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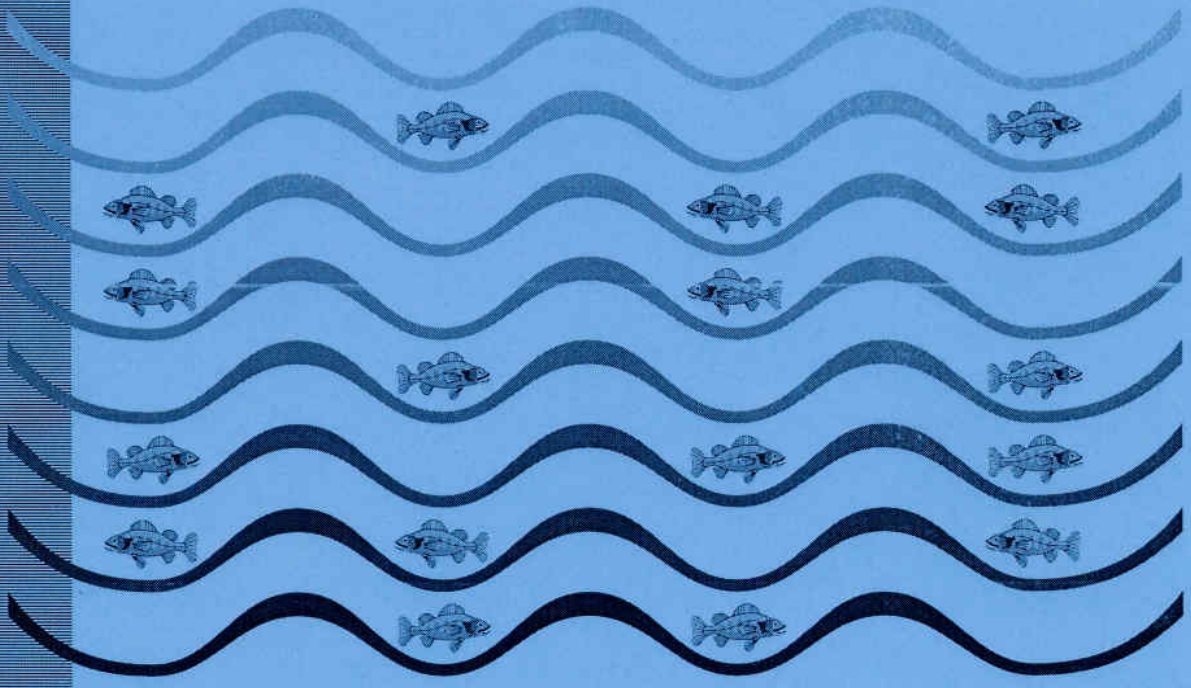
City of New Haven Long Term CSO Control Plan

The City of New Haven

New Haven Water Pollution Control Authority

Technical Memorandum #5
Monitoring Program Results



CH2MHILL

March, 1998

CH2M HILL
50 Stanford Street
10th Floor
Boston, MA
02114-2517
Tel 617.523.2260
Fax 617.723.9036

CH2MHILL

March 23, 1998

135807.BA.03

Mr. Lawrence Smith
City of New Haven
City Engineer's Office
200 Orange Street, 5th Floor
New Haven, CT 06510

Mr. Raymond Smedberg, P.E.
City of New Haven
Water Pollution Control Authority
East Shore Water Pollution Abatement Facility
345 East Shore Parkway
New Haven, CT 06512

Dear Sirs:

Subject: New Haven LTCP Project
Task 3 - Monitoring Program

Attached for your review and comment is a draft of Technical Memorandum #5. This memorandum documents the approach that was used to identify data needs, gather existing data, and collect needed data through a flow/rain monitoring program. It includes an analysis of the collected data and overflow statistics as well as a description of the data library that has been built to support hydraulic model calibration. We would appreciate receiving your comments or suggestions by April 17, 1998. Please also pass the memo along to Henry, Bill Root, and Bill Idarola for their comments.

Sincerely,

CH2M HILL

Perrin Bowling/BOS
Task Manager

cc: Cliff Bowers/CH2M HILL
Peter von Zweck/CH2M HILL
Tom Ryan/ADS

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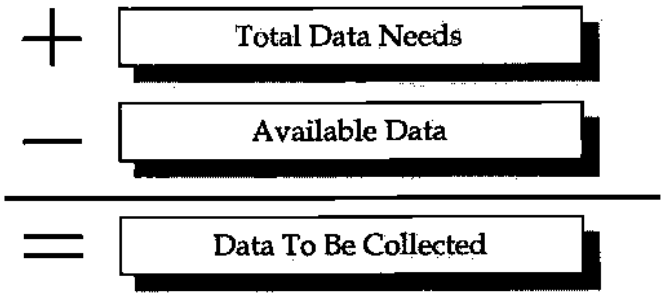
Introduction

The Long-Term CSO Control Project has been established for the purpose of reevaluating the current sewer separation approach to controlling combined sewer overflows. Specific project goals include

- reducing the overall cost of constructing CSO controls,
- producing documents required for CSO related issues described in the WPCA's existing NPDES permit, and
- producing a long-term CSO Control Plan which is consistent with the EPA's guidance document.

The project includes development of a computer model to simulate hydrologic and hydraulic conditions in the drainage areas and sewer system of New Haven. In order for the model to provide a realistic simulation, it must be calibrated with flow and rain data obtained within the study area. Task 3 of the project was designed to support calibration of the model and evaluation of receiving water impacts through the collection and management of data.

The scope of this task was threefold and is depicted in the following figure: identifying data requirements, gathering and reviewing available data, and conducting a monitoring program to provide data where gaps existed.



At the beginning of this task, a meeting was held to identify data needs and discuss existing data. The meeting is documented by minutes which were provided with a previous submittal, TM#4, as well as the presentation slides used during the meeting. This technical memorandum (TM#5) documents the existing data and the process of collecting supplemental data. Existing data are identified and described in the next section, followed by an extensive description of the monitoring program that was undertaken and an evaluation of the data obtained. Data management and the library that archives the database are highlighted near the end of the document. Finally, conclusions are presented, including a correlation of overflow statistics with rain events.

Existing Data

This section of the technical memorandum documents sources of flow and precipitation data external to the project. It describes sites which have been monitored, installation dates, and data formats. Unless otherwise specified, all data are in electronic format.

Flow, Depth, and Velocity Data

- Depth, velocity, and flow measurements at 15-minute timesteps were obtained for 12 locations on the boundaries of the City of New Haven (where inflow from neighboring communities enters the city). At 10 of the sites, data are available from January 1996 through December 1997. The other two sites have fewer data, one from September 1996 to December 1997 and the other for January through December 1997. *(Source: ADS Environmental Services, Inc., No Date)*

- Short-term (21-day) records of depth, velocity, and flow at 15-minute timesteps were acquired for 7 locations in eastern New Haven (near and in Fair Haven). These data were taken during March and April of 1997 to examine flooding problems associated with the James Street Siphon. *(Source: ADS Environmental Services, Inc., 1997)*

- A one-month study from 11/6/97 to 12/5/97 that obtained flow, velocity, and depth measurements was performed along the Wooster Street Interceptor at Wallace Street. The report provides hard copy tables of data at hourly and 10-minute intervals. *(Source: City of New Haven from New England Pipe Cleaning Company, 1997)*

Flow Data

- Daily effluent flows from the East Shore Water Pollution Abatement Facility (WPAF) are available from January 1993 through May 1997. *(Source: Water Pollution Control Authority, No Date)*

- Bi-monthly pumping station throughput is available for July 1996 to June 1997 at the Welton Street, Park Street, Arch Street, and Brookside Pumping Stations. *(Source: Water Pollution Control Authority, No Date)*

- Flows through the Boulevard, East Street, and East Shore pumping stations and the WPAF effluent flow are available in hourly increments for 1996 and 1997 except June through August of 1997 and some missing days throughout the data set. These data were handwritten on paper and have been entered into an electronic database for inclusion in the data library. *(Source: Water Pollution Control Authority, No Date)*

Rainfall Data

- Rainfall depth from a gauge at the East Shore WPAF was obtained in half-hour increments from July 1994 through May 1997. *(Source: Water Pollution Control Authority, No Date)*

- Rainfall records for six Regional Water Authority gauges near the city were obtained in 15-minute intervals. At three of the gauges, data were available from January 1996 through June 1997. The remaining three gauges collected data from January through June 1997. One of the gauges is quite near the city boundary, and most are within 2 miles. The furthest gauge is within 10 miles of the city. *(Source: South Central Connecticut Regional Water Authority, No Date)*

- Long-term rainfall records for two USGS stations near the study area (Tweed Airport and Lake Saltonstall) were acquired as daily rainfall depths for May 1948 through May 1969 and April 1978 through December 1995 for Tweed and Saltonstall, respectively. The Lake Saltonstall data set is missing a large amount of data. Hourly records also were obtained for January 1991 through December 1995 for the Lake Saltonstall station. *(Source: EarthInfo, Inc., 1996)*

- A long-term rainfall record from the USGS gauge at Hartford's Bradley Airport was available from 1954 to 1994 in hourly increments. *(Source: EarthInfo, Inc., 1996)*

Figure 1 shows a map identifying the gauges that are listed above, with the exception of the rain gauge in Hartford. Figure 2 is a chart which provides the duration of records for the various data sets.

Long-term rainfall data from a variety of gauges are helpful for identifying spatial, temporal, and seasonal variations and trends, as well as for estimating recurrence intervals of storms with varying depths and intensities. Flows from the Water Pollution Abatement Facility are useful for determining how quickly the sewer system returns to normal flow patterns after a storm, seasonal trends such as groundwater infiltration, and diurnal flow patterns. Flows at points throughout the system including the city boundaries and pump stations can provide pictures of smaller portions of the system. These data provide critical information needed to understand New Haven's sewer system and develop and calibrate a hydraulic model. By undertaking a flow and rain monitoring program, additional data about flows in the system, overflows at regulating structures, and rain throughout New Haven could be supplied to meet the data needs that had previously been identified. The monitoring program is described in the next section.

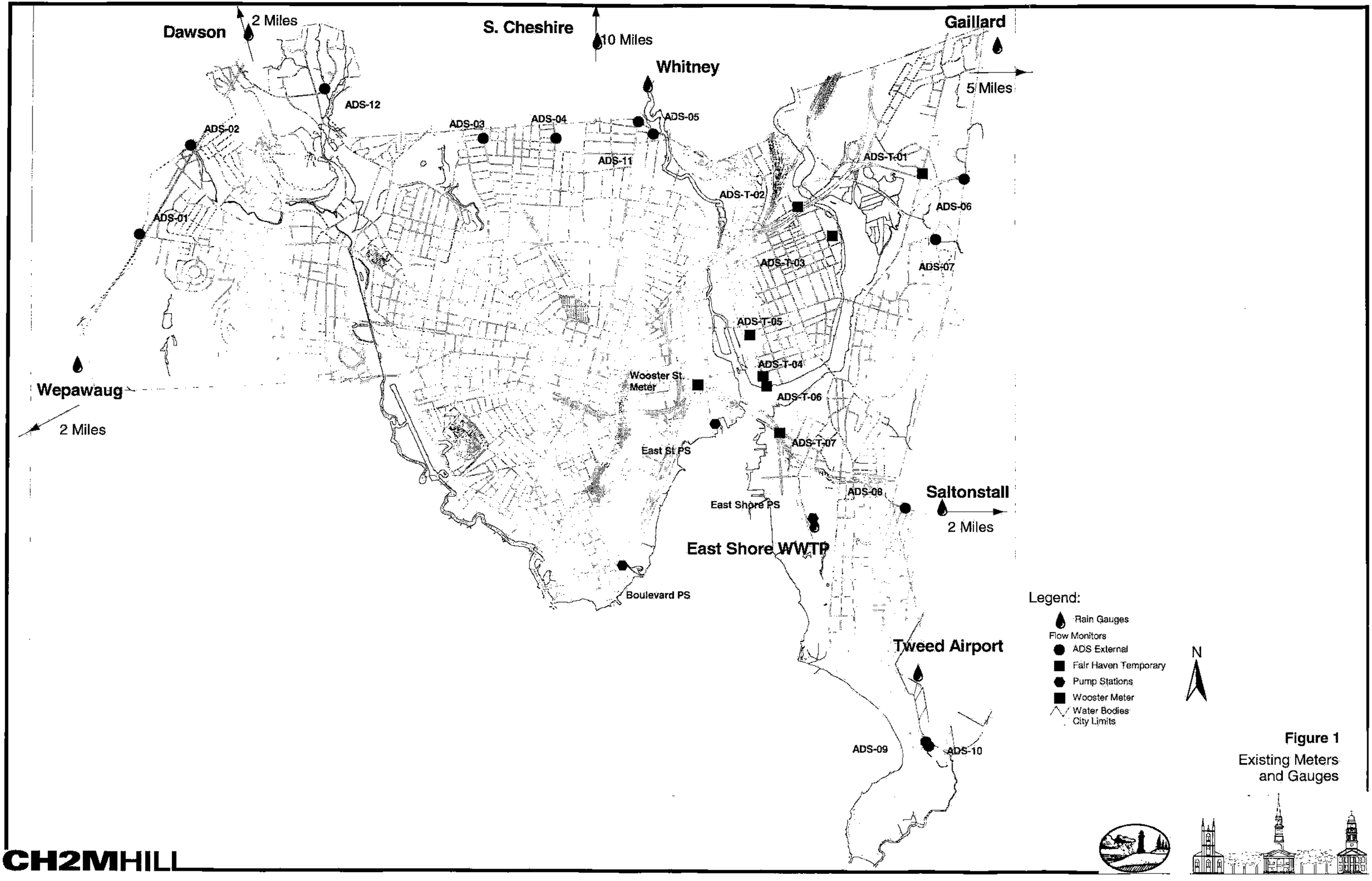


Figure 1
Existing Meters and Gauges

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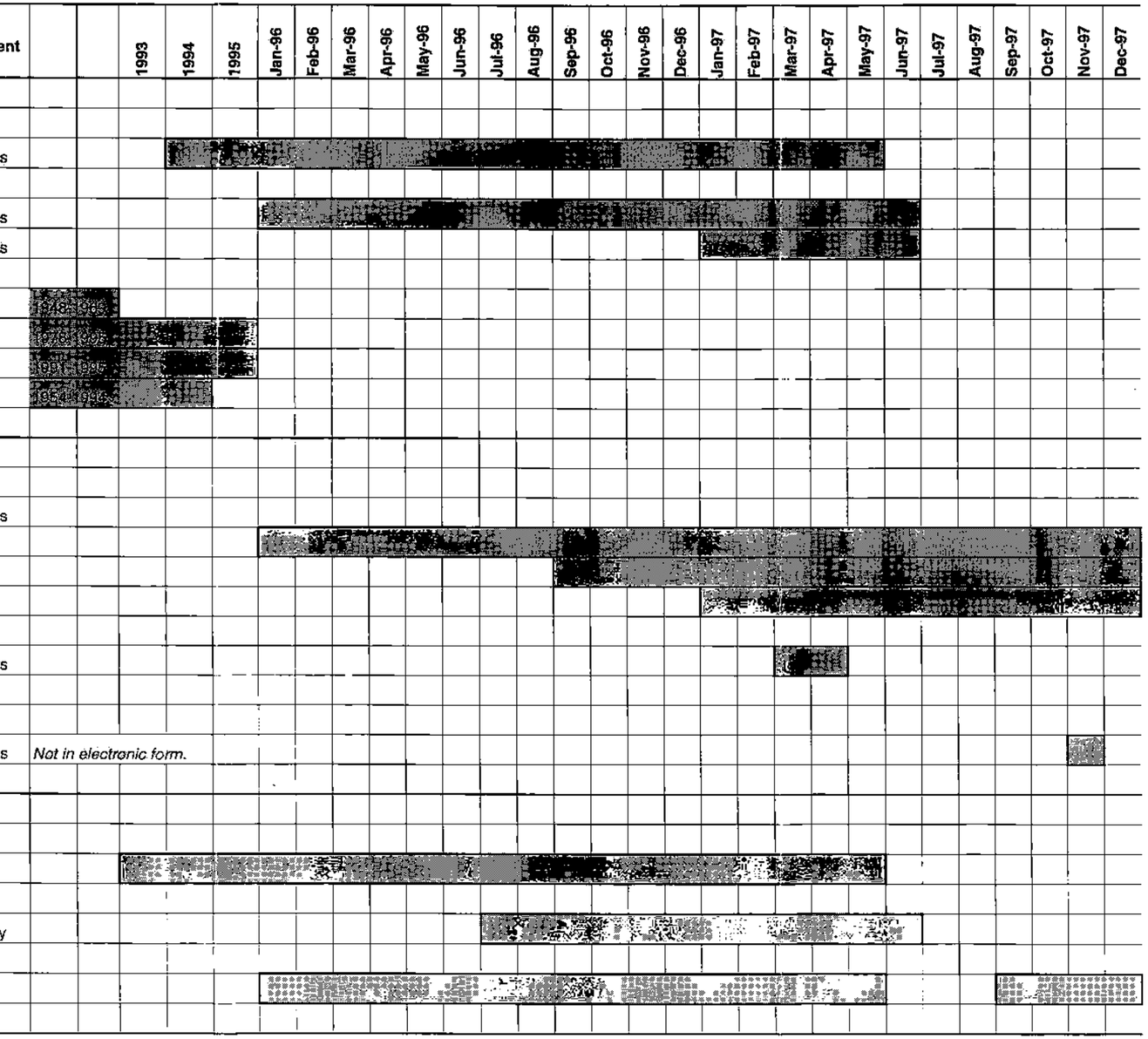
Data Type and Location of Gauge or Meter	Source	Measurement Interval
RAIN		
East Shore WPAF	WPCA	30 minutes
Dawson, Whitney, Wepawaug	Regional Water Authority	15 minutes
Saltonstall, Gaillard, S. Cheshire	Regional Water Authority	15 minutes
Tweed Airport USGS Gauge	EarthInfo	daily
Lake Saltonstall USGS Gauge	EarthInfo	daily
Lake Saltonstall USGS Gauge	EarthInfo	hourly
Bradley Airport USGS Gauge	EarthInfo	hourly
FLOW, DEPTH, VELOCITY		
City Boundary Long-Term Meters	ADS Env. Services	15 minutes
NH01 to NH10		
NH11		
NH12		
Fair Haven Temporary Meters	ADS Env. Services	15 minutes
Wooster Street Interceptor	City of New Haven	10 minutes
FLOW		
East Shore WPAF	WPCA	daily
Welton, Park, Arch, Brookside Pump Stations	WPCA	bi-monthly
Boulevard, East Street, East Shore, WPAF	WPCA	hourly



Not in electronic form.

Figure 2
Timeline of Calibration Data

Data Collection Program

Introduction

To supplement the data already obtained, and to meet the needs of the model development task, a data collection/monitoring program was included in the project. The program was approximately 90 days in length, between September 12 and December 16, 1997.

Specific goals of the monitoring program included determining volume, frequency, and duration of CSOs throughout New Haven, and obtaining flow measurements from small service areas with characteristics representative of those found throughout the study area, including:

- combined sewer areas,
- separated sewer areas without roof leader connections (originally built separated; these areas will be referred to as "separated"), and
- separated sewer areas with roof leader connections (originally built combined; these areas will be referred to as "partially separated").

The sites selected for monitoring these areas included drainage basins of a range of sizes (30 to 100 acres) and were representative of land uses found throughout the study area to allow extension of the measurements to other, similar areas during model calibration.

Generally, the more data available for use in calibrating a model, the better. However, data needs always must be balanced with limited resources available for acquisition. An extensive amount of consideration went into deciding where to locate the flow meters, and details are provided in the section below. This technical memorandum is a companion to TM #4 (CH2M HILL, 1997) and the two-volume final report by ADS (1998), to which the reader is referred for further information.

Flow Meters

A meeting was held in July to address issues such as data needs, seasonal impacts on monitoring, sampling and recording timesteps, and the number of meters required to obtain reliable data at a site. Another meeting took place in August to discuss administrative and technical issues and to finalize the meter locations. Several complicating issues such as lack of access to overflow weirs and low flow velocities were raised at this meeting, so further investigation of site sketches, photos, and city maps was undertaken before locations were finalized. Once site surveys were performed by ADS, a few of the sites had to be relocated due to poor monitoring conditions such as sediment or turbulence.

In a few parts of New Haven, sewer separation projects were under design and construction was imminent. The areas included Livingston Street; Orange Street Phase II; Orange, Bishop, and Clinton; Humphrey Street; Wooster Square; and Elm Haven. It had been

decided that these areas were to be included in the hydraulic model as separated areas. Because monitoring occurred while these areas were still served by combined sewers, only one of the overflow regulators (#010) impacted by the ongoing projects was monitored. These measurements can now serve as a "before" picture of the combined system that can potentially be paired with an "after" picture once separation has been completed.

At many of the flow-monitoring sites, a single meter was installed in a manner which allowed direct measurement of the flows in the interceptor and indirect measurement of the volume, frequency, and duration of overflows. However, at some sites such a configuration was not possible, and one type of measurement had to be chosen over the other or two meters were installed. Tables 1 and 2 provide details about the locations of the 23 overflow- and 7 inflow monitoring sites, respectively, and indicate what type of data was collected at each site. Table 2 also presents the approximate sewershed acreage contributing to the inflow meters and the primary land uses in the basins. The 7 inflow meters included 3 in separated sewer areas, 2 in partially separated sewer areas with roof leader connections, and 2 in combined sewer areas. The site sheets created by ADS, which give information about each installation and site conditions, are given in Appendix A.

Table 1 . Overflow Monitoring Locations

Flow Meter Number	NPDES Regulator Number	Monitoring Location	Data Type
M2	002	E.T. Grasso Blvd @ Lamberton St	Interceptor, overflow
M3	003	E.T. Grasso Blvd @ Orange Ave	Interceptor, overflow
M4	004	E.T. Grasso Blvd @ Legion Ave	Interceptor, overflow
M5a	005	E.T. Grasso Blvd @ Derby St (combined sewer)	Local inflow (combined)
M5b	005	E.T. Grasso Blvd @ Derby St (overflow pipe)	Overflow
M6	006	Whalley Ave @ Fitch St	Interceptor, overflow
M8	008	Munson St @ Orchard St	Interceptor, overflow
M9	009	Grand Ave @ James St	Interceptor, overflow
M10	010	East St @ I-91	Interceptor, overflow
M14a	014	Trumbull St @ Orange St (combined sewer)	Interceptor, overflow
M14b	014	Trumbull St @ Orange St (storm sewer)	Storm sewer, overflow
M15a	015	James Street Siphon (combined sewer)	Interceptor
M15b	015	James Street Siphon (overflow pipe)	Overflow
M16	016	Poplar St @ River St	Overflow
M18	018	Lombard St @ N. Front St	Local inflow (combined), overflow
M19a	019	Pine St @ N. Front St (combined sewer)	Interceptor, overflow
M19b	019	Pine St @ N. Front St (overflow pipe)	Overflow
M20	020	Quinnipiac Ave @ Clifton St	Interceptor, overflow
M21	021	East St Pump Station	Interceptor, overflow
M22	022	Allen Place	Interceptor, overflow
M24	024	Boulevard Pump Station @ Sea Street	Interceptor, overflow
M25a	025	Union Ave Pump Station	Overflow
M25b		Temple St @ George St	Interceptor, overflow

Table 2. Inflow Monitoring Locations

Flow Meter Number	Approx. Acreage	Monitoring Location	Data Type and Land-Use Type
S1	100	Lowin Ave south of Fountain St	Separated / residential
S2	30	Anthony St south of Whalley Ave	Separated / residential
S3	49	Chapel St east of Alden Ave	Separated / residential
RL1	31	Division St east of Winchester Ave	Separated with roof leader connections / residential
RL2	36	State St northeast of George St	Separated with roof leader connections / commercial, residential
C1	98	Poplar St south of Grand Ave	Combined / residential, commercial, cemetery
C2	37	Orchard St between Davenport and Sylvan	Combined / residential, commercial

ADS measured depths and velocities and then used these data to calculate flow rates. Measurements were taken at 5-minute intervals. Depths were measured using both ultrasonic and pressure depth meters, while velocities were obtained from a Doppler velocity sensor. Flow rates were typically calculated by ADS using the continuity equation. During certain periods when velocity data were poor or unavailable (for instance, due to debris collected on the meter), an empirical relationship between depth and velocity was used to generate synthetic velocities. More information is provided below in the discussion about quality control of data.

Figure 3 provides a map showing the approximate metering location for each of the flow meters and rain gauges. (Figure 4, displayed in the *Quality Control of Data* section later, provides a system schematic for additional information.)

Rain Gauges

Four rain gauges were installed in secure areas throughout New Haven. Since the flow data are to be used to calibrate models that estimate flow based on precipitation input, it was critical to obtain rainfall data during the same period that flow monitoring occurred. The gauges were installed much closer to the monitoring sites than existing long-term rain gauges. Table 3 describes the locations of the four rain gauges, and they are displayed in Figure 3 along with the flow meter locations.

Rainfall data were recorded in increments of hundredths of an inch (0.01 in) at each of the gauges at 5-minute intervals throughout the project. For further information, the final report by ADS can be consulted (ADS, 1998).

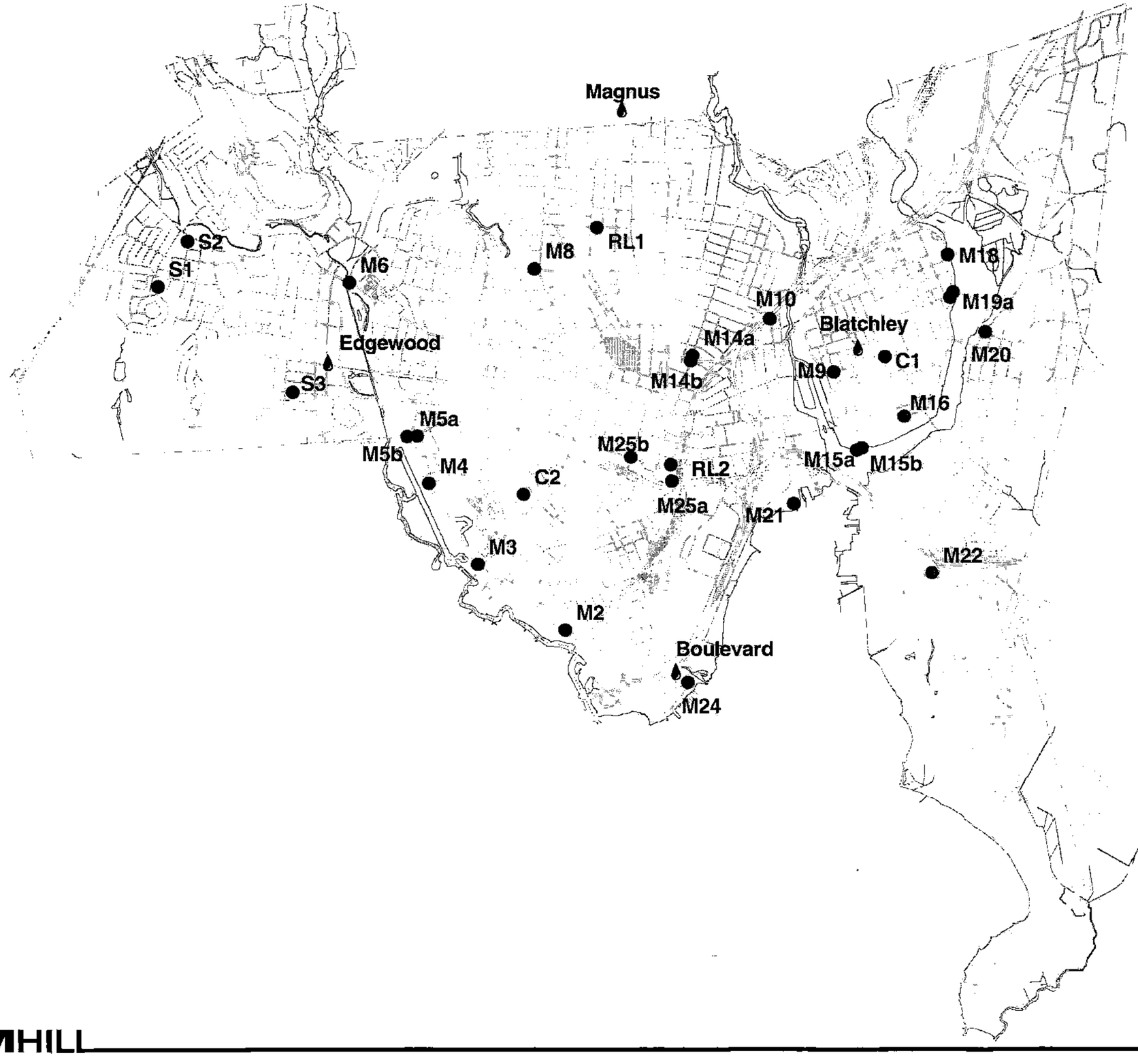


Figure 3
Monitoring Program
Meters and Gauges

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Table 3. Rain Gauge Locations

Rain Gauge ID Number	Site	Location
RG1	Edgewood School	West Rock Ave and Edgewood Ave
RG2	Boulevard Pump Station	Sea St and S. Water St
RG3	Albertus Magnus College	Huntington St and Winchester Ave
RG4	Police Substation	295 Blatchley Ave

Quality Control of Data

Once the data were gathered, they were tested by several different methods to ensure good quality of the data. These tests included checks for completeness, continuity, and reliability. For further reference and graphs, data tables, meter information, and field procedures, the reader is referred to ADS' report (1998).

Completeness check

The completeness check was designed to identify data gaps and periods with questionable or unusable data. Typically, flow rates were calculated by ADS using the continuity equation in concert with depth and velocity measurements. However, sometimes measurements were missing due to the existence of debris, grease, condensation in the ultrasonic crystals, or other unusual conditions at the monitoring site. ADS determined a relationship between depth and velocity at each site (using a program called Curvefit) that could be used to generate synthetic velocities for given depth data when velocity data were missing (ADS, 1998).

Table 4 shows the percentage of records that are missing from the database for depth, flow, and velocity. It also indicates the percentage of records which cannot be used for model calibration because of a variety of reasons or which should be used only with caution due to tidal influence. For the sites where data problems existed, a flag was put in the database next to each problematic record indicating that it should not be used for calibration ("NFC") or was tidally influenced ("TID"). Examples of reasons for designating records as "NFC" are blockages due to root obstructions and backwater due to mechanical failure of a system component such as a bar rack. The next-to-last column of Table 4 indicates for which sites the Curvefit program was used intermittently by ADS to generate velocities. A brief explanation of the problems with the data is given in the Comments column of Table 4 and then later in the *Reliability Check* section.

At Site C1, the large amount of missing data appears to have been caused by the use of the wrong timestep for most of September, as data were obtained at 15-minute increments instead of 5-minute increments. The problem was remedied on September 29.

Table 4. Results of Completeness Check

Meter	Percentage of Records					Curvefit used?***	Comments
	Without Depth	Without Flow	Without Velocity	Marked NFC*	Marked TID**		
M2	1.3%	1.3%	1.3%	0%	0%	Yes	
M3	0.1%	0.1%	0.1%	0%	0%	Yes	
M4	0.1%	0.2%	0.2%	0%	0%	Yes	
M5a	0.8%	1.1%	1.1%	0%	0%		
M5b	0.8%	0.8%	0.8%	0%	0%		
M6	0.0%	0.3%	0.3%	0%	0%	Yes	
M8	0.2%	1.1%	1.1%	0%	0%	Yes	
M9	1.2%	4.2%	4.2%	0%	19%	yes	Tidal influence
M10	0.1%	0.6%	0.6%	0%	0%	yes	
M14a	0.1%	0.2%	0.2%	0%	0%		
M14b	0.2%	0.2%	0.0%	0%	0%		
M15a	0.8%	1.2%	0.5%	4%	14%		Bar rack failure, tidal influence
M15b	0.1%	0.1%	0.1%	20%	11%		Bar rack failure, tidal influence
M16	3.9%	3.9%	3.9%	0%	0%		
M18	0.9%	1.0%	1.0%	13%	0%		Possible blockage
M19a	0.1%	0.1%	0.1%	0%	0%	yes	
M19b	0.1%	0.1%	0.0%	0%	0%		
M20	0.1%	0.3%	0.3%	0%	0%		
M21	0.2%	0.4%	0.6%	0%	32%	yes	Tidal influence
M22	1.0%	1.0%	1.0%	17%	0%	yes	Possible blockage
M24	0.3%	0.4%	0.2%	0%	0%		
M25a	0.1%	0.1%	0.1%	0%	33%		Tidal influence
M25b	0.3%	0.4%	0.1%	0%	0%		
C1	12.6%	12.6%	12.6%	9%	0%	yes	Possible blockage
C2	0.1%	0.4%	0.4%	0%	0%	yes	
RL1	1.0%	1.1%	0.9%	0%	0%		
RL2	0.0%	0.1%	0.1%	0%	0%		
S1	0.2%	3.1%	3.0%	57%	0%		Possible blockage
S2	0.8%	0.9%	0.8%	0%	0%		
S3	1.1%	1.3%	0.3%	28%	0%		Possible blockage
RG1		0.03%		0%	0%		
RG2		0.05%		0%	0%		
RG3		0.10%		0%	0%		
RG4		0.12%		0%	0%		

* Records were flagged in the database as "NFC" when they were not to be used for calibration. Such a designation could occur due to a blockage in the line or some other cause of bad data.

** Records were flagged as "TID" when they were to be used for calibration only with caution, due to tidal influence of the data.

*** ADS used the Curvefit program (when possible) when velocities were unavailable. See text for more information.

Continuity check

Balance Throughout the System

In order to ensure that the quantities being measured by the meters balanced, a check of continuity between meters within the system was made. A similar check was performed by ADS before they submitted their final report.

Average flows at each monitoring location were computed for the entire monitoring period and for a relatively dry period of six days from October 3-8, 1997 (0.06 in of rain was measured on October 5). Figure 4 shows a schematic of the flow monitoring network courtesy of ADS, with the average flows for the October period given next to each meter on the schematic (refer to Tables 1 and 2 for exact meter locations). Averages were calculated based on the five-minute measuring intervals and also by using hourly flows. For all meters the two types of averages were within 0.04 mgd. Figure 4 also shows flows measured by the meters at two of the larger pump stations (East Street and Boulevard) by the WPCA for the same October period. These values will be discussed in the next section.

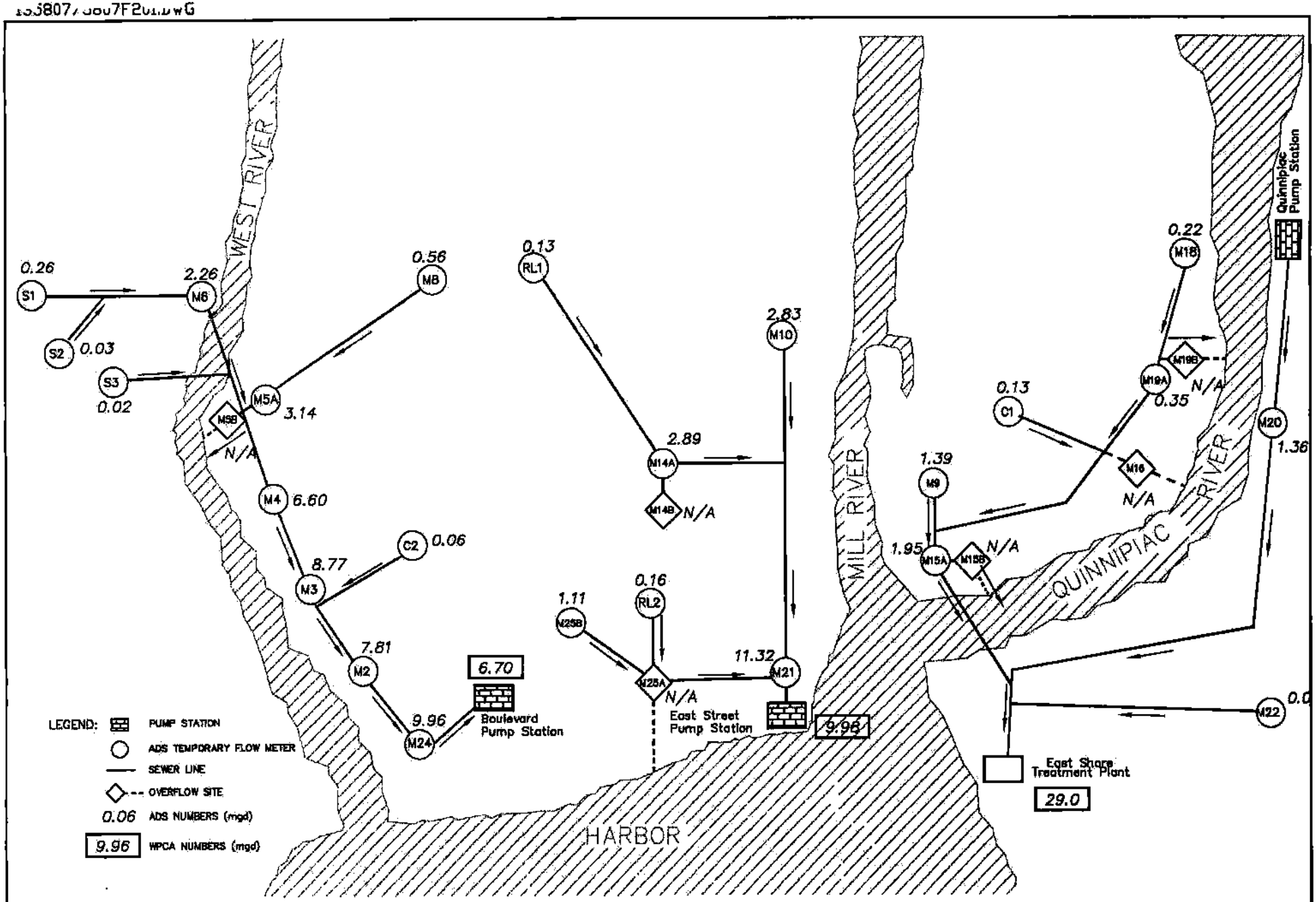
One significant discontinuity was discovered by ADS. Throughout the project, the average flow rate measured by M2 (Boulevard and Lamberton) was 0.93 mgd lower than that indicated by M3 (Boulevard and Orange Ave), although M2 was downstream and should therefore have registered a higher flow rate. This imbalance was thoroughly investigated by ADS personnel in the field, who took a new set of precise pipe measurements (to calculate cross-sectional area), examined every manhole in the approximately 3800 ft between the two sites, and spoke to personnel within the City. A letter from ADS describing the situation and providing field calibration data is given in Appendix B. The discontinuity is still under investigation. ADS plans to remeasure the cross-sections at the two sites with smaller increments as well as taking some instantaneous depth and velocity readings. When the issue is resolved, it will be addressed by an addendum to this technical memorandum.

Comparison of Data at Pump Stations

Another check involved comparing data from the two meters installed just upstream (in the diversion chambers) of the East Street and Boulevard Pump Stations and the WPCA flow records from the pump stations. The WPCA records hourly flow measurements on handwritten logs. Average flows for the October period were calculated from the WPCA records, and a comparison with those averages was made by using the totalizer values given on the logs. Table 5 shows the pertinent averages for comparison.

Table 5. Continuity Check of Pump Station Data (mgd)

Average Type	Boulevard		East Street	
	ADS Meter M24	WPCA Pump Station	ADS Meter M21	WPCA Pump Station
5-minute	9.96		11.32	
Hourly	9.97	6.68	11.28	10.46
Totalizer		6.70		9.98



ADS 80 North Harrison Ave Unit 31 Congers, NY 10920

Figure 4
Flow Monitoring Network Schematic
Average Daily Flow Oct. 3–8, 1997

It can be seen from the table that the numbers compare fairly well for the East Street Pump Station (ESPS). Although the hourly and totalizer averages for the ESPS show some discrepancy, the ADS values are within 8-13% of the WPCA flows, which indicates a fairly good agreement. However, the Boulevard Pump Station (BPS) comparison shows a large discrepancy, with the ADS data almost 50% higher than the BPS numbers. This discrepancy is under investigation to determine the cause. The mag meters at the BPS are scheduled for annual calibrations this month (March). Once the results of the calibrations have been received, a draw-down test of the pumps may be conducted to provide further information. As with the previous discrepancy, this issue will be addressed by an addendum to this technical memorandum once it is resolved.

Reliability check

Velocity vs. Depth Scatter Plots

In order to test the reliability of the data, depths and velocities were graphed for each site. Scatter plots were created to examine the spread of the data and confirm that they lie within reasonable limits. In general, the dry-weather flow data at the sites lay within a well-defined range that showed the diurnal variation of flows. When many different sites were compared, problems that occurred during the monitoring period were pinpointed and wet-weather flows became obvious. Figure 5 shows an example of a scatter plot at Site M4 (NPDES 004). The graph shows the relationship between instantaneous depth and velocity at hourly increments throughout the monitoring period. The plot indicates significant depths, such as the height of weirs (there are three weirs at this site), the pipe crown, and the silt level measured in the pipe. Also included is a vertical line at a velocity of 2.0 fps, which is generally considered to be the velocity needed for self-cleansing in a pipe. As can be seen in Figure 5, the bulk of the flows are at velocities slower than 2.0 fps. Wet-weather influence is seen to the upper right of the plot where there are fewer data points. Also indicated are two data points which occurred during a significant storm on October 31, 1997 (volume of a 3.5-month storm, peak 1-hour intensity of almost a 1-month storm). (Since the monitoring program, the two lower weirs at Site 004 have been raised to the level of the highest weir to combat dry-weather overflow problems.) Hourly plots for all of the monitoring sites are presented in Appendix C. On some of these plots, mean high tide and/or mean sea level are also included for reference.

Several sites were discovered to have had conditions which prohibit or caution the use of some data for calibration of the model. A brief description of the problems encountered is given below. Refer to Appendix C for the scatter plots at these sites.

Meter M9 (NPDES 009, Grand Ave @ James St)

The regulator is known to have tidal influence if the tide gate downstream at Site 015 is not working properly. The data indicate that a problem occurred with the tide gate towards the end of September, and spring tidal influence is seen for the duration of the project. The periods of influence included 10/14-10/20, 11/12-11/16, and 12/11-12/14, and caution is needed when using data from these periods for model calibration.

Meter M15 (NPDES 015, James St Siphon)

The regulator site is at a very low elevation, with the weir below the mean high tide elevation. There was apparent tidal influence during spring tides, despite the presence of a tide gate at the outfall. In addition, a mechanical failure of the bar rack leading to the

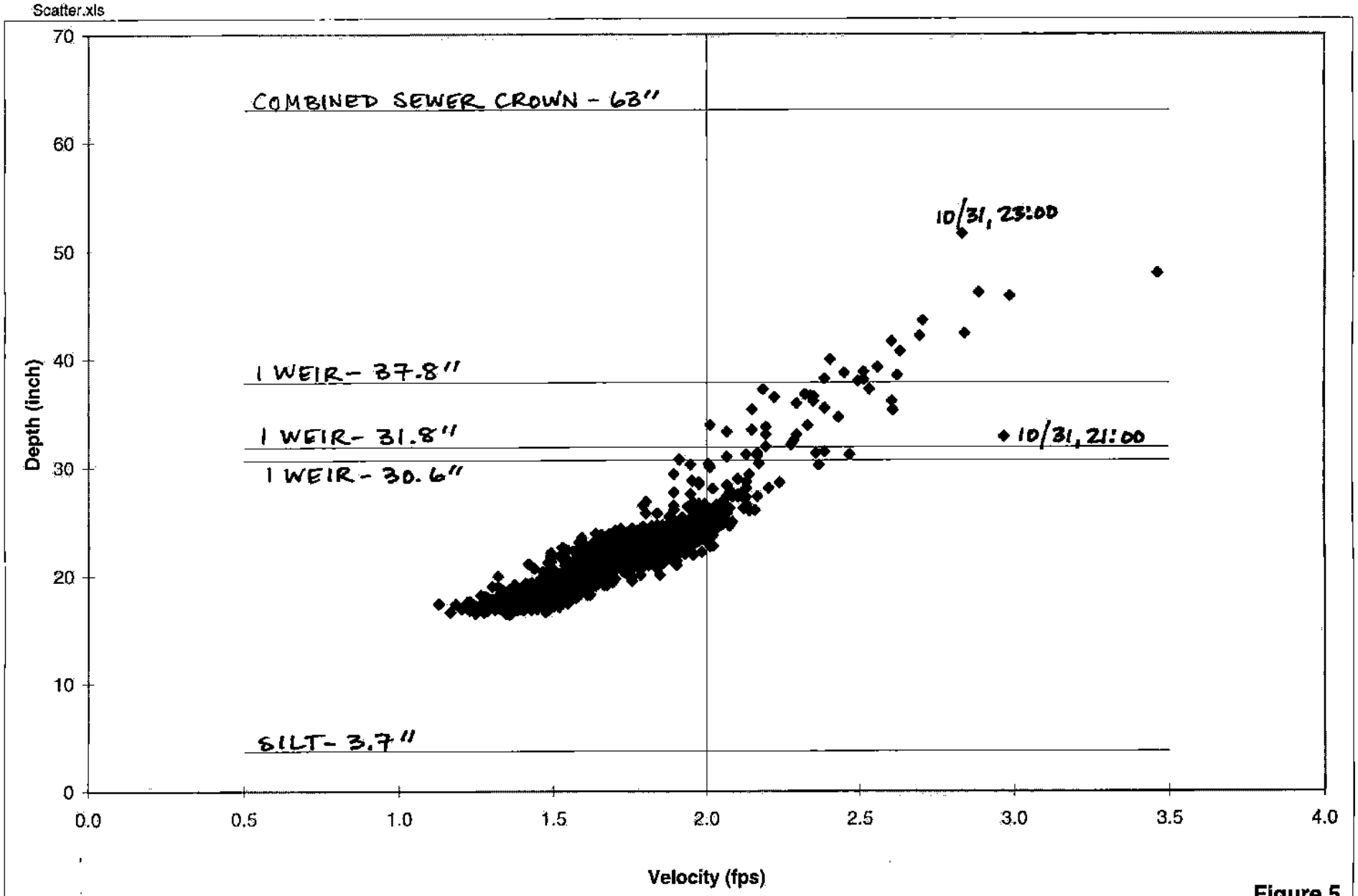


Figure 5
Meter M4 Hourly Graph
NPDES 004
(E.T.Grasso Blvd @ Legion Ave)

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siphon occurred during October, causing a dry-weather overflow. Backwater from the failure combined with tidal influence prevents the data from 10/11 to 10/29 from being used for calibration. Tidally-influenced data periods that can be used with caution for calibration include 9/17-9/20, 11/14-11/16, and 12/11-12/14.

Meter M18 (NPDES 018, Lombard St @ N. Front St)

High depths and low velocities, possibly indicating backwater from a downstream blockage, began on December 5 and continued through the end of monitoring on December 16.

Meter M21 (NPDES 021, East St Pump Station)

This site appears to be affected by spring tides. Data periods that were flagged to be used with caution during calibration include 9/12-9/21, 10/13-10/21, 11/12-11/16, and 12/9-12/16.

Meter M22 (NPDES 022, Allen Place)

High depths and low velocities apparent at the beginning of the project, from September 12 to 27, are possibly due to a blockage. Though the depth and velocity are more variant at this site than at others due to the nature of the flows (primarily highway drainage, with a small sanitary contribution from a nearby school), when compared to the data for the rest of the period, the data appear suspect.

Meter M25a (NPDES 025, Union St and State St)

This site appears to receive tidal inflow during spring tides. Periods that are to be used with caution during calibration include 9/12-9/20, 10/12-10/21, 11/12-11/16, and 12/9-12/16. It also appears from the data that this site receives inflow from the storm sewer (to which flow would be discharged in the event of an overflow). The configuration of the site allows flow to seep through weepholes at the bottom of the overflow pipe. The scatter plot shows influence from both wet-weather and tides at a range of velocities. More information about this site is given later in the *Overflow Statistics* section.

Meter C1 (Poplar St south of Grand Ave)

A probable blockage occurred in this combined sewer before the beginning of monitoring and continued until a rain event on September 20.

Meter S1 (Lowin Ave south of Fountain St)

This site was reported to have excessive silt and grease problems throughout the monitoring period. About October 23, depth began to increase and velocity began to decrease, indicating a possible blockage that continued for the duration of the monitoring program.

Meter S3 (Chapel St east of Alden Ave)

An apparent blockage occurred between September 20 and October 16 in this 12" diameter separated sewer which services a primarily residential area.

Precipitation

Comparison of Volumes with Previous Years

Though the monitoring program had a dry start, the overall volume of precipitation during the program turned out to be average: about 38 storms occurred, with a cumulative volume of 10 inches. This volume is an average amount for the autumn period when monitoring occurred. Figure 6 shows cumulative precipitation for the period of the monitoring program (September 12 through December 16) for 30 years. Data were obtained from two long-term USGS gauges: between 1948 and 1968 at Tweed Airport and between 1978 and 1995 at Lake Saltonstall. The latter data set was missing significant portions of its record, and years that did not have complete data sets were not included in this analysis. The rainfall (averaged over the four rain gauges) during the monitoring period in 1997 was 18th in the ranking (1 = greatest depth of rain) when compared to the 29 years that had complete data from the two USGS gauges. Table 6 provides a similar comparison that is separated into months. More years of data could be included in the monthly analysis because of sporadic data availability. As the table shows, October and November ranked 9th and 10th out of 40, respectively, while the pertinent portions of September and December were much drier, ranking at 30th and 28th, respectively.

Table 6. Precipitation Volume Comparison By Month

Rank	Sep 12-30		October		November		Dec 1-16	
	Year	Rain (in)	Year	Rain (in)	Year	Rain (in)	Year	Rain (in)
1	1960	7.3	1955	10.1	1963	8.6	1953	4.8
2	1966	4.5	1990	7.9	1951	7.8	1968	4.4
3	1956	3.4	1959	7.4	1983	6.8	1956	4.1
4	1993	3.3	1958	6.6	1968	6.6	1957	3.5
5	1995	3.2	1983	5.6	1955	5.6	1950	2.9
6	1961	3.1	1957	5.1	1985	5.2	1959	2.9
7	1989	3.0	1995	4.9	1948	5.0	1964	2.9
8	1958	3.0	1984	4.3	1954	4.7	1954	2.9
9	1987	2.8	1997	4.3	1957	4.5	1993	2.8
10	1962	2.7	1951	4.0	1997	4.2	1967	2.6
11	1983	2.7	1966	3.7	1953	4.0	1991	2.6
12	1991	2.7	1953	3.6	1959	3.9	1952	2.5
13	1952	2.6	1962	3.6	1962	3.6	1990	2.3
14	1963	2.6	1993	3.5	1967	3.5	1951	2.1
15	1949	2.3	1956	3.2	1994	3.4	1983	2.0
16	1955	2.2	1978	3.1	1982	3.3	1949	2.0
17	1978	2.0	1965	2.9	1956	3.2	1958	1.8
18	1957	2.0	1986	2.8	1950	3.1	1987	1.7
19	1954	1.8	1960	2.7	1958	2.9	1963	1.6
20	1965	1.3	1967	2.5	1966	2.9	1960	1.4
21	1990	1.3	1949	2.3	1952	2.8	1984	1.4

Rank	Sep 12-30		October		November		Dec 1-16	
	Year	Rain (in)	Year	Rain (in)	Year	Rain (in)	Year	Rain (in)
22	1992	1.3	1992	2.2	1993	2.6	1979	1.2
23	1964	1.3	1954	2.2	1995	2.6	1948	1.2
24	1953	1.2	1961	2.1	1961	2.6	1962	1.1
25	1988	1.2	1988	2.1	1960	2.5	1965	1.0
26	1986	1.1	1964	2.1	1989	2.3	1995	0.9
27	1951	1.0	1991	2.0	1992	2.3	1966	0.9
28	1967	0.9	1968	1.9	1964	2.2	1997	0.8
29	1985	0.8	1985	1.7	1984	2.2	1985	0.8
30	1997	0.7	1950	1.7	1949	2.2	1961	0.6
31	1950	0.7	1948	1.5	1965	2.0	1955	0.5
32	1948	0.6	1952	0.7	1988	1.8	1988	0.3
33	1959	0.0	1963	0.3	1990	1.7	1989	0.3
34	1984	0	1979	inc.	1991	0.3	1978	inc.
35	1968	0	1980	inc.	1978	inc.	1980	inc.
36	1979	inc.	1981	inc.	1979	inc.	1981	inc.
37	1980	inc.	1982	inc.	1980	inc.	1982	inc.
38	1981	inc.	1987	inc.	1981	inc.	1986	inc.
39	1982	Inc.	1989	inc.	1986	inc.	1992	inc.
40	1994	Inc.	1994	inc.	1987	inc.	1994	inc.

Note: inc. denotes incomplete data record which was not included in analysis

Return Periods of Precipitation Events

Another useful way to examine rainfall data is by determining the return periods, or recurrence intervals, of individual storms. The return period is a statistical measure of the likelihood of recurrence of a storm of particular size. For example, a one-year storm is a storm magnitude which has on any given day a 1 in 365 chance of occurring or being exceeded. It is a storm that, on average, could be expected to occur about once per year.

For determination of the return periods of storm events, a long-term consecutive rainfall record is required. Because the records available near New Haven were not consecutive and were not considered to be of sufficient duration, a 40-year record from Hartford's Bradley Airport was examined. (For comparison, because Hartford is not a coastal city, a long-term rainfall record from Providence, RI, was also examined, and the results were in agreement with those derived using the Hartford data set.) Both volumes (measured as inches of depth) and peak 1-hour intensities (in/hr) of storms in the 40-year period were examined to determine the recurrence intervals. The storms that occurred during the monitoring program could then be compared to the long-term plots to estimate the return periods of the events. Figures 7 and 8 show the results of these analyses for precipitation depth and intensity, respectively. The long-term record is plotted as a line, and the events from the monitoring program are graphed as diamonds. The volumes and intensities and their corresponding recurrence intervals for the storms during the monitoring program are given in Table 7, along with storm durations. The five highest volumes and intensities are

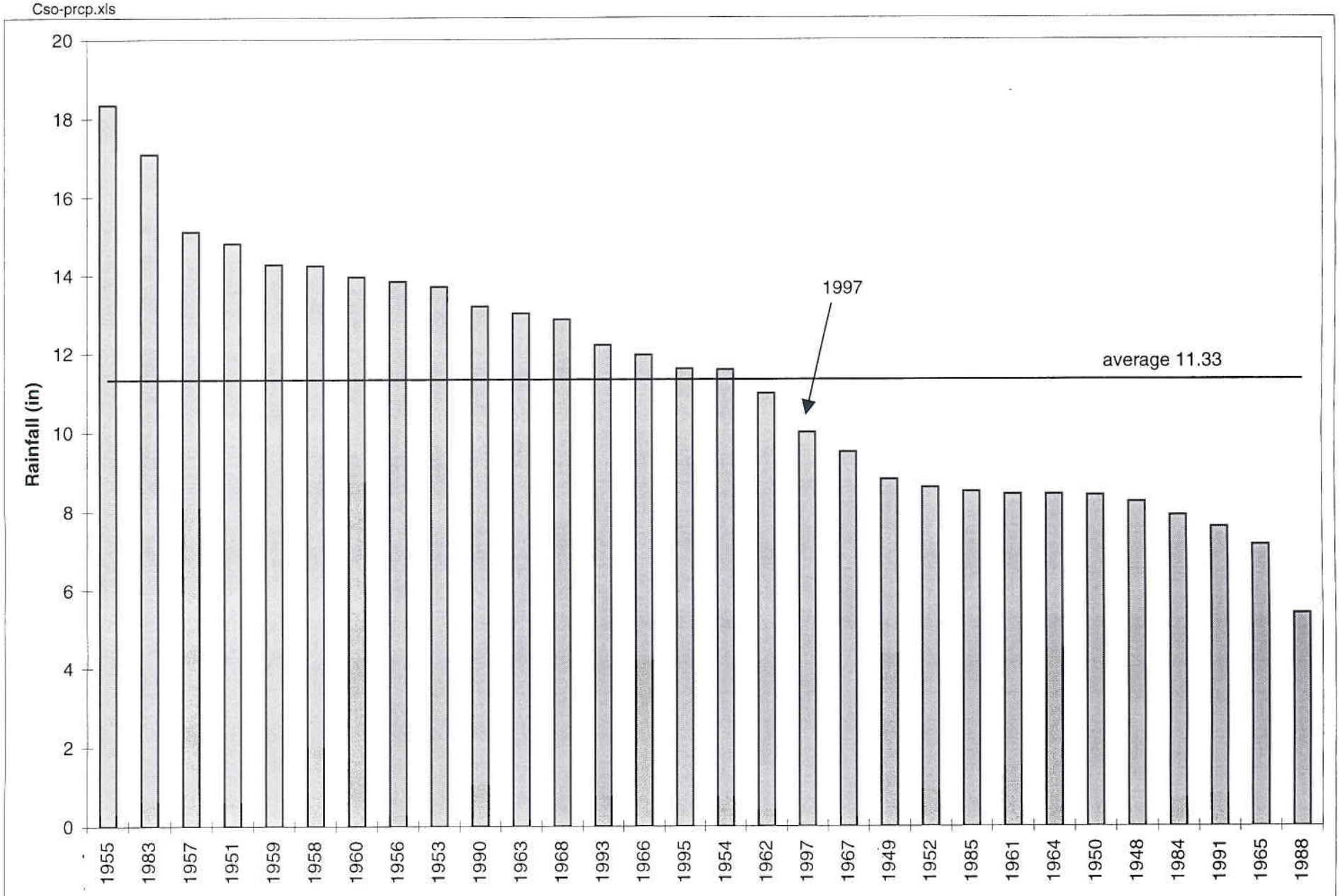

Figure 6
Cumulative Precipitation

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highlighted. Table 7 presents the results of the return period analysis for the *average* rainfall over the four gauges in the monitoring program. It was determined that the differences between using the average values and using those from only one gauge were not significant.

In determining what constituted a separate rain event, records from the East Shore Water Pollution Abatement Facility for the amount of effluent flow were examined for October 23-31, 1997. The beginning of this period was at the end of a long dry spell, and the period includes all or part of three storms. The wet weather influence on the WPAF effluent was observed to last less than six hours. Therefore, a six-hour interval was chosen to represent the smallest amount of time required between rain storms that are considered separate events. This interevent time was also employed in the computation of overflow statistics.

By examination of Figures 7 and 8, it can be seen that the storms that occurred during the monitoring program were neither of great magnitude nor high intensity. It was hoped that storms of a great variety of magnitude and intensity would occur during the program, so that a larger range of data would be available for calibration. Because the data do not adequately represent larger storms (for instance, a 2-year storm), if the hydraulic model is to be calibrated for such events, it will require extrapolating from the existing data. Such a method is feasible but requires assumptions and involves uncertainty.

