as necessary to prevent damaging the unit or surrounding surfaces.
2. Handle products by methods to prevent bending or over stressing.
3. Lift the unit only at the lifting lugs.
4. Do not drop, roll or skid unit off of the delivery vehicle. Use suitable handling equipment.

Store material to permit access for inspection and identification.

Keep all materials off of the ground, using pallets or platforms, sloped to provide drainage, and covered to prevent condensation, corrosion and deterioration.

LONG TERM STORAGE

If the drive unit is not installed immediately, store in a dry, protected area. Add a rust preventive such as Mobil Oil Vaprotec 60032. After removal from storage, the drive unit should be drained and refilled with a lubricating oil as indicated on the lubrication schedule. Drives which are used for standby service should also have Vaprotec 60032 added to the lubricating oil and should be non vented. Check oil levels after long term storage before start up.

Store all miscellaneous loose hardware with the unit.

INSTALLATION

DO NOT PLACE ANY GROUT UNTIL A FMC SERVICE ENGINEER HAS INSPECTED AND APPROVED THE SCREEN INSTALLATION.

Prior to installation of equipment, all concrete preparation shall be completed and the work area shall be maintained in a broom clean condition during the equipment installation.

An anchor bolt drawing layout is supplied with the contract; check the drawing for bolt size, quantity and location.

Install the **bar rack** into the channel. **Bar rack** will be adjusted later.

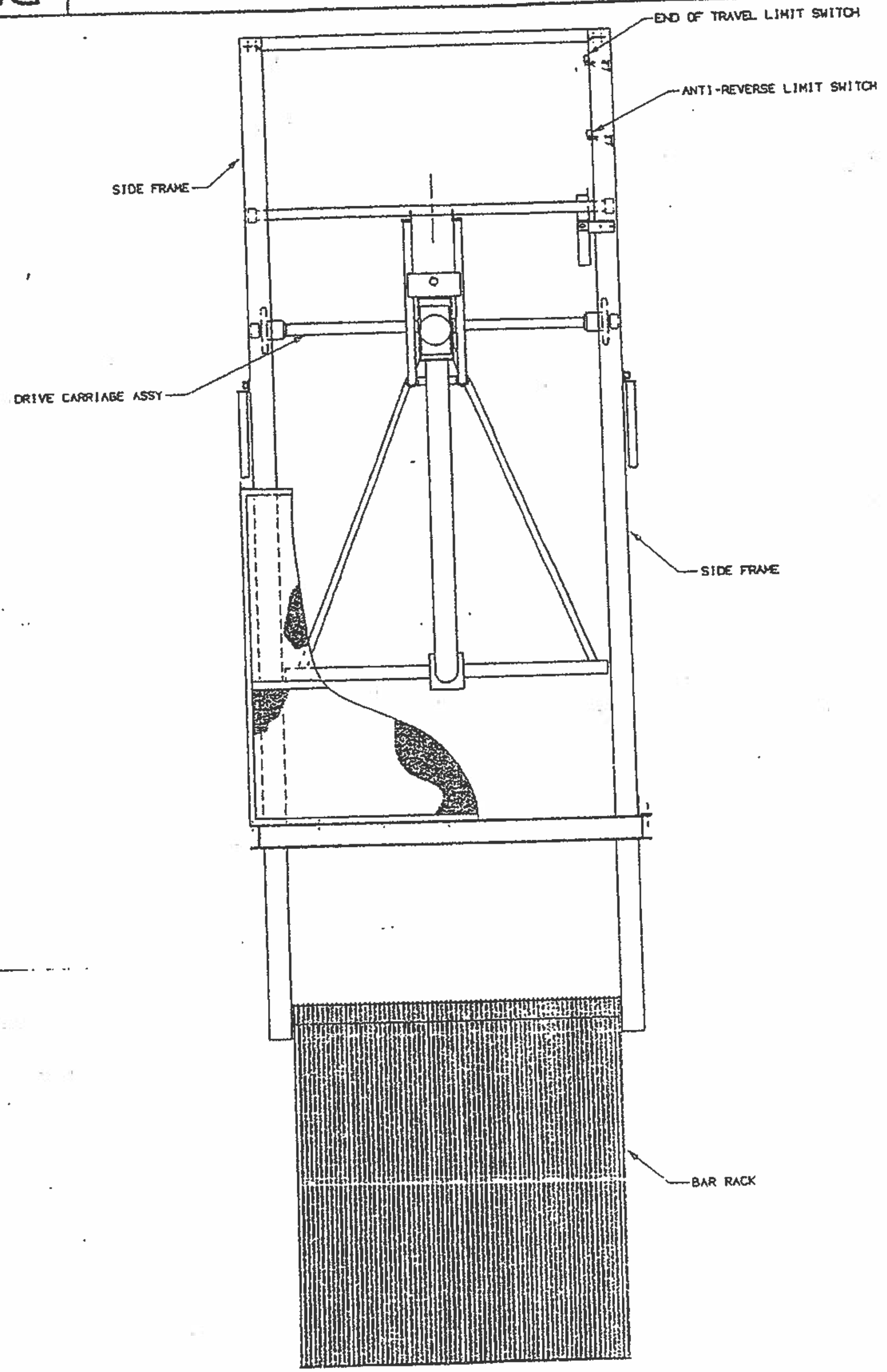
Position the **base frame** and **side frames** over the anchor bolts. Adjust the **side frames** to be plumb and at the incline as shown on the drawings. Tighten anchor bolts allowing about 1 1/2" for grout under the **base frame.**

Position the bar rack over the anchor bolts in bottom of the channel and fasten it at the top to the bottom of the dead plate.

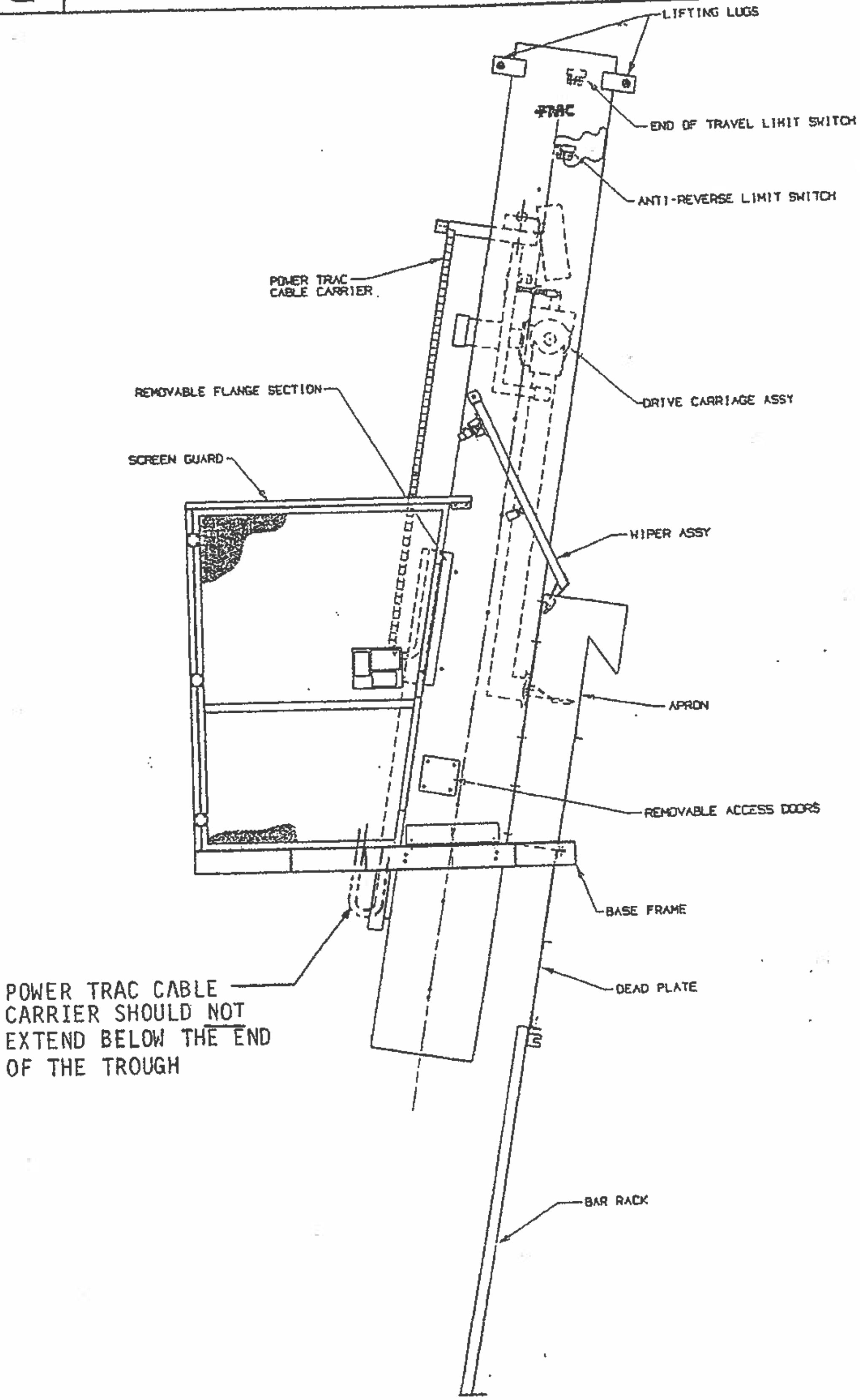
Adjust the **rake teeth** to the **apron** as follows:

1. Turn the **spring assembly** adjusting nut and locking nut to relieve the compression on the spring.
2. Turn the stop nuts at the inside of the **guide shaft support** until the **rake teeth** are 1/4" away from the **apron.**
3. Lock the stop nuts in position using the locking nuts.
4. Reset the spring tension to the dimension shown on the drawings.

Move the **rake assembly** to the bottom of its travel. Adjust the **bar rack** and **rake blade** so that the **rake teeth** engage the **bar rack** with clearance on both sides and penetration to allow 1/4" of clearance between the face of the bars and the pocket of the tooth. Move the rake assembly up the **bar rack** adjusting the bars to provide clearance for the full travel of the rake. Secure the bolts between the **bar rack** and the **dead plate** or **apron** to maintain these adjustments.

