SANITARY SEWER INFILTRATION/ INFLOW AND EXFILTRATION STUDY

Task 1
of the
Zero-Offsite Water-Discharge Study

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EXECUTIVE SUMMARY

This report has been prepared as one of several studies being conducted for, and in the development of, a Zero-Offsite Water-Discharge Plan for Rocky Flats Plant (RFP) in response to Item C.7 of the Agreement in Principle (AIP) between the U. S. Department of Energy (DOE) and the Colorado Department of Health (CDH) (DOE and State of Colorado, 1989). The DOE/CDH Agreement Item C.7 states "Source Reduction and Zero Discharge Study: Conduct a study of all available methods to eliminate Rocky Flats discharges to the environment including surface waters and ground water. This review should include a source reduction review" (AIP, p. 8).

This infiltration/inflow and exfiltration (I/I/E) study report assesses the location and quantification of infiltration, inflow or exfiltration into the sanitary sewer system at the RFP for the period May 11, 1990 through May 13, 1991, or a period of about one year. The infiltration/inflow and exfiltration analysis identifies, to the extent possible, the presence, flow rate, and type of infiltration/inflow or exfiltration conditions which exist in the sanitary sewer system.

Infiltration may occur when existing sewer lines and manholes undergo material and joint degradation and deterioration as well as when new sewer lines are poorly designed and constructed. If the system is below the water table, ground water may enter the system and increase the flow rates in the sewers. *Inflow* normally occurs when rainfall or snowmelt enters the sewer system through direct connections such as roof drains and catch basins. *Exfiltration* may occur under the same sewer system conditions as infiltration except when the water table is below the sewer invert.

Based upon an analysis of measured flows in the RFP sanitary sewer system at six monitoring sites during the period May 11, 1990 through May 13, 1991, it is estimated that there is some infiltration and inflow to the RFP system. The table below summarizes the estimates of I/I/E for each of the six monitoring sites for the monitoring period.

SUMMARY OF I/I/E ESTIMATES AT SANITARY SEWER MONITORING SITES

Monitoring Site	Estimated Infiltration (MGY)	Estimated Exfiltration (MGY)	Estimated Inflow (MGY)	Total I/I (MGY)
MH-3	1.2	-0.2	2.6	3.6
NPUA	0.9	-1.7	5.0	4.2
S120a	1.7	-0.9	1.0	1.8
S116a[1)]	0.7	-0.5	1.8	2.0
S401	2.4	-0.2	1.5	3.7
SPUA	5.6	-2.1	1.4	4.9
Total (NPUA + SPUA)	6.5	-3.8	6.4	9.1
Previous Estimates:				
ASI (1988)	---	---	---	6-10
ASI, (Task 1, 1990c)	---	---	---	12.6

1) Measurements at this monitoring site are questionable because of force main pumping.

Analysis of the preliminary results indicates that the sanitary sewer system at the RFP may have about 9.1 MGY of total infiltration/inflow which enters the system through high ground water and precipitation entering the system through various pathways such as roof drains, leaky manhole covers, and possibly cooling tower sumps and other connections. Estimated total infiltration accounts for about 6.5 MGY of the total and inflow accounts for up to 6.4 MGY of the total. Exfiltration, amounting to about -3.8 MGY may occur from the system. This additional total infiltration/inflow of about 9.1 MGY is about 13 percent of the 72.1 MGY discharged from the STP in 1990. However, studies by the American Public Works Association

(Sullivan and Ewing, 1985) indicate that an aggressive program to reduce the I/I/E may only reduce the total I/I/E by 30 percent at best. Therefore, only about 2.7 MGY of the 9.1 MGY total infiltration/inflow would be removed. This removal would only reduce the annual flow at the STP by about 4 percent. In our opinion, the cost of reducing the total infiltration/inflow would not be cost effective at this time. Because a majority of the sanitary sewer system was rehabilitated in 1985, additional rehabilitation probably would not significantly improve the system. Much of the existing sanitary sewer system consists of relatively small pipe diameters (3 to 8 in). Rehabilitation of these small pipe diameters is generally more costly than larger pipe and result in large decreases in hydraulic capacity of the system.

Exfiltration of -3.8 MGY is about 5 percent of the annual STP discharge of 72.1 MGY. This is well within the measurement errors for this type of study. Reduction of exfiltration, if it exists, is not recommended. The exfiltration rates are most likely the result of inaccuracies in computation as a result of both poor water use data at the RFP and errors in flow measurements in the sewers.

An additional consideration related to rehabilitation of the sanitary sewer at the RFP is the cost of access to the sewers themselves. Excavation at the RFP is nearly prohibitive because of known Individual Hazardous Substance Sites (IHSSs) other existing utilities, and electrical cables. Slip lining of pipes and other trenchless technology could make rehabilitation less costly if sufficient pipe capacity currently exists.

Errors associated with the total infiltration/inflow estimates include flow measurements errors (about 10 to 15 percent) and theoretical wastewater production rate errors (about 10 to 20 percent). These errors would not account for the differences between the sum of estimated inflow from S120A, S401, and S116a versus SPUA. However, these magnitude errors would account for the errors in total infiltration/inflow for the other sanitary sewer monitoring sites. This is particularly true for the infiltration and exfiltration components of the study. Minimum (early morning) flow rates in the sewers are most likely caused by cooling tower discharges,

which are automatic in many towers, rather than infiltration. Further investigation of this is probably not warranted given the high cost of reducing the total infiltration/inflow at the RFP. Also, the seemingly high inflow values, shown on the table above, are most likely because of the poor estimates of the theoretical wastewater production rates due to poor water metering, rather than massive amounts of inflow from roof drains or other sources.

Of the estimated 9.1 MGY total infiltration/inflow, about 4.2 MGY, or about 46 percent, is sourced in the plutonium processing areas as measured at NPUA (Building 990 Diversion Box - North). The remaining 4.9 MGY, or about 54 percent, is sourced in the non-plutonium processing areas as measured at SPUA (Building 990 Diversion Box - South). We judge that the inflow estimated at NPUA and SPUA is probably not that large and is because of the errors in short term (daily and weekly) theoretical wastewater production rates. The theoretical wastewater production rate at the RFP is probably not a constant, but a variable which changes with the atmospheric conditions. Because cooling tower contributions to the sanitary sewer system are between 25 and 30 percent of the flow rate, the atmospheric conditions would cause a variable wastewater production rate and cause the apparently large inflows calculated at MH-3, NPUA, S116a, and S401.

Infiltration/inflow analyses for municipal sanitary sewer systems generally develop the quantities of infiltration and inflow in terms of a unit length of the sanitary sewer system in order to judge whether the measured and/or calculated values of I/I/E are excessive. Infiltration quantities are usually presented in terms of gpd per inch-diameter-mile of pipe. Inflow quantities are usually presented in terms of gallons per 1000 ft of pipe for a specified time period such as one day. The table below summarizes these unit infiltration and inflow rates for the RFP sanitary sewer system for each monitoring site, as well as the total system.

Analysis of the unit rates of infiltration indicates that the unit infiltration rates for the various subsystems monitored for this report period ranged from about 150 gpd per inch-mile of sewer pipe, to over 2640 gpd per inch-mile of sewer pipe. EPA recognizes that if the unit infiltration

rate is less than about 3000 gpd per inch-mile of sewer pipe, then the infiltration rate is not excessive and spending money to reduce this infiltration rate is not cost effective (Personal Communication, J. T. Kunz, Donohue & Associates, December 13, 1990). Therefore, because the unit infiltration rates at all monitoring sites in the RFP sanitary sewer system are less than the EPA-recognized rule-of-thumb for excessive infiltration, it would not be cost effective to reduce this infiltration.

SUMMARY OF UNIT I/I/E ESTIMATES AT SANITARY SEWER MONITORING SITES

Monitoring Site	Infiltration (gpd)	Infiltration (gpd/in-mi)	Inflow (gpd)	Inflow (gpd/1000 ft)
MH-3	3,200	640	7,100	2,230
NPUA	2,600	150	13,700	1,240
S120a	4,600	530	2,700	400
S116a	1,900	400	4,900	1,100
S401	6,500	2,640	4,100	1,960
SPUA	15,300	500	3,800	170
Total (NPUA + SPUA)	17,900	370	17,500	520

The unit inflow rates to the RFP sanitary sewer system, as measured or calculated at the monitoring sites, range from about 170 gpd per 1000 ft of sewer pipe, to about 2,230 gpd per 1000 ft of sewer pipe. Typically, municipal systems having less than about 3000 to 5000 gpd per 1000 ft of sewer line have found that spending money to reduce inflow rates is not cost

effective. Therefore, because the unit inflow rates at the monitoring sites in the RFP sanitary sewer system are less than the rule-of-thumb for excessive inflow, it would not be cost effective to reduce this inflow.

EPA also has given a guideline of 120 gpcd for excessive total infiltration/inflow in a municipal sanitary sewer system (Sullivan and Ewing, 1985). Using the 6,374 RFP employees as a base, the total infiltration/inflow for the RFP sanitary sewer system would have to be in excess of 279 MGY, compared to the actual value at NPUA plus SPUA of about 12.6 MGY, to be considered excessive. Thus, the 9.1 MGY estimated by this report for infiltration/inflow for the RFP sanitary sewer system cannot be defined as excessive using EPA-recognized rules-of-thumb and guidelines. Therefore, it is recommended that continued monitoring of the sanitary sewer system at the RFP be discontinued, because it could be shown to not have excessive infiltration/inflow or exfiltration.

SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION STUDY

1.0 INTRODUCTION

1.1 BACKGROUND

This report has been prepared as one of several studies being conducted for, and in the development of, a Zero-Offsite Water-Discharge Plan for Rocky Flats Plant (RFP) in response to Item C.7 of the Agreement in Principle (AIP) between the U. S. Department of Energy (DOE) and the Colorado Department of Health (CDH) (DOE and State of Colorado, 1989). The DOE/CDH Agreement Item C.7 states "Source Reduction and Zero Discharge Study: Conduct a study of all available methods to eliminate Rocky Flats discharges to the environment including surface waters and ground water. This review should include a source reduction review" (AIP, p. 8).

1.2 SCOPE AND PURPOSE

This infiltration/inflow and exfiltration study report assesses the location and quantification of infiltration, inflow or exfiltration into the sanitary sewer system at the RFP for the period May 11, 1990 through May 13, 1991. The infiltration/inflow and exfiltration analysis identifies, to the extent possible, the presence, flow rate, and type of infiltration/inflow or exfiltration conditions which exist in the sanitary sewer system (ASI, 1990b).

Infiltration may occur when existing sewer lines and manholes undergo material and joint degradation and deterioration as well as when new sewer lines are poorly designed and constructed. If the system is below the water table, ground water may enter the system and increase the flow rates in the sewers. *Inflow* normally occurs when rainfall or snowmelt enters the sewer system through direct connections such as roof drains and catch basins. *Exfiltration*

may occur under the same sewer system conditions as infiltration except when the water table is below the sewer invert.

Peak flow rates affect the sizing of the sanitary sewers and the pumping facilities. They also affect the sizing of the hydraulic treatment units, including clarifiers, chlorination units and plant pumping stations. Even the biological treatment units can be affected by the sewage flow conditions (EPA, 1975). At the RFP, the quantities of infiltration/inflow and exfiltration in the sanitary sewer system is important because one of the goals of zero discharge is to recycle the effluent from the STP to plant processes. Thus, a balance between the water available from the STP, other processes, and purchased water, versus the demand for water at the RFP must occur. Another goal of zero discharge is to minimize the releases of water from the RFP to the environment. Therefore, exfiltration should be minimized.

2.0 INFILTRATION/INFLOW AND EXFILTRATION ANALYSIS

2.1 DATA AND LITERATURE REVIEW AND ANALYSIS

2.1.1 Existing Sewer System

A sewer-map analysis of the existing sanitary system was conducted, based upon the utility drawings of the RFP (Rocky Flats Plant, 1986; 1989; 1990). Figure 1 shows a schematic of the existing sanitary sewer system as it currently exists at the RFP. In addition to this existing system there are many miles of old sewer lines which were abandoned in place and disconnected from the system during the rehabilitation of the sanitary sewer system in 1985 and also during prior years (EMC Engineers, Inc. and KKBNA, Inc., 1985). The exact number of miles of abandoned sanitary sewer lines at the RFP is unknown.

Table 1 is a summary of the existing sanitary sewer system inventory as compiled from RFP sanitary sewer drawings (Rocky Flats Plant, 1987). There are approximately 35,000 linear feet (ft) of sanitary sewer lines at the RFP, ranging in diameter from 3 inches (in) to 12 in. Approximately 265 ft of the system is 3-in diameter and approximately 8,300 ft of the system is 4-in diameter pipe. This 4-in diameter pipe generally connects the individual buildings to the main sanitary sewer system. About 7,300 ft is 6-in diameter, about 7,800 ft is 8-in diameter, about 3,300 ft is 10-in diameter, and about 8,000 ft is 12-in diameter. The pipe materials in the existing sanitary sewer include vitrified clay pipe (VCP), polyvinyl chloride pipe (PVC), cast iron pipe (CIP) and ductile iron pipe (DIP). The PVC sanitary sewer pipe is the newest at the RFP and was installed in 1984 or later. The VCP sewer lines were installed earlier from 1974 to 1983. Table 1 shows the length of each type and diameter of existing sanitary sewer pipe in the RFP system.

In-sewer flow measurements were made at six locations within the system as shown on Figure 1. These six locations are identified on Figure 1 as maintenance holes (manholes) S120a

TABLE 1

SUMMARY INVENTORY OF RFP SANITARY SEWER SYSTEM

Pipe Diameter (in)	Length (ft)	Pipe Material[1)]
3	265	DIP
Subtotal	265	
4	2,380	VCP
4	5,012	PVC
4	760	CIP
4	200	DIP
Subtotal	8,352	
6	77	VCP
6	4,433	PVC
6	2,788	CIP
Subtotal	7,298	
8	1,291	VCP
8	6,492	PVC
Subtotal	7,783	
10	750	PVC
10	2,562	VCP
Subtotal	3,312	
12	3,542	VCP
12	4,264	PVC
12	162	DIP
Subtotal	7,968	
TOTAL	34,978	

1) VCP = Vitrified Clay Pipe
PVC = Polyvinyl Chloride Pipe
CIP = Cast Iron Pipe
DIP = Ductile Iron Pipe

(Central Avenue at Fire Station), S401 (8th Street near Building 442), S116a (9th Street near Building T889A), MH-3 (Parking Lot at 7th Street and Sage Avenue), and the Building 990 North and South Diversion Box chambers. Additionally, effluent (but not influent) flow measurements are made at the Sewage Treatment Plant (STP) at Building 995.

Table 2 is a summary of the existing system inventory at the sanitary sewer monitoring points used for this infiltration/inflow and exfiltration study. Of the approximately 35,000 ft of sanitary sewer pipe, about 6,700 ft is measured at S120a, about 2,100 ft at S401, about 4,400 ft at S116a, and about 3,200 ft at MH-3. At the Building 990 North Diversion Box (NPUA), about 11,000 ft of pipe contribute and at the Building 990 South Diversion Box (SPUA), about 22,600 ft of pipe contribute. About an additional 1,000 ft of pipe is present between the Building 990 Diversion Box and the STP (Figure 1 and Table 2).

Figure 2 presents the existing sanitary sewer system at the RFP. Manhole numbers and the lowest invert elevations of these manholes, based upon the construction drawings available in the RFP drawing files, are shown. Information was not available for all manholes. Several manholes in each line were checked for consistency with the as-built drawings. The newest sanitary sewer lines are in the T130 Complex, where about 2,000 ft of 4-in to 8-in diameter sewer line was constructed in 1990 and connected to the existing sanitary sewer line at Building 130, and in the T893 Complex where about 850 ft of 3-in, 4-in, and 6-in diameter sewer line was installed in 1990 (Figures 1 and 2). Many sanitary sewer lines were replaced in 1985, however, six lines were not replaced. Based upon the information reviewed, these six lines (Figures 1 and 2) include: (1) approximately 960 ft of sanitary sewer from Building T371C to MH-6, constructed in 1984; (2) approximately 2,800 ft from Buildings 371/374 extending to MH-1, constructed in about 1974; (3) approximately 700 ft of sewer from Building 664 past Building 850 to manhole S302, constructed in 1984; (4) approximately 1300 ft of pipe from Building 130

TABLE 2

SUMMARY INVENTORY OF RFP SANITARY SEWERS DISCHARGING TO I/I MONITORING SITES

Monitoring Site	Pipe Diameter (in)	Pipe Material[1)]	Length (ft)
S120a	4	VCP	25
	4	PVC	1,885
	6	PVC	1,417
	8	PVC	2,852
	12	PVC	564
Subtotal			6,743
S401	4	CIP	450
	4	VCP	103
	6	PVC	724
	6	VCP	40
	8	PVC	771
Subtotal			2,088
S116a	4	PVC	515
	4	VCP	1,050
	4	CIP	250
	6	CIP	1,588
	8	PVC	1,045
Subtotal			4,448
MH-3	4	PVC	159
	6	VCP	37
	6	PVC	887
	8	VCP	347
	10	VCP	1,007
	10	PVC	750
Subtotal			3,187
Building 990 North Diversion Box	4	PVC	550
	4	VCP	490
	4	DIP	200
	6	PVC	1,703
	6	VCP	37
	6	CIP	1,200

TABLE 2 (Concluded)

SUMMARY INVENTORY OF RFP SANITARY SEWERS DISCHARGING TO I/I MONITORING SITES

Monitoring Site	Pipe Diameter (in)	Pipe Material[1)]	Length (ft)
Building 990	8	PVC	271
North	8	VCP	1,291
Diversion	10	PVC	750
Box	10	VCP	2,562
(Concluded)	12	PVC	653
	12	VCP	1,346
Subtotal			11,053
Building 990	3	DIP	265
South	4	PVC	4,298
Diversion	4	VCP	1,890
Box	4	CIP	760
	6	PVC	2,730
	6	VCP	40
	6	CIP	1,588
	8	PVC	5,839
	12	PVC	3,128
	12	DIP	162
	12	VCP	1,850
Subtotal			22,550
Building 995	8	PVC	400
STP	12	VCP	756
	12	PVC	219
Plus Bldg 990 Diversion Box North and South			33,603
TOTAL			34,978

1) VCP = Vitrified Clay Pipe
PVC = Polyvinyl Chloride Pipe
CIP = Cast Iron Pipe
DIP = Ductile Iron Pipe

past Building 124 to manhole S122c, constructed in 1983; (5) approximately 1,200 ft of force main and sewer pipe from buildings 771/774 to Building 778, constructed in about 1984; and (6) approximately 1,600 ft of force main and sewer pipe from Building 881 to manhole S302 (construction date unknown). This 8,560 ft of pipe and force main constitutes about 24 percent of the total estimated length of 34,978 ft of sanitary sewer pipe in the system.

ASI (1988) analyzed metered sewage effluent flows at the RFP Sanitary Treatment Plant (STP) and metered water usage data collected by EG&G for the period December 1986 through March 1988. As part of this study, the monthly water use and STP effluent data were plotted from January 1986 through June 1990 as shown on Figure 3. No analysis of these monthly metered water versus metered STP discharges were made, however, sewage flows were significantly higher than water usage during the late winter, spring and early summer. These months correspond to the wettest months of the year in the Denver metropolitan area, as well as the months of highest ground-water elevations at the RFP. Analysis of the December 1986 through March 1988 data on Figure 3 by ASI (1988) indicated that total infiltration/inflow at the RFP STP may be on the order of 10 million gallons per year (MGY).

Cognizant EG&G personnel were interviewed to obtain data on past problems with the system, previous maintenance or rehabilitation, potential cross connections with the storm sewer, locations where storm and sanitary sewers are located in the same trenches or in close proximity, and known drain connections to the sanitary sewer. The results of these interviews have lead to an inventory of the existing sewer system including the type of sewer system, i.e. separate or combined system or combination; age of sewers; pipe materials; types of joints and joint materials; numbers of manholes and catch basins; maximum, minimum and average depth of sewers; bedding and backfill materials; construction techniques; types and numbers of overflows and bypasses; and physical conditions of the sewers.

In addition, the results of these interviews indicated that STP operators routinely notice that sewage inflows to the plant increase during rainfall or snowmelt at the RFP. Long-term (1986-

1990) STP effluent discharges (there are no influent measurements) generally average about 250,000 gallons per day (gpd) during week days (Monday through Friday) and about 100,000 gpd on week ends (Saturday and Sunday). Analysis of daily effluent discharges at the STP for the period May 1990 through May 1991 indicate that weekday flows average about 224,000 gpd and weekend flows average about 148,000 gpd. During rainfall or snowmelt, the STP operators believe that these inflows may double. The relationships between historical flows at the STP and rainfall or snowmelt events are not well documented. RFP personnel have not noticed backups, bypassing or surcharging in the sanitary sewer system, either during periods of high ground water and/or wet weather events. Lack of these problems indicate that infiltration/inflow is not a serious condition in the RFP sanitary sewer system.

RFP personnel indicated that sewage from the Wind Site, near the intersection of Colorado Highways 93 and 128 in the northwest corner of the plant site, and the East and West Guard Stations is trucked to the RFP and discharged into the sanitary sewer system at manhole S122c near Building 124 (Figures 1 and 2). The Wind Site sewage is about 10,000 gallons per week and the guard stations about 3,000 gallons per week. This additional discharge should be measured at monitoring site S120a. RFP personnel are aware of some roof drain connections directly to the sanitary sewer, but no building or footing drain connections. At least one of the cooling tower sumps (Building 374) receives storm runoff and snowmelt from nearby roof drains and surrounding soil areas. The cooling tower sumps are generally pumped into the sanitary sewers to dispose of cooling tower blowdown water. Therefore, there are pathways for inflow to enter the sanitary sewers using routes other than manholes. There are no known cross connections between the storm drain system and the sanitary sewer system.

2.1.2 Existing Hydrologic Conditions

Rainfall and other hydrologic data, such as ground-water elevations, also were collected to support this study. Precipitation data have been collected at various locations at the RFP since

1953. The current meteorological station is located in the West Buffer Zone about 1.5 miles west of the STP. This meteorological station was installed in the mid 1980's. Prior to that time, precipitation data at the RFP also had been collected at various other locations around the plant site. A 24-year summary of daily precipitation at the RFP for the years 1953 through 1976 is presented in Table 3. This summary is assumed to constitute the "normal" monthly precipitation for the RFP. The daily data used to generate this summary were not available and therefore, an updated analysis using more recent precipitation data could not be made. Based upon the 24-year summary in Table 3, the average annual precipitation at the RFP is about 15.2 in. The monthly distribution of precipitation shows that May is the wettest month (2.88 in) and January is the driest month (0.50 in).

The report period of May 1990 to May 1991 had both wetter-than-normal months (July, August and September 1990, and February and May 1991) and drier-than-normal months (June and December 1990, and February and May 1991) as shown in Table 3. Extreme precipitation values shown in Table 3 have been exceeded during the years since 1976. For example, September 1989 had a total monthly precipitation of 6.03 in, compared to the 1953-1976 maximum for September of 4.53 in. Also, November 1984 had no recorded precipitation, compared to the 1953-1976 minimum for November of 0.15 in (ASI, Task 21, 1991b). However, it is judged that the 24-year average for the 1953-1976 period does represent an acceptable "normal" for comparison of more recent precipitation data such as those collected by EG&G during this study.

Analysis of Table 3 indicates that the May 1990 precipitation of 1.43 in was less than the normal of 2.88 in, but that the May 1991 precipitation of 3.74 in was nearly one inch more than normal. The June 1990 precipitation (0.12 in) was significantly less than the normal for June (1.69 in), whereas, the July 1990 precipitation (3.02 in) was more than double the normal July precipitation (1.38 in). Because the EG&G raingage was out of order for 14 days during August 1990, no on-site precipitation data were available for a complete month at the RFP. Supplemental precipitation data from the Boulder, CO climatological station (about 10 miles north of the RFP) were used to fill in the 14 missing days in August 1990. Based upon this data fill-in, the August

TABLE 3

24-YEAR PRECIPITATION SUMMARY ROCKY FLATS PLANT (1953-1976)[1)]

Month	Average Total Precipitation (in)	Maximum Total Precipitation (in)	Minimum Total Precipitation (in)	Monitoring Period Precipitation[2)] (in)	
				1990	1991
JAN	0.50	1.73	0.06	--	0.19
FEB	0.65	1.81	0.07	--	0.04
MAR	1.22	2.50	0.13	--	0.41
APR	1.71	4.73	0.10	--	1.50
MAY	2.88	9.70	0.08	1.82	3.76
JUN	1.69	4.79	0.22	0.12	--
JUL	1.38	5.10	0.30	3.16	--
AUG	1.19	3.69	0.10	1.40[3)]	--
SEP	1.61	4.53	0.00	2.00	--
OCT	0.99	4.83	0.03	0.48	--
NOV	0.81	2.00	0.15	0.57	--
DEC	0.53	1.50	0.09	0.01	--
ANNUAL	15.16	--	--	--	--

1) EG&G Rocky Flats, Inc., PE/EWE

2) Daily precipitation data for monitoring period is presented in Appendix A-1.

3) Includes 14 days of data from the Boulder, CO Climatological Station to replace missing data at the RFP.

1990 precipitation (1.41 in) was slightly higher than the normal August precipitation (1.19 in). Therefore, the May 1990 through May 1991 precipitation (15.46 in) was less than the normal for the same period (18.34 in.) However, both wetter- and drier-than-normal periods were used for this report for the RFP Sanitary Sewer I/I/E Study. Rainfall data from the EG&G-operated meteorological station in the West Buffer Zone were available for concurrent periods with the STP effluent flows and potable water usage. The relationship of rainfall data to the metered sewage effluent flows at the STP will give an indication of whether significant inflow to the sanitary sewer system is occurring. A summary of daily precipitation for October 1989 through August 1991 at the RFP is given in Appendix A-1.

The relationship of ground-water elevation data to the depth of the sewer system will yield an indication of whether significant infiltration or exfiltration may be occurring. To assess the seasonal significance of the May 1990 through May 1991 measured alluvial ground-water elevations (Appendix B-1) compared to longer-term alluvial ground-water elevations, a time series of ground-water elevations for Wells 3586 and 4486, located as shown on Figure 4, were plotted as shown on Figure 5 for their periods of record. These two monitoring wells were selected because they have verified data and are located within the Controlled Area near the sanitary sewer system. Longer-term alluvial monitoring wells were judged to be not representative of the RFP Controlled Area, which is of interest in this report.