Table 7. Volumes, Intensities, and Recurrence Intervals of Storm Events During Monitoring (Averaged Over All 4 Rain Gauges)

Event Date and Time	Precip Volume (in)	Volume Recurrence Interval (mth)	Precip Intensity (in/hr)	Intensity Recurrence Interval (mth)	Precip Duration (hr)
9/20/97 18:35	0.13	0.20	0.13	0.34	0.5
9/25/97 22:15	0.02	0.13	0.02	0.15	5.2
9/28/97 21:50	0.59	0.49	0.21	0.62	9.3
10/5/97 6:20	0.06	0.16	0.05	0.21	2.9
10/6/97 7:05	0.00	#N/A	0.00	#N/A	0.1
10/15/97 4:50	0.06	0.16	0.03	0.15	5.5
10/15/97 17:40	0.02	0.12	0.01	0.13	5.3
10/16/97 5:10	0.02	0.12	0.02	0.13	0.8
10/24/97 23:50	0.82	0.69	0.12	0.34	14.5
10/26/97 19:00	1.43	1.73	0.26	0.85	15.8
10/27/97 21:45	0.00	#N/A	0.00	#N/A	0.1
10/31/97 20:15	1.86	3.45	0.28	0.89	29.9
11/2/97 11:20	0.11	0.19	0.06	0.22	4.3
11/4/97 13:05	0.02	0.13	0.02	0.15	0.3
11/8/97 0:25	0.01	0.12	0.01	0.13	0.8
11/8/97 12:50	2.14	5.14	0.37	1.60	32.8
11/13/97 23:40	0.07	0.16	0.04	0.17	20.7
11/15/97 10:00	0.39	0.34	0.11	0.30	13.8
11/16/97 8:40	0.24	0.26	0.07	0.22	6.3
11/17/97 9:30	0.01	0.12	0.01	#N/A	0.6

Event Date and Time	Precip Volume (in)	Volume Recurrence Interval (mth)	Precip Intensity (in/hr)	Intensity Recurrence Interval (mth)	Precip Duration (hr)
11/20/97 7:55	0.00	#N/A	0.00	#N/A	0.1
11/21/97 21:20	0.75	0.63	0.16	0.44	16.9
11/22/97 22:45	0.09	0.18	0.03	0.15	12.4
11/24/97 6:00	0.01	0.12	0.01	#N/A	0.8
11/26/97 20:25	0.13	0.20	0.10	0.27	3.1
11/28/97 14:25	0.01	0.12	0.01	#N/A	0.3
11/29/97 8:00	0.00	#N/A	0.00	#N/A	0.1
11/30/97 15:35	0.19	0.23	0.05	0.18	15.7
12/4/97 3:15	0.12	0.20	0.08	0.24	4.0
12/4/97 21:50	0.01	0.12	0.01	#N/A	3.2
12/5/97 7:25	0.01	0.12	0.01	#N/A	0.7
12/5/97 15:20	0.09	0.18	0.06	0.22	2.4
12/5/97 23:55	0.00	#N/A	0.00	#N/A	0.1
12/10/97 14:15	0.01	0.12	0.01	#N/A	1.3
12/11/97 12:10	0.01	0.12	0.01	#N/A	1.8
12/12/97 9:15	0.22	0.25	0.06	0.22	11.8
12/13/97 8:05	0.32	0.30	0.10	0.27	10.2
12/14/97 9:40	0.06	0.16	0.04	0.17	2.4
TOTAL	10.00				256.5
MAXIMUM	2.14	5.14	0.37	1.60	32.8
MINIMUM	0.003	0.12	0.003	0.13	0.1
AVERAGE	0.26	0.51	0.07	0.34	6.8
STD DEV	0.51	1.04	0.09	0.33	8.3

Note: #N/A indicates that the corresponding volume or intensity was smaller than values considered in the long-term records, so a recurrence interval was not computed.

Overflow Statistics

The statistics of interest for overflow sites are frequency, volume, and duration of overflow events. The flow rate was estimated for each time step during a rainfall event, as explained below. By multiplying the flow rates by the timestep, a volume could be computed. The durations were estimated based on start and end times of depth in the pipe exceeding the overflow "trigger" depth (weir height or overflow pipe invert elevation).

The following statistics are estimates and they include uncertainty. Flow meters require calibration, unusual hydraulic conditions can be encountered in monitoring, and flow estimation equations employ empirical coefficients and sometimes require the use of simplifying assumptions—all of which add uncertainty to the estimates. In addition, statistics for most of the sites were estimated indirectly from depth measurements at or near the weir or overflow pipe. The following statistics are intended to give an approximation for the volume, frequency, rate, and duration of overflows and to allow comparison within

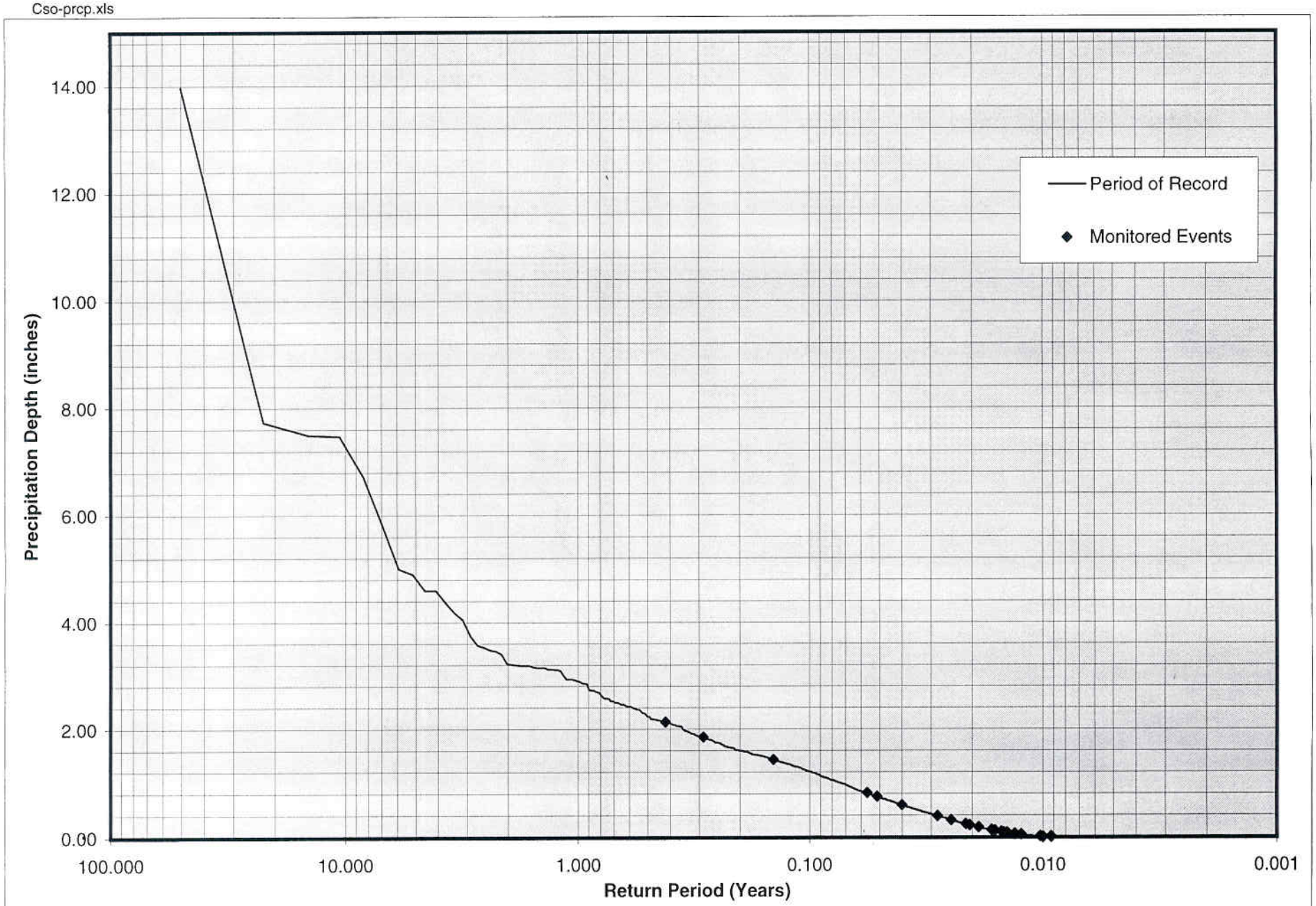

Figure 7
Precipitation Depth Return Periods

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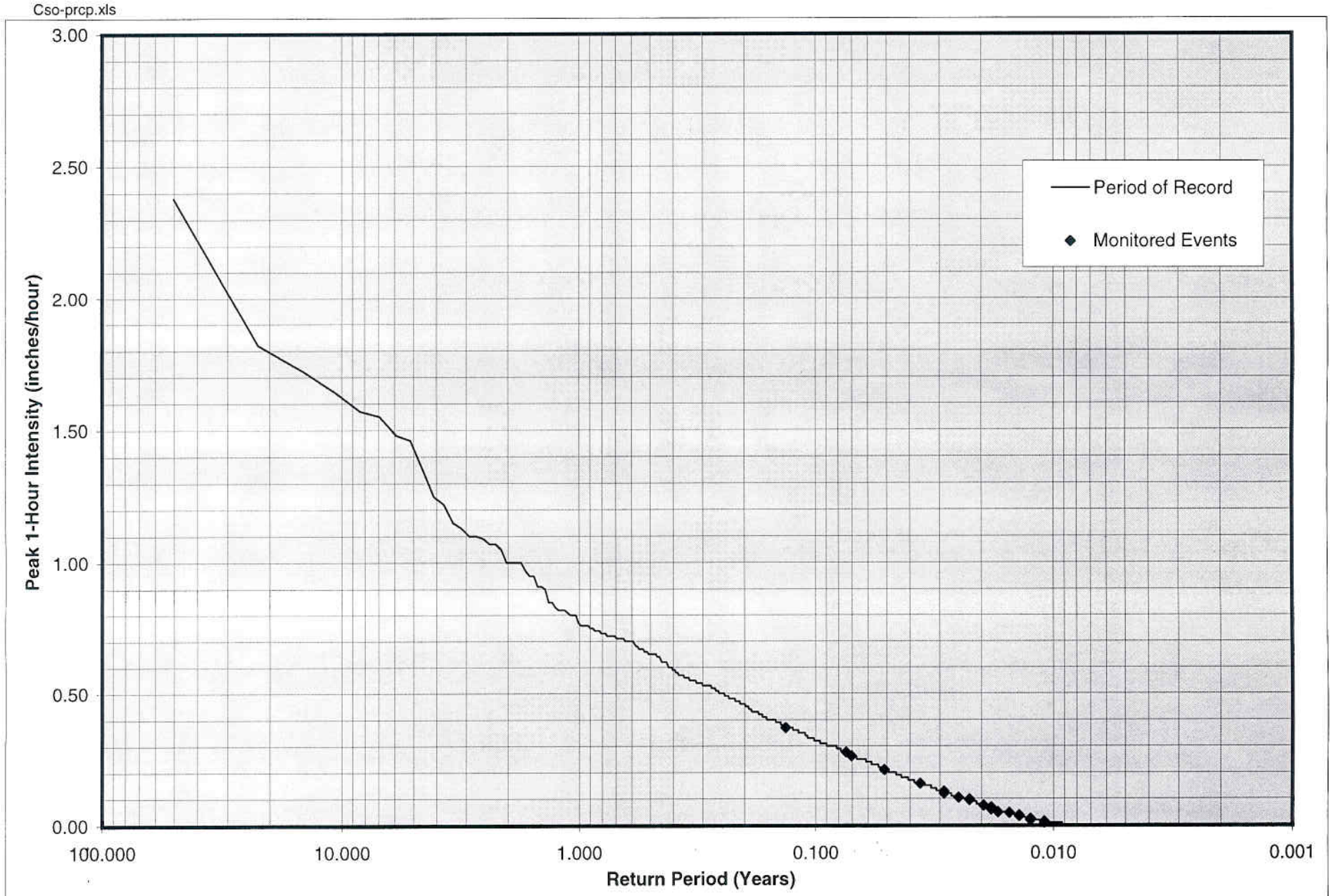

Figure 8
Precipitation Intensity Return Periods

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the system. In addition, the statistics can lead to the development of relationships which help predict the storm volume or intensity that might trigger overflows at individual sites.

As noted previously, an interevent time of 6 hours was chosen based on WPAF effluent flow records. Overflows that are separated by at least 6 hours are considered to be separate events. In some cases, a storm that varied in intensity but was lengthy in duration caused more than one overflow at a site.

Of the 30 meters employed during the program, 7 were placed in combined or separated areas to gauge local inflows. In addition, 4 sites each had two meters installed. Based on a comparison of flow depths to weir or overflow pipe invert elevations, 6 of the 19 regulator sites where meters were located did not have overflows during the monitoring period. These sites were NPDES #s 008, 010, 014, 020, 025, and a site just upstream of 025, which was termed 025b for convenience. (Overflows at Site 025b are conveyed by a storm sewer to which, approximately 3 blocks downstream, overflows at Site 025 are also discharged. The flows are then conveyed together about 0.8 miles to the twin outfalls on New Haven Harbor.)

To estimate discharge at the remaining 13 locations, three methods were used: 4 sites had direct meter placements in overflow pipes, so the flow rates had been measured; 8 locations had overflow weirs, and the weir equation could be used; discharge at the final site, with twin overflow pipes to a box culvert, was estimated using Manning's equation. Table 8 shows the correspondence between the sites (designated by NPDES number, except for Site 025b, as described above) and the method used to estimate overflow rates.

Table 8. Methods Used to Estimate Overflows at Specific Sites

Site	Method
002	Weir equation
003	Weir equation
004	Weir equation
005	Meter in overflow pipe
006	Manning's equation
008	(no overflow)
009	Weir equation
010	(no overflow)
014	(no overflow)
015	Meter in overflow pipe
016	Meter in overflow pipe
018	Weir equation
019	Meter in overflow pipe
020	(no overflow)
021	Weir equation
022	Weir equation
024	Weir equation
025	(no overflow)
025b	(no overflow)

For the locations with overflow weirs, the weir equation was used to estimate overflow discharge rates, which were then converted to volumes. The weir equation is

$$Q = CLH^{\frac{3}{2}}$$

where:

Q ≡ discharge (cfs)
C ≡ weir coefficient
L ≡ weir length (ft)
H ≡ head, or depth of flow over the weir (ft)

A value of 3.09 for the weir coefficient, corresponding to that for a broad-crested weir (Streeter and Wylie, 1985), was used for all sites with overflow weirs. The use of Manning's equation is detailed below in the description of NPDES Site 006.

Statistics

Tables 9 and 10 present the estimates of overflow statistics for CSO volumes and rates, respectively. Dates and times of storms with which overflows were associated are given in the first column of the tables. Note that, as mentioned previously, sometimes more than one overflow occurred during a storm that was considered continuous based on a 6-hour interevent time. In such cases, the date when the overflow occurred is noted without a time next to it. Volumes and peak intensities are indicated in the tables for each storm. Because rain data were collected in 5-minute intervals, peak intensities for the storms based on both 5 minutes and 1 hour are presented.

Site Descriptions and Computation Assumptions

The following section highlights details of interest at each site. It may be helpful to the reader to refer to Appendix C where the velocity-depth scatter plots are presented.

NPDES 002 (E.T. Grasso Boulevard @ Lamberton St)

One weir of approximately 3.9 ft in length was located at a depth of 60.6" above the meter, which was installed in the regulator chamber. Four overflows occurred at this location during the monitoring period. The highest volume (approximately 0.11 MG) and peak rate (about 10.5 cfs) occurred during the same storm on October 31, 1997. Data indicate that the interceptor surcharged a couple of times during the period. A silt level of approximately 9 inches was noted at this location. It can be seen on the scatter plot that even during wet weather the velocities at this site do not reach the self-cleansing velocity of 2 fps.

NPDES 003 (E.T. Grasso Boulevard @ Orange Ave)

An 8-ft long weir is located on the side of the Boulevard Interceptor at a depth of about 46.8" under Orange Avenue. Though the weir length along the interceptor is 8 ft, the 54" overflow pipe connects to the interceptor at a shallow angle which could cause overflows to flow over the weir in a skewed direction. For simplicity it was assumed that the weir length to be used in calculations was 8 ft.

Table 9. Estimated CSO Volumes

Storm Date and Time	Precipitation Event			CSO Volumes (MG)																		
	Volume (inches)	Peak 5-Minute Intensity (in/hr)	Peak 1-Hour Intensity (in/hr)	002	003	004	005	006	008	009	010	014	015	016	018	019	020	021	022	024	025	025b	Total
9/20/97 18:35	0.13	0.39	0.13			0.02	0.00002																0.02
9/25/97 22:15	0.02	0.12	0.02											0.03									0.03
9/28/97 21:50	0.59	0.57	0.21		0.09	0.21	0.00007			0.01			0.10	0.09	0.00004	0.01			0.01				0.52
10/5/97 6:20	0.06	0.15	0.05																				0
10/6/97 7:05	0.00	0.03	0.00																				0
10/15/97 4:50	0.06	0.06	0.03																				0
10/15/97 17:40	0.02	0.06	0.01																				0
10/16/97 5:10	0.02	0.06	0.02																				0
10/24/97 23:50	0.82	0.15	0.12		0.00004	0.18				0.00				0.17		0.01		0.05					0.42
10/26/97 19:00	1.43	0.36	0.26	0.07	1.62	1.57				0.14				0.36	0.01	0.04		1.42	0.01	4.22			9.45
10/27/97 21:45	0.00	0.03	0.00																				0
10/31/97 20:15	1.86	0.99	0.28	0.11	1.13	1.21	0.00002			0.07			1.07	0.06	0.002	0.01		0.08	0.0001	4.45			8.19
11/1/97				0.0003	1.23	1.63	0.002			0.27			2.09	0.45		0.07		0.92	0.001	5.36			12.03
11/2/97 11:20	0.11	0.12	0.06							0.00						0.003							0.006
11/4/97 13:05	0.02	0.12	0.02																				0
11/8/97 0:25	0.01	0.03	0.01													0.0002							0.0002
11/8/97 12:50	2.14	0.45	0.37	0.02	1.59	1.93	0.0003	0.12		0.15			2.12	0.43	0.02	0.02		0.05	0.01	1.20			7.65
11/9/97					0.41	0.90	0.002			0.01			0.64	0.18		0.04		0.003	0.0003				2.18
11/13/97 23:40	0.07	0.12	0.04																				0
11/14/97					0.03	0.14	0.00002						0.17	0.02		0.01			0.003				0.37
11/14/97																0.0001							0.0001
11/15/97 10:00	0.39	0.15	0.11							0.14				0.01									0.15
11/16/97 8:40	0.24	0.09	0.07													0.0003							0.0003
11/17/97 9:30	0.01	0.03	0.01																				0
11/20/97 7:55	0.00	0.03	0.00																				0
11/21/97 21:20	0.75	0.21	0.16		0.05	0.17				0.01			0.50	0.02		0.02			0.0002				0.77
11/22/97 22:45	0.09	0.06	0.03											0.01									0.01
11/24/97 6:00	0.01	0.06	0.01																				0
11/26/97 20:25	0.13	0.21	0.10			0.0002				0.0002				0.002		0.0004							0.003
11/28/97 14:25	0.01	0.06	0.01																				0
11/29/97 8:00	0.00	0.03	0.00																				0
11/30/97 15:35	0.19	0.09	0.05																				0
12/4/97 3:15	0.12	0.12	0.08											0.004									0.004
														0.004									0.004
12/4/97 21:50	0.01	0.06	0.01																				0
12/5/97 7:25	0.01	0.03	0.01																				0
12/5/97 15:20	0.09	0.12	0.06																				0
12/5/97 23:55	0.00	0.03	0.00																				0
12/10/97 14:15	0.01	0.03	0.01																				0
12/11/97 12:10	0.01	0.03	0.01																				0
12/12/97 9:15	0.22	0.12	0.06																				0
12/13/97 8:05	0.32	0.21	0.10											0.01		0.0002							0.01
12/14/97 9:40	0.06	0.06	0.04																				0
Totals	10.00			0.20	6.16	7.97	0.00	0.12	0.00	0.80	0.00	0.00	6.70	1.84	0.03	0.22	0.00	2.53	0.02	15.23	0.00	0.00	41.82
Maximum	2.14	0.99	0.37	0.11	1.62	1.93	0.002	0.12		0.27			2.12	0.45	0.02	0.07		1.42	0.01	5.36			12.03
Average	0.26	0.15	0.07	0.05	0.68	0.72	0.001	0.12		0.07			0.96	0.12	0.01	0.01		0.42	0.003	3.81			0.97
Minimum	0.003	0.030	0.003	0.0003	0.00004	0.0002	0.00002	0.12		0.0002			0.101	0.002	0.00004	0.0001		0.003	0.0001	1.20			0

Note: an overflow event listed with a date but not a time occurred at least 6 hours after the previous overflow event but during a storm which was considered to be only one event (i.e., no gaps of at least 6 hours). See text for more detail.

Table 10. Estimated Peak CSO Rates

	Precipitation Event			CSO Rates (cfs)																		
Storm Date and Time	Volume (inches)	Peak 5-Minute Intensity (in/hr)	Peak 1-Hour Intensity (in/hr)	002	003	004	005	006	008	009	010	014	015	016	018	019	020	021	022	024	025	025b
9/20/97 18:35	0.13	0.39	0.13			1.7	0.01															
9/25/97 22:15	0.02	0.12	0.02											4.8								
9/28/97 21:50	0.59	0.57	0.21		7.6	12.5	0.02			1.4			6.4	5.0	0.02	0.6			0.9			
10/5/97 6:20	0.06	0.15	0.05																			
10/6/97 7:05	0.00	0.03	0.00																			
10/15/97 4:50	0.06	0.06	0.03																			
10/15/97 17:40	0.02	0.06	0.01																			
10/16/97 5:10	0.02	0.06	0.02																			
10/24/97 23:50	0.82	0.15	0.12		0.01	2.7				0.04				8.5		0.4		1.6				
10/26/97 19:00	1.43	0.36	0.26	4.1	29.5	24.5				2.6				8.9	1.4	0.6		17.9	0.4	46.3		
10/27/97 21:45	0.00	0.03	0.00																			
10/31/97 20:15	1.86	0.99	0.28	10.5	39.7	40.3	0.01			3.0			18.1	5.4	0.4	0.6		3.3	0.02	73.6		
11/1/97				0.1	13.0	15.2	0.9			5.0			41.1	10.0		0.9		6.3	0.1	30.7		
11/2/97 11:20	0.11	0.12	0.06							0.2						0.3						
11/4/97 13:05	0.02	0.12	0.02																			
11/8/97 0:25	0.01	0.03	0.01													0.1						
11/8/97 12:50	2.14	0.45	0.37	2.1	32.2	30.6	0.1	7.0		3.6			26.4	14.0	2.6	0.7		3.4	0.2	33.4		
11/9/97					9.4	13.7	0.9			0.3			27.5	3.9		0.6		0.4	0.03			
11/13/97 23:40	0.07	0.12	0.04																			
11/14/97					2.5	7.0	0.01						7.8	1.7		0.6			0.6			
11/14/97																0.03						
11/15/97 10:00	0.39	0.15	0.11							3.6				1.5								
11/16/97 8:40	0.24	0.09	0.07													0.03						
11/17/97 9:30	0.01	0.03	0.01																			
11/20/97 7:55	0.00	0.03	0.00																			
11/21/97 21:20	0.75	0.21	0.16		2.1	4.4				0.7			12.4	4.6		0.6			0.1			
11/22/97 22:45	0.09	0.06	0.03											3.4								
11/24/97 6:00	0.01	0.06	0.01																			
11/26/97 20:25	0.13	0.21	0.10			0.1				0.1				0.5		0.1						
11/28/97 14:25	0.01	0.06	0.01																			
11/29/97 8:00	0.00	0.03	0.00																			
11/30/97 15:35	0.19	0.09	0.05																			
12/4/97 3:15	0.12	0.12	0.08											0.7								
														1.7								
12/4/97 21:50	0.01	0.06	0.01																			
12/5/97 7:25	0.01	0.03	0.01																			
12/5/97 15:20	0.09	0.12	0.06																			
12/5/97 23:55	0.00	0.03	0.00																			
12/10/97 14:15	0.01	0.03	0.01																			
12/11/97 12:10	0.01	0.03	0.01																			
12/12/97 9:15	0.22	0.12	0.06																			
12/13/97 8:05	0.32	0.21	0.10											5.9		0.02						
12/14/97 9:40	0.06	0.06	0.04																			
Maximum	2.14	0.99	0.37	10.5	39.7	40.3	0.9	7.0		5.0			41.1	14.0	2.6	0.9		17.9	0.9	73.6		
Average	0.26	0.15	0.07	4.2	15.1	13.9	0.3	7.0		1.9			20.0	5.0	1.1	0.4		5.5	0.3	46.0		
Minimum	0.003	0.03	0.003	0.1	0.01	0.1	0.01	7.0		0.04			6.4	0.5	0.02	0.02		0.4	0.02	30.7		

Note: an overflow event listed with a date but not a time occurred at least 6 hours after the previous overflow event but during a storm which was considered to be only one event (i.e., no gaps of at least 6 hours). See text for more detail.

There was no access directly at the weir, so the meter was placed in the Boulevard interceptor approximately 50 ft downstream of the weir. It is believed that the hydraulic grade line at the meter is representative enough of that upstream at the weir to use the metered depths for estimating overflows.

There were 9 overflows at this location during the monitoring period, including 2 overflows with a volume of about 1.6 MG and a peak overflow rate of about 30 cfs. An overflow of smaller volume which occurred on October 31 had the highest peak overflow rate at this site of almost 40 cfs. The site did not surcharge during the monitoring period. A silt level of about 2 inches was noted by ADS during field work. As noted for Site 002 downstream, the scatter plot for Site 003 indicates that the velocities did not reach the self-cleansing velocity of 2 fps even during wet weather.

NPDES 004 (E.T. Grasso Boulevard @ Legion Ave)

Three 2-ft long weirs constitute the regulator at this site. During the monitoring program, the weirs were at depths of 30.6", 31.8", and 37.8", although recently (Feb/Mar 1998) the two lowest weirs have been raised to the level of the highest weir (37.8") to address overflow problems. No access was available at the regulator, so the meter was installed about 26 ft downstream of the weirs. The site did not surcharge during the monitoring period. Although the combined sewer is 63" high, with the lowest weir at a depth of 30.6" the interceptor could not flow more than half full before overflowing. During the monitoring period, 11 overflows occurred at this site. The peak overflow rate of 40 cfs occurred on October 31, and the highest overflow volume, estimated at 1.9 MG, was associated with a storm on November 8. Silt of about 3.7" depth was noted by ADS. In contrast to the sites downstream of this location, velocities in the interceptor at this location reach and surpass the self-cleansing velocity. It appears possible that this velocity is reached sometime during the diurnal cycle, but certainly it is exceeded during storms.

NPDES 005 (E.T. Grasso Boulevard @ Derby Ave)

Two meters were installed at this site: one in the inflow pipe and one in the overflow pipe. The site has a complex arrangement. Incoming dry-weather flow passes the first flow meter (M5a) and drops into an elliptical opening 2 ft wide by 3 ft long that leads to the interceptor. When flow rates become fast enough, the flow leaps across the opening, but is partially obstructed by a curved "bump" that matches the curve of the interceptor running below it and reaches a maximum height of about 21.6" above the invert of the inflow and overflow pipes. The bump has two orifices through which additional flow can be conveyed to the interceptor or received from the interceptor if it is surcharged. Beyond this structure is the overflow pipe—where the second meter (M5b) was installed—which leads to the outfall on the West River.

The scatter plot for M5a indicates that the connection between the inflow pipe and the interceptor did not exceed the weir height during the monitoring period. However, overflows can still occur by two other methods at this site: incoming flows at high enough rates to jump the elliptical opening, or the interceptor surcharging through the holes in the bump of the pipe. The scatter plot for M5b shows depths greater than the weir height. Therefore, it is likely that at least some of the overflows at this site were due to surcharge in the interceptor. The data from meter M5b also indicate that the pipe takes a significant

amount of time to drain completely. Drainage "tails" are seen on the depth plots following each overflow.

Seven overflows occurred at this site during monitoring, although all were small in comparison to other sites throughout the city. The highest volume (0.002 MG) was associated with the storm of October 31-November 2. The peak rate (0.88 cfs) was observed a week later on November 9. Velocities in the inflow pipe were almost always higher than the self-cleansing velocity of 2 fps, and velocities in the overflow pipe exceeded this number at times during wet weather. No surcharging or sediment deposition were noted in either monitoring location.

NPDES 006 (Whalley Ave @ Fitch St)

A 36" diameter line discharges into a 60" combined sewer just upstream of the twin 24" overflow pipes at 006. The pipes flow into a box culvert which leads to the West River. Overflows were estimated by using Manning's equation,

$$Q = \frac{c_0}{n} A R^{2/3} S_0^{1/2}$$

where

Q ≡ discharge (cfs)
c_0 ≡ coefficient, 1.49 for English units
n ≡ Manning's n
A ≡ cross-sectional area of the flow (ft^2)
R ≡ hydraulic radius, defined as cross-sectional area/wetted perimeter (ft)
S_0 ≡ bedslope of the box culvert (ft/ft)

Manning's n was assumed to be 0.013 for a brick pipe (Chaudhry, 1993). The bedslope was calculated from the invert and outfall elevations and pipe length to be approximately 0.090 ft/ft, or 9%. The depth in the interceptor necessary for an overflow to occur is approximately 30.5".

Only one overflow occurred at this site during the monitoring period. Its volume was estimated to be 0.12 MG, and its peak rate was determined to be approximately 7 cfs. The overflow occurred on November 8. The scatter plot for this location shows that velocities do not vary much diurnally and never surpass the self-cleansing velocity of 2 fps. Indeed, the site has about 13" of silt deposited in the 60" combined sewer, indicating low velocities.

NPDES 008 (Munson St @ Orchard St)

The meter at this site indicated that there were no overflows during the monitoring period. According to a letter from the City Engineer to DEP in October of 1996, the overflows at this site and nearby 007 were eliminated through sewer separation. At 007, overflows are physically prevented by a plug in the overflow pipe, but the structure at 008 was left open, presumably so that very extreme events can be relieved. The data obtained through monitoring showed that depths during wet weather were quite low, reaching a peak of about 15.3" during a storm of 2.14" (maximum 1-hour intensity 0.37 in/hr) in a pipe that is 39" in height. Overflows would occur for depths exceeding 32.6".

NPDES 009 (Grand Ave @ James St)

There are no detailed drawings of this regulator and there is no access manhole at the overflow regulator. Therefore, the meter was installed in a manhole approximately 35 ft downstream of the regulator. Owing to the lack of access, it was necessary to make some assumptions about the height of the regulator. It was assumed that the connection functions like a weir, so that dry-weather flow passes through the interceptor and wet-weather flow, once it reaches a certain depth, spills over into the overflow pipe. For simplicity, it was assumed that the weir length was equal to the overflow pipe diameter, or 36". It was assumed that the weir is at the springline of the interceptor, or a depth of ½ of 43.75" (21.9"). These assumptions were determined to be reasonable based on a video from a recent TV inspection at the regulator.

Eleven overflows were estimated to have occurred at this site during the monitoring period. It is important to note that the assumptions above directly impact the estimation of overflow statistics, since the overflow volumes were calculated based on depth of flow in the interceptor. The greatest volume and peak rate of an overflow—0.27 MG and 5 cfs, respectively—occurred on November 1. Although self-cleansing velocity is exceeded, perhaps daily, but certainly during wet weather, a silt level of about 10.4" was noted during monitoring. The site did not surcharge during the period.

This site is known to have tidal influence if the tide gate at Site 015 (James St Siphon) is not working properly. There is indication from meter M15b that a problem with the tide gate occurred towards the end of September and continued through the end of the monitoring period. Data from meter M9 clearly show spring tidal influence during October and December. Influence likely occurred during November, but it was masked by wet weather.

NPDES 010 (East St @ I-91)

There are two separate regulator chambers at this site, approximately 8 ft apart. The upstream weir is 9.5 ft long at a depth of 62.4". The downstream weir, 3.8 ft long, allows an overflow for depths greater than 54.4". The configuration of the two chambers allows overflows to occur at the downstream weir before the upstream weir. However, there were no overflows during the monitoring period at this site. A small silt level of about 2.4" was observed. The site did not surcharge during the monitoring period.

NPDES 014 (Trumbull St @ Orange St)

At this location the combined sewer is connected via a chamber to a storm sewer, and there is a small weir between them. The weir is at an elevation that is equivalent to a depth of 55.2" in the combined sewer and 14.4" in the storm sewer. The configuration is such that either pipe could overflow into the other. The meters at this site indicated that there were no overflows during the monitoring period. Depths never rose above 25.5" in the combined sewer or 5" in the storm sewer. Neither the 66" combined sewer nor the 68" storm sewer surcharged during the period, and no silt was observed. The combined sewer flows at velocities above 1.5 fps and well surpasses the self-cleansing velocity on a daily basis. The storm sewer did not have velocities above 2 fps, even during wet weather.

NPDES 015 (James St Siphon)

The meters were located in the regulator chamber which is upstream of the siphon intake. One meter (M15a) was placed in the inflow pipe, and the other (M15b) in the overflow pipe.

Dry weather flow makes a turn of about 60° at the weir and flows through an orifice which has an area of approximately 3 ft^2 that is created by the position of stop logs in the chamber. Typical dry weather flow depths are below mean sea level. Wet weather overflows occur over the weir to the overflow pipe when depths in the chamber exceed 37.9". The weir is at an elevation which is about 14.5" ***below*** the mean high tide level. Though there is a tide gate at the outfall (approximately 170 ft from the weir), significant tidal influence was seen in the data at spring tides.

The siphon has two bar racks which provide screening of the flows before they enter the siphon. In October, one of the bar racks malfunctioned and the backup rack failed to come into service. A significant flow backup occurred which led to a dry-weather overflow. This event potentially spanned three rain events, based upon the dates in the dry-weather overflow report made by the WPCA. It is impossible to determine the magnitude of wet weather overflows which might have occurred associated with these events under normal hydraulic conditions, although it should be noted that the data report by ADS indicates spikes in the flows associated with the storms.

There was no water in the overflow pipe at the beginning of the monitoring period. On September 29 something occurred which caused the depth recorded by M15b to never drop below approximately 8.5" for the duration of the monitoring period. It is surmised that a problem with the tide gate occurred which prevented its proper operation and forced a certain depth of water to remain in the pipe.

Overflow statistics were computed by using the data from meter M15b, which was placed in the overflow pipe. Because of the daily tidal influence, a threshold value of 1.0 mgd was used to filter the data. Only flows exceeding 1.0 mgd were included in the data from which statistics were estimated. This assumption caused the volumes and durations reported to be lower than what likely occurred, but it allowed the calculation of representative statistics. Without using a threshold value, the statistics program would calculate excessive durations and volumes.

Not including the dry (and possibly wet) weather overflow(s) that occurred in late October, there were 7 overflows at this site. The peak rate of 41.1 cfs happened on November 1, while the greatest overflow volume (2.12 MG) occurred a week later on November 8. The inflow pipe data showed evidence of surcharge.

NPDES 016 (Poplar St @ River St)

The meter at this site was installed in the overflow pipe. Though there is a tide gate at the outfall, significant tidal influence is observable in the pipe. Every effort was made when examining the overflow statistics to ensure that reported overflows were associated with rain events and were not just due to high tides. However, there is more uncertainty in the statistics at this site than at many of the other sites because of this influence.

Sixteen overflow events occurred during the monitoring period. The highest volume (0.45 MG) and peak rate (14.0 cfs) occurred on November 1 and November 8, respectively. Data indicate that at times the overflow pipe flows full, but it did not become surcharged during the monitoring period. The weir is at a depth of 39.8" in the 48" overflow pipe.

NPDES 018 (Lombard St @ N. Front St)

Four overflows occurred at this site during the monitoring period, although they were comparatively small. Both the largest volume (0.02 MG) and peak rate (2.5 cfs) of the overflows were associated with a storm on November 8. The self-cleansing velocity is exceeded on a daily basis, and there was no silt reported for the monitoring site. However, the Front Street Interceptor, into which the combined sewer at this location flows, has a significant silt layer—25" deep in a 36" pipe. No surcharging of the combined sewer at the monitoring site occurred during the period.

NPDES 019 (Pine St @ N. Front St)

This site lies downstream of Site 018, on the Front Street Interceptor. Fourteen overflows occurred during the period. The most significant overflow volume (0.07 MG) and the highest overflow rate (0.87 cfs) occurred during the same storm on November 1. There was no access directly at the regulator, so an additional meter was placed in the overflow pipe. No surcharge was noted at the site, but self-cleansing velocity was reached only on two occasions during wet weather and a significant silt layer of about 8.4" was reported. The overflow pipe appears to be influenced by spring tides; however, depths in the overflow pipe due to tides did not surpass the assumed weir height, and therefore it is surmised that tidal intrusion to the interceptor is not occurring. There is no tide gate at the outfall, but the pipe is at a steep slope and the assumed weir height is almost 40" above mean high tide. It should be noted, though, that the monitoring elevation was 18" above mean high tide and influence by spring tides was observable.

NPDES 020 (Quinnipiac Ave @ Clifton St)

The configuration at the site allows a 12" sanitary pipe to overflow into a storm sewer discharging to the Quinnipiac River. The meter indicated that there were no overflows during the monitoring period. The data show that this location is impacted by the pump cycle at the upstream Quinnipiac Ave Pump Station. No surcharge was indicated by the data and no sediment deposition was reported.

NPDES 021 (East St Pump Station)

This monitoring site is at the junction chamber that functions as a bypass for the East Street Pump Station. The pump station has 4 pumps, each capable of pumping 9900 gpm, or approximately 14.3 mgd. Six overflows occurred during the monitoring program. The peak overflow volume and rate of 1.4 MG and 17.9 cfs, respectively, occurred during a storm on October 26-27. Some tidal influence is notable at spring tides. Data indicated that the inflow pipe surcharged often during wet weather. No sediment deposition was reported, as the self-cleansing velocity is exceeded at times during wet weather.

NPDES 022 (Allen Place)

This site primarily receives storm drainage coming from a nearby highway, but there is also a small amount of sanitary sewage discharged. Eight overflows occurred during the monitoring period. The largest volume (0.007 MG) and peak rate (0.85 cfs) were comparatively small, and both occurred during the same storm on September 28. No surcharge of the inflow pipe or sediment deposition were noted.

NPDES 024 (Boulevard Pump Station)

This site is located at the bypass chamber for the Boulevard Pump Station. The pump station is equipped with 4 pumps, each of which can handle 8000 gpm (~11.5 mgd). Four overflows occurred at this site, and three of them exceeded the volume of all other overflows during the monitoring period at any site. The volumes ranged from 1.2 MG (November 8) to 5.4 MG (November 1). The peak rates were also quite high comparatively, ranging from 30.7 cfs (November 1) to 73.6 cfs (October 31). Some surcharge occurred, and it should be noted that the weir crests are below the crown of the inlet pipe. The velocity-depth profile at this site was different from those at other sites, as wet weather influence tended to *decrease* velocities while increasing depths. Velocities exceeded the self-cleansing velocity of 2 fps except during wet weather.

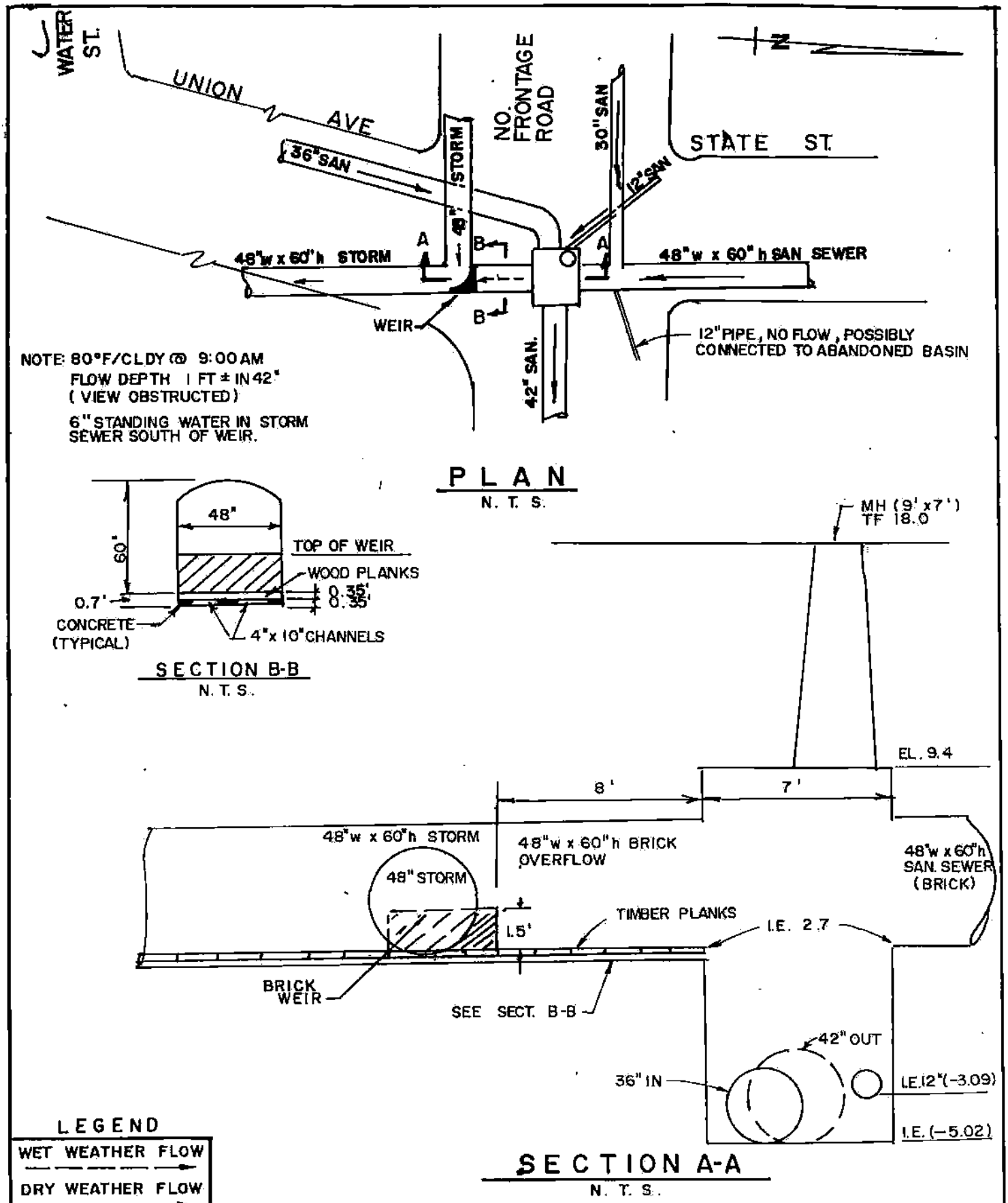
Tidal inflow to the regulating chamber from the overflow pipe was documented during a site survey. Unlike many of the other sites that are affected by tides, the data do not show any particular influence during spring tides, leading to the conclusion that tidal influence could be a common or even daily occurrence at this site. The mean high tide elevation is only 3.5" below the weirs, and the normal depth of flow is approximately mean sea level.

NPDES 025 (Meter M25a, Union St and State St)

This monitoring site is also located at the junction chamber for the bypass of a pump station—the Union Pump Station, which has 4 pumps with a total capacity of 23,700 gpm, or approximately 34 mgd. The data at this site indicate that there were no overflows during the monitoring period. However, there was significant tidal intrusion and stormwater inflow. The overflow pipe is constructed such that stormwater from beyond the weir in the overflow pipe can seep into the regulator chamber via weep holes in the weir (see Figure 9). The bottom of the overflow pipe upstream of the weir is raised with boards approximately 4" so that water can flow underneath. Depths measured in the overflow pipe indicate that flow must have also entered the overflow pipe by flowing over the weir from the storm sewer back into the regulator chamber. In addition, depths of up to 45" in the overflow pipe indicate that the 7-ft deep regulator chamber must have been nearly filled at times, indicating that the pump station was not keeping up with the inflow. It is estimated that 18.7 MG of tidal and storm water entered the combined sewer system through this regulator during the monitoring program and was conveyed to the WPAF for treatment—an average of about 0.2 MG per day.

Meter M25b (Temple St @ George St)

This site is approximately three blocks upstream of Site 025. It contains an overflow regulator which allows excessive flows to be discharged to the same storm sewer to which Site 025 (Meter M25a) overflows downstream. Although it has not been assigned an NPDES number, the site was selected for monitoring to determine whether overflows occur and, if so, to provide some statistics about the overflows. The data indicate that there were no overflows during the monitoring period.



OVERFLOW NO. OE 9/025
UNION AVE @ STATE ST.
NEW HAVEN, CONNECTICUT

Figure 9
Regulator Sketch
for NPDES Site 025

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Data Management

The purpose of the data management plan is to maintain collected data in a format that will support model calibration. This section identifies software packages and formats used in establishing an electronic database for the project and expands on the information that was provided in a previous submittal (Technical Memorandum #4).

An important requirement of calibration data is that they be easily imported into the model. This requirement, the facility of using PC-based software, and the use of Microsoft products within the consulting team led to the choice of Microsoft Access as the database software for the data library. In addition to the convenience of storing large numbers of records (90 days of data taken at 5-minute intervals produces almost 26,000 records per site), Microsoft Access provides a method of querying the databases which can be used to perform quality control of the data, create summaries based on grouping data (such as hourly records), and identify records which should not be used or should be used cautiously in calibrating the hydraulic model.

A new database was created for data from each different source. Thus, flow data for the WPCF and flow data from the City boundaries constitute two separate databases. Within a database, different tables were used to distinguish between different monitoring locations or gauges. Table 11 shows details about the different data sets that constitute the data library.

Table 11. Contents of Data Library

Data Type	Source	Description	Data Interval	Measurement Interval	Number of Tables
Rainfall	WPCA	ESWPAF	7/94 – 5/97	30 min	1
Rainfall	RWA	Nearby Rain Gauges	1/96 – 6/97	15 min	6
Rainfall	EarthInfo	Tweed	1948-1969	Daily	1
		Saltonstall	1978-1995	Daily	1
		Saltonstall	1991-1995	Hourly	1
Flow, Depth, Velocity	ADS	Long-Term Meters on City Boundary	1/96 – 12/97	15 min	12
Flow, Depth, Velocity	ADS	Temporary Meters in Fair Haven	3/97 – 4/97	15 min	7
Flow	WPCA	ESWPAF	1/93 – 5/97	Daily	1
Flow	WPCA	4 small PS	7/96 – 6/97	Bi-monthly	4
Flow	WPCA	3 large PS and WPAF effluent	1/96 – 5/97 9/97 – 12/97	Hourly	4

Conclusions

Correlation of Overflow Statistics with Rain Events

If there is a correlation between overflow statistics such as volume and rate with precipitation volume or intensity, the correlation can be used as a predictive tool during future wet weather events. For example, it could be known that if 0.5" of rain occurred, 5 sites would begin to overflow, and the potential overflow volume could be estimated. Using a method of graphing called bubble plots, the possibility of correlations was examined at all the sites. Figures 10 and 11 show bubble plots for two of the sites, NPDES 016 and 022, respectively. Overflow volumes are graphed against precipitation volume, with the size of the point (bubble) representing precipitation intensity. Figure 10 shows a strong correlation between overflow volume and precipitation volume (R^2=0.97). As precipitation volume increases, so does the overflow volume. In addition, generally the bubbles grow in size as the volumes increase. Figure 11 shows a site which has no correlation. This site has extremely variable flows that consist primarily of highway drainage, which probably leads to more variable responses to rain events. It is possible that with more events the site would begin to show more of a correlation. Appendix D presents plots for all sites where overflows occurred. In addition to the plot types described above, bubble plots with CSO rate versus precipitation intensity and bubble size dependent on precipitation volume are also included in Appendix D.

Using trendlines, predictive equations could be developed for sites that had reasonable correlations. Table 12 presents the equations and R^2 values for the overflow sites which were active during the monitoring period and had correlations. It also indicates for which sites correlations could not be developed because of too few data points or highly variant data. For the volume equations, x is the precipitation volume and y the overflow volume. For the intensity/rate equations, x represents the precipitation intensity and y the overflow rate. It is interesting to note that for every case except one, the R^2 values for the rate equations were lower than the corresponding values for the volume equations. The one exception was at Site 018, where there were only 4 data points with which to develop a trend. For many of the sites, the volume correlation was quite strong, suggesting that it is reasonable to use the equations to estimate when overflows might occur and of what magnitude they might be. It is important to note that if the sewer system is in a state different from that under which the equations were developed, the equations should be applied with caution. Such a case might occur if the interceptors were cleaned of sediment or if a blockage was occurring during the storm.

Table 12. CSO Trendline Equations and R^2 Values

	Precipitation Volume and CSO Volume		Precipitation Intensity and CSO Rate	
NPDES Site	**Equation**	**R^2 Value**	**Equation**	**R^2 Value**
002	Too few data points to develop correlation			
003	$y = 0.5421x^2 + 0.0073x$	0.86	$y = 251.01x^2 + 17.173x$	0.70
004	$y = 0.7398x^2 - 0.0862x$	0.96	$y = 223.05x^2 + 22.741x$	0.72
005	$y = 0.0004x^2 + 0.0003x$	0.94	$y = 9.3261x^2 - 0.7642x$	0.79
006	Too few data points to develop correlation			
009	$y = 0.0285x^2 + 0.0554x$	0.56	$y = 7.5104x^2 + 8.6829x$	0.46
015	$y = 0.5275x^2 + 0.3772x$	0.92	$y = -10.101x^2 + 91.66x$	0.47
016	$y = 0.1104x^2 + 0.0606x$	0.97	$y = 11.621x^2 + 31.923x$	0.63
018	$y = 0.0035x^2 - 0.0019x$	0.51	$y = 37.709x^2 - 7.1096x$	0.79
019	$y = 0.0099x^2 + 0.0124x$	0.89	$y = -4.4601x^2 + 3.6814x$	0.51
021	Too few data points to develop correlation/no apparent correlation			
022	Too few data points to develop correlation/no apparent correlation			
024	Too few data points to develop correlation			

There are uncertainties involved with monitoring flows in a sewer system, caused by factors ranging from debris in the sewer to unusual hydraulic conditions to insufficient data about overflow weirs. The overflow statistics in this report have been derived from a consistent data set that has been quality controlled, and they can serve as a picture of what occurs in New Haven's system. In some cases, correlations make it possible to predict what might happen during future storms.

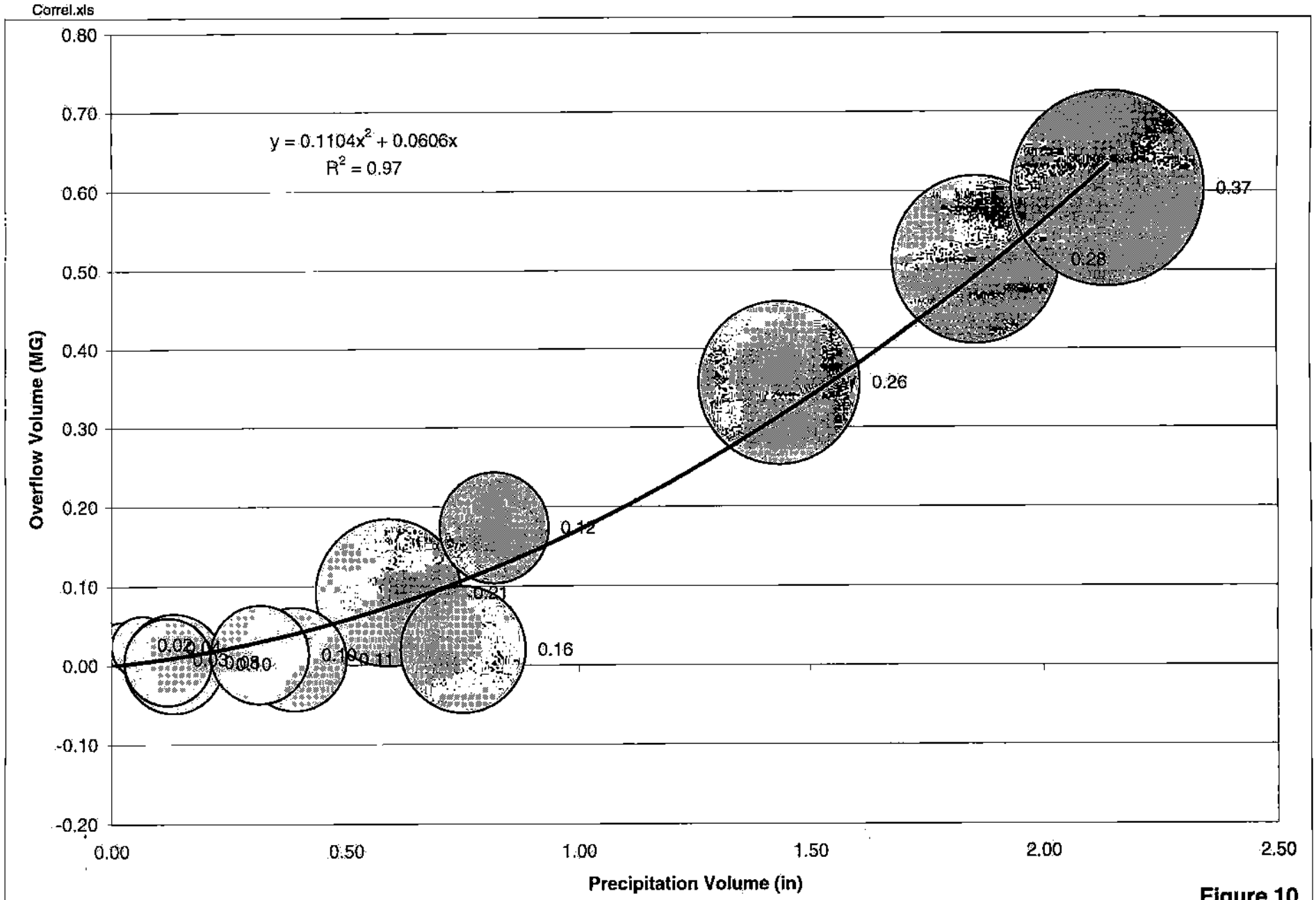

Figure 10
Correlation Bubble Plot
for NPDES Site 016

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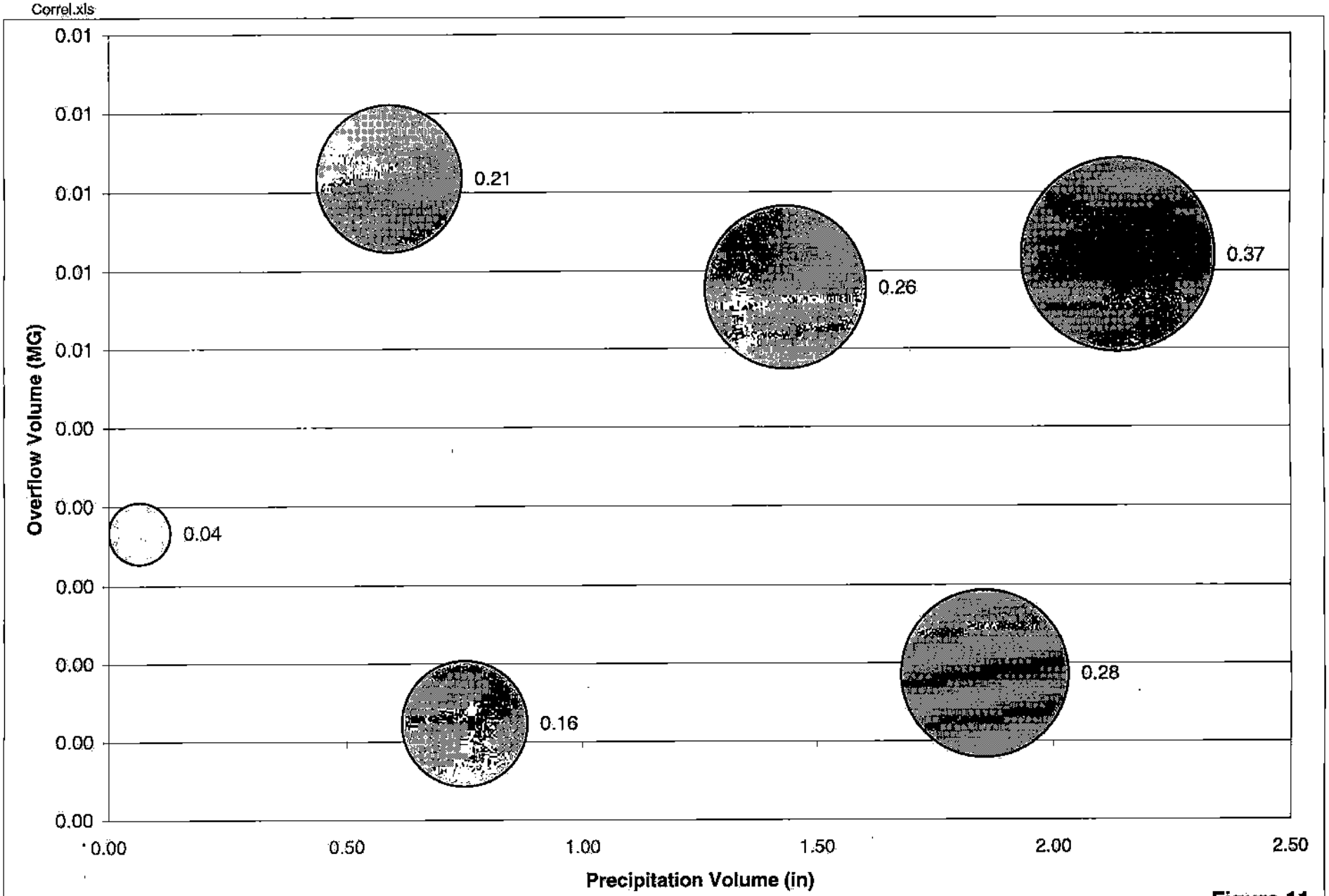

Figure 11
Correlation Bubble Plot
for NPDES Site 022

CH2MHILL

References

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Appendix A: Monitoring Site Sheets

Source: ADS Environmental Services, 1998.