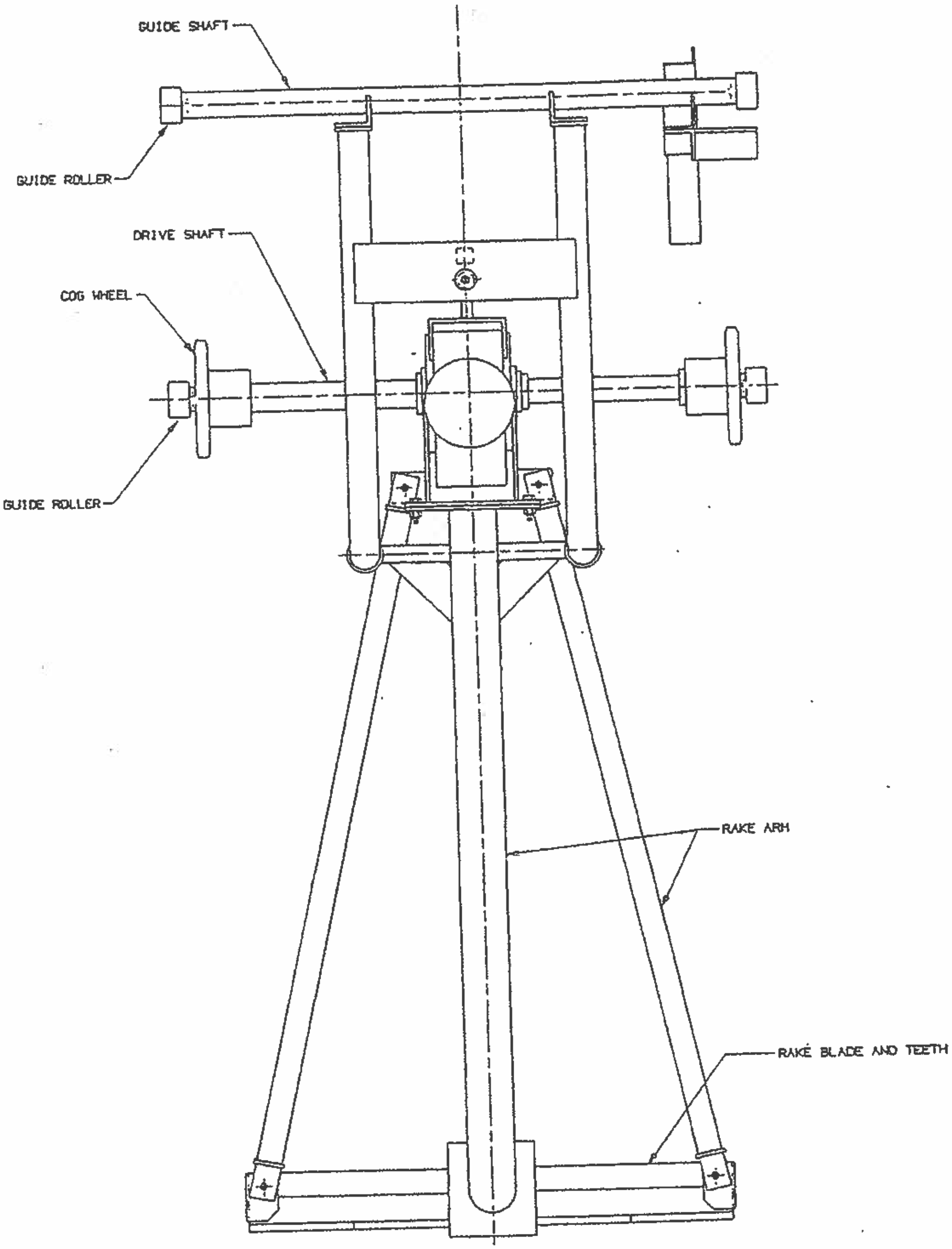


COG RAKE BAR SCREEN ASSEMBLY

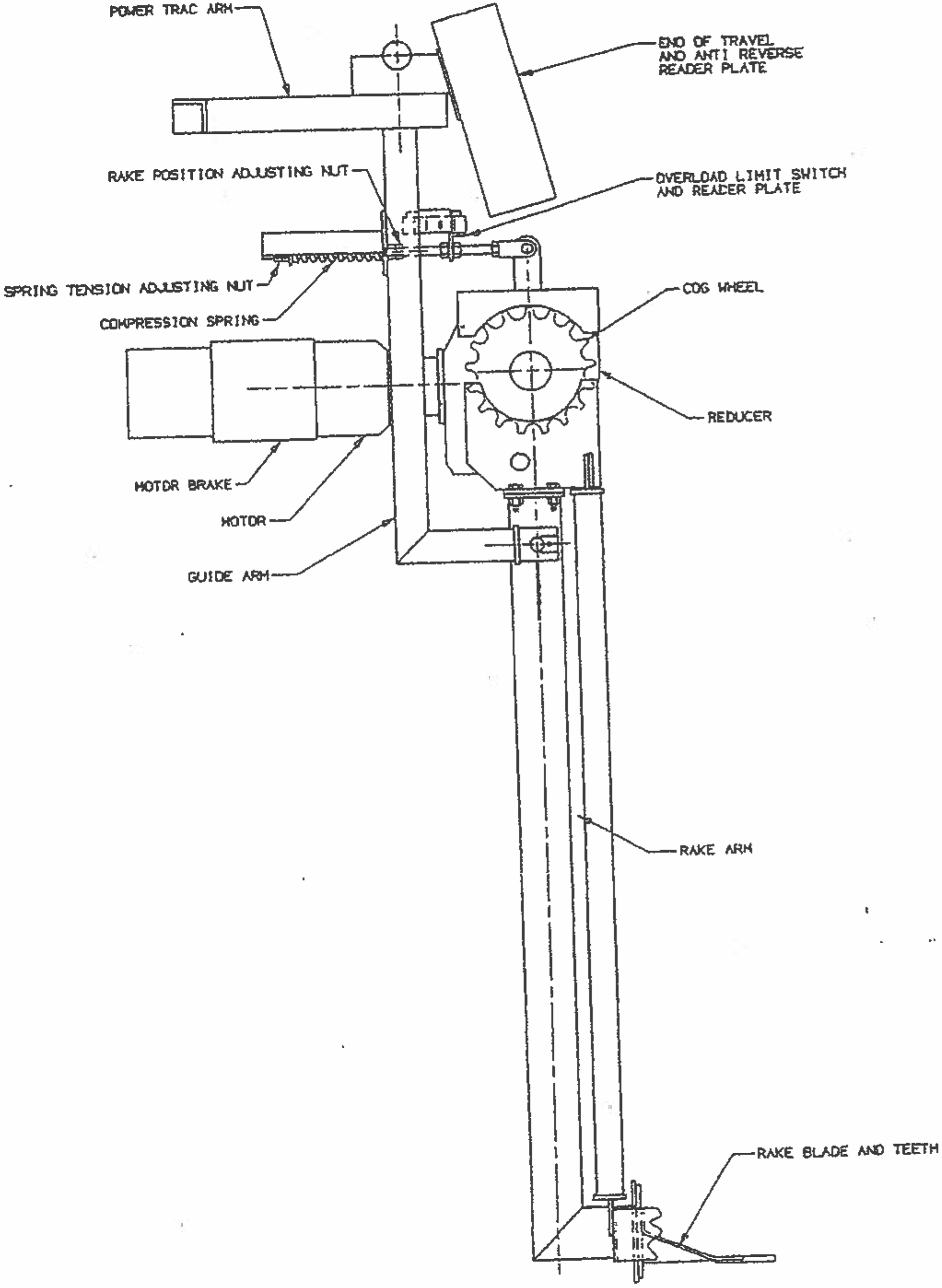


POWER TRAC CABLE CARRIER SHOULD NOT EXTEND BELOW THE END OF THE TROUGH

COG RAKE BAR SCREEN ASSEMBLY



RAKE CARRIAGE ASSEMBLY



RAKE CARRIAGE ASSEMBLY

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START UP

Before starting the unit run through the following check list:

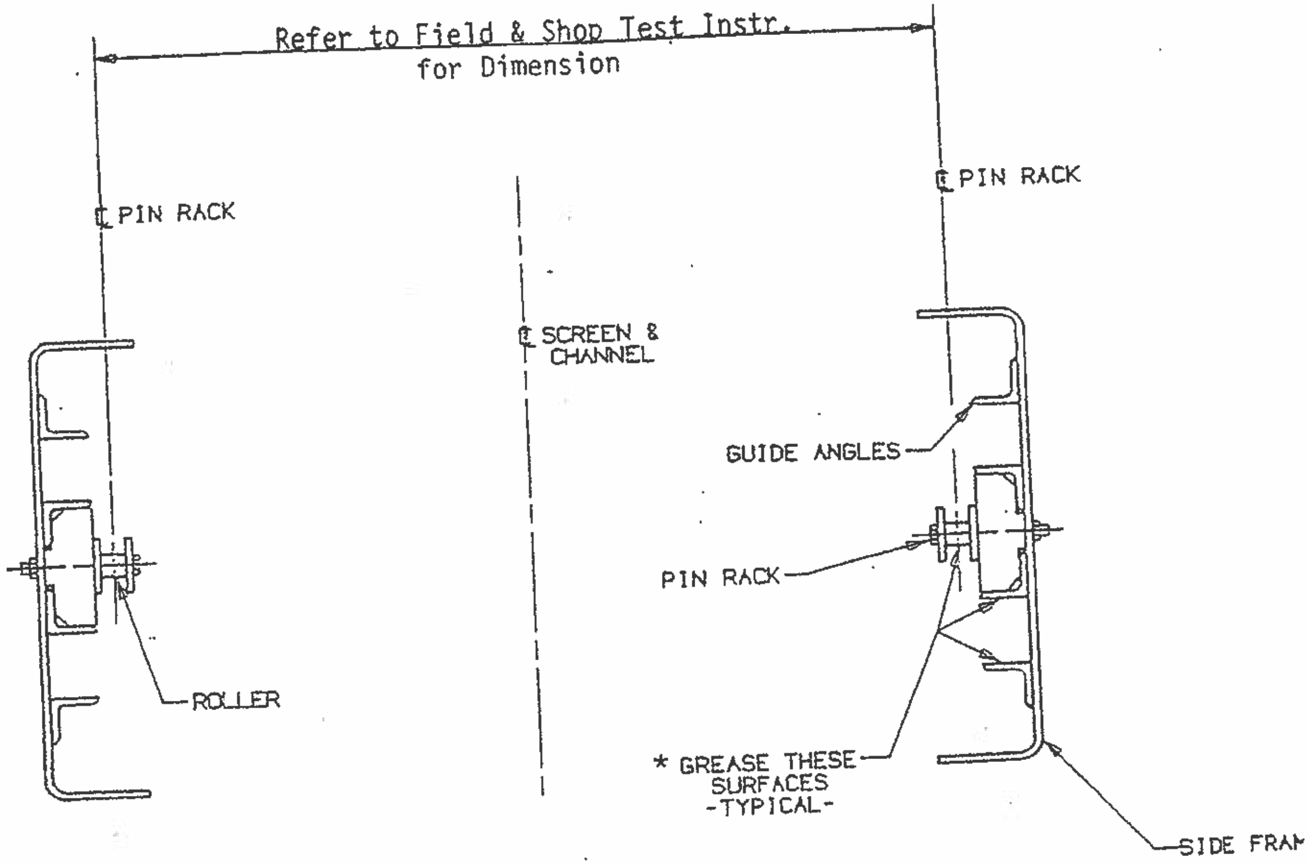
1. Remove all temporary protective coatings and fixtures (shipping angles, ties, etc.).
2. Inspect all bearings, shafting and rollers. Clean and remove all grease, dirt, etc..
3. Check oil levels of the reducers (note: the reducer oil level should be checked with the drive carriage in the ascending position). Always be sure that the reducers are filled with the correct oil to the proper level before operating.
4. Lubricate the pin rack. (nonmetallic systems do not require lubrication)
5. Locate the proximity switches.
6. Check all wiring connections.
7. Check each electrical control circuit to assure that operation complies with specifications and performance requirements.
8. Check motor amperage for comparison to nameplate value. Check the nameplate for correct speed, horsepower, voltage, hertz and phase for conformance with power supply and equipment. (Note: the coil on the motor with brake may be dual voltage. Be certain it is wired for the proper voltage.)
9. Test controls in the automatic mode.
10. Manually lower carriage to the lowest position and engage teeth in bar rack. Check tooth clearance with bar rack. Teeth should travel the full length of the bar rack with out touching the bars. Make adjustments as required.