Analysis of Figure 5 indicates that alluvial ground-water elevations in the vicinity of the sanitary sewer system have historically been highest during the months of March, April, and May. These months represent the snowiest month (March) and the wettest month (May) in the Denver metropolitan area. Snowmelt during February and March would generally tend to recharge the alluvial ground-water system causing rising ground-water elevations. The period of this study (May 1990 through May 1991) included both the historically highest and lowest ground-water elevations at the RFP. Therefore, the infiltration estimates based upon this May 1990 through May 1991 period should include a good range of ground-water conditions.

Ground-water elevations in eight alluvial wells were monitored weekly during the period May 11, 1990 through May 3, 1991 (Appendix B-1). A summary of the hydrographs of the eight wells is shown on Figure 6. The locations of these eight alluvial wells are shown on Figure 4 and summarized in Table 4, with other alluvial wells used to estimate alluvial water surface elevations shown on Figures 7 and 8. A summary of the weekly water elevations in these wells, along with selected field water-quality data from the wells, is given in Appendix B-1.

Additional alluvial wells are monitored monthly by EG&G. Ground-water elevations in these additional alluvial wells were used to construct water table maps of the RFP at selected times. Based upon the hydrographs shown on Figure 6 and the additional alluvial well data provided by EG&G, alluvial ground-water elevations at the RFP were contoured for the periods July 25-31, 1990, a period of high alluvial ground-water elevations, and January 1-7, 1991, a period of low alluvial ground-water elevations. The contoured alluvial ground-water surfaces for these two periods are shown on Figures 7 and 8, respectively. Figure 7 shows the alluvial ground-water elevation for the period July 25 through 31, 1990 using approximately 24 alluvial wells including the eight wells monitored during this study. Some of the wells used for this analysis are located outside the boundary of Figure 7 and are not shown. Figure 8 shows the alluvial ground-water elevation for the period January 1 through 7, 1991 using approximately 48 alluvial wells. Some of the wells used for this analysis also are outside the boundary of Figure 8 and are not shown. Figures 7 and 8 show the alluvial ground-water elevations compared to the sanitary sewer system manhole invert elevations taken from the as-built drawings. Analyses of Figures 7 and 8 indicate that about 19 percent of the sanitary sewer system was beneath the water table during the July 25-31, 1990 period and about 18 percent of the length of the sanitary sewer system was beneath the water table during the January 1-7, 1991 period. These portions of the sanitary sewer system could be a source of infiltration. Conversely, over 80 percent of the sanitary sewer system has manhole inverts above the alluvial water table. This portion of the sanitary sewer system may have potential for exfiltration. As indicated in the discussion of long-term alluvial ground-water elevations, a larger percentage of the sanitary sewer system may be beneath the alluvial water table during other months than shown on Figures 7 and 8.

Table 4

SUMMARY OF SHALLOW WELL MEASUREMENT LOCATIONS

WELL NO.	SEWER SYSTEM MEASURING POINT
PZ 5589	S120a
PZ 4486	S401
PZ 0789, PZ 2389, and 6189	S116a
PZ 4589 and PZ 4289	MH-3
3586	DIVERSION BOXES

Interviews with RFP personnel indicated that they had observed ground-water entering MH-4 just upstream from the MH-3 monitoring point (Figures 1 and 2). This observation was made in May, immediately after monitoring was initiated in the sanitary sewers. The quantity of water flow during this observation was not made. However, subsequent observations (October 1990) in the same manhole indicated that inflow had decreased, but did not cease, and was still observed occurring at very low flow rates (estimated to be less than 1 gpm).

2.1.3 Existing Water Use

Water consumption and wastewater effluent flow data, along with processes and personnel information for each building at the RFP may give an indication of the expected sewer flows. The number of showers, sinks, toilets, water fountains, or other sources of flow to the sanitary sewer for each building were obtained from EG&G personnel for calendar years (CY) 1989 and 1990 as part of Tasks 11 and 13 (ASI, 1991a), and this flow source information was used as part of this study. The on-going drain study, being conducted by EG&G to determine which drains may be connected to the sanitary sewer, has not been completed in time for use in this study report to improve estimates of flow sources (ASI, Task 18, 1991c).

Raw water at the RFP is purchased from the Denver Water Board. The latest complete years of water use data are CY 1989 and CY 1990 when 121,394,000 gallons and 128,903,000 gallons of water was purchased and brought on site, respectively (ASI, Tasks 11 and 13, 1991a). Only a portion of the raw water is treated at the RFP water treatment plant located in Building 124 to potable quality. In CY 1989, about 71,000,000 gallons of raw water was treated for potable use and in CY 1990 about 85,000,000 gallons of raw water was treated for potable use. The remainder of the 1989 CY and 1990 CY purchased water was bypassed to feed the Plant raw water system. Potable water is used for all direct human uses and consumption, fire protection, laundry, film developing, some cooling tower makeup, air washers, landscape irrigation and process water. Process water use includes chemical preparation, machine and instrument cooling and laboratory needs. Raw water is used primarily for cooling towers and two areas of lawn

irrigation (outside Buildings 130 and 850) during the irrigation season. Process water and laundry water are not discharged to the sanitary sewer. The remaining non-consumptive potable water is discharged to the sanitary sewer along with most cooling tower blowdown from both potable and raw water. Therefore, the purchased water alone is not a good estimate of water available for discharge to the sanitary sewer.

The Tasks 11 and 13 study (ASI, 1991a) performed water balances for the RFP for CY 1989 and CY 1990. Table 5 summarizes the 1989 CY water balance for the RFP by area. Results of this water balance indicate that about 55.3 million gallons (MG) of water should have been discharged to the sanitary sewer system during CY 1989 as shown in Table 5. However, during 1989, about 74.1 MG of effluent were measured and discharged from the STP. These numbers indicate that total infiltration/inflow to the sanitary sewer system during CY 1989 may have been on the order of 18.8 MG. Additionally, cooling towers are an important contributor to the flow in the sanitary sewer system. ASI (Tasks 11 and 13, 1991a) estimated that of the 55.3 MGY of sanitary wastewater, about 21.4 MGY, or about 39 percent, was from cooling tower and air washer blowdown.

Table 6 summarizes the 1990 CY water balance for the RFP area. Results of this water balance indicate that about 67.2 MG of water should have been discharged to the sanitary sewer system during CY 1990 as shown in Table 6. However, during CY 1990, about 72.1 MG of effluent were measured and discharged from the STP. These numbers indicate that total infiltration/inflow to the sanitary sewer system during CY 1990 may have been on the order of 4.9 MG. ASI (Tasks 11 and 13, 1991a) estimated that of the 67.2 MG of sanitary wastewater, about 15.0 MG, or about 22 percent was from cooling tower and air washer blowdown.

Because the cooling towers use less water and blow down less frequently during cooler weather (i.e. when it is raining), their operations tend to mask inflow contributions to the sanitary sewers from rainfall or snowmelt. This masking makes the estimation of both infiltration and inflow

Table 5

SUMMARY OF 1989 CY RFP WATER BALANCE[1)]

	Inputs		Outputs		
RFP Area	Domestic	Raw	Process Waste	Sanitary Waste	Losses[2)]
Wind Site[3)]	0.52	0.00	0.00	0.52	0.00
Lump Sum	15.58	0.00	0.10	13.96	1.52
Bldg 371/374	2.43	10.63	0.23	4.74	8.09
400 Complex	11.63	6.42	1.97	8.40	7.68
Bldg 443	0.17	4.29	0.89	2.73	0.84
Bldg 707/750/559	2.23	10.86	0.12	4.13	8.84
771/774 Complex	7.07	0.00	1.07	4.00	2.00
776/777/778/779	8.65	12.92	6.38	4.32	10.87
800 Complex	17.70	4.14	0.35	8.70	12.79
900 Area	4.84	0.00	0.00	3.81	1.03
TOTALS	70.82	49.26	11.11	55.31	53.66

1) Source: ASI (Tasks 11 and 13, 1991a). All values in million gallons per year.
2) Losses are primarily evaporation from cooling towers and air washers.
3) Water source is a well rather than Denver Water Board Water.

Table 6

SUMMARY OF 1990 CY RFP WATER BALANCE[1)]

	Inputs		Outputs		
RFP Area	Domestic	Raw	Process Waste	Sanitary Waste	Losses[2)]
Wind Site[3)]	0.81	0.00	0.00	0.81	0.00
Lump Sum	27.96	0.00	0.10	25.68	2.18
Bldg 371/374	3.09	5.81	0.28	3.37	5.25
400 Complex	9.54	4.45	1.63	6.48	5.88
Bldg 443	0.65	3.94	0.56	1.45	2.58
Bldg 707/750/559	2.28	11.52	0.05	4.45	9.30
771/774 Complex	8.88	0.00	0.20	5.03	3.65
776/777/778/779	11.89	13.05	5.59	9.56	9.79
800 Complex	18.80	5.42	0.24	9.50	14.48
900 Area	1.63	0.00	0.00	0.91	0.72
TOTALS	85.53	44.19	8.65	67.24	53.83

1) Source: ASI (Tasks 11 and 13, 1991a). All values in million gallons per year.
2) Losses are primarily evaporation from cooling towers and air washers.
3) Water source is a well rather than Denver Water Board Water.

difficult. The actual quantities of cooling tower blowdown and other water contributions to the sanitary sewers are not measured consistently at the RFP (ASI, Tasks 11 and 13, 1991a). The sanitary sewer system quantities shown in Tables 5 and 6 are theoretical values, based upon a per capita domestic RFP discharge of 25 gallons for non-shower areas; increased for areas with shower facilities and also increased by between one and three gpm for cooling tower blowdown. For the estimated 5840 employees (Table 7) on site each work day over 250 work days per year in CY 1989 (ASI, Tasks 11 and 13, 1991a), the average work day per capita discharge to the sanitary sewers was about 38 gallons per capita per day (gpcd) at the RFP. For the estimated 6,374 employees (Table 7) on site each work day over 250 days per year in 1990, the average work day per capita discharge to the sanitary sewers was about 42 gpcd at the RFP. While these per capita values could be used to calculate the theoretical wastewater reaching the sewers at various locations within the RFP, they did not predict the theoretical wastewater flows in the sanitary sewer as well as the water balance data in Tables 5 and 6. Therefore, the water balance data for the 1989 CY and 1990 CY were used to estimate the theoretical wastewater flow rates at the monitoring locations for use in estimating infiltration/inflow and exfiltration from the RFP sanitary sewer system.

2.2 FLOW MONITORING AND FIELD INVESTIGATIONS

To obtain sufficient flow data for the analysis, timing and location of flow measurements in the sanitary sewer system were carefully planned. The time suitable for flow measurements at the RFP is generally limited to times of high ground water and heavy rainfall seasons. For the RFP, this season occurs during the months of April, May, June, July and August. It is also desirable to obtain accurate flow measurements over an entire year. Therefore, the measurements lasted from May 1990 to May 1991.

In addition to a system determination of infiltration/inflow conducted using the STP flows as discussed above, flow measurements were conducted in the sanitary sewer system at six other locations by subdividing the sewer system into subsystems and measuring the flow in each

Table 7

NUMBER OF RFP EMPLOYEES CONTRIBUTING TO I/I MONITORING SITES, CY 1989 AND CY 1990

CY 1989

Work Shift	Monitoring Site NPUA[1]	MH-3	S120a	S401	S116a	SPUA[2]	Total (NPUA + SPUA)
Day	1,530	302	1,541[3]	726	700	3,420	4,950
P.M.	239	27	107	195	32	380	619
Mid.	100	9	81	66	9	171	271
TOTALS	1,869	338	1,729	987	741	3,971	5,840

CY 1990

Work Shift	Monitoring Site NPUA[1]	MH-3	S120a	S401	S116a	SPUA[2]	Total (NPUA + SPUA)
Day	1,491	285	1,988[4]	692	749	4,071	5,562
P.M.	226	49	106	149	47	330	560
Mid.	96	30	47	70	20	160	256
TOTALS	1,813	364	2,141	911	816	4,561	6,374

1) NPUA = Building 990 North Diversion Box.
2) SPUA = Building 990 South Diversion Box.
3) Includes 50 personnel total at the Wind Site and East and West Guard Stations.
4) Includes 23 personnel total at the Wind Site and East and West Guard Stations.

subsystem separately. Cognizant EG&G personnel selected the six measurement locations as shown on Figure 1. Table 8 summarizes the RFP buildings connected to the sanitary sewer at each measurement location. These buildings were determined from the RFP utility drawings upstream from each measurement location. Four manholes (S120a, S401, S116a and MH-3) and the Building 990 Diversion Box (2 locations) were selected for flow measurements. Flow into manhole S120a generally includes the 100-series buildings plus Buildings 331, 331A, and 441 (Table 8 and Figure 1). Flow into manhole S401 includes the 400-series buildings (Table 8 and Figure 1). Manhole S116a measures flows from the 600- and 800-series buildings (Table 8 and Figure 1). Flow into manhole MH-3 includes the 300-series buildings inside the Protected Area (PA) (Table 8 and Figure 1).

The Building 990 Diversion Box combines sewage from the plutonium processing areas of the RFP with that from the rest of the RFP. The diversion box has two chambers, a north and a south chamber. The north chamber (NPUA) receives sewage from the 700-series buildings within the PA, some of the 900-series buildings, 500-series buildings, and those buildings measured at MH-3. The south chamber (SPUA) receives sewage from miscellaneous buildings plus buildings measured at Manholes S120a, S401 and S116a. Buildings not measured by the in-sewer monitoring sites include those downstream from the Building 990 Diversion Box (Buildings 990, 991 and 995). Building 991 is the inactive reverse osmosis plant and Building 995 is the existing STP.

Table 8 indicates that 24 buildings are measured at Manhole S120a; nine buildings and three cooling towers (CT's) at Manhole S401; 14 buildings and one cooling tower at Manhole S116a; and four buildings and one cooling tower at Manhole MH-3. The NPUA receives flow from 19 buildings and seven cooling towers, plus the four buildings and one cooling tower at MH-3, for a total of 23 buildings and eight cooling towers. The SPUA receives flow from 12 buildings plus those measured at Manholes S120a, S401 and S116a for a total of 59 buildings and four cooling towers. Buildings 990, 991 and 995 are not measured by the instrumentation in the sanitary sewers but are included in the flows which are measured at the STP effluent discharge.

Table 8

BUILDINGS CONTRIBUTING TO I/I MONITORING SITES

Manhole	Buildings Measured[1)]
S120a	111, 112, 115, 119, 120, 121, 122, 123, 124, 125, 130, T130A - I, 131, 331, 331A, 441
S401	439, 440, 442, 443, 444, 444A, 447, 448, 454CT, 457CT, 460, 460CT
S116a	664, T690A - H, 850, 881, 881CT, 883, T883A, 889
MH-3	371, T371C, 371CT, 374, 376
NORTH DIVERSION BOX	559, 560, 563, 702CT, 705, 706, 707, 709CT, 711CT, 729, 750, 764, 770, 771CT(E & W), 771/774, 774CT, 776, 777, 778, 779, 783CT, 788, 910, 980, plus buildings measured at MH-3
SOUTH DIVERSION BOX	334, 452, 551, 662, T750A - D, 865, 886, T886A & B, T893A & B, plus buildings measured at S120a, S401, and S116a
BUILDINGS NOT MEASURED	990, 991, 995

1) CT after the building number indicates a cooling tower.

Table 7 summarizes the number of RFP employees contributing to each of the sanitary sewer measuring points, based upon 1989 CY and 1990 CY employee estimates by EG&G. The cooling tower blowdowns are a significant addition (between about 25 and 30 percent) to the sanitary sewer system flows, are highly variable depending upon the atmospheric conditions, and must be considered in order to account for water discharges to the sanitary sewer system. Therefore, instead of using the 38 or 42 gpcd in the theoretical flow calculations, the average of the CY 1989 and CY 1990 water balance values for each building or complex shown in Tables 5 and 6 were used.

Field reconnaissance of each of the manholes and the diversion box were conducted prior to actual flow measurements or equipment installation. EG&G personnel accompanied ASI personnel to help field locate each manhole and to provide background information about the manholes. Manholes were opened and checked for accessibility and suitability for installation of equipment. Both a Site-Specific Health and Safety Plan (HASP) and a Job Safety Analysis (ASI, 1990a) were prepared and used during the equipment installation.

The six sanitary sewer monitoring locations (Figure 1) do not include the STP, where flows are metered as part of the STP operation. Two of the flow-measurement locations (NPUA and SPUA at the Building 990 Diversion Box) are located within the PA and required Q-cleared personnel or escorts for equipment installation, maintenance, and monitoring.

Because there was no historical evidence of manhole surcharging during wet weather at the RFP, primary flow measuring devices (flumes) were installed in the sewer manholes and water-level recorders with floats (prior to December 1990) or pressure transmitters and data loggers (after December 1990) were used to measure heads on the flumes. Figure 9 gives engineering details of the locations of flow-measurement installations. This installation uses a Palmer-Bowlus critical-depth flume, a scow float or pressure transducer to measure head on the flume, and a Stevens Type-F mechanical recorder or HERMIT datalogger is record these heads.

Because of the difficulty of retrieving digital data using laptop computers within the RFP Protected Area, chart recorders only were used so the data could be easily reviewed for classification and removed from the site for analysis. Therefore, at the Building 990 Diversion Box, rectangular weirs were installed to measure flows at the two locations (NPUA and SPUA) at that site and the two sites were equipped with Stevens Type-F water-level recorders and floats. Flow rating curves and tables at each of the monitoring sites are given in Appendix C.

Continuous stage data in the sanitary sewer at the six monitoring points (Figure 1) was translated to instantaneous discharge by: (1) digitizing the stage data from the recorder charts or obtaining the data logger data file as appropriate; (2) operating on the stage data with the appropriate rating curve for each site; and (3) calculating daily and weekly average discharges from the instantaneous data. Appendix A-2 contains the average daily flows for the sanitary sewer monitoring sites for the period May 1990 to May 1991.

Analysis of the instantaneous discharge values indicated that the flows at monitoring sites S401, S116a, Building 990 North and South Diversion Boxes, and, to a lesser extent, MH-3 were highly affected by cooling tower blowdown which caused nearly instantaneous "spikes" in the flow hydrographs. These spikes lasted for only a few minutes and were extremely difficult to measure, especially with the dataloggers. The stage-recording time interval on the dataloggers was set to two minutes to measure these spikes. Other peak discharges in the sanitary sewer are caused by showers used at the end of each of the three shifts (day, P.M., and midnight) at the RFP and by two force mains (Figure 2), one from Building 881 (measured at manhole S116a) and one from Building 771 (measured at NPUA).

Measurements for the determination of infiltration/inflow or exfiltration were accompanied by measurements of ground-water elevations and pH, temperature and specific conductance in nearby alluvial wells (Appendix B-1). The locations of eight wells selected for water-level measurements and indicator water-quality measurements for this study are shown on Figure 4 and summarized in Table 4. Ground-water elevations were measured weekly in the eight wells during

the period May 1990 to May 1991. These eight wells were supplemented by monthly ground-water elevation measurements in about 40 other wells made by EG&G as part of their routine environmental monitoring. The ground-water measurements enabled an assessment of whether excess water measured in the sewers came from ground-water sources. These ground-water elevation measurements also permitted an assessment of exfiltration potential from the sanitary sewer system.

Daily rainfall data are collected at the RFP by EG&G and were made available for use in the infiltration/inflow and exfiltration analysis (Appendix A-1). Fourteen days in August 1990 (August 3-7, 11-13, and 17-22) had no reported rainfall because of equipment malfunctions at the meteorological station. For these fourteen days, rainfall data from the Boulder, Colorado station, about 10 miles north of the RFP were used for comparison purposes (Appendix A-1) in the I/I/E analysis.

Measurements of limited water quality characteristics (pH, specific conductance and water temperature) of water in the sewer system also was made during the weekly visits to the flow monitoring sites (Appendix B-2). The purpose of these indicator water-quality measurements was to assess if the low flows in the sewers had the same indicator water characteristics as the nearby ground water. Because alluvial ground water may have distinctive chemical characteristics, it may be possible to identify the source of infiltration using indicator water-quality variables such as pH and specific conductance.

Data collection began on May 8, 1990 at monitoring site S401, May 9 at monitoring site S116a, May 10 at monitoring sites S120a and MH-3, and May 11 at NPUA and SPUA (the Building 990 North and South Diversion Box chambers). This infiltration/inflow and exfiltration analysis covers the period from installation of the monitoring equipment in mid-May 1990 to approximately mid-May 1991, a period of about 12 months. Daily measured wastewater flows at the monitoring sites, as well as total daily flows at the STP (Building 995) for the May 11, 1990 through May 13, 1991 are tabulated in Appendix A-2.

2.3 DETERMINATION OF INFILTRATION/INFLOW AND EXFILTRATION

2.3.1 Methodology

Infiltration/Inflow and exfiltration estimates for measured flows at the STP and the six monitoring locations within the RFP Controlled Area were made using procedures outlined by the U. S. Environmental Protection Agency (EPA, 1975). To estimate the total infiltration/inflow or exfiltration for the period of record (May 1990 to May 1991) the following procedure was used (EPA, 1975) as demonstrated on Figure 10:

(a) The average weekly or daily wastewater flows for the period of record were calculated and plotted versus time.

(b) The theoretical wastewater production rate for the RFP, based upon the average per capita rate and the RFP population, along with the rainfall and ground-water elevations were plotted versus time on the same plot.

(c) On the plot from (b) above, the total area above the theoretical wastewater production curve and below the measured wastewater flow curve was measured. This area represented the **total** infiltration/inflow.

(d) On the same plot, the total area, if any, below the theoretical wastewater production curve and above the measured wastewater flow curve was measured. This area could represent total exfiltration for the period (not shown on Figure 10).

(e) The curves for measured wastewater flow, rainfall, and ground water were compared to assess their inter-relationships.

To estimate the total infiltration the for the period of record, the following procedure was used (EPA, 1975) as shown on Figure 11:

(a) From the plot generated by the procedure above (Figure 10), time periods with typical wastewater flow conditions were selected. The time periods in which exfiltration was suspected to have occurred also were included.

(b) For each of the time periods, daily measured wastewater flow, the theoretical wastewater production rate, and the rainfall data were plotted versus time (Figure 11).

(c) The lower limit of the measured wastewater flow curve corresponding to dry weather days was estimated from the instantaneous flow data. The area between this lower limit and the theoretical wastewater production rate was measured. This area represents the base infiltration, or exfiltration, for the period.

(d) The average of the base infiltration for all typical flow periods was calculated and adjusted for estimated exfiltration rates, if any. This latter value represented the total infiltration at the monitoring point of interest (Figure 11).

To estimate the total inflow for the period of record (May 1990 to May 1991) the total calculated infiltration was subtracted from the total calculated infiltration/inflow. The peak values for infiltration and inflow were not estimated because of the difficulty in determining the relationship between rainfall and inflow. The peak infiltration value will be estimated after collection of more data, because it may change substantially if ground-water elevations vary at the RFP over a seasonal cycle.

The following procedure was used to estimated the peak inflow for the period of record at the RFP as shown on Figure 12 (EPA, 1975):

(a) The measured wastewater flow and rainfall records are carefully examined to select the days with the highest wastewater flows and heaviest rainfall.

(b) For each of these days, the actual instantaneous measured wastewater flow rates are plotted versus time along with the rainfall data (Figure 12).

(c) On each of the above measured flow curves a typical measured wastewater flow curve for one of the nearest dry weather days will be superimposed (Figure 12).

(d) The difference in flow for small time periods (1-hour) between the two measured wastewater flow curves is measured and summed for each day.

(e) The maximum flow differences for all the days considered are compared and the largest difference selected as the peak inflow in the sewer system.

2.3.2 I/I/E at the NPUA Monitoring Site

An assessment of the infiltration/inflow and exfiltration (I/I/E) in the plutonium processing part of the RFP sanitary sewer system was done using the data collected at the Building 990 North Diversion Box (NPUA) monitoring site. The measured weekly flows at the NPUA are shown on Figure 13 for the weeks ending May 20, 1990 through May 12, 1991 (42 weeks with 10 weeks of partial or missing data). Wastewater flow during this period averaged about 79,100 gpd. ASI (Tasks 11 and 13, 1991a) estimated that the annual theoretical discharge to the sanitary sewer system at NPUA is between about 21.0 MGY, based upon the CY 1989 water balance and about 23.3 MGY, based upon the CY 1990 water balance for Buildings 559, 707, 750, 776, 777, 778, and 779; the 771/774 Complex; Building 371/374; and the 900 area (Tables 5, 6, and 8). These annual estimates also include cooling tower blowdown estimated to be 3 gallons per minute (gpm) for each cooling tower in addition to the sanitary wastes from toilets, sinks, and showers in the individual buildings at the RFP. Assuming that these annual water balance discharges are distributed over 250 working days per year (ASI, Tasks 11 and 13, 1991a), gives a weekday theoretical wastewater flow rate at NPUA of between 84,000 gpd and 93,200 gpd.

NPUA serves 19 buildings, 7 cooling towers plus the buildings measured at the MH-3 monitoring site (Table 8). These buildings have an estimated employee contribution of between 1,813 and 1,869 people during the work week (Table 7). On weekends the total work force at the RFP is typically only about 35 people. Only a few of these personnel contribute flow to NPUA. For purposes of this analysis it was assumed that only the cooling towers contributed flow at NPUA on weekends. This weekend flow was assumed to be about 34,000 gpd. The weekly (Monday through Sunday) theoretical wastewater production rate for NPUA ranges between 488,000 gallons (gal) and 543,000 gal. For purposes of this study, the average of 488,000 gallons per week (gal/wk) and 543,000 gal/wk, or 516,000 gal/wk was used as the theoretical wastewater production. This theoretical weekly wastewater production value is shown on Figure 13.

Figure 13 shows the total infiltration/inflow for NPUA along with concurrent alluvial ground-water elevations for Well PZ4289 (representative of the NPUA sanitary sewer system), and the weekly precipitation at the RFP or Boulder, Co. The total infiltration/ inflow was obtained by subtracting 516,000 gal/wk from the measured flows shown on Figure 13. The resulting total infiltration/inflow for the 24 infiltration/inflow weeks ending May 20, 1990 through May 12, 1991 was about 141,000 gal/wk or about 4.2 MGY. Figure 13 also indicates that exfiltration may be occurring from the sanitary sewer system contributing flow to NPUA. This total potential exfiltration was estimated to be about -77,000 gal/wk for the 18 weeks of exfiltration, or about -1.7 MGY. The net total infiltration/inflow and exfiltration at NPUA is about 2.5 MGY, based upon the 42 week period of record. It should be noted from Figure 13 that the measured wastewater flows appear to decrease during rainfall days and increase during non rainfall days because of the activity of the cooling towers which blow down less frequently when the air temperatures are cooler (i.e., during cloudy days). Therefore, the theoretical wastewater production rate, shown as a constant on Figure 13, is probably a variable based upon the daily water usage at the RFP. The metered daily water usage is generally not available for enough individual buildings to provide the detailed data necessary to obtain a variable theoretical wastewater production rate for each monitoring point. This data gap may lead to overprediction of the total infiltration/inflow and exfiltration at the RFP.