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		C1
RG Zone	**Bat Serial #**	**Monitor #**
RG4		
Velocity	**Lit Diameter**	**Diameter**
	N/A	PH = 45.50" PW = 30.50"

oject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

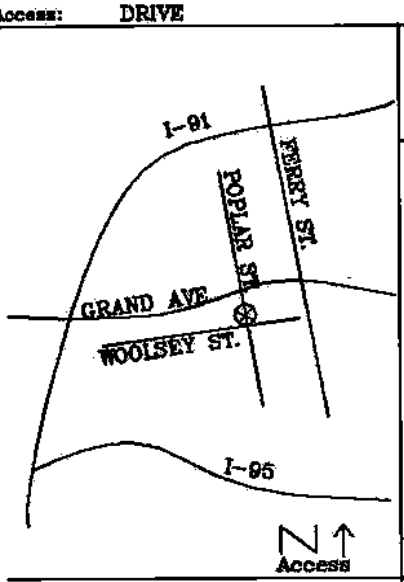
ss/Location: 244 POPLAR STREET

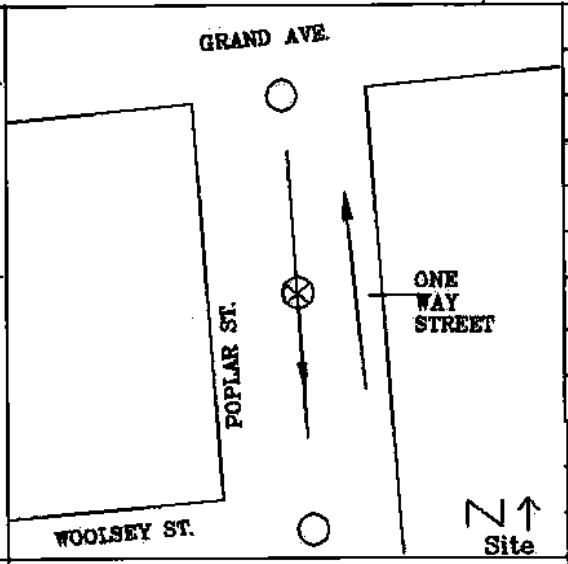
(BETWEEN GRAND AVENUE AND WOOLSEY STREET)

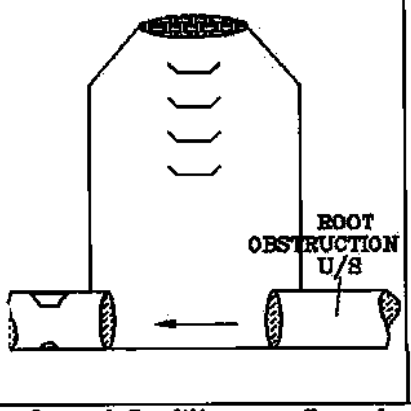
one Co. Address:

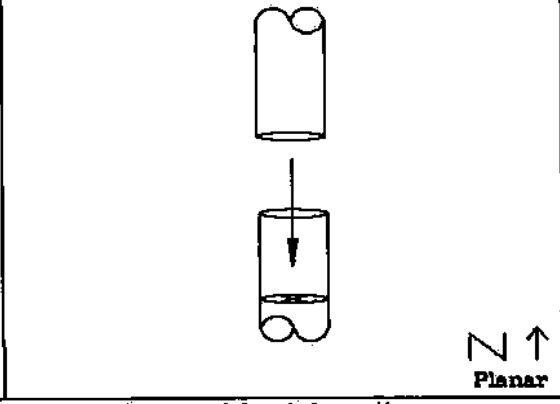
Phone Number:

Access: DRIVE









INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED DOWNSTREAM OF MANHOLE

SAFETY

Manhole Depth: 16.0'

Traffic: LIGHT-MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD, SLIGHTLY CHOPPY FLOW, BUT MONITORABLE

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: YES Height: 5.0'

R.O.W. #: N/A

Inv.: DOF: 4.00" +/- .25" Time: 09:45 Vel: 1.50 fps Silt: 0.0"

Upstream Manhole DID NOT INVESTIGATE

GOOD 1500 MONITORABLE SITE

A LOT OF ROOT OBSTRUCTIONS UPSTREAM

Downstream Manhole DID NOT INVESTIGATE

Land System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		C2
RG Zone	**Bat Serial #**	**Monitor #**
RG2		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 48.00" PW = 30.50"

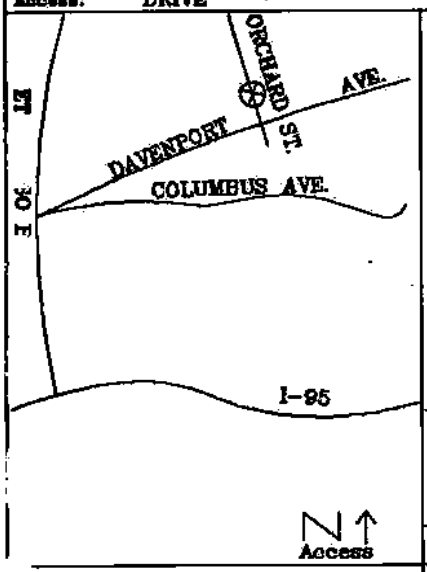
oject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

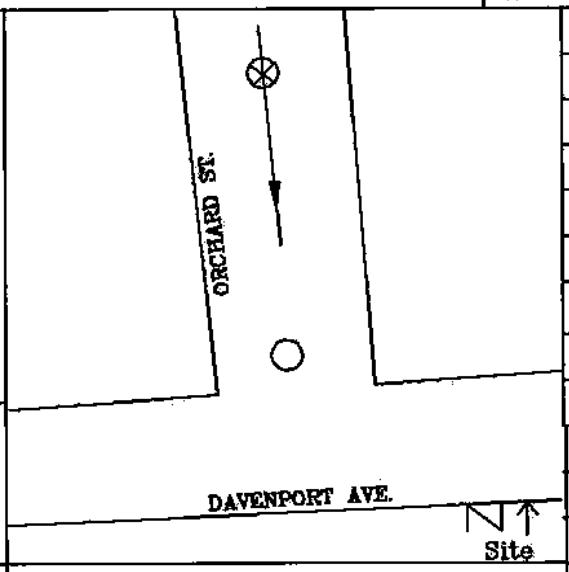
ss/Location: ORCHARD STREET; NORTH OF DAVENPORT AVENUE

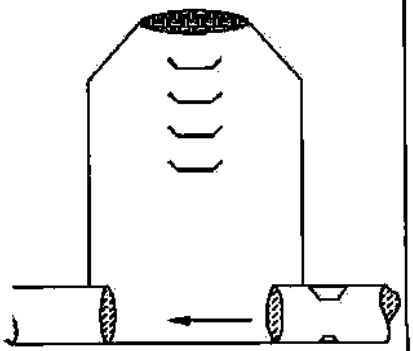
one Co. Address:

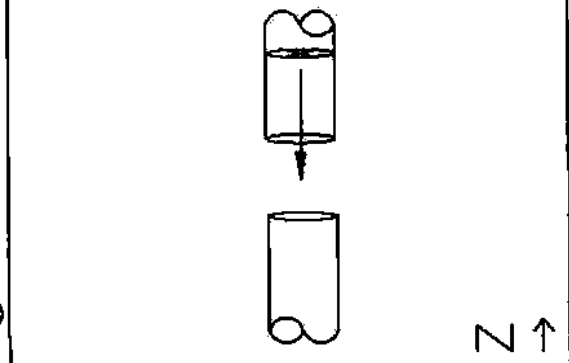
Phone Number:

Access: DRIVE









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: SHALLOW, SMOOTH, LAMINAR FLOW

urcharge: N/A Height: N/A

Inv.: DOF: 3.00" +/- .25" Time: 13:10 Vel: 1.50 fps Silt: 0.50"

'pstream Manhole DID NOT INVESTIGATE

ownstream Manhole DID NOT INVESTIGATE

Snd System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED UPSTREAM OF MANHOLE

SAFETY

Manhole Depth: 20.0'

Traffic: MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

GOOD 1500 SITE

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M2
RG Zone	Bat Serial #	Monitor #
RG2		
Velocity	Lif Diameter	Diameter
	N/A	PH = 82.00" PW = 101.00"

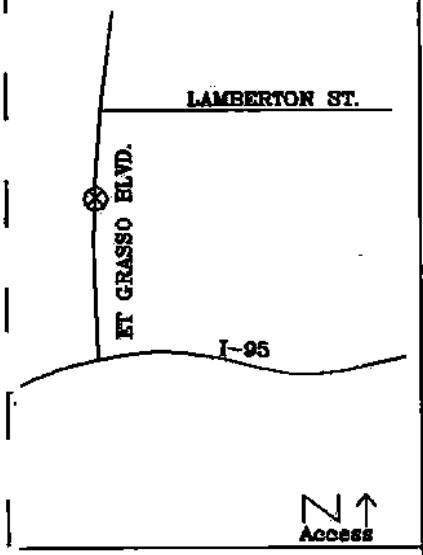
Project/Phase: NEW HAVEN CSO Date: 5 SEPT 97 Name: MPN

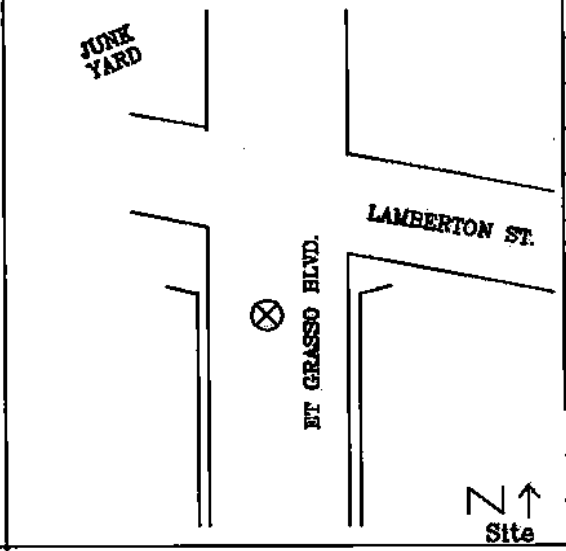
Area/Location: UNDER ET GRASSO BOULEVARD; SOUTH OF LAMBERTON STREET

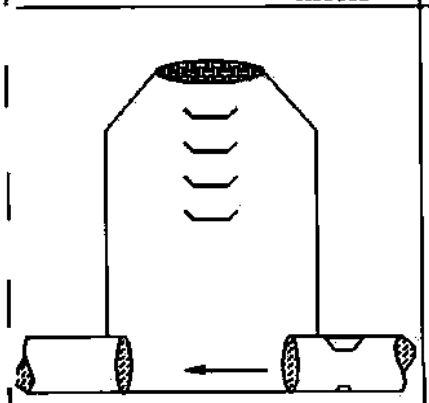
Phone Co. Address:

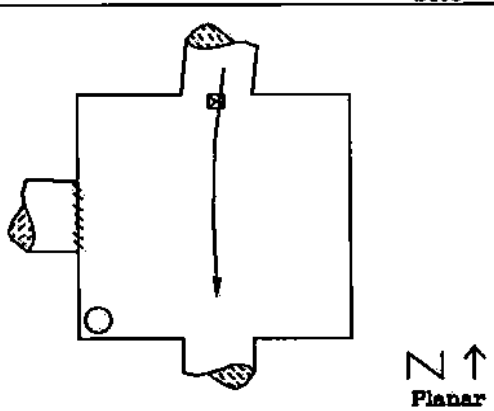
Phone Number:

Access: DRIVE INTO JUNK YARD









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: SLOW, DEEP SMOOTH FLOW

Surcharge: YES Height: 10.0'

Inv.: DOF: 26.00" +/- .25" Time: 09:15 Vel: 1.0 fps Silt: 0.0"

Upstream Manhole DID NOT INVESTIGATE

Downstream Manhole DOES NOT ISOLATE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION

PRESSURE & VELOCITY INSTALLED JUST U/S OF CHAMBER, ULTRASONICS ARE INSTALLED ON OVERHEAD OF CHAMBER

SAFETY

Manhole Depth: 15.0'

Traffic: NEGATIVE

Gas @ Investigation: GOOD

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

NEED CHEST WADERS TO INSTALL

SITE COVERED WITH TIRE & MATTRESS

NO MANHOLE COVER

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M3
RG Zone	Bat Serial #	Monitor #
RG2		
Velocity	Lif Diameter	Diameter
	N/A	PH = 64.50" PW = 73.00"

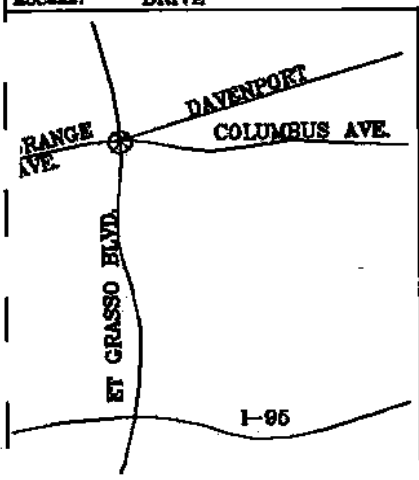
Project/Phase: NEW HAVEN CSO Date: 2 SEPT 97 Name: MPN

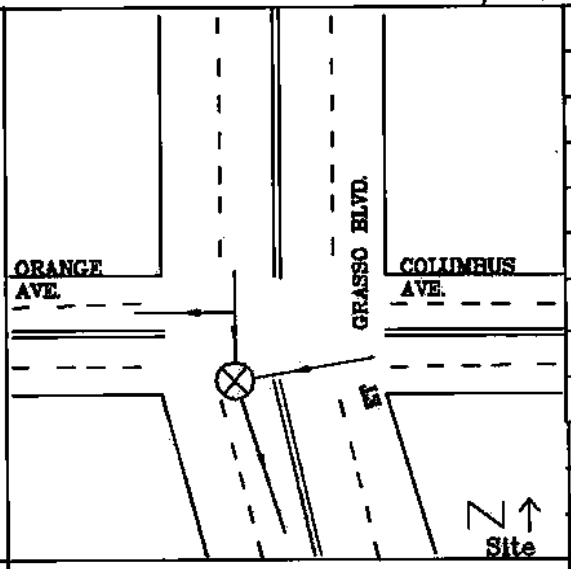
Address/Location: ORANGE AVENUE AND ET GRASSO BOULEVARD

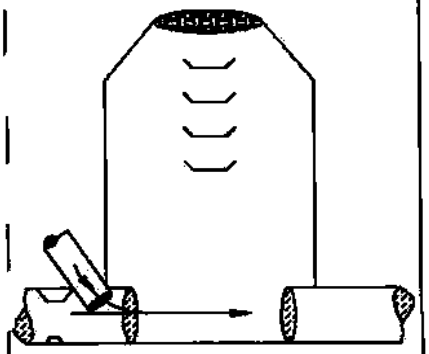
Phone Co. Address:

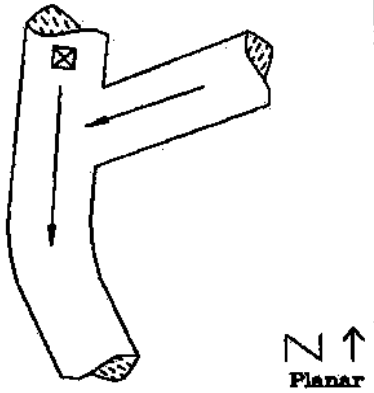
Phone Number:

Access: DRIVE









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: DEEP, SMOOTH, SLOW FLOW

Surcharge: YES Height: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

Upstream Manhole GOOD SITE

Downstream Manhole DID NOT INVESTIGATE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC VELOCITY & PRESSURE INSTALLED U/S OF MANHOLE NOT INCLUDING FLOW FROM EAST ON COLUMBUS AVENUE

SAFETY

Manhole Depth: 5.0'

Traffic: HEAVY

Gas @ Investigation: NEGATIVE

Manhole Condition: FAIR

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Policy:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

TOP SIDE INVESTIGATION CONDUCTED

NEED CHEST WADERS FOR INSTALLATION

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M4
RG Zone	Bat Serial #	Monitor #
RG1		
Velocity	Lif Diameter	Diameter
	N/A	PH = 63.00" PW = 65.00"

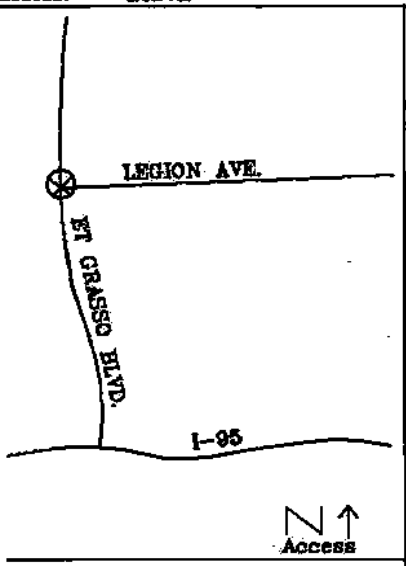
Project/Phase: NEW HAVEN CSO Date: 2 SEPT 97 Name: MPN

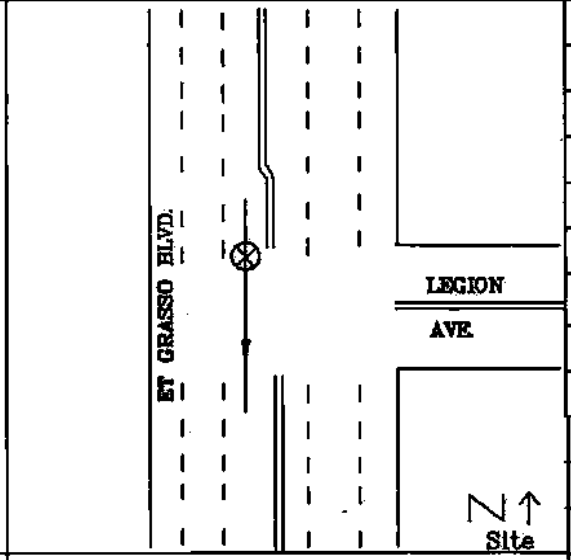
Area/Location: LEGION AVENUE AND ET GRASSO BOULEVARD

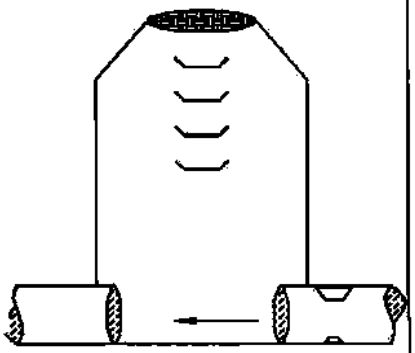
Phone Co. Address:

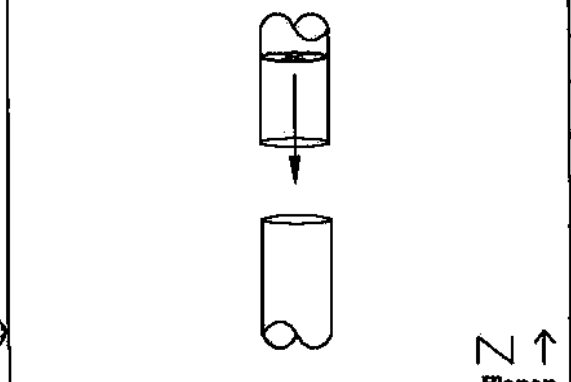
Phone Number:

Access: DRIVE









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: DEEP, SMOOTH FLOW

Surcharge: N/A Height: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

Upstream Manhole GOOD SITE

Downstream Manhole GOOD SITE

Grid System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION

ULTRASONIC, VELOCITY & PRESSURE

INSTALLED UPSTREAM

SAFETY

Manhole Depth: 10.0'

Traffic: HEAVY

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

TOP SIDE INVESTIGATION DONE

NO MEASUREMENTS TAKEN

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M5A
RG Zone	**Bat Serial #**	**Monitor #**
RG1		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 48.25" PW = 49.50"

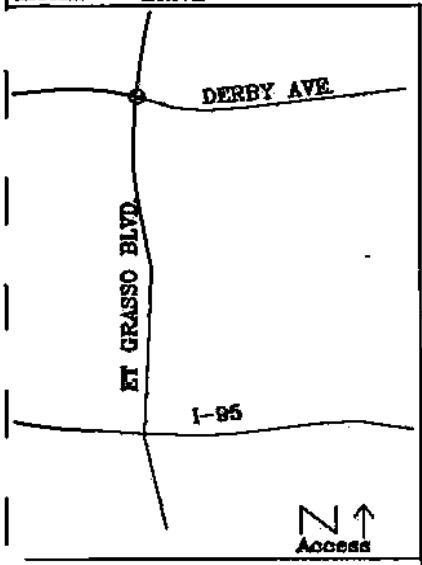
roject/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

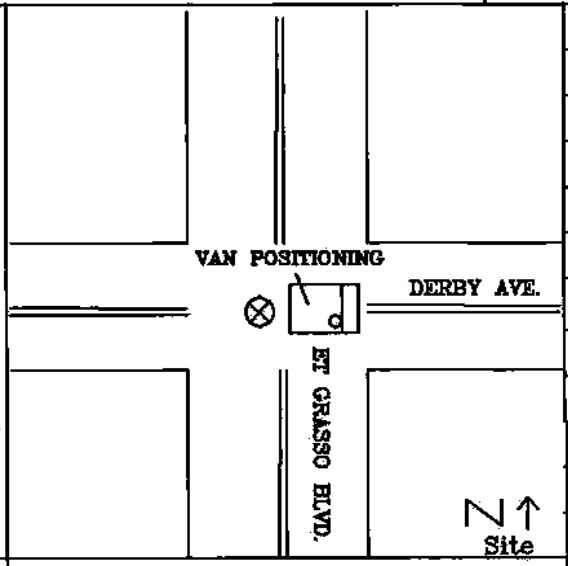
ss/Location: DERBY AVENUE @ ET GRASSO BOULEVARD

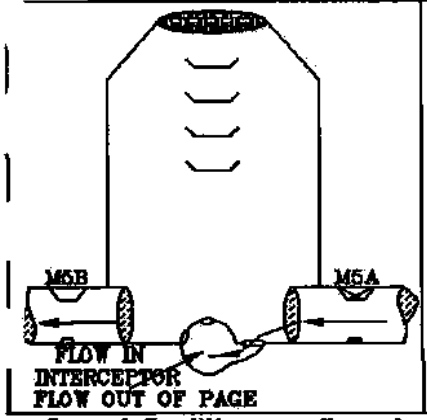
hone Co. Address:

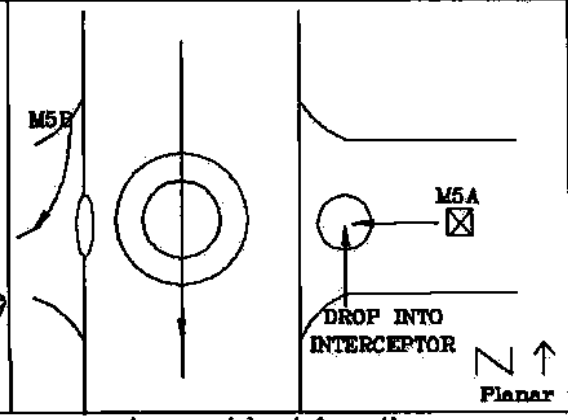
Access: DRIVE

Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: FAST FLOW

Surcharge: N/A Height :

Inv: DOF: 6.00" +/- .25" Time: 10:45 Vel: 3.0 fps Silt: 0.0"

'ream Manhole DID NOT INVESTIGATE

Downstream Manhole DOES NOT ISOLATE FLOW BEFORE INTERCEPTOR

dini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION

ULTRASONIC, VELOCITY, & PRESSURE

INSTALLED 5.0' U/S OF DROP

SAFETY

Manhole Depth: 12.0'

Traffic: HEAVY

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular IRREGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

SAME MANHOLE AS M5B;

GOOD 1500 MONITORABLE SITE;

VAN CAN ONLY BE POSITIONED AS SEEN ABOVE DUE TO HEAVY TRAFFIC

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M5B
RG Zone	Bat Serial #	Monitor #
RG1		
Velocity	Lift Diameter	Diameter
	N/A	PH = 47.75" PW = 49.25"

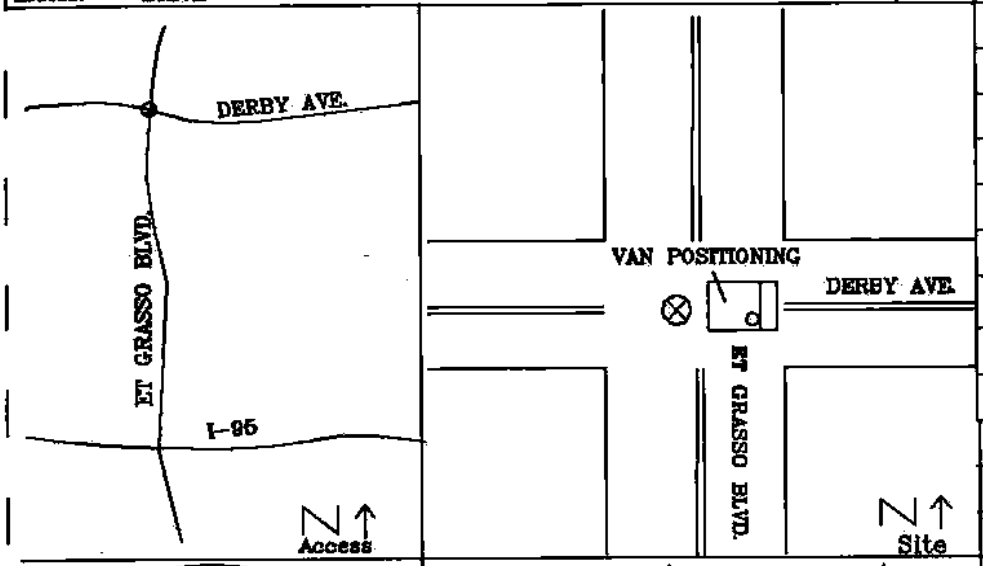
Project/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

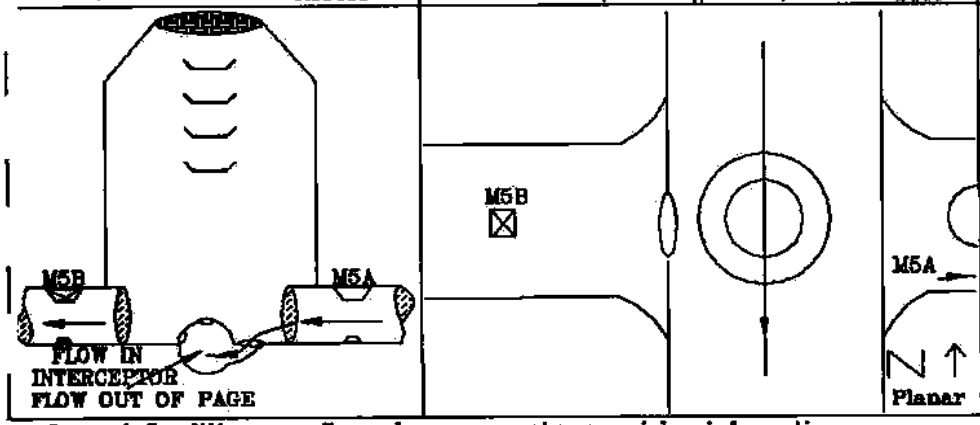
Address/Location: DERBY AVENUE @ ET GRASSO BOULEVARD

Phone Co. Address:

Phone Number:

Access: DRIVE





INSTALLATION

SPECIAL INSTALLATION

ULTRASONIC, VELOCITY, & PRESSURE

INSTALLED 15.0' DOWNSTREAM

SAFETY

Manhole Depth: 12.0'

Traffic: HEAVY

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular IRREGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type:

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: NO FLOW @ TIME OF INVESTIGATION

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: N/A Height: N/A

R.O.W. #: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

OVERFLOW LINE FOR M5A

Upstream Manhole DOES NOT ISOLATE

SAME MANHOLE AS M5A;

GOOD 1500 MONITORABLE SITE;

Downstream Manhole OUTFALL

INSTALL AS FAR DOWN THE OUTFALL AS POSSIBLE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M6
RG Zone	Bat Serial #	Monitor #
RG1		
Velocity	Lif Diameter	Diameter
	N/A	PH = 66.75" PW = 60.50"

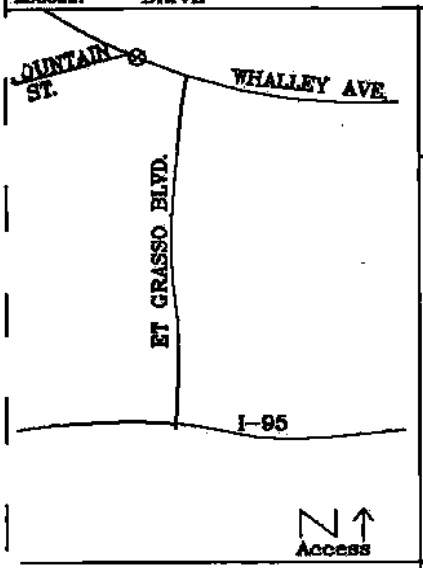
Project/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

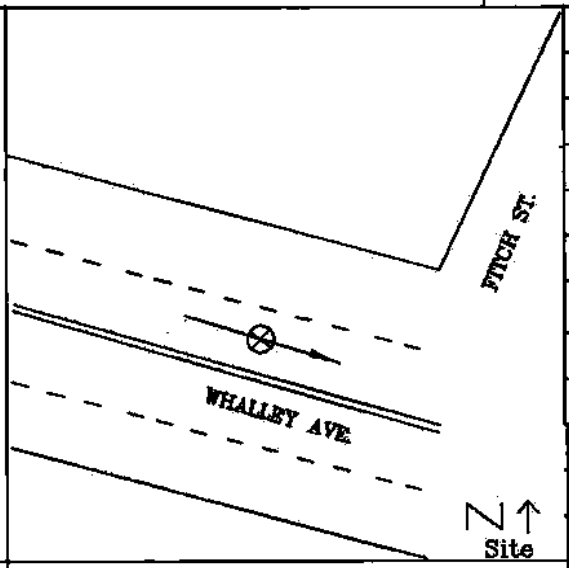
Case/Location: WHALLEY AVENUE; NORTHWEST OF FITCH STREET, 100 FEET

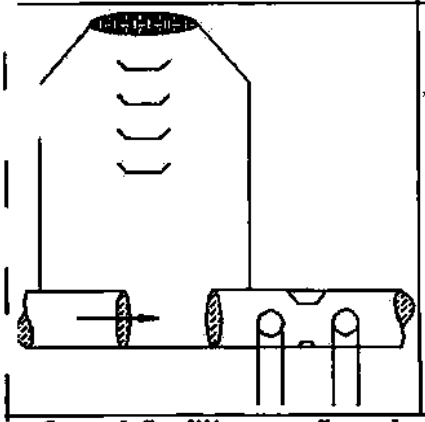
Phone Co. Address:

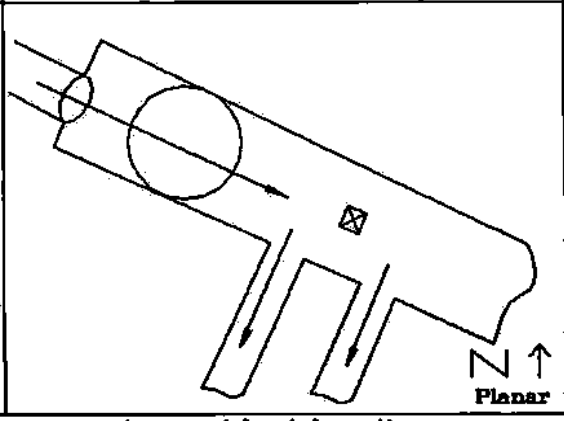
Phone Number:

Access: DRIVE









INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED D/S OF MANHOLE, DIRECTLY IN BETWEEN THE 2-24" OVERFLOW LINES

SAFETY

Manhole Depth: 9.0'

Traffic: HEAVY

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD, SMOOTH, LAMINAR FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: YES Height: 9.0'

R.O.W. #: N/A

Inv.: DOF: 26.00" +/- .25" Time: 11:30 Vel: 1.30 fps Silt: 20.00"

Upstream Manhole DID NOT INVESTIGATE

GOOD 1500 METERING SITE

Downstream Manhole DID NOT INVESTIGATE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M8
RG Zone	Bat Serial #	Monitor #
RG3		
Velocity	Lif Diameter	Diameter
	N/A	PH = 39.00" PW = 24.50"

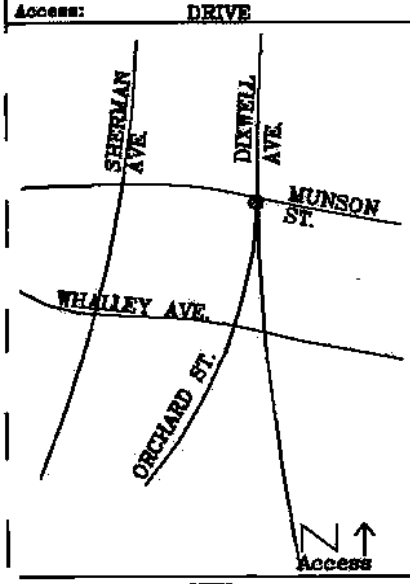
Project/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

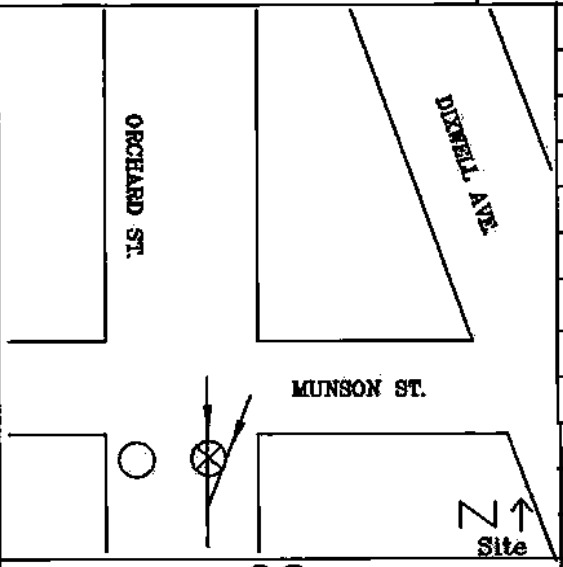
Address/Location: ORCHARD STREET AND MUNSON STREET

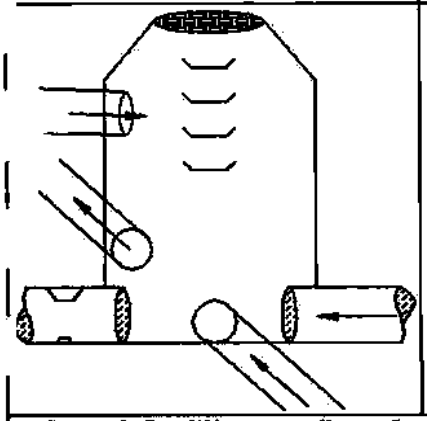
Phone Co. Address:

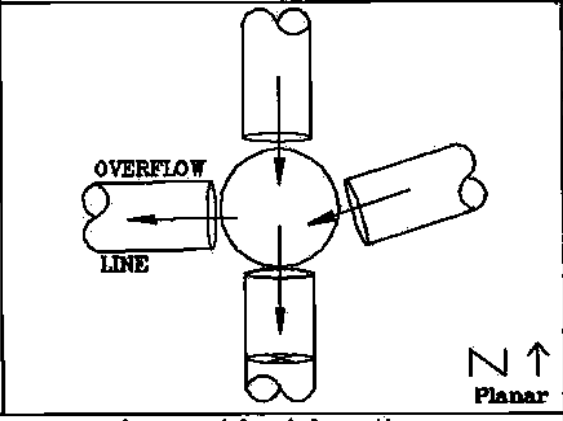
Phone Number:

Access: DRIVE









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD, SMOOTH FLOW; MOST FLOW COMES DIRECTLY DOWN ORCHARD ST.; MINIMAL AMOUNT OF FLOW GENERATED FROM WEST SIDE OF MUNSON ST.

Surcharge: N/A Height: N/A

Inv.: DOF: 10.50" +/- .25" Time: 12:00 Vel: 2.0 fps Silt: 1.00"

Upstream Manhole DOES NOT ISOLATE

Downstream Manhole DOWNSTREAM OF WET WEATHER OVERFLOW

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC VELOCITY & PRESSURE D/S OF MANHOLE; INSTALL VELOCITY & PRESSURE ON RIGHT SIDE OF PIPE

SAFETY

Manhole Depth: 12.0'

Traffic: LIGHT-MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: FAIR

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

GOOD 1500 MONITORING SITE

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		MS
RG Zone	**Bat Serial #**	**Monitor #**
RG4		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 43.75" PW = 30.00"

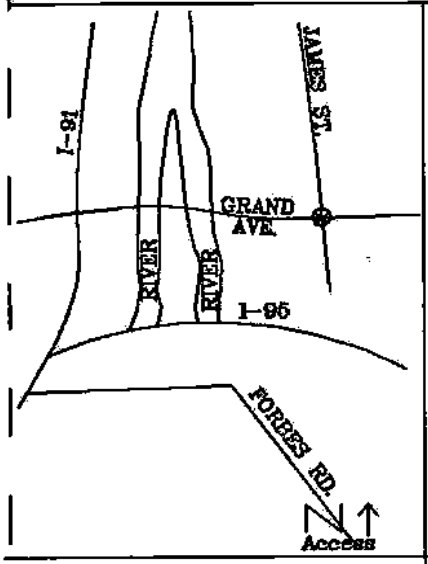
Project/Phase: NEW HAVEN CSO Date: 23 SEPT 97 Name: GE

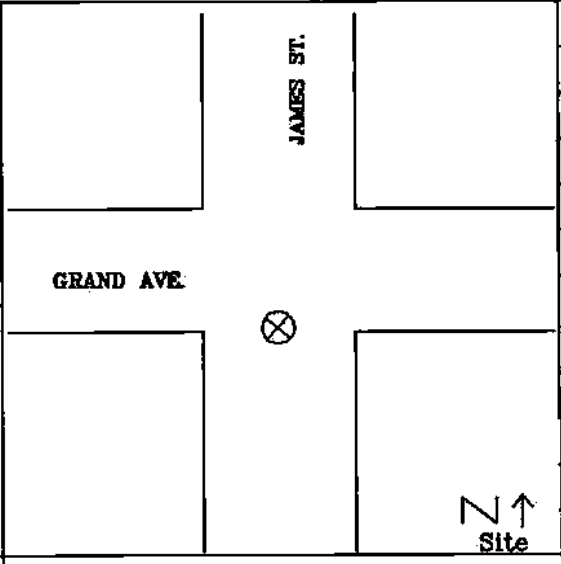
Address/Location: INTERSECTION OF GRAND AVE. & JAMES ST.

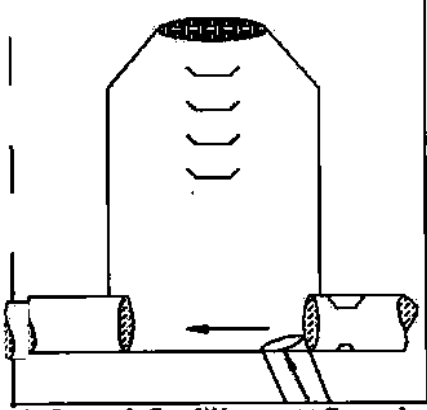
Telephone Co. Address:

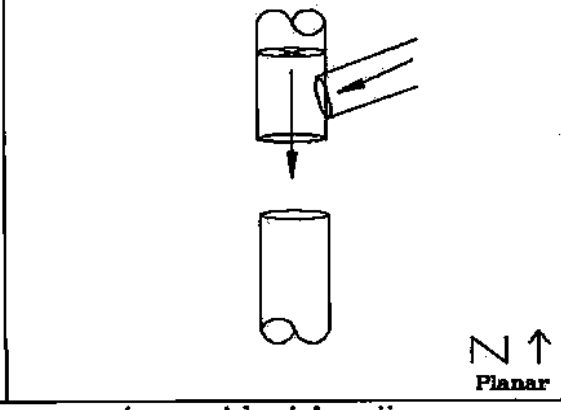
Phone Number:

Access: DRIVE









INSTALLATION

SPECIAL INSTALLATION 10.0'

U/S. PAST SIDE CONNECTION

SAFETY

Manhole Depth: 38.0'

Traffic: HEAVY

Gas ● Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

(General Condition, overflows, bypasses, weirs, special information,
) monitor characteristics, surcharge
P Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: MODERATELY SMOOTH FLOW. HEAVY SILT & DEBRIS

Approval:

Access Pole #:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

Surcharge: N/A Height: N/A

Inv.: DOF: 16.00" +/- .25" Time: 13:00 Vel: 1.50 fps Silt: 10.00"

Upstream Manhole DID NOT INVESTIGATE

To Downstream Manhole DID NOT INVESTIGATE

Engini System Character: Residential/Commercial/Industrial/Vacant Residential/Commercia

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M10
RG Zone	Bat Serial #	Monitor #
RG3		
Velocity	Lif Diameter	Diameter
	N/A	62.50"

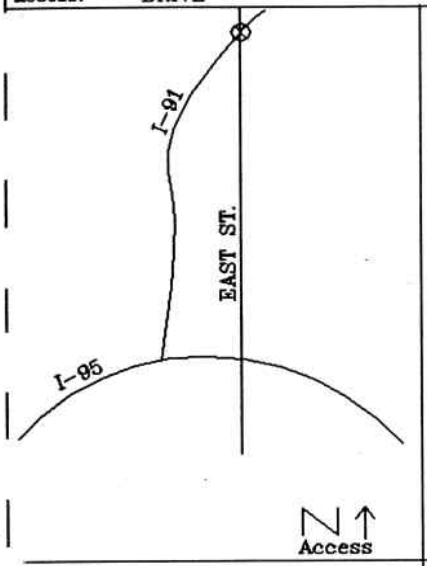
Project/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

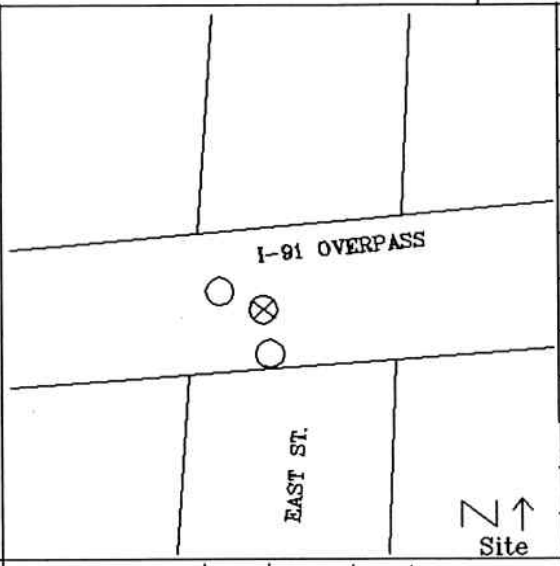
Access/Location: ON EAST STREET UNDER THE I-91 OVERPASS

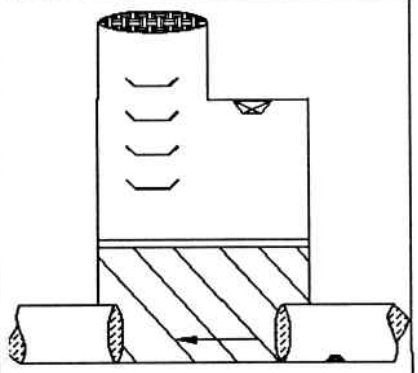
Phone Co. Address:

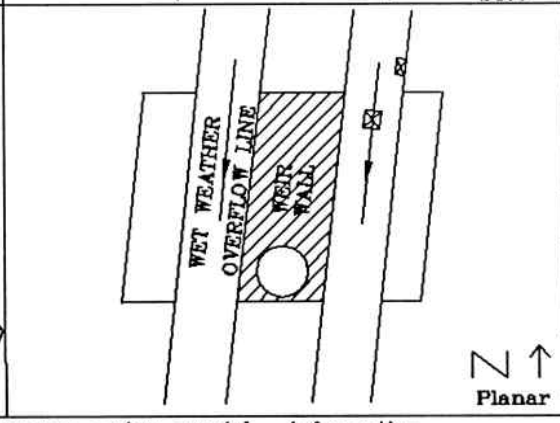
Access: DRIVE

Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD, SMOOTH, LAMINAR FLOW

Surcharge: YES Height: 6.0'

Inv.: DOF: 23.00" +/- .25" Time: 13:15 Vel: 1.50 fps Silt: 6.00"

Upstream Manhole DID NOT INVESTIGATE

Downstream Manhole DOES NOT ISOLATE WET WEATHER OVERFLOW

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; VELOCITY & PRESSURE INSTALLED JUST U/S IN THE INFLUENT LINE & ULTRASONIC INSTALLED D/S OF INFLUENT LINE ON THE CHAMBER

SAFETY OVERHEAD

Manhole Depth: 17.0'

Traffic: MODERATE-HEAVY

Gas & Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGUALR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

GOOD 1500 MONITORING SITE

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M14A
RG Zone	**Bat Serial #**	**Monitor #**
RG3		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 67.00" PW = 68.50"

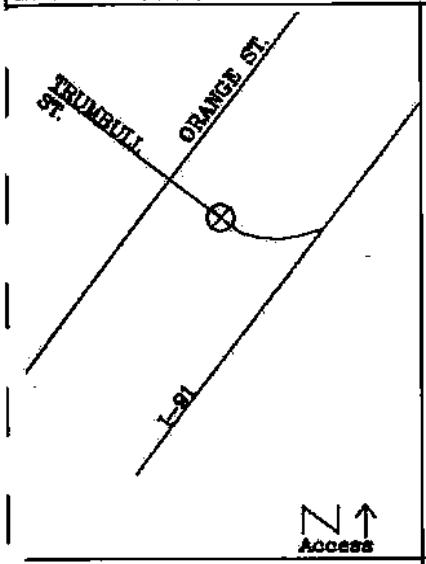
roject/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

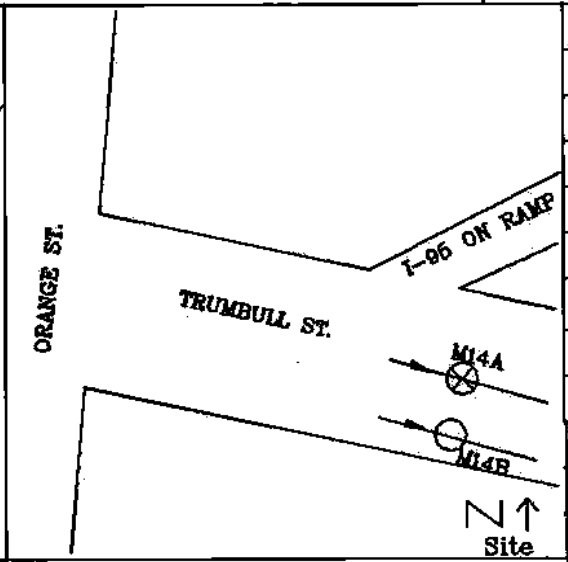
ss/Location: TRUMBULL STREET EAST OF ORANGE STREET

hone Co. Address:

Access: DRIVE

Phone Number:





INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED U/S IN INFLUENT LINE BUT D/S OF 8.00" SERVICE CONNECTION

SAFETY

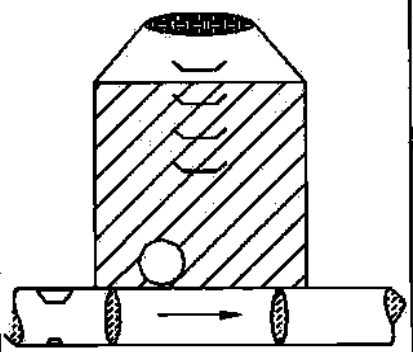
Manhole Depth: 12.0'

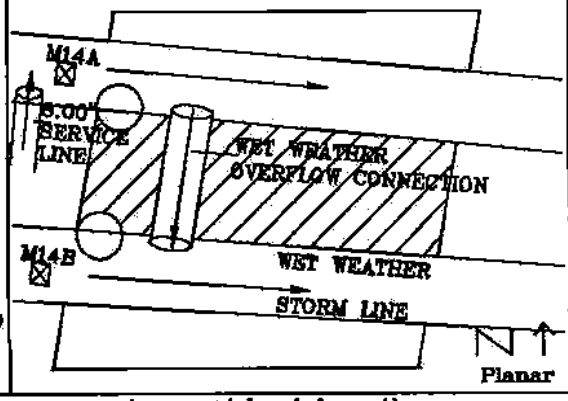
Traffic: MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD SMOOTH FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: YES Height: 5.0'

R.O.W. #: N/A

Inv.: DOF: 9.00" +/- .25" Time: 14:20 Vel: 2.0 fps Silt: 0.0"

'ream Manhole DID NOT INVESTIGATE

GOOD 1500 MONITORING SITE

SAME CHAMBER AS M14B

Downstream Manhole DOES NOT ISOLATE SYSTEM

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

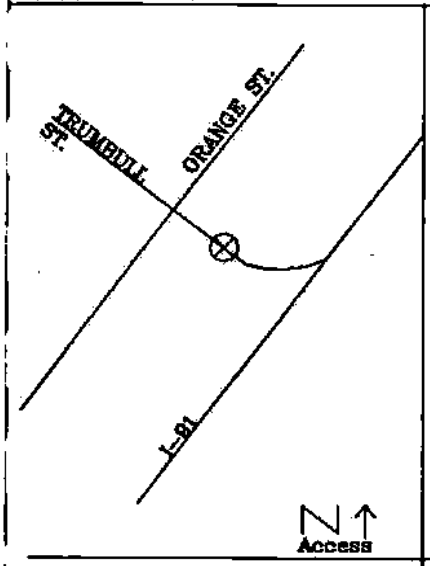
Town	Manhole #	AN
NEW HAVEN		M14B
RG Zone	Bat Serial #	Monitor #
RG3		
Velocity	Lif Diameter	Diameter
	N/A	PH = 66.13" PW = 105.00"

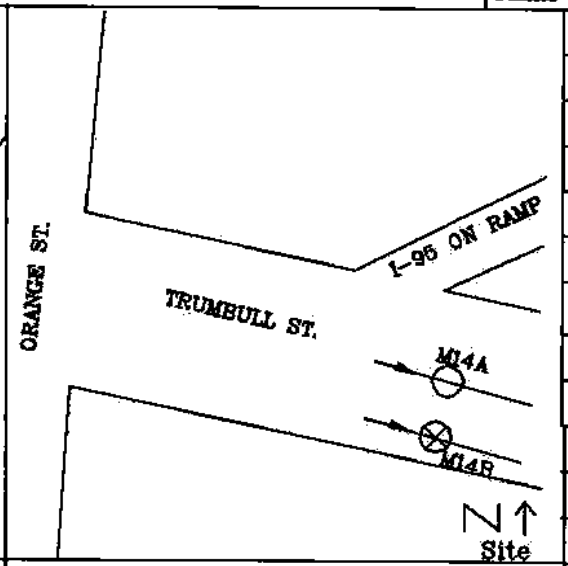
roject/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

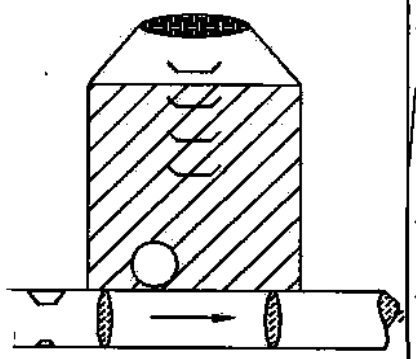
ess/Location: TRUMBULL STREET EAST OF ORANGE STREET

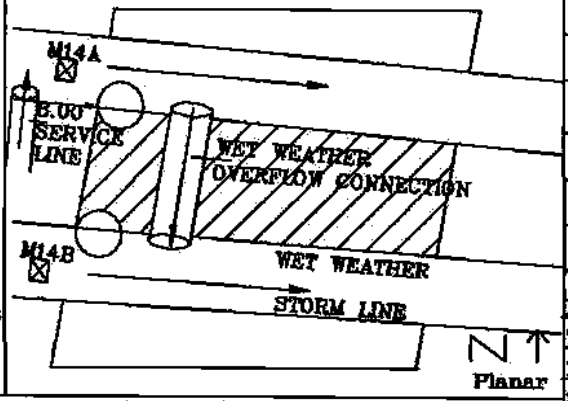
hone Co. Address:

Access: DRIVE Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: NO FLOW PRESENT DURING INSPECTION

urcharge: YES Height: 6.0'

Inv: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

--ream Manhole DID NOT INVESTIGATE

wnstream Manhole DID NOT INVESTIGATE

ni System Character: Residential/Commercial/Industrial/Vacent RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED U/S IN STORM LINE

SAFETY

Manhole Depth: 12.0'

Traffic: MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: CONCRETE

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

OVERFLOW LINE FOR M14A

SAME CHAMBER AS M14A

GOOD 1500 MONITORING SITE

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M15A
RG Zone	Bat Serial #	Monitor #
RG4		
Velocity	Lif Diameter	Diameter
		PH = 46.75"
		PW = 46.00"

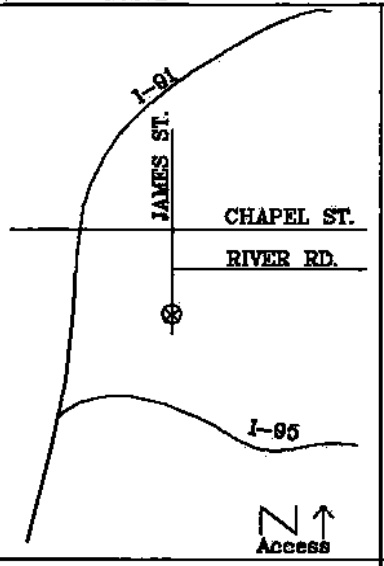
roject/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

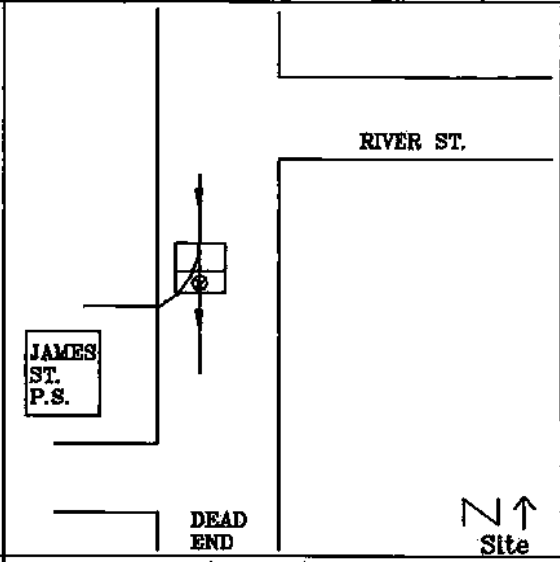
ess/Location: JAMES STREET SOUTH OF RIVER STREET

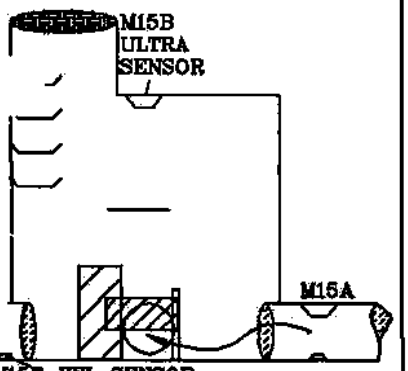
hone Co. Address:

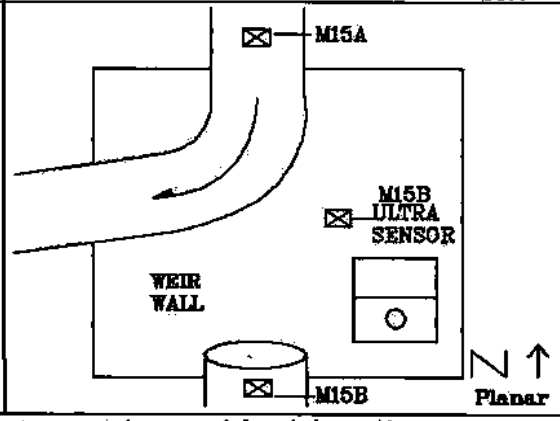
Access: DRIVE

Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: GOOD, SMOOTH FLOW

urcharge: YES Height: 6.0'

Inv.: DOF: 13.00" +/- .25" Time: 15:00 Vel: 1.50 fps Silt: 0.0"

ream Manhole DID NOT INVESTIGATE

ownstream Manhole DOES NOT ISOLATE

ind System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED 6.0' U/S ON BRICK PIPE SURFACE

SAFETY

Manhole Depth: 9.0'

Traffic: LOW

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

GOOD 1500 MONITORING SITE

INSTALL U/S ON BRICK SURFACE, NOT ON CONCRETE BEFORE CHAMBER

HEAVY SQUARE M/H COVER FOR ACCESS

SAME CHAMBER AS M15B

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M15B
RG Zone	Bat Serial #	Monitor #
RG4		
Velocity	Lit Diameter	Diameter
	N/A	PH = 48.25" PW = 48.00"

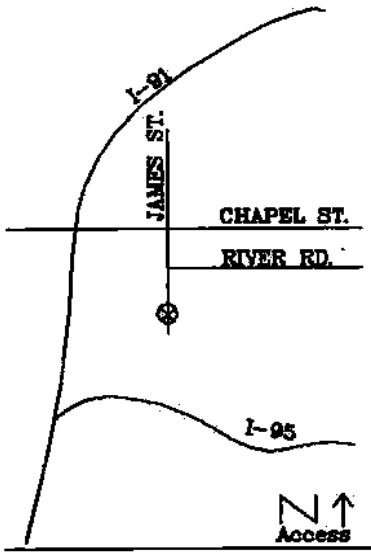
roject/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

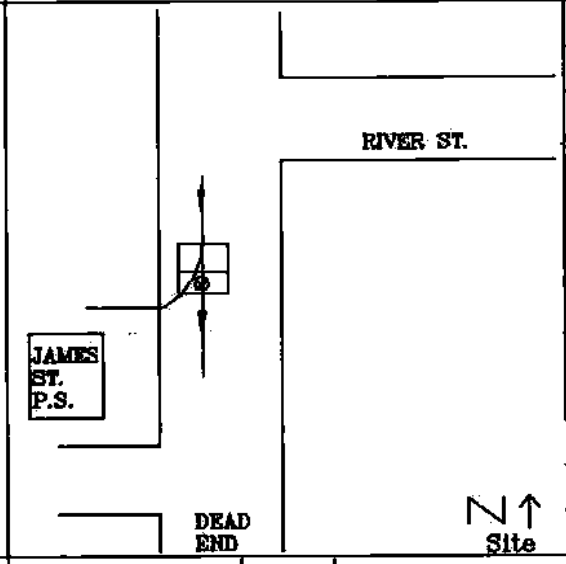
ea/Location: JAMES STREET SOUTH OF RIVER STREET

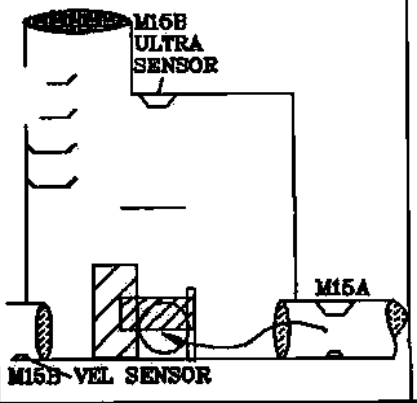
hone Co. Address:

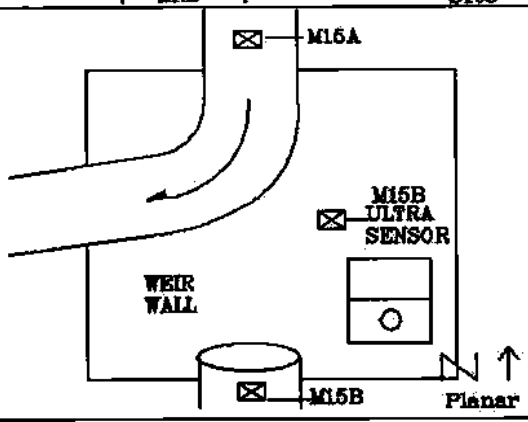
Phone Number:

Access: DRIVE









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

' Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: NO FLOW PRESENT DURING INVESTIGATION

Surcharge: N/A Height: N/A

Inv: DOF: 9.00" +/- .25" Time: 12:45 Vel: 0.0 fps Silt: 0.0"

tream Manhole DOES NOT ISOLATE

Downstream Manhole TIDE GATE CHAMBER

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; VELOCITY & PRESSURE D/S IN WET WEATHER OVERFLOW LINE & ULTRASONIC INSTALLED OVER WEIR WALL

SAFETY

Manhole Depth: 9.0'

Traffic: LOW

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: CONCRETE

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

OVERFLOW LINE FOR M15A

GOOD 1500 METERING SITE

HEAVY SQUARE M/H COVER ACCESS

SAME CHAMBER AS M15A

ADS Environmental Services, Inc.