LUBRICATION

Reducers are filled with oil to the proper levels when they are shipped to the construction site. Check the oil in the reducers referring to the reducer manual sheets for the proper level. The reducer is furnished with a synthetic oil and should be replaced with synthetic oil when changed.

Liberally apply "Bison Open Gear Guard" grease to the rollers in the pin racks (nonmetallic drive systems do not require lubrication on the pin rack). Apply a light coat of grease to the contact surfaces of the guide angles in the side frames.

Refer to the LUBRICATION SCHEDULE for frequency of lubrication.



SIDE FRAME SECTION

*Non-metallic Pin Rack systems do <u>not</u> require lubrication

RAKE ARM AND RAKE TEETH ADJUSTMENT

Move the rake carriage to a position where the rake teeth are in the area of the apron.

Adjust the **rake teeth** to the **apron** as follows:

1. Turn the **spring assembly** adjusting nut and locking nut to relieve the compression on the spring.
2. Turn the stop nuts at the inside of the **guide shaft support** until the **rake teeth** are 1/4" away from the **apron**.
3. Lock the stop nuts in position using the locking nuts.
4. Reset the spring tension to the dimension shown on the drawings.

ADJUSTMENT OF PROXIMITY LIMIT SWITCHES

End of Travel and Anti-Reverse

Run the rake carriage to its parked position above the top pin.

Adjust the limit switch reader plate so that the end of travel limit switch is tripped in this position.

Check to see that the anti-reverse limit switch is tripped while the rake blade is in the area of the wiper blade.

Clearance between the limit switch sensing area and the reader plate should not exceed 1/2 inch.

Test run through cycles and adjust switches as required until proper stop is achieved.

Overload

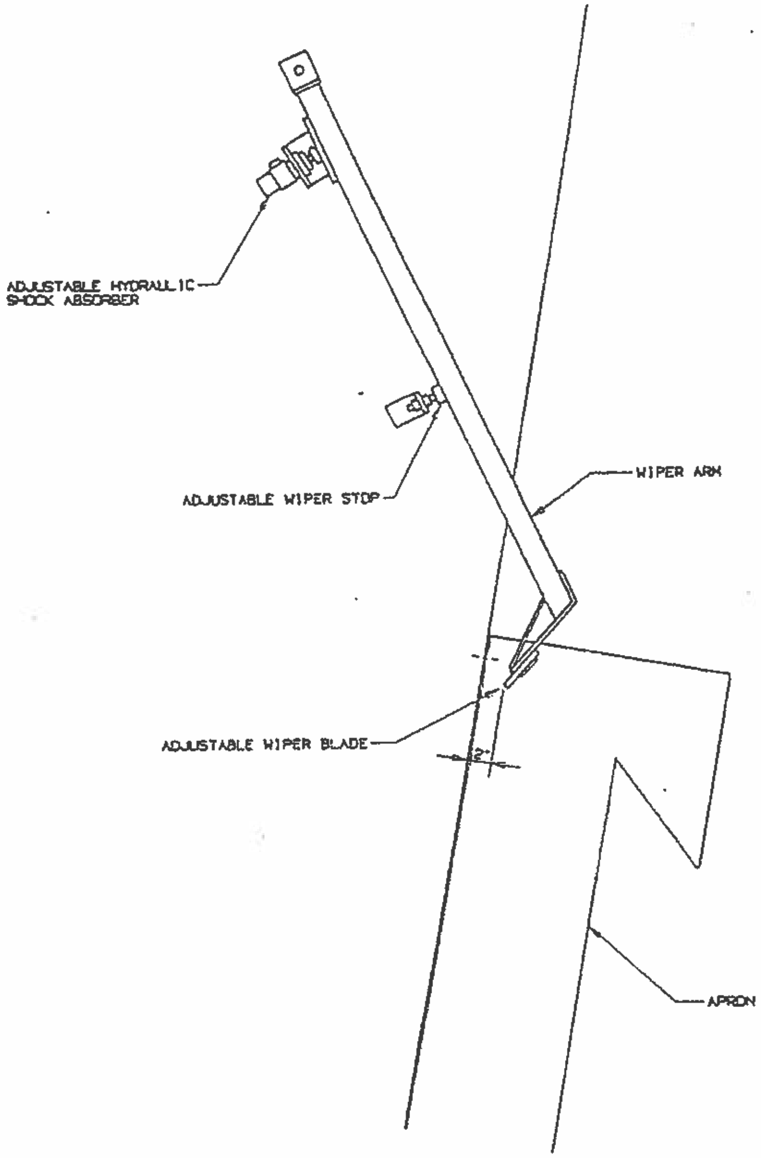
Place a 4" thick board across the bar rack in the area where the rake teeth initially engage the bar rack.

Manually lower the rake carriage so that the teeth contact the board. Stop the carriage when the drive shaft has rounded the bottom pin and is in its upward travel position.

With the teeth 4" away from the bar rack simulating an overload condition adjust the reader plate so that the switch will trip in this position.

RAKE WIPER SETTING

1. Adjust the wiper stop so that the wiper blade is 2" past the side frame with the wiper in its rest position.
2. Adjust the shock absorber so that the plunger is 1/8" from full compression.
3. Manually raise and release the wiper to check the shock absorber cushioning affect. Equalize the shock absorbers to provide a soft contact with the wiper stop.
4. Cycle the rake carriage through the wiper to check the wiping action with the rake. The wiper blade should have uniform contact with the rake surface and should not touch the rake side plates.



RAKE WIPER ASSEMBLY

MAINTENANCE

Disconnect and LOCKOUT all power sources before initiating any maintenance and repair.

The carriage assembly must be secured in position before any disassembly of the brake and or motor is attempted or before the manual brake release is operated.

Repairs of the motors for class I and II and gear reducers must be done by the manufacturers.

Refer to individual maintenance instructions for each of the components of the machine.

The following general maintenance should be carried out once a month, except as indicated, to maintain proper operation of the machine:

1. To ensure adequate cooling of the reducer and motor, deposits of dirt and dust on the surfaces of the units must be removed at frequent intervals.
2. Check the location of the limit switches so that they are located as originally set.
3. Grease the motor every 4 months.
4. Change the oil in the reducer after 20,000 operating hours.

Replacement of Guide Rollers

1. Stop the drive carriage with the guide roller positioned at the removable access doors in the side frame.
2. Disconnect and LOCKOUT all power sources before initiating any maintenance and repair.
3. Remove the access door.
4. With an allen wrench unscrew the guide roller.
5. Clean threads in the end of the shaft and apply "Loctite" general blue, to threads of new guide roller.
6. Replace new guide roller into end of shaft.
7. Tighten guide roller so that its shoulder is seated against the end of the shaft to a torque of 100 Ft. Lbs..
8. Replace access door.

Removal of Drive Carriage

1. Stop the drive carriage with the with the drive shaft positioned at the removable flange sections in the middle track section of the side frame.
2. Disconnect and LOCKOUT all power sources before initiating any maintenance and repair.
3. Disconnect the SO cables and power track from the drive carriage.
4. Remove the removable power track guards, flange plates and track angle section.
5. Move the carriage assembly out of the side frame through the flange openings allowing the guide shaft to roll in the guide track until it can pass through the flange opening.

Reassembly of the Drive Carriage

1. Move the guide shaft through the access opening into the guide track in the side frames. Move the guide shaft up until the drive shaft assembly passes through the access opening and engages the cog wheels into the pin rack. Make certain that the cog wheels are engaged at the same pin in both side frames.
2. Secure the drive shaft assembly in position to prevent it from descending the pin rack during assembly.
3. Replace the flange plates, removable track angle section and power track guard.
4. Make certain the guide shaft is centered between the side frames and is parallel to the drive shaft.
5. Adjust rake blade to provide clearance between the rake teeth and the bar rack.
6. Mount the power track with the SO cable and make all electrical connections.

SHUTDOWN PROCEDURES

SHUTDOWN FOR MAINTENANCE

1. Position the carriage so that it is accessible from the operating floor level.
2. Disconnect and **LOCKOUT** all power sources before initiating any maintenance and repair.
3. If disassembly of the brake and/or motor is required or the manual brake release is operated, then before doing so the carriage assembly must be secured in position.
4. If a temporary access platform is needed, FMC requires that all OSHA standards be followed.

LONG TERM SHUTDOWN

1. Position the carriage so that it is accessible from the operating floor level.
2. Disconnect and **LOCKOUT** all power sources.
3. Grease the pin rack and tracking.
   (Grease on the pin rack is not required on non-metallic drive systems.)
4. Cover the reducer and motor.
5. Cover the limit switches and junction boxes.