An increase in alluvial ground-water elevations occurred in July as a result of precipitation occurring after nearly four weeks of dry weather conditions (Figure 13). Therefore, the period between July 2 and July 29 was used to assess the infiltration and inflow quantities. Figure 14 shows the daily measured and theoretical wastewater flows at NPUA along with the daily rainfall for the period. Non-precipitation day low flows (measured between 12:00 Midnight and 4:00 a.m.) were estimated from the instantaneous data for the period of record. This estimated low flow for dry weather days was about 2,600 gpd or about 0.9 MGY as shown on Figure 14. The alluvial ground-water elevations (Figures 7 and 8) indicate that part of the sanitary sewer system contributing to NPUA is at or below the local water table. Ground-water elevation data collected at Wells PZ4289 and PZ4589 are given in Appendix B-1 and indicate that the ground-water

elevations rose and then fell, probably in response to the rainfall, during the July 2, 1990 through July 29, 1990 analysis period for total infiltration. When this total infiltration is subtracted from the total infiltration/inflow, the theoretical inflow remaining was calculated as shown on Figure 14. A plot of the precipitation at the RFP during the same period (Figure 14) indicated some correlation with measured wastewater flows, but also some days when high flows occurred there was no rainfall. The estimated inflow at NPUA from the sanitary sewer system is about 13,700 gpd, or about 5.0 MGY, which seems high because of the relatively poor correlation between rainfall and measured wastewater flow (Figures 13 and 14).

2.3.3 I/I/E at the MH-3 Monitoring Site

Monitoring Site MH-3 measures sanitary sewer flows from the 371/374 Buildings as well as Building T371C and other minor sources as shown on Figure 1 and Table 8. The measured weekly flows at MH-3 are shown on Figure 15 for the weeks ending May 20, 1990 through May 5, 1991 (37 weeks with 15 weeks of partial or missing data). The wastewater flow, as measured during this period at Monitoring Site MH-3 averaged about 22,600 gpd. ASI (Tasks 11 and 13, 1991a) estimates that the annual theoretical discharge to the sanitary sewer system at MH-3 is between about 4.74 MGY, based upon the CY 1989 water balance and about 3.37 MGY, based upon the CY 1990 water balance for Buildings 371/374 (Tables 5, 6, and 8). These annual estimates also include cooling tower blowdown estimated to be 3 gpm. Assuming that these annual water balance discharges are distributed over 250 working days per year (ASI, Tasks 11 and 13, 1991a), gives a weekday theoretical wastewater production rate of between 13,500 gpd and 19,000 gpd at MH-3.

MH-3 serves four buildings as well as the Building 371 cooling tower (Table 8). These buildings have an estimated employee contribution of between 338 and 364 people during the work week (Table 7). On weekends few people contribute to the flow at MH-3. For purposes of this analysis, it was assumed that only the Building 371 cooling tower contributed to flow at MH-3 on weekends. This weekend flow was assumed to be about 5,700 gpd. The weekly (Monday

through Sunday) theoretical wastewater production rate for MH-3 ranges between 78,900 gal and 106,400 gal. For purposes of this study, the average of 78,900 gal/wk and 106,400 gal/wk, or 92,600 gal/wk was used as the theoretical wastewater production. This theoretical weekly wastewater production value is shown on Figure 15.

Figure 15 shows the total infiltration/inflow for MH-3 along with the concurrent alluvial ground-water elevations for Well PZ4589 (representative of the sanitary sewer system MH-3), and the weekly precipitation at the RFP or Boulder, CO. The total infiltration/ inflow was obtained by subtracting the weekly theoretical wastewater production rate at MH-3 of 92,600 gal/wk from the measured flows shown on Figure 15. The resulting total infiltration/inflow for the 30 infiltration/inflow weeks ending May 20, 1990 through May 5, 1991 was about 85,900 gal/wk, or about 3.6 MGY. Figure 15 also indicates that small amounts of exfiltration may be occurring from the sanitary sewer system contributing to MH-3. This potential exfiltration was estimated to be about -19,600 gal/wk for the 7 weeks of exfiltration, or about -0.2 MGY. The net total infiltration/inflow and exfiltration at MH-3 is about 3.4 MGY, based upon the 37 week period of record. In contrast to NPUA (Figure 13), MH-3 shows measured wastewater generally increasing during rainfall events indicating some inflow. The actual theoretical wastewater production at MH-3 is probably a variable (due to the Building 371 cooling tower) rather than a constant rate. This inadequacy in the data will lead, in our opinion, to overprediction of the total infiltration/inflow at MH-3.

July 1990 was selected as a typical month for analysis of total infiltration because alluvial water elevations rose and then fell during the month (Figure 15). The period between July 2 and July 29 was used to assess the quantity of infiltration and inflow at MH-3. Figure 16 shows the daily measured and theoretical wastewater flows at MH-3 along with the daily rainfall for the period. Non-precipitation day low flows (measured between 12:00 Midnight and 4:00 a.m.) were estimated form the instantaneous data for the period. This estimated low flow for dry weather days was about 3,200 gpd or about 1.2 MGY as shown on Figure 16. The alluvial ground-water elevations (Figures 7 and 8) indicate that part of the sanitary sewer system contributing to MH-3

is at or below the local water table. When this total infiltration is subtracted from the total infiltration/inflow, the theoretical inflow remaining is as shown on Figure 16. A plot of the precipitation at the RFP during the same period (Figure 16) indicated that there is some correlation with measured wastewater flows, but also some days when high flows occurred and there was little or no rainfall. The estimated inflow at MH-3 is about 7,100 gpd, or about 2.6 MGY, which seems high because there is not a clear cause and effect correlation of increasing wastewater flows and rainfall on Figures 15 and 16.

2.3.4 I/I/E at the SPUA Monitoring Site

An assessment of the infiltration/inflow and exfiltration in the non-plutonium part of the RFP sanitary sewer system was done using the data collected at the SPUA monitoring site. The weekly flows at SPUA are shown on Figure 17 for the weeks ending May 20, 1990 through May 12, 1991 (42 weeks with 10 weeks of partial or missing data). This wastewater flow averaged about 125,600 gpd. ASI (Tasks 11 and 13, 1991a) estimates that the annual theoretical discharge to the sanitary sewer system at SPUA is between 34.3 MGY, based upon the CY 1989 water balance and 43.9 MGY, based upon the CY 1990 water balance for the non-plutonium buildings at the RFP (Tables 5, 6, and 8). These annual estimates also include cooling tower blowdown estimated to be 3 gpm per cooling tower in addition the sanitary wastes from toilets, sinks, and showers in the individual buildings contributing flow to SPUA. Assuming that these annual water balance discharges are distributed over 250 working days per year (ASI, Tasks 11 and 13, 1991a), gives a weekday theoretical wastewater production rate of between 137,200 gpd and 175,600 gpd at SPUA.

SPUA serves 59 buildings and 4 cooling towers (Table 8). During the monitoring period, these buildings had an estimated employee contribution of between 3,971 and 4,561 people during the work week (Table 7). On weekends few people normally contribute to the flow at SPUA, however, overtime work during the flow-measurement period did contribute flow, but this theoretical flow is unknown. For purposes of this analysis, it was assumed that only the 4

cooling towers contributed flow to SPUA on weekends. This weekend flow was assumed to be about 15,000 gpd. The weekly (Monday through Sunday) theoretical wastewater production rate for SPUA ranges from about 716,000 gal to about 908,000 gal. For purposes of this study, the average of 716,000 gal/wk and 908,000 gal/wk, or 812,000 gal/wk was used as the theoretical wastewater production. This theoretical weekly wastewater production value is shown on Figure 17.

Figure 17 shows the total infiltration/inflow for SPUA along with the concurrent alluvial groundwater elevations for Well PZ 4289 (representative of the SPUA sanitary sewer system), and the weekly precipitation at the RFP and Boulder, CO. The total infiltration/inflow was obtained by subtracting 812,000 gal/wk from the measured flows shown on Figure 17. The resulting total infiltration/inflow for the week ending May 20, 1990 through the week ending May 12, 1991 was about 156,000 gal/wk for the 20 weeks of infiltration/inflow, or about 4.9 MGY. Figure 17 also indicates that exfiltration may be occurring from the sanitary sewer system contributing flow to SPUA. This total potential exfiltration was estimated to be about -104,000 gal/wk for the 13 weeks of exfiltration, or about -2.1 MGY. The net total infiltration/inflow and exfiltration at SPUA is about 2.8 MGY, based upon the 42 week period of record analyzed.

In contrast to NPUA, the measured wastewater flows at SPUA appear to increase during rainfall events indicating some inflow. The measured wastewater flows at SPUA do not exhibit as strong a response to the cooling towers as flows at SPUA. The actual theoretical wastewater production at SPUA is probably a variable rather than a constant rate as used in this analysis. Detailed water use data are not available to verify this. This inadequacy in the water use data will, in our opinion, overestimate the total infiltration/inflow at SPUA.

As with the other sanitary sewer monitoring sites, July 1990 was selected as a typical month for analysis of total infiltration because alluvial water elevation rose and then fell during the month (Figure 17). The period between July 2 and July 29 was used to assess the quantity of infiltration and inflow at SPUA. Figure 18 shows the daily measured and theoretical wastewater

flows at SPUA along with the daily rainfall for the period. Non-precipitation day low flows (measured between 12:00 Midnight and 4:00 a.m.) were estimated from the instantaneous data for the period. This estimated low flow for dry weather days was about 15,300 gpd as shown on Figure 18. Alluvial ground-water elevations (Figures 7 and 8) indicate that part of the sanitary sewer system contributing to SPUA is at or below the local water table. When this total infiltration is subtracted from the total infiltration/inflow, the theoretical inflow remaining is as shown on Figure 18. A plot of the precipitation at the RFP during the same period (Figure 18) indicated that there is some correlation with measured wastewater flows, but also some days when high flows occurred and there was little or no rainfall. The estimated inflow at SPUA from the sanitary sewer system is about 3,800 gpd or about 1.4 MGY.

2.3.5 I/I/E at the S120a Monitoring Site

Monitoring Site S120a measures sanitary sewer flows from the so-called Lump Sum area (Tables 5 and 6). The measured weekly flows at S120a are shown on Figure 19 for the weeks ending May 20, 1990 through May 5, 1991 with 13 weeks of missing data (38 weeks). Wastewater flow measured during this period averaged 47,700 gpd. ASI (Tasks 11 and 13, 1991a) estimates that the annual theoretical discharge to the sanitary sewer system at S120a is between 14.5 MGY, based upon the CY 1989 water balance and 26.5 MGY, based upon the CY 1990 water balance for the Lump Sum area and the Wind Site (Tables 5, 6, and 8). These annual estimates do not include cooling towers, because none are known to discharge to the sanitary sewer upstream from S120a. Assuming that these annual water balance discharges are distributed over 250 working days per year (ASI, Tasks 11 and 13, 1991a), gives a weekday theoretical wastewater production rate of between about 58,000 gpd and 106,000 gpd at S120a. This range is rather large and does not reflect the RFP personnel increase of 412 people between 1989 and 1990 (Table 7). Therefore, a 38 gpcd increase for 412 people, or about 11,500 gpd was added to the 58,000 gpd from the CY 1989 water balance to give a weekday water production of 69,500 gpd. Additionally, not all of the water used reaches the sewers at S120a, because of the office

environment contributing to the sewer at that location. Typically, about 90 percent of the 69,500 gpd water use reaches the sewers, or about 62,500 gpd.

Manhole S120a serves 24 buildings (Table 8) having an estimated employee population of between 1,729 and 2,141 people during the work week (Table 7). On weekends the work force may be as few as 35 people, however, overtime may increase this weekend number. For purposes of this analysis, it was assumed that 35 people contribute flow to S120a. This weekend flow was assumed to be about 1300 gpd. The weekly (Monday through Sunday) theoretical wastewater production rate for S120a is about 315,600 gal. For purposes of this study, the 315,600 gal/wk was used as the theoretical wastewater production. This theoretical weekly wastewater production value is shown on Figure 19.

In addition, Figure 19 shows the total infiltration/inflow for S120a along with the concurrent alluvial ground-water elevations for Well PZ5589 (representative of the S120a sanitary sewer system), and the weekly precipitation at the RFP or Boulder, Co. The total infiltration/ inflow was obtained by subtracting 315,600 gal/wk from the measured flows shown on Figure 19. The resulting total infiltration/inflow for the weeks ending May 20, 1990 through May 5, 1991 was about 60,800 gal/wk for the 22 weeks of infiltration/inflow, or about 1.8 MGY. Figure 19 also indicates that potential exfiltration occurs during low ground-water elevation conditions in June and early July 1990. This exfiltration is estimated to be -40,100 gal/wk for the 16 weeks of exfiltration, or about -0.9 MGY. The net total infiltration/inflow and exfiltration at S120a is about 0.9 MGY based upon the 38 week period of record analyzed. Recorded wastewater flow rates at S120a appear to be directly correlated with alluvial ground-water elevations. As water table levels dropped so did the measured flow rates. Increases in water table elevations appeared to produce an increase in measured flow rates at S120a. No clear correlation of weekly rainfall with weekly measured sanitary sewer flows is evident from analysis of Figure 19.

The actual theoretical wastewater production at S120a is probably the closest to a constant rate because there are no cooling towers dominating the flow. This location is the only one of the

six monitoring sites which behaves as a commercial office area which dominates the sanitary sewer flow regime. However, the theoretical wastewater flow rate is still probably a variable rather than a constant rate. This may lead to overprediction of the total infiltration/inflow at S120a.

July 1990 was selected as a typical month for analysis of total infiltration because alluvial water elevations and then fell during the month (Figure 19). The period between July 2 and July 29 was used to assess the quantity of infiltration and inflow at S120a. Figure 20 shows the daily measured and theoretical wastewater flows at S120a along with the daily rainfall for the period. Non-precipitation days low flows (measured between 12:00 Midnight and 4:00 a.m.) were estimated from the instantaneous data for the period. This estimated low flow for dry weather days was about 4,600 gpd or about 1.7 MGY, as shown on Figure 20. The alluvial ground-water elevations (Figures 7 and 8) indicate that none of the sanitary sewer system contributing to S120a is at or below the local water table for the two times shown (July and August 1990). When the total infiltration is subtracted from the total infiltration/inflow, the theoretical inflow remaining is as shown on Figure 20. A plot of the precipitation at the RFP during the same period (Figure 20) indicated that there is some correlation with measured wastewater flows. The estimated inflow at S120a from the sanitary sewer system is about 2,700 gpd or about 1.0 MGY.

2.3.6 I/I/E at the S116a Monitoring Site

Monitoring Site S116a measures sanitary sewer flows from the 800 complex at the RFP (Figure 1). The measured weekly flows at S116a are shown on Figure 21 for the weeks ending May 20, 1990 through May 5, 1991, with 15 weeks missing because of data gaps (37 weeks). This wastewater flow averaged about 27,500 gpd. ASI (Tasks 11 and 13, 1991a) estimates that the annual theoretical discharge to the sanitary sewer system at S116a is between 8.7 MGY, based upon the CY 1989 water balance and 9.5 MGY, based upon the CY 1990 water balance for the 800 Complex (Tables 5, 6, and 8). These annual estimates also include cooling tower blowdown estimated to be 3 gpm per cooling tower. Assuming that these annual water balance discharges

are distributed over 250 working days per year (ASI, Tasks 11 and 13, 1991a), then the weekday theoretical wastewater production rate at S116a would be between about 34,800 gpd and 38,000 gpd, which is larger than the recorded daily average wastewater flow of 27,500 gpd.

S116a serves 14 buildings and one cooling tower (Table 8). These buildings have an estimated employee contribution of between 741 and 816 people during the work week (Table 7). On weekends few people contribute to the flow at S116a, however, overtime during the monitoring period may contribute weekend flows. For purposes of this analysis, it was assumed that only the cooling tower contributed to flow at S116a on weekends. This weekend flow was assumed to be about 4300 gpd. The weekly (Monday through Sunday) theoretical wastewater production rate for S120a is between 182,600 gal and 198,600 gal. For purposes of this study, the average of 182,600 gal/wk and 198,600 gal/wk, or about 190,600 gal/wk was used as the theoretical wastewater production. This theoretical weekly wastewater production value is shown on Figure 21.

Figure 21 shows the total infiltration/inflow for S116a along with concurrent alluvial ground-water elevations for Well PZ6189 (representative of the S116a sanitary sewer system), and the weekly precipitation at the RFP and Boulder, Co. The total infiltration/inflow was obtained by subtracting 190,600 gal/wk from the measured flows shown on Figure 21. The resulting total infiltration/inflow for the weeks ending May 20, 1990 through May 5, 1991 was about 76,500 gal/wk for 19 weeks or about 2.0 MGY. There is no clear trend of measured wastewater flows related to either alluvial ground-water elevations or rainfall (Figure 21). The theoretical wastewater production rate at S116a is more than the measured wastewater flows. The reason for this is unknown, but could be due to inaccurate flow measurements, infiltration/inflow, or poor estimates of water use in the 800 Complex by the 1989 water balance study.

The actual theoretical wastewater production at the 800 Complex is probably slightly less than the average estimated by ASI (Tasks 11 and 13, 1991a) which could lead to estimation errors of total infiltration/inflow at S116a. As a result of the theoretical wastewater production rate being

more than the measured wastewater flow, a potential exfiltration rate of -21,600 gal/wk for 18 of the 37 weeks, or about -0.5 MGY was estimated. Therefore, the net total infiltration/inflow and exfiltration is about 1.5 MGY at S116a for the 37 week period of record analyzed.

Additionally, as shown on Figure 2, wastewater from the Building 881 cooling tower is pumped via a force main to MH-S302 upstream from S116a. This pumping is known to cause the recorder charts to be difficult to read and difficult to interpret. This could also be a source of error in the recorded flow estimates at S116a.

As with the other monitoring locations, July 1990 was selected as a typical month for analysis of total infiltration because alluvial ground-water elevations were rose in July due to rainfall at the RFP (Figure 21). The period between July 2 and July 29 was used to assess the quantity of infiltration and inflow at S116a. Figure 22 shows the daily measured and theoretical wastewater flows at S116a along with the daily rainfall for the period. Non-precipitation day low flows (measured between 12:00 Midnight and 4:00 a.m.) were estimated from the instantaneous data for the period. This estimated low flow for dry weather days was about 1,940 gpd or about 0.7 MGY, as shown on Figure 22. The alluvial ground-water elevations (Figures 7 and 8) indicate that only a very small part of the sanitary sewer system contributing to S116a is at or below the local water table. When this total infiltration is subtracted from the total infiltration/inflow, the theoretical inflow remaining is as shown on Figure 22. A plot of the precipitation at the RFP during the same period (Figure 22) indicated some correlation with measured wastewater flows, but also some days when high flows occurred and there was little or no rainfall. The estimated inflow at S116a, based upon annual estimates from Figure 21 alone, is about 4,900 gpd, or about 1.8 MGY.

2.3.7 I/I/E at the S401 Monitoring Site

Monitoring Site S401 measures sanitary sewer flows from the 400 Complex, including Building 443 (the steam plant) (Figure 1). The measured weekly flows at S401 are shown on Figure 23

for the weeks ending May 20, 1990 through May 5, 1991 with 20 missing weeks (31 weeks). This wastewater flow averaged about 40,700 gpd. ASI (Tasks 11 and 13, 1991a) estimates that the annual theoretical discharge to the sanitary sewer system at S401 is between 11.1 MGY, based upon the CY 1989 water balance and 7.9 MGY, bases upon the CY 1990 water balance for the 400 Complex and Building 443 (Tables 5, 6, and 8). These annual estimates also include the cooling tower blowdown estimated to be 3 gpm for each cooling tower. Assuming that these annual water balance discharges are distributed over 250 working days per year (ASI, Tasks 11 and 13, 1991a), gives a weekday theoretical wastewater production rate of between 31,600 gpd and 44,400 gpd at S401.

S401 serves 9 buildings and 3 cooling towers (Table 8). These buildings have an estimated employee contribution of between 911 and 987 people during the week (Table 7). On weekends the number of people varies, but is assumed to be small. For purposes of this analysis, it was assumed that only the 3 cooling towers contributed to flow a S401 on weekends. This weekend flow was assumed to be about 13,000 gpd. The weekly (Monday through Sunday) theoretical wastewater production rate for S401 ranges between 184,000 gal and 248,000 gal. For purposes of this study, the average of 184,000 gal/wk and 248,000 gal/wk, or about 216,000 gal/wk was used as the theoretical wastewater production. This theoretical weekly wastewater production value is shown on Figure 23.

Figure 23 shows the total infiltration/inflow for S401 along with the concurrent alluvial ground-water elevations for Well 4486 (representative of the S401 sanitary sewer system), and the weekly precipitation at the RFP and Boulder, CO. The total infiltration/inflow was obtained by subtracting 216,000 gal/wk from the measured flows shown on Figure 23. The resulting total infiltration/inflow for the 29 infiltration/inflow weeks ending May 20, 1990 through May 5, 1991 was about 75,600 gal/wk or about 3.7 MGY. Minor exfiltration, less than -0.2 MGY, may occur from the sanitary sewer system contributing to S401. The measured wastewater flows do not generally follow the changes in ground-water elevations or show a clear response to precipitation. This is because the cooling towers tend to mask the impacts of both infiltration and inflow. The

actual theoretical wastewater production is highly dependent on the cooling tower blowdowns to the sanitary sewer. Because water use records for the cooling towers are poor, the actual theoretical wastewater production is not well defined for this monitoring site. This inadequacy in the data will, in our opinion, lead to overprediction of the total infiltration/inflow at S401.

Similar to the other monitoring sites, July was selected as a typical month for analysis of total infiltration because alluvial water elevations rose in response to rainfall during the month of July (Figure 23). The period between July 2 and July 29 was used to assess the quantities of infiltration and inflow at S401. Figure 24 shows the daily measured and theoretical wastewater flows at S401 along with the daily rainfall for the period. Non-precipitation day low flows (measured between 12:00 Midnight and 4:00 a.m.) were estimated from the instantaneous data for the period. This estimated low flow for dry weather days was about 6,500 gpd or about 2.4 MGY as shown on Figure 24. The alluvial ground-water elevations (Figures 7 and 8) indicate that none of the sanitary sewer system contributing to S401 is at or below the local water table. When this total infiltration is subtracted form the total infiltration/inflow, the theoretical inflow remaining is as shown on Figure 24. A plot of the precipitation at the RFP during the same period (Figure 24) indicated that there is some correlation with measured wastewater flows, but also some days when high flows are not well correlated with rainfall events. The estimated inflow at S401 from the sanitary sewer system is about 4,100 gpd or about 1.5 MGY. The data on Figure 24 also suggest small amounts (about -0.2 MGY) of exfiltration in the sanitary sewer system measured at monitoring site S401.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon a preliminary analysis of measured flows in the RFP sanitary sewer system at six monitoring sites during the period May 11, 1990 through May 13, 1991, it is estimated that there is some infiltration and inflow to the RFP system. Table 9 summarizes the preliminary estimates of I/I/E for each of the six monitoring sites. Analysis of Table 9 indicates that the sanitary sewer system at the RFP for the period of record may have about 9.1 MGY of total infiltration/inflow which enters the system through high ground water and precipitation entering the system through various pathways such as roof drains, leaky manhole covers, and possibly cooling tower sumps and other connections.

Estimated total infiltration accounts for about 6.5 MGY of the total and inflow accounts for up to 6.4 MGY of the total. Exfiltration, amounting to about -3.8 MGY may occur from the system. This additional total infiltration/inflow of about 9.1 MGY is about 13 percent of the 72.1 MGY discharged from the STP in 1990. However, studies by the American Public Works Association (Sullivan and Ewing, 1985) indicate that an aggressive program to reduce the I/I/E may only reduce the total I/I/E by 30 percent at best. Therefore only about 2.7 MGY of the 9.1 MGY total infiltration/inflow would be removed. This removal would only reduce the annual flow at the STP by about 4 percent.

Exfiltration of -3.8 MGY is about 5 percent of the annual STP discharge of 72.1 MGY. This is well within the measurement errors for this type of study. Reduction of exfiltration, if it exists, is not recommended. The exfiltration rates are most likely the result of inaccuracies in computation as a result of both poor water use data at the RFP and errors in flow measurement in the sewers.

In our opinion, the cost of reducing the total infiltration/inflow would not be cost effective at this time. Because a majority of the sanitary sewer system was rehabilitated in 1985, additional rehabilitation probably would not significantly improve the system. Much of the existing sanitary

Table 9

SUMMARY OF I/I/E ESTIMATES AT SANITARY SEWER MONITORING SITES

Monitoring Site	Estimated Infiltration (MGY)	Estimated Exfiltration (MGY)	Estimated Inflow (MGY)	Total I/I (MGY)
MH-3	1.2	-0.2	2.6	3.6
NPUA	0.9	-1.7	5.0	4.2
S120a	1.7	-0.9	1.0	1.8
S116a[1)]	0.7	-0.5	1.8	2.0
S401	2.4	-0.2	1.5	3.7
SPUA	5.6	-2.1	1.4	4.9
Total (NPUA + SPUA)	6.5	-3.8	6.4	9.1
Previous Estimate:				
ASI (1988)	---	---	---	6-10
ASI (Task 1, 1990c)	---	---	---	12.6

1) Measurements at this monitoring site are questionable because of force main pumping.

sewer system consists of relatively small pipe diameters (3 to 8 in). Rehabilitation of these small pipe diameters is generally more costly than larger pipe and result in large decreases in hydraulic capacity of the system.

An additional consideration related to rehabilitation of the sanitary sewer at the RFP is the cost of access to the sewers themselves. Excavation at the RFP is nearly prohibitive because of known Individual Hazardous Substance Sites (IHSSs) other existing utilities, and electrical cables. Slip lining of pipes and other trenchless technology could make rehabilitation less costly if sufficient pipe capacity currently exists.

Errors associated with the total infiltration/inflow estimates include flow measurements errors (about 10 to 15 percent) and theoretical wastewater production rate errors (about 10 to 20 percent). These errors would not account for the differences between the sum of estimated inflow (Table 8) from S120a, S401 and S116a versus SPUA. However, these magnitude errors would account for the errors in total infiltration/inflow for the individual sanitary sewer monitoring sites. This is particularly true for the infiltration and exfiltration components of the study. Minimum (early morning) flow rates in the sewers are most likely caused by cooling tower discharges, which are automatic in many towers, rather than infiltration. Further investigation of this is probably not warranted given the high cost of reducing the total infiltration/inflow at the RFP. Also, the seemingly high inflow values shown on Table 8 are most likely because of the poor estimates of the theoretical wastewater production rates due to poor water metering, rather than massive amounts of inflow from roof drains or other sources.