1500 Site Report

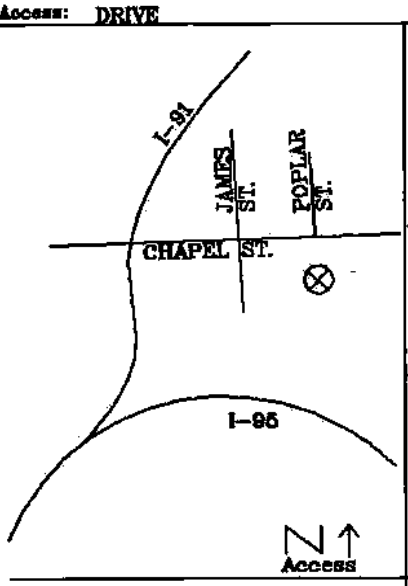
Town	Manhole #	AN
NEW HAVEN		M16
RG Zone	Bat Serial #	Monitor #
RG4		
Velocity	Lif Diameter	Diameter
	N/A	PH = 45.63" PW = 59.00"

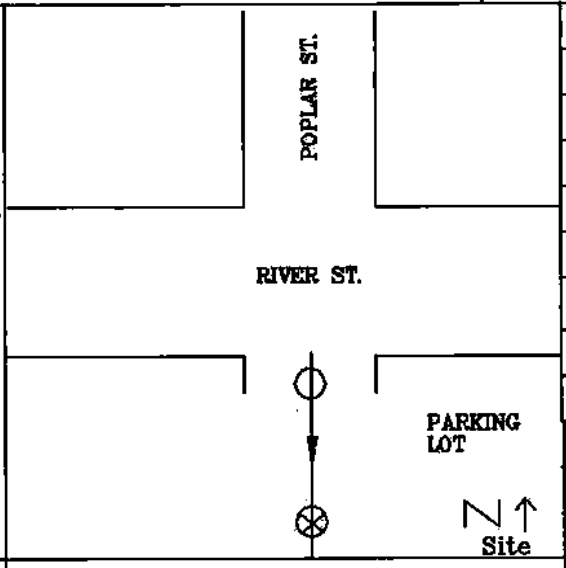
Project/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

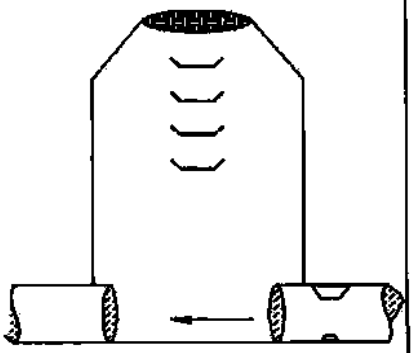
Address/Location: POPLAR STREET AND RIVER STREET

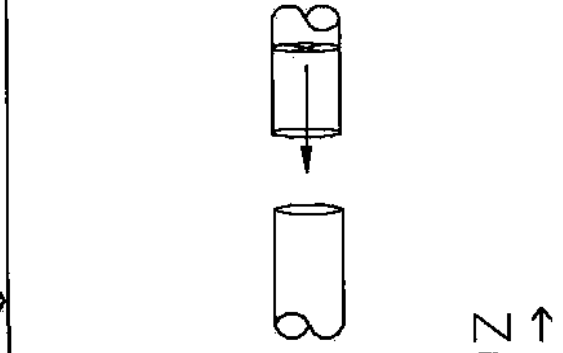
Phone Co. Address:

Access: DRIVE Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: NO FLOW DURING INVESTIGATION

Surcharge: N/A Height: N/A

Inv.: DOF: 0.50" +/- .25" Time: N/A Vel: N/A fps Silt: 0.0"

Upstream Manhole TOO CLOSE TO WEIR SPILL OVER/ POOR HYDRAULICS DURING WET WEATHER

Downstream Manhole DID NOT INVESTIGATE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESURE U/S OF MANHOLE

SAFETY

Manhole Depth: 10.0'

Traffic: NEGATIVE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

OUTFALL LINE

TIDAL INFLUENCED PIPE

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M16
RG Zone	**Bat Serial #**	**Monitor #**
RG4		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 44.00" PW = 30.25"

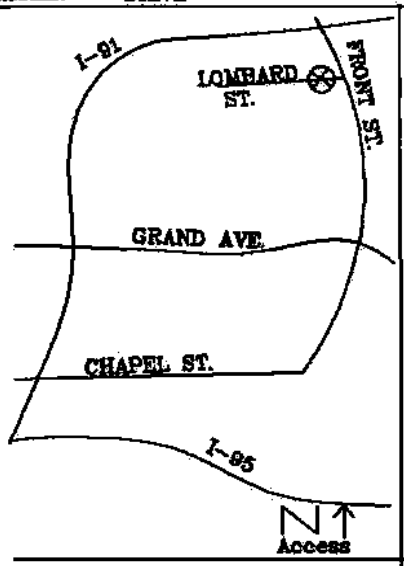
oject/Phase: NEW HAVEN CSO Date: 27 AUG 97 Name: MPN

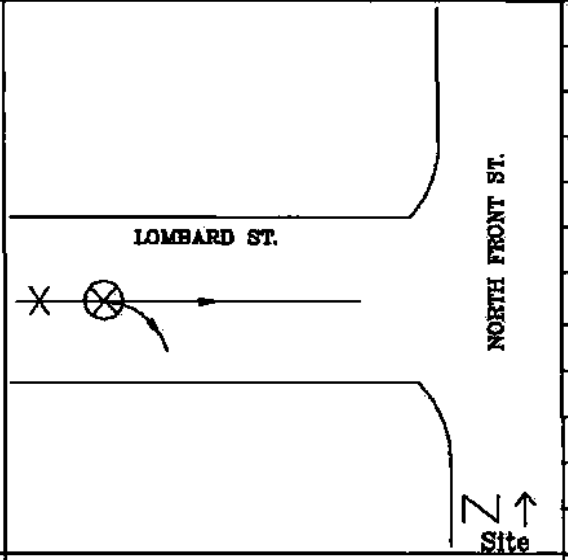
es/Location: LOMBARD STREET IN FRONT OF 13 LOMBARD STREET; WEST OF NORTH FRONT STREET

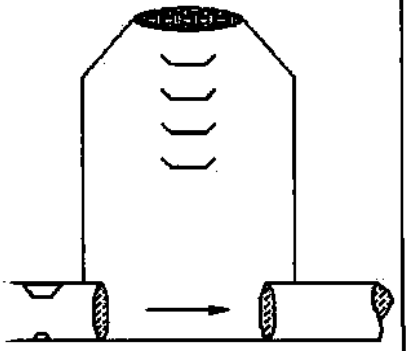
one Co. Address

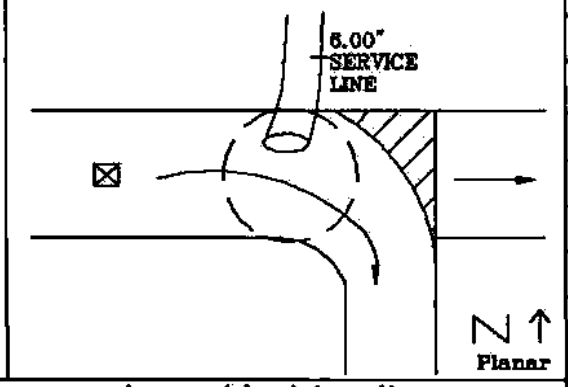
Access: DRIVE

Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

INSTALLATION

SPECIAL INSTALLATION WITH ULTRASONIC, VELOCITY & PRESSURE

SAFETY

Manhole Depth: 7.6'

Traffic: LOW-MODERATE

Gas ● Investigation: NEGATIVE

Manhole Condition:

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK/ OVAL

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

ydraulics: GOOD SMOOTH FLOW; FAST FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

rcharge: N/A Height: N/A

R.O.W. #: N/A

Inv.: DOF: 2.00" +/- .25" Time: 13:15 Vel: 2.5 fps Silt: 0.0"

'eam Manhole DID NOT INVESTIGATE

GOOD 1500 METERING SITE

TIGHT FIT BECAUSE OF 6.00" PVC LINE

ownstream Manhole DOES NOT ISOLATE

ini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M19A
RG Zone: RG4	Bat Serial #	Monitor #
Velocity	Lif Diameter: N/A	Diameter: PH = 28.00" PW = 49.00"

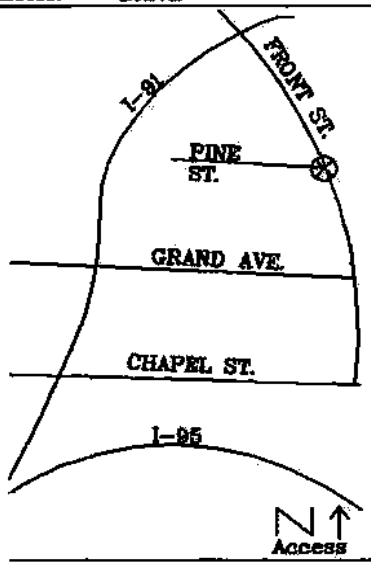
oject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

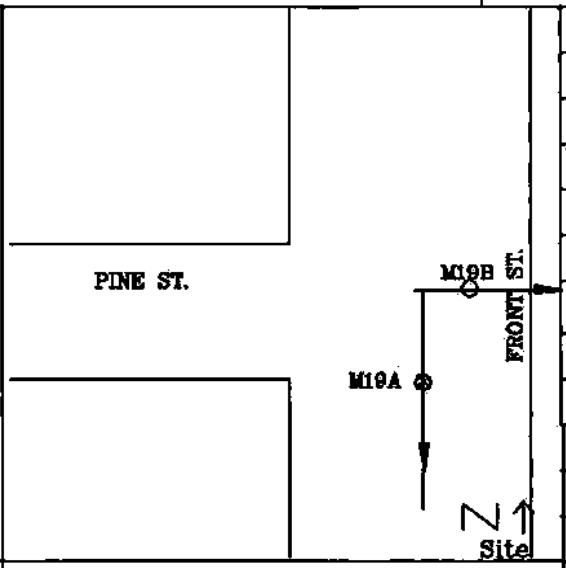
ns/Location: FRONT STREET AND PINE STREET

one Co. Address:

Access: DRIVE

Phone Number:





INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED U/S OF MANHOLE

SAFETY

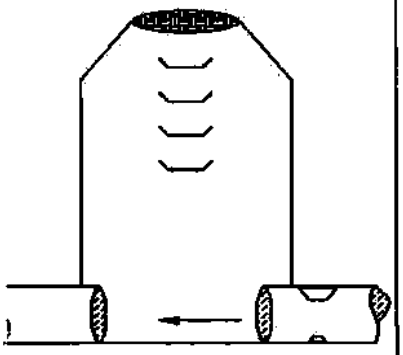
Manhole Depth: 10.0'

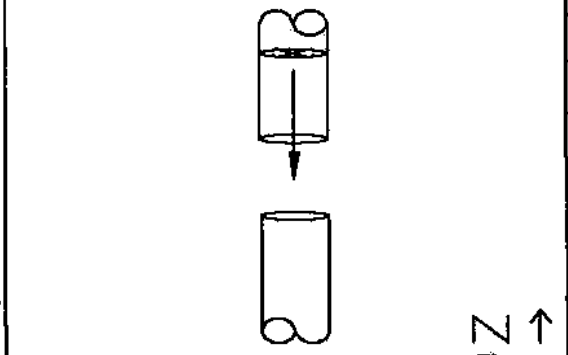
Traffic: MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: FAIR

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: GOOD, DEEP, SMOOTH FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

rcharge: N/A Height: N/A

R.O.W. #: N/A

Inv: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

--*ream Manhole DOES NOT ISOLATE

TOPSIDE INSPECTION DONE ON 8/28

GOOD 1500 MONITORING SITE

ownstream Manhole DID NOT INVESTIGATE

ini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M19B
RG Zone	**Bat Serial #**	**Monitor #**
RG4		
Velocity	**Lit Diameter**	**Diameter**
	N/A	24.00"

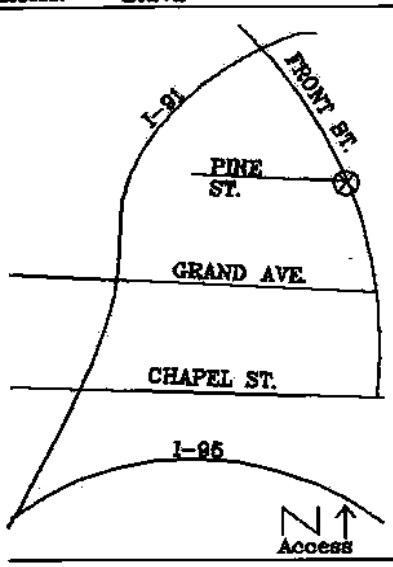
roject/Phase: NEW HAVEN CSO Date: 5 SEPT 97 Name: MPN

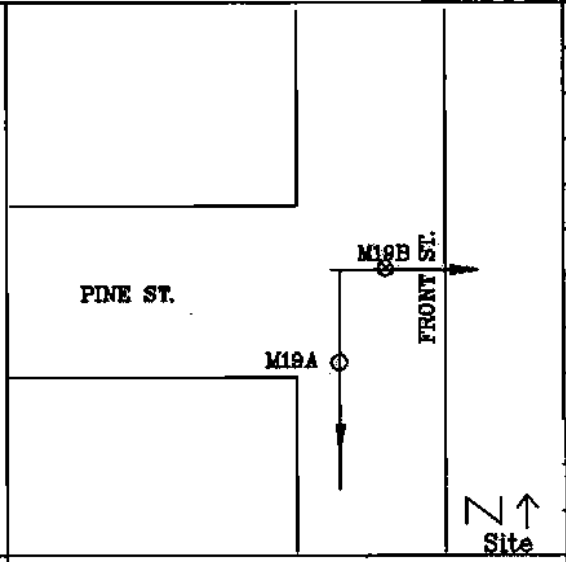
ss/Location: PINE STREET AND FRONT STREET

hone Co. Address:

Access: DRIVE

Phone Number:





INSTALLATION

RING & CRANK ASSEMBLY;

ULTRASONIC, VELOCITY & PRESSURE

INSTALLED U/S OF MANHOLE IN

OVERFLOW LINE

SAFETY

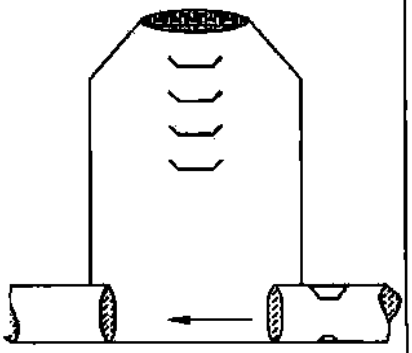
Manhole Depth: 6.0'

Traffic: NEGATIVE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR



Q.C. Inspector:

Date:

Comments:

Pipe Type: CONCRETE

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: NO FLOW @ TIME OF INVESTIGATION

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

urcharge: N/A Height: N/A

R.O.W. #: N/A

Inv.: DOF: 0.00" +/- .13" Time: 12:00 Vel: 0.0 fps Silt: 0.0"

'ream Manhole DOES NOT ISOLATE SYSTEM

ownstream Manhole OUTFALL TO QUINNIPIAC RIVER

final System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M20
RG Zone	Bat Serial #	Monitor #
RG4		
Velocity	Lif Diameter	Diameter
	N/A	24.00"

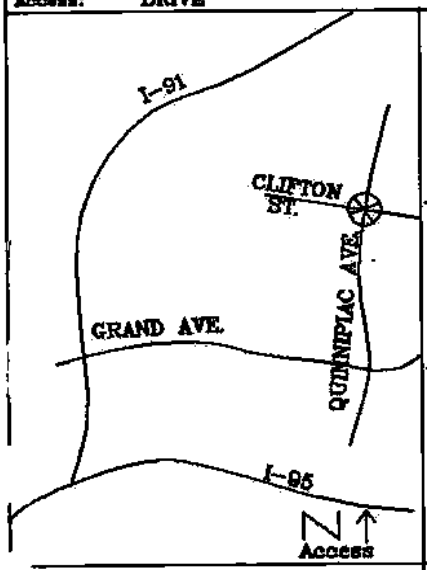
oject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

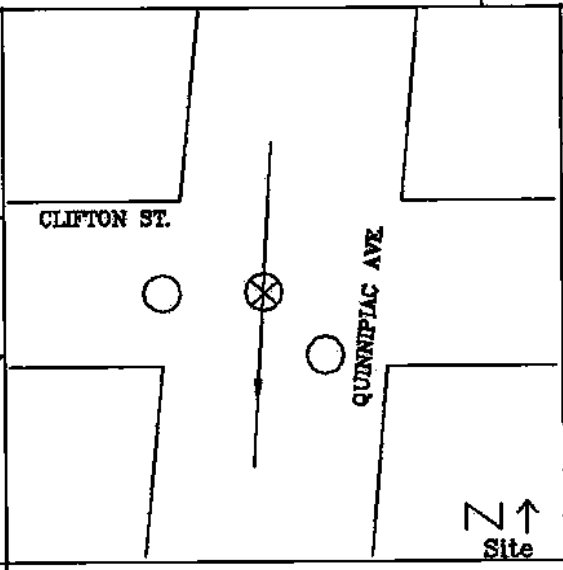
ss/Location: QUINNIPIAC AVENUE AND CLIFTON STREET

one Co. Address:

Phone Number:

Access: DRIVE





INSTALLATION

RING & CRANK ASSEMBLY;

VELOCITY & PRESSURE INSTALLED D/S OF MANHOLE; ULTRASONICS INSTALLED ON SURCHARGE MOUNT IN MANHOLE

SAFETY

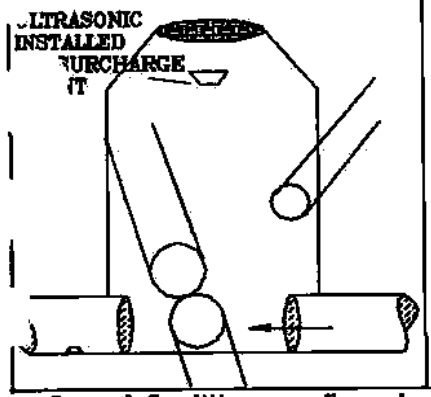
Manhole Depth: 4.0'

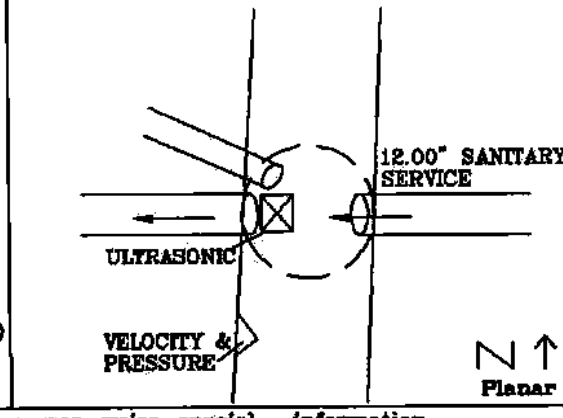
Traffic: MODERATE-HEAVY

Gas ● Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: PRC

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD LAMINAR FLOW; 12.00" SANITARY CONNECTION NOT PROVIDING ENOUGH TURBULENCE TO EFFECT FLOW METER INSTALLED DOWNSTREAM

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

Surcharge: YES Height: 3.0'

Inv.: DOF: 8.00" +/- .25" Time: 10:00 Vel: 2.0 fps Silt: 2.00"

Upstream Manhole DOES NOT ISOLATE

GOOD 1500 MONITORABLE SITE

Downstream Manhole DID NOT INVESTIGATE

Wind System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M21
RG Zone	**Bat Serial #**	**Monitor #**
RG4		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 67.00" PW = 66.25"

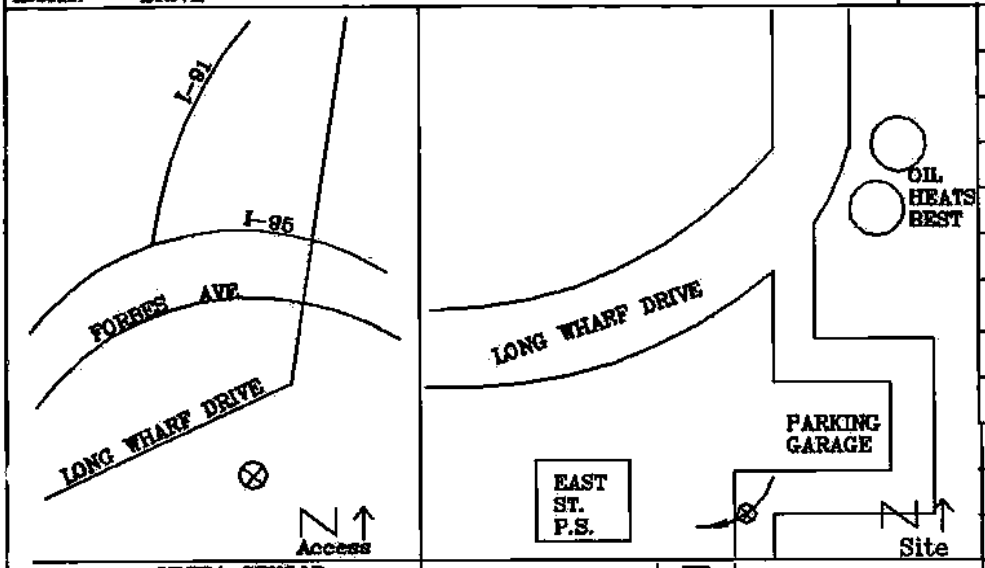
eject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

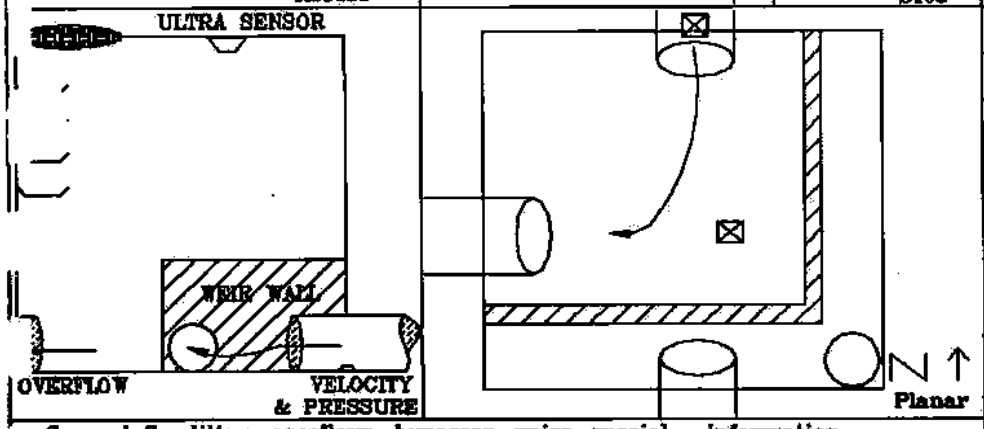
ss/Location: EAST STREET PUMP STATION

one Co. Address:

Access: DRIVE

Phone Number:





INSTALLATION

SPECIAL INSTALLATION; VELOCITY & PRESSURE INSTALLED ON INFLUENT PIPE, & ULTRASONIC INSTALLED OVER DIVERSION CHAMBER

SAFETY

Manhole Depth: 10.0'

Traffic: LOW

Gas @ Investigation: LOW OXYGEN (19.1%)

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments;

Pipe Type: PRC

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: SURCHARGED IN DIVERSION CHAMBER @ TIME OF INVESTIGATION

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

urcharge: YES Height: 6.0'

Inv.: DOF: 66.00" +/- .50" Time: 11:45 Vel: 0.60 fps Silt: 0.0"

vnstrm Manhole DID NOT INVESTIGATE

1500 MONITOR INSTALLATION

ownstrnam Manhole PUMP STATION

Ind System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

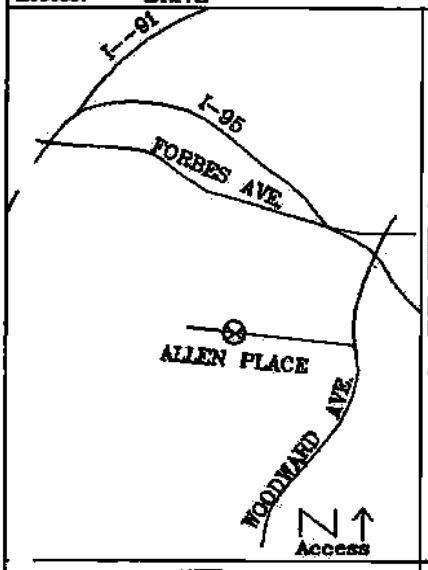
Town	Manhole #	AN
NEW HAVEN		M22
RG Zone	Bat Serial #	Monitor #
RG4		
Velocity	Lif Diameter	Diameter
	N/A	24.13"

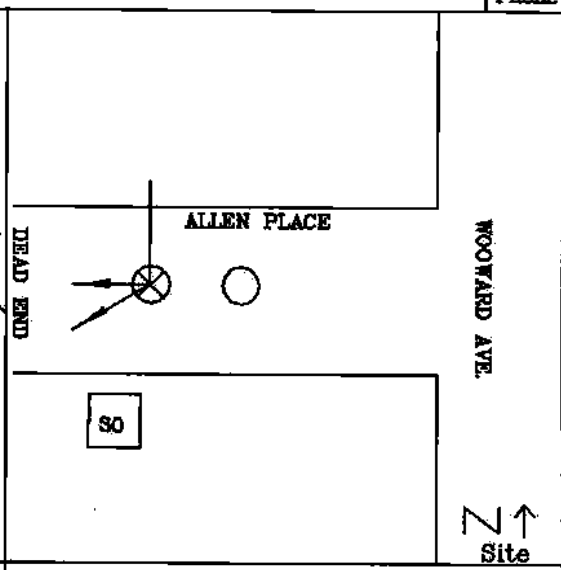
Project/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

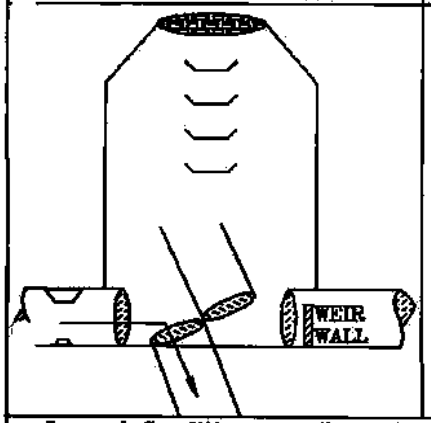
ss/Location: 30 ALLEN PLACE

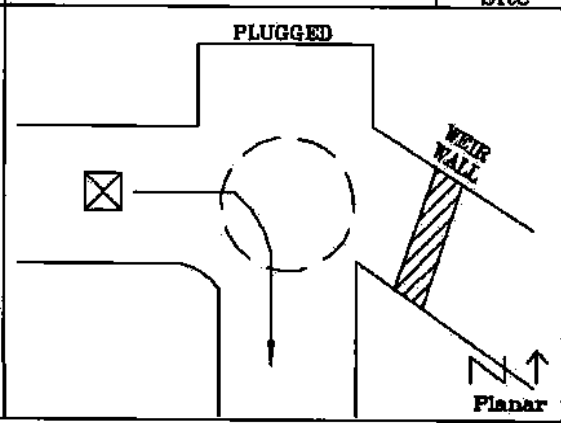
one Co. Address:

Access: DRIVE Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

draulics: WAVY, SHALLOW FLOW; BUT MONITORABLE;

charge: YES Height: 3.0'

Inv.: DOF: 2.00" +/- .25" Time: 10:50 Vel: 1.50 fps Silt: 0.75"

eam Manhole DID NOT INVESTIGATE

eam Manhole DOES NOT ISOLATE

l System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

INSTALLATION

24.00" RING & CRANK ASSEMBLY;

ULTRASONIC, VELOCITY & PRESSURE

SAFETY

Manhole Depth: 4.0'

Traffic: LIGHT-NONE

Gas @ Investigation: NEGATIVE

Manhole Condition: FAIR

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: RCP

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

REQUEST 1600 FOR SHALLOW FLOW

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M24
RG Zone	**Bat Serial #**	**Monitor #**
RG2		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 69.25" PW = 82.00"

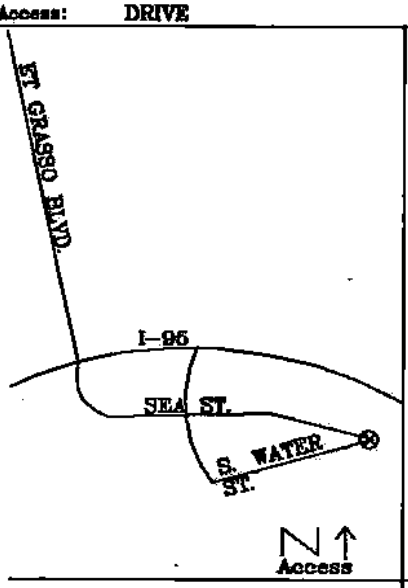
roject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

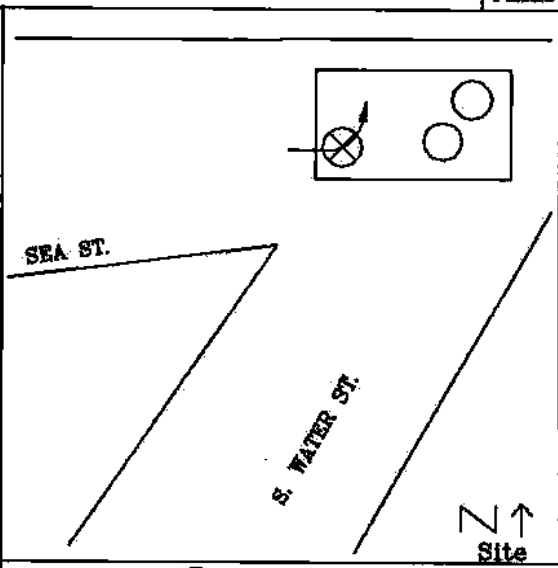
ess/Location: SOUTH WATER STREET AND SEA STREET

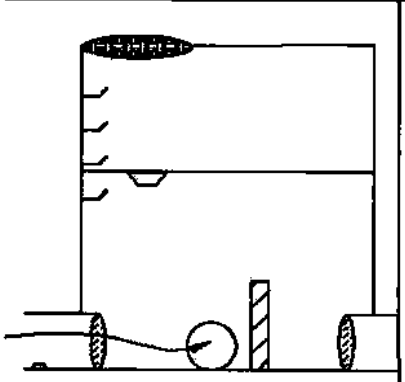
hone Co. Address:

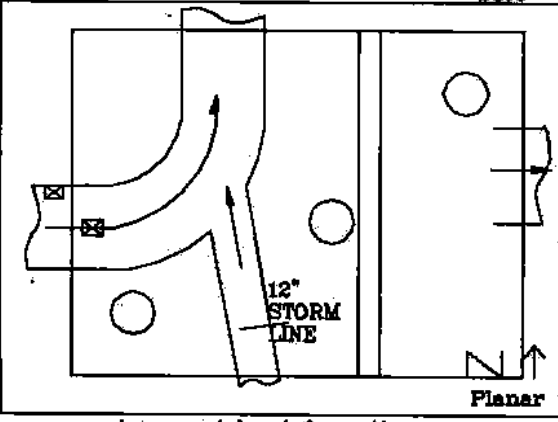
Access: DRIVE

Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

INSTALLATION

SPECIAL INSTALLATION; VELOCITY & PRESSURE INSTALLED ON CONCRETE IN INFLUENT LINE; ULTRAS INSTALLED ON TOP OF CHAMBER D/S OF INFLUENT LINE

SAFETY

Manhole Depth: 10.0'

Traffic: LIGHT

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

ydraulics: TURBULENT FLOW OVER SILT 3 FT. U/S OF CHAMBER; SENSORS INSTALLED IN RELATIVELY MODERATE FLOW PRIOR TO CHAMBER ON RIGHT SIDE OF PIPE. ULTRASONIC ON CHAMBER OVERHEAD.

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

urcharge: YES Height: N/A

Inv.: DOF: 23.00" +/- .25" Time: 12:00 Vel: 1.50 fps Silt: 0.0"

Upstream Manhole N/A

GOOD 1500 METERING SITE

Downstream Manhole N/A

ni System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		M25A
RG Zone	Bat Serial #	Monitor #
RG2		
Velocity	Lif Diameter	Diameter
	N/A	PH = 60.00" PW = 47.00"

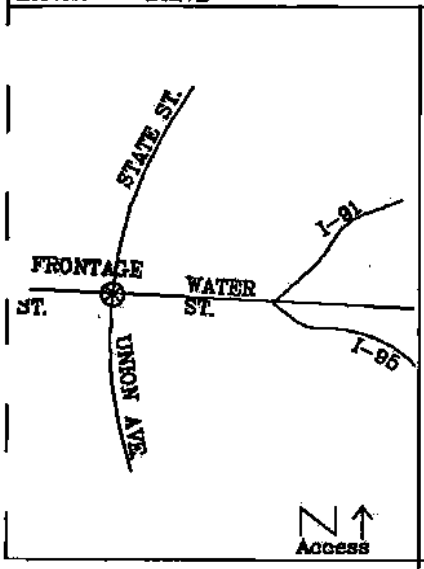
Project/Phase: NEW HAVEN CSO Date: 5 SEPT 97 Name: MPN

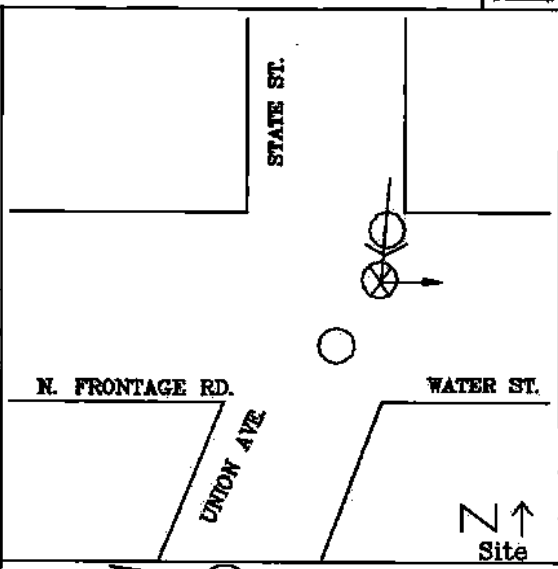
ess/Location: NORTH FRONTAGE ROAD AND STATE STREET ON SOUTHEAST CORNER

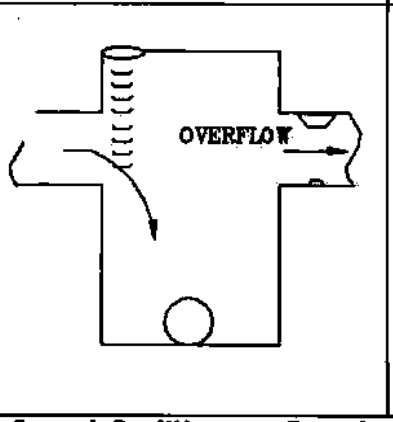
hone Co. Address:

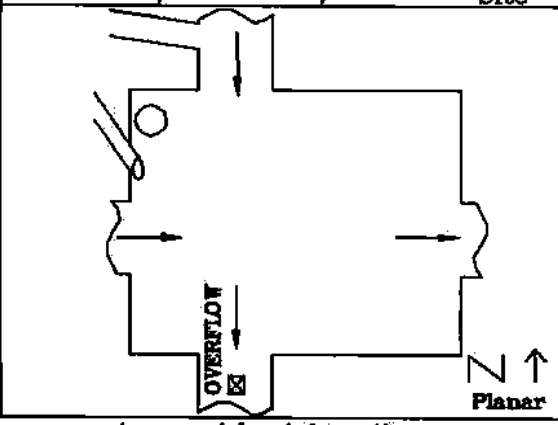
Access: DRIVE

Phone Number:









General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

INSTALLATION

ALL SENSORS INSTALLED IN OVERFLOW LINE

SAFETY

Manhole Depth: 25.0'

Traffic: HEAVY

Gas ● Investigation: NEGATIVE

Manhole Condition: FAIR, A LOT OF CONCRETE IN MANHOLE CHAMBER

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg.				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

ydraulics: FAST, SMOOTH FLOW

urcharge: YES Height: 15.0'

Inv.: DOF: 4.50" +/- .25" Time: 10:35 Vel: 3.0 fps Silt: 0.0"

eam Manhole WILL NOT ISOLATE

ownstream Manhole DID NOT INVESTIGATE

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

SITE IS VERY LOUD AND ULTRASONICS WILL NOT WORK UNTIL MANHOLE IS SURCHARGED AT LEAST 15.0'

ini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

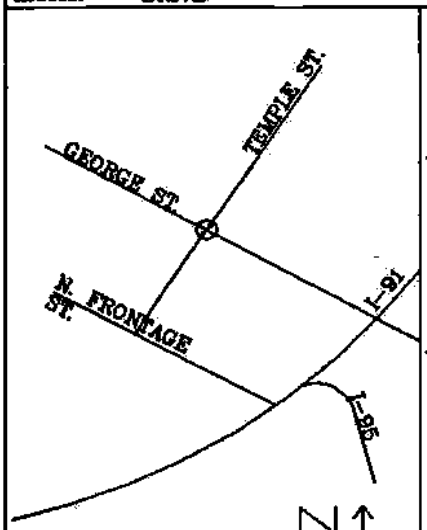
Town	Manhole #	AN
NEW HAVEN		M25B
RG Zone	Bat Serial #	Monitor #
RG2		
Velocity	Lif Diameter	Diameter
	N/A	48.00"

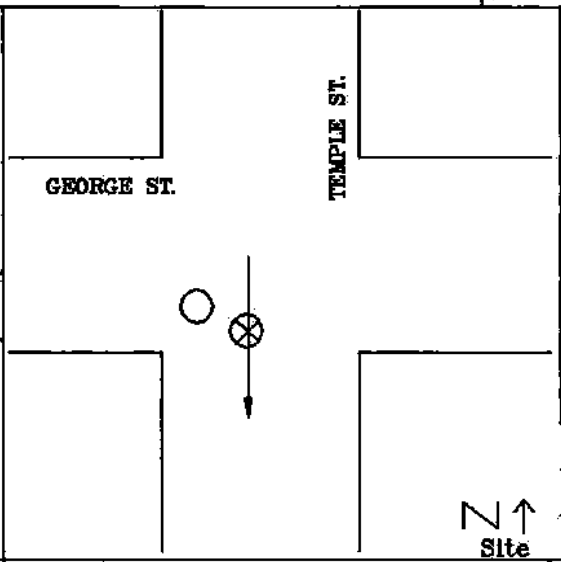
ject/Phase: NEW HAVEN CSO Date: 5 SEPT 97 Name: MPN

ss/Location: TEMPLE STREET AND GEORGE STREET

one Co. Address:

Access: DRIVE Phone Number:





INSTALLATION

48.00" RING WITH VELOCITY & PRESSURE INSTALLED AS FAR U/S AS POSSIBLE; ULTRASONIC INSTALLED ON CHAMBER OVERHEAD

SAFETY

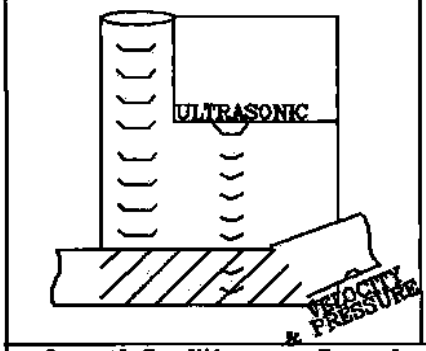
Manhole Depth: 11.0'

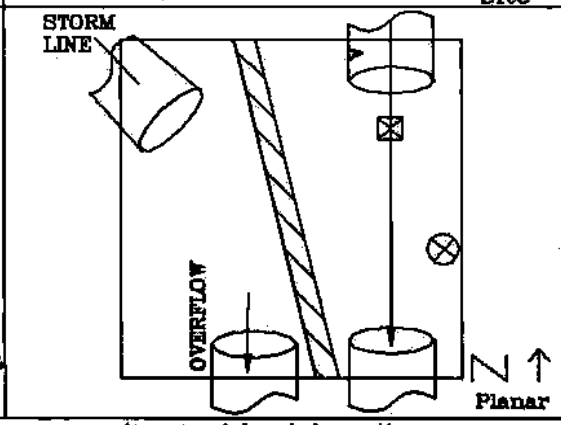
Traffic: HEAVY

Gas @ Investigation: NEGATIVE

Manhole Condition: FAIR

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: CONCRETE

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

draulics: FAST, ROLLING FLOW: DUE TO THE SLOPE OF THE INCOMING LINE, THE DEEPER THE FLOW THE POORER THE HYDRAULICS WILL BE DUE TO BACK UP SINCE OUTGOING LINE IS A 24.00" LINE

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

_ archarge: YES Height : 8.0'

Inv.: DOF: 3.00" +/- .13" Time: 11:45 Vel: 4.50 fps Silt: 0.0"

'-eam Manhole DID NOT INVESTIGATE

wnstream Manhole DID NOT INVESTIGATE

ni System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL/COMMERCIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		RLI
RG Zone	**Bat Serial #**	**Monitor #**
RG3		
Velocity	**Lif Diameter**	**Diameter**
	N/A	PH = 31.00" PW = 20.50"

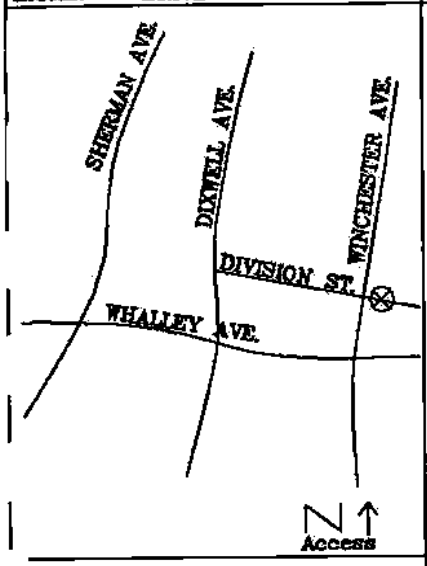
oject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

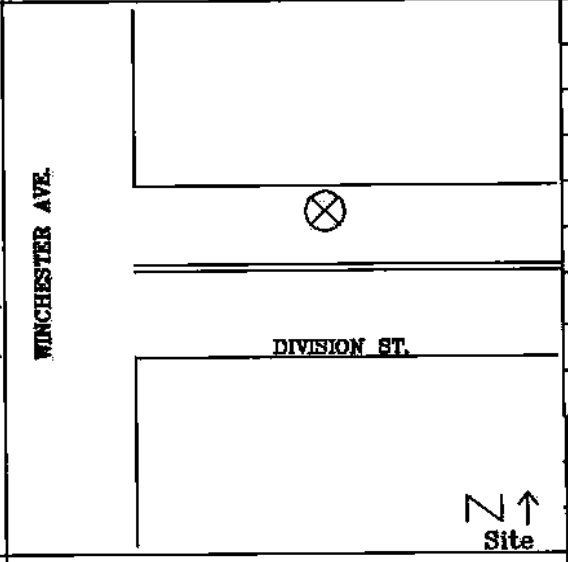
ss/Location: DIVISION STREET, EAST OF WINCHESTER AVENUE

one Co. Address:

Phone Number:

Access: DRIVE





INSTALLATION

SPECIAL INSTALLATION WITH ULTRASONIC, VELOCITY & PRESSURE INSTALLED U/S OF MANHOLE

SAFETY

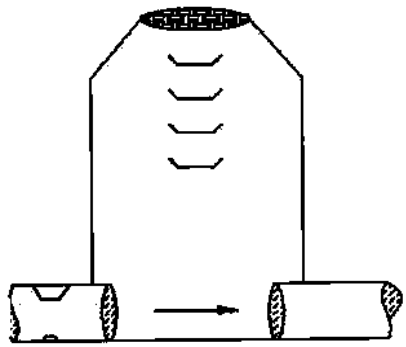
Manhole Depth: 10.5'

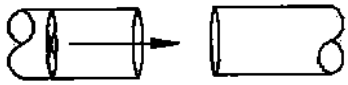
Traffic: MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: BRICK

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: FAST, SMOOTH FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

Surcharge: YES Height: 4.0'

Inv: DOF: 3.00" +/- .25" Time: 14:15 Vel: 3.0 fps Silt: 0.0"

Upstream Manhole DID NOT INVESTIGATE

Downstream Manhole DID NOT INVESTIGATE

Muni System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		R12
RG Zone	**Bat Serial #**	**Monitor #**
RG2		
Velocity	**Lif Diamster**	**Diameter**
	N/A	PH = 29.50" PW = 20.50

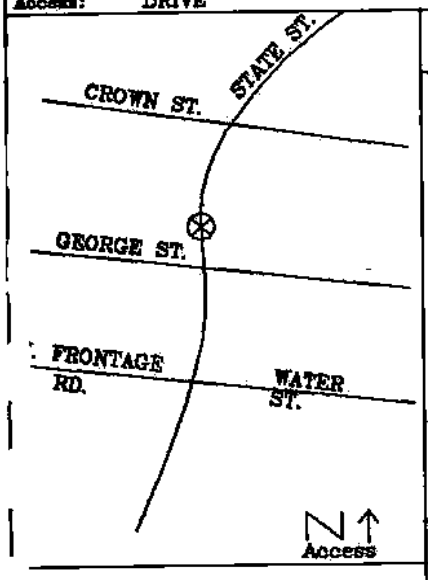
oject/Phase: NEW HAVEN CSO Date: 5 SEP 97 Name: MPN

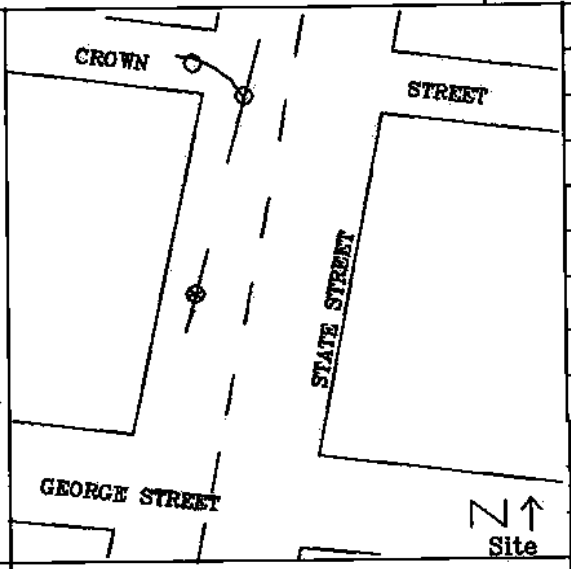
ess/Location: 210 STATE STREET; ON SOUTHBOUND STATE STREET BETWEEN CROWN STREET AND GEORGE STREET

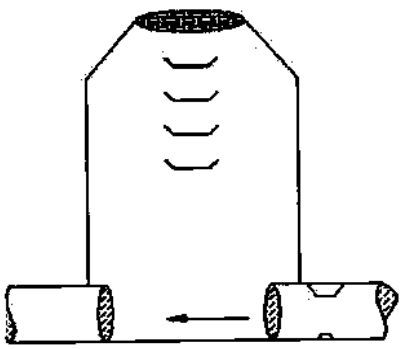
one Co. Address:

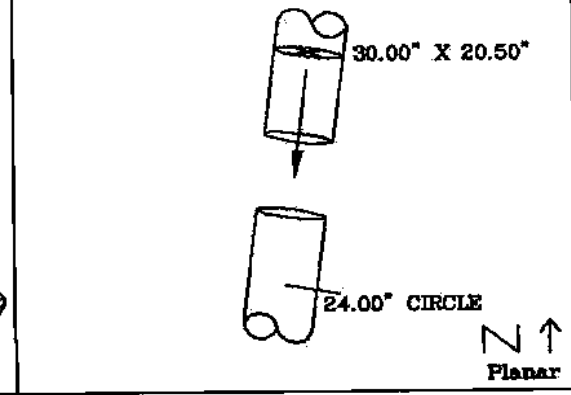
Phone Number:

Access: DRIVE









INSTALLATION

SPECIAL INSTALLATION; ULTRASONIC, VELOCITY & PRESSURE INSTALLED UPSTREAM

SAFETY

Manhole Depth: 10.0'

Traffic: MODERATE

Gas & Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: CONCRETE

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: SLOW, SMOOTH FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

Surcharge: N/A Height: N/A

Inv.: DOF: 5.00" +/- .25" Time: 10:05 Vel: 1.30 fps Silt: 0.0"

Upstream Manhole SIDE CONNECTION CAUSING POOR HYDRAULICS

MAY BE ABLE TO BEND A 30.00" RING TO INSTALL

Downstream Manhole DID NOT INVESTIGATE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		S1
RG Zone: RG1	Bat Serial #	Monitor #
Velocity	Lft Diameter: N/A	Diameter: 12.00"

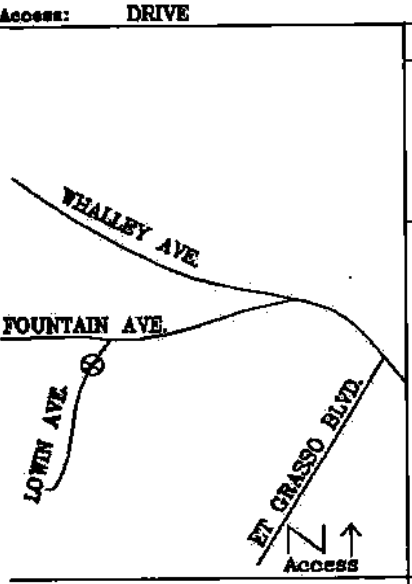
roject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

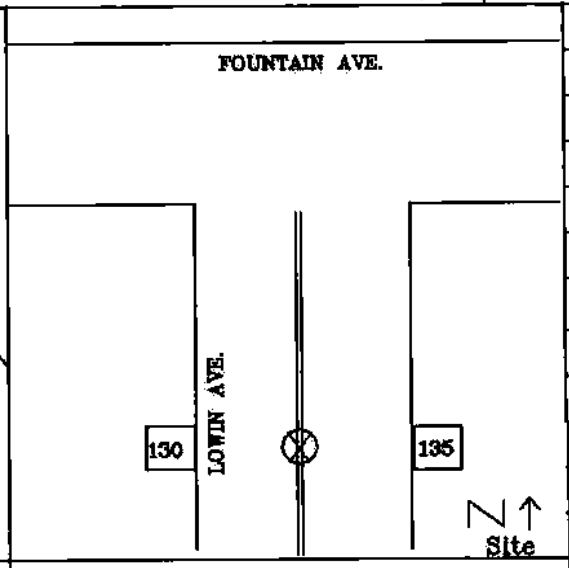
ess/Location: 130 LOWIN AVENUE

home Co. Address:

Access: DRIVE

Phone Number:





INSTALLATION

12.00" RING & CRANK WITH
ULTRASONIC, VELOCITY & PRESSURE

SAFETY

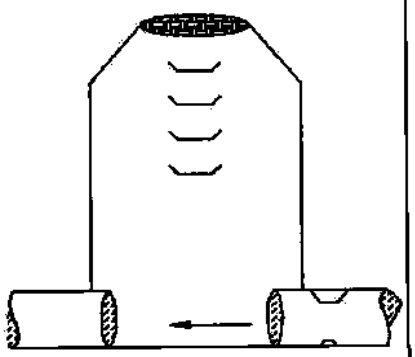
Manhole Depth: 19.0'

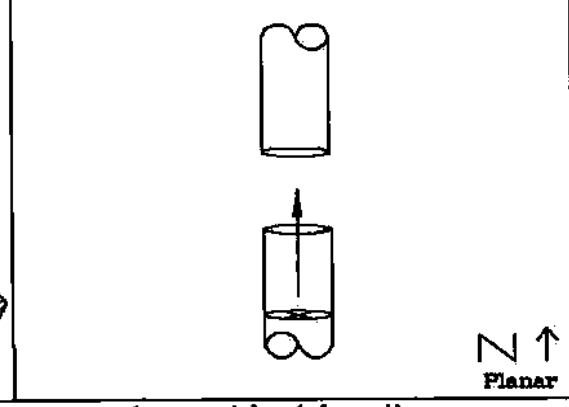
Traffic: MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: CLAY

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD SMOOTH FLOW; PIPE CLOSE TO SURCHARGE AT INVESTIGATION

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

Surcharge: YES Height: 4.0'

Inv.: DOF: 10.00" +/- .25" Time: 13:45 Vel: 1.20 fps Silt: 0.50"

tream Manhole POOR HYDRAULICS

GOOD 1500 SITE

Downstream Manhole DID NOT INVESTIGATE

Mini System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		S2
RG Zone: RG1	Bat Serial #	Monitor #
Velocity	Lif Diameter: N/A	Diameter: 15.00"

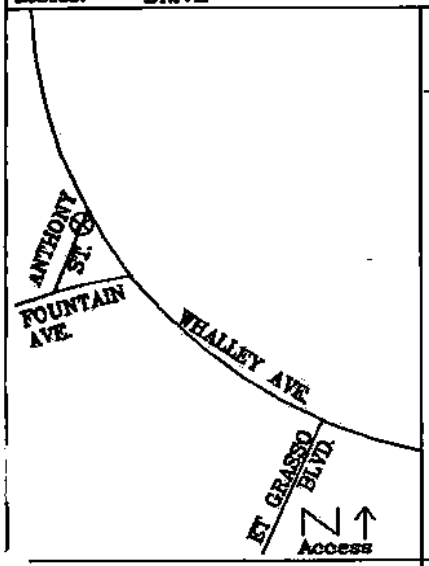
roject/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

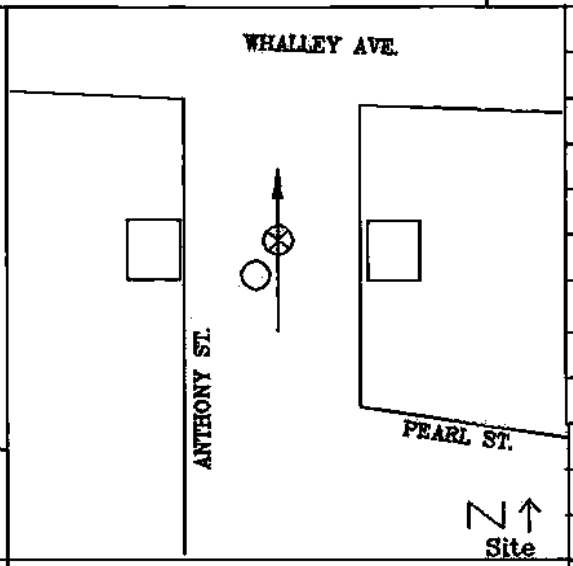
ess/Location: ANTHONY STREET BETWEEN WHALLEY AVENUE AND PEARL STREET

hone Co. Address:

Access: DRIVE

Phone Number:





INSTALLATION

15.00" RING WITH CRANK;

ULTRASONIC, VELOCITY & PRESSURE

INSTALLED UPSTREAM

SAFETY

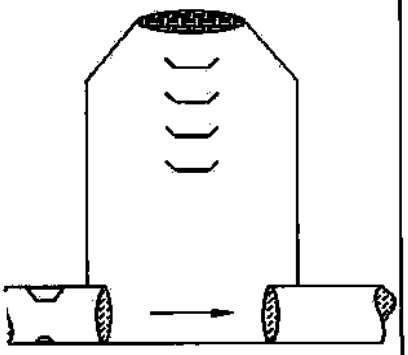
Manhole Depth: 8.0'

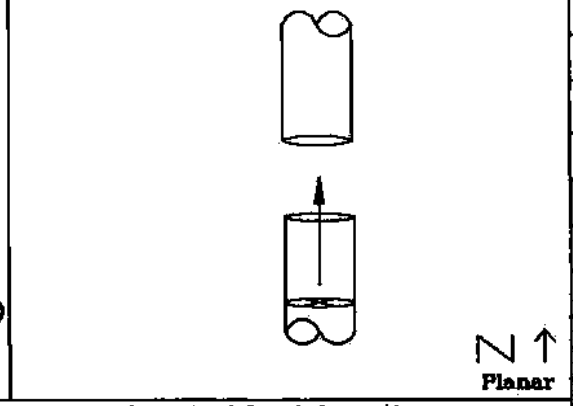
Traffic: LIGHT-MODERATE

Gas @ Investigation: NEGATIVE

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR





Q.C. Inspector:

Date:

Comments:

Pipe Type: CLAY

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

ydraulics: FAST SHALLOW FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

urcharge: YES Height: 2.0'

R.O.W. #: N/A

Inv.: DOF: 1.50" +/- .25" Time: 14:07 Vel: 3.0 fps Silt: 0.0"

'ream Manhole DID NOT INVESTIGATE

ownstream Manhole DID NOT INVESTIGATE

Dni System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		S3
RG Zone	**Bat Serial #**	**Monitor #**
RG1		
Velocity	**Lit Diameter**	**Diameter**
	N/A	12.00"

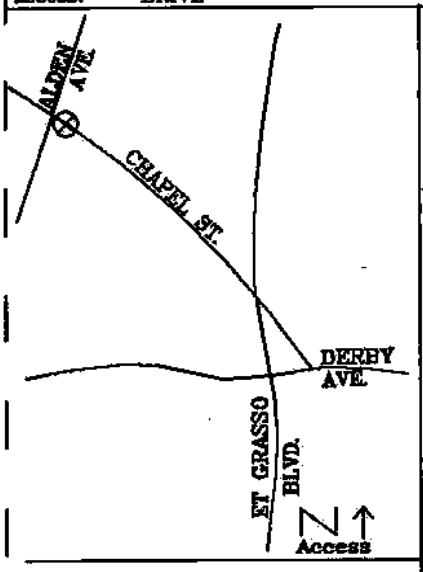
Project/Phase: NEW HAVEN CSO Date: 28 AUG 97 Name: MPN