TROUBLE SHOOTING

Problem	Possible Solution
Rake moves in opposite direction as indicated on the control panel.	Reverse leads on motor.
Motor brake does not hold or is overheating.	Refer to "Troubleshooting" guide in brake service instruction.
Rake does not stop in parked position.	Check the gap between the limit switch and the read angle. Gap should be less than 1/2 inch.
Rake does not engage bar rack properly.	Realign rake teeth to bar rack.

LUBRICATION SCHEDULE

ITEM	FREQUENCY	LUBRICANT	REMARKS
Check oil level of reducer			See reducer section for lubricant specifications.
Lubricate reducer brgs.			See reducer section for lubricant specifications.
Lubricate motor	See the motor section of manual	Mobilux 2 Mobilgrease HP Shell Alvania Gulfcrown 2 Exxon Ronex MP	See the motor section of manual for lubricant specifications.
Manually lubricate pin rack	1 Month	Bison open gear guard	Manually lubricate. (Not required with non-metallic pin rack)

MOTOR ENCLOSURE
SERVICE INSTRUCTION

The Motor Enclosure furnished with this Cog Rake Bar Screen is designed to provide an air entrapped area around the motor and brake to allow for submerged operation during unusually high water levels.

The Motor Enclosure is not a sealed air tight container but rather is open to the bottom of the rake arm providing a "diving bell" affect.

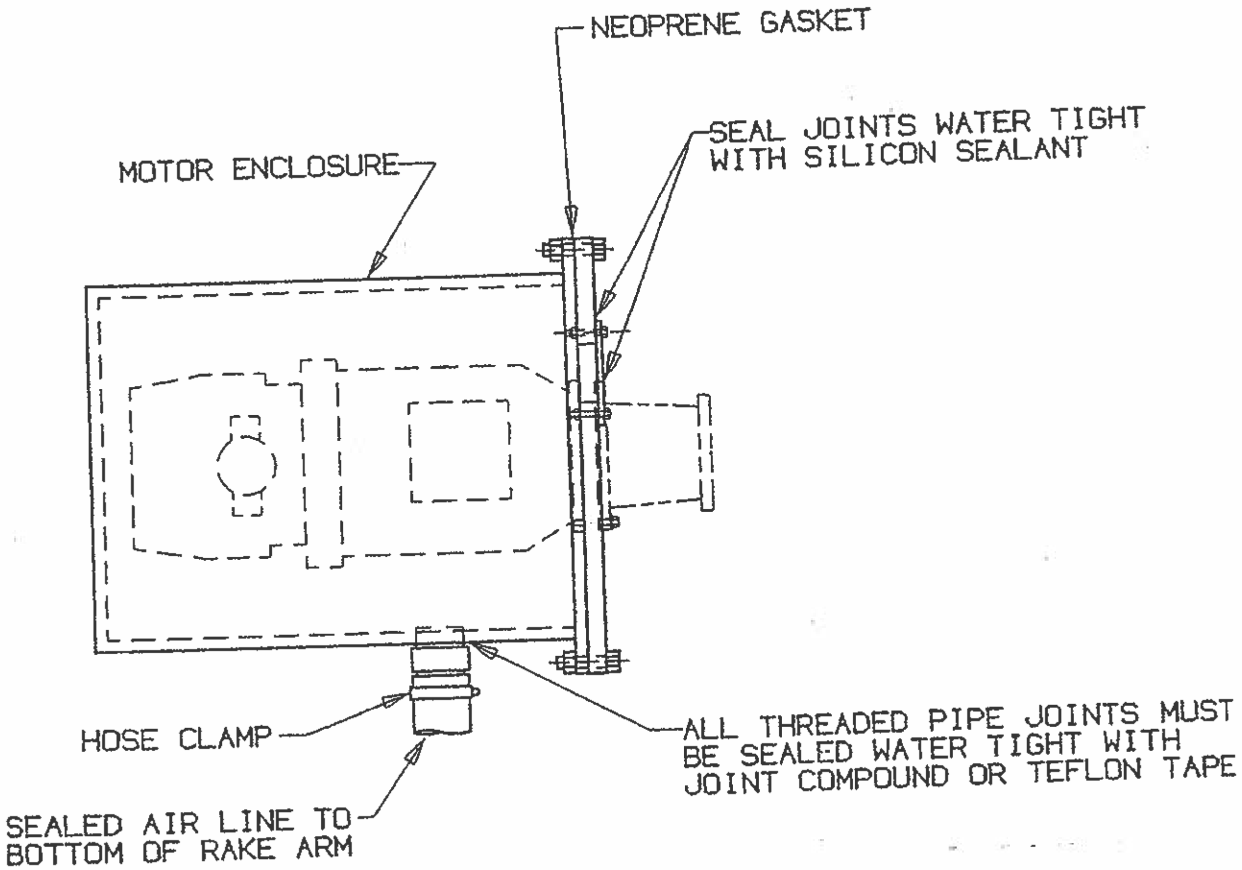
In order for the Motor Enclosure to function properly it is important that all connections at the Enclosure and it's connected piping be sealed water tight except for the opening at the bottom of the rake arm.

Enclosure Removal

1. Clean Enclosure to remove any dirt or debris.
2. Remove hose clamp and flexible hose from bottom side of Enclosure.
3. Remove flange bolts.
4. Remove Enclosure and neoprene gasket.
5. Take care not to drop Enclosure. (The enclosure must be water tight to function properly.)

Enclosure Installation

1. Clean all mating surfaces.
2. Position the neoprene gasket onto the flange plate.
3. Position the Enclosure over the motor aligning the bolt holes.
4. Tighten the bolts in a pattern to evenly distribute pressure on the gasket.
5. Connect the flexible hose with the hose clamp to the nipple on the bottom side of the Enclosure.
6. All connections including flange connections, threaded connections and hose connections must be water tight for the Enclosure to function properly.



MOTOR ENCLOSURE ASSEMBLY

LOAD CURRENT RELAY OVERLOAD SETTING

COG TYPE BAR SCREEN

1. Preliminary

   a. Turn the left hand "differential" adjusting screw counterclockwise to zero.

   b. Turn the right hand "trip current" adjusting screw clockwise to 10 on the scale.

2. Start the screen in hand and watch until the rake reaches the bottom of travel. Once the rake teeth engage the bar rack on the ascending run, turn the LCR "trip current" adjusting screw slowly counterclockwise until the LCR trips, stopping the rake.

3. At this point, turn the LCR "trip current" adjusting screw clockwise the distance equal to 1/2 of a number on the trip dial.

4. Start the screen again and run to the top park position.

'D'

TROJANUV
WATER CONFIDENCE™

Brian M. Sibiga, PE
Wendel Duchscherer
140 John James Audubon Parkway
Suite 201
Amherst, NY 14228

Re; Kingston, NY (LTB20396G) – Increased flow to 13.6 MGD

Dear Brian,

Trojan has reviewed the request to increase the peak flow from 13.0 MGD to 13.6 MGD with the equipment presently proposed. Trojan is comfortable with the increased peak flow and the amount of equipment (120 lamps) that the UV system will perform hydraulically and will meet disinfection.

Please note the changes in the peak flow and disinfection limit and standard will affect the submittal and various sections will have to be revised. Also, The bioassay dose will decrease with the higher peak flow and the same number of lamps.

If you have any questions or concerns, please do not hesitate to contact me.

Thank you,

Cathy Robson

Cathy Robson
Municipal Designer
Trojan Technologies

CC: Mark Koester – Koester Associates Inc.

'E'

City of Kingston Wastewater Treatment Plant
Hydraulic Loading Calculations

Entrance Weir:
36”W x 48”DP ~ 13.7 MGD

Primary Bar Screen:
36”W x 30” Water Depth = 15 MGD Rating

Grit Chamber:
23’ Dia. x 7’ DP with a 1’8” sloping floor = 3,255.3 CF
= 24,349 Gal

Secondary Bar Screen:
36”W x 30” Water Depth = 15 MGD Rating

Primary Tank By-Pass:
24”W x 32”H Slide Gate ~ 18.6 MGD
30” Dia. Orifice w/ 10’ Head ~ 45 MGD

Primary Tanks:
Volumes:
75.5’L x 18’W x 11’ DP = 14,949 CF
= 111,819 Gal
x 4 Tanks = 447,274 Gal

Detention Times:
@4 MGD = 2.68 hrs
@6 MGD = 1.79 hrs
@8 MGD = 1.34hrs
@10 MGD = 1.07 hrs
@12 MGD = 0.89 hrs

Weir Loading Rates:
Recommendation by 10 State Standards = 30,000 GPD/LF
Weir length each tank = 68 LF
x 4 Tanks = 272 LF

@4 MGD = 14,706 GPD/LF
@6MGD = 22,059 GPD/LF
@8MGD = 29,412 GPD/LF
@10MGD = 36,764 GPD/LF
@12MGD = 44,118 GPD/LF

Surface Overflow Rates:
Recommendation by 10 State Standards = 1,500 - 3,000 GPD/SF
75.5’L x 18’W= 1359 SF

x 4 Tanks = 5436 SF

@4MGD = 736 Gal/D/SF
@6MGD = 1104 Gal/D/SF
@8MGD = 1472 Gal/D/SF
@10MGD = 1840 Gal/D/SF
@12MGD = 2208 Gal/D/SF

Primary settling of normal domestic wastewater can be expected to remove 1/3 of the influent BOD when operating at an overflow rate of 1000 gpd/sq ft

Settle Sewage Pumps & Wetwell:
x 2 Duty Pumps ~
+ 1 Redundant Pump ~

Settle Sewage Pumps Outlet Weir Structure
Outlet Weir 24"W x 30"H ~ 16.8 MGD
30" Dia. Orifice w/ 5' Head ~ 29 MGD

Aeration Tank By-Pass:
24"W x 30"H Slide Gate ~ 16.8 MGD
30" Dia. Orifice w/ 5' Head ~ 29 MGD

Aeration Tank Blowers:
100 hp Blowers (Marathon Electric VSD Motor's) ~ 2623 CF/Min.
x 3 Duty Blowers ~ 7869 CF/Min.
+ 1 Redundant Blower ~ 2623 CF/Min.