Of the estimated 9.1 MGY total infiltration/inflow, about 4.2 MGY, or about 46 percent, is sourced in the plutonium processing areas as measured at NPUA (Building 990 North Diversion Box). The remaining 4.9 MGY, or about 54 percent, is sourced in the non-plutonium processing areas as measured at SPUA (Building 990 South Diversion Box). We judge that the inflow estimated at NPUA and SPUA is probably not that large and is because of the errors in short term (daily and weekly) theoretical wastewater production rates. The theoretical wastewater

production rate at the RFP is probably not a constant, but a variable which changes with the atmospheric conditions. Because cooling tower contributions to the sanitary sewer system are between 25 and 30 percent of the annual wastewater flow rate, the atmospheric conditions would cause a variable wastewater production rate and cause the apparently large inflows calculated at MH-3, NPUA, S116a, and S401.

Infiltration/inflow analyses for municipal sanitary sewer systems generally develop the quantities of infiltration and inflow in terms of a unit length of the sanitary sewer system in order to judge whether the measured and/or calculated values of I/I/E are excessive. Infiltration quantities are usually presented in terms of gpd per inch-diameter-mile of pipe. Inflow quantities are usually presented in terms of gallons per 1000 ft of pipe for a specified time period such as one day. Table 10 summarizes these unit infiltration and inflow rates for the RFP sanitary sewer system for each monitoring site, as well as the total system.

Analysis of Table 10 indicates that the unit infiltration rates for the various subsystems monitored for this report period ranged from about 150 gpd per inch-mile of sewer pipe, to over 2640 gpd per inch-mile of sewer pipe. EPA recognizes that if the unit infiltration rate is less than about 3000 gpd per inch-mile of sewer pipe, then the infiltration rate is not excessive and spending money to reduce this infiltration rate is not cost effective (Personal Communication, J. T. Kunz, Donohue & Associates, December 13, 1990). Therefore, because the unit infiltration rates at all monitoring sites in the RFP sanitary sewer system are less than the EPA-recognized rule-of-thumb for excessive infiltration, it would not be cost effective to reduce this infiltration.

The unit inflow rates to the RFP sanitary sewer system as measured or calculated at the monitoring sites (Table 10) range from about 170 gpd per 1000 ft of sewer pipe, to about 2,230 gpd per 1000 ft of sewer pipe. Typically, municipal systems having less than about 3000 to 5000 gpd per 1000 ft of sewer line have found that spending money to reduce inflow rates is not cost effective. Therefore, because the unit inflow rates at the monitoring sites in the RFP sanitary

TABLE 10

SUMMARY OF UNIT I/I/E ESTIMATES AT SANITARY SEWER MONITORING SITES

Monitoring Site	Infiltration (gpd)	Infiltration (gpd/in-mi)	Inflow (gpd)	Inflow (gpd/1000 ft)
MH-3	3,200	640	7,100	2,230
NPUA	2,600	150	13,700	1,240
S120a	4,600	530	2,700	400
S116a	1,900	400	4,900	1,100
S401	6,500	2,640	4,100	1,960
SPUA	15,300	500	3,800	170
Total (NPUA + SPUA)	17,900	370	17,500	520

sewer system are less than the rule-of-thumb for excessive inflow, it would not be cost effective to reduce this inflow.

EPA also has given a guideline of 120 gpcd for excessive total infiltration/inflow in a municipal sanitary sewer system (Sullivan and Ewing, 1985). Using the 6,374 RFP employees (Table 7) as a base, the total infiltration/inflow for the RFP sanitary sewer system would have to be in excess of 279 MGY, compared to the actual value at NPUA plus SPUA of about 9.1 MGY, to be considered excessive. Thus, the 9.1 MGY estimated by this report for infiltration/inflow for the RFP sanitary sewer system cannot be defined as excessive using EPA-recognized rules-of-thumb and guidelines. Therefore, it is recommended that continued monitoring of the sanitary sewer system at the RFP be discontinued, because it could be shown to not have excessive infiltration/inflow or exfiltration.

4.0 ACKNOWLEDGMENTS

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R. A. Applehans, EG&G - PE/EWE
F. A. Walker, EG&G - FPM
A. McLean, EG&G - EM/NEPA
E. W. Mende, EG&G - EM/CWAD
A. C. Shah, DOE - E&G

This study report was prepared and submitted in partial fulfillment of the Zero-Offsite Water-Discharge Study being conducted by ASI on behalf of EG&G Rocky Flats, Inc. EG&G's Project Engineer for this Study was Mr. R. A. Applehans of EG&G's Plant Engineering/Environmental and Waste Engineering.

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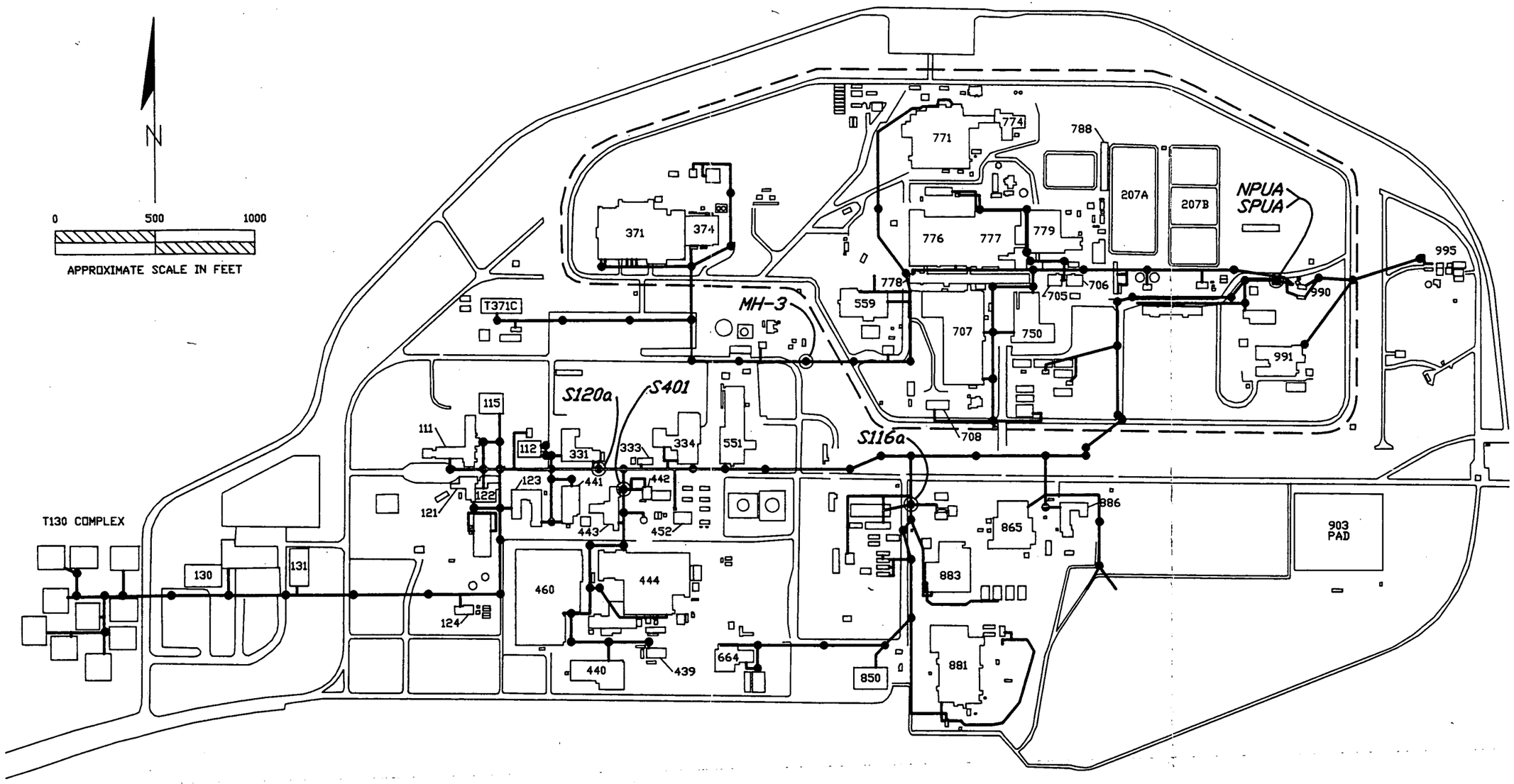
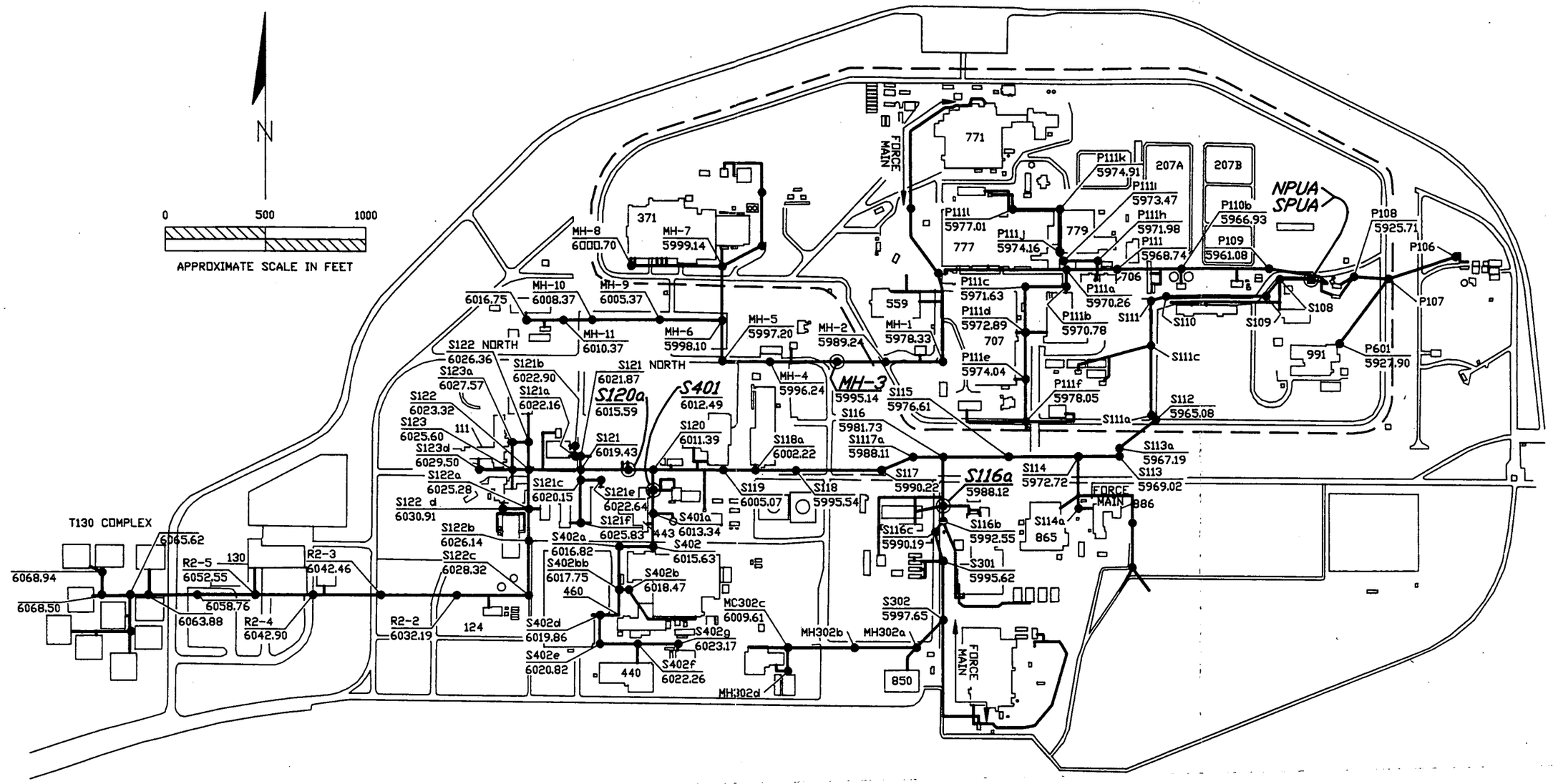
FIGURES



LEGEND

- • MANHOLE
- ◉ MONITORING LOCATION
- —— SEWER LINE
- - — - PROTECTED AREA

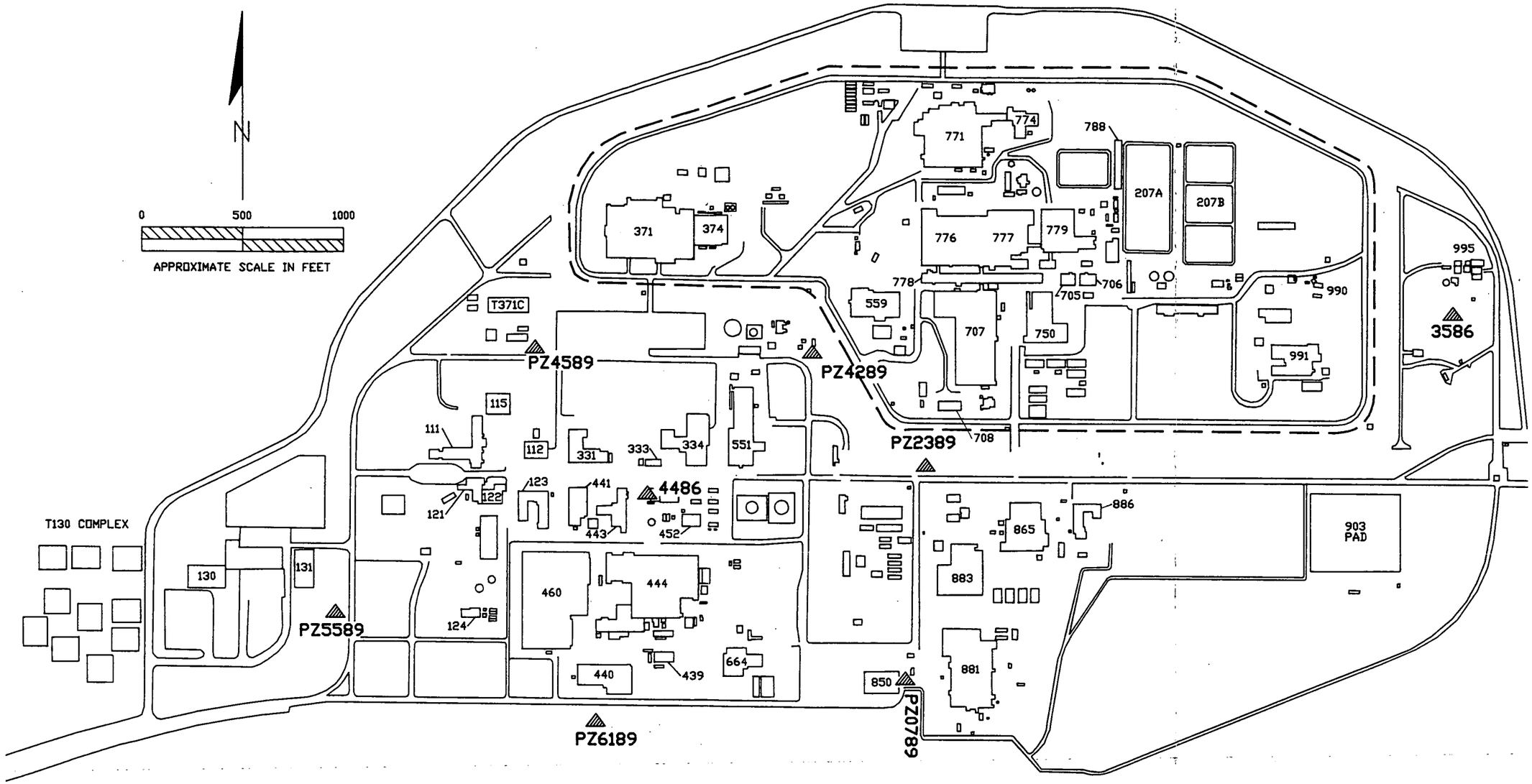
AREA PLOT PLAN SANITARY SEWER SYSTEM		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT: 208.0101	FIGURE 1
	DATE:SEPTEMBER 1991	



LEGEND

- ● MANHOLE
- ◉ MONITORING LOCATION
- XXXXX / XXXX.XX — MANHOLE NUMBER / INVERT ELEVATION
- ——— SEWER LINE
- — — — PROTECTED AREA

MANHOLE INVERT ELEVATIONS		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT: 208.0101	FIGURE 2
	DATE: SEPTEMBER 1991	

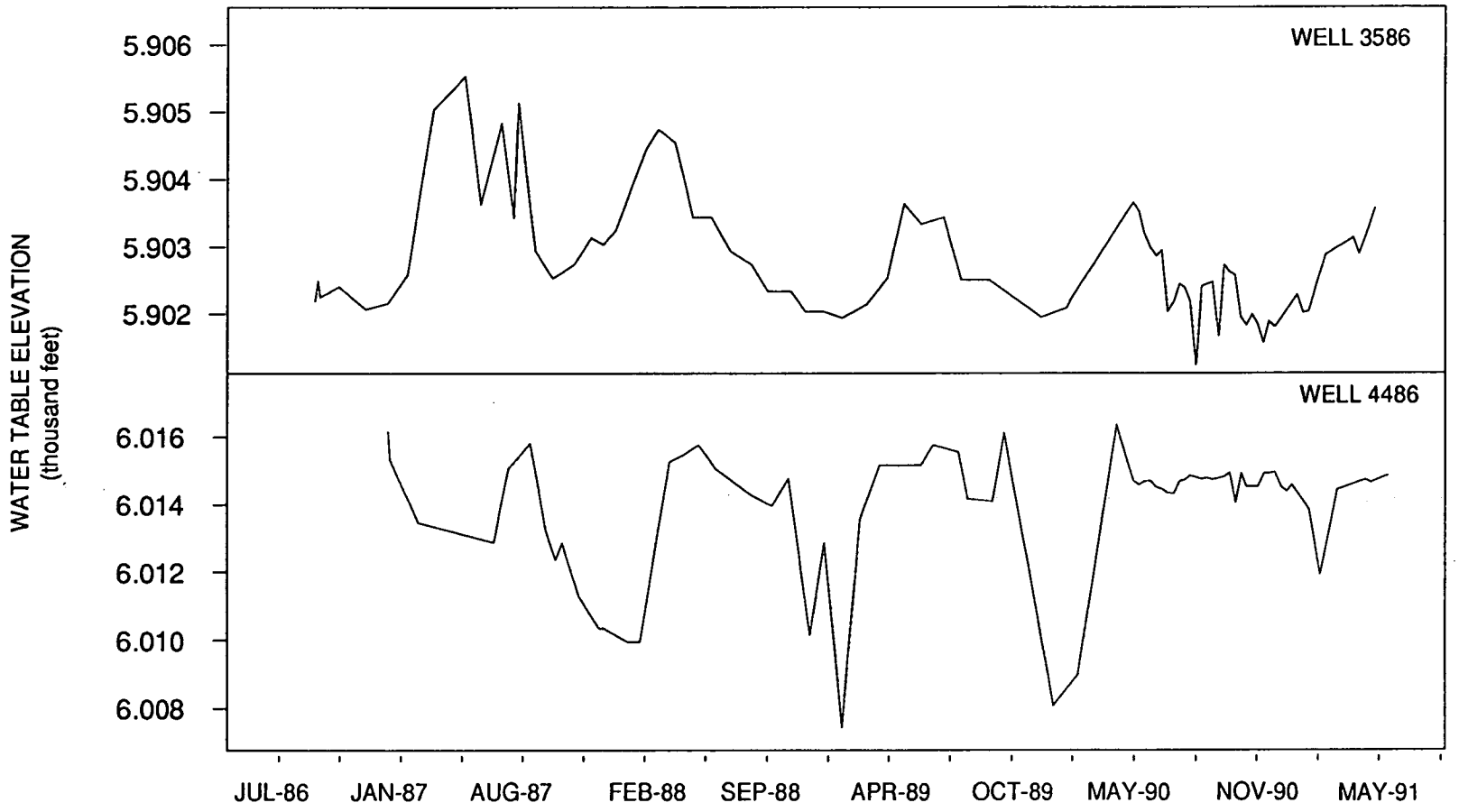


LEGEND

XXXXX ▲ ALLUVIAL WELL

— — - PROTECTED AREA

MONITORED ALLUVIAL WELL LOCATIONS		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT: 208.0101	FIGURE 4
	DATE: SEPTEMBER 1991	



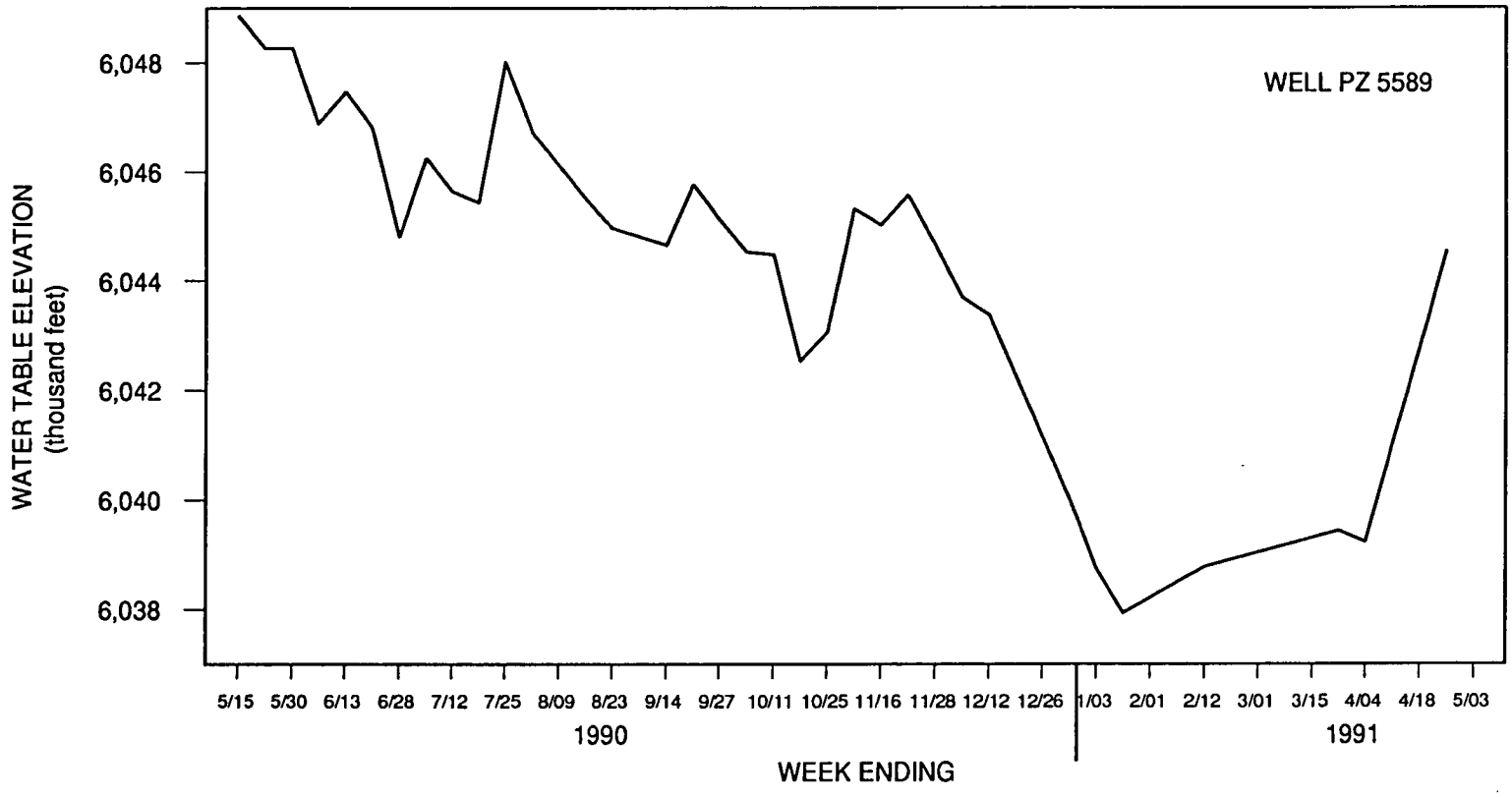
HYDROGRAPHS FOR MONITORING WELLS
3586 AND 4486 (1986-1991)

SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991
PROJECT 20801.01

FIGURE 5



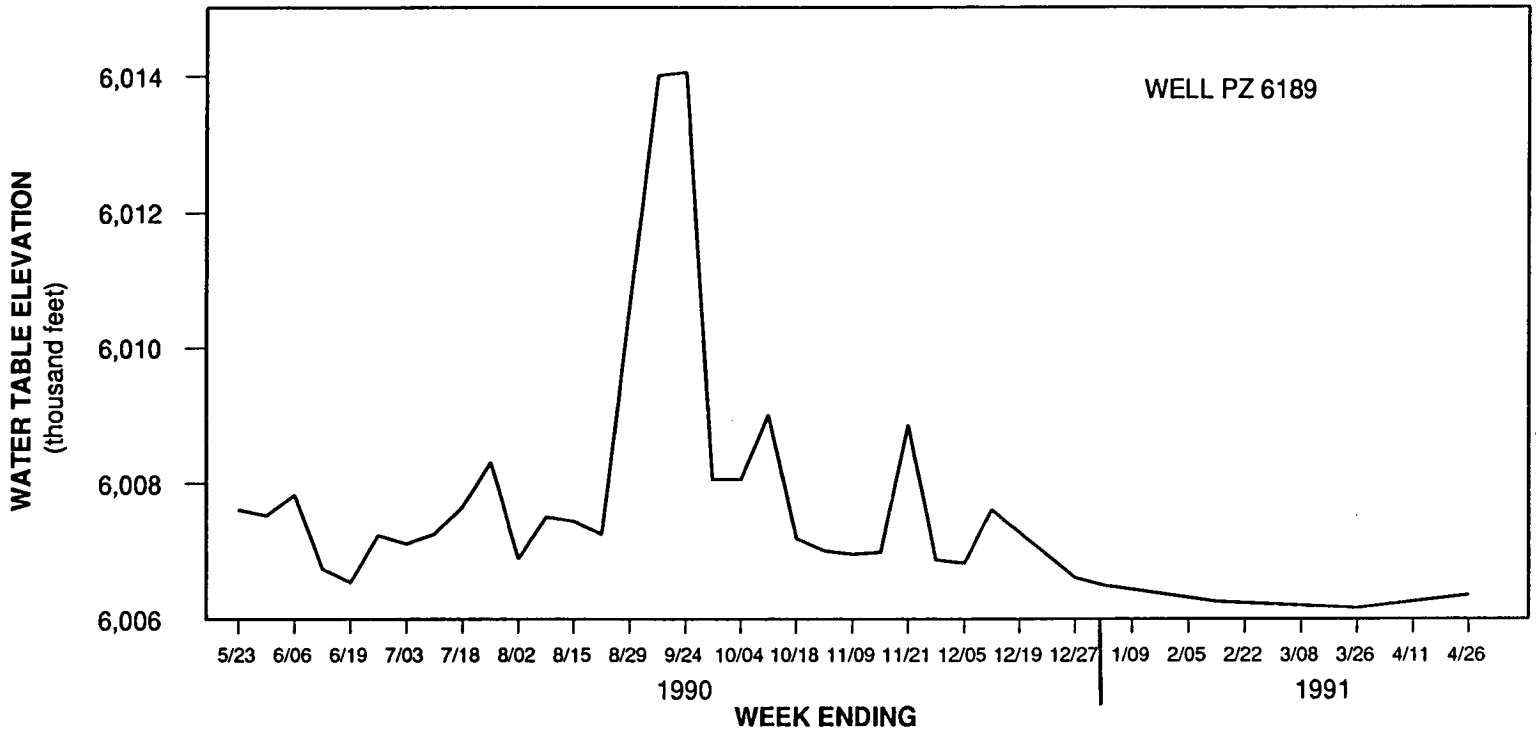
HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991
PROJECT 20801.01