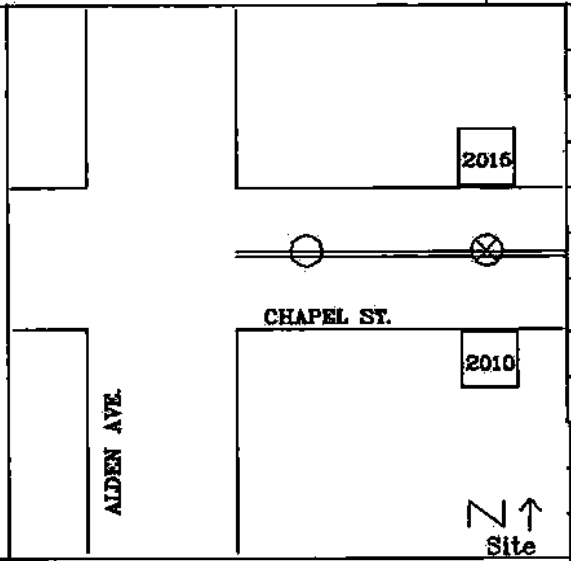
Address/Location: 2010 CHAPEL STREET; EAST OF ALDEN AVENUE

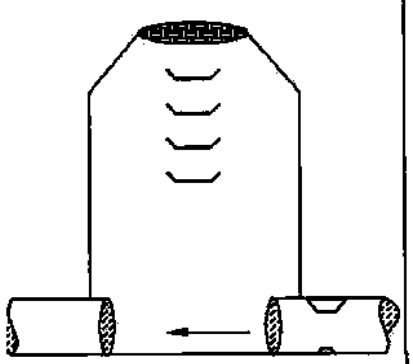
Phone Co. Address:

Phone Number:

Access: DRIVE







INSTALLATION

RING & CRANK WITH

ULTRASONIC, VELOCITY & PRESSURE

SAFETY

Manhole Depth: 18.0'

Traffic: MODERATE-HEAVY

Gas @ Investigation: GOOD

Manhole Condition: GOOD

Frame: Regular/Irregular REGULAR

Q.C. Inspector:

Date:

Comments:

Pipe Type: CLAY

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge
Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics: GOOD SMOOTH FLOW

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: YES Height : 3.0'

R.O.W. #: N/A

Inv.: DOF: 3.00" +/- .25" Time: 13:30 Vel: 1.50 fps Silt: 0.0"

Upstream Manhole POOR HYDRAULICS

TOPSIDE INSPECTION DONE ON 8/28

1500 MONITORABLE SITE

Downstream Manhole DID NOT INVESTIGATE

Sani System Character: Residential/Commercial/Industrial/Vacant RESIDENTIAL

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		RG1
RG Zone	**Bat Serial #**	**Monitor #**
RG1		
Velocity	**Lif Diameter**	**Diameter**
	N/A	

roject/Phase: NEW HAVEN CSO Date: 2 SEPT 97 Name: MPN

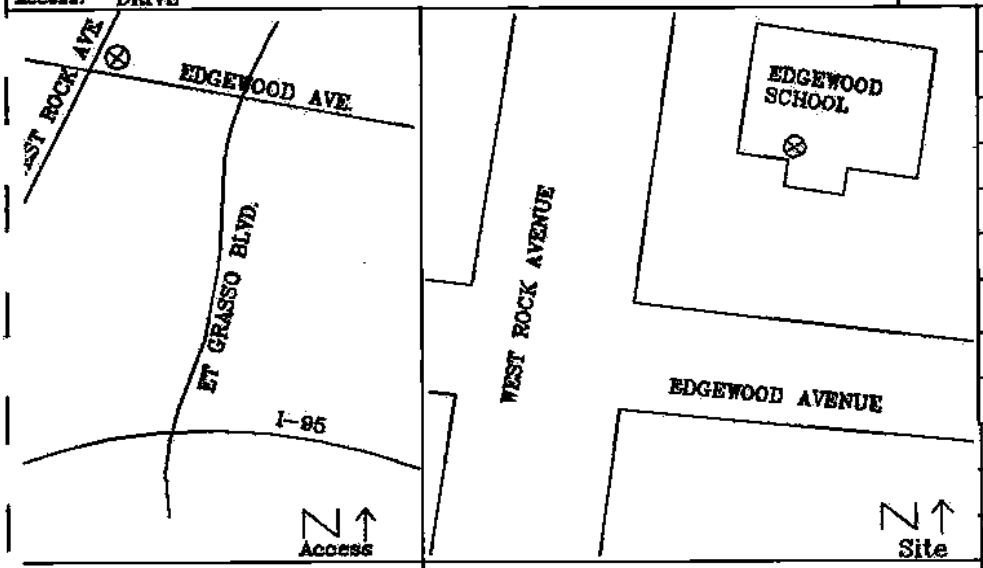
ess/Location: EDGEWOOD SCHOOL

WEST ROCK AVENUE & EDGEWOOD AVENUE

hone Co. Address:

Access: DRIVE

Phone Number:



INSTALLATION

1500 METER RAIN GAUGE

8.00" TIPPING BUCKET

SAFETY

Manhole Depth:

Traffic:

Gas @ Investigation: Negative

Manhole Condition:

Frame: Regular/Irregular Regular

Q.C. Inspector:

Date:

Comments:

Pipe Type :

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics:

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: N/A Height : N/A

R.O.W. #: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

" -tream Manhole N/A

Downstream Manhole N/A

Mini System Character: Residential/Commercial/Industrial/Vacant Residential/Commercial

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		RG2
RG Zone	**Bat Serial #**	**Monitor #**
RG2		
Velocity	**Lit Diameter**	**Diameter**
	N/A	

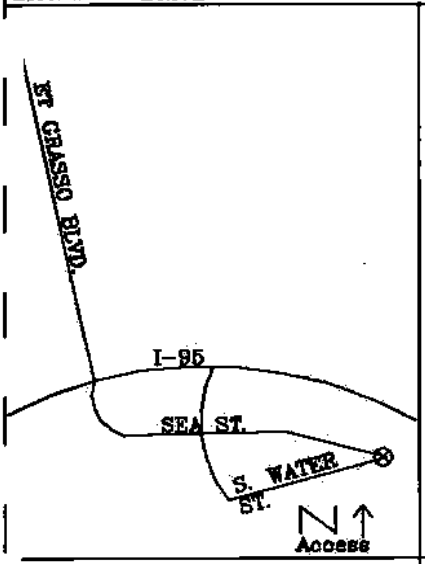
Project/Phase: NEW HAVEN CSO Date: 2 SEPT 97 Name: MPN

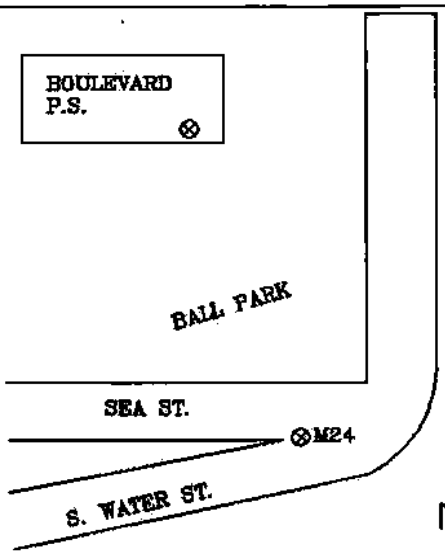
Address/Location: BOULEVARD, PUMP STATION

Phone Co. Address:

Phone Number:

Access: DRIVE





INSTALLATION

1500 METER RAIN GAUGE

AND 8.00" TIPPING BUCKET

SAFETY

Manhole Depth:

Traffic:

Gas @ Investigation: Negative

Manhole Condition:

Frame: Regular/Irregular Regular

Q.C. Inspector:

Date:

Comments:

Pipe Type:

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

' Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics:

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

R.O.W. #: N/A

Surcharge: N/A Height: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

Upstream Manhole N/A

Downstream Manhole N/A

Mini System Character: Residential/Commercial/Industrial/Vacant Residential/Commercia

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		RG3
RG Zone	**Bat Serial #**	**Monitor #**
RG3		
Velocity	**Lif Diameter**	**Diameter**
	N/A	

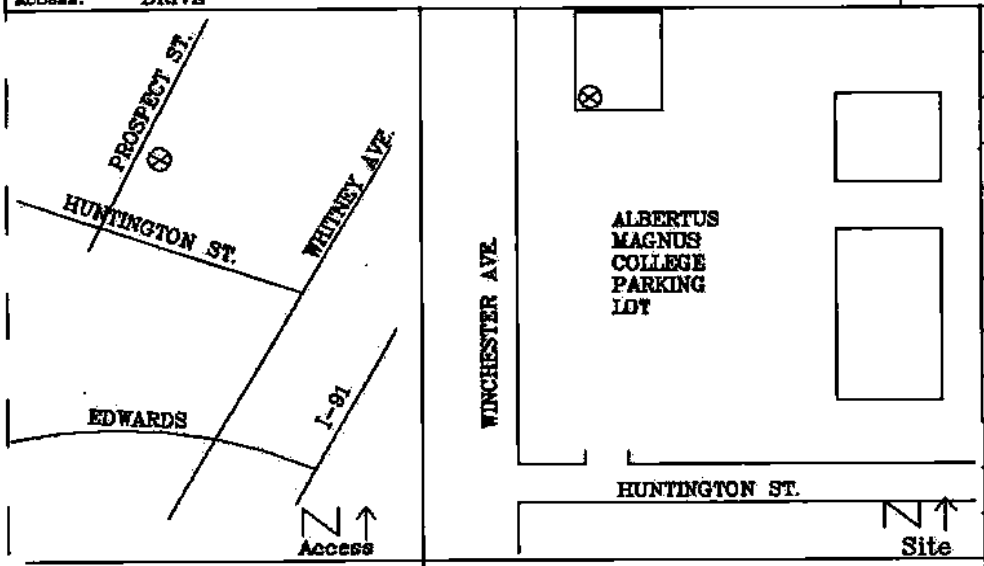
roject/Phase: NEW HAVEN CSO Date: 2 SEPT 97 Name: MPN

ess/Location: ALBERTUS MAGNUS COLLEGE

hone Co. Address:

Phone Number:

Access: DRIVE



INSTALLATION

1500 METER RAIN GAUGE

AND 8.00" TIPPING BUCKET

SAFETY

Manhole Depth:

Traffic:

Gas @ Investigation: Negative

Manhole Condition:

Frame: Regular/Irregular Regular

Q.C. Inspector:

Date:

Comments:

Pipe Type :

BACKUP	Y	N	?	Distance
Trunk Reg				
Lift Sta.				
STP				
Other Input				
Ind U/S				
L/S U/S				

General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

Hydraulics:

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge : N/A Height : N/A

R.O.W. #: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

Upstream Manhole N/A

Downstream Manhole N/A

Mini System Character: Residential/Commercial/Industrial/Vacant Residential/Commercial

ADS Environmental Services, Inc.

1500 Site Report

Town	Manhole #	AN
NEW HAVEN		RG4
RG Zone	**Bat Serial #**	**Monitor #**
RG4		
Velocity	**Lif Diameter**	**Diameter**
	N/A	

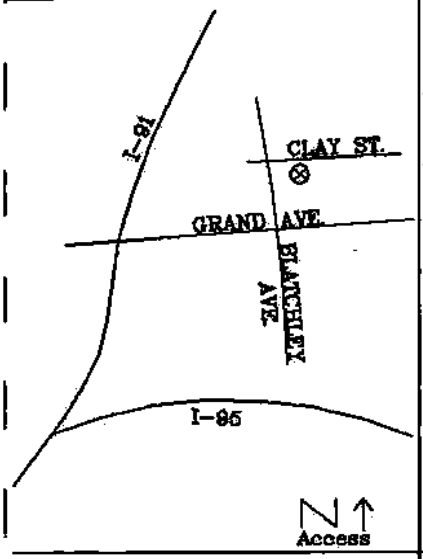
Project/Phase: NEW HAVEN CSO Date: 2 SEPT 97 Name: MPN

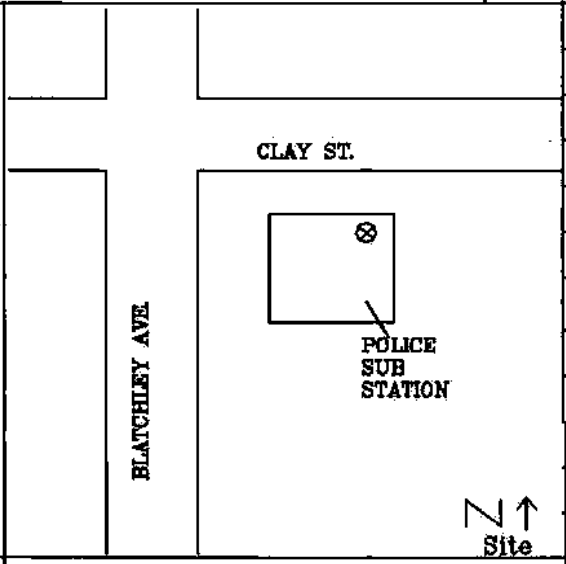
ess/Location: 295 BLATCHLEY AVE., NEW HAVEN POLICE SUB STATION

Phone Co. Address:

Access: DRIVE

Phone Number:





General Condition, overflows, bypasses, weirs, special information, monitor characteristics, surcharge

* Please make a precise drawing if odd-shaped pipe or special installation

INSTALLATION

8.00" TIPPING BUCKET WITH

1500 METER RAIN GAUGE

SAFETY

Manhole Depth:

Traffic:

Gas @ Investigation: Negative

Manhole Condition:

Frame: Regular/Irregular Regular

Q.C. Inspector:

Date:

Comments:

Pipe Type:

BACKUP	Y	N	?	Distance
Trunk Reg.				
Lift Sta.				
STP				
Other input				
Ind U/S				
L/S U/S				

Hydraulics:

Approval:

Access Pole#:

Distance from M/H:

Road Cut Length: N/A

Trench Length: N/A

Surcharge: N/A Height: N/A

R.O.W. #: N/A

Inv.: DOF: N/A +/- .13" Time: N/A Vel: N/A fps Silt: 0.0"

'ream Manhole N/A

Downstream Manhole N/A

Mini System Character: Residential/Commercial/Industrial/Vacant Residential/Commercia

Appendix B: Communication from ADS

ENVIRONMENTAL SERVICES, INC.

- Flow Monitoring
- I/I Reduction
- CSO/Stormwater Management
- Sewer System Evaluation Surveys

February 25, 1998

Ms. Perrin Bowling
Environmental Engineer
CH2MHill
50 Staniford Street
10th Floor
Boston, MA 02114-2517

RE: New Haven CSO Study Flow Monitoring

Dear Perrin:

At your request I have summarized results and observations for flow monintoring sites M2 and M3 for the above referenced project.

Site M3(Orange Avenue and ET Grasso Boulevard)

The monitoring period for Site M3 was September 9, 1997 - December 17, 1997. The average daily flow as reported in our final report was 9.19 mgd. During the monitoring period several calibrations were conducted. The results are as follows:

Date	Field Depth(in)	Monitor Depth(in)	Field Velocity (fps)	Monitor Velocity(fps)	Silt (in)
09/09/97	30.75	30.41	1.15	1.17	2.00
09/19/97	35.50	35.64	1.40	1.09	2.00
09/23/97	35.00	35.04	1.49	1.35	2.00
09/30/97	34.12	34.52	1.33	1.41	2.00
10/07/97	35.00	34.77	1.12	1.45	2.00
10/10/97	35.25	35.18	1.39	1.50	2.00
10/23/97	35.00	35.08	1.38	1.50	2.00
10/27/97	37.25	36.99	1.48	1.67	2.00
11/03/97	35.25	35.28	1.43	1.58	2.00
12/17/97	35.38	35.18	1.49	1.46	2.00

I have enclosed scattergraphs for Site M3 that shows all monitoring data as well as calibration points. The calibration markers are black diamonds. Please note that the velocities listed in the table above are peak velocities, while the velocities in the scattergraph are average velocities.

The size of the sewer in which M3 was installed was identified on comprehensive sewer maps provided to ADS as 66 inches. In addition, the sketch provided by CH2MHill for this site, the sewer is shown as a 66 inch round sewer. ADS performed a precise pipe measurement that indicated the sewer is actually an odd-shaped pipe with a pipe height of 64.5 inches and a pipe width of 74 inches. It would be helpful to review as-built drawings of this sewer if they are available.

Site M2(South of Lamberton Street under ET Grasso Boulevard)

The monitoring period for Site M2 was September 6, 1997 - December 17, 1997. The average daily flow as reported in our final report was 8.265 mgd. During the monitoring period several calibrations were conducted. The results are as follows:

Date	Field Depth(in)	Monitor Depth(in)	Field Velocity (fps)	Monitor Velocity(fps)	Silt (in)
09/06/97	33.00	32.95	1.24	1.25	10.00
09/30/97	32.50	31.96	1.13	1.11	6.00
10/07/97	32.50	32.31	0.60	1.09	8.50
10/07/97	32.50	32.54	0.63	1.12	8.50
10/10/97	n/a	n/a	1.15	1.12	8.50
10/23/97	29.88	29.80	0.83	0.80	8.75
10/27/97	33.00	33.30	1.26	1.19	8.50
11/03/97	32.75	32.59	1.09	1.09	9.00
12/17/97	30.75	29.60	1.94	0.99	9.00

I have enclosed scattergraphs for Site M2 that shows all monitoring data as well as calibration points. As with Site M3, the calibration markers are black diamonds, the velocities listed in the table above are peak velocities and the velocities in the scattergraph are average velocities.

The size of the sewer in which M2 was installed was identified on comprehensive sewer maps provided to ADS as 62 inches by 102 inches. A pipe measurement performed by ADS confirmed these dimensions 62 inches (Height) by 102 inches (Width).

Summary of Results and Subsequent Investigations

Based on conversations with CH2MHill as well as review of comprehensive sewer maps M3 is upstream of M-2. However, flow monitoring results indicated higher flows at M-3. ADS performed follow-up investigations in January 1998. Eight full descent manhole inspections were performed inclusive of M-3, M-2 and the six manholes in between the monitoring locations. These inspections revealed that the silt profiles had changed significantly at both sites. The silt measured at Sites M-3 and M-2 was 16 and 26 inches respectively. There was activity one manhole upstream of M-2. Some type of treatment system is discharging flow to a manhole that appears to have been recently constructed. In addition, review of the hydrographs for both sites indicates some level of tidal influence. One or both of these factors may have affected the site hydraulics(i.e. flow bypassing,infiltration/exfiltration).

Please contact me at your earliest convenience with your questions or comments at (914)268-1201.

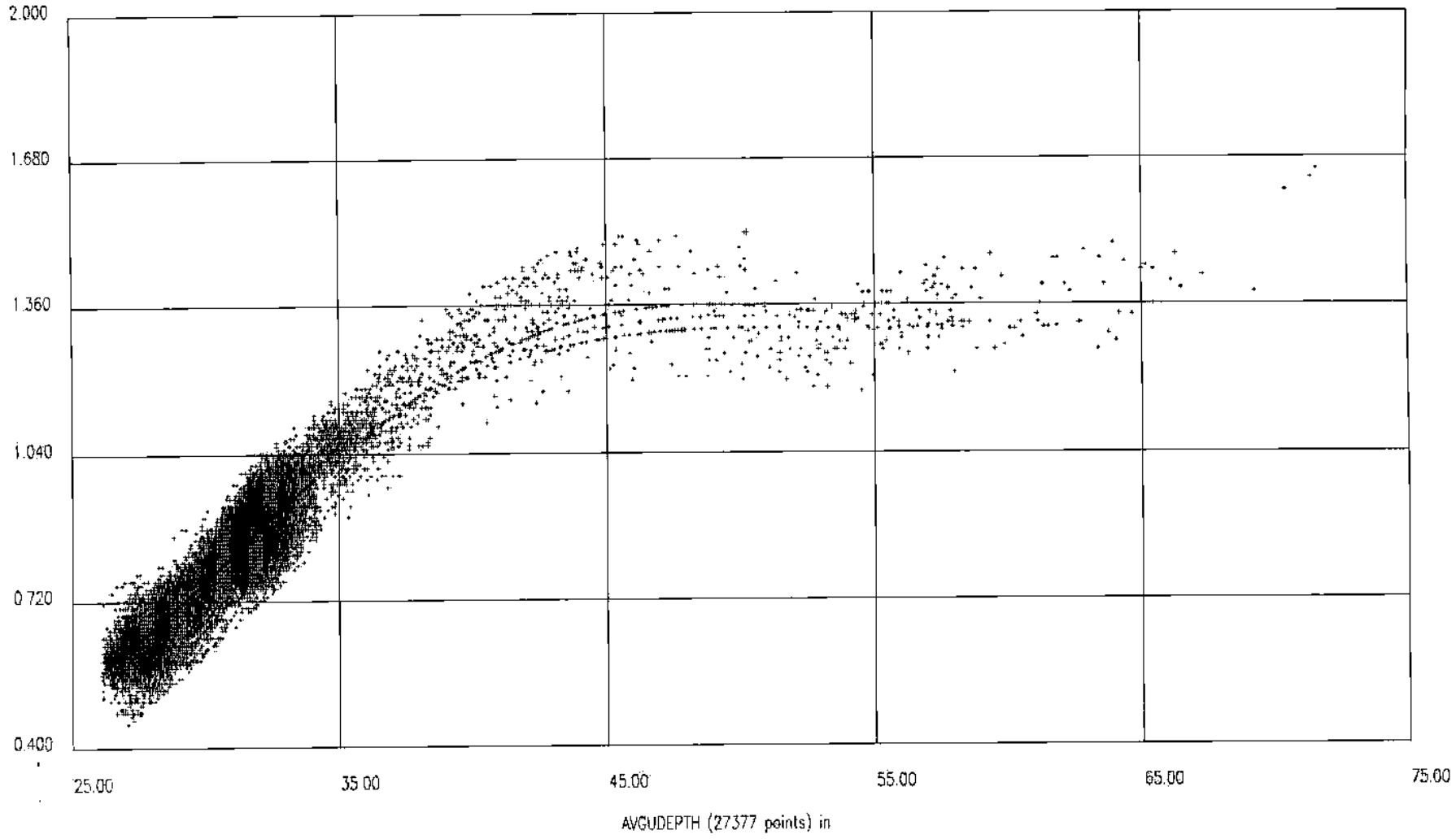
Very truly yours,
ADS ENVIRONMENTAL SERVICES, INC.

Thomas J. Ryan, P.E.
Project Manager

cc: CH2MHill von Zweck
ADS Archard

ADS ENVIRONMENTAL SERVICES, INC.

Location NHCSO_M2



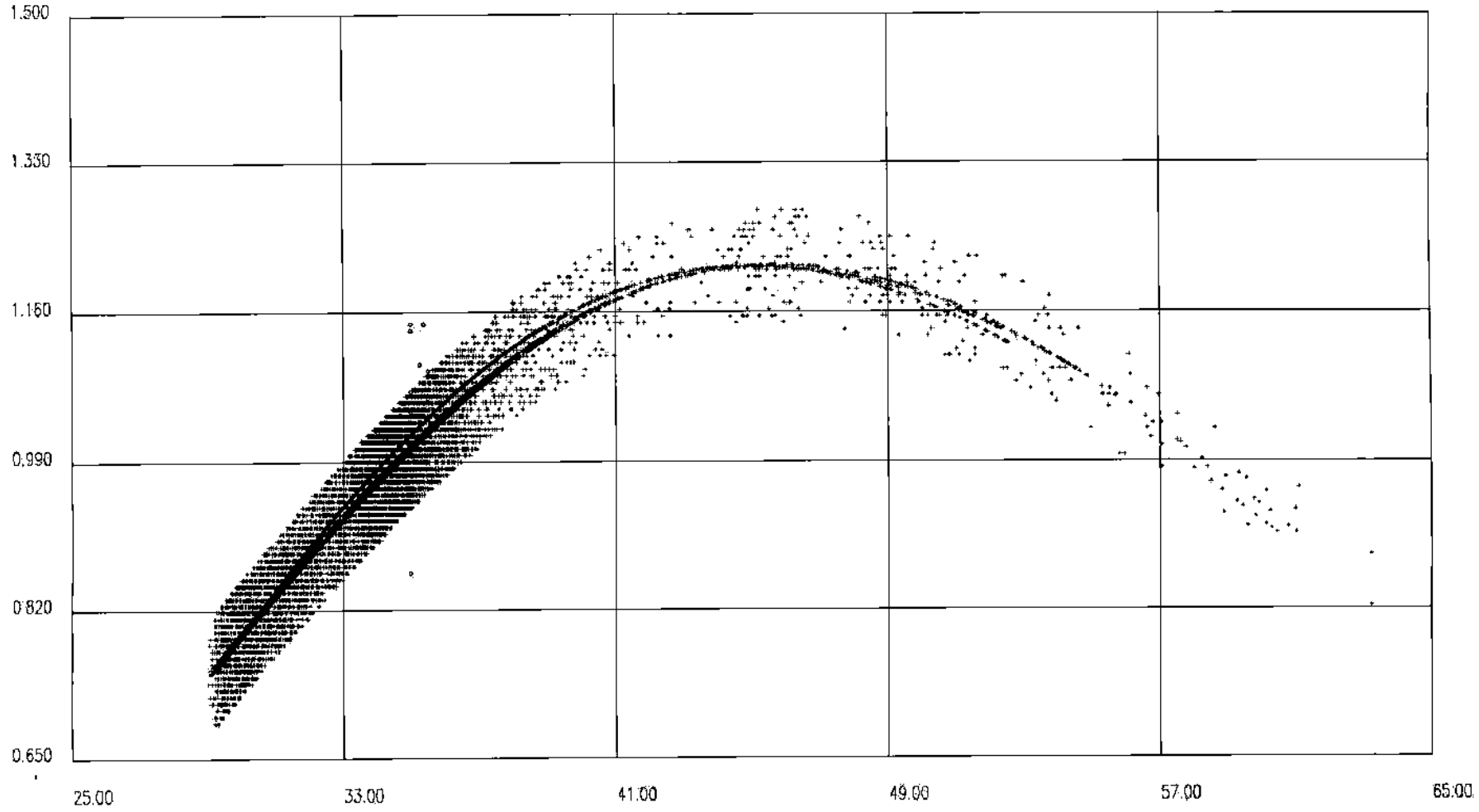
All Cals Used

02/19/98
10:51:18

12-Sep-1997 00:00:00 to 17-Dec-1997 08:35:00

ADS ENVIRONMENTAL SERVICES, INC.

Location NHCSO_M3



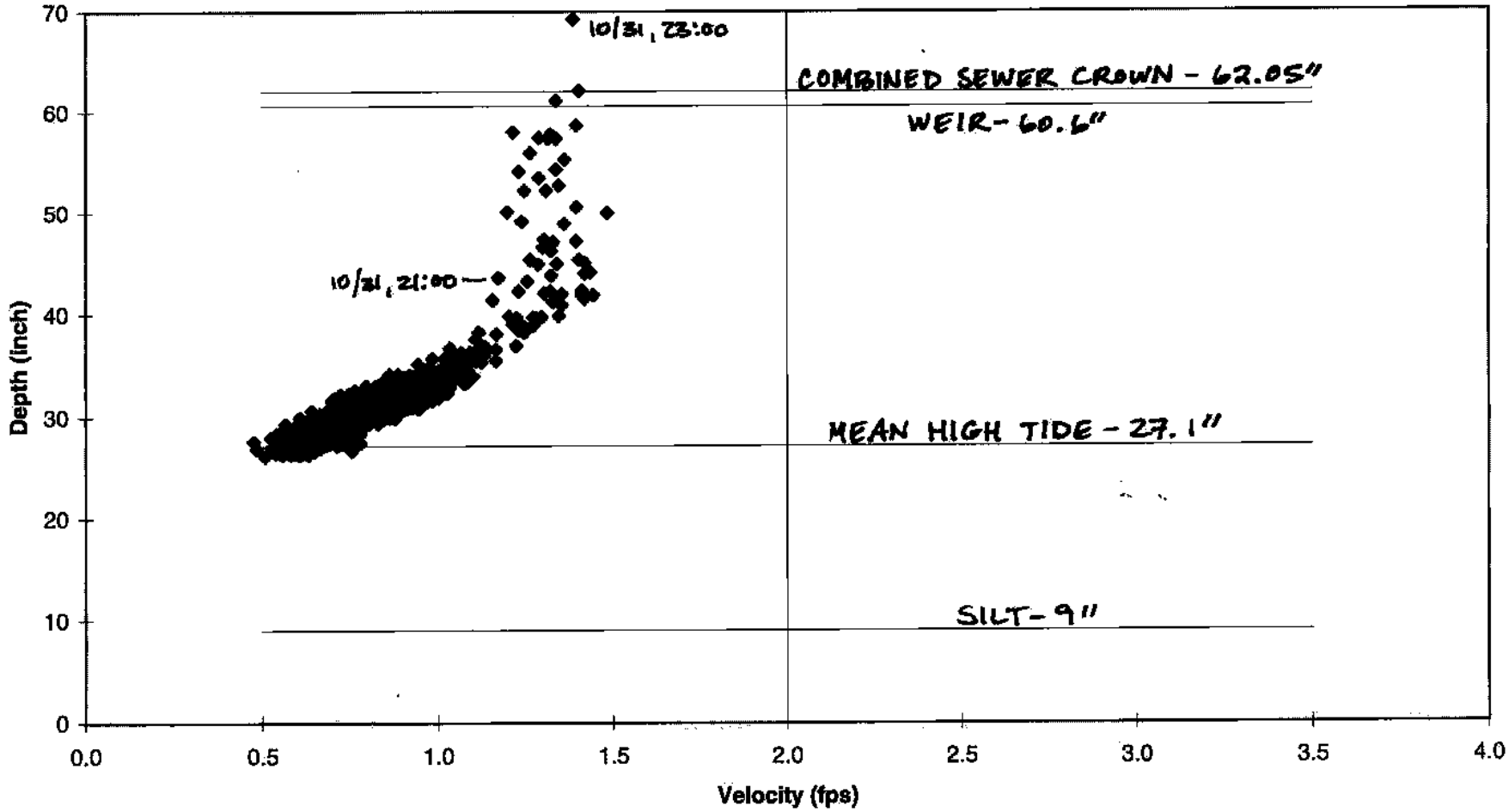
All Cals Used

02/19/98
10:57:57

12-Sep-1997 00:00:00 to 17-Dec-1997 09:10:00

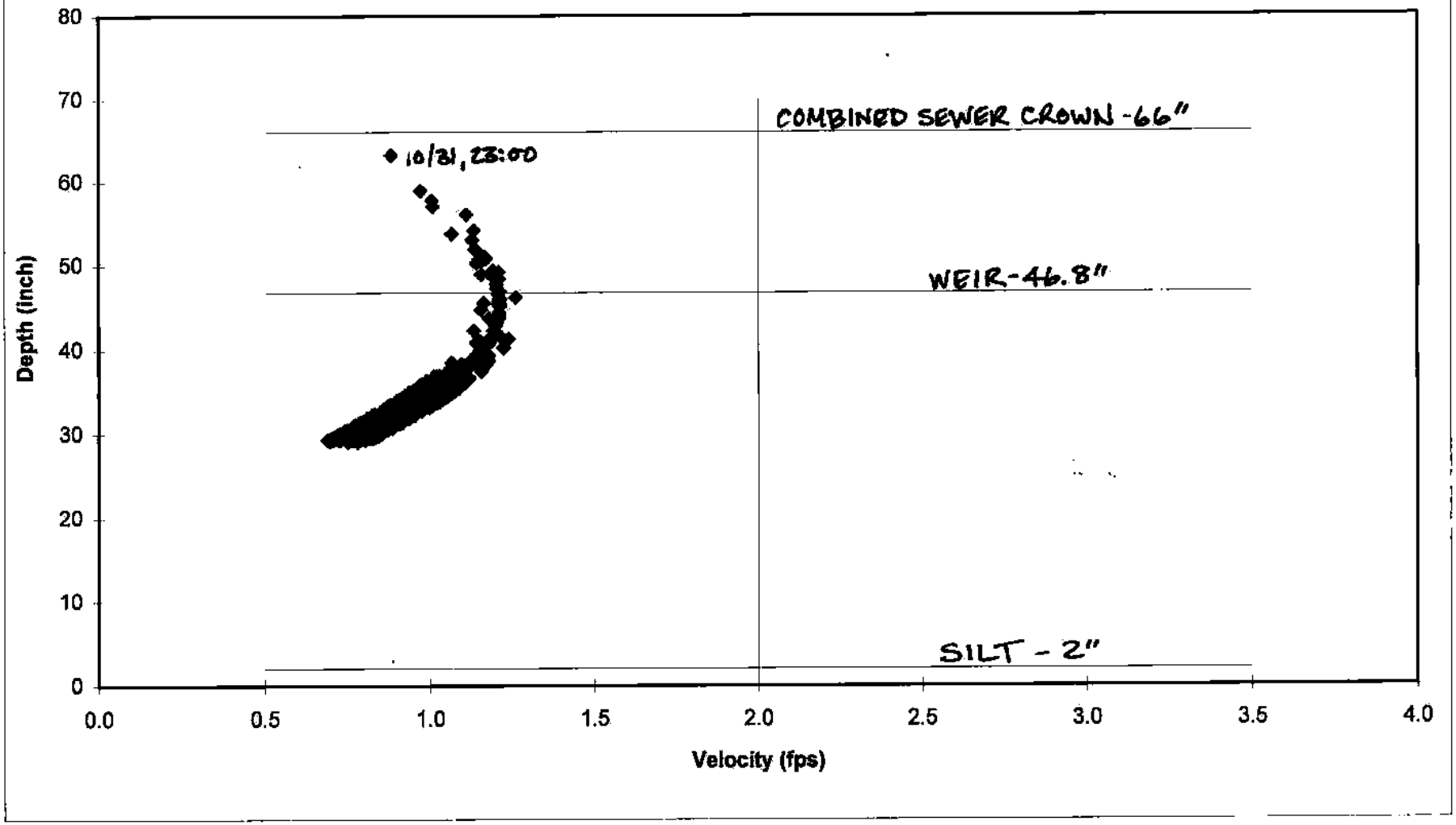
Appendix C: Velocity-Depth Scatter Plots

Meter M2 Hourly Graph
NPDES 002
(E.T. Grasso Blvd @ Lamberton St)



2/27/98 8:50 AM
M2 Chart 2
scatter.xls

Meter M3 Hourly Graph
NPDES 003
(E.T. Grasso Blvd @ Orange Ave)



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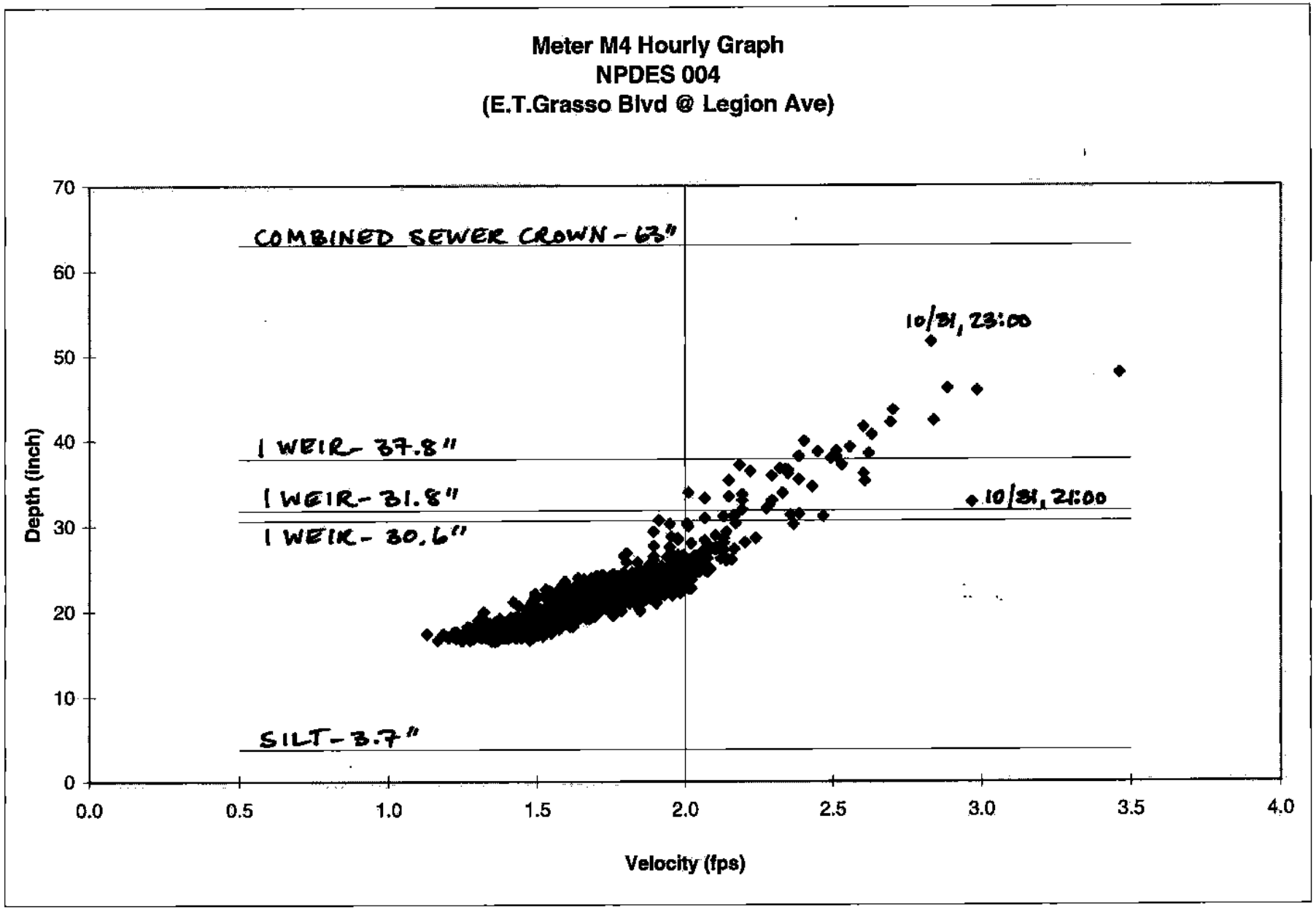
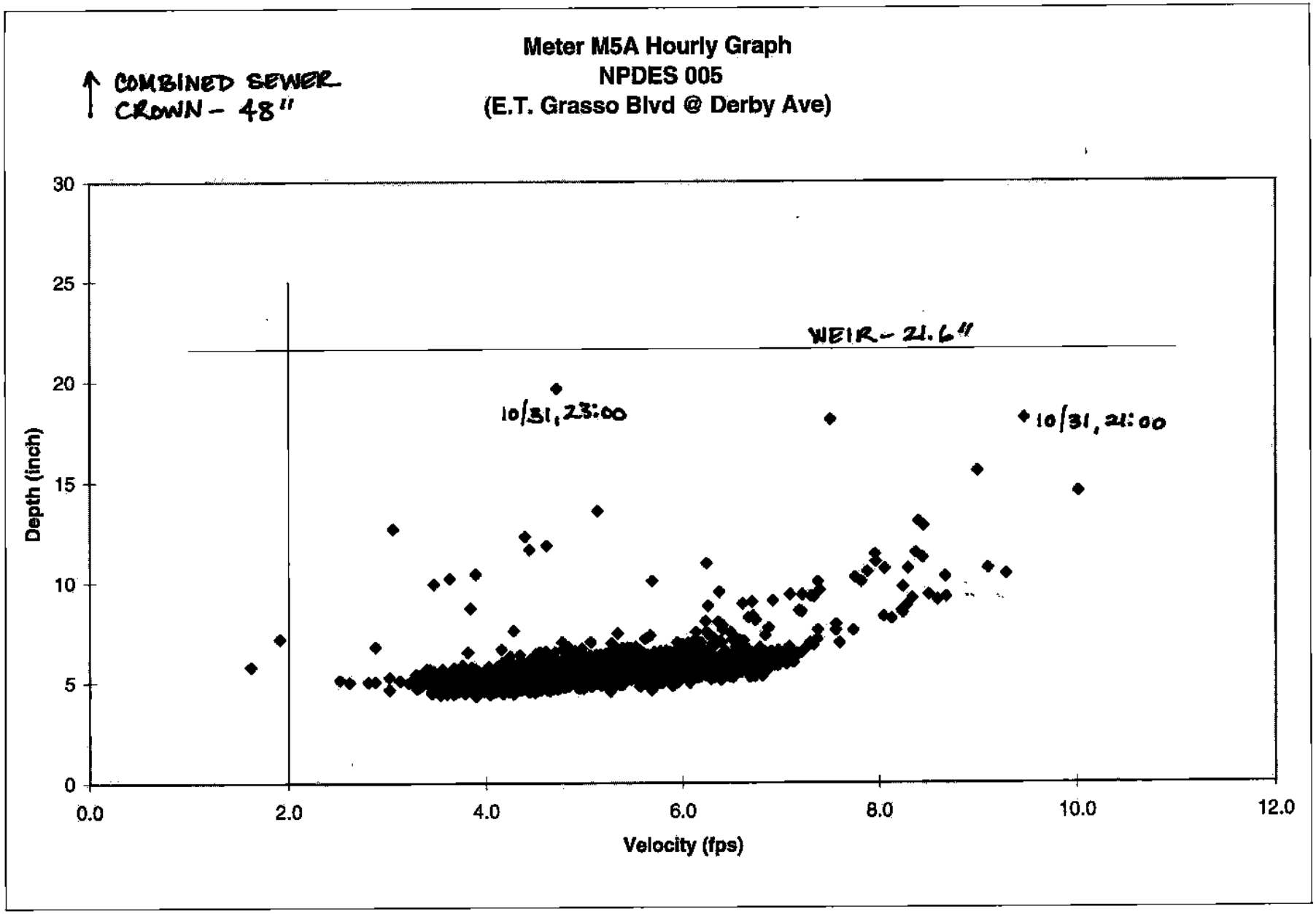
M3 Chart 1
scatter.xls



3/18/98 9:38 AM
M4 Chart 1
scatter.xls



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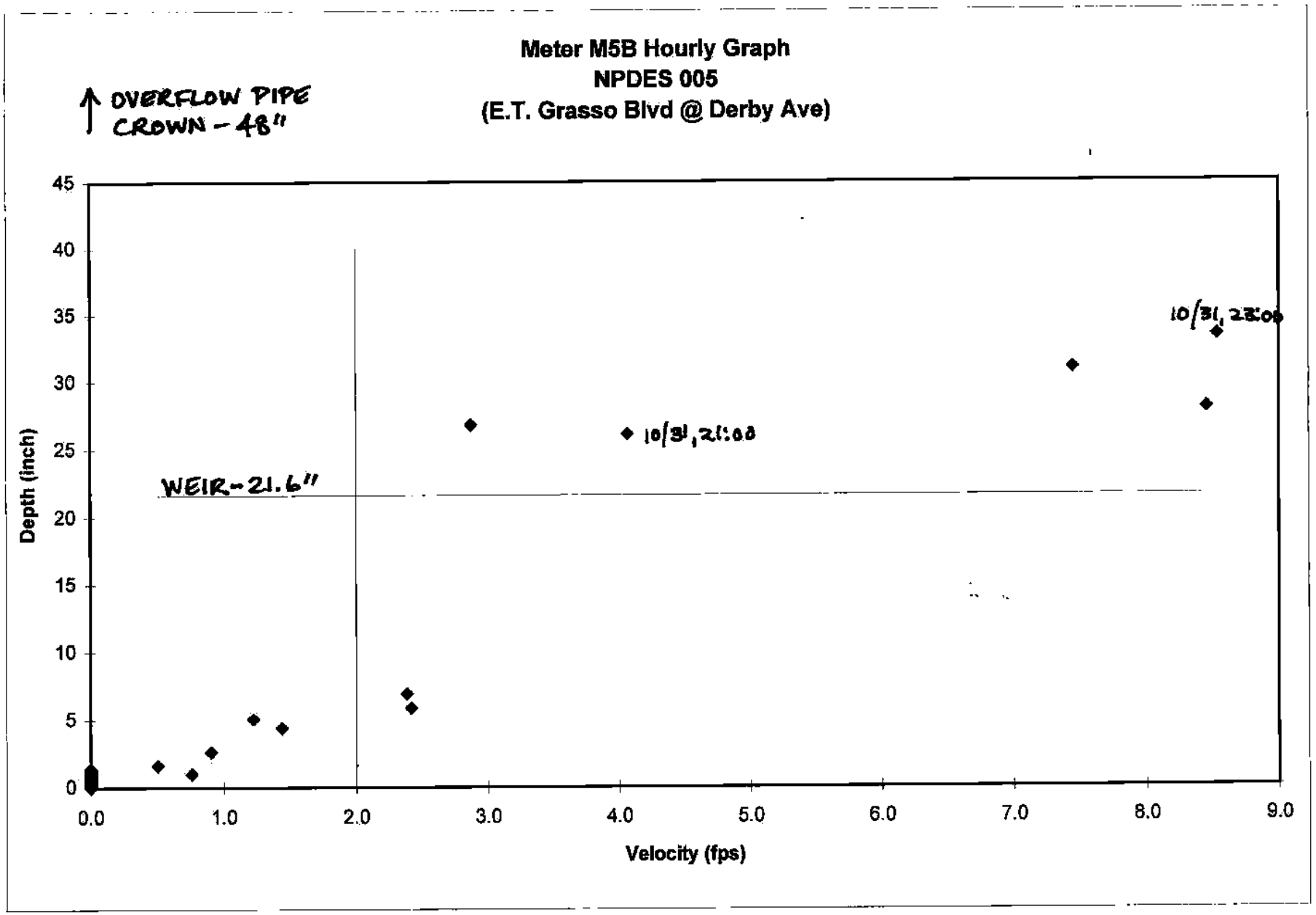
M5A Chart 1
scatter.xls



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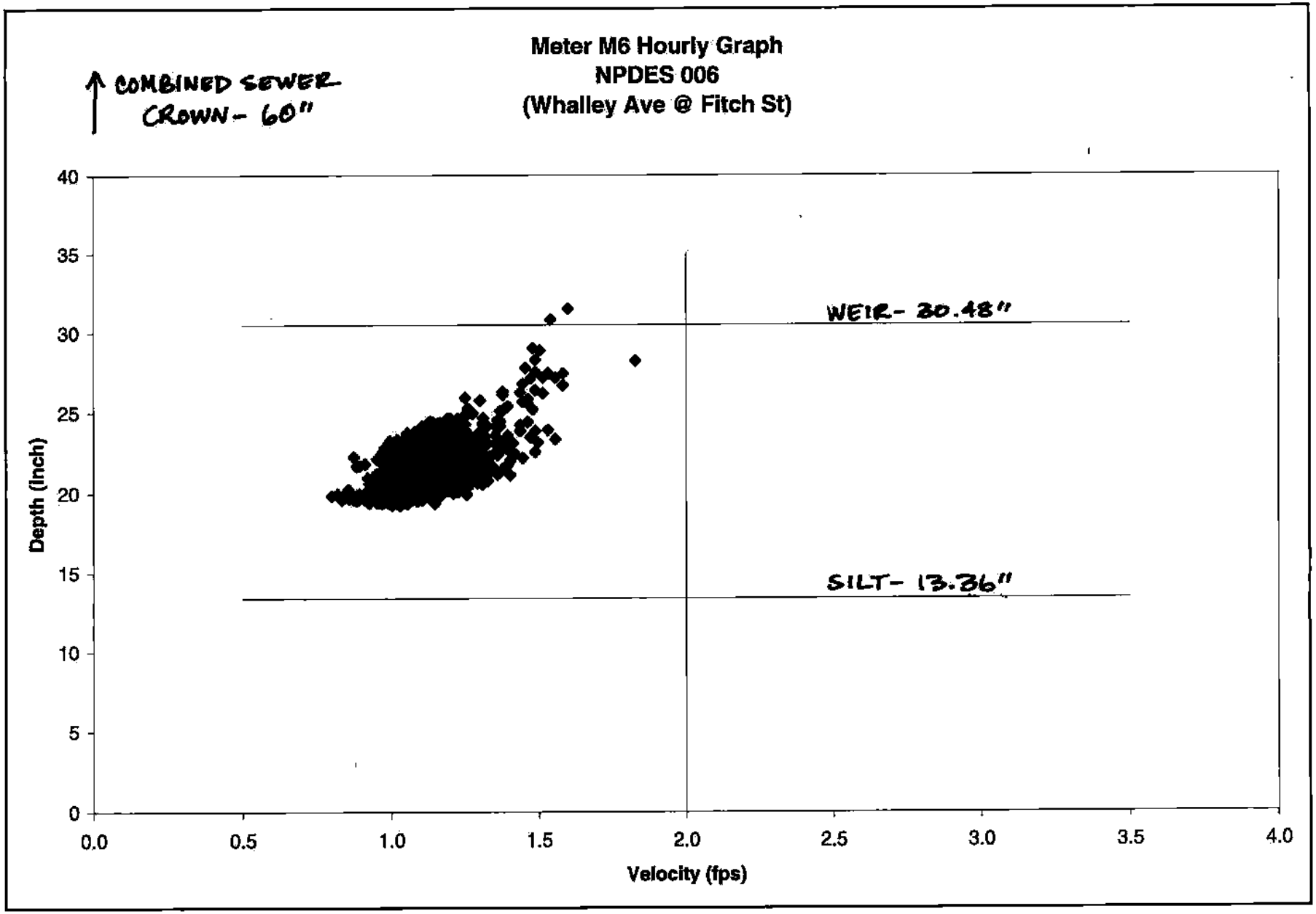
M5B Chart 1
scatter.xls



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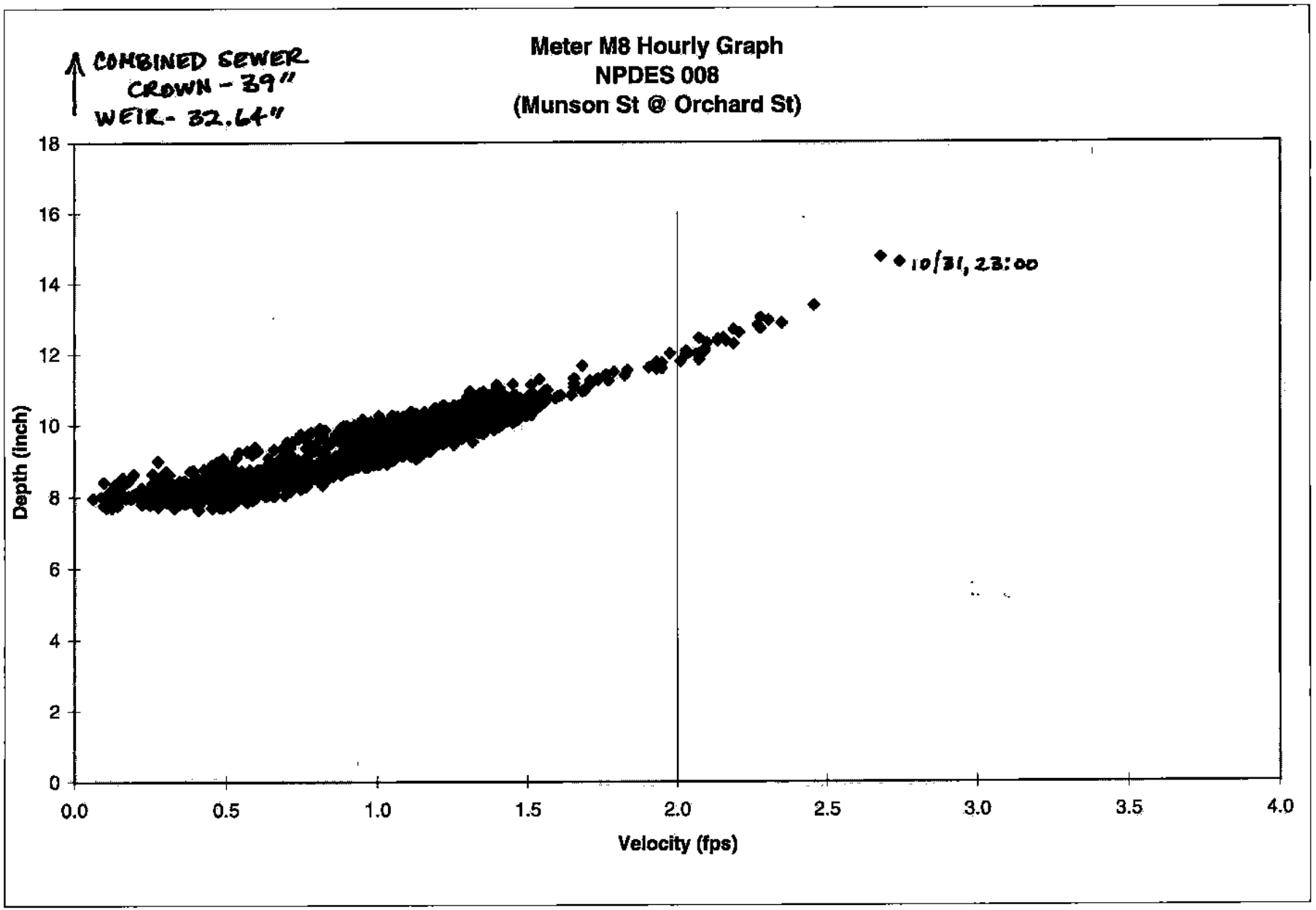
M6 Chart 2
scatter.xls



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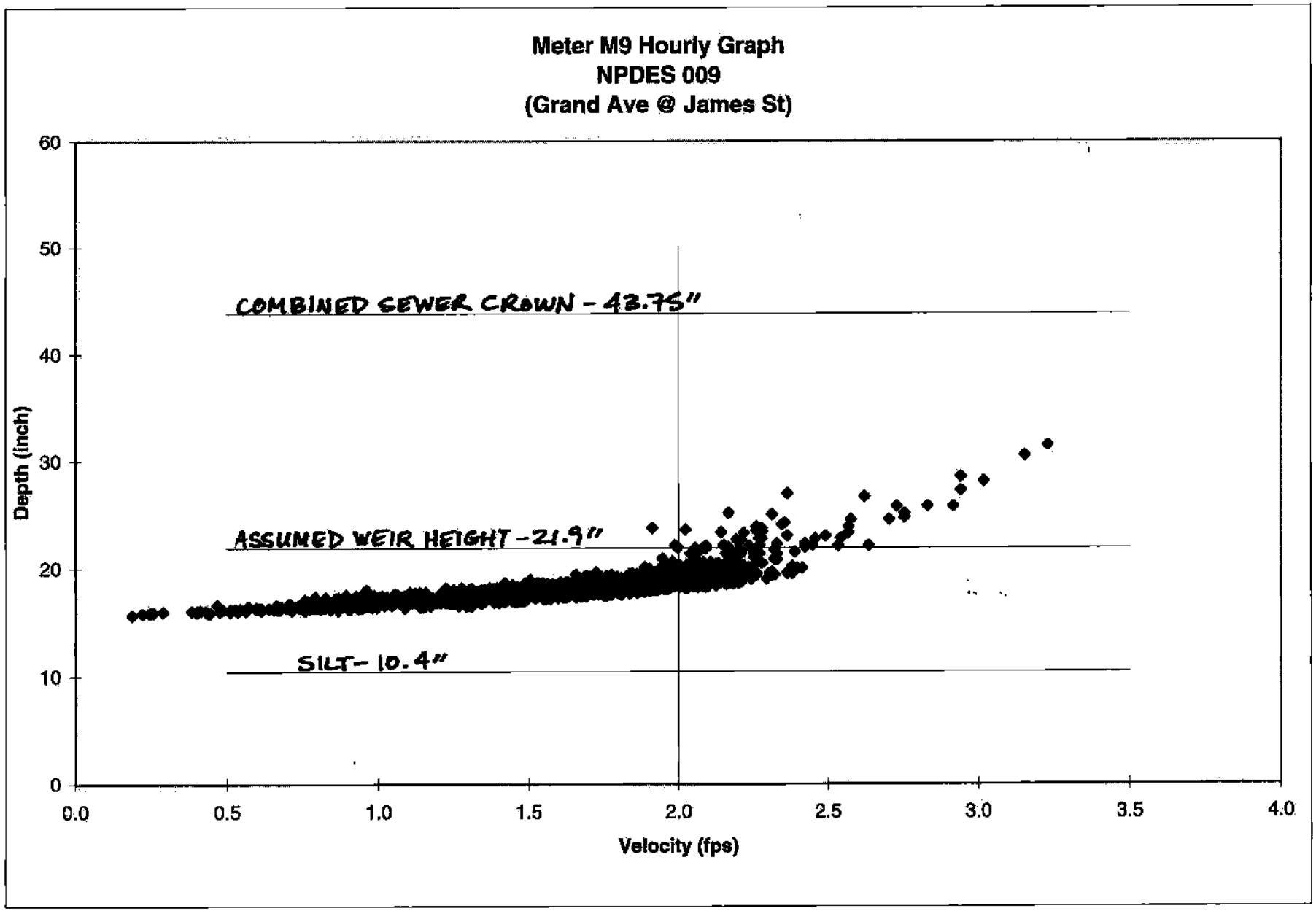
M8 Chart 1
scatter.xls