Diffused Aeration
Oxygen capacity of 17,146 Lbs/D

Aeration Tanks:
Volumes:
111'L x 30' W x 15.5'DP = 51,615 CF
= 386,080 Gal
x 3 Tanks = 1,158,240 Gal

Contact Times:
@4mgd = 6.95 Hrs
@6mgd = 4.63 Hrs
@8mgd = 3.48 Hrs
@10mgd = 2.77 Hrs
@12mgd = 2.32 Hrs

Secondary Tanks:
Volumes:
90'L x 24'W x 11.45'DP = 24,732 CF
= 180,470 Gal

x 4 Tanks = 721,880 Gal

Detention Times:
@4MGD = 4.33 Hrs
@6MGD = 2.89 Hrs
@8MGD = 2.17 Hrs
@10MGD = 1.73 Hrs
@12MGD = 1.44 Hrs

Weir Loading Rates:
Recommendation by 10 State Standards = 30,000 GPD/LF
Weir Length each tank = 192 LF
x 4 tanks = 768 LF

@4MGD = 5,208 GPD/LF
@6MGD = 7,813 GPD/LF
@8MGD = 10,417 GPD/LF
@10MGD = 13,021 GPD/LF
@12MGD = 15,625 GPD/LF

Surface Overflow Rates:
Recommendation by 10 State Standards = 1200 GPD/SF
90'L x 24'W = 2160 SF
x 4 Tanks = 8640 SF

@4MGD = 463 GPD/SF
@6MGD = 694 GPD/SF
@8MGD = 926 GPD/SF
@10MGD = 1,157 GPD/SF
@12MGD = 1,388GPD/SF

U. V. Lights & Channel:

The UV Disinfection System has both primary and redundant components that include 2 channels of High Intensity UV bulb's containing 2 light lamps each with 5 rack's per bank, 6 bulbs per bank, resulting in 60 lamps per channel, 120 lamps total (Trojan); while the redundant third channel utilizes 3 light banks each with 11 rack's per bank, 8 lamps per bank, resulting in 264 lamps total (Fisher-Porter).

The UV Light's are set up horizontal and parallel with the flow in open channels; each channel is 2'8" wide 4' deep & 41' long with 12 1/2" wide Channel Reduction Baffles.

Water levels in the channels are controlled by automatic control gates at the end of each channel; maximum depth = 2.15'; 6.8 MGD per channel, instantaneous.

The UV radiation used for the disinfection system is low pressure mercury vapor lamp's @254 nm.

Lift Station:

Wet Well volume:

Wet Well Volume:

7.5'W x 15'L

Pump Capacity:

#1 Pump - 245 GPM

#2 Pump - 440 GPM

Total Flow Capacity ~ 685 GPM

= 1 MGD

Solids Handling Calculations

Return Active Sludge Pumps

#1 & #2 Digester's

Each digester is 44' in diameter by 22'high with a
6'' ledge 10' up from the floor, with a 4'4" sloping
floor. ,
Total cu/ft =35,607*7.48 cu/ft/gal=266,607gal's each

Gravity Thickener

Volume tank

20' dia.*11' deep =.785*20*20*11=3454 cu/ft
3454*7.48 =25,836 gal --

Cone
20'dia*2'deep =.785*20*20*2*.33=207 cu/ft
207*7.48=1550 gal

Total gal's=27,386
Flow's based on avg./yr. 158,400 gal's/d

Weir overflow rates
62.8 lin./ft =2,552 gal/d/lin/ft

Hydraulic Loadings
314sq/ft = 504 gpd/sq/ft
Recommendation-400-800 gal/d/sqft

Detention Time

27,386*24=657,264
158,400 gal/d = 4.14 hrs

Sludge volume ratio- Sludge retention time

8,596 gal/sldg/ @ 3'
4,544 gal/d/pumped =1.89/d's
Recommendation- 1-2 days

'F'

INFILTRATION RATE SUMMARY

EXHIBIT 5

Mini System	Sanitary Sewer (Inch-Miles)	Estimated High Groundwater Infiltration Rate (GPD)	GPDIM	Percent of Total High Groundwater Infiltration
2	17.79	116,725	6,561	2.0
3A	45.48	550,514	12,105	9.4
3B	84.22	492,443	5,847	8.4
3C	7.86	79,355	10,096	1.4
4A	52.20	14,688	281	0.2
4B	103. 35	483,602	4,679	8.2
5	35.78	274,087	7,660	4.7
6A	8.01	9,838	1,228	0.2
6B	2.07	39,467	19,066	0.6
7A	46.79	1,353,657	28,930	23.0
7B	15.56	138,417	8,898	2.4
8A	35.86	12,054	336	0.2
8B	3.57	10,772	3,017	0.2
9A	113.55	1,121,786	9,879	19.1
9B	98.02	495,394	5,054	8.4
9C	5.08	1,441	284	Nil
9D	25.96	151,442	5,834	2.6
10	12.15	62,296	5,127	1.1
11A	3.67	3,231	880	0.1
11B	32.62	0	0	0
14A	33.50	119,161	3,557	2.0
14B	27.96	341,812	12,225	5.8
TOTALS	811.05	5,876,642		100.0

AVERAGE: 7,245

PUMP 1- BLOCK PARK

G

	JAN	Rain	FEB	Rain	MAR	Rain	APR	Rain	MAY	Rain	JUN	Rain	JUL	Rain	AUG	Rain	SEP	Rain	OCT	Rain	NOV	Rain	DEC	Rain
1		0.10		0.00		0.00	19.13	0.00	3.28	0.00														
2		0.00	4.62	0.10	17.41	0.10		0.00	3.26	0.10														
3		0.10	3.57	0.10	16.37	0.10		0.00	3.11	0.10														
4		0.00	3.49	0.00	15.72	0.00		0.00	3.21	0.00														
5	6.38	0.00	3.30	0.00	7.16	0.00		0.10	3.11	0.00														
6	2.48	0.00		0.00	23.19	0.00	10.43	0.10	2.67	0.00														
7	4.09	0.10		0.00	10.08	0.00	6.65	0.00		0.20														
8	2.96	0.00		0.00	6.84	0.00	8.81	0.60		0.20														
9		0.00		0.10		0.00	11.24	0.00		0.00														
10		0.00		0.10		0.00	16.32	0.00		0.00														
11		0.00	3.79	0.00	8.88	0.00		0.00	2.16	0.50														
12	2.39	0.00		0.00	7.80	0.30	34.43	0.00	2.21	0.20														
13	0.68	0.00		0.00		0.20	13.55	0.00	2.42	0.00														
14	2.97	0.00		0.00		0.20	13.79	0.00	2.47	0.00														
15	3.04	0.00		0.10	13.70	0.10	12.08	0.00		0.00														
16		0.00		0.10	12.31	0.00	7.44	0.20	1.94	0.00														
17		0.70		0.00	9.64	0.00		0.10	3.79	0.00														
18		0.00		0.00	8.70	0.00		0.00	2.30	0.60														
19		0.10		0.00	2.00	0.00	26.52	0.00	2.32	0.00														
20	3.59	0.00		0.00		0.00	5.53	0.00		0.00														
21	3.51	0.00	3.78	0.00	6.60	0.00	4.80	0.00		0.00														
22	3.40	0.00	8.40	0.10	12.16	1.70	3.68	0.00		0.00														
23		0.00	14.08	1.10		0.10	3.88	0.00		0.00														
24		0.40	22.69	1.20	21.77	0.00	11.61	0.30	6.26	0.00														
25		1.20		1.20	14.96	0.30	4.40	0.30	1.67	0.00														
26	20.21	0.00		0.10	17.02	0.00	3.73	0.40		0.00														
27	12.08	0.10		0.20		0.00	3.54	0.10		0.00														
28		0.00		0.10		1.30	3.13	0.00	6.50	0.00														
29		0.00				0.10		0.00		0.00														
30		0.00			21.77	0.60		0.00		0.00														
31						0.10				0.00														
	67.78	2.80	67.72	4.60	254.08	5.20	226.69	2.20	52.90	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	115.3		128.2		349.3		261.9		61.9															

PUMP 2

	JAN	Rain	FEB	Rain	MAR	Rain	APR	Rain	MAY	Rain	JUN	Rain	JUL	Rain	AUG	Rain	SEP	Rain	OCT	Rain	NOV	Rain	DEC	Rain
1		0.10		0.00		0.00	18.50	0.00	2.55	0.00														
2		0.00	5.11	0.10	3.29	0.10		0.00	2.55	0.10														
3		0.10	4.99	0.10	10.64	0.10		0.00	3.40	0.10														
4		0.00	5.26	0.00	11.93	0.00		0.00	2.90	0.00														
5	6.72	0.00	4.93	0.00	17.15	0.00		0.10	2.40	0.00														
6	3.29	0.00		0.00		0.00	14.40	0.10	2.40	0.00														
7	5.14	0.10		0.00		0.00	14.00	0.00		0.20														
8	4.05	0.00		0.00	5.30	0.00	11.70	0.60		0.20														
9		0.00		0.10		0.00	15.40	0.00		0.00														
10		0.00		0.10		0.00	16.80	0.00		0.00														
11		0.00		0.00		0.00		0.00	1.60	0.50														
12	2.80	0.00		0.00		0.30	31.10	0.00	1.80	0.20														
13	3.53	0.00		0.00		0.20	14.60	0.00	2.00	0.00														
14	3.54	0.00		0.00		0.20	15.30	0.00	1.80	0.00														
15	3.53	0.00		0.10		0.10	13.20	0.00		0.00														
16		0.00		0.10		0.00	9.50	0.20		0.00														
17		0.70		0.00		0.00		0.10		0.00														
18		0.00		0.00		0.00		0.00	1.40	0.60														
19		0.10		0.00	2.80	0.00	27.20	0.00	3.10	0.00														
20	6.50	0.00		0.00		0.00	5.30	0.00	1.80	0.00														
21	2.33	0.00		0.00		0.00	3.50	0.00	1.60	0.00														
22	4.43	0.00		0.10	2.50	1.70	3.10	0.00	2.20	0.00														
23		0.00	5.31	1.10	15.50	0.10	3.10	0.00	2.20	0.00														
24		0.40	8.50	1.20	21.40	0.00		0.30	4.50	0.00														
25		1.20	11.13	1.20	14.90	0.30		0.30	1.40	0.00														
26	19.62	0.00	17.89	0.10	16.30	0.00	9.30	0.40		0.00														
27	8.02	0.10		0.20		0.00	3.90	0.10		0.00														
28		0.00		0.10		1.30	3.20	0.00	5.80	0.00														
29		0.00				0.10	2.90	0.00		0.00														
30		0.00			21.40	0.60	2.70	0.00		0.00														
31						0.10				0.00														
	73.50	2.80	63.12	4.60	143.11	5.20	238.70	2.20	47.40	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	122.3		152.1		218.6		289.5		48.1															

H

Alan Adin

From: Dennis M. Larios, P.E. [dmlarios@blengineers.com]
Sent: Friday, May 05, 2006 9:28 AM
To: Ted Petrides; Alan Adin
Subject: Kingston CSO's-Balancing of Diversion Chambers

Ted and Alan,

This is to summarize our meeting of 5/4/06.