FIGURE 6A



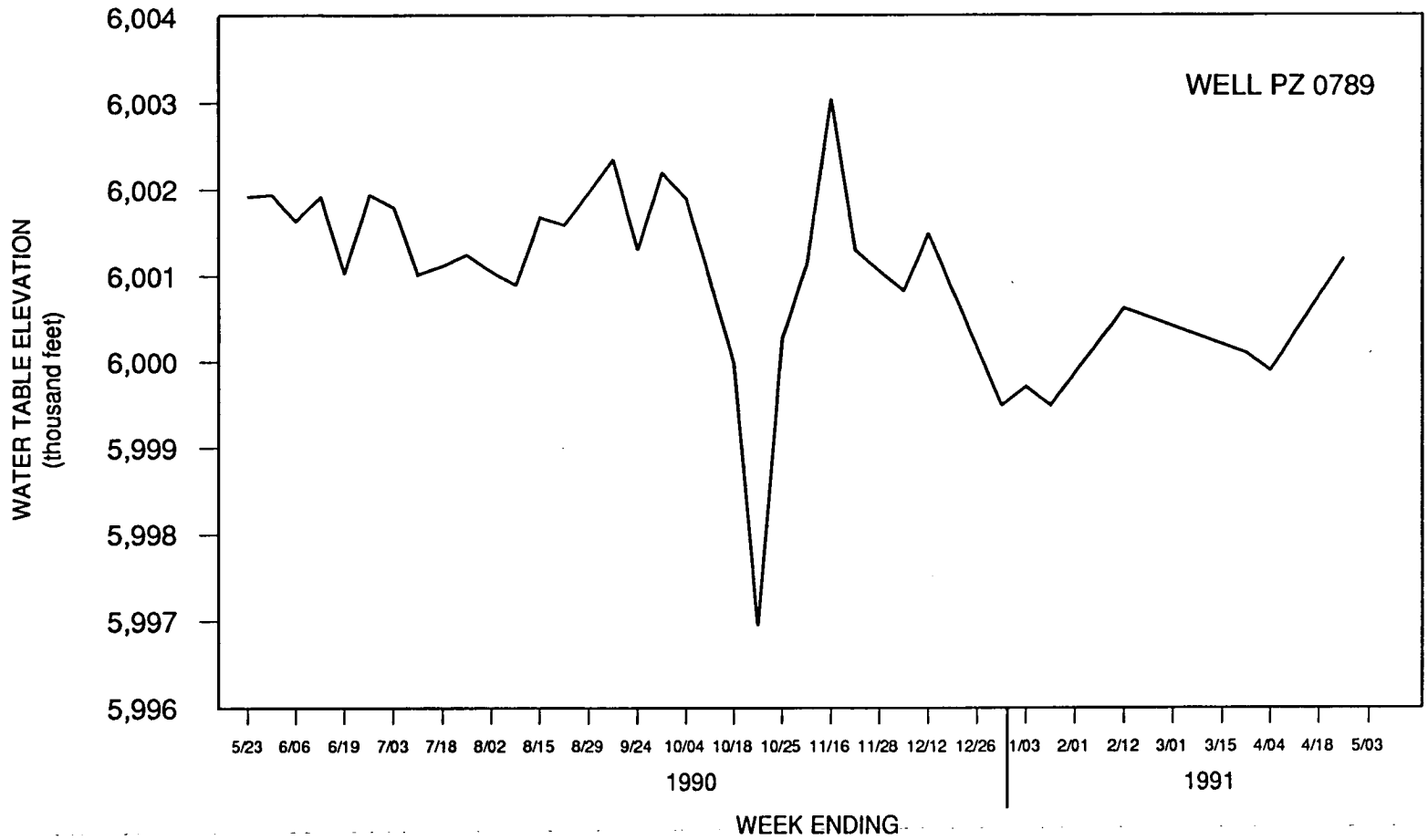
HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991
PROJECT 20801.01

FIGURE 6B



HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

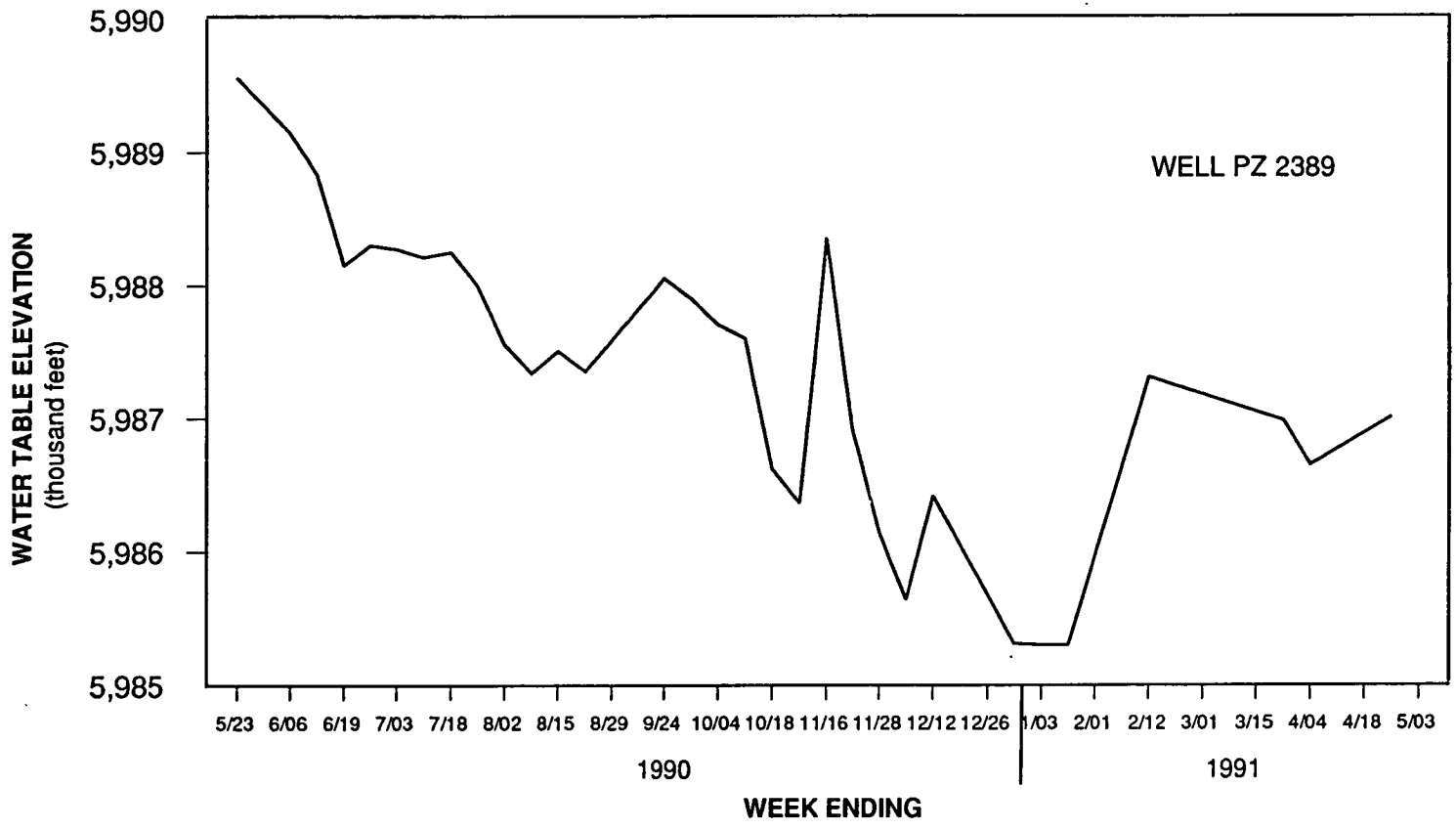
SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991

PROJECT 20801.01

FIGURE 6C



HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

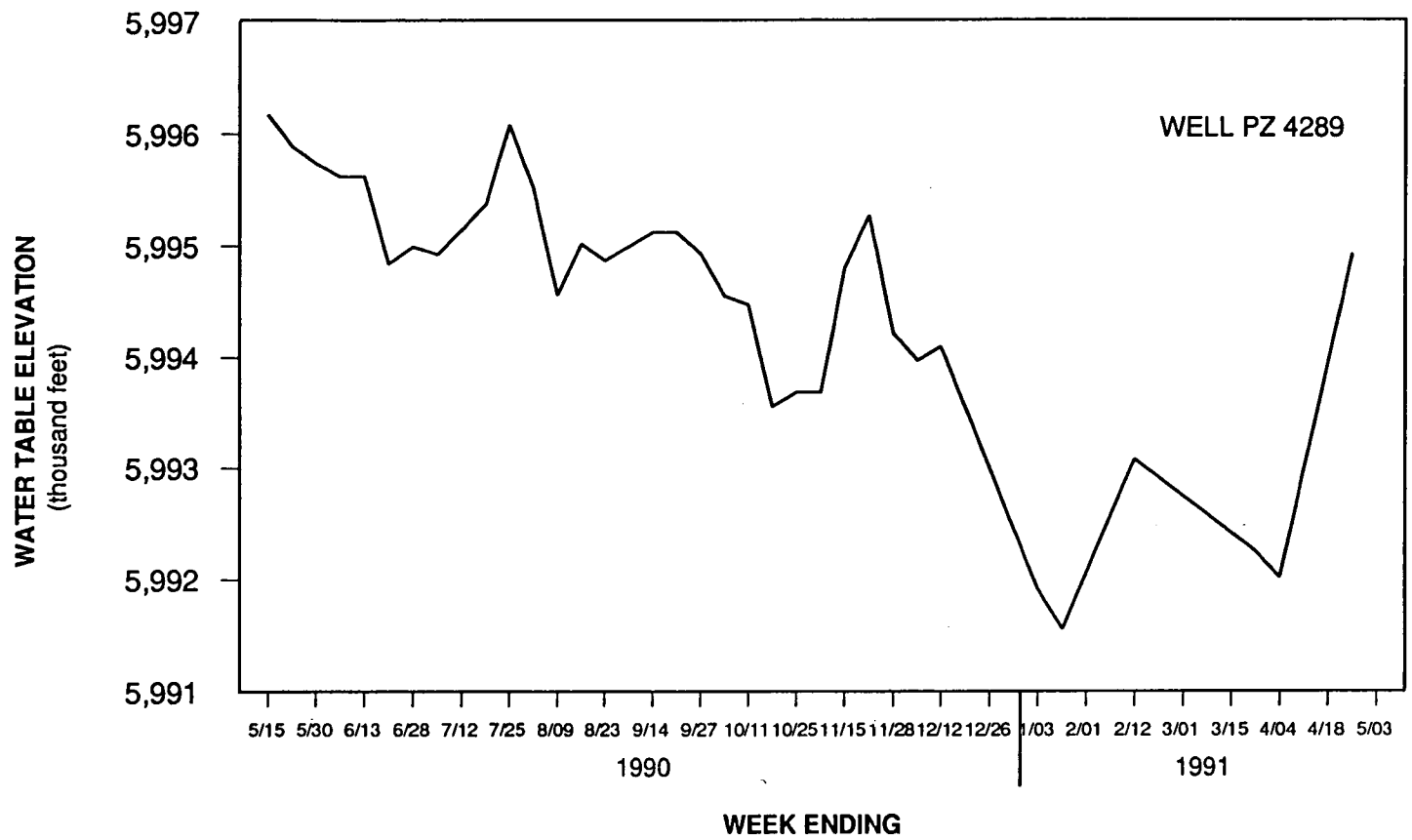
SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991

PROJECT 20801.01

FIGURE 6D



HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

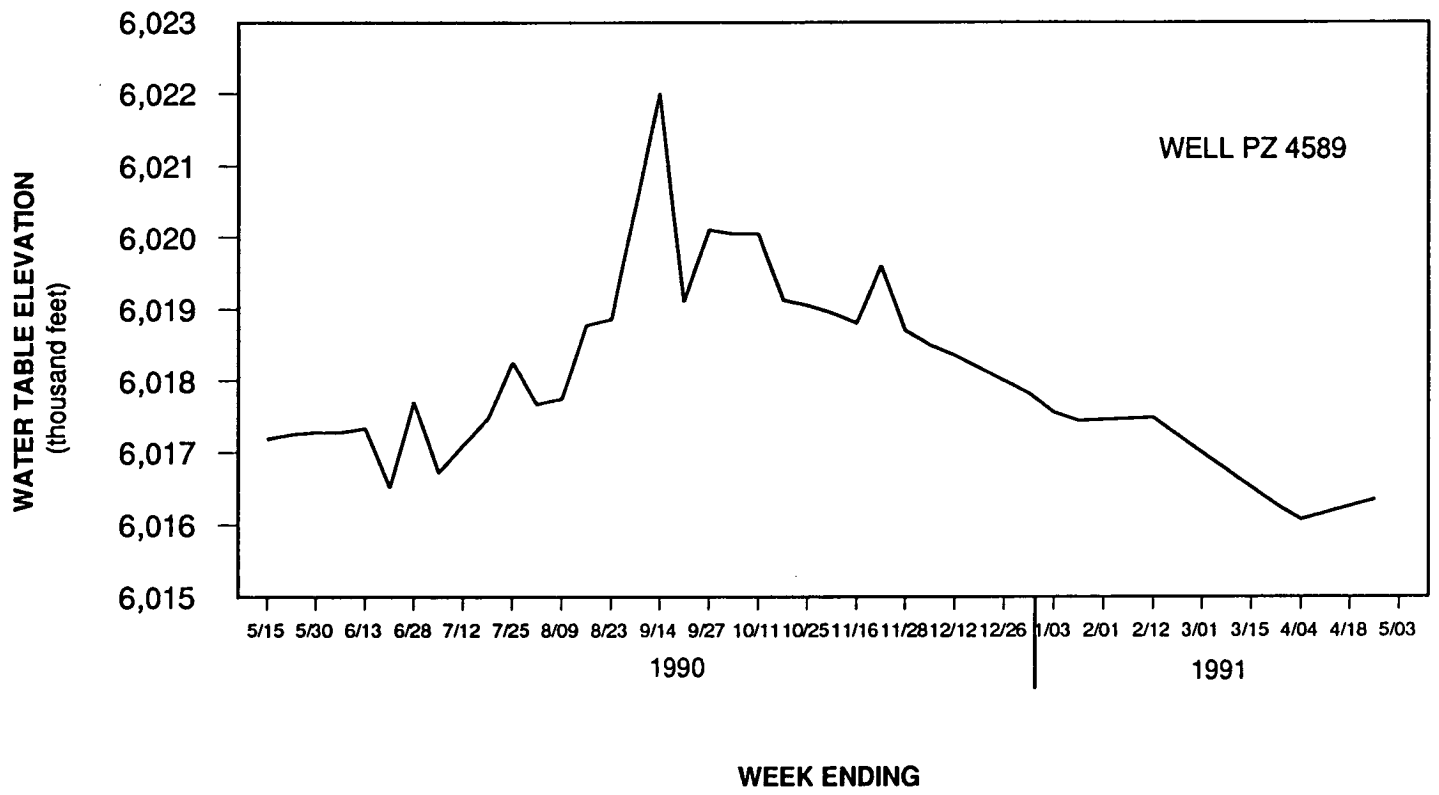
SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991

PROJECT 20801.01

FIGURE 6E



HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

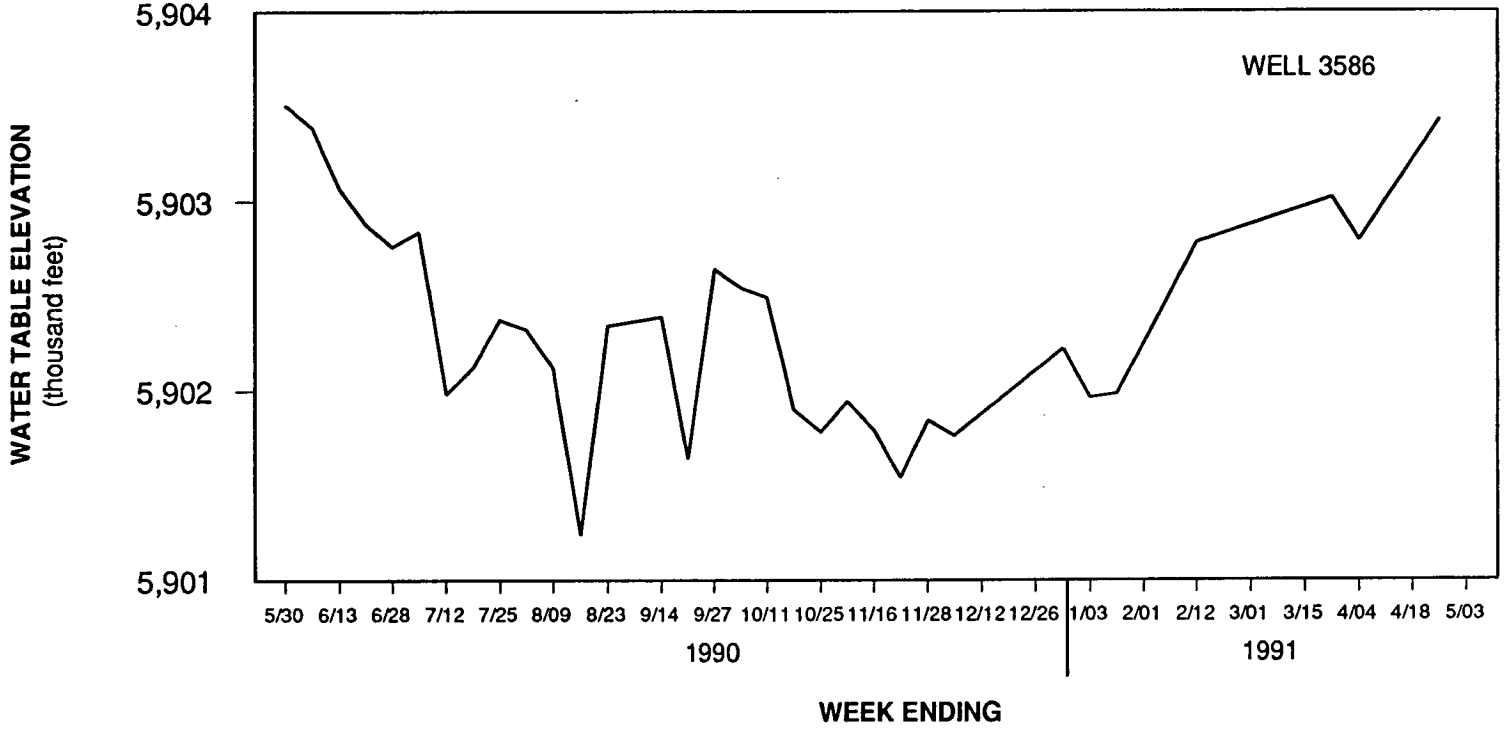
SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991

PROJECT 20801.01

FIGURE 6F



HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

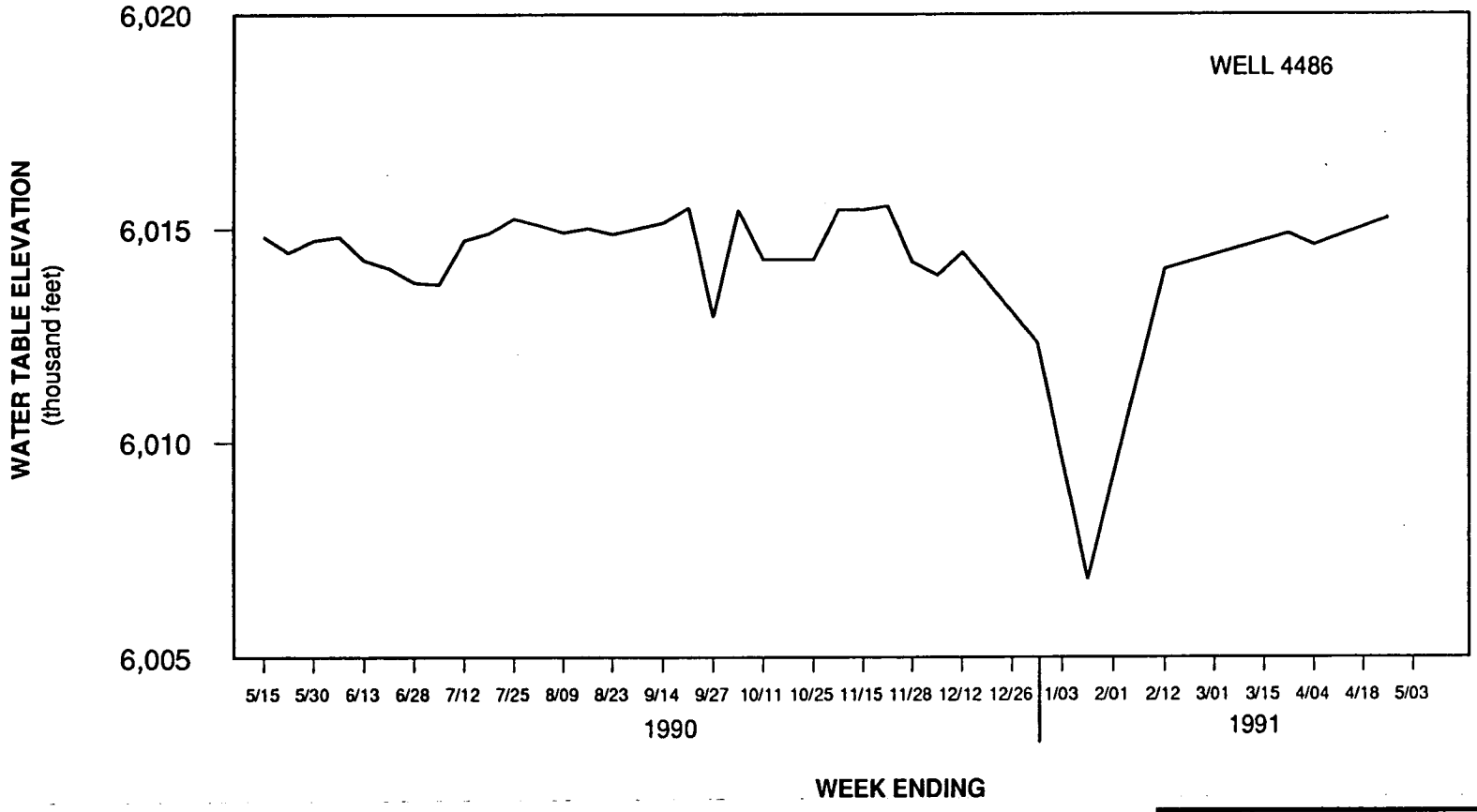
SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991