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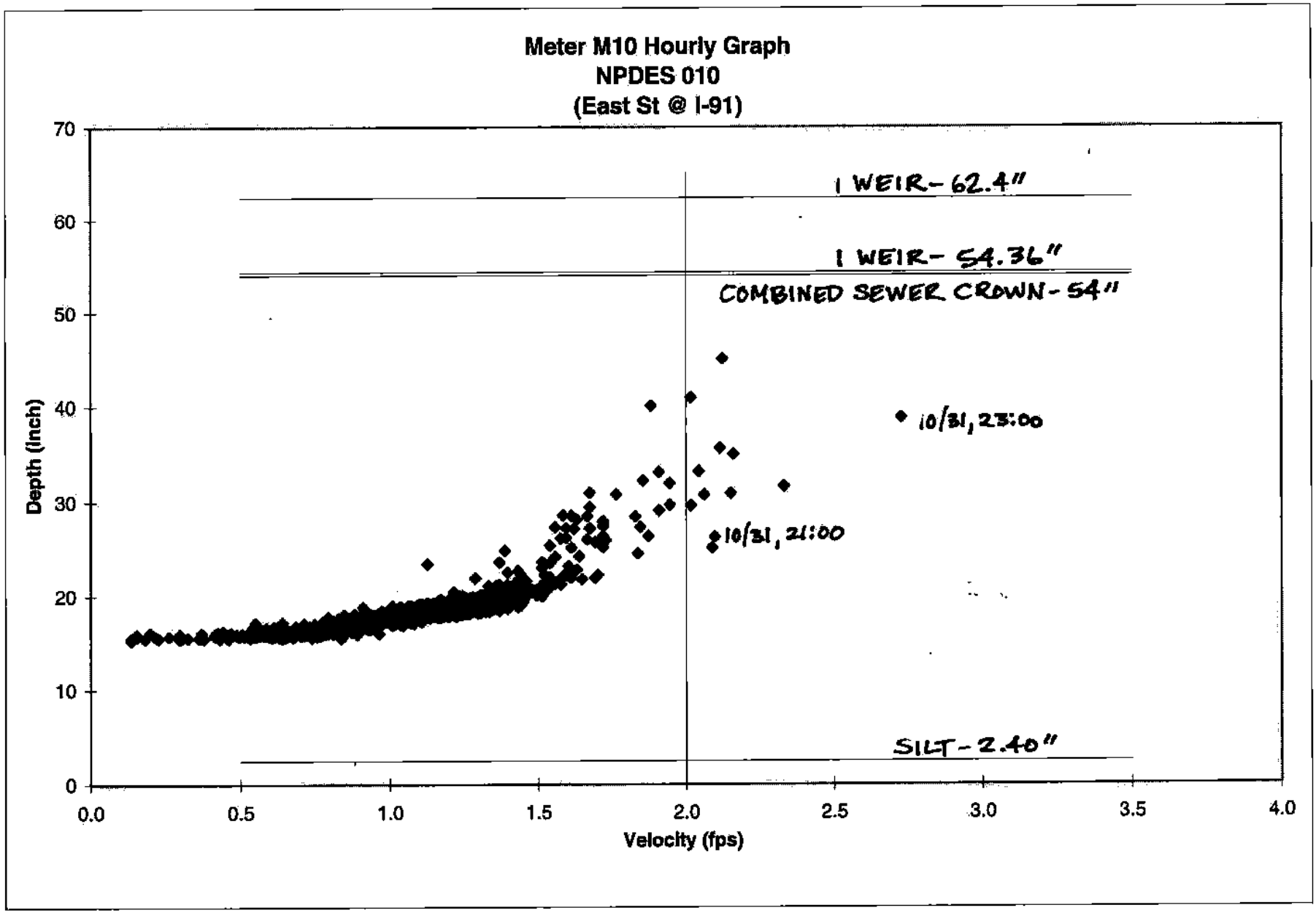
M9 Chart 1
scatter.xls



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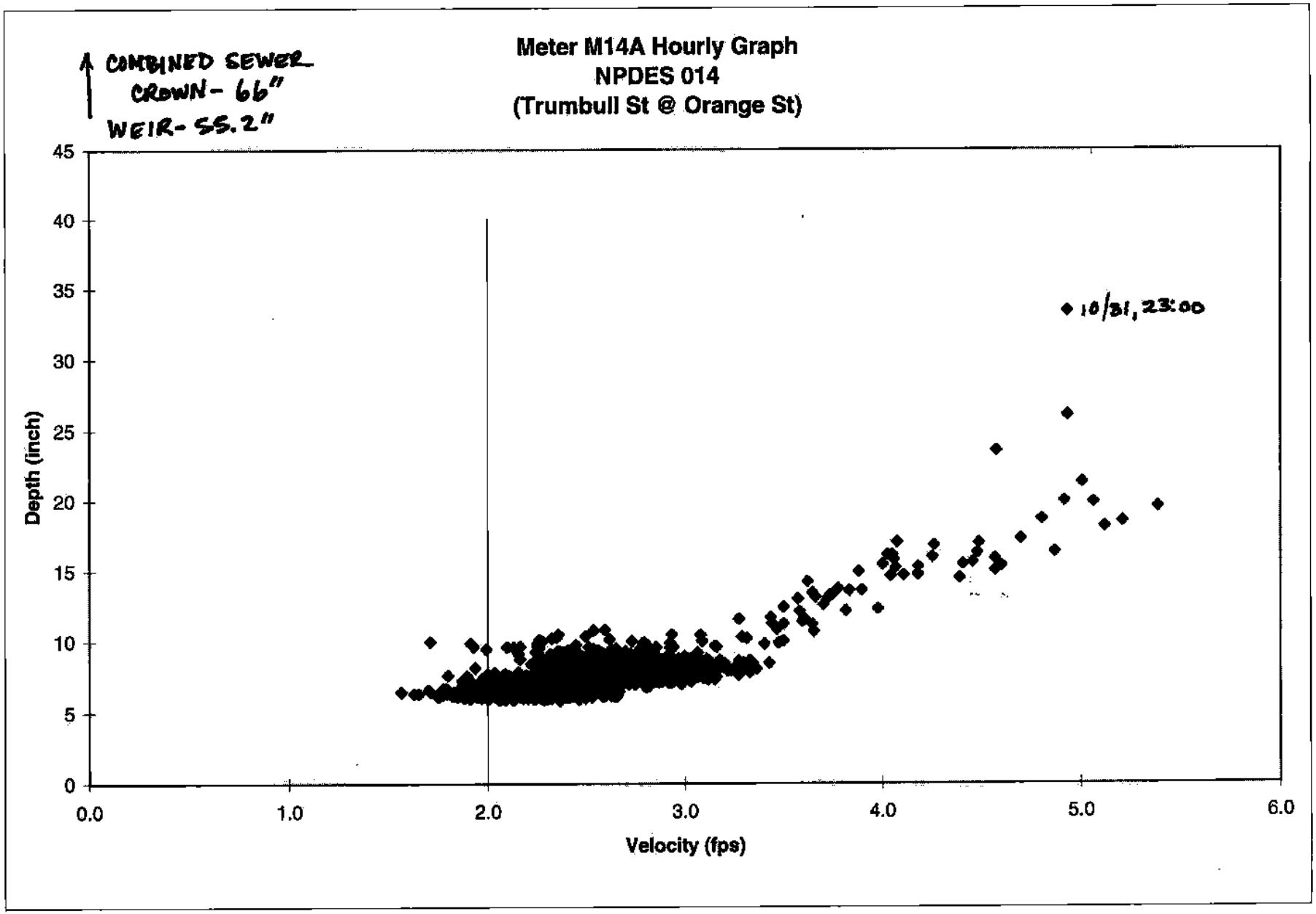
M10 Chart 1
scatter.xls



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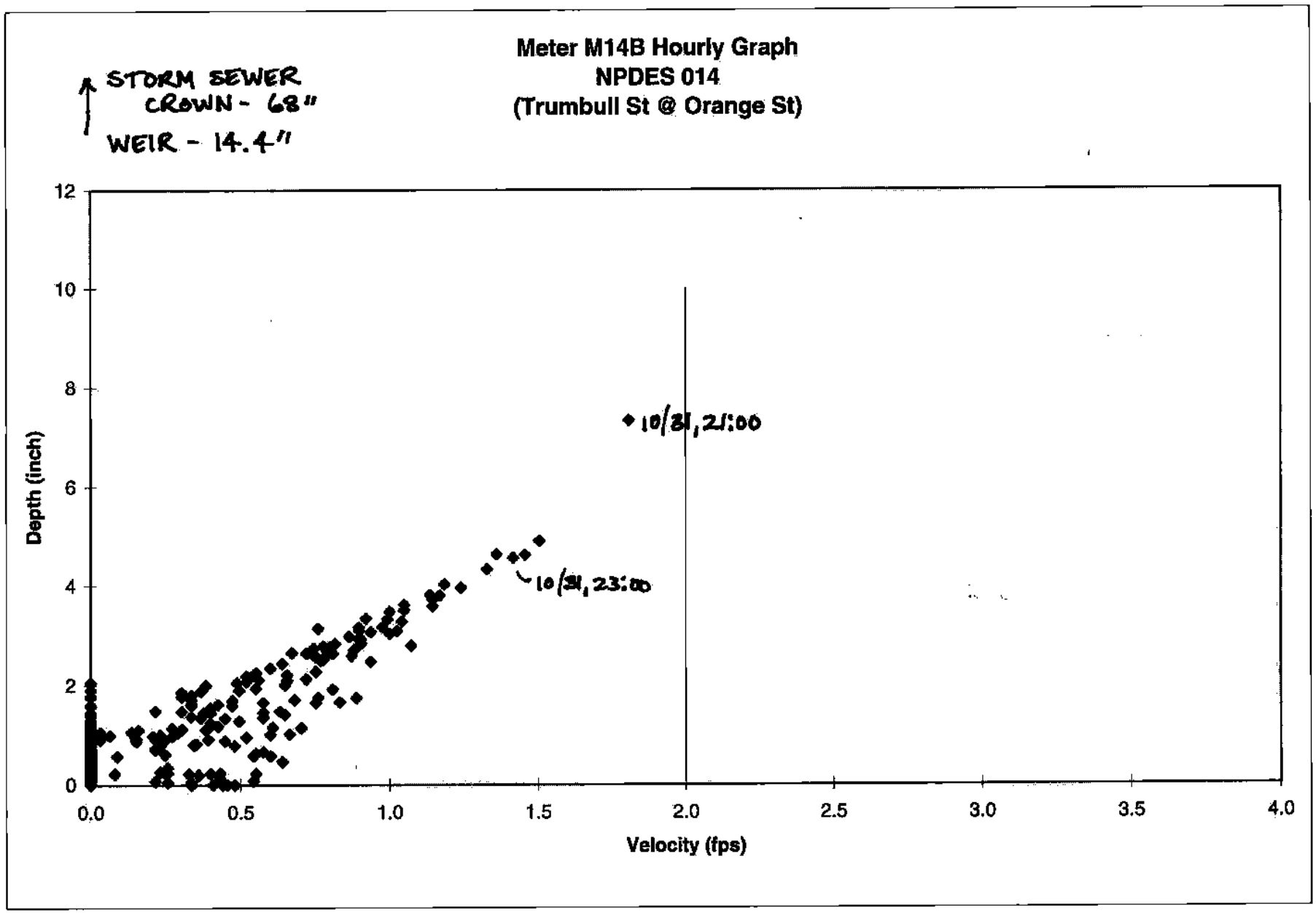
scatter.xls



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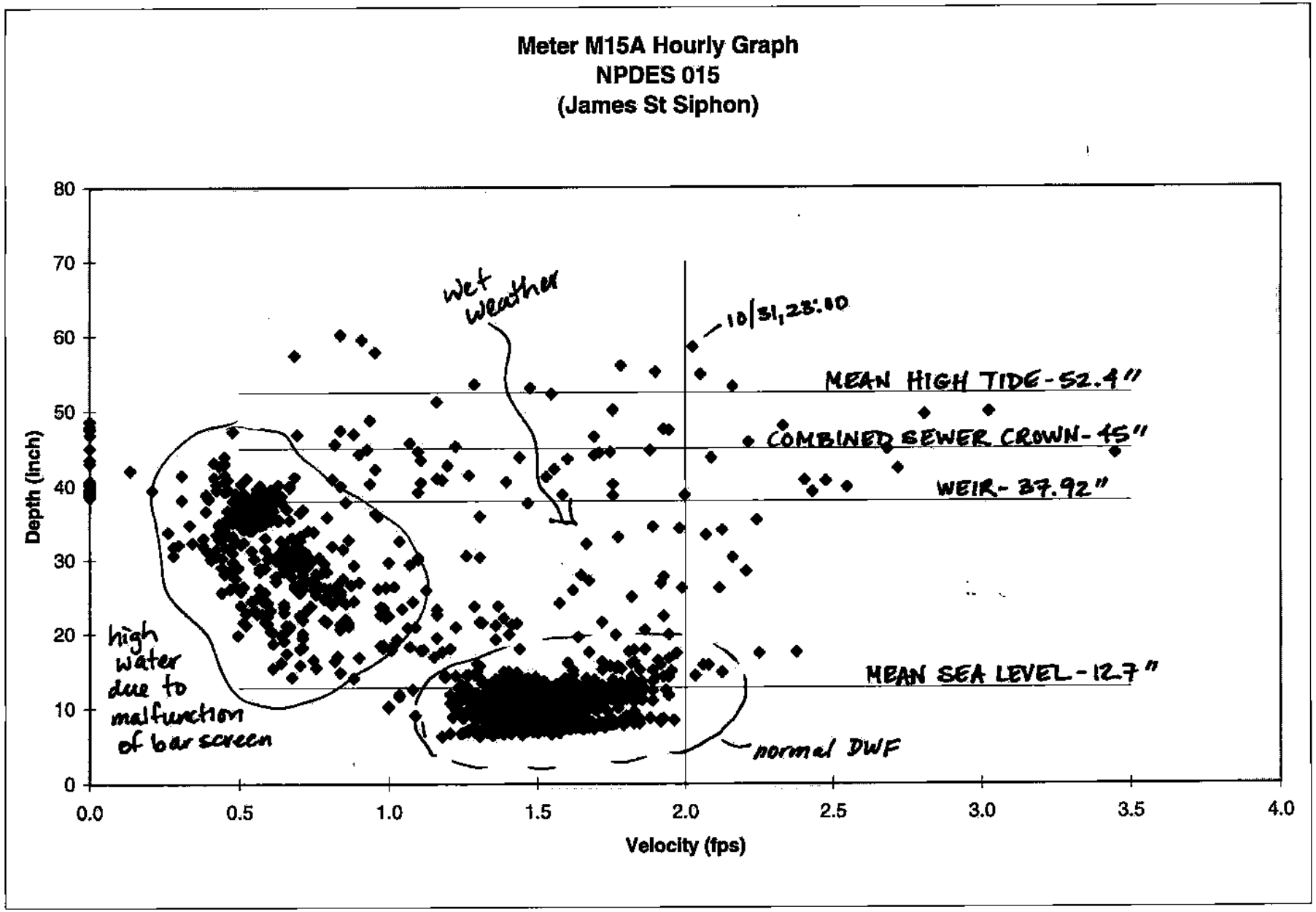
M14B Chart 1
scatter.xls



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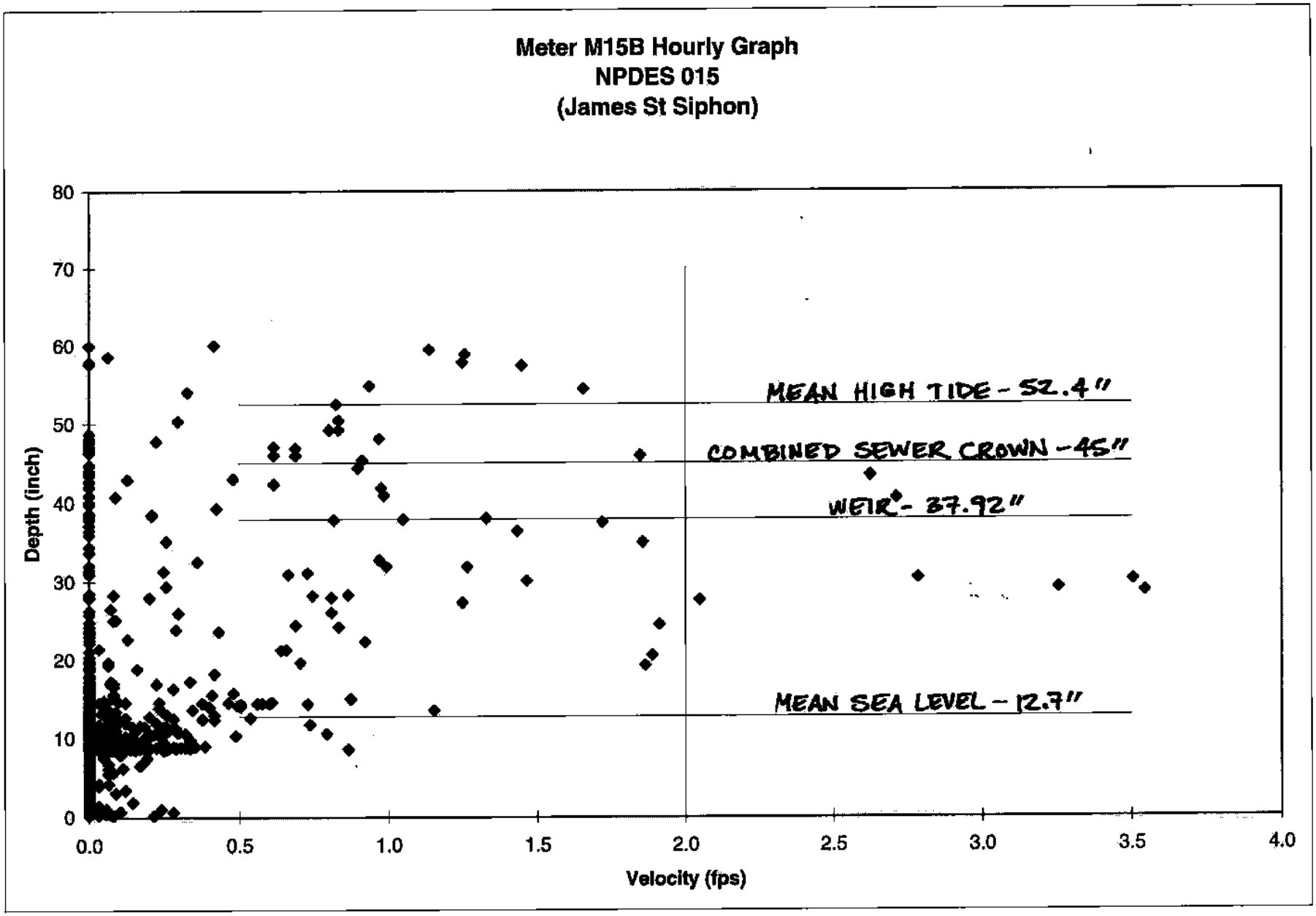
M15A Chart 2
scatter.xls



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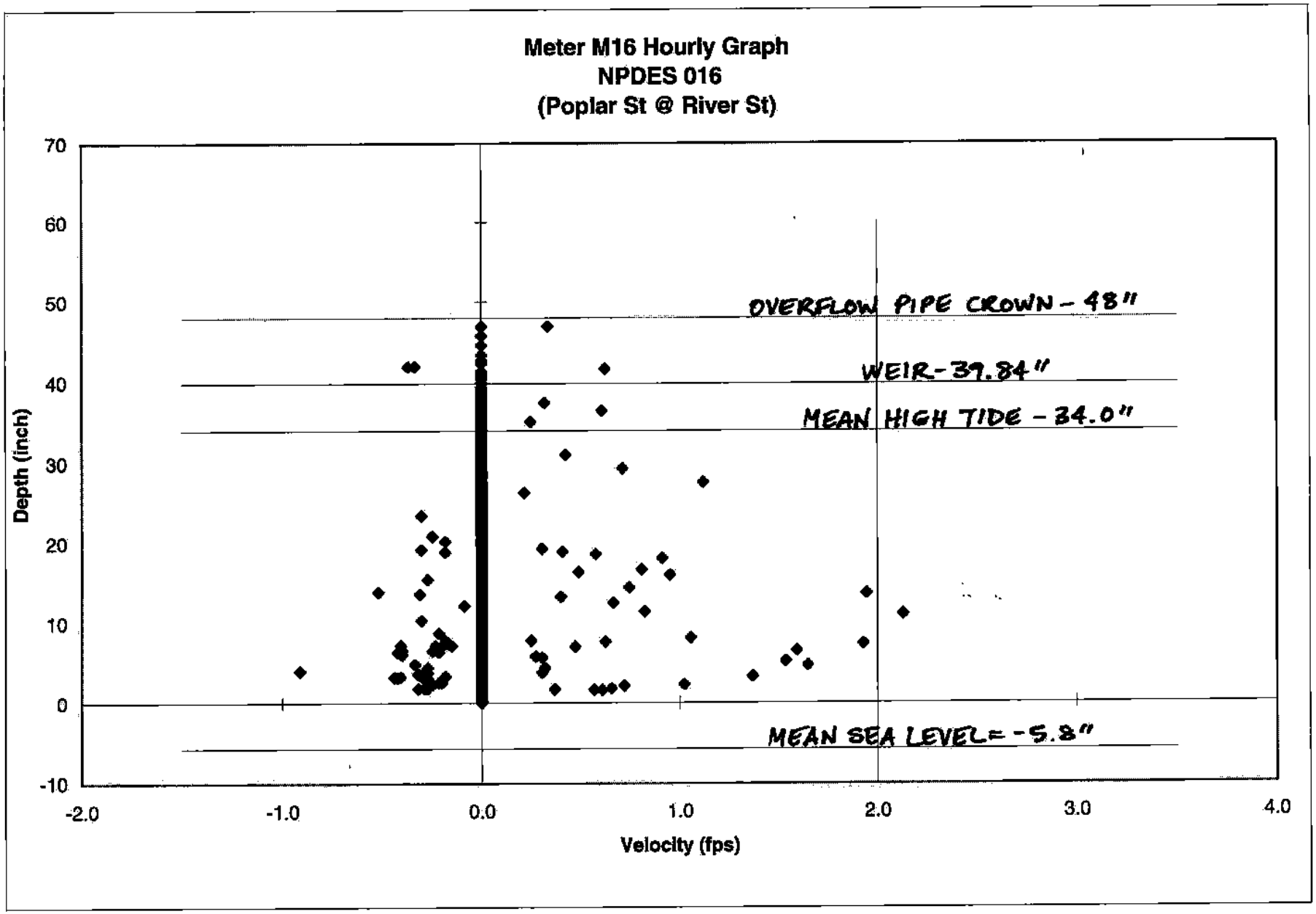
scatter.xls



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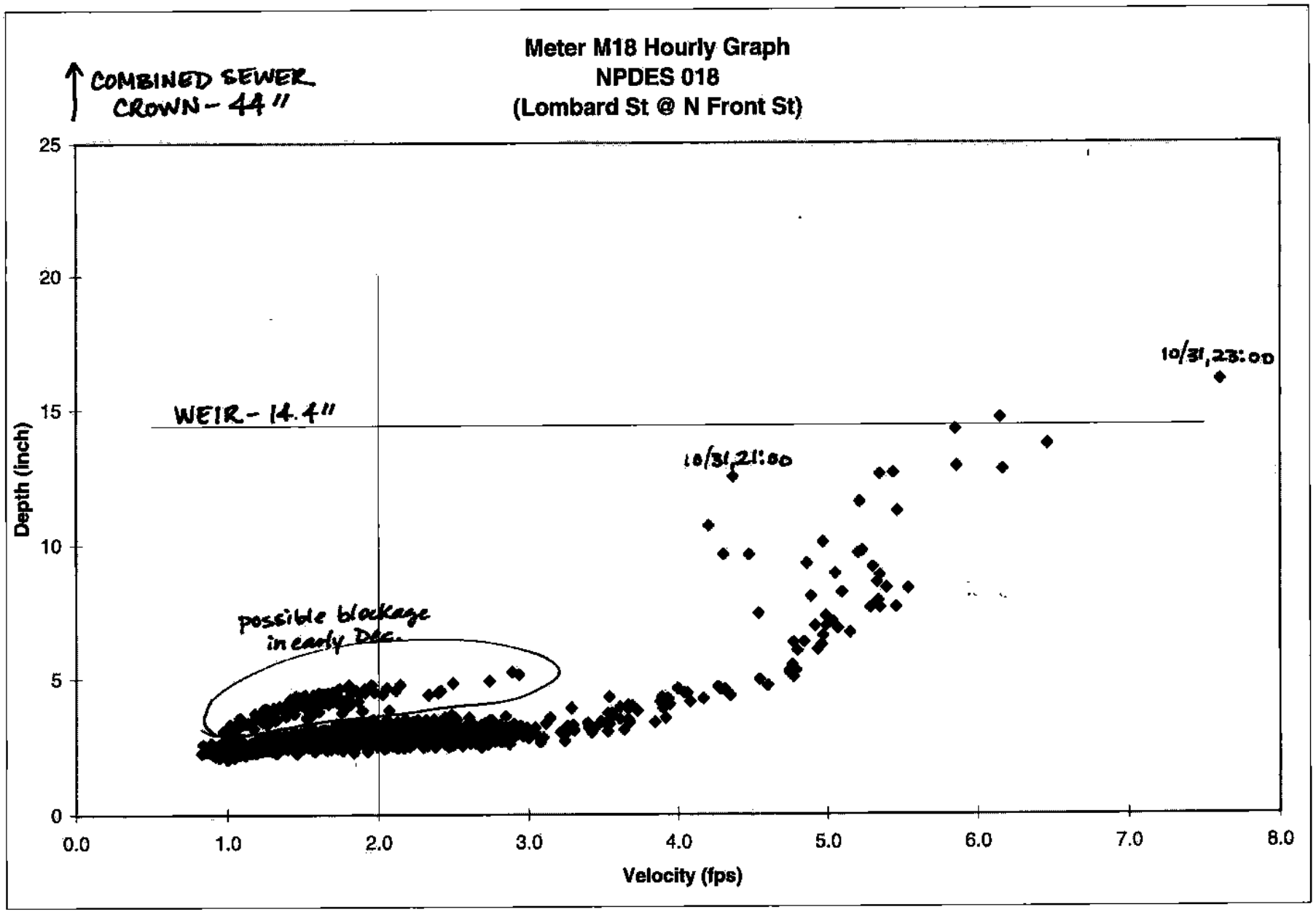
M16 Chart 1
scatter.xls



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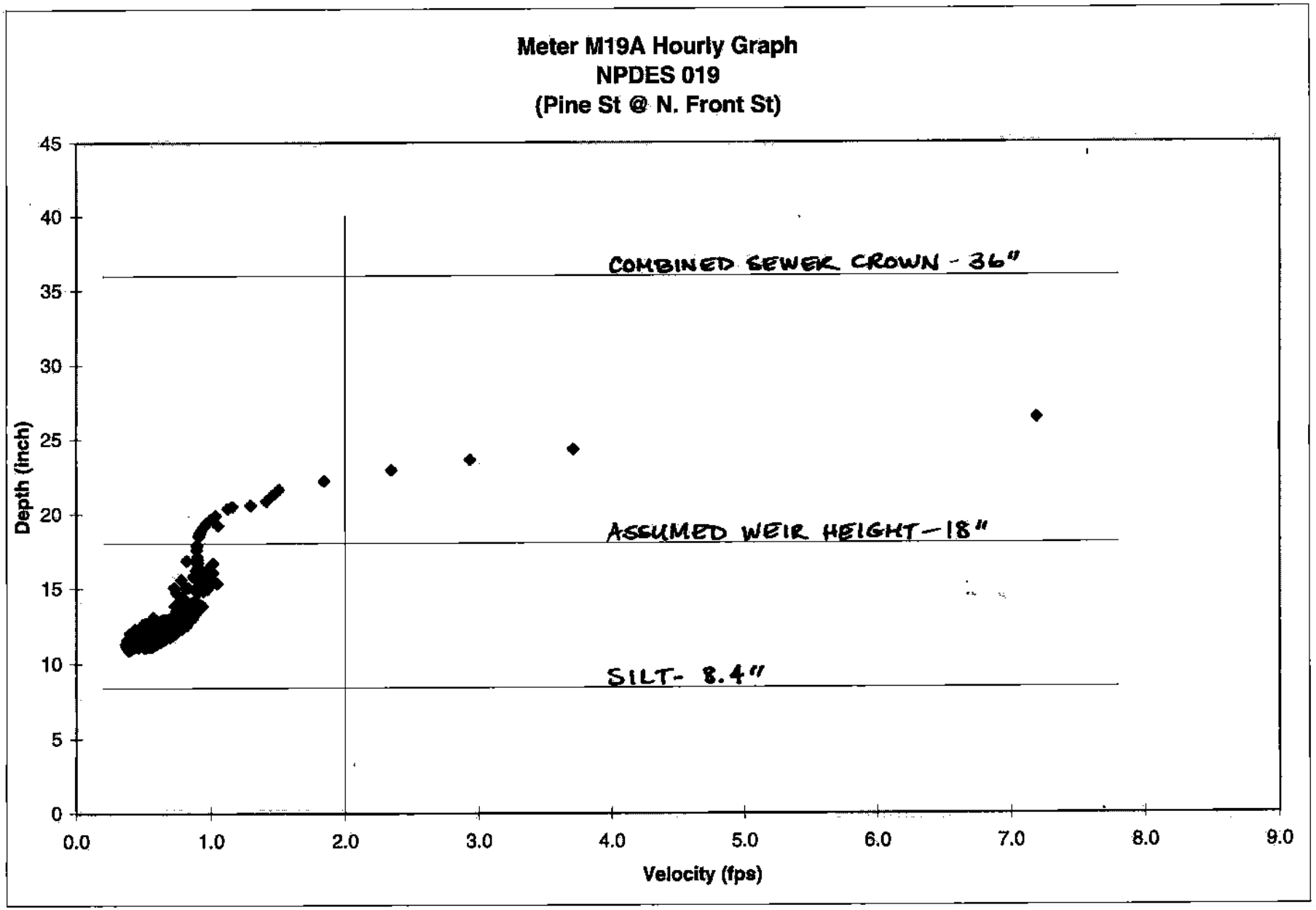
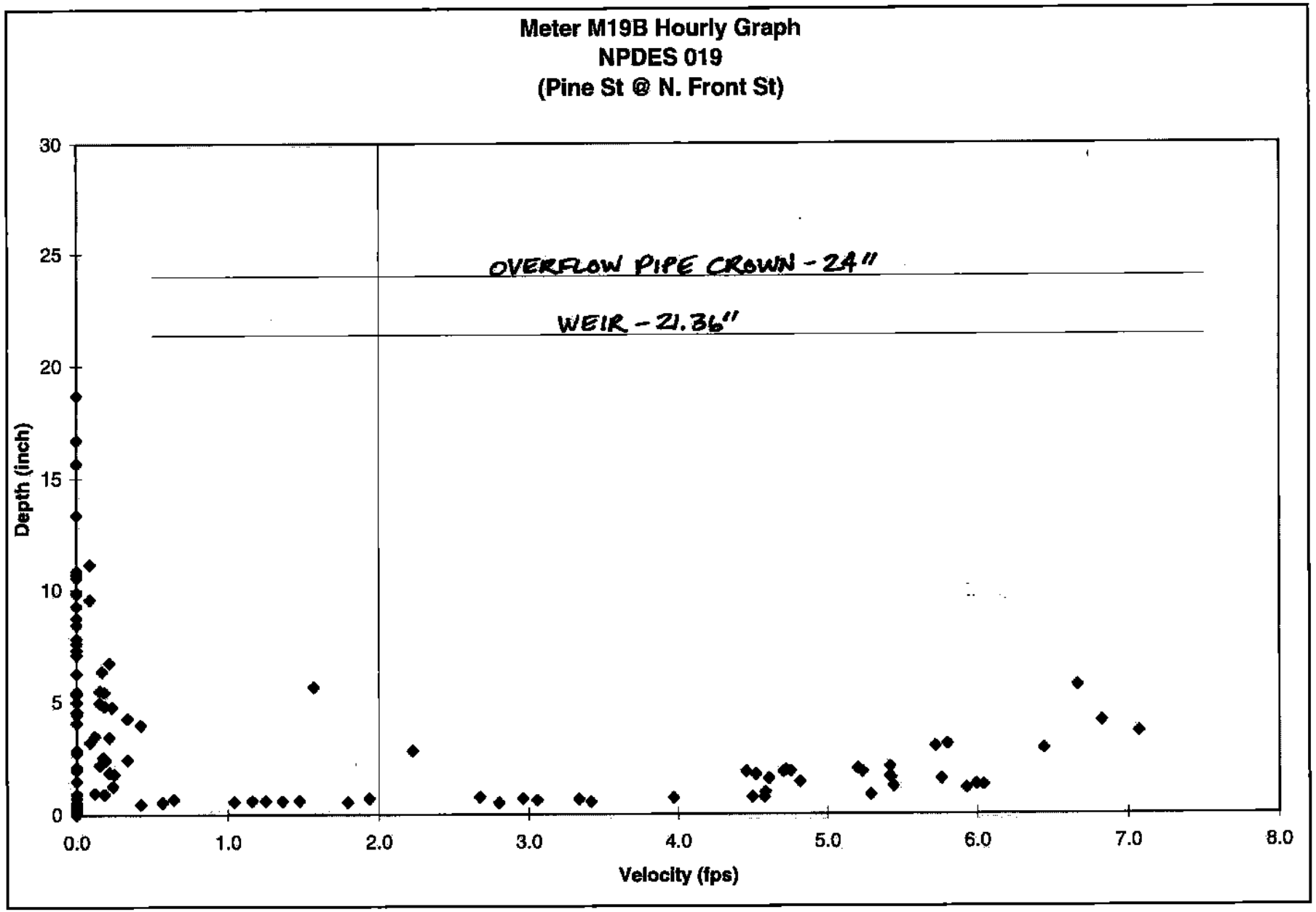
M18 Chart 1
scatter.xls



3/2/98 9:16 AM
M19A Chart 1
scatter2.xls



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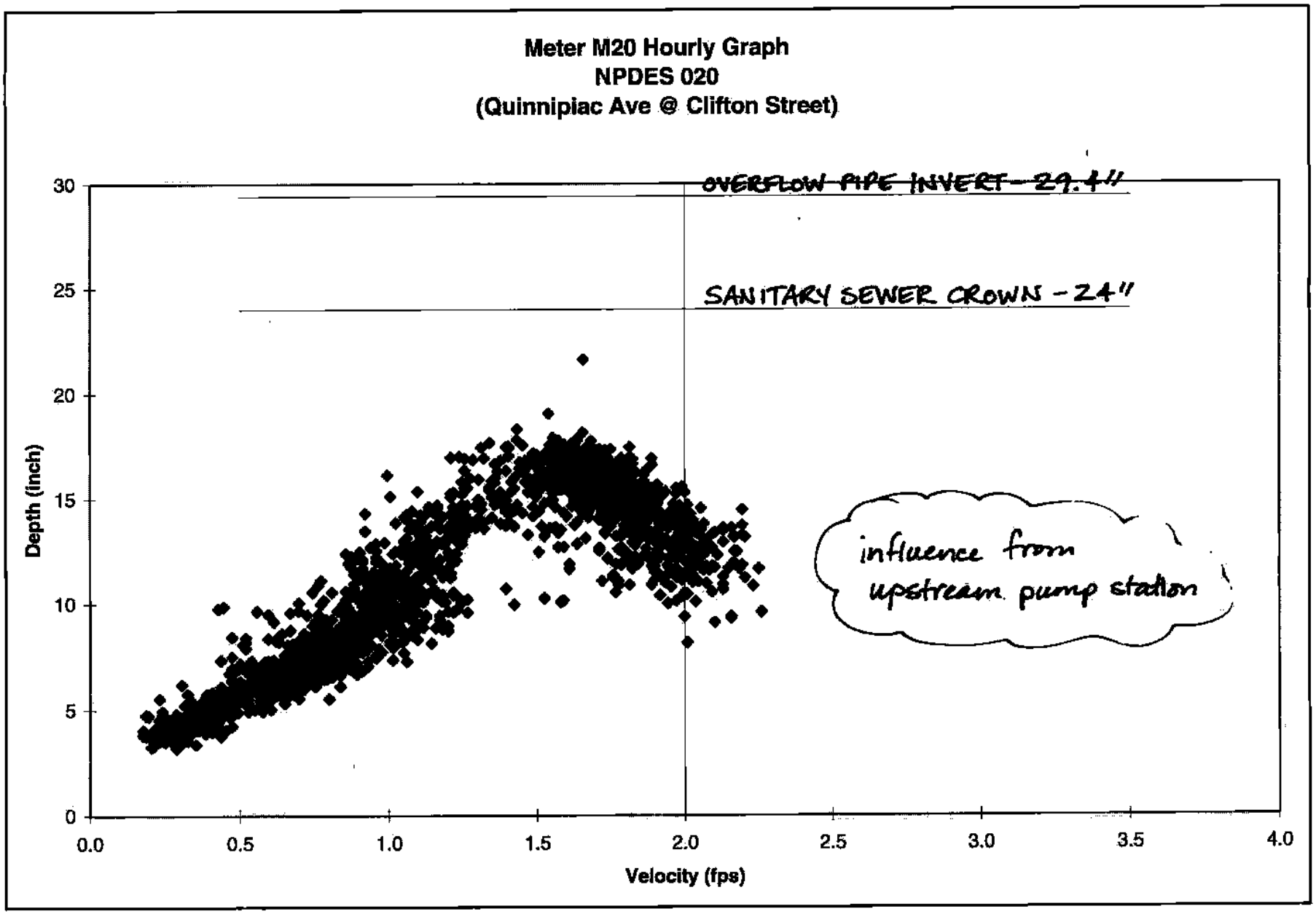
scatter2.xls



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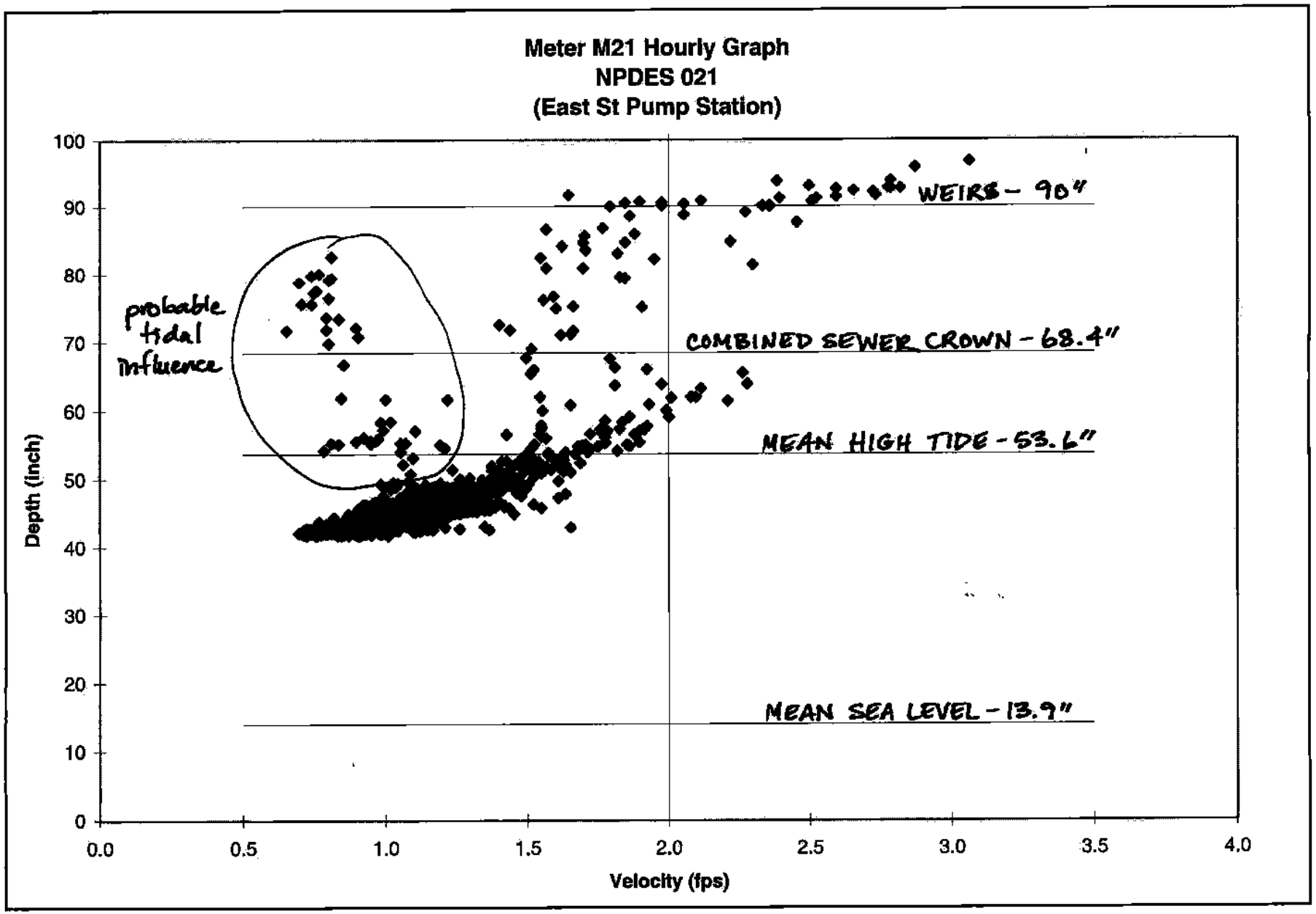
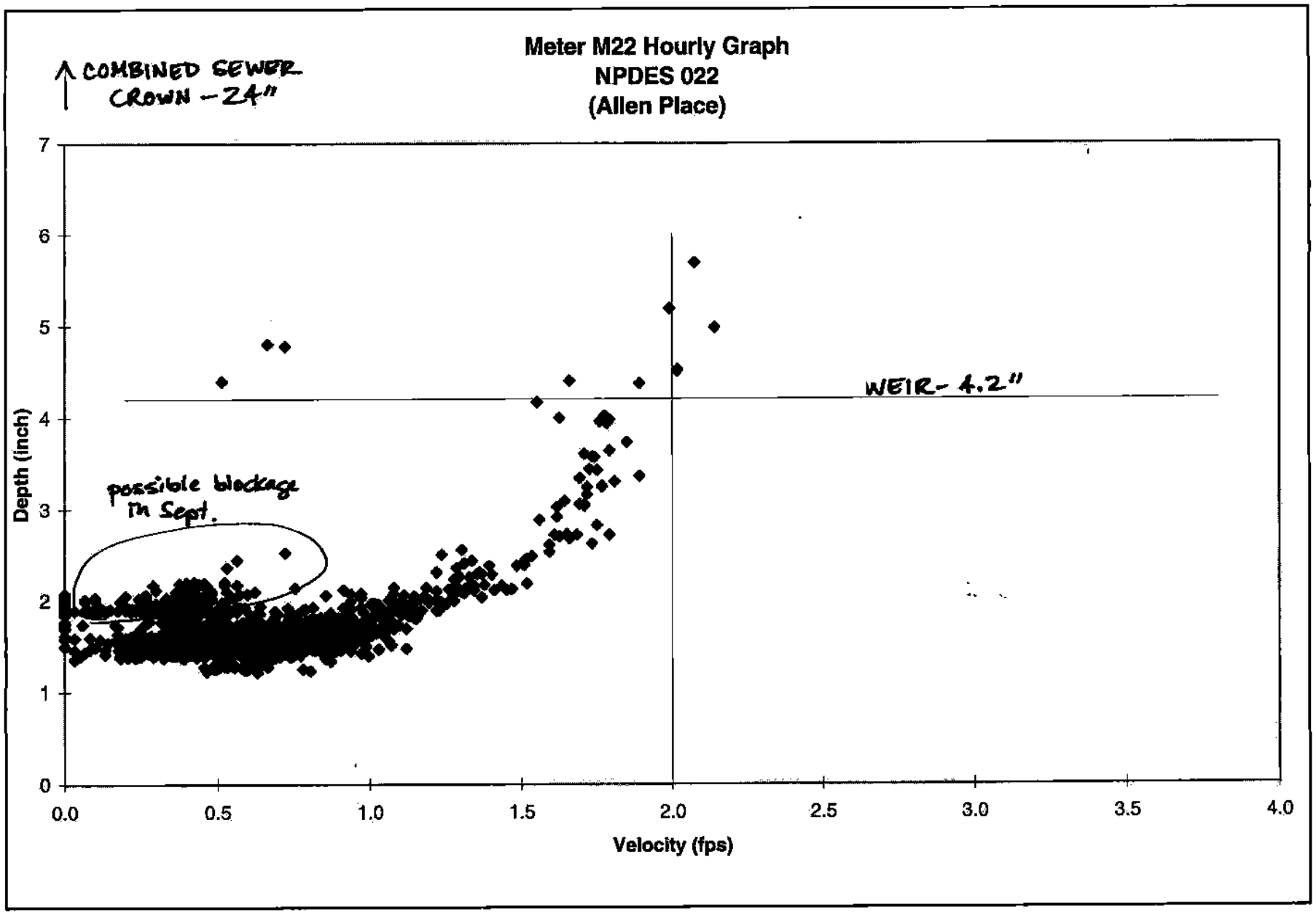
M20 Chart 1
scatter2.xls



2/26/98 12:13 PM
M21 Chart 1
scatter2.xls



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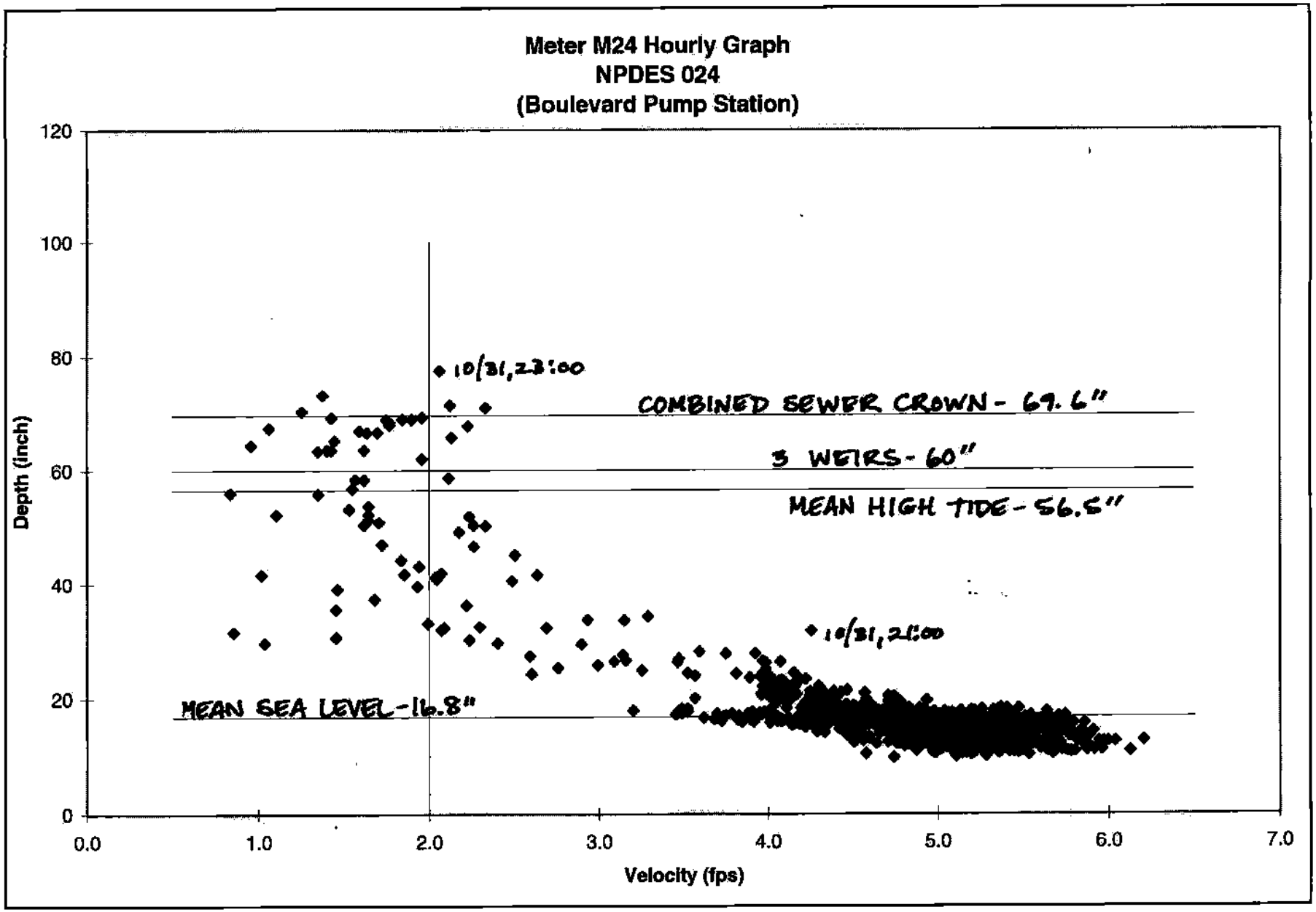
M22 Chart 1
scatter2.xls



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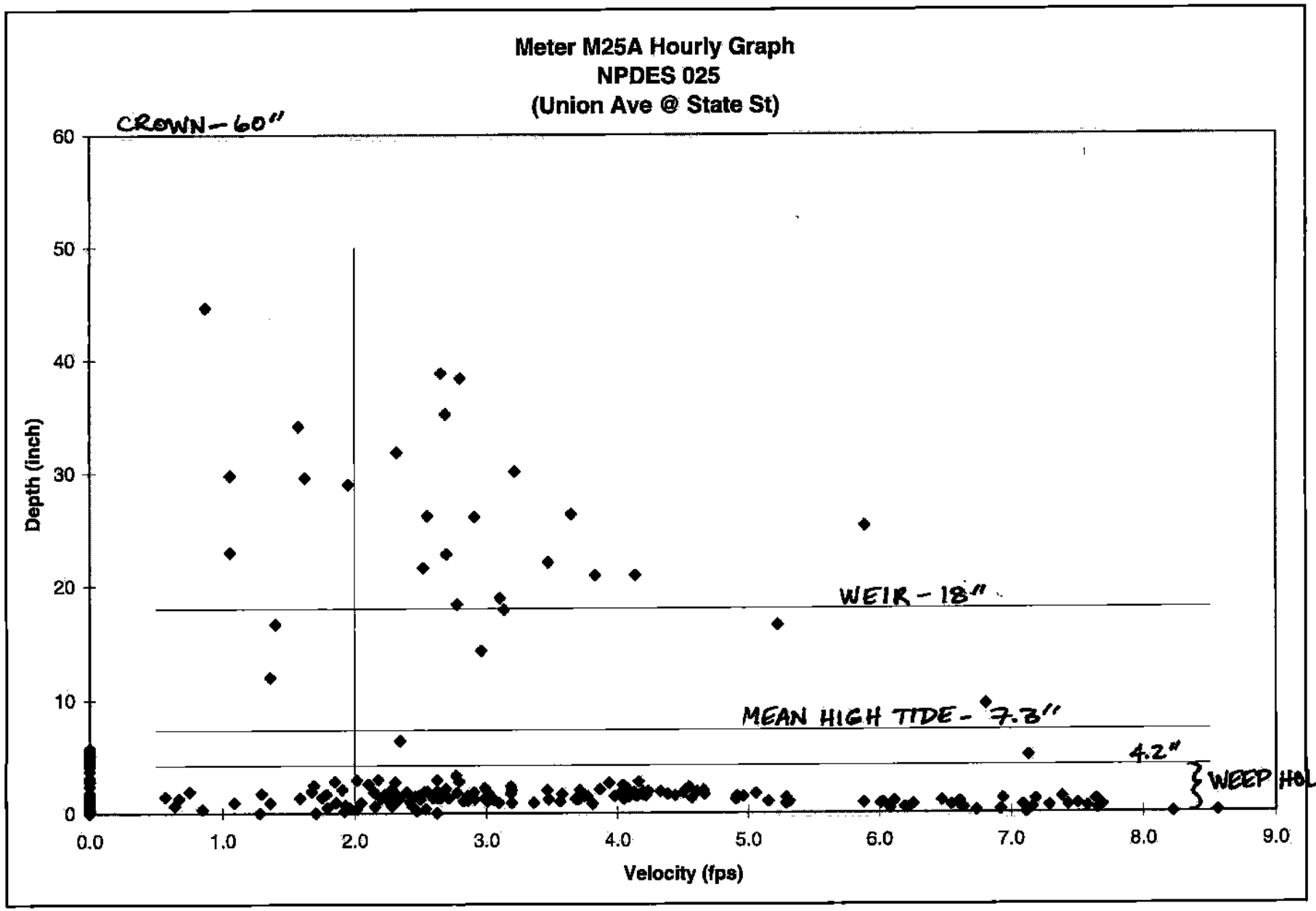
M24 Chart 1
scatter2.xls



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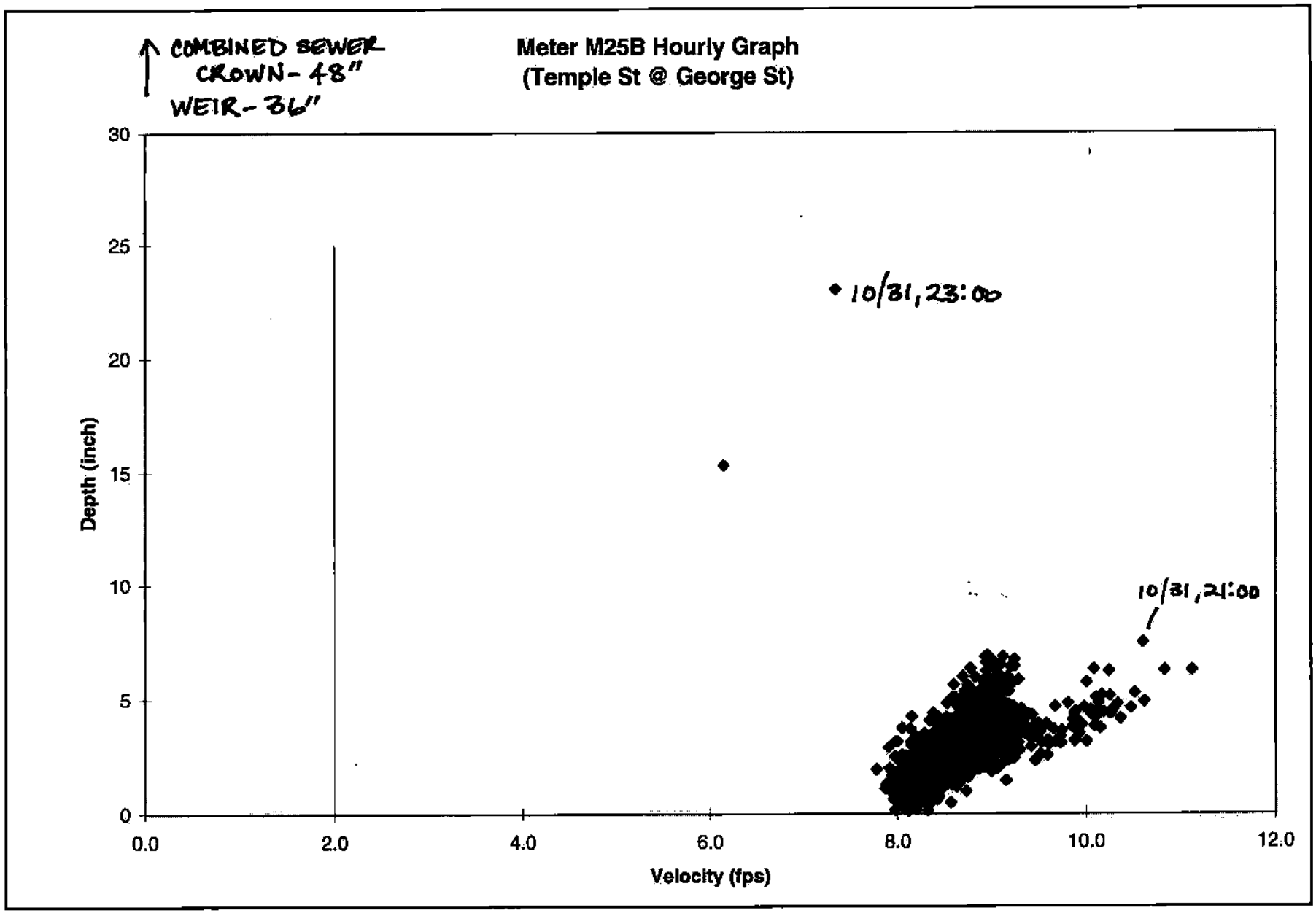