Now that the Wilber Avenue Diversion Chamber/CSO has its own double-barrel siphon connected directly to the WWTF, it is important to balance the four Diversion Chambers so that rainfall events do not overload the WWTF. In approximate terms, the peak hourly flow at the plant should be targeted to be 10.5 MGD. I would think the allocation should be approximately as follows:

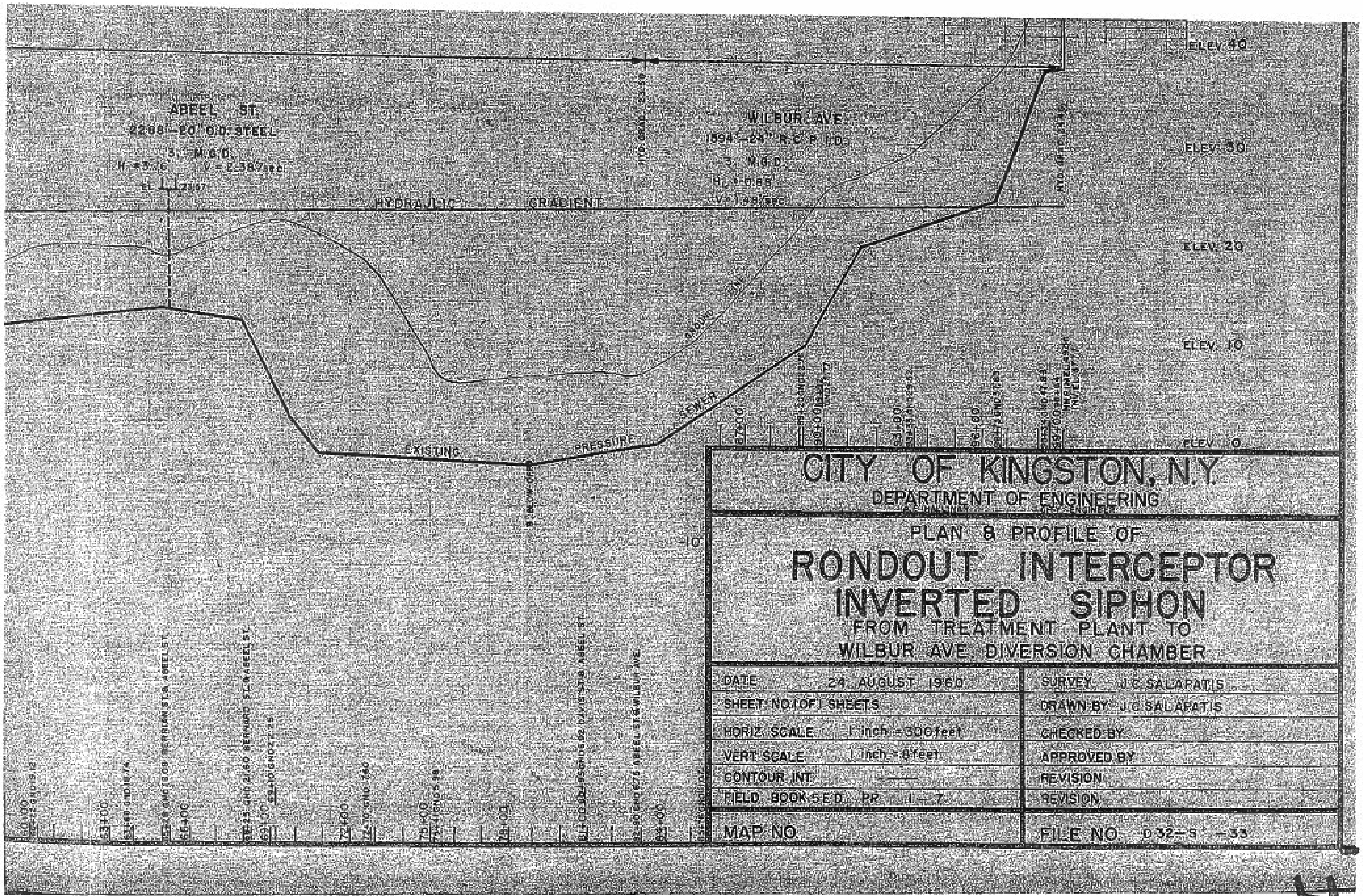
Hasbrouck CSO	1.4 MGD
Broadway CSO	0.5 MGD
Hunter/Ravine CSO	0.5 MGD
Wilber Ave CSO	6.5 MGD
Port Ewen Sewer Improvement Area	1.3 MGD
East Strand PS/Ponchockie Area	0.3 MGD
TOTAL	10.5 MGD

This will require controls at the first three CSO's as they now have total use of the Rondout Interceptor that used to be shared with Wilber. It may require some fine-tuning at Wilber as well.

The CSO's are permitted, by must cease 24 hours after the end of a rainfall event. Hasbrouck, Broadway and Ravine are pretty pure CSO areas, while Wilber is more of an infiltration area where flows don't drop off as quickly.

Talk to you soon.

Dennis



CITY OF KINGSTON, N.Y.