PROJECT 20801.01

FIGURE 6G



HYDROGRAPHS FOR MONITORED ALLUVIAL WELLS

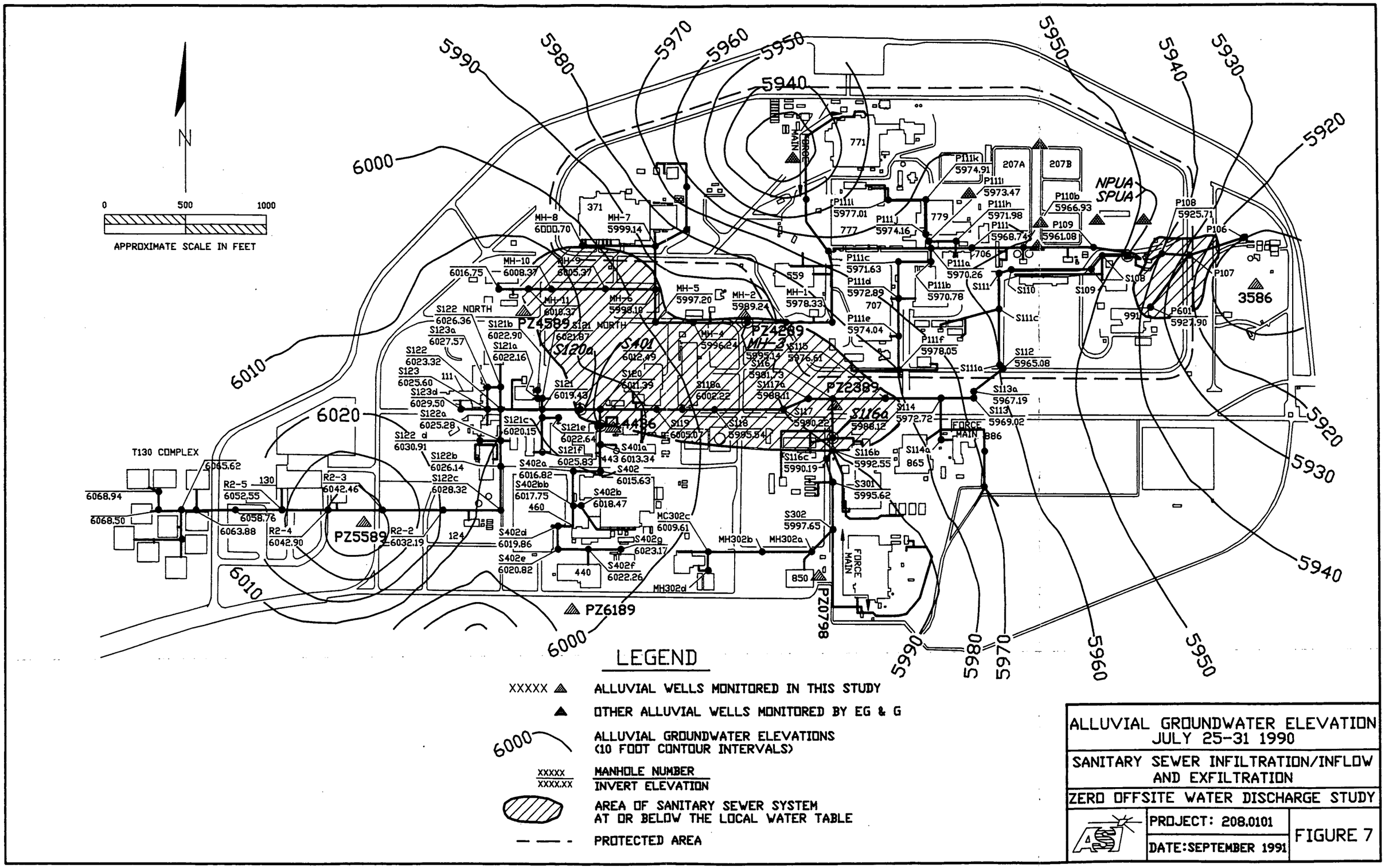
SANITARY SEWER I/I AND E

ZERO-OFFSITE WATER-DISCHARGE

SEPTEMBER 1991

PROJECT 20801.01

FIGURE 6H



ALLUVIAL GROUNDWATER ELEVATION
JULY 25-31 1990

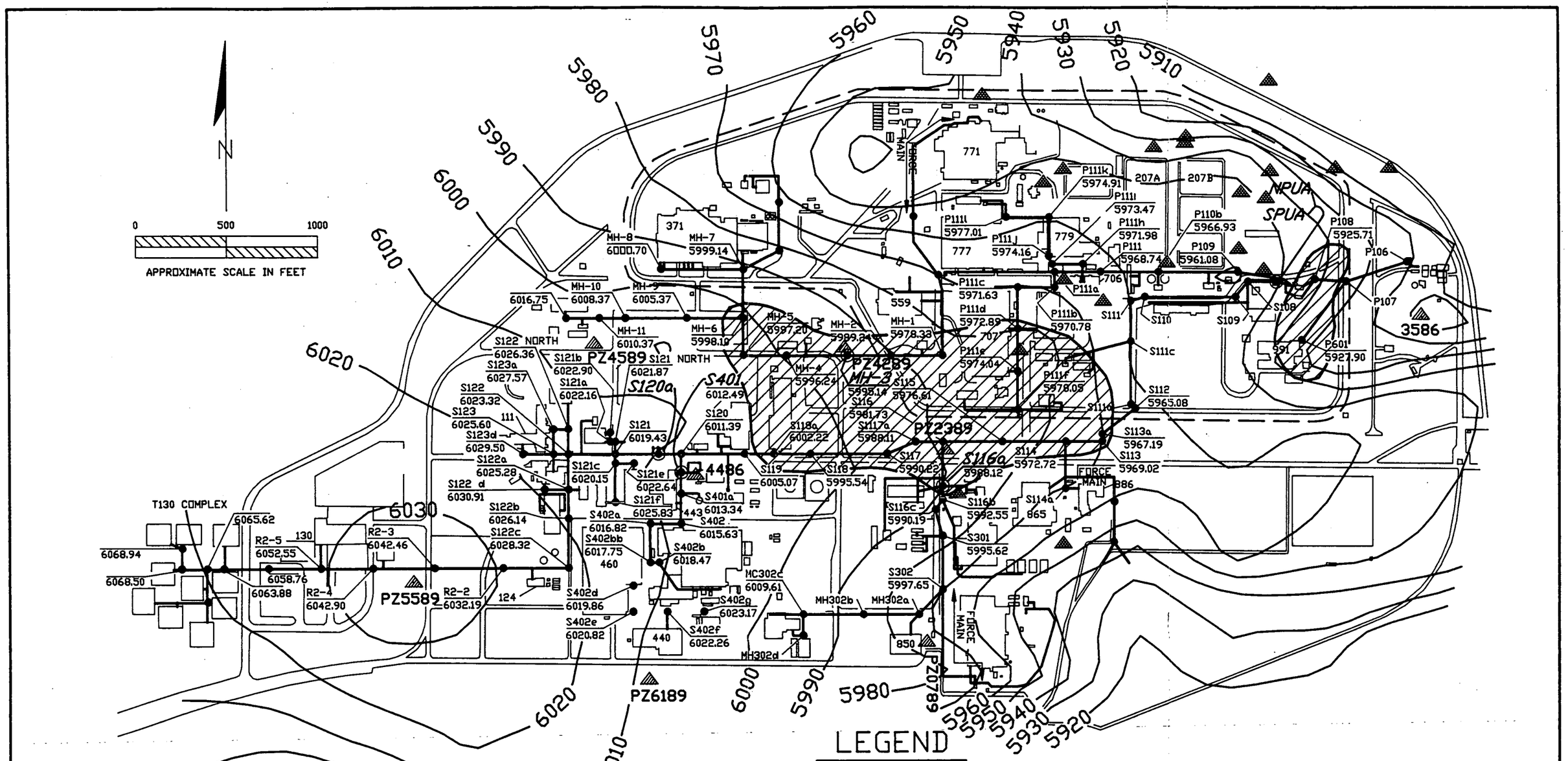
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION

ZERO OFFSITE WATER DISCHARGE STUDY

PROJECT: 208.0101

DATE: SEPTEMBER 1991

FIGURE 7



LEGEND

XXXXX ▲ ALLUVIAL WELLS MONITORED IN THIS STUDY

▲ OTHER ALLUVIAL WELLS MONITORED BY EG & G

ALLUVIAL GROUNDWATER ELEVATIONS (10 FOOT CONTOUR INTERVALS)

XXXXX / XXXX.XX — MANHOLE NUMBER / INVERT ELEVATION

AREA OF SANITARY SEWER SYSTEM AT OR BELOW LOCAL WATER TABLE

— — — PROTECTED AREA

ALLUVIAL GROUNDWATER ELEVATION
JANUARY 1-7, 1991

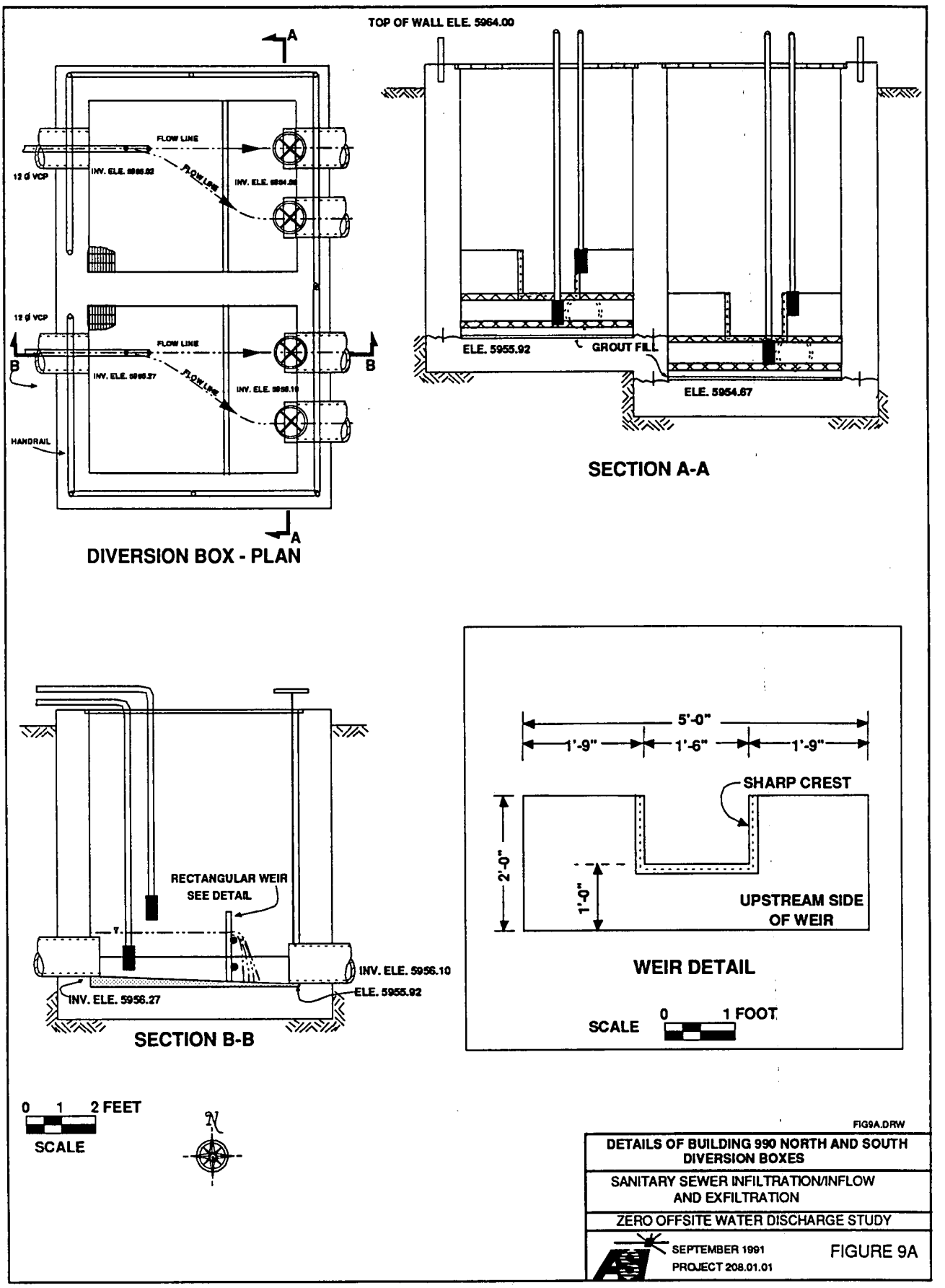
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION

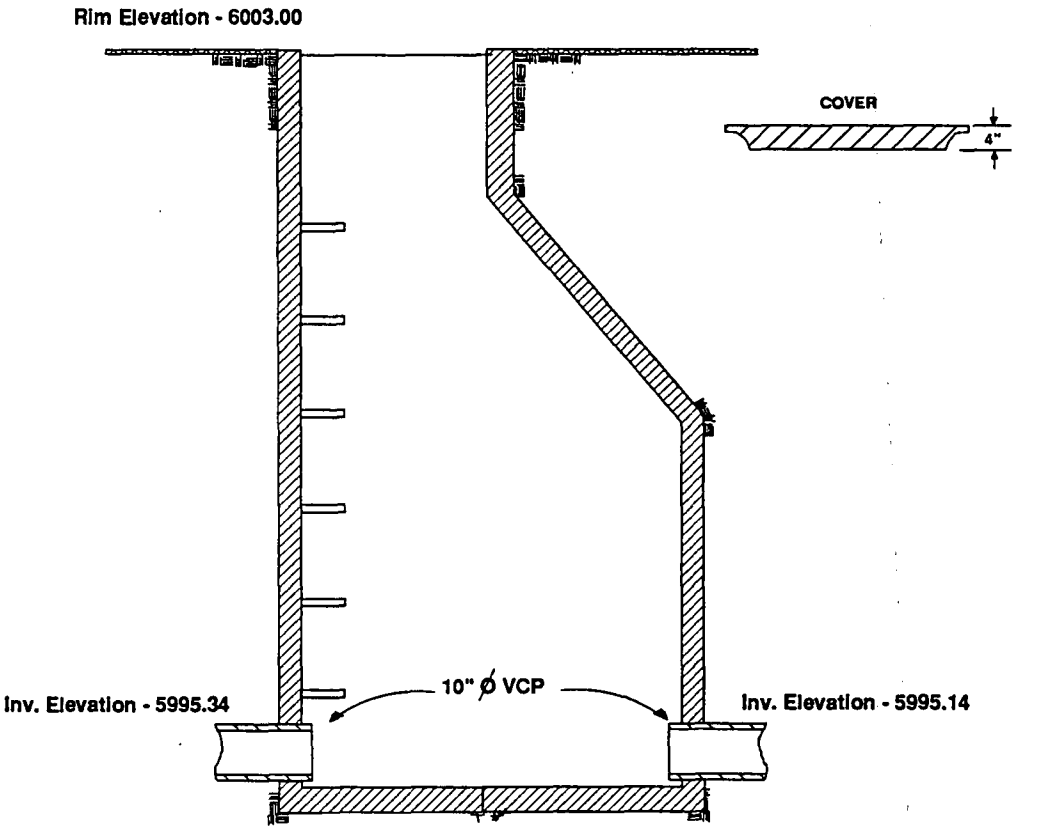
ZERO OFFSITE WATER DISCHARGE STUDY

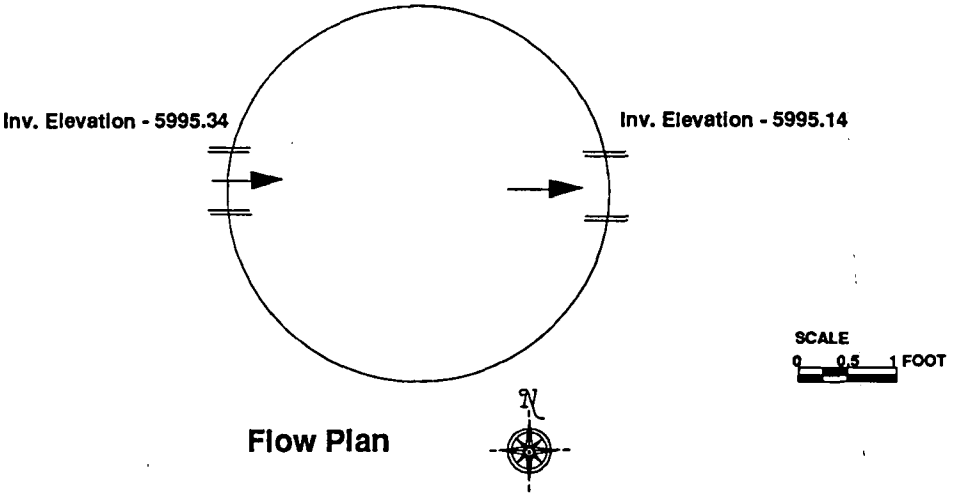
PROJECT: 208.0101

DATE: SEPTEMBER 1991

FIGURE 8


TOP OF WALL ELE. 5964.00
A
FLOW LINE
12 ø VCP
INV. ELE. 5955.92
INV. ELE. 5954.67
FLOW LINE
12 ø VCP
FLOW LINE
B
B
INV. ELE. 5956.27
INV. ELE. 5956.10
FLOW LINE
HANDRAIL
A
DIVERSION BOX - PLAN
ELE. 5955.92
GROUT FILL
ELE. 5954.67
SECTION A-A
RECTANGULAR WEIR
SEE DETAIL
INV. ELE. 5956.10
ELE. 5955.92
INV. ELE. 5956.27
SECTION B-B
5'-0"
1'-9"
1'-6"
1'-9"
SHARP CREST
2'-0"
1'-0"
UPSTREAM SIDE
OF WEIR
WEIR DETAIL
SCALE
0
1 FOOT
0 1 2 FEET
SCALE
N
FIG9A.DRW
DETAILS OF BUILDING 990 NORTH AND SOUTH
DIVERSION BOXES
SANITARY SEWER INFILTRATION/INFLOW
AND EXFILTRATION
ZERO OFFSITE WATER DISCHARGE STUDY
SEPTEMBER 1991
PROJECT 208.01.01
FIGURE 9A





Flow Plan

FIG9B.DRW

IDEALIZED CROSS SECTION OF MANHOLE MH-3
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION
ZERO OFFSITE WATER DISCHARGE STUDY
SEPTEMBER 1991 PROJECT 208.01.01 — FIGURE 9B

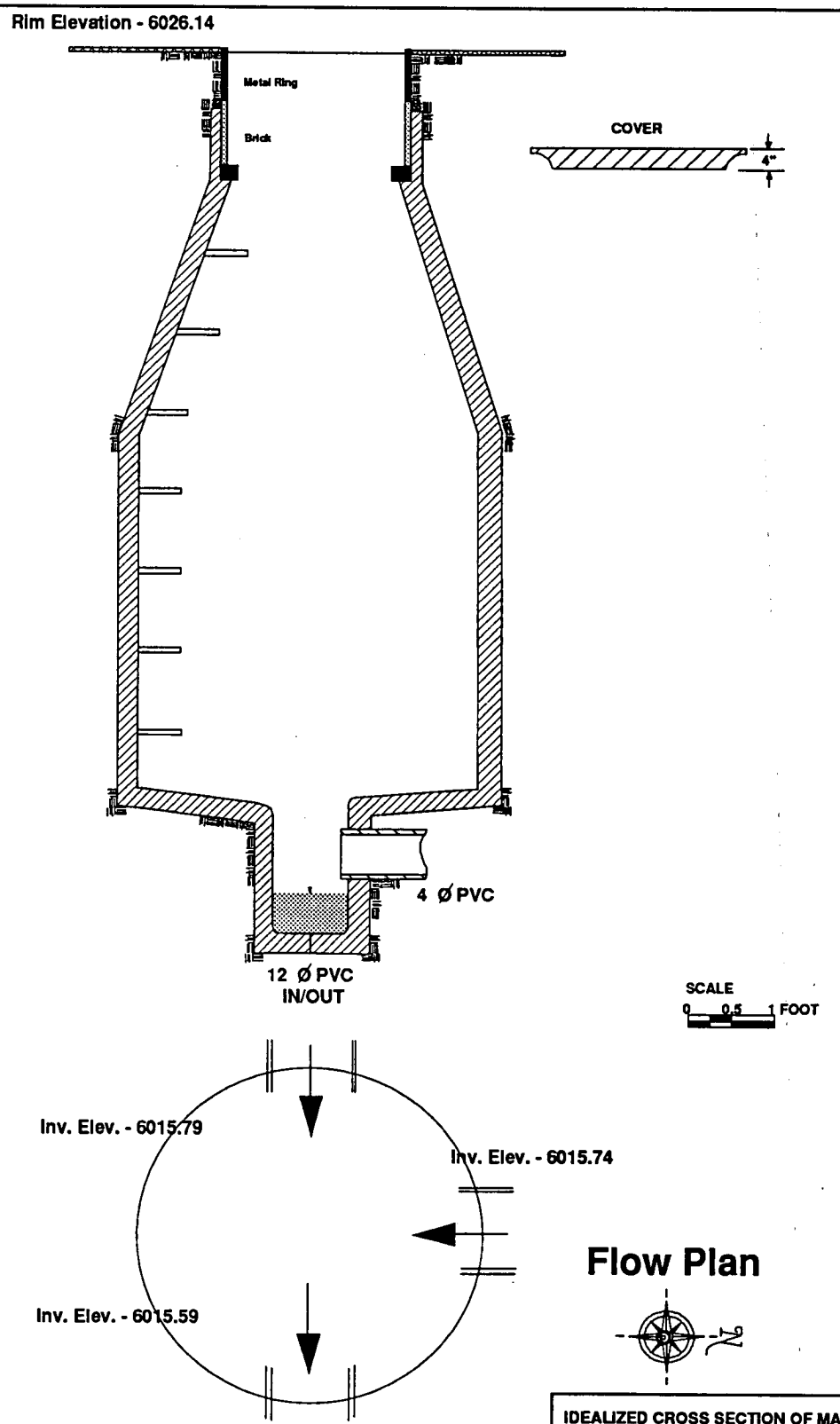


FIG9C.DRW

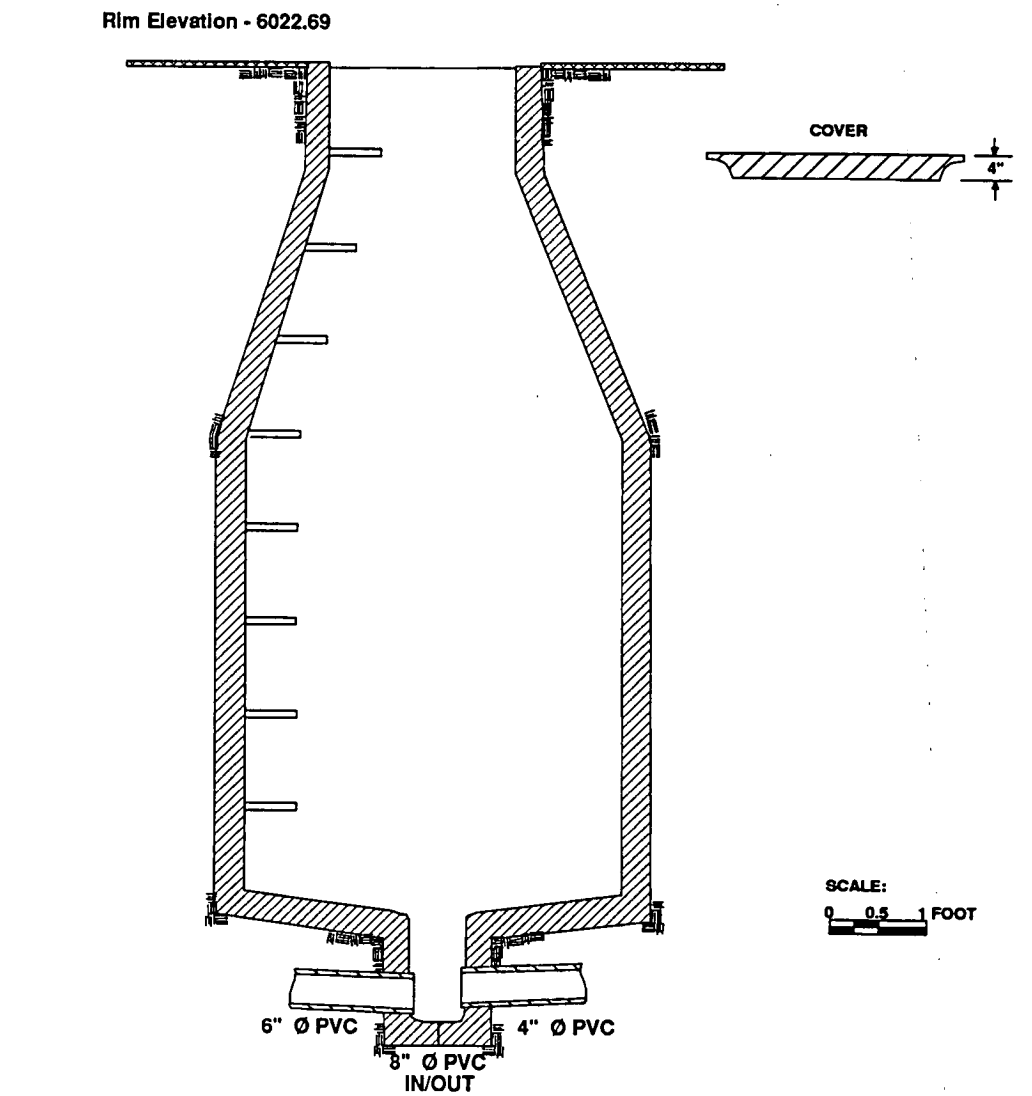
IDEALIZED CROSS SECTION OF MANHOLE S120a

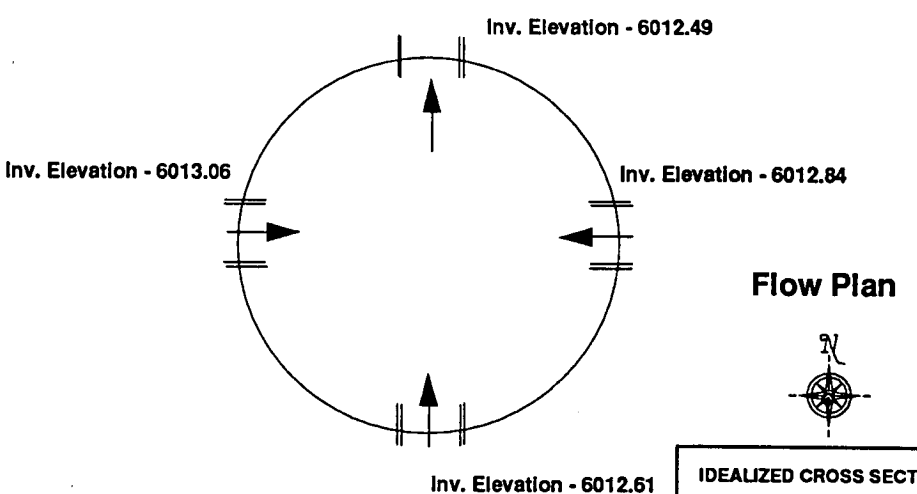
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION

ZERO OFFSITE WATER DISCHARGE STUDY

SEPTEMBER 1991
PROJECT 208.01.01

FIGURE 9C

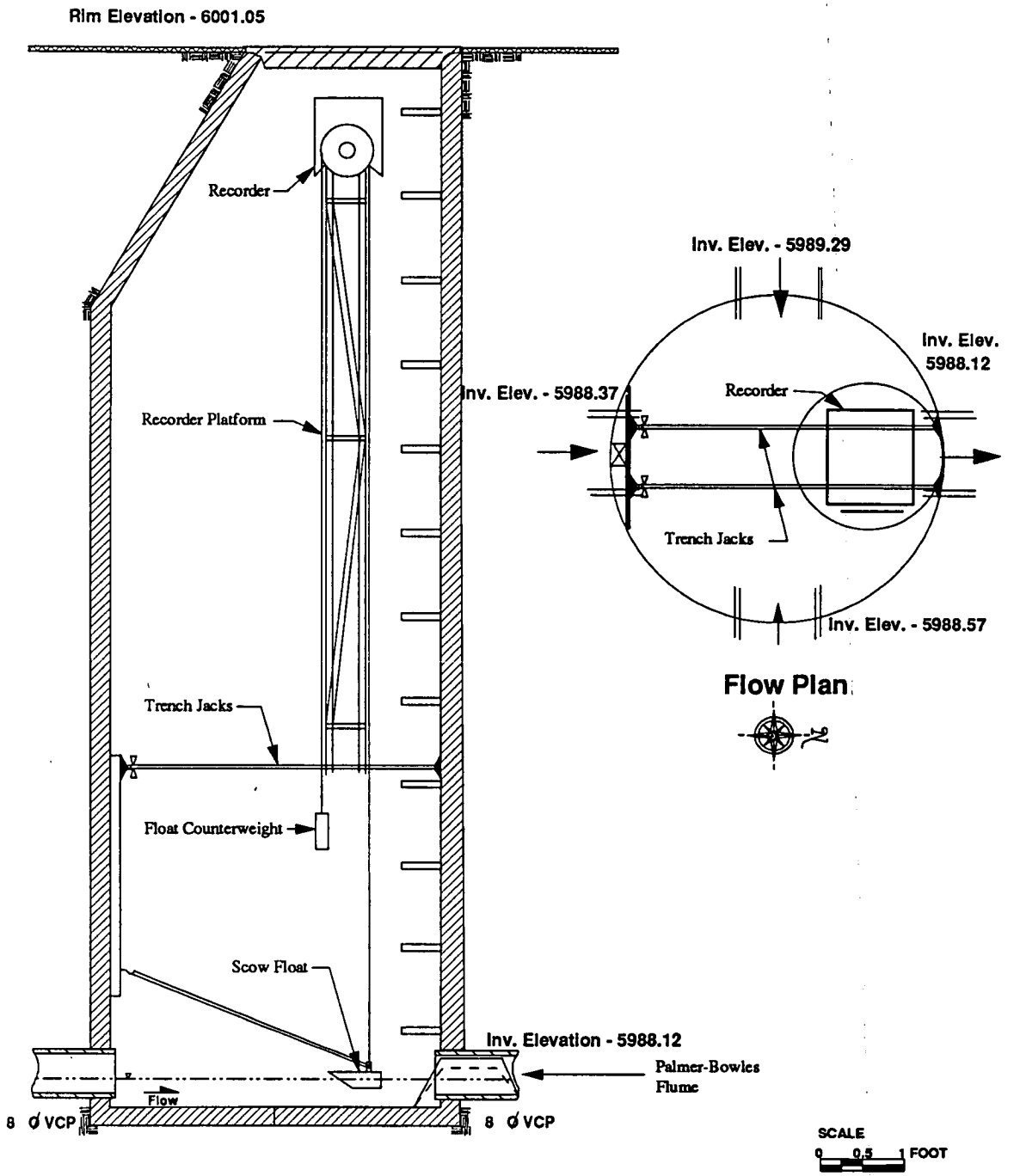




Flow Plan

FIG9D.DRW

IDEALIZED CROSS SECTION OF MANHOLE S401
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION
ZERO OFFSITE WATER DISCHARGE STUDY
SEPTEMBER 1991 PROJECT 208.01.01 — FIGURE 9D