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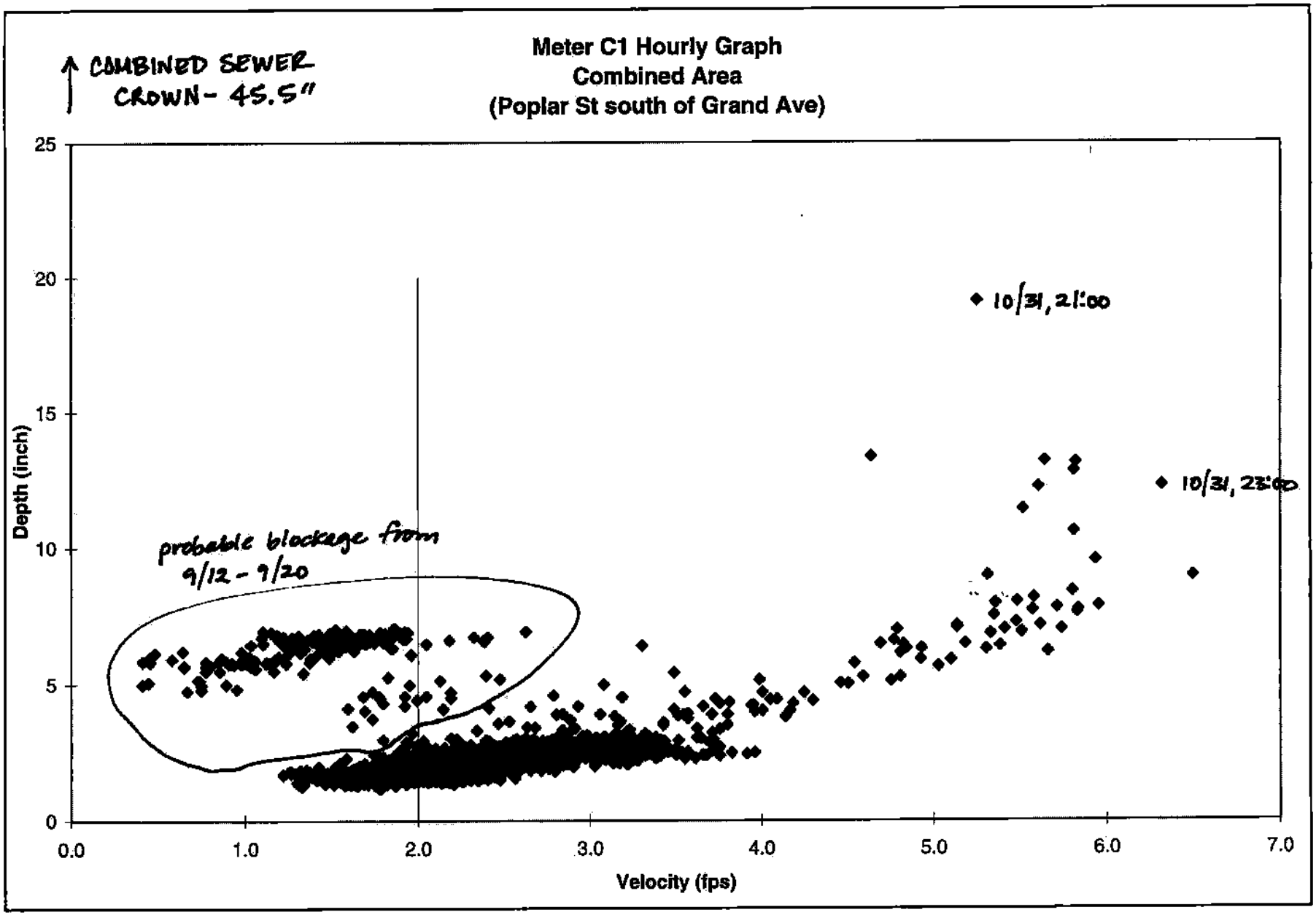
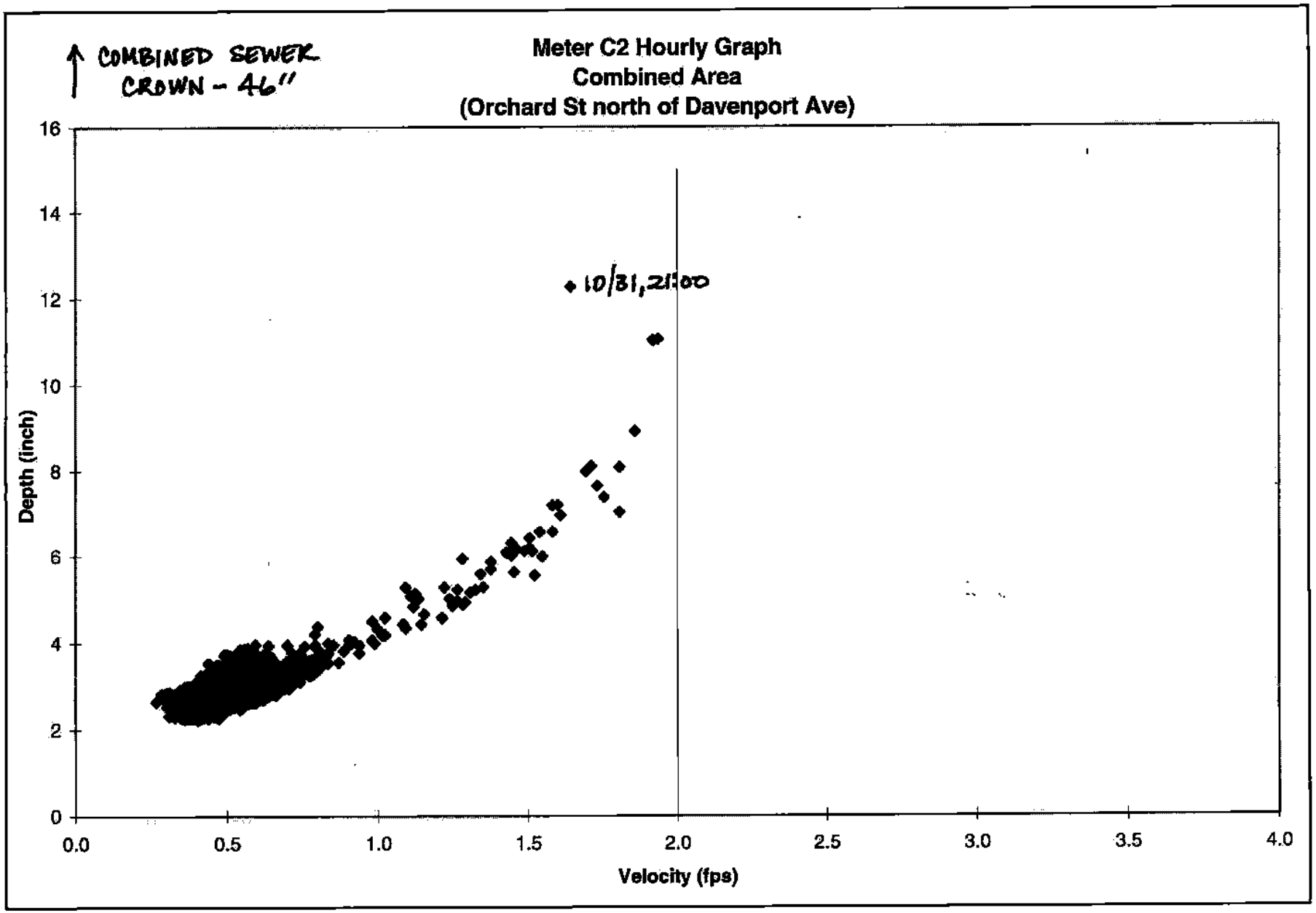
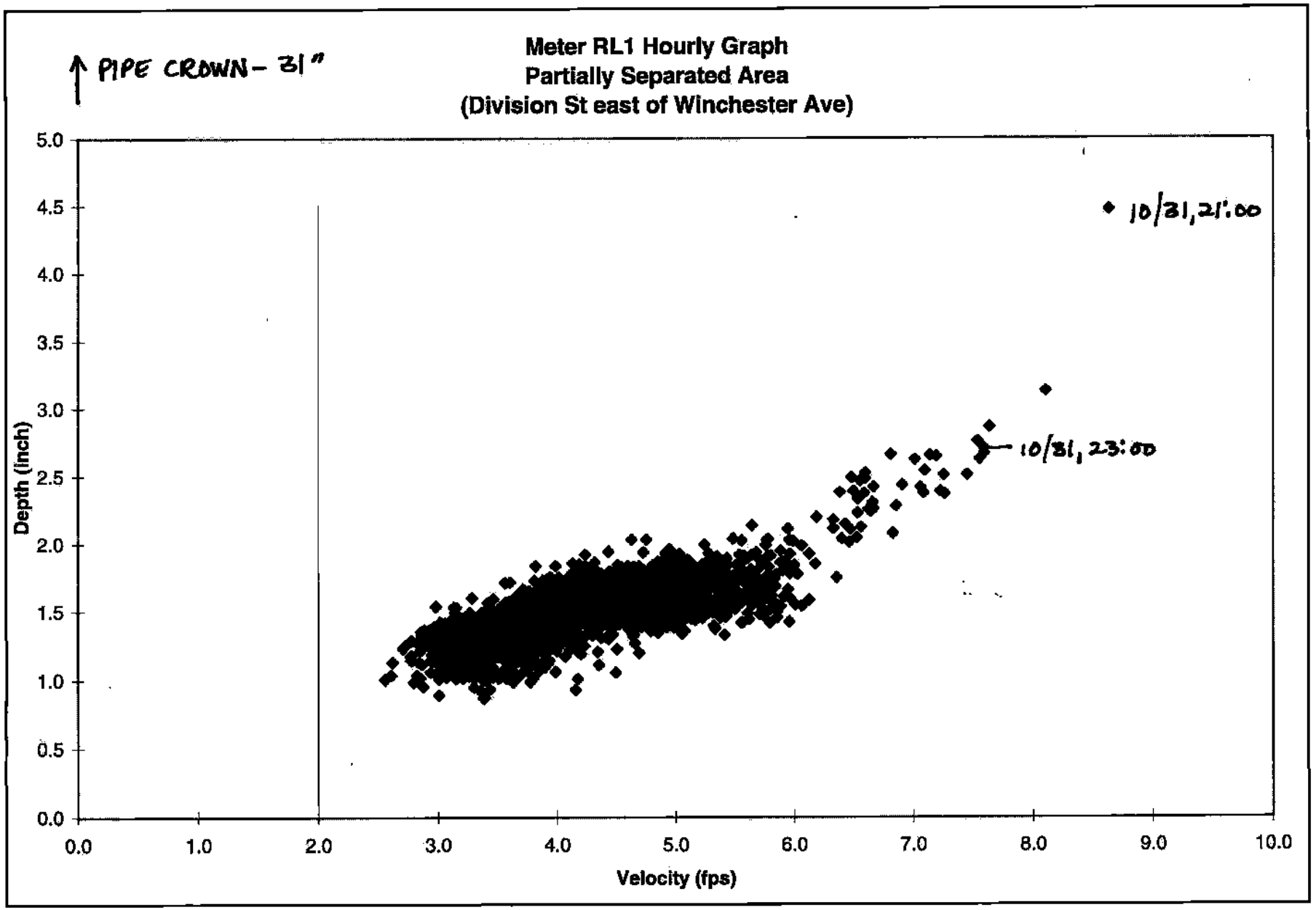


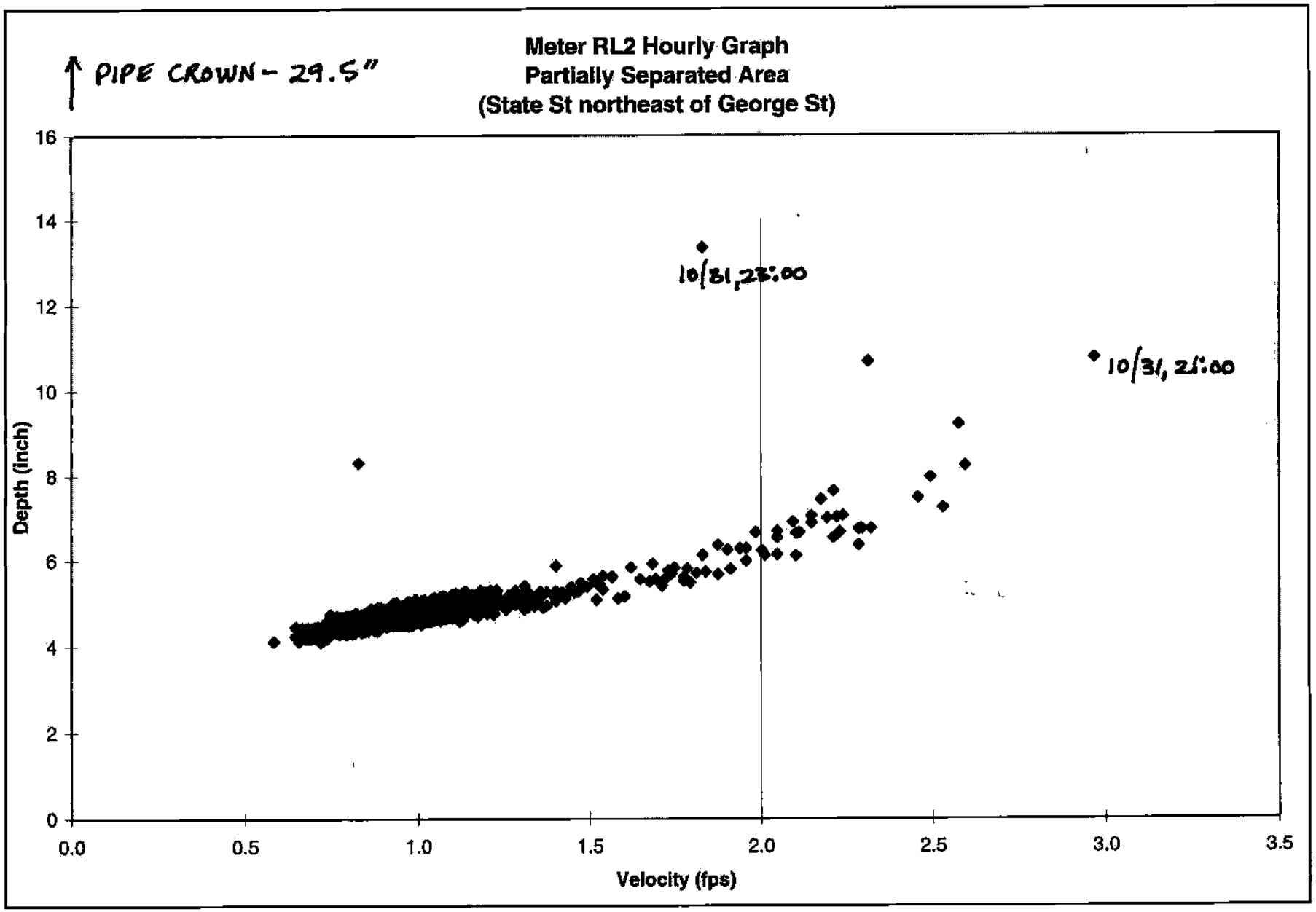
2/26/98 12:12 PM
C1 Chart 1
scatter2.xls



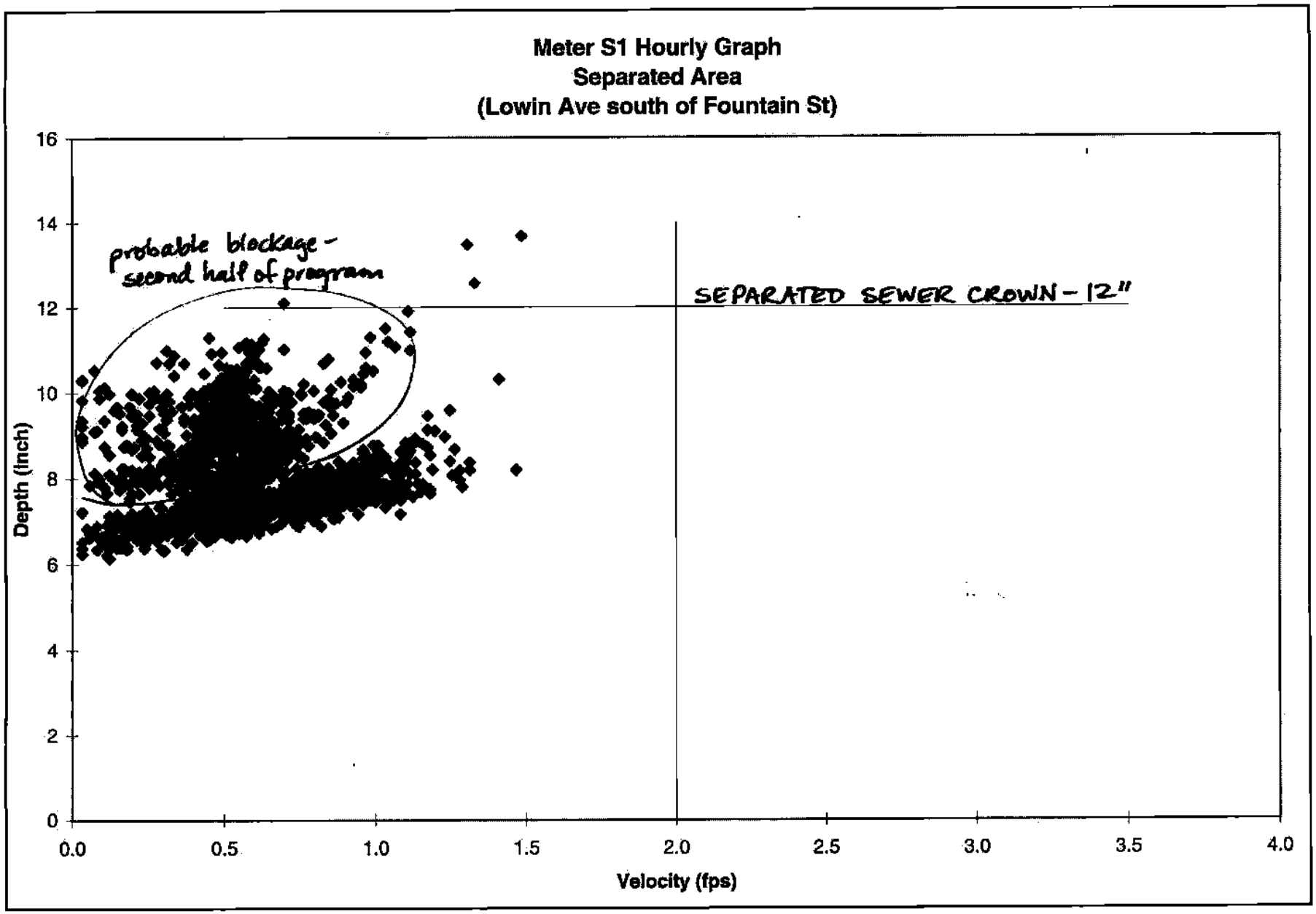
2/26/98 12:06 PM
C2 Chart 1
scatter2.xls



2/26/98 12:41 PM
RL1 Chart 1
scatter2.xls



2/26/98 12:08 PM
RL2 Chart 1
scatter2.xls



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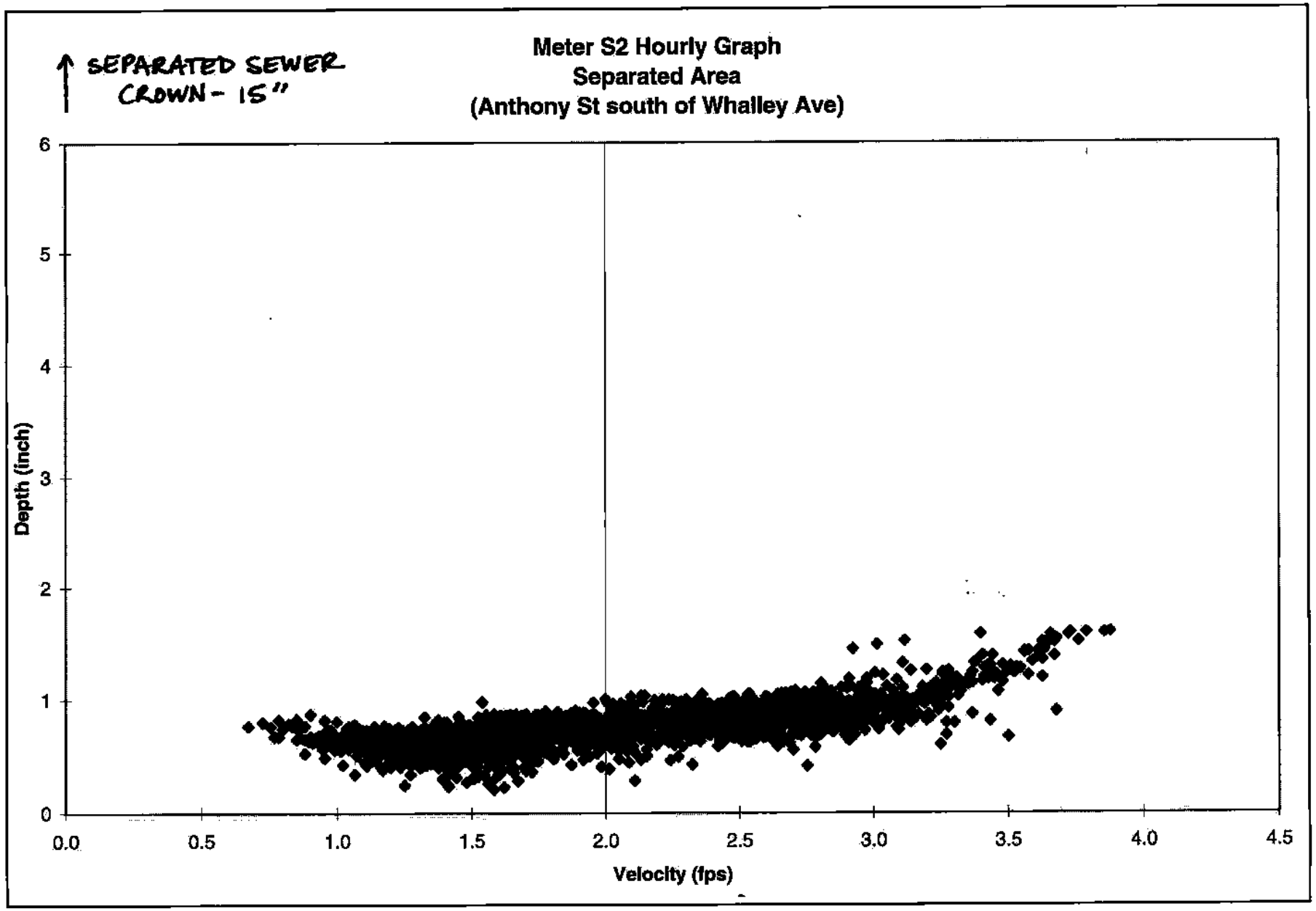
S1 Chart 1
scatter2.xls



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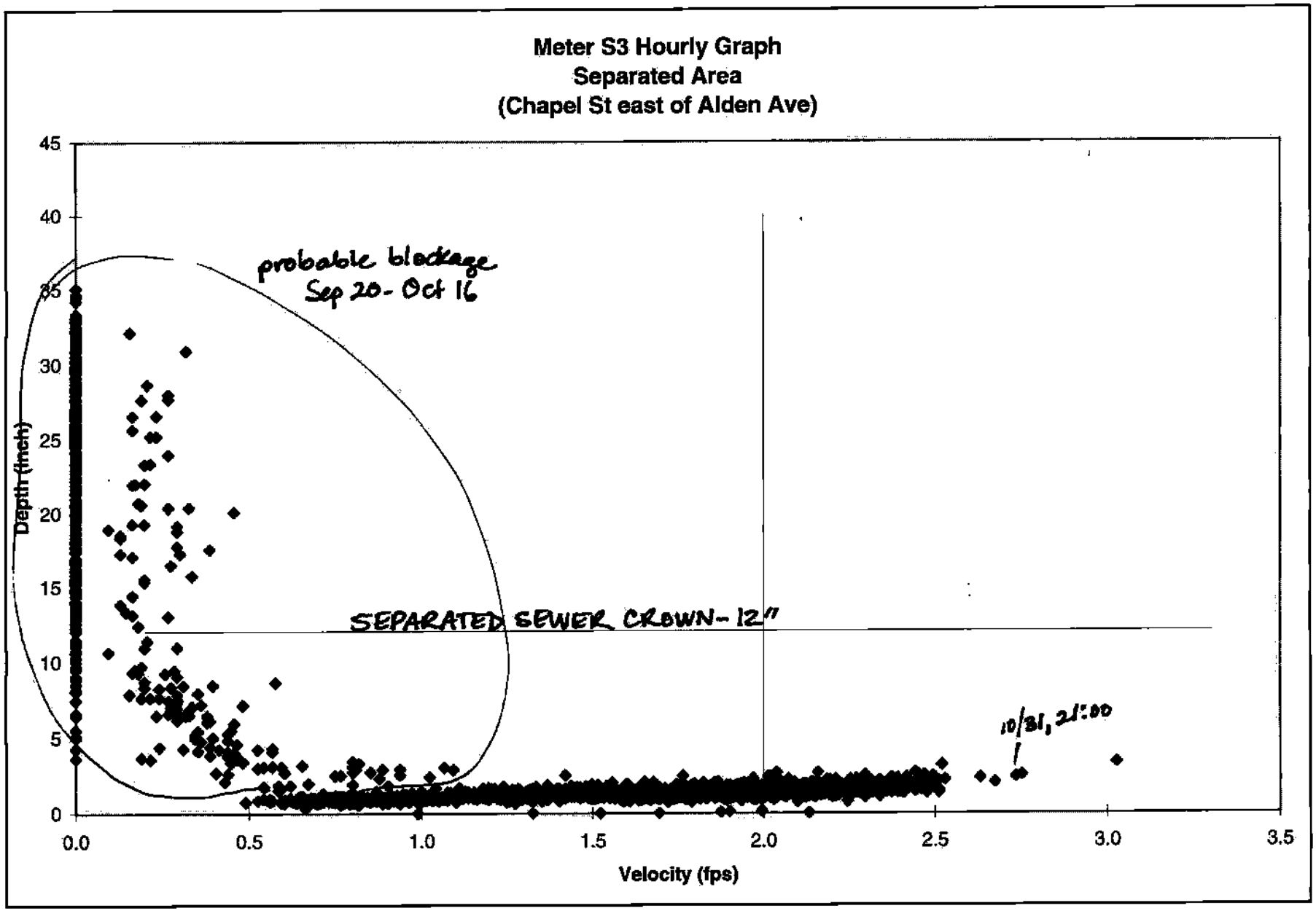
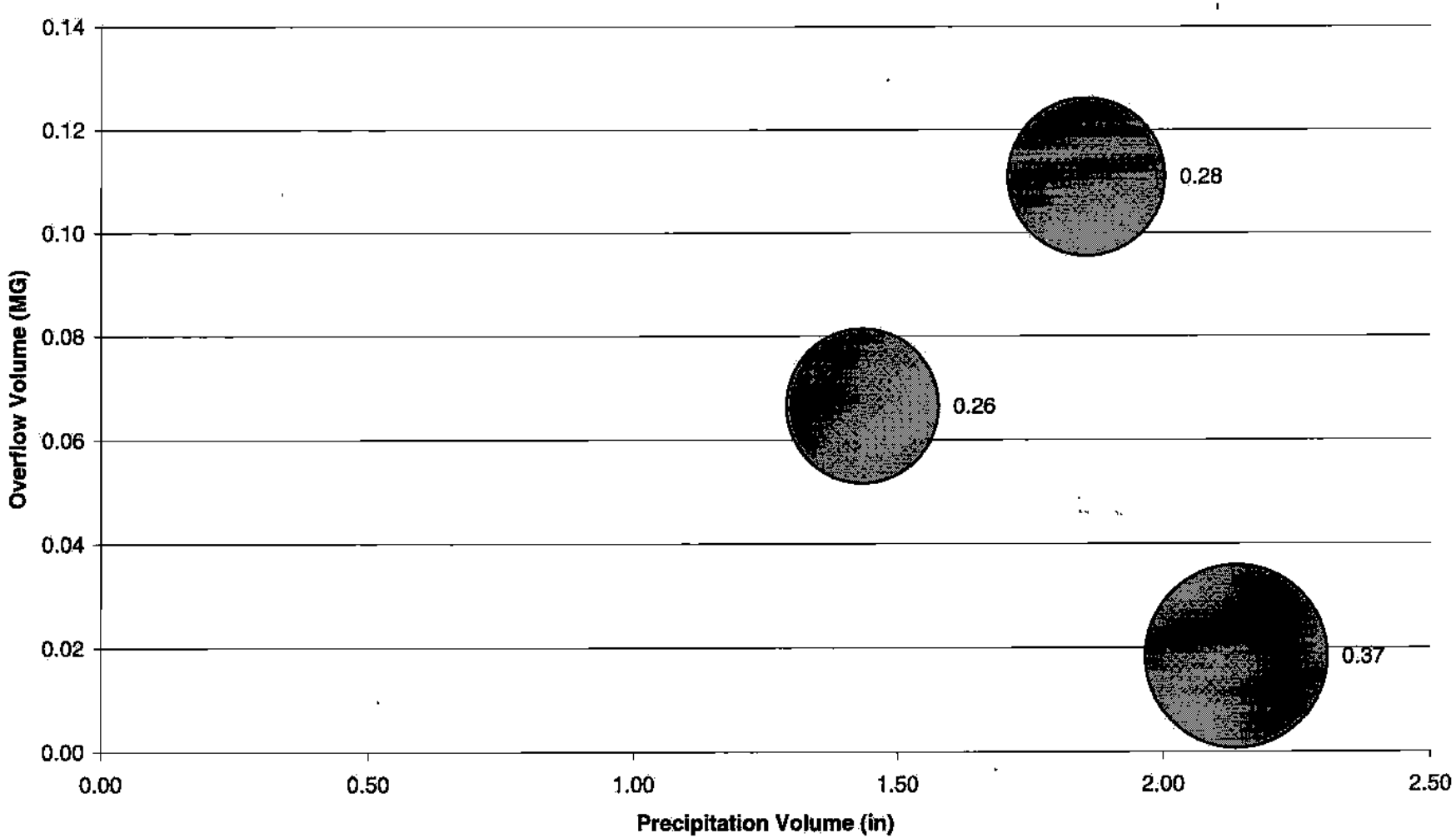
S2 Chart 1
scatter2.xls



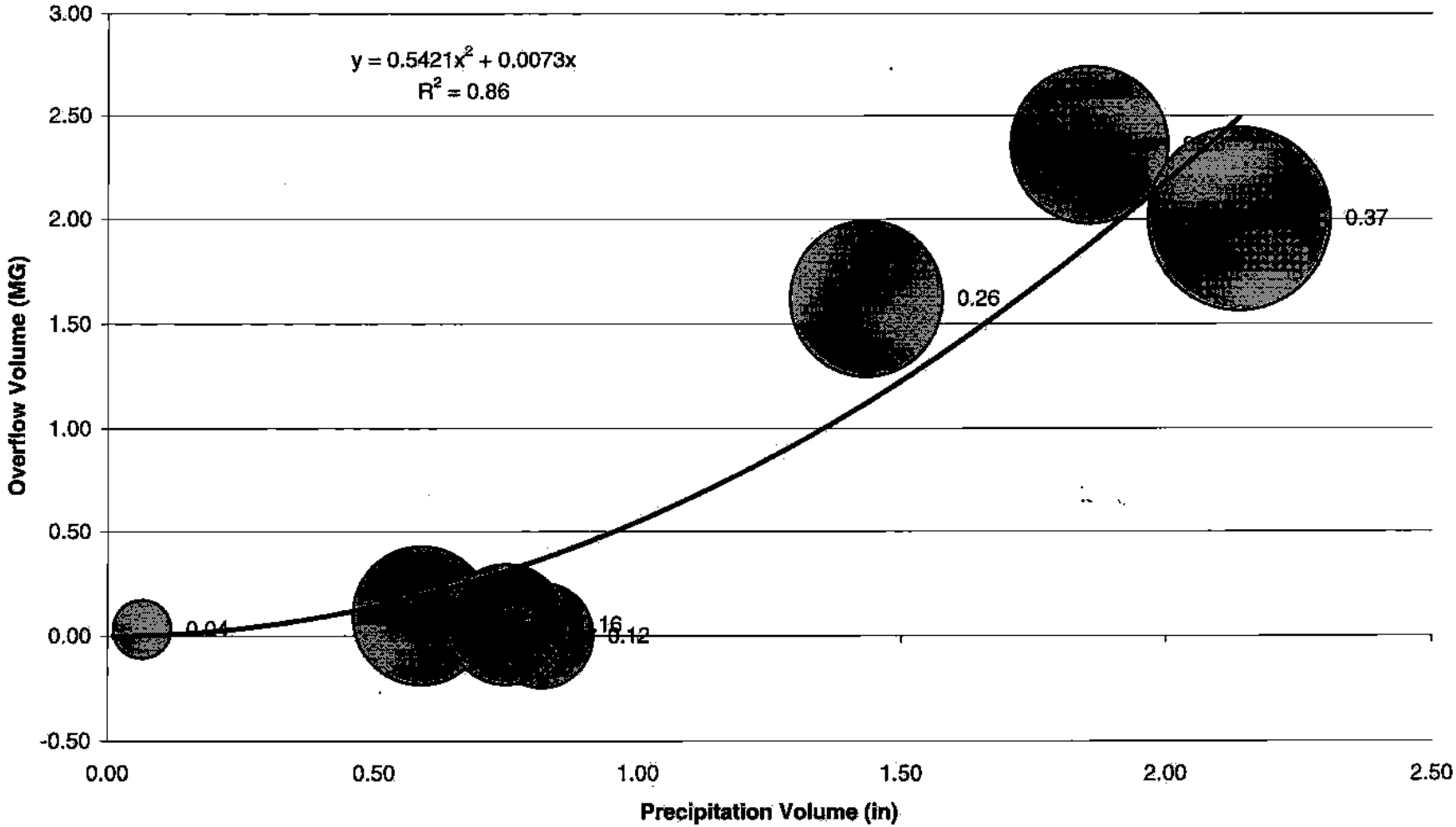
2/26/98 12:04 PM
S3 Chart 1
scatter2.xls

Appendix D: Bubble Plots

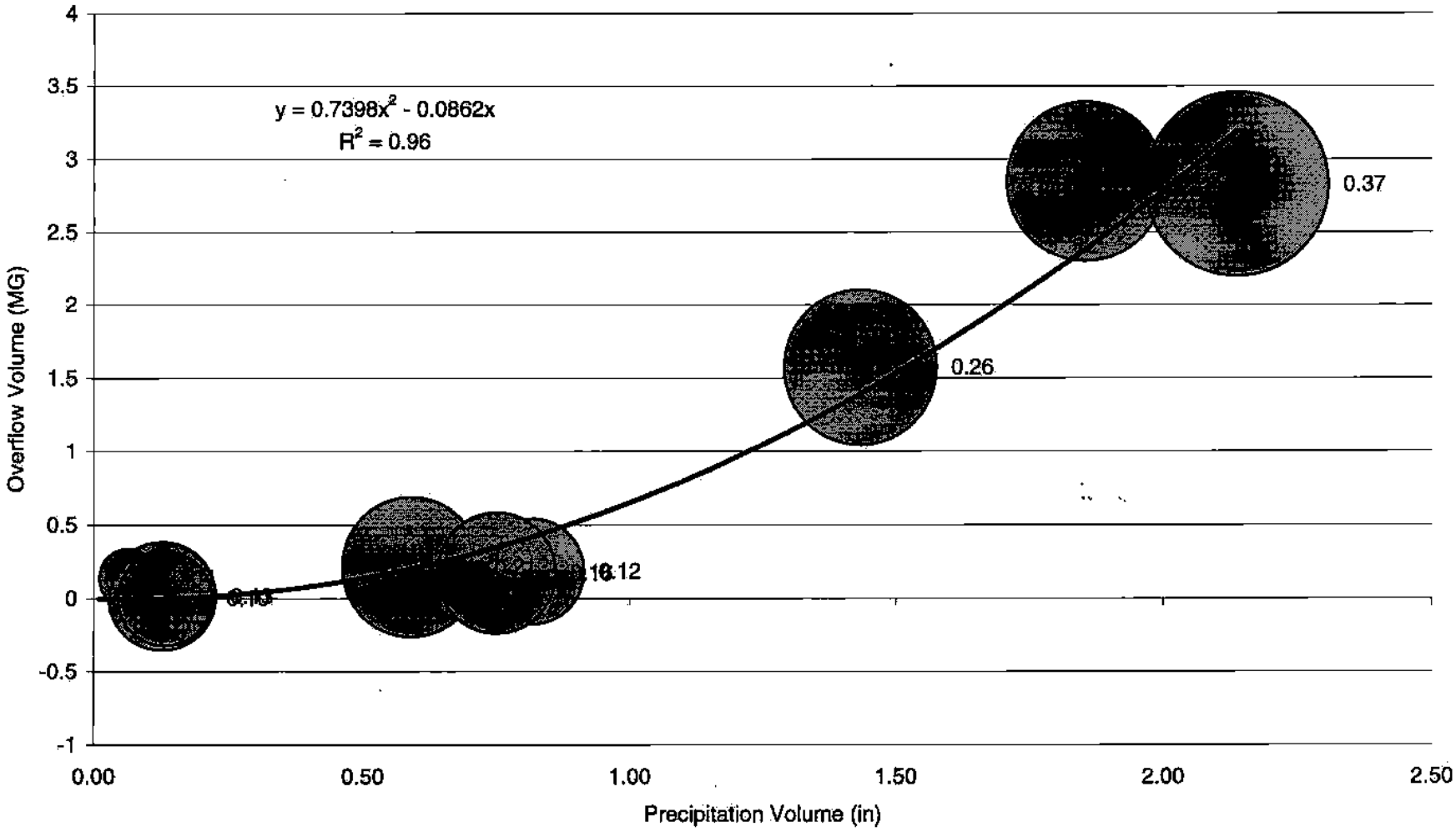
Site 002
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



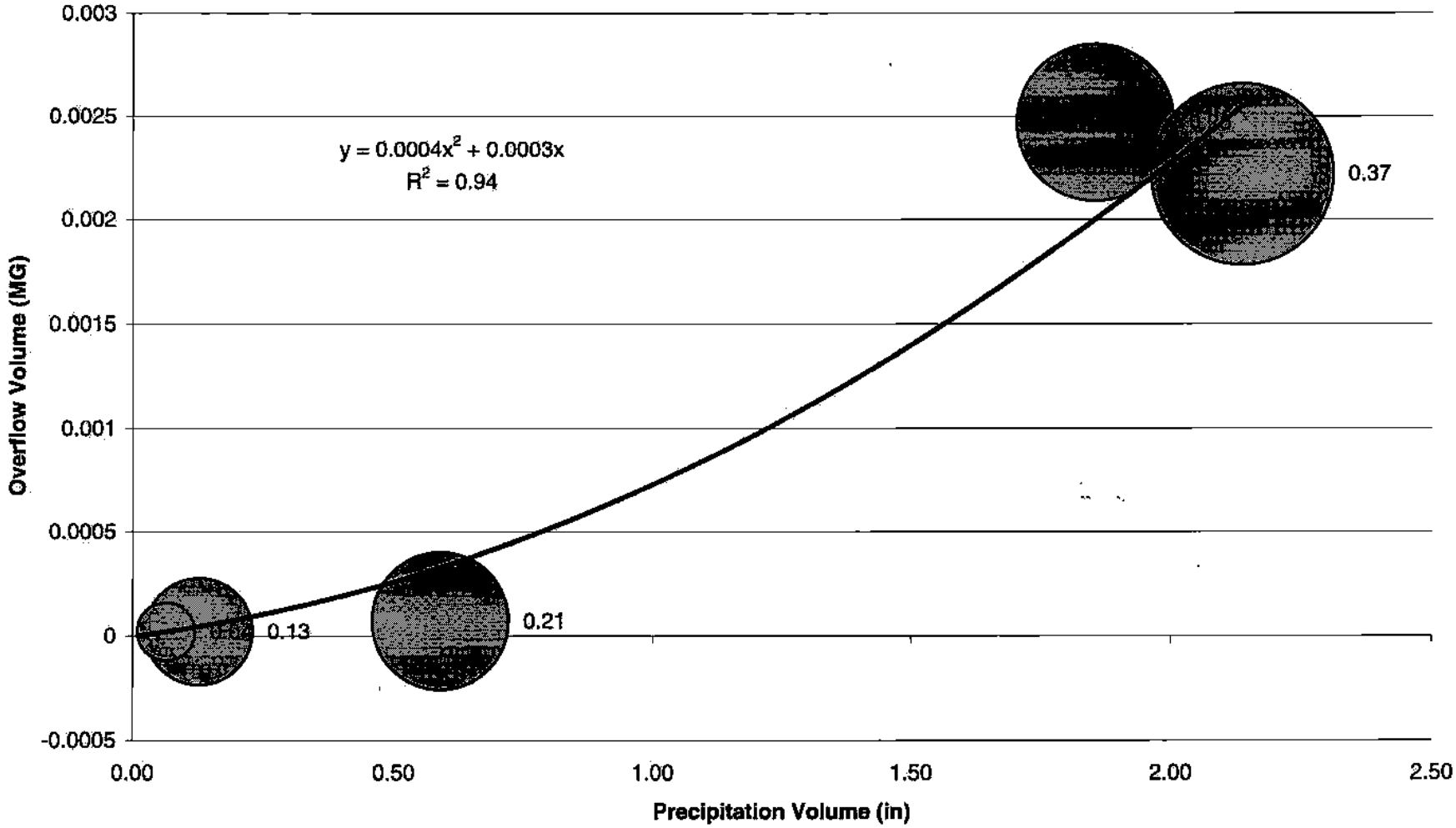
Site 003
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



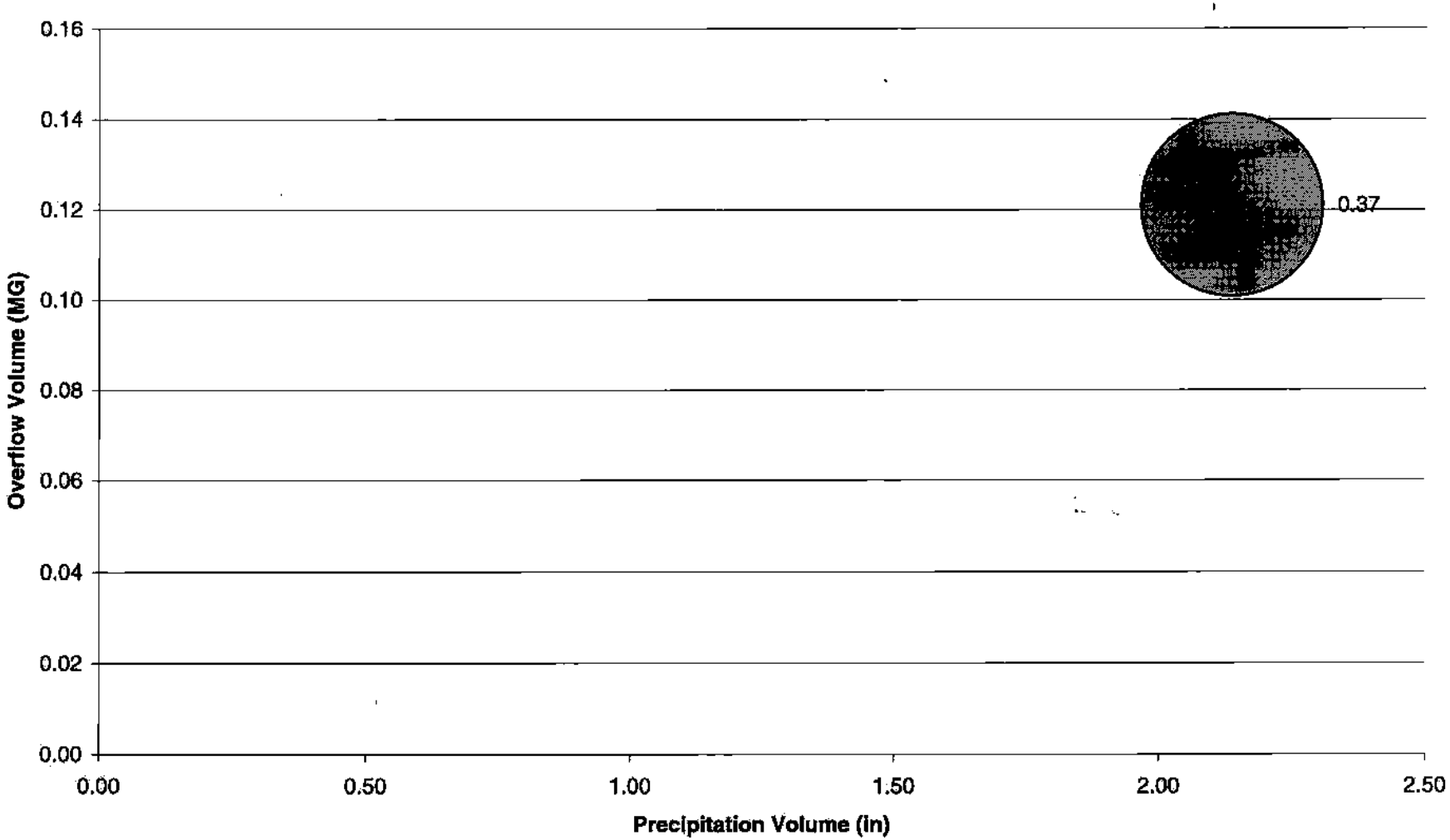
Site 004
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



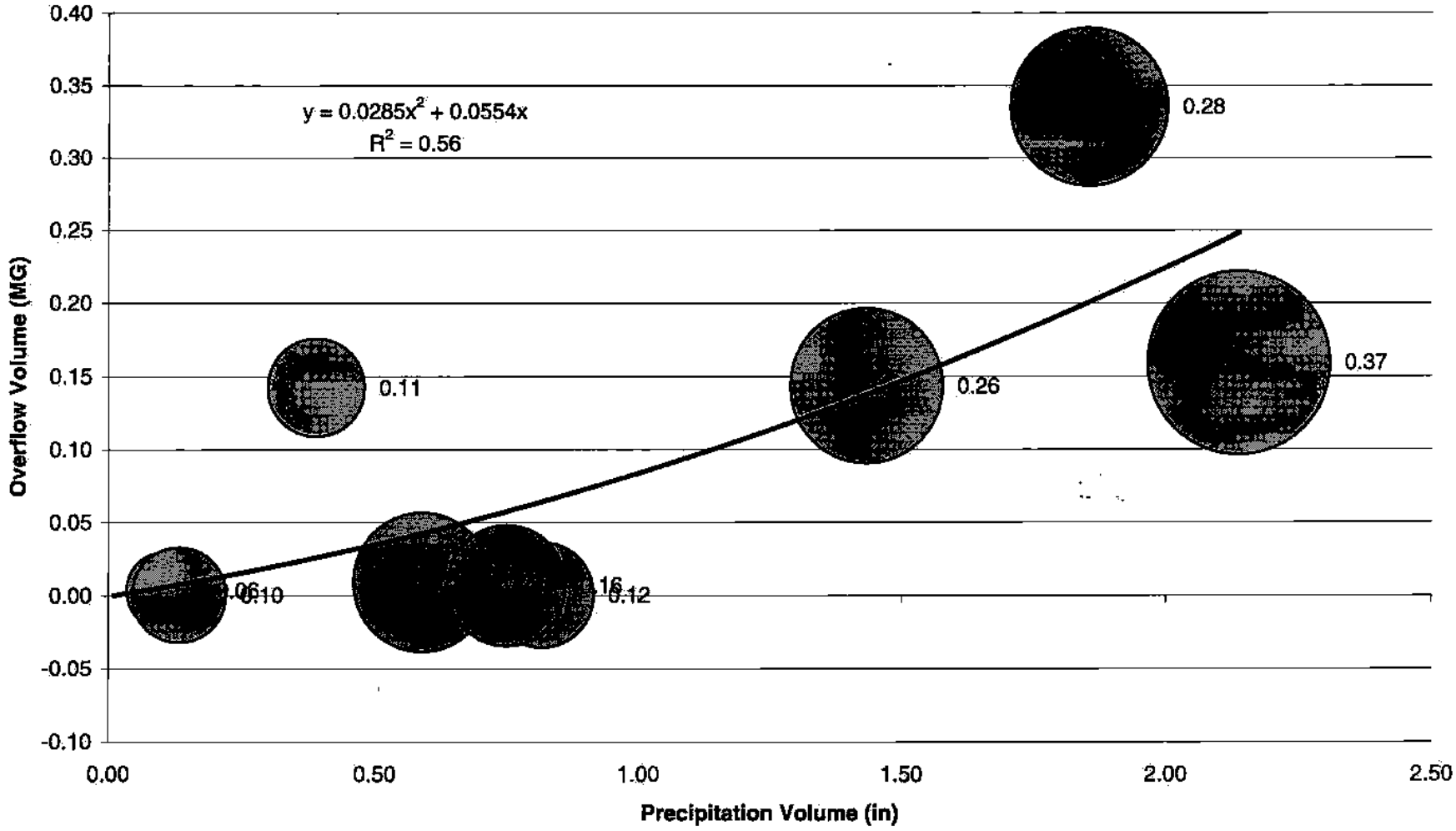
Site 005
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



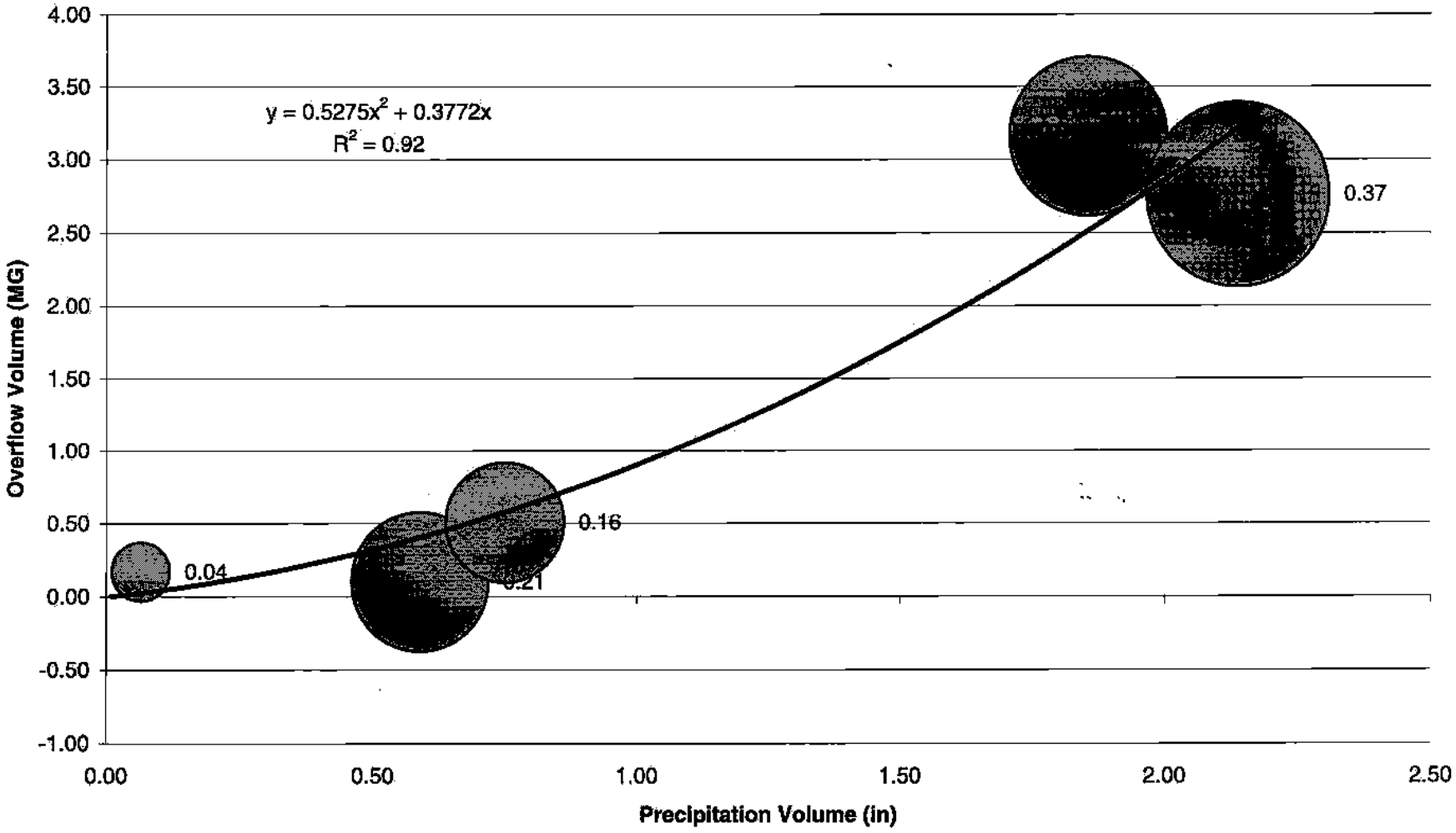
Site 006
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



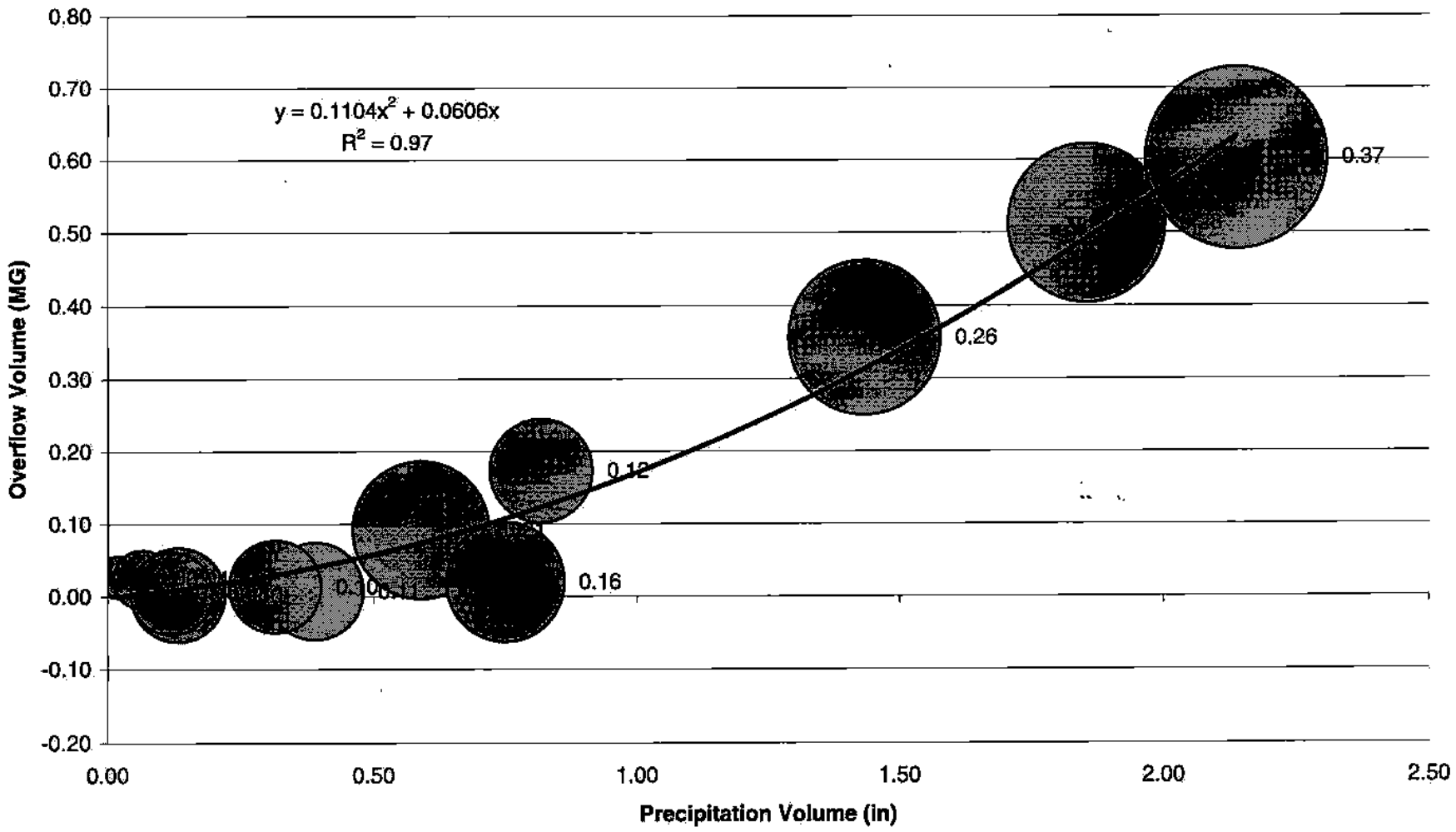
Site 009
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



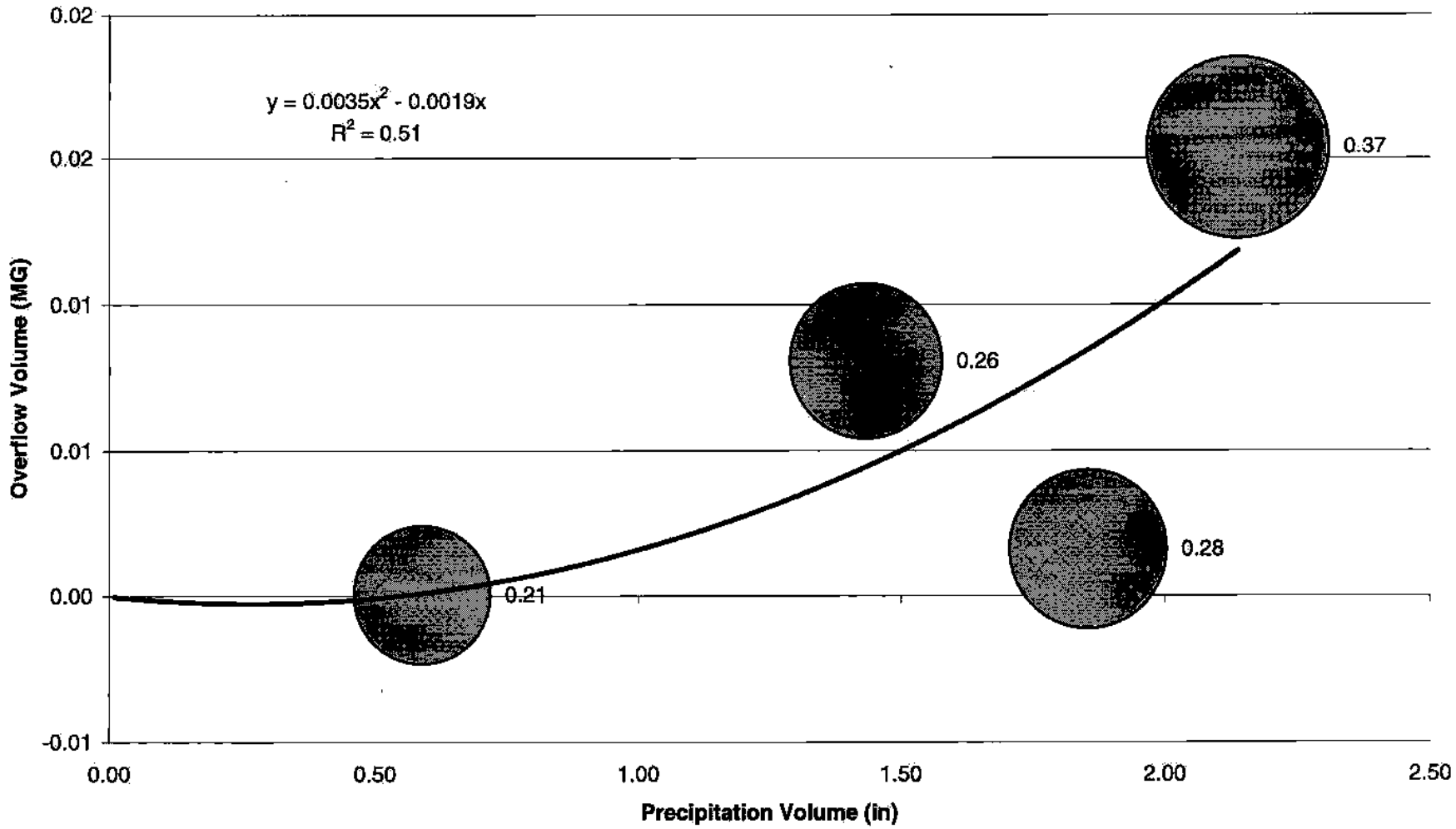
Site 015
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