DEPARTMENT OF ENGINEERING

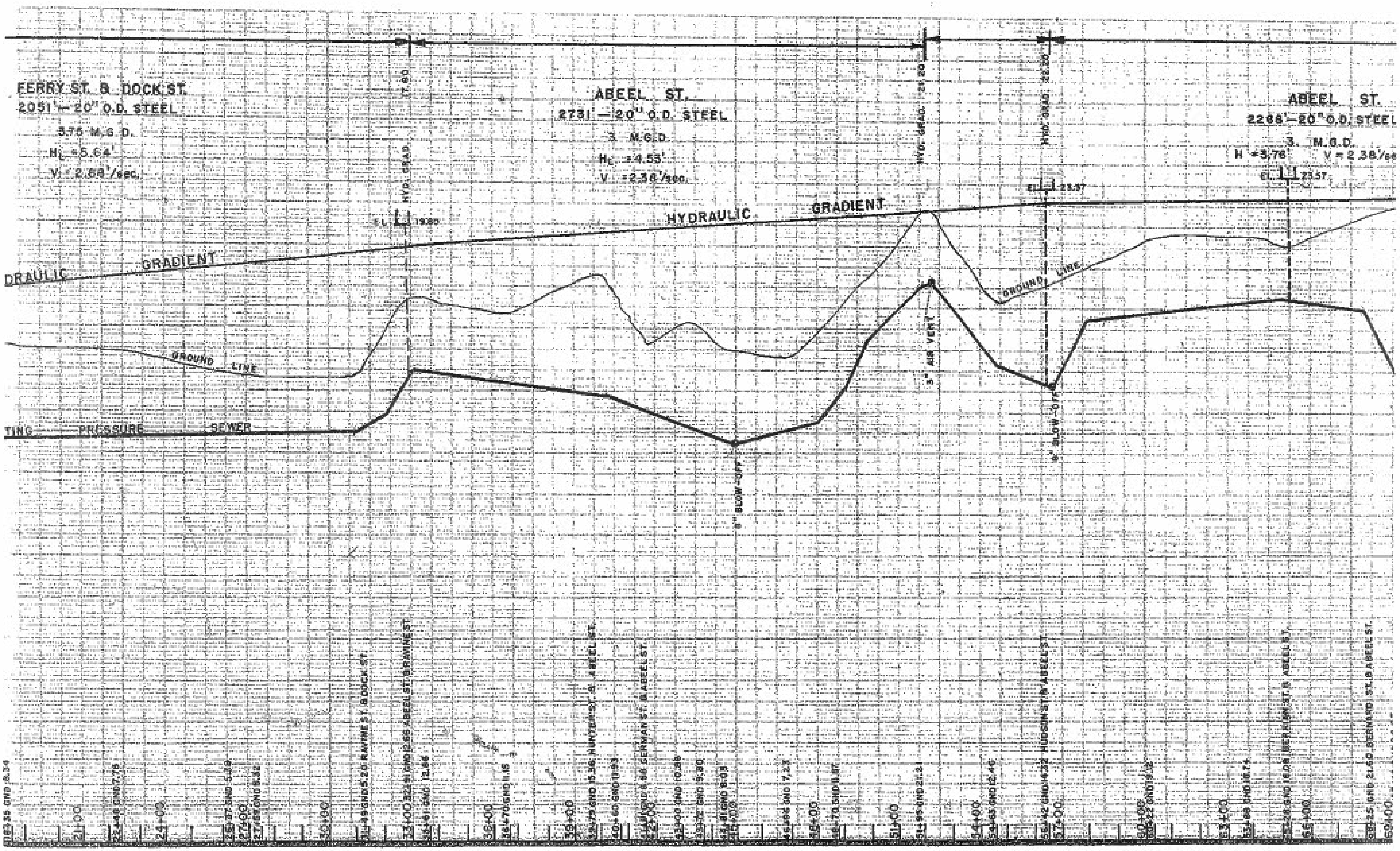
PLAN & PROFILE OF

RONDOUT INTERCEPTOR INVERTED SIPHON

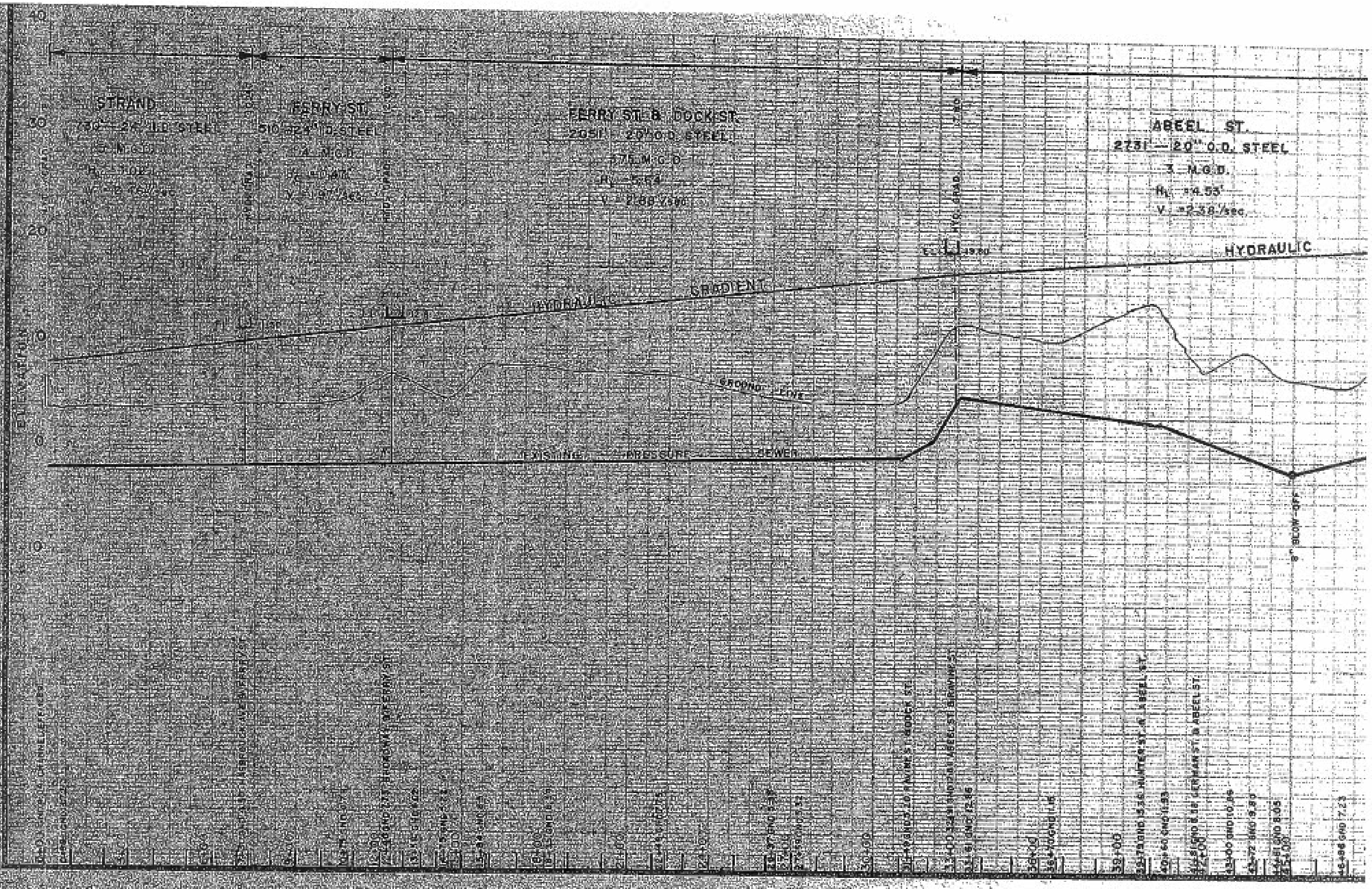
FROM TREATMENT PLANT TO WILBUR AVE. DIVERSION CHAMBER

DATE 24 AUGUST 1960	SURVEY J.C. SALAPATIS
SHEET NO.1 OF 1 SHEETS	DRAWN BY J.C. SALAPATIS
HORIZ. SCALE 1 inch = 300 feet	CHECKED BY
VERT. SCALE 1 inch = 8 feet	APPROVED BY
CONTOUR INT. ——	REVISION
FIELD BOOK S.E.D. PP. 1—7	REVISION
MAP NO.	FILE NO. D32—S —33

H.


FERRY ST. & DOCK ST.
2051'—20" O.D. STEEL
3.75 M.G.D.
H_L =5.64'
V_1 =2.88'/sec.
ABEEL ST.
2731'—20" O.D. STEEL
3. M.G.D.
H_C =4.53'
V =2.36'/sec.
ABEEL ST.
2268'—20" O.D. STEEL
3. M.G.D.
H =3.76'
V = 2.38'/se
17.80
HYD. GRAD.
EL. 19.80
HYD. GRAD. 21.20
HYD. GRAD. 22.20
EL. 23.37
EL. 23.57
DRAULIC GRADIENT
HYDRAULIC GRADIENT
GROUND LINE
GROUND LINE
TING PRESSURE SEWER
8" BLOW-OFF
3" AIR VENT
8" BLOW-OFF
18+35 GND 8.34
21+00
22+48 GND 7.78
24+00
26+37 GND 5.89
27+00
27+69 GND 8.32
30+00
31+49 GND 5.20 RAVINE ST. & DOCK ST
33+00 32+91 GND 12.66 ABEEL ST. & RAVINE ST
34+61 GND 12.86
36+00
36+70 GND 11.15
39+00
39+79 GND 15.56 HUNTER ST. & ABEEL ST.
40+60 GND 11.93
41+91 GND 8.56 GERMAN ST. & ABEEL ST.
42+00
43+00 GND 10.88
43+72 GND 9.80
44+81 GND 8.03
45+00
46+86 GND 7.23
48+00
48+70 GND 11.87
51+00
51+95 GND 21.31
54+00
54+63 GND 12.46
56+42 GND 14.32 HUDSON ST. & ABEEL ST
57+00
60+00
60+22 GND 19.12
63+00
63+88 GND 16.74
65+28 GND 16.08 BERRIAN ST. & ABEEL ST.
66+00
68+25 GND 21.60 BERNARD ST. & ABEEL ST.
69+00

Increment Plant 1

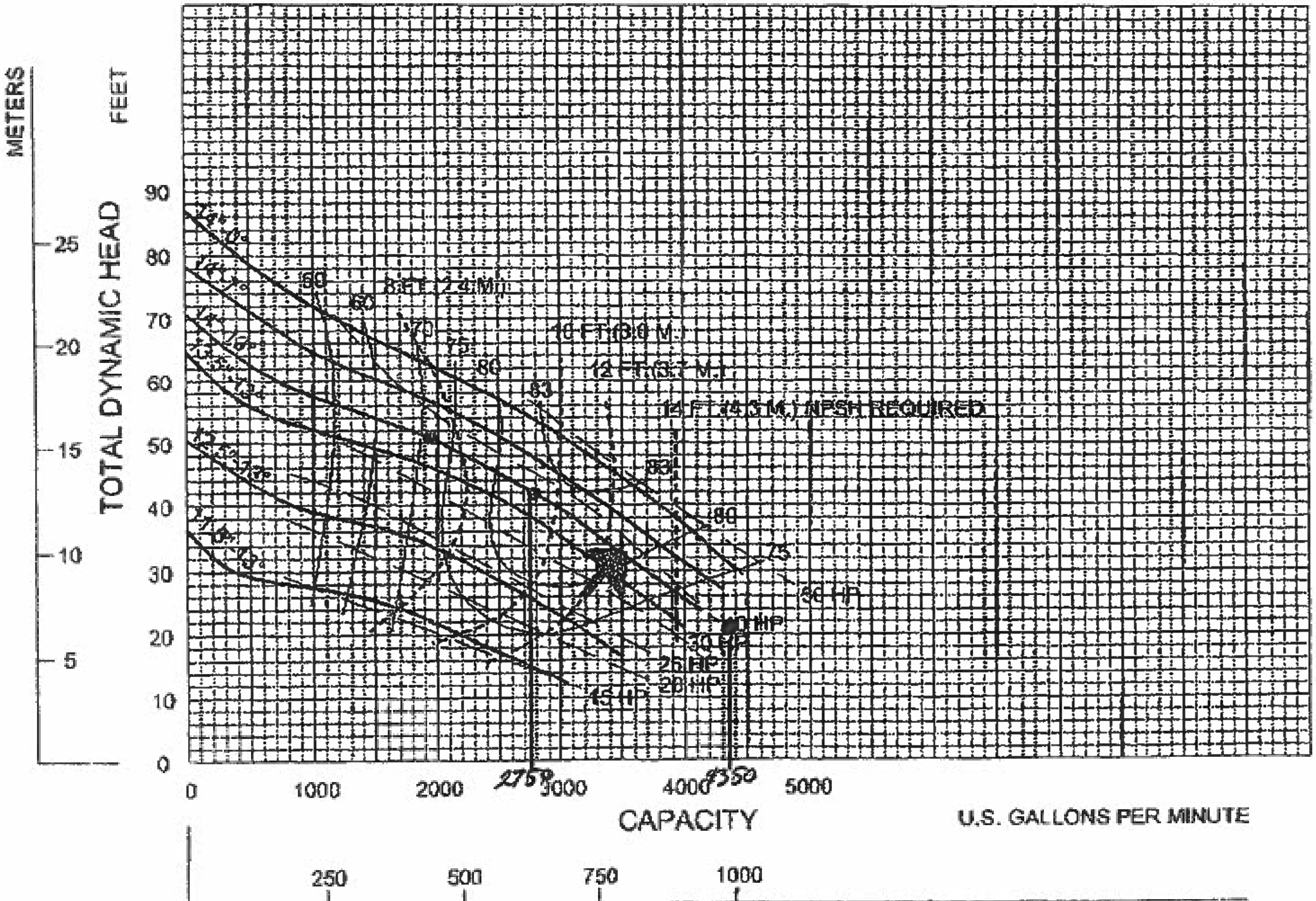


Feet x .305 = Meters
Inches x 25.4 = Millimeters
GPM x .227 = Cubic Meters/Hour
GPM x 3.785 = Liters/Minute
HP x .746 = KW

Speed	Impeller Dia.	Style	Solids Dia.	N_S	Suction	Discharge	No. vanes
1175	VARIOUS	ENCLOSED	4.25"	3900	8"	12"	2