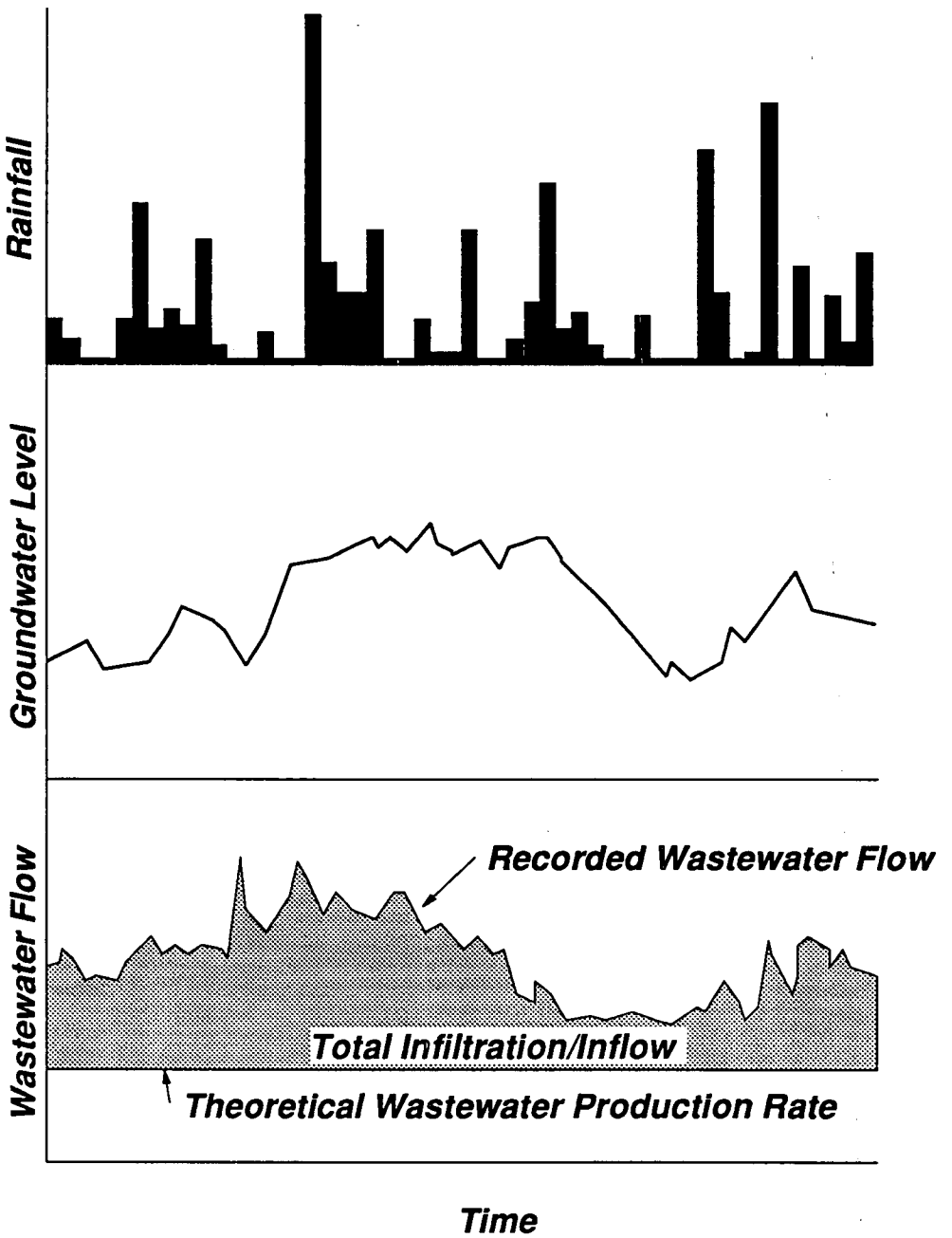
IDEALIZED CROSS SECTION OF MANHOLE S116a WITH MEASURING DEVICE INSTALLED

SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION

ZERO OFFSITE WATER DISCHARGE STUDY

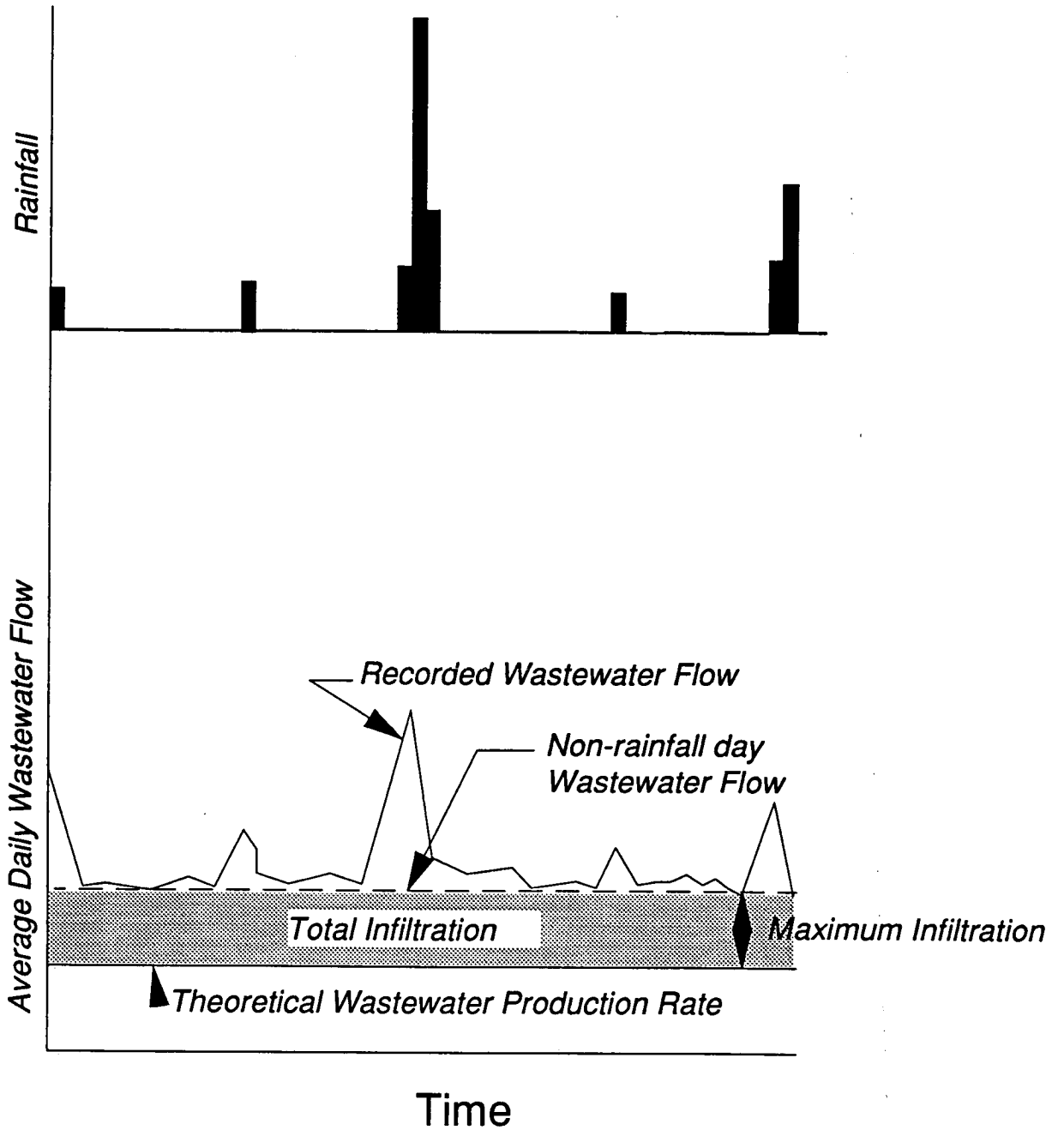
SEPTEMBER 1991
PROJECT 208.01.01

FIGURE 9E



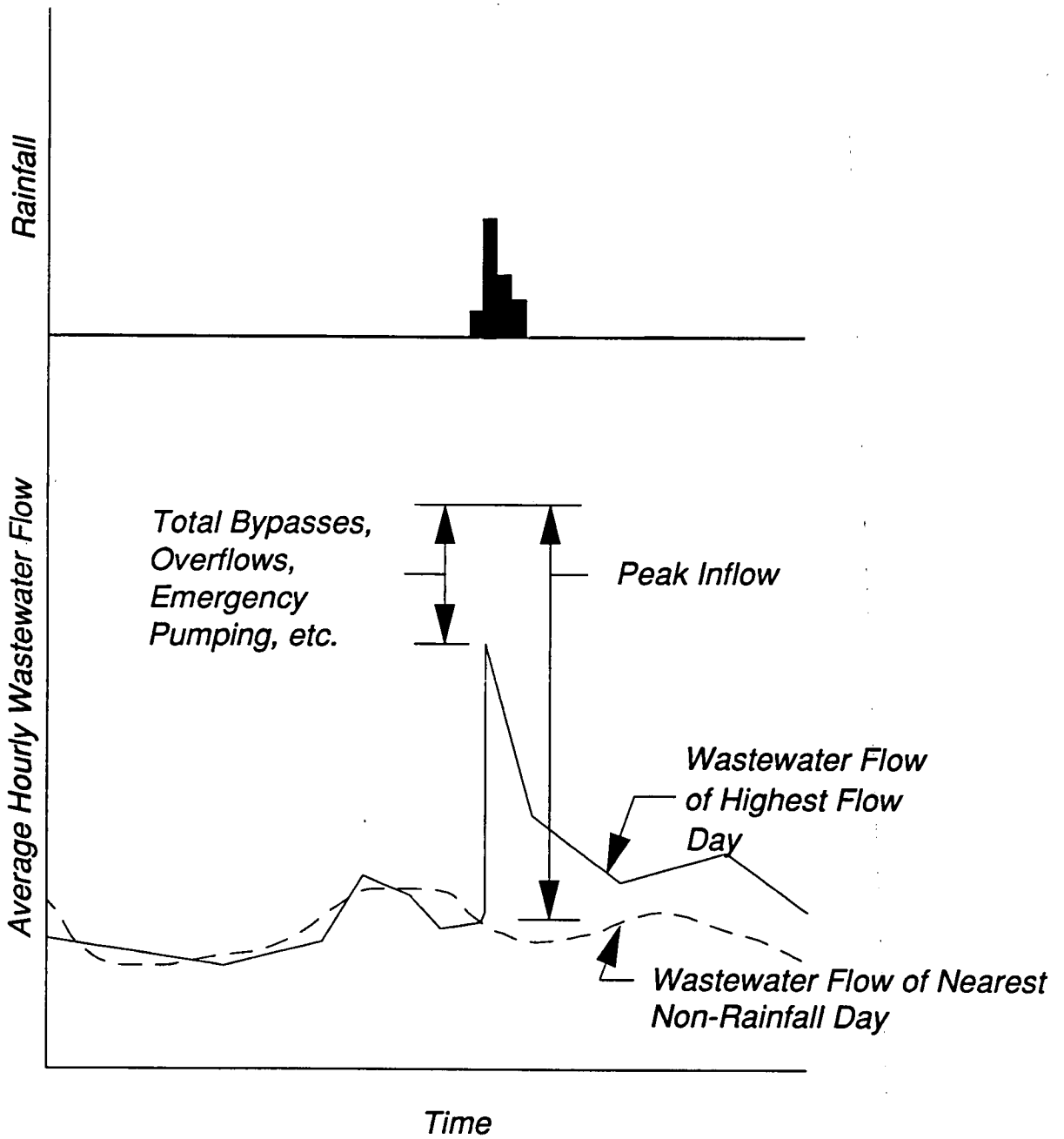
SOURCE: EPA (1975)

ESTIMATION OF TOTAL INFILTRATION/INFLOW		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIGURE
	DATE: SEPTEMBER 1991	10



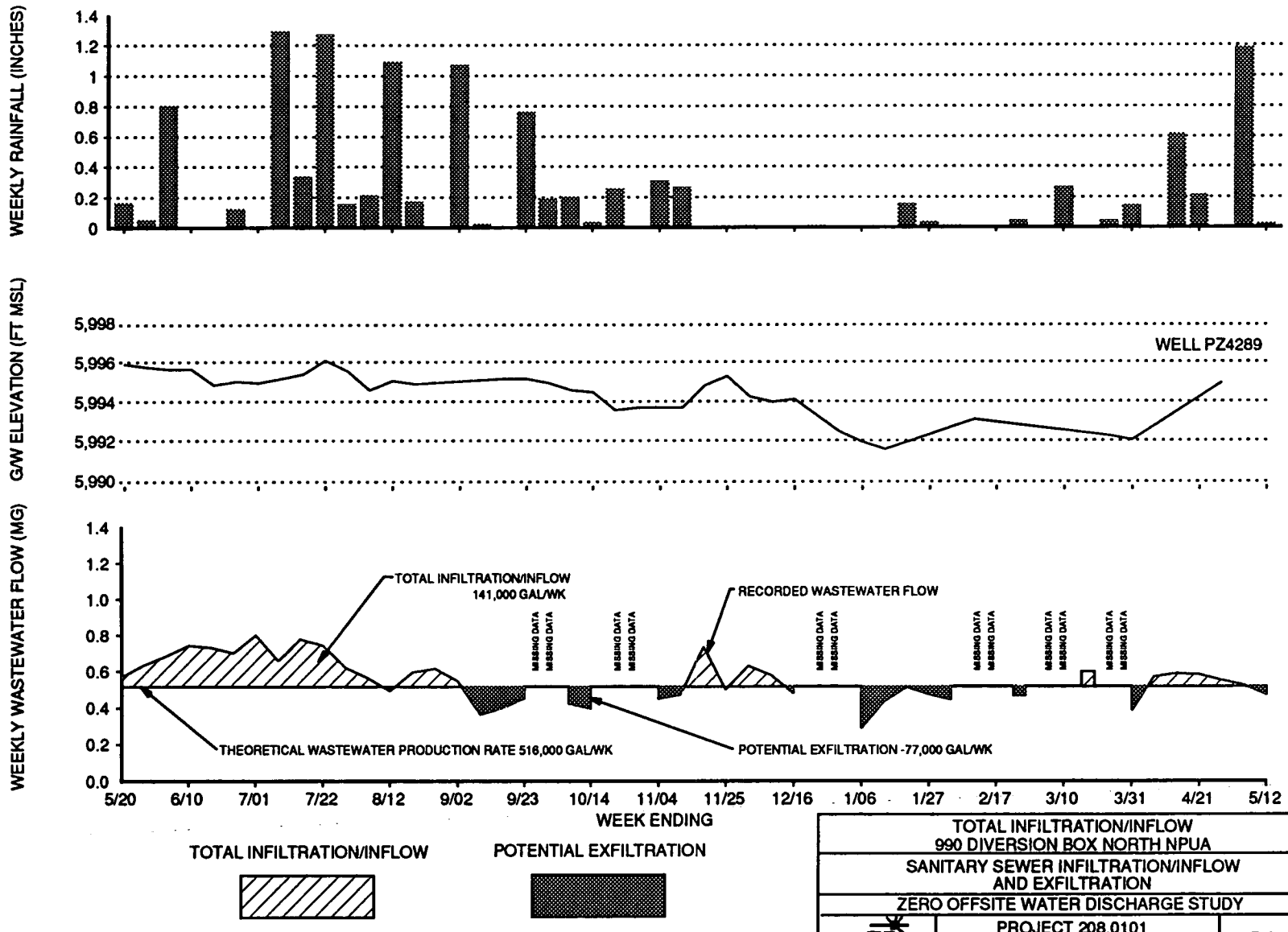
SOURCE: EPA (1975)

ESTIMATION OF TOTAL INFILTRATION		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIGURE
	DATE: SEPTEMBER 1991	11



SOURCE: EPA (1975)

ESTIMATION OF PEAK INFLOW		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIGURE
	DATE: SEPTEMBER 1991	12



TOTAL INFILTRATION/INFLOW
990 DIVERSION BOX NORTH NPUA

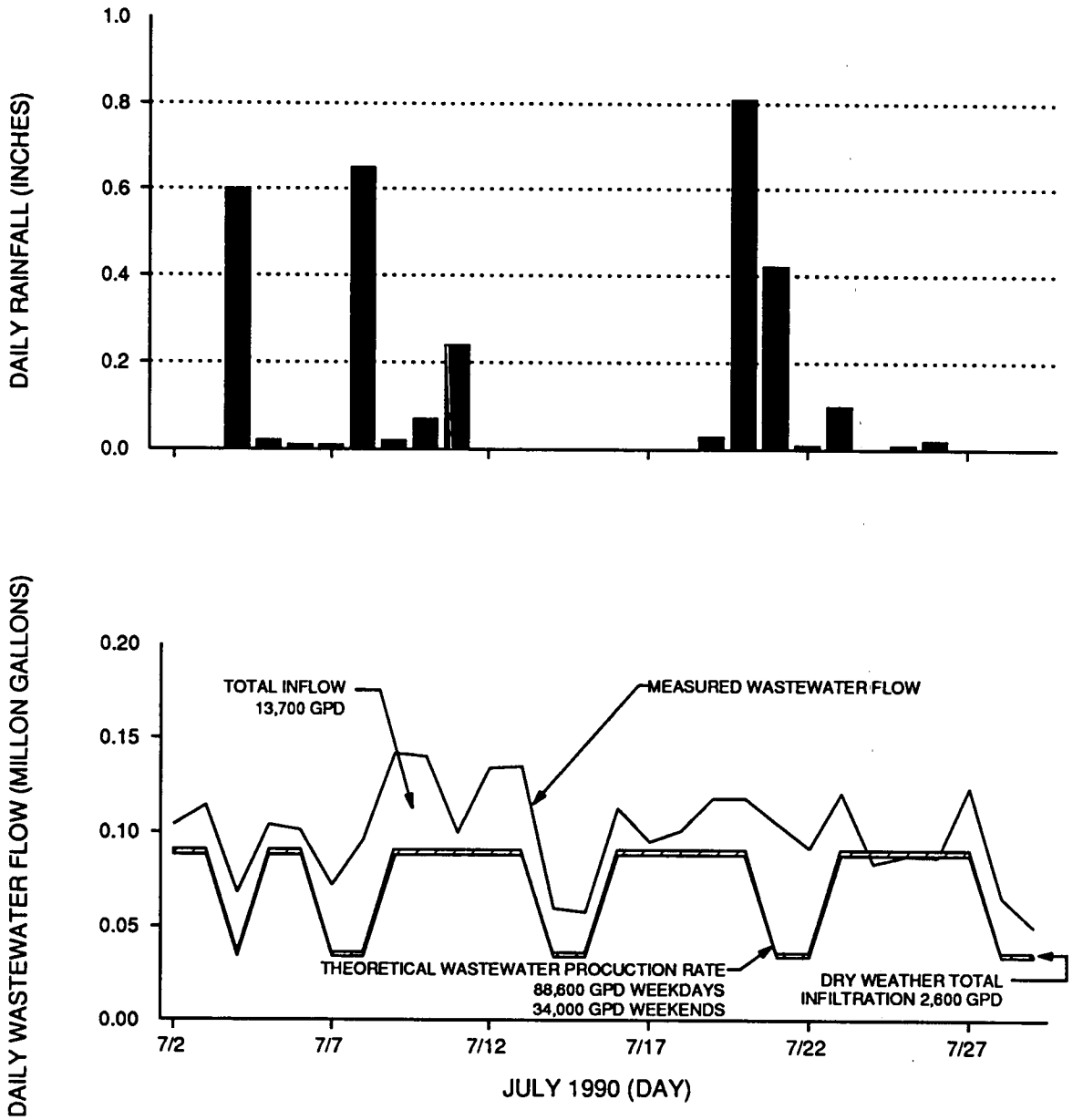
SANITARY SEWER INFILTRATION/INFLOW
AND EXFILTRATION

ZERO OFFSITE WATER DISCHARGE STUDY

PROJECT 208.0101

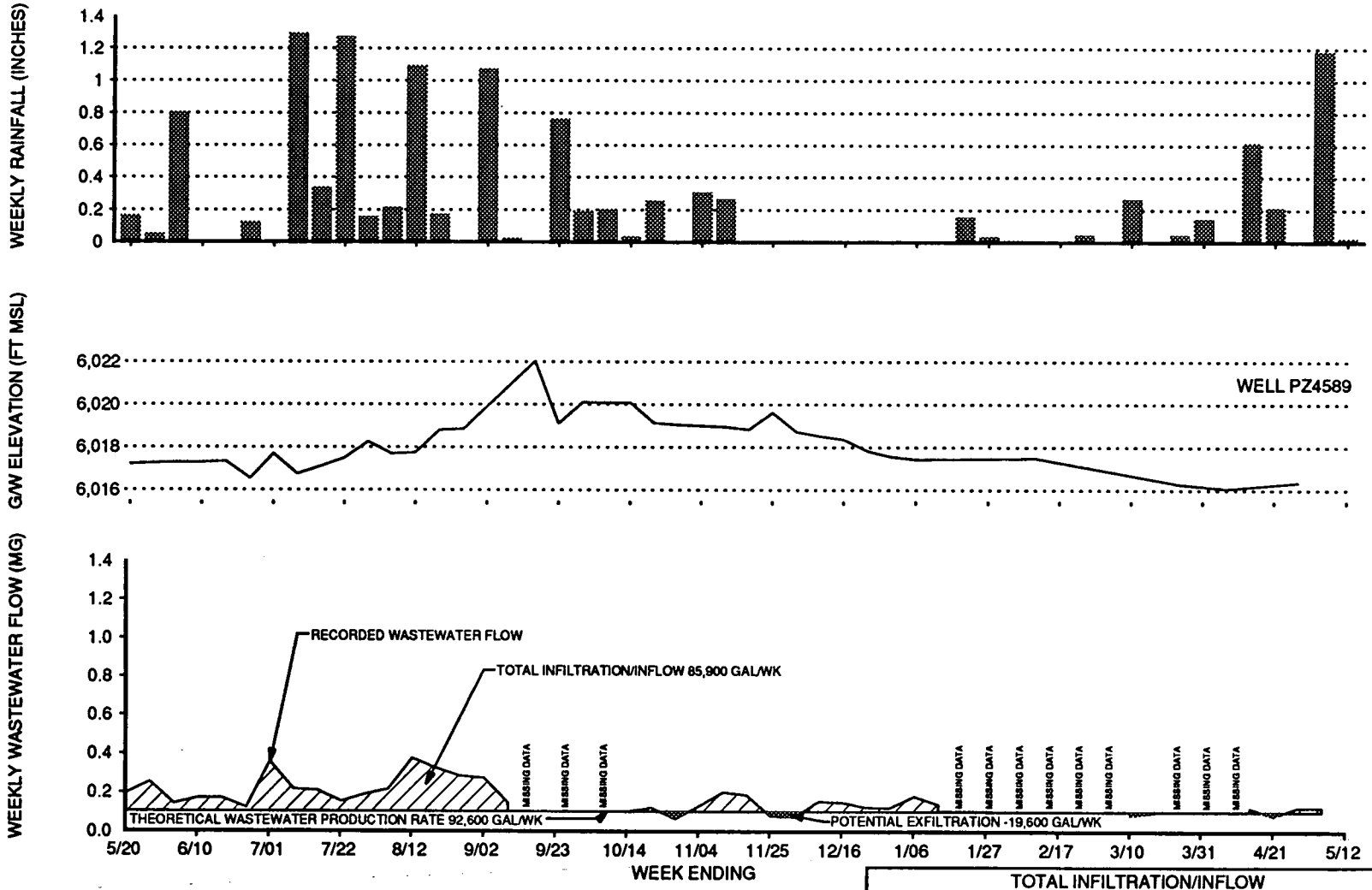
DATE: SEPTEMBER 1991

FIG.13



TOTAL INFILTRATION

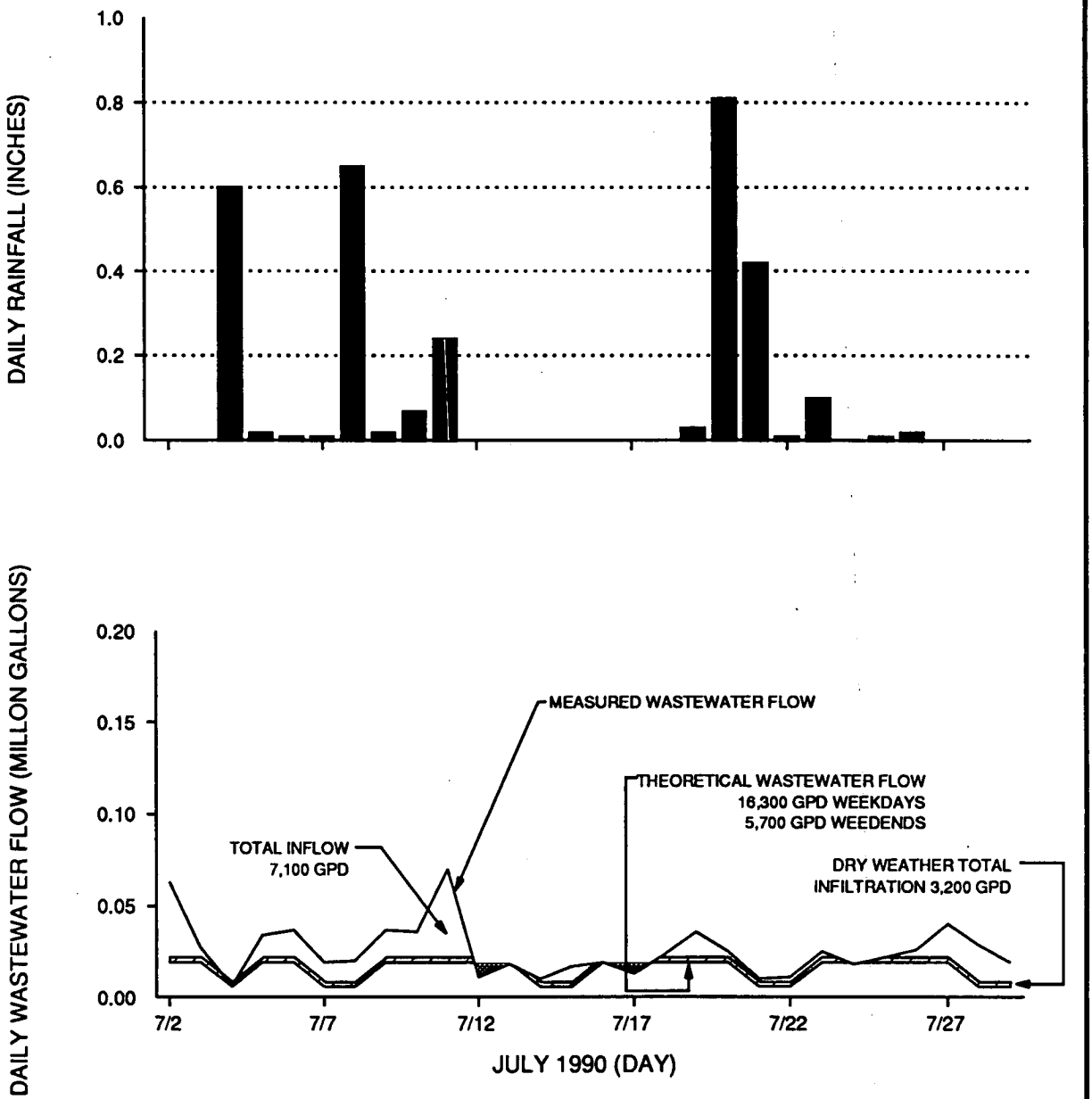
TOTAL INFILTRATION AND TOTAL INFLOW 990 DIVERSION BOX NORTH NPUA		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.14
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION/INFLOW