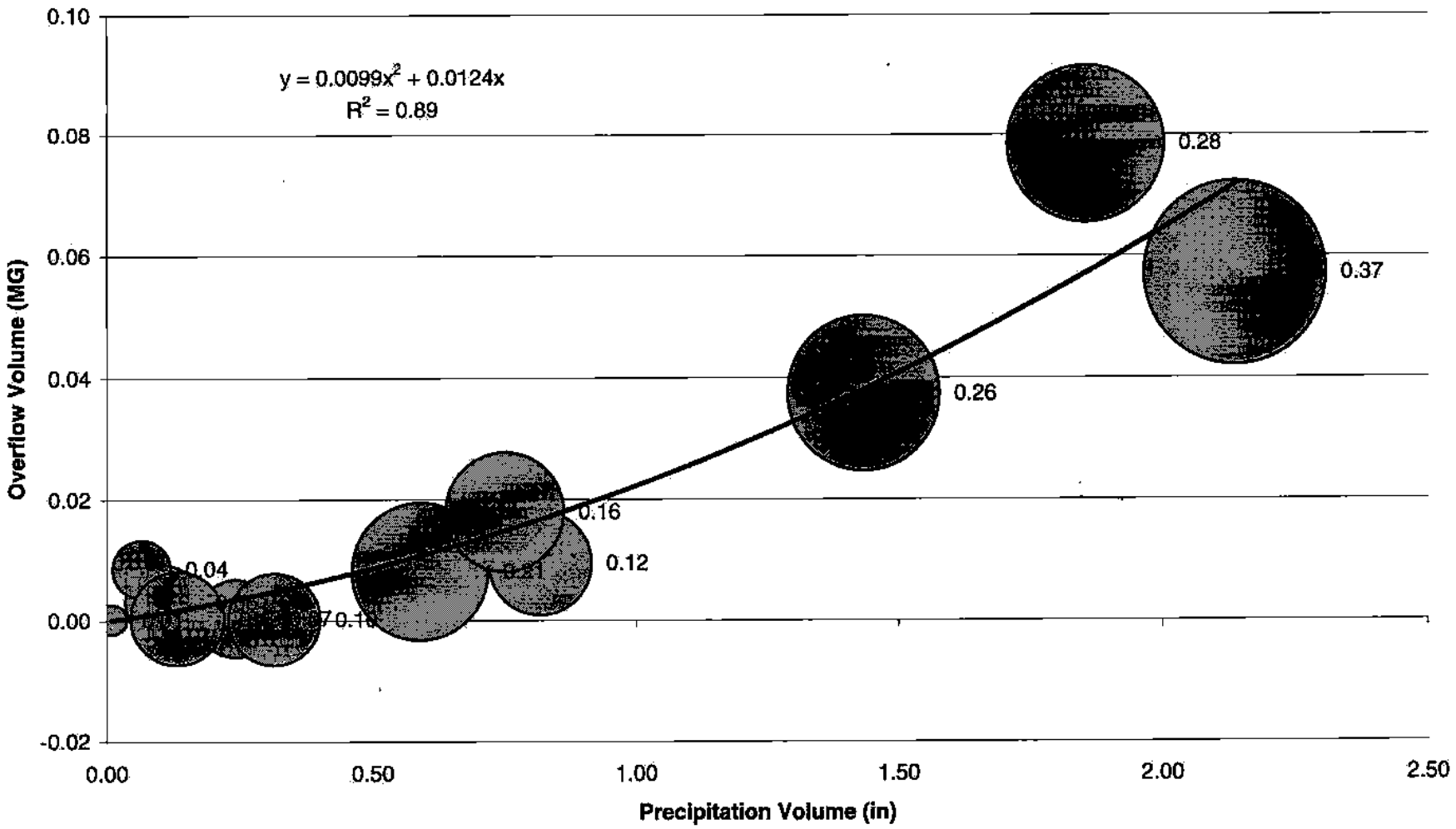
Site 016
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



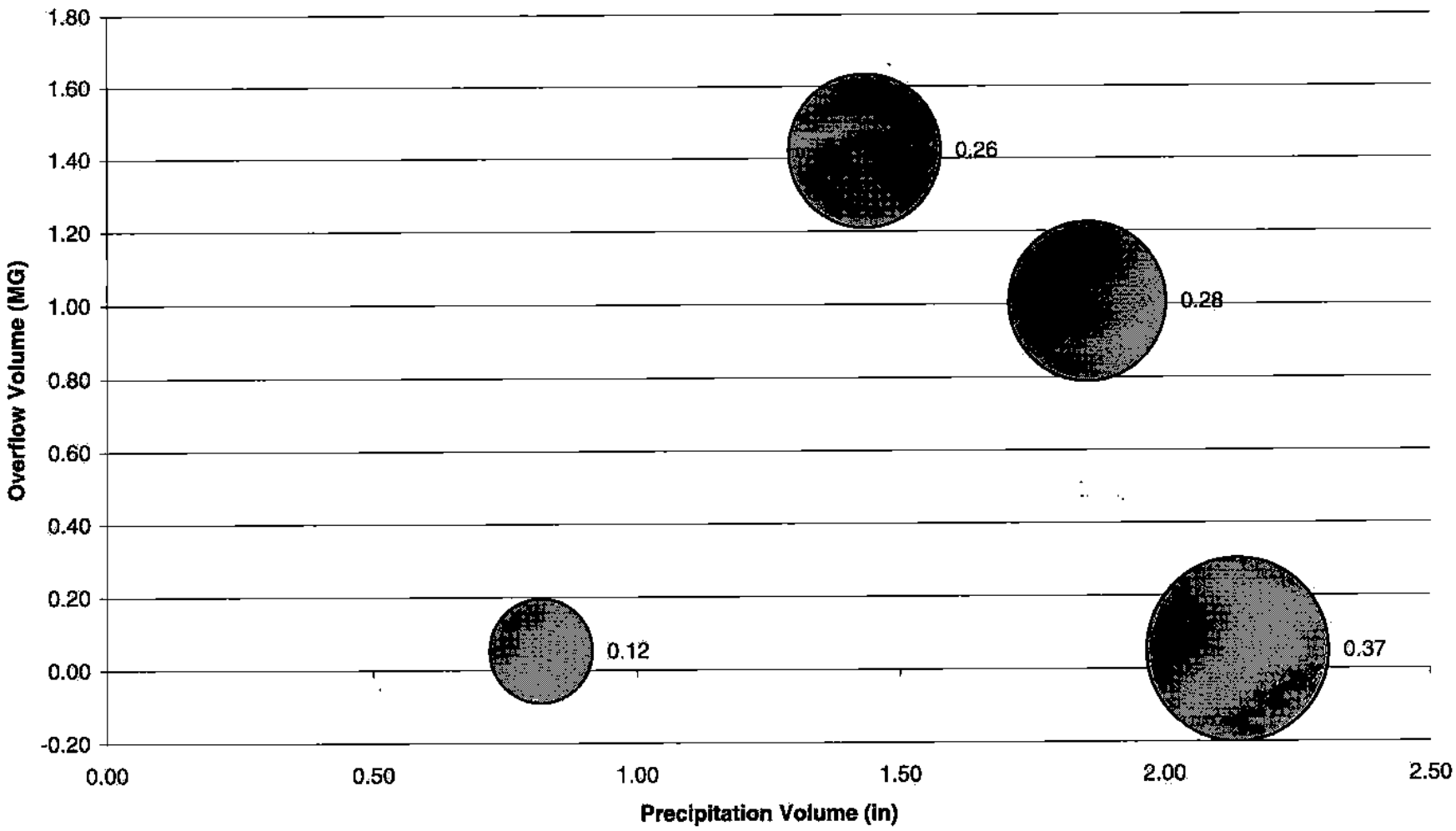
Site 018
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



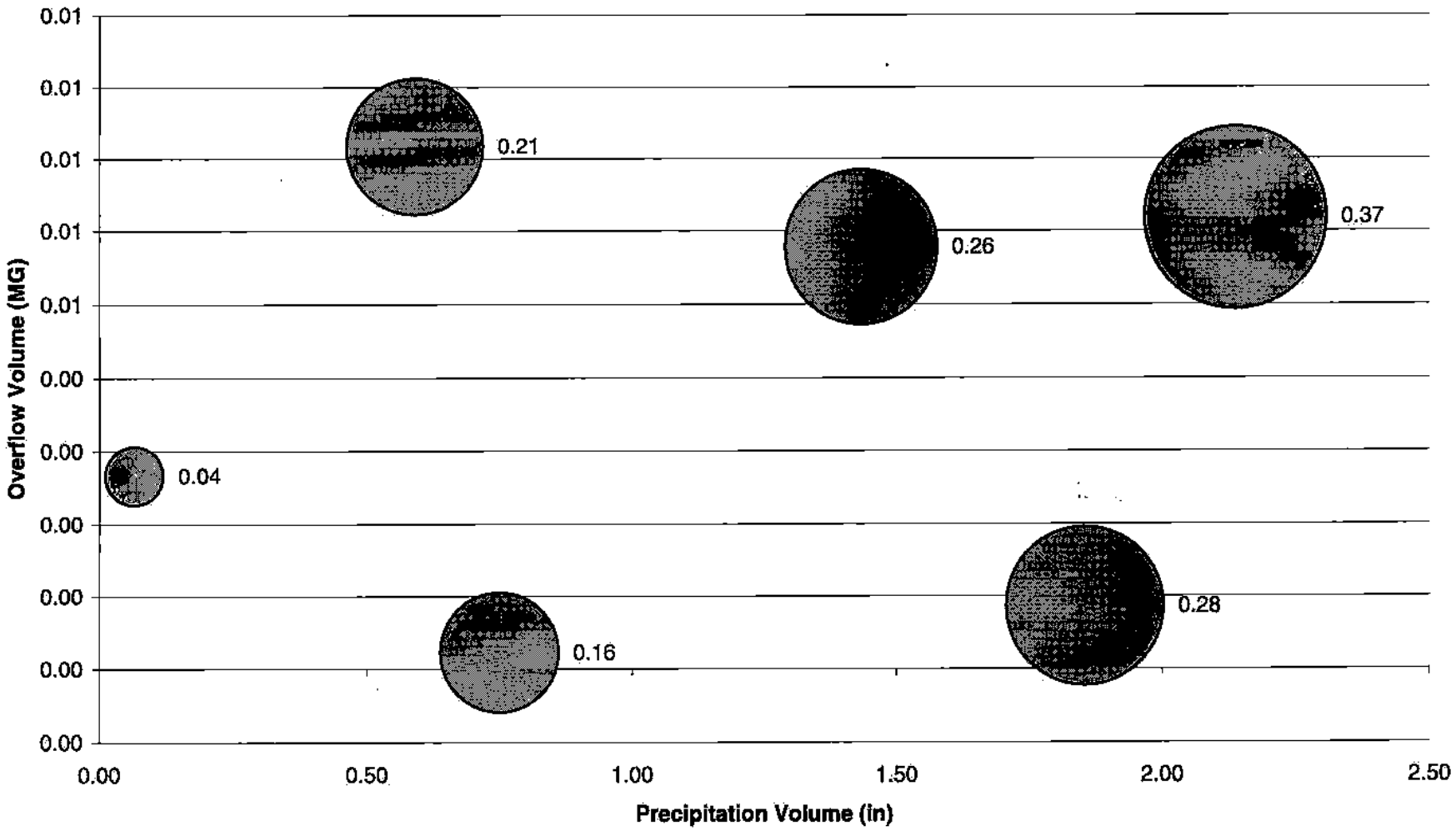
Site 019
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



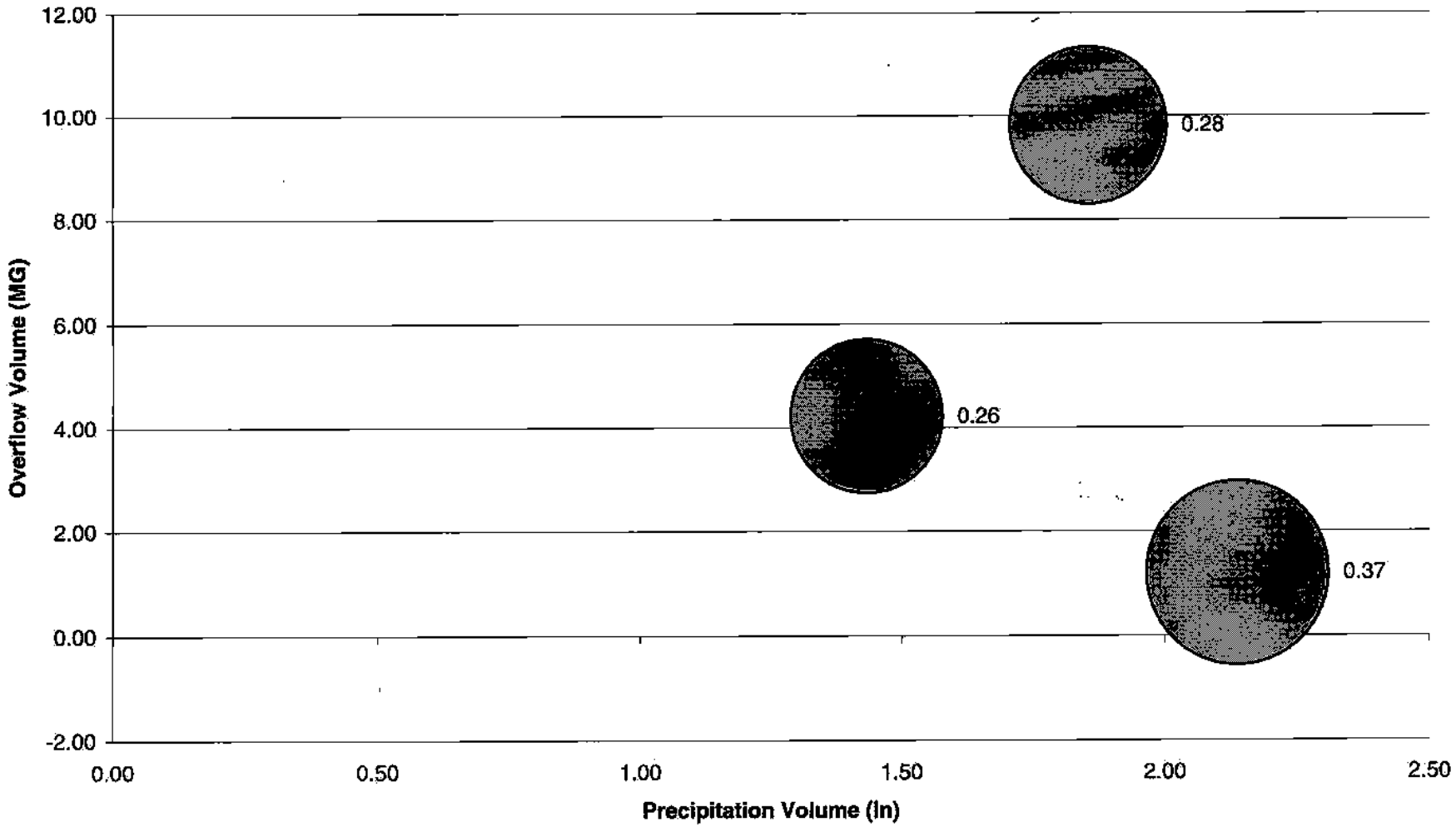
Site 021
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



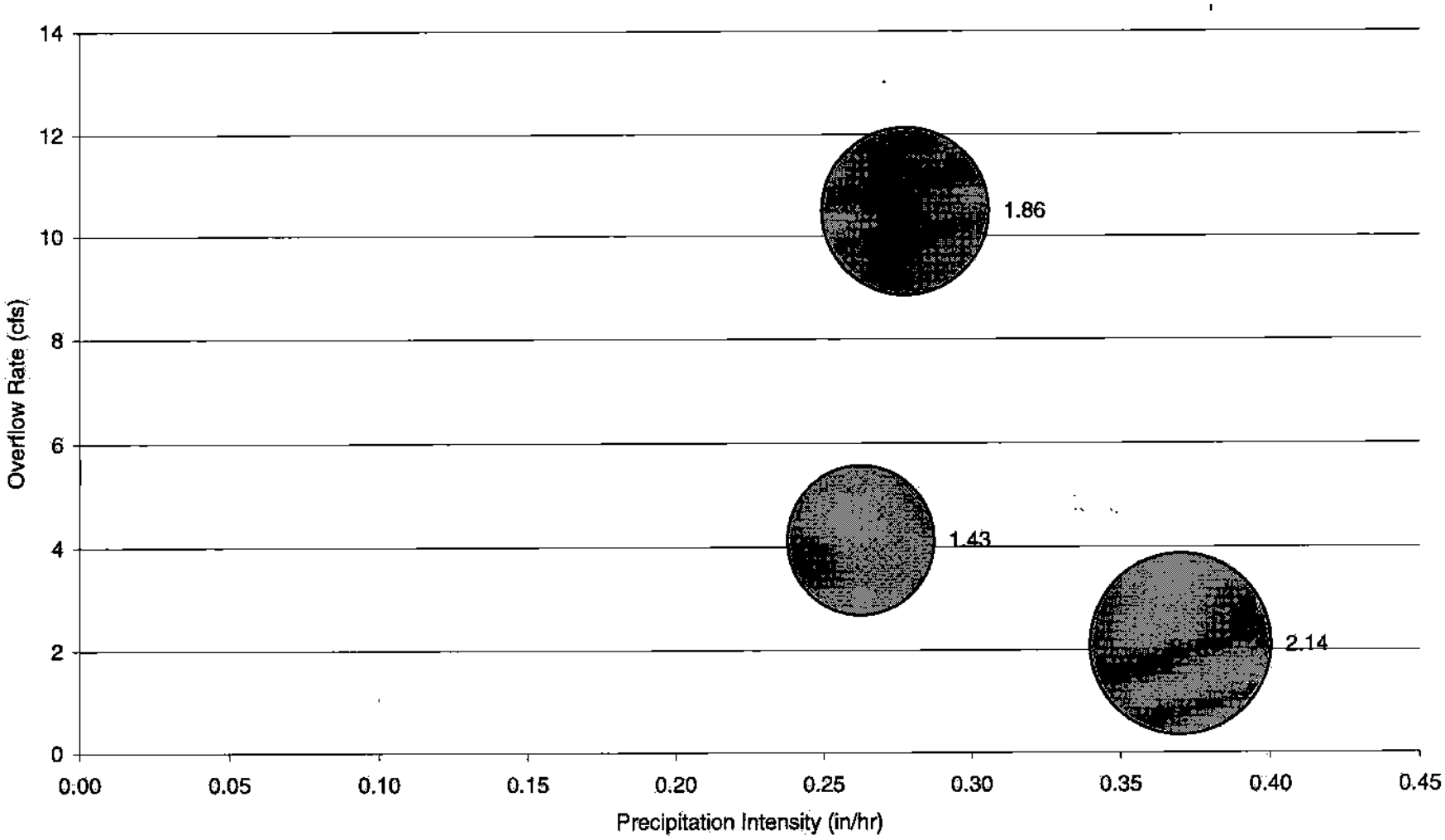
Site 022
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



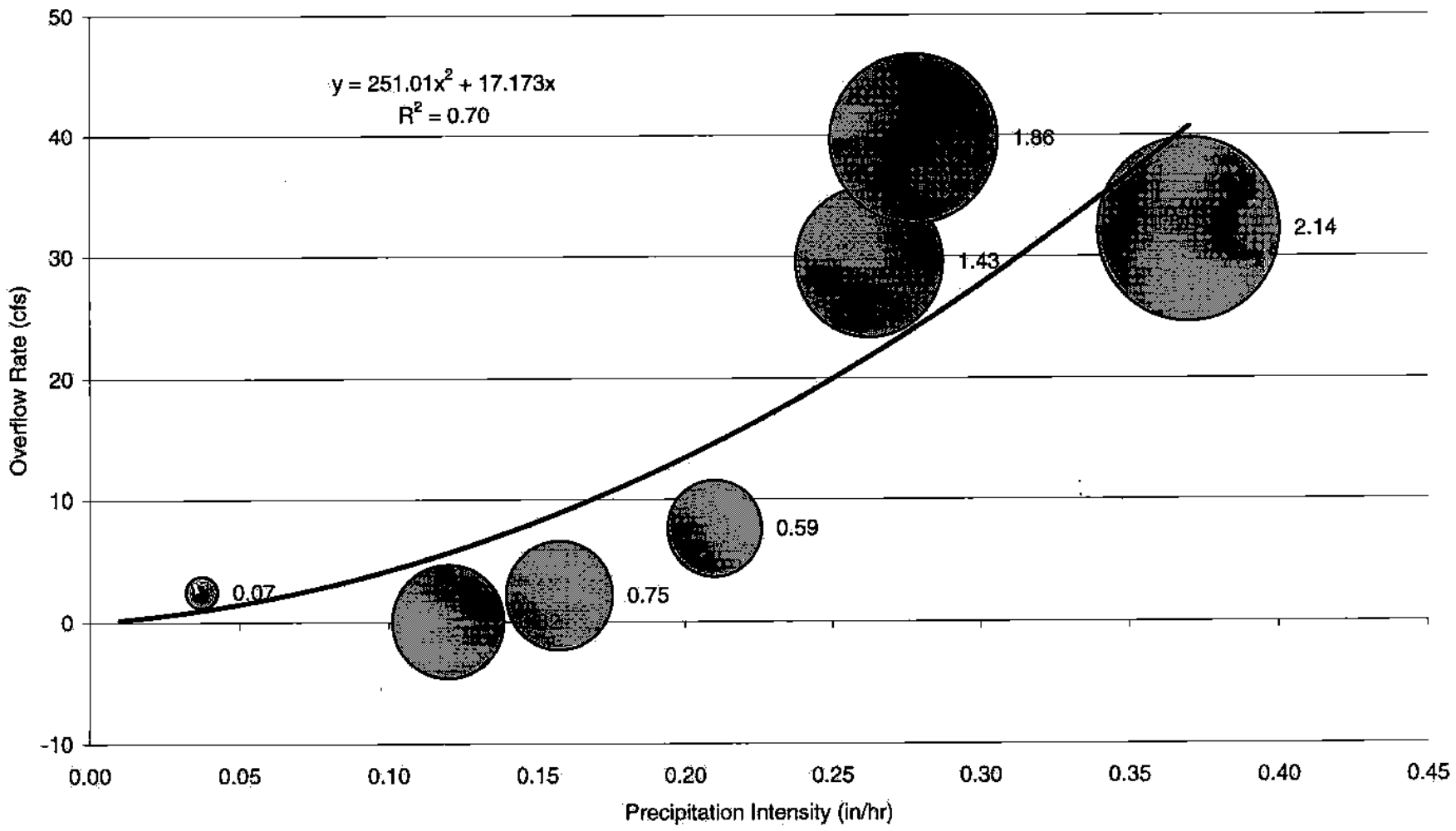
Site 024
Correlation Between Precipitation Volume and Overflow Volume
(bubble size indicates precipitation intensity)



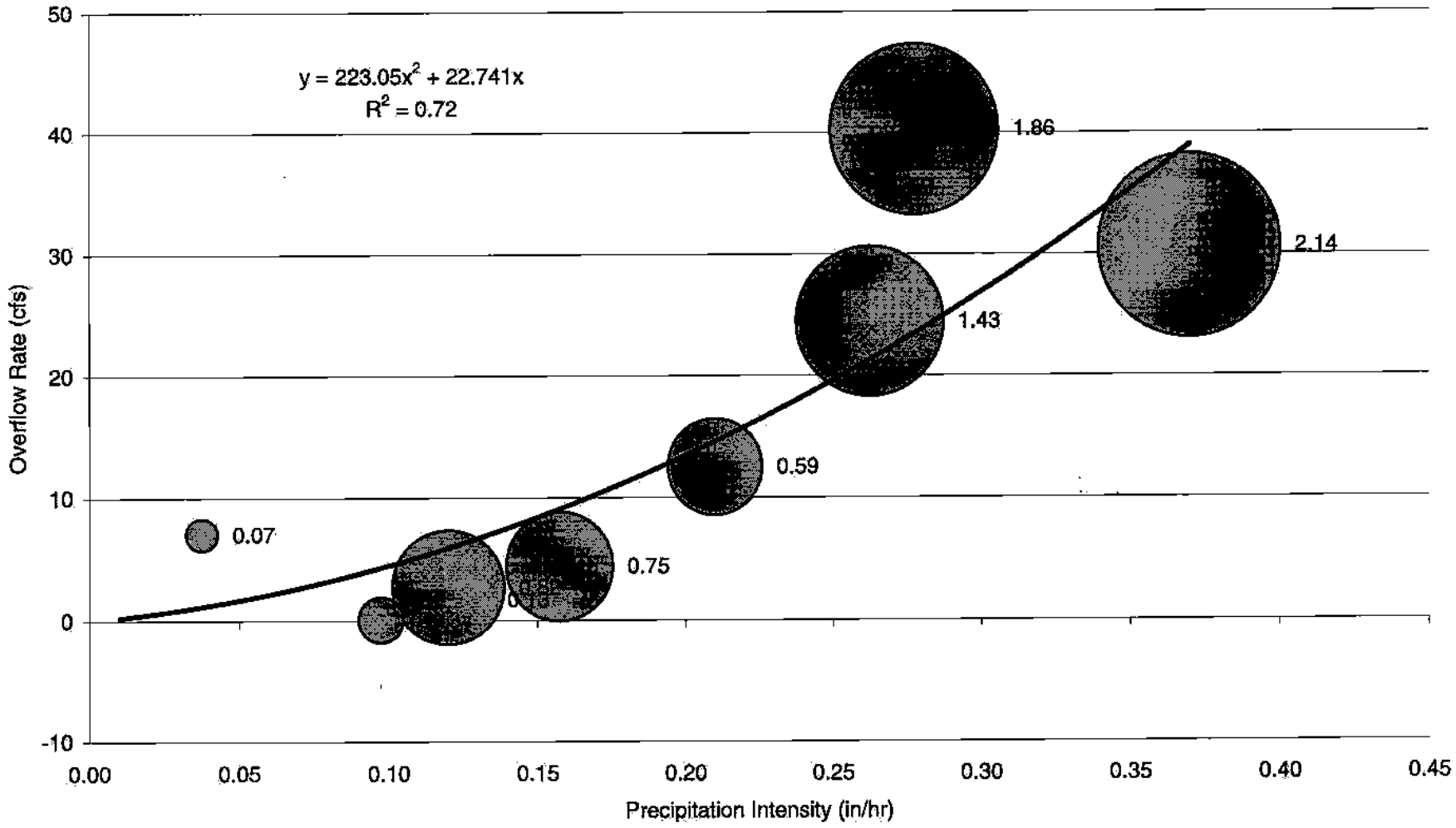
Site 002
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



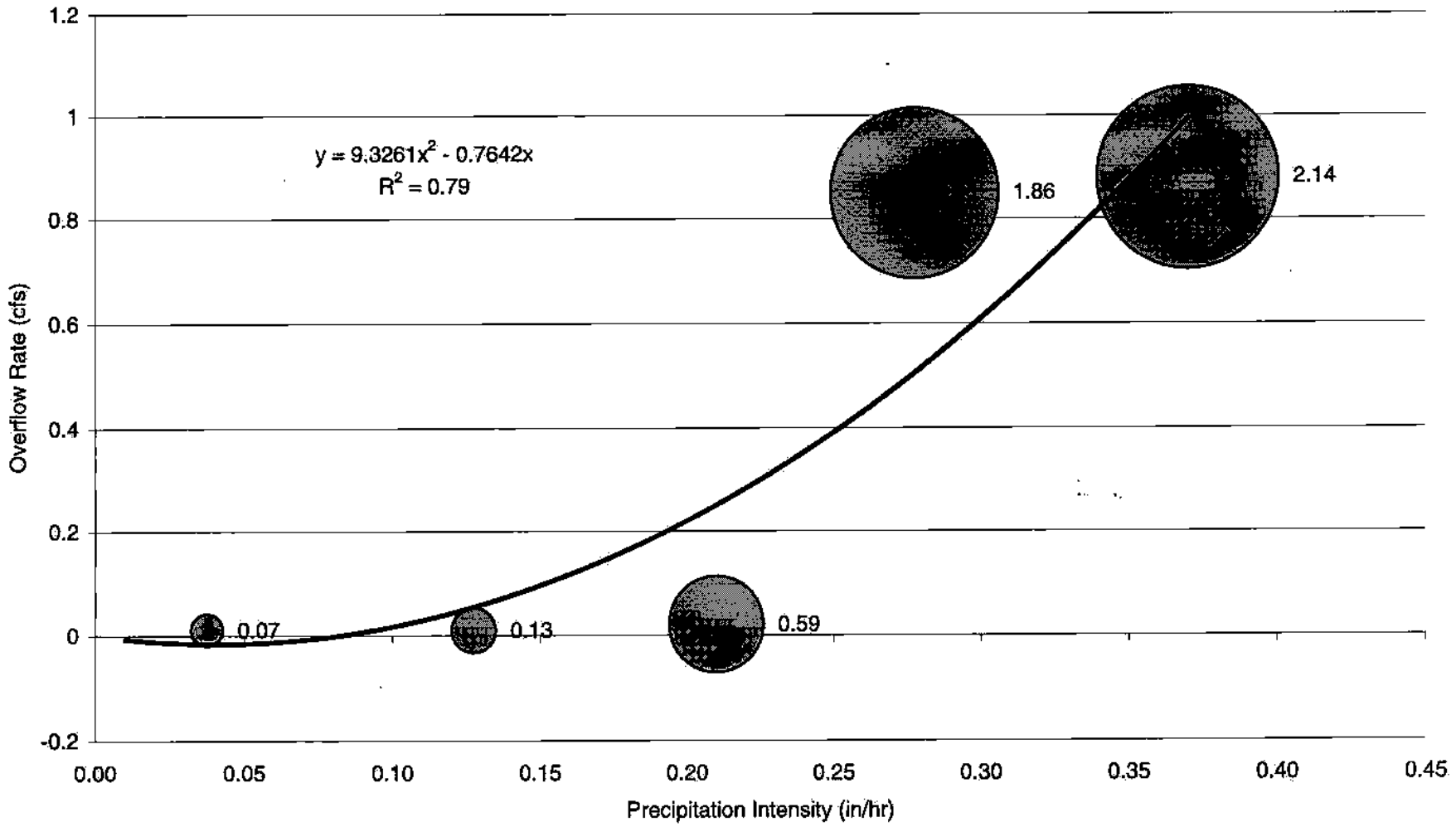
Site 003
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



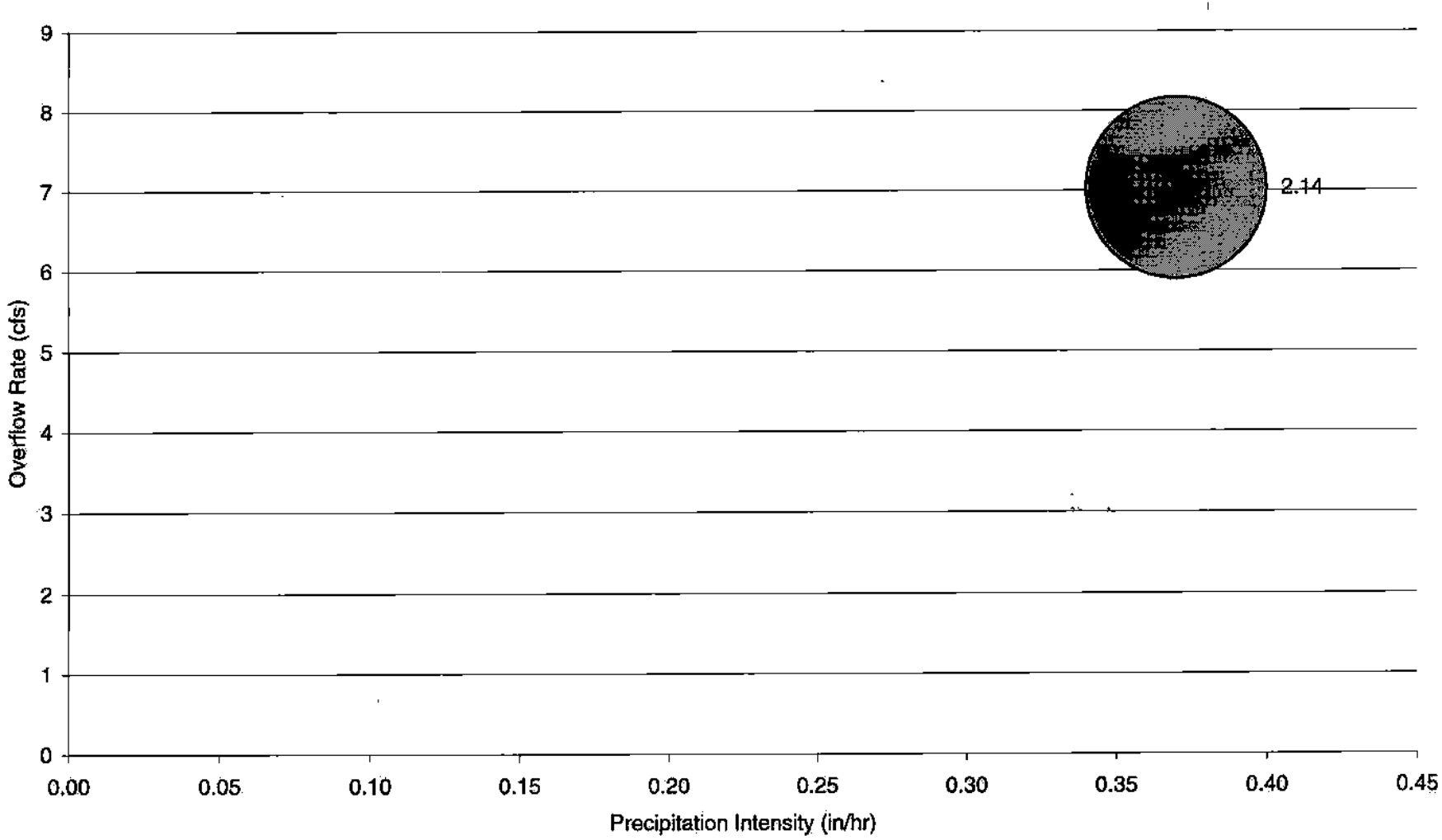
Site 004
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



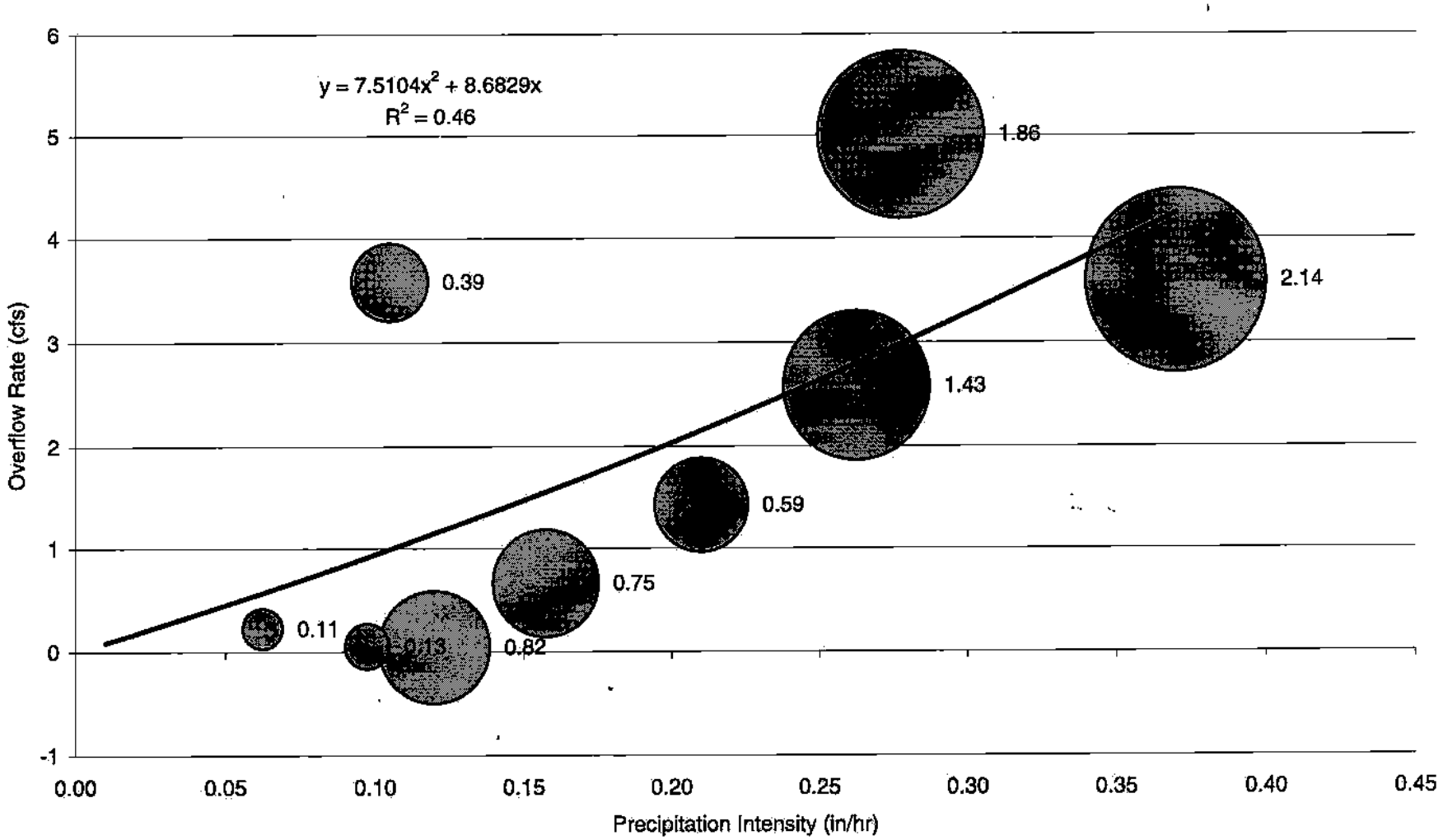
Site 005
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



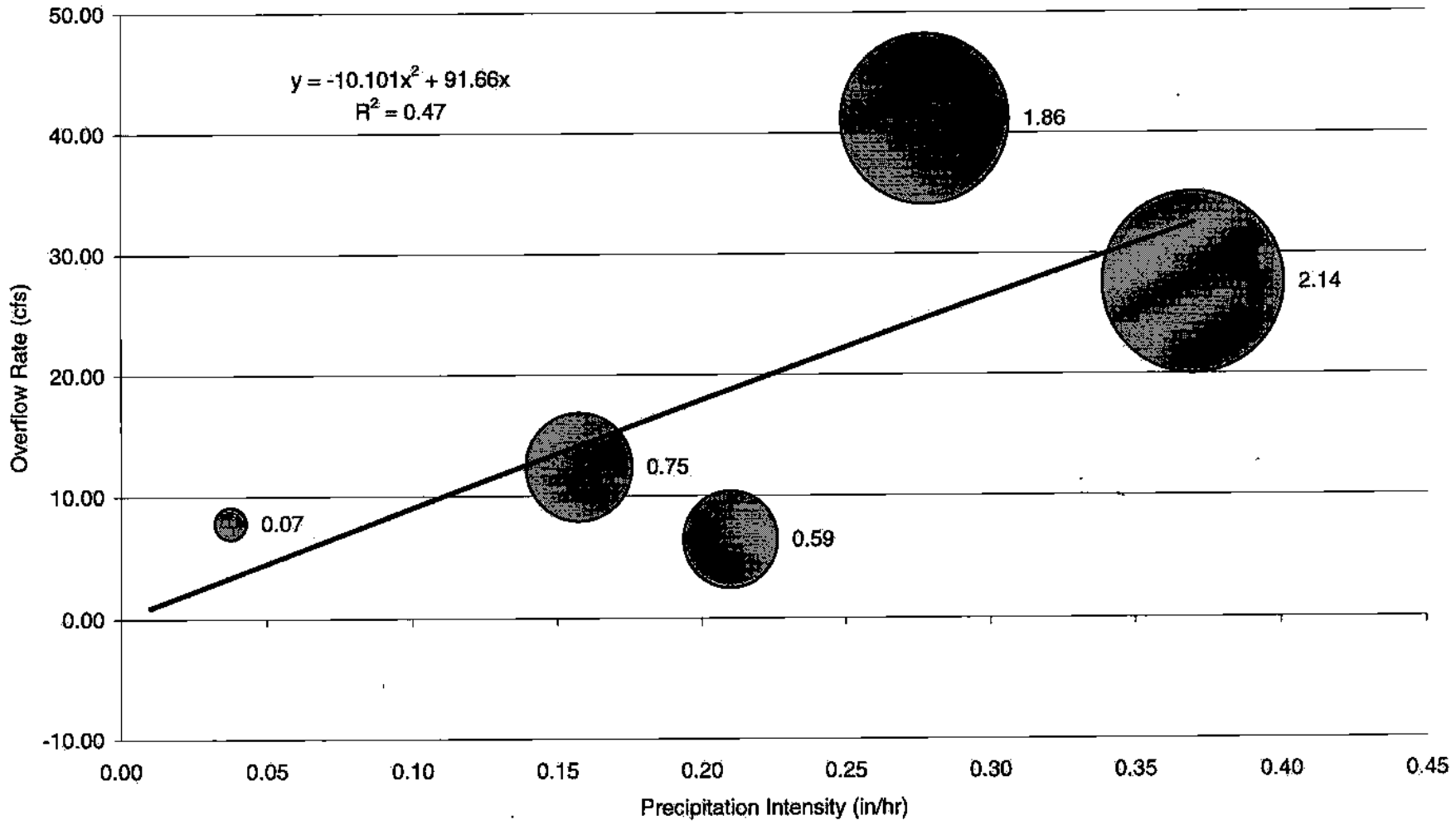
Site 006
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



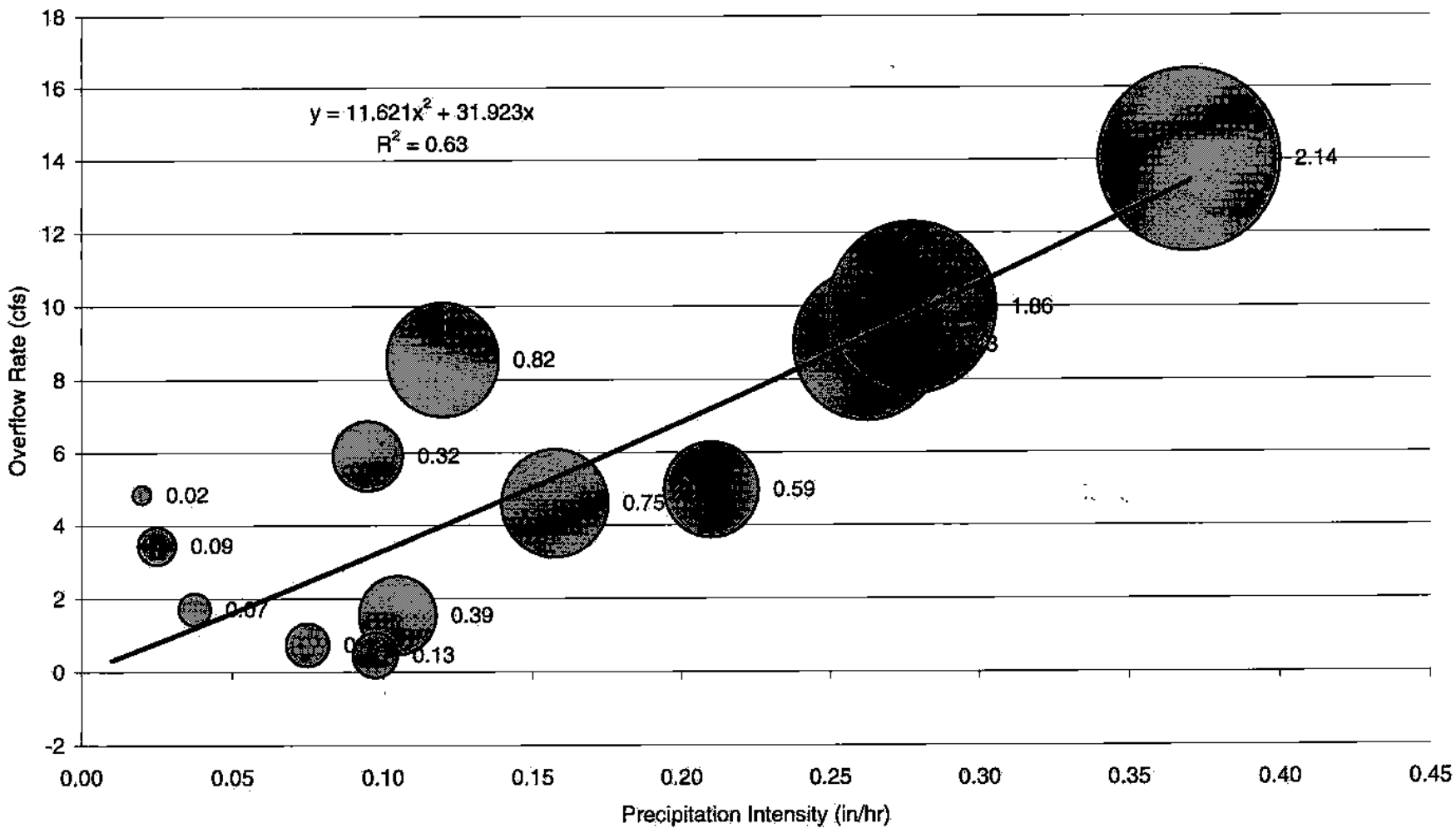
Site 009
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



Site 015
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)

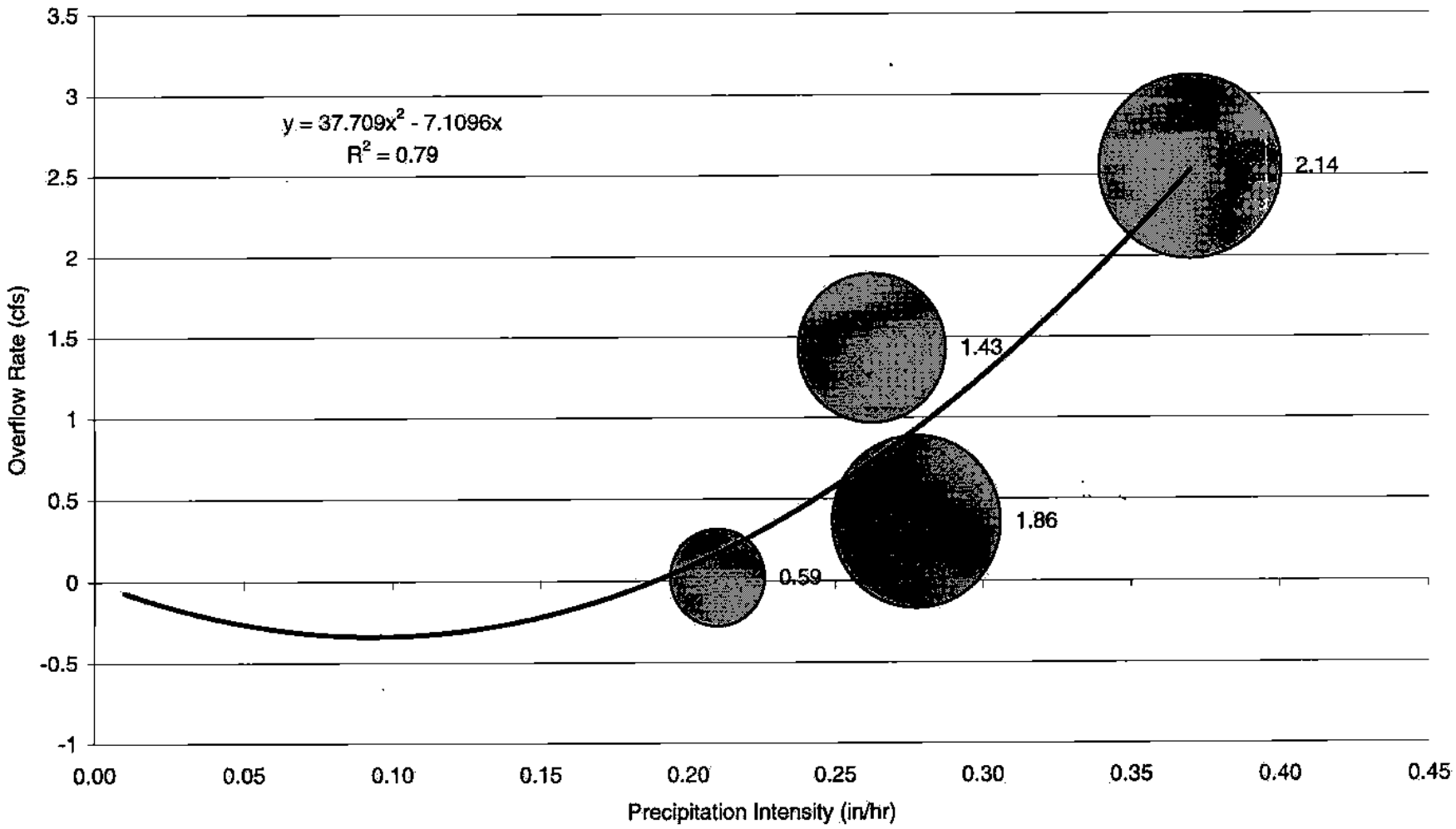


Site 016
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)

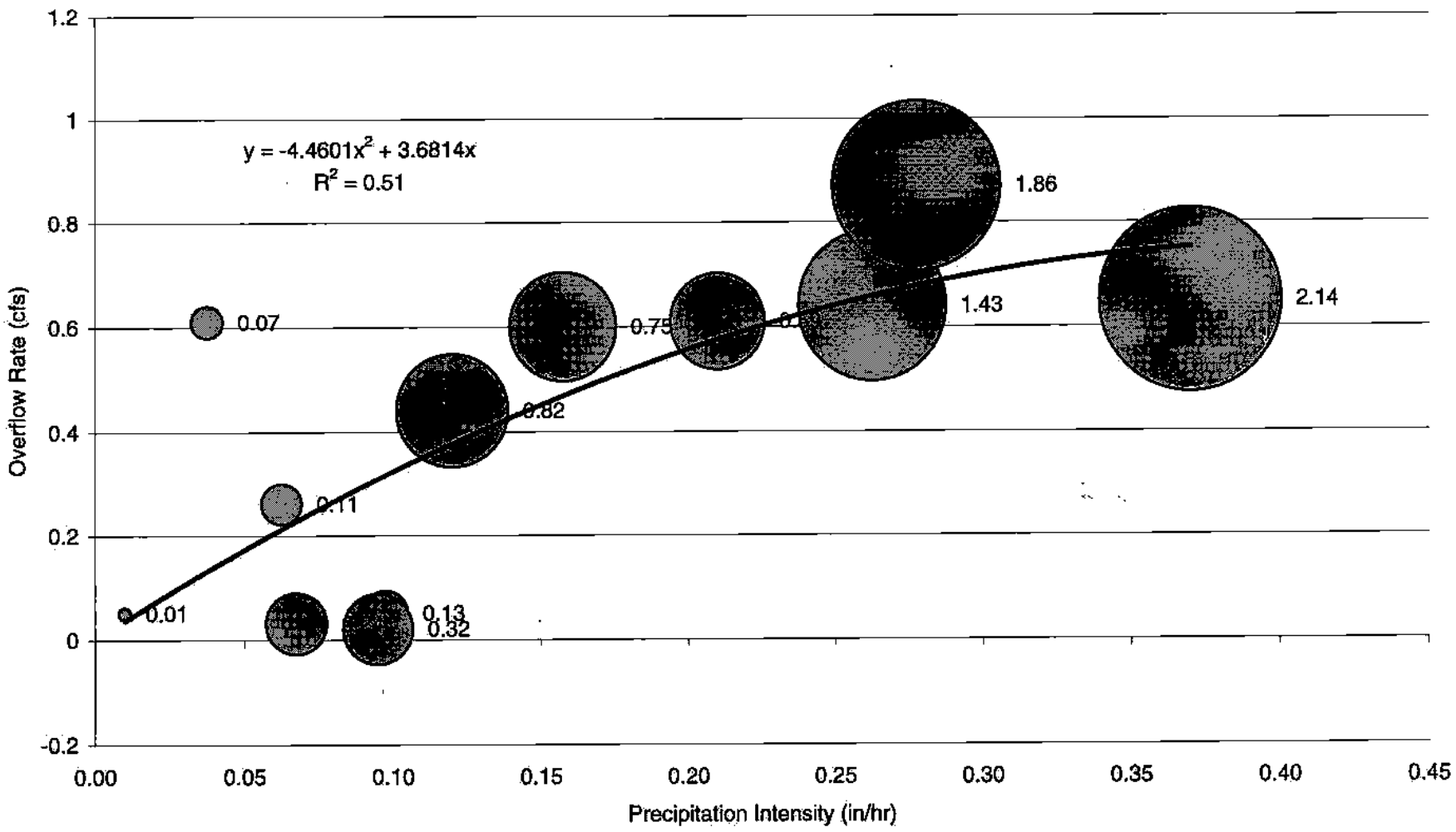


3/18/98 11:17 AM
Correl.xls

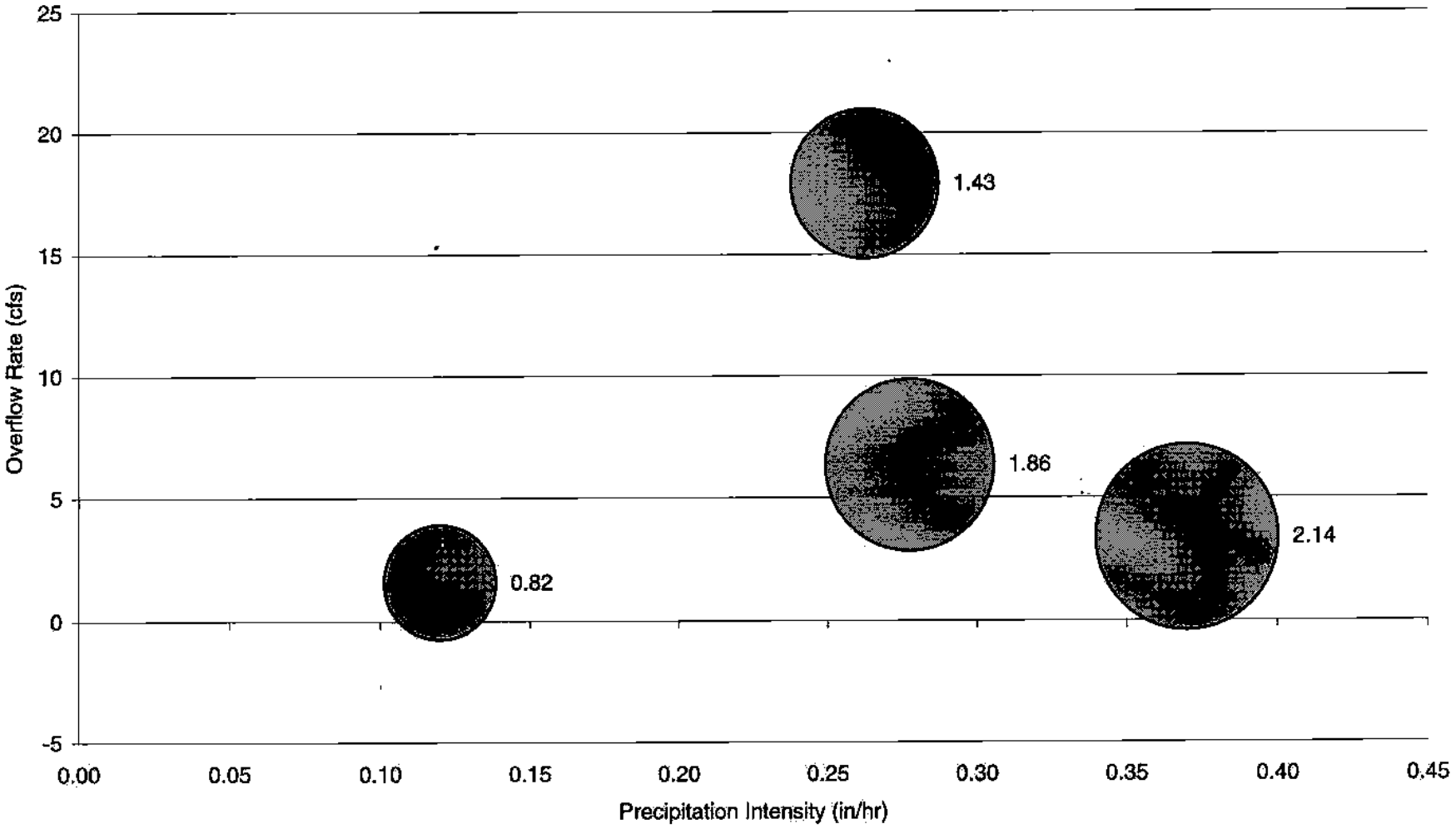
Site 018
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



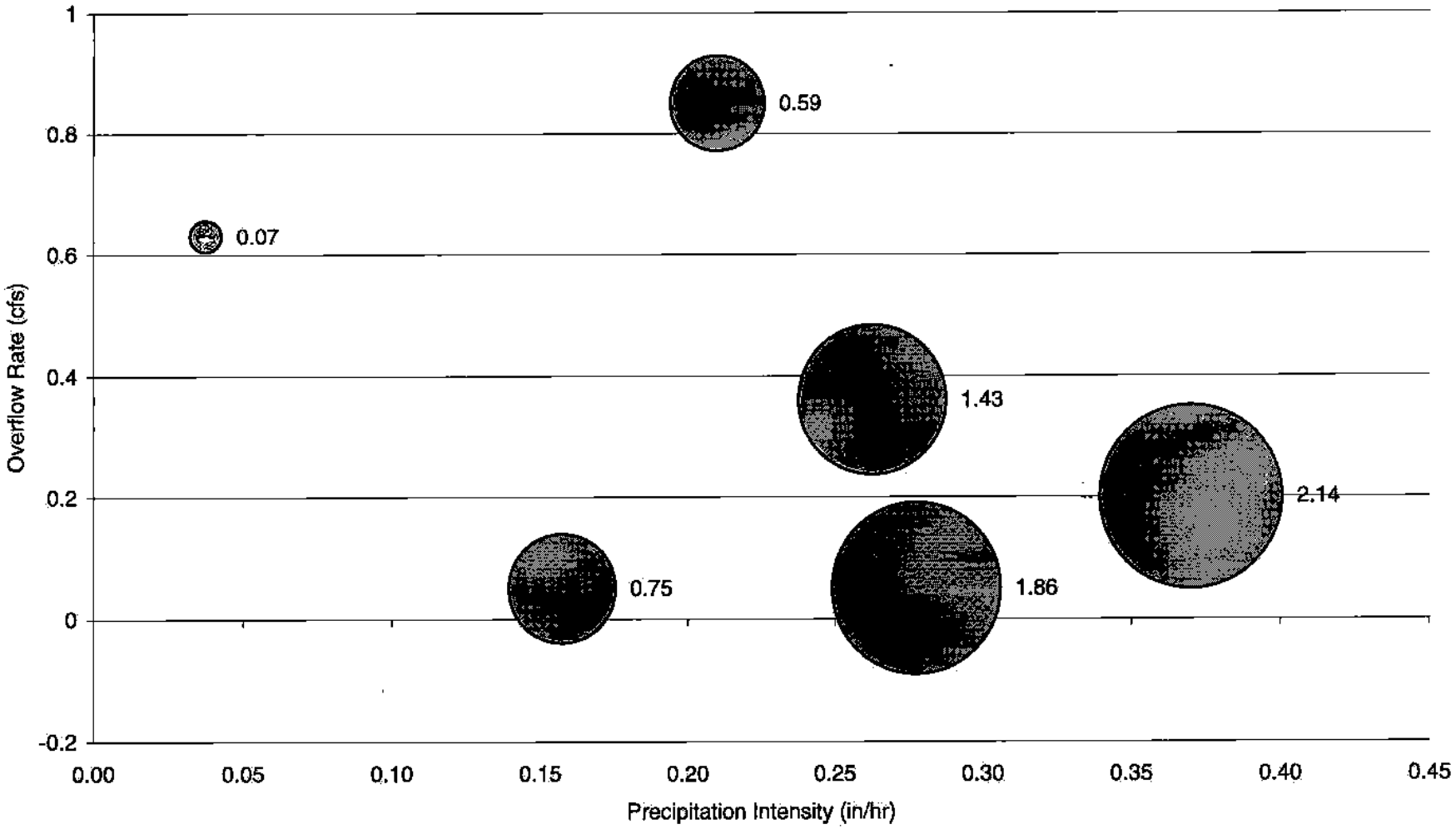
Site 019
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



Site 021
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



Site 022
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)



Site 024
Correlation Between Precipitation Intensity and Overflow Rate
(bubble size indicates precipitation volume in inches)