SINGLE VOLUTE

MOUNTING CONFIG.: CC, VM, F, VF, EM, VC



CUBIC METERS PER HOUR

DURING NORMAL OPERATIONS PUMPS OPERATE
AT APPROXIMATELY 18 PSIG ≈ 42' TDH ⇒ 2750 GPM
= 3.96 MGD

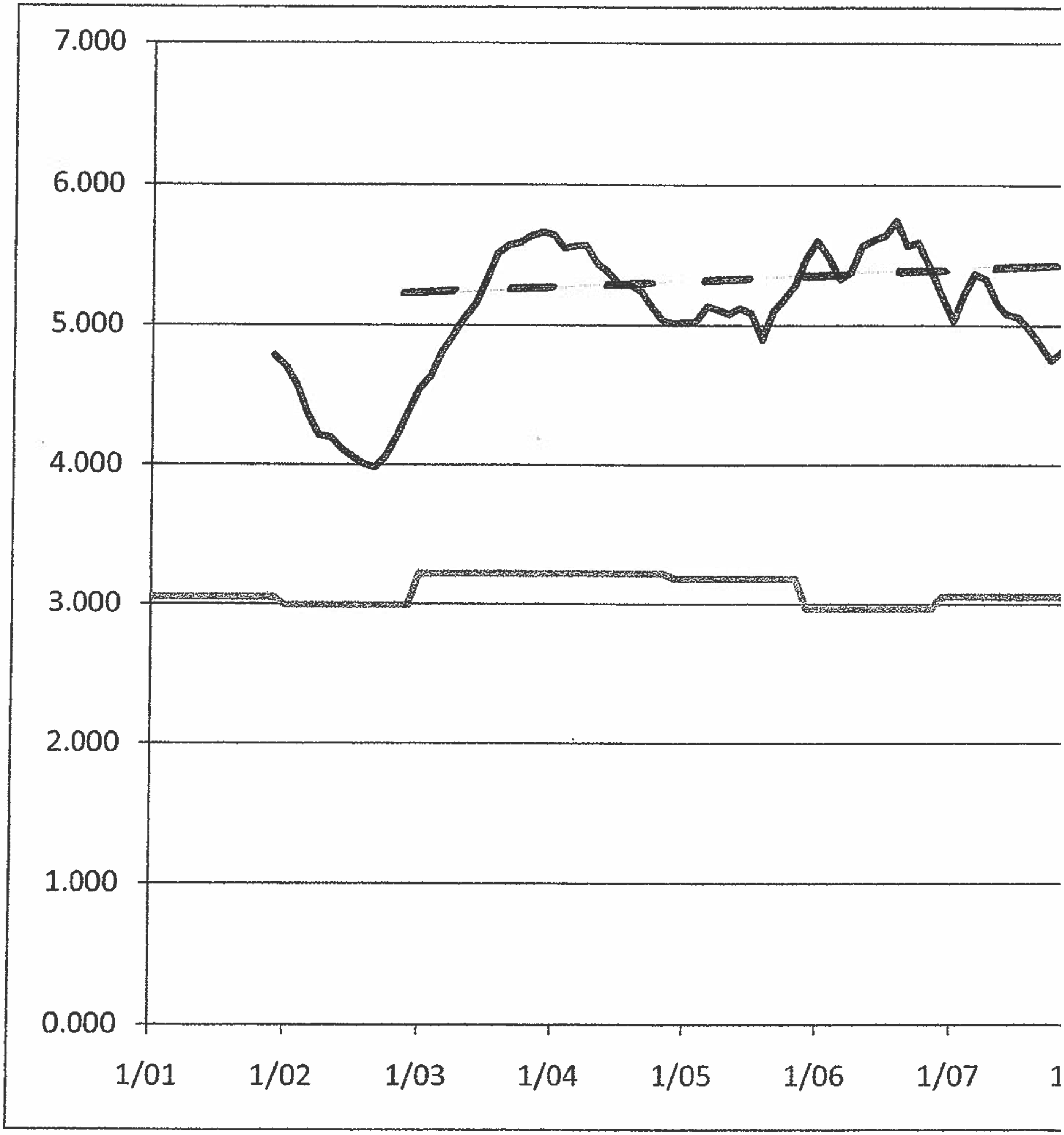
1299

Performances shown are for cool water, close-coupled electric configuration with packing. Other mounting styles of liquids may require horsepower and/or performance adjustments.

CORNELL

Cornell Pump Company • Portland, Oregon

12NHTL - 1200 RPM


7.000
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1/05
1/06
1/07
1

L

Erie County Division of Sewerage Management
General Infiltration and Inflow (I&I) - Contribution Removal Values By Source

Problem/Repair Type	Severity	ECSD WO Priority[7]	I&I Contribution (gpm)
Manholes			
Surface Water Entering MH: Low Lying Get Raised OR Inflow Protector Installed			4
Frame[1], Frame to Cone, Cone to Barrel, or Barrel Joint leaks	Severe	5	5
	Moderate	4	3
	Slight	3	1
Frame, Cone, Barrel leaks (not along joints)	Severe	5	2
	Moderate	4	1
	Slight	3	0.5
Exposed frame and cone in ditch (Exterior)	Severe	5	15
	Moderate	4	10
	Slight	3	5
Manhole replacement needed			10[6]
Cracks in the concrete or paved surface area surrounding a manhole with leaks in frame and cone			10
Pipe Segments[2]			
Joint infiltration or Cracked pipe			1
Pipe broken			2
Leaking lateral at the connection to the main			1
Sliplining Required/100 feet[4]	8" pipe		1.1
	10" pipe		1.25
	12" pipe		1.5
	15" pipe		1.88
	18" pipe		2.25
Private Sources			
Low-lying lawn vent	General		0.1 to 80[3]
	Missing/Wrong Vent Cap		value used 0.1[6]
	Low Lying Vent		value used 1[6]
	Loose/Broken Vent Riser		value used 10[6]
Downspout			5
Sump pump [4]			1
Deficient residential lateral (target is clay tile pipe)	Case-specific, no general classification		range 15 to 70 value used 42 [5]

1. The term frame in this report includes the manhole frame adjustment rings or bricks beneath the frame.
2. During the Parsons I&I study in ECSD 1 conducted in 2001, CCTV inspection was conducted in dry weather, under frozen ground conditions. Field observations were not always available, therefore, these general values were assigned to various defects.
3. Individual low-lying lawn vents vary in contribution according to surface characteristics.
4. NYSDEC approved values, per 2005 correspondence under the ECSD 2 SPDES I&I Plan.
5. Value used 42 gpm. However, lower or higher values may be used based on actual condition.
6. Values used in 2006 Annual Report, not yet approved by NYSDEC.
7. Changed to industry standard (modified MACP) 5 grades, 3-5 above, 2 slight deficiencies but no repair, 1 nothing needed.

'M'

City of Kingston
NEW YORK

OFFICE OF THE CITY ENGINEER

May 14, 2007

Dennis Larios, P.E.
Brinnier and Larios, P.C.
67 Maiden Lane
Kingston, NY 12401

Re: **Infiltration into Delta Place Sanitary Sewer**

Dear Dennis:

Based on our estimation, the infiltration into the Delta Place Sanitary Sewer was approximately 250,000 gallons per day.

Also, the infiltration removed from two manholes at Twin Ponds amounted to 45,000 GPD.

If you need any further information, please let me know

Respectfully,

Ted Petrides, PE
City Engineer

larios ltr re delta place 5-14-07

FAXED
5-14
11:45 AM

CITY HALL, 420 BROADWAY, KINGSTON, NEW YORK 12401 (845) 331-0080 FAX (845) 334-3958

1652

City of Kingston
420 Broadway • Kingston, NY 12401

APPENDIX

I

EPA CSO Financial Capability Assessment – Phase 1

The Residential Indicator

MALCOLM PIRNIE

CITY OF KINGSTON
EPA CSO FINANCIAL CAPABILITY ASSESSMENT - PHASE 1 THE RESIDENTIAL INDICATOR

WORKSHEET 1: CALCULATION OF COST PER HOUSEHOLD

Description		Amount	EPA Line No.	Source
Current and Projected Wastewater Treatment and CSO Control Costs:				
Current WWT Costs:				
Annual O&M Expense (excluding Depreciation)		$ 3,242,866	100	The City of Kingston, NY 2009 Financial Report
Annual Debt Service (Principal & Interest)		1,003,507	101	City of Kingston Sewer Fund Combined Principal and Interest Payments Due 2010 Debt Service (Debt schedules provided by the City.)
Subtotal		$ 4,246,373	102	Calculation
Projected WWT and CSO Control Costs:				
Annual Incremental O&M Expense		$ 51,400	103	Assumed at 1 percent of CSO Costs
Capital Cost for WWT				
Capital Cost for CSO Controls	$ 5,140,000			Total Phase I and Phase II LTCP Program (Spoke with Tina Wolf - email from Rob 10/29/2010)
Capital Cost of WWT and CSO Controls	$ 5,140,000			
Annual Debt Service (Principal & Interest)		$412,447	104	Calculation assuming debt issued at 5 percent interest rate for 20 years.
Subtotal		$463,847	105	Calculation
Total Current and Projected WWT and CSO Control Costs		$ 4,710,220	106	Calculation
Allocaton of WWT and CSO Costs to City Customers:				
Wastewater Flow Statistics:				
Port Ewen Flow		141,911	gpd	
City of Kingston Flow		1,694,200	gpd	
Total Flow Treated by the City of Kingston		1,836,110	gpd	
City Flow as a Percentage of Total Flow		92.3%		Calculation
Current and Future WWT Costs:				
Total Current WWT Costs		$ 4,246,373		Calculation. Same as EPA Line No. 102
Total Projected WWT and CSO Control Costs		463,847		Calculation. Same as EPA Line No. 105
Total Current and Future WWT and CSO Costs		$ 4,710,220		Calculation. Same as EPA Line No. 106
City Portion of Total Current and Future WWT and CSO Costs		$ 4,346,173		
Allocaton of WWT and CSO Costs to City Customers:				
Residential City Flow as a Percentage of Total City Flow		57.4%		Residential Share of Consumption over the last 4 quarters; Data Provided by City
Residential Share of Total City WWT and CSO Control Costs		$ 2,494,969	107	Calculation
Determination of WWT and CSO Cost Per Household:				
Total Number of Households in Service Area		6,816	108	2nd Quarter 2010 5/8 Metered Customers; Data Provided by City
Cost Per Household		**$366**	109	Calculation

CITY OF KINGSTON

EPA CSO FINANCIAL CAPABILITY ASSESSMENT - PHASE I - THE RESIDENTIAL INDICATOR

WORKSHEET 2:

CALCULATION OF THE RESIDENTIAL INDICATOR

Description	Amount	EPA Line	Source
Adjusted Median Household Income Levels			
Using Weighted Average MHI: Census Year for MHI	2008	201	2000 U.S. Census Bureau. City of Kingston MHI (in 1999 dollars)
Adjustment Factor	1.06	202	Calculation - Adjusted to 2010
Adjusted MHI	$47,600	203	MHI adjusted to 2010
Annual WWT and CSO Control Cost Per Household (CPH)	$366.05	204	Calculation
Residential Indicator: (CPH as % of MHI)	**0.77%**	205	Calculation

Analysis of the Residential Indicator **Low**

Financial Impact	Residential Indicator (CPH as % MHI)
Low	Less than 1.0 Percent of MHI
Mid-Range	1.0-2.0 Percent of MHI
High	Greater than 2.0 Percent of MHI