POTENTIAL EXFILTRATION

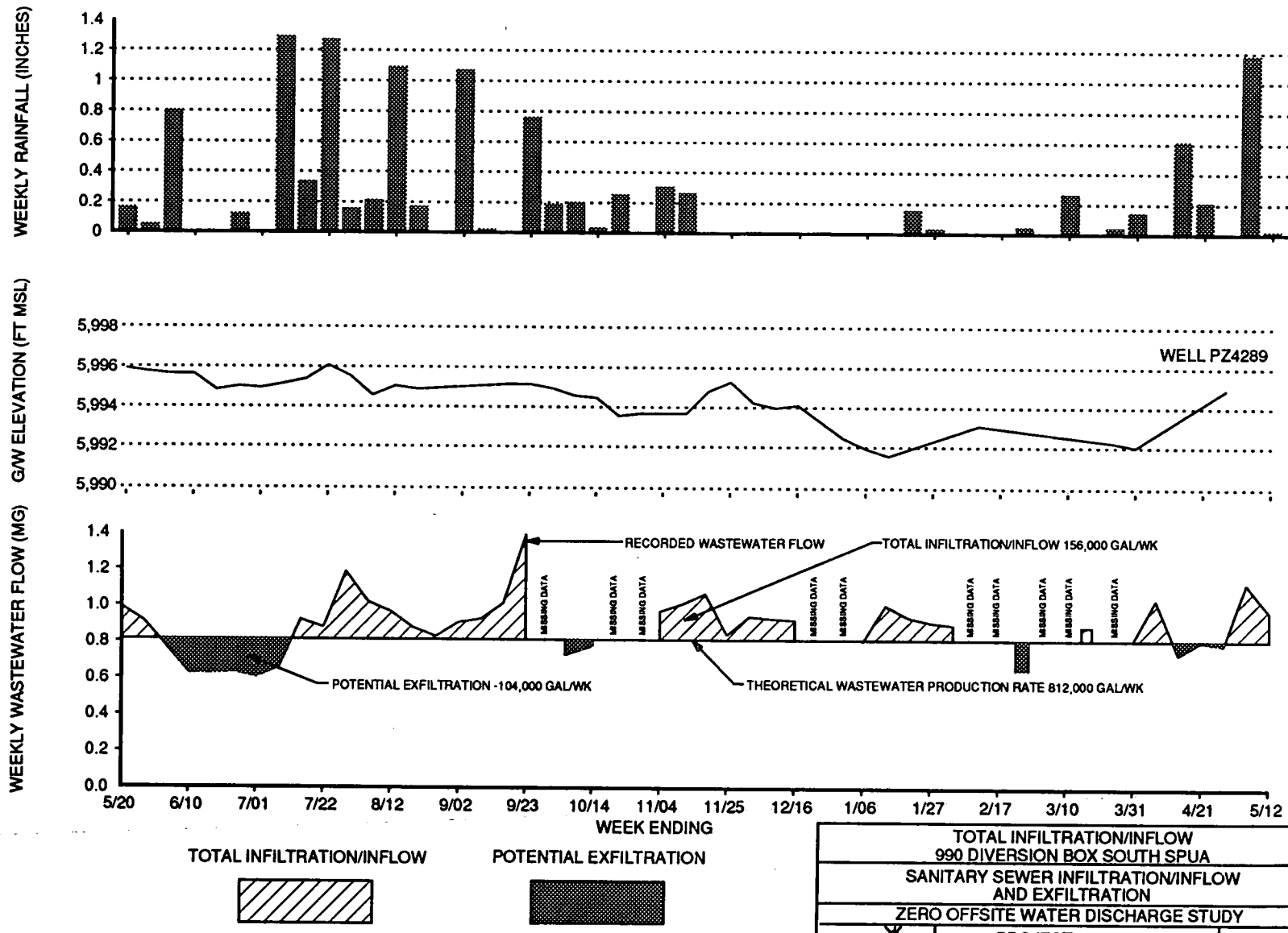
TOTAL INFILTRATION/INFLOW MANHOLE MH-3		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.15
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION

POTENTIAL EXFILTRATION

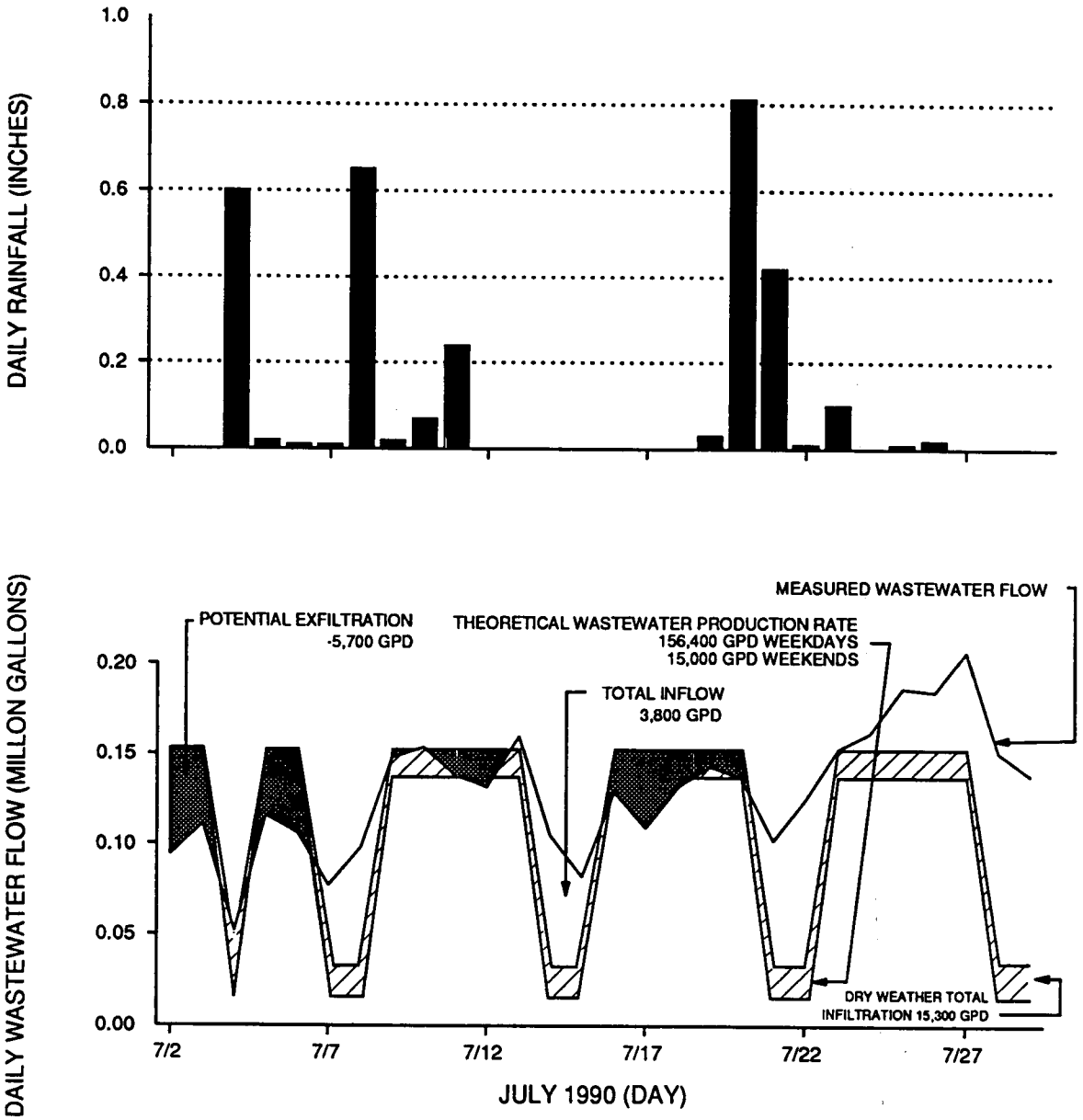
TOTAL INFILTRATION AND TOTAL INFLOW MANHOLE MH-3		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.16
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION/INFLOW

POTENTIAL EXFILTRATION

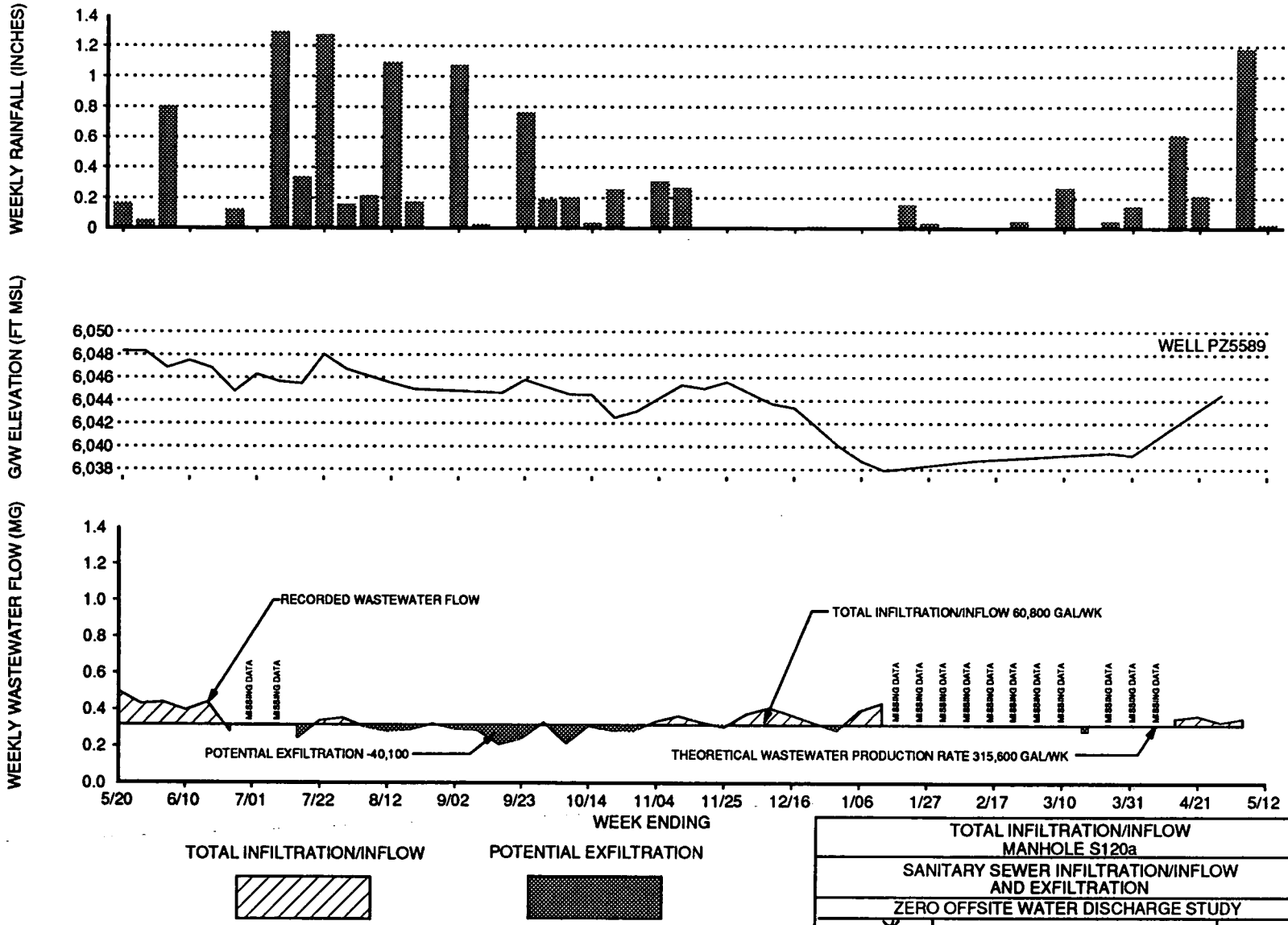
TOTAL INFILTRATION/INFLOW 990 DIVERSION BOX SOUTH SPUA		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.17
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION

POTENTIAL EXFILTRATION

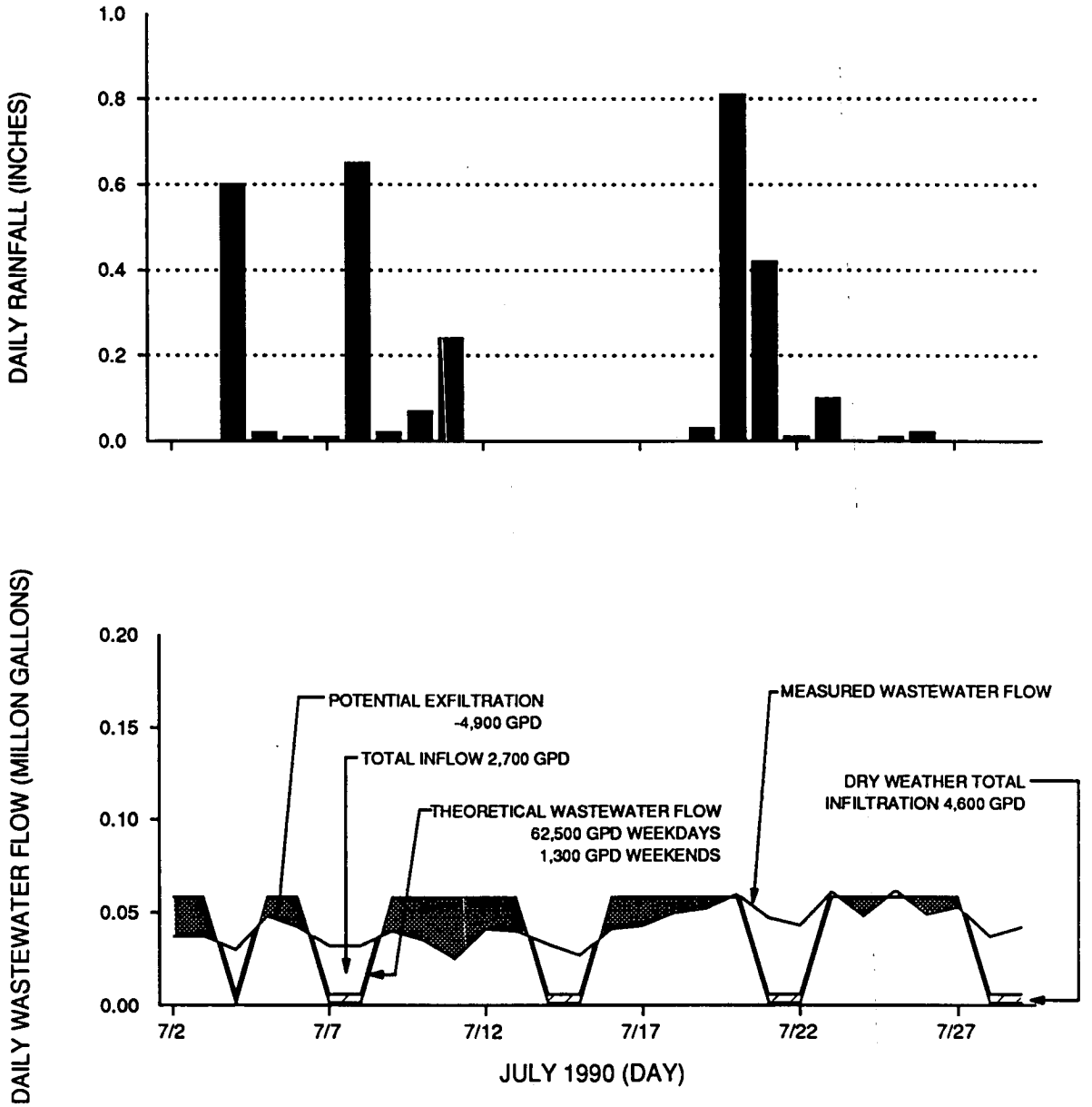
TOTAL INFILTRATION AND TOTAL INFLOW 990 DIVERSION BOX SOUTH SPUA		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.18
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION/INFLOW

POTENTIAL EXFILTRATION

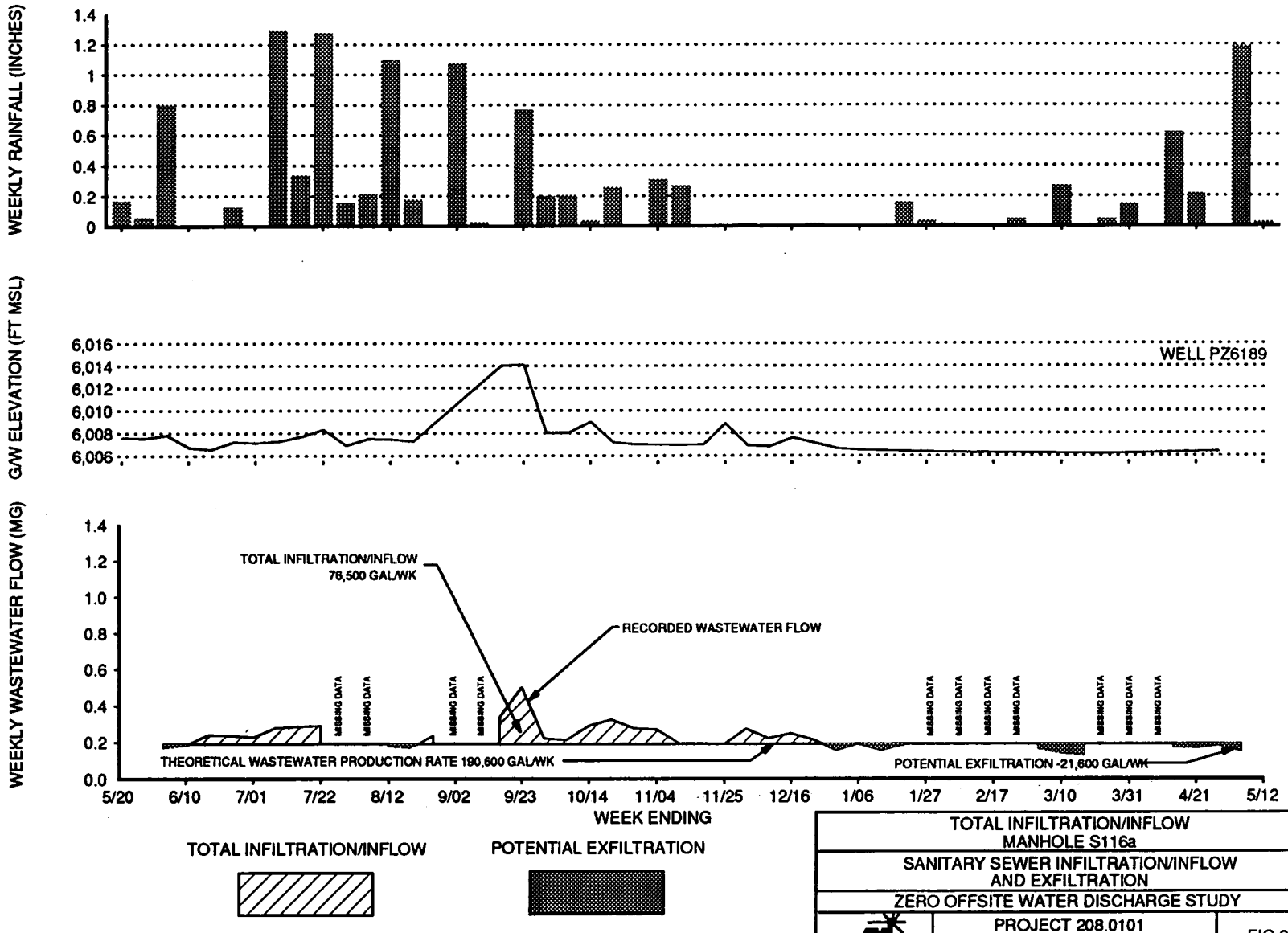
TOTAL INFILTRATION/INFLOW MANHOLE S120a		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.19
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION

POTENTIAL EXFILTRATION

TOTAL INFILTRATION AND TOTAL INFLOW MANHOLE S120a		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.20
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION/INFLOW
MANHOLE S116a

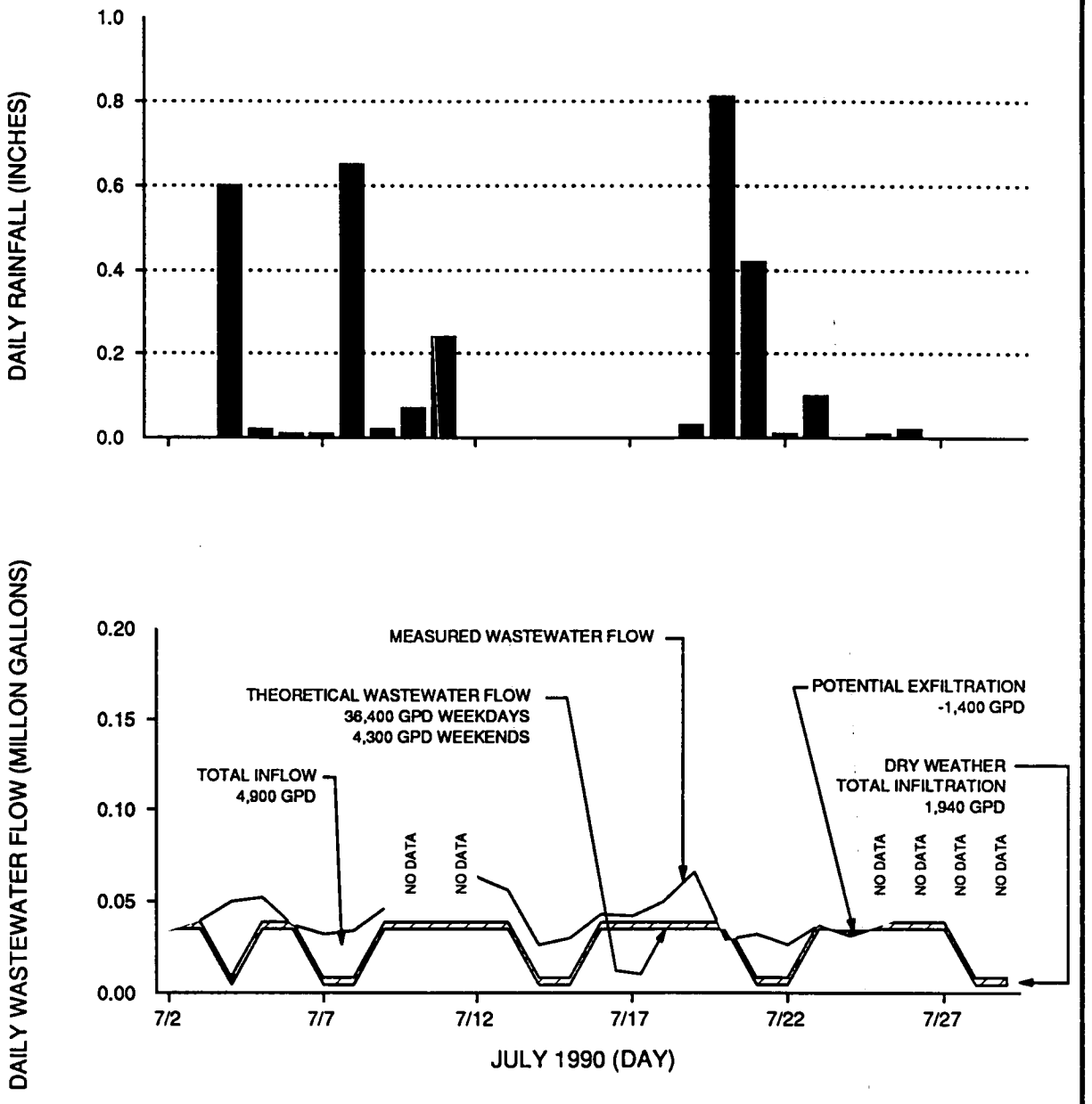
SANITARY SEWER INFILTRATION/INFLOW
AND EXFILTRATION

ZERO OFFSITE WATER DISCHARGE STUDY

PROJECT 208.0101

DATE: SEPTEMBER 1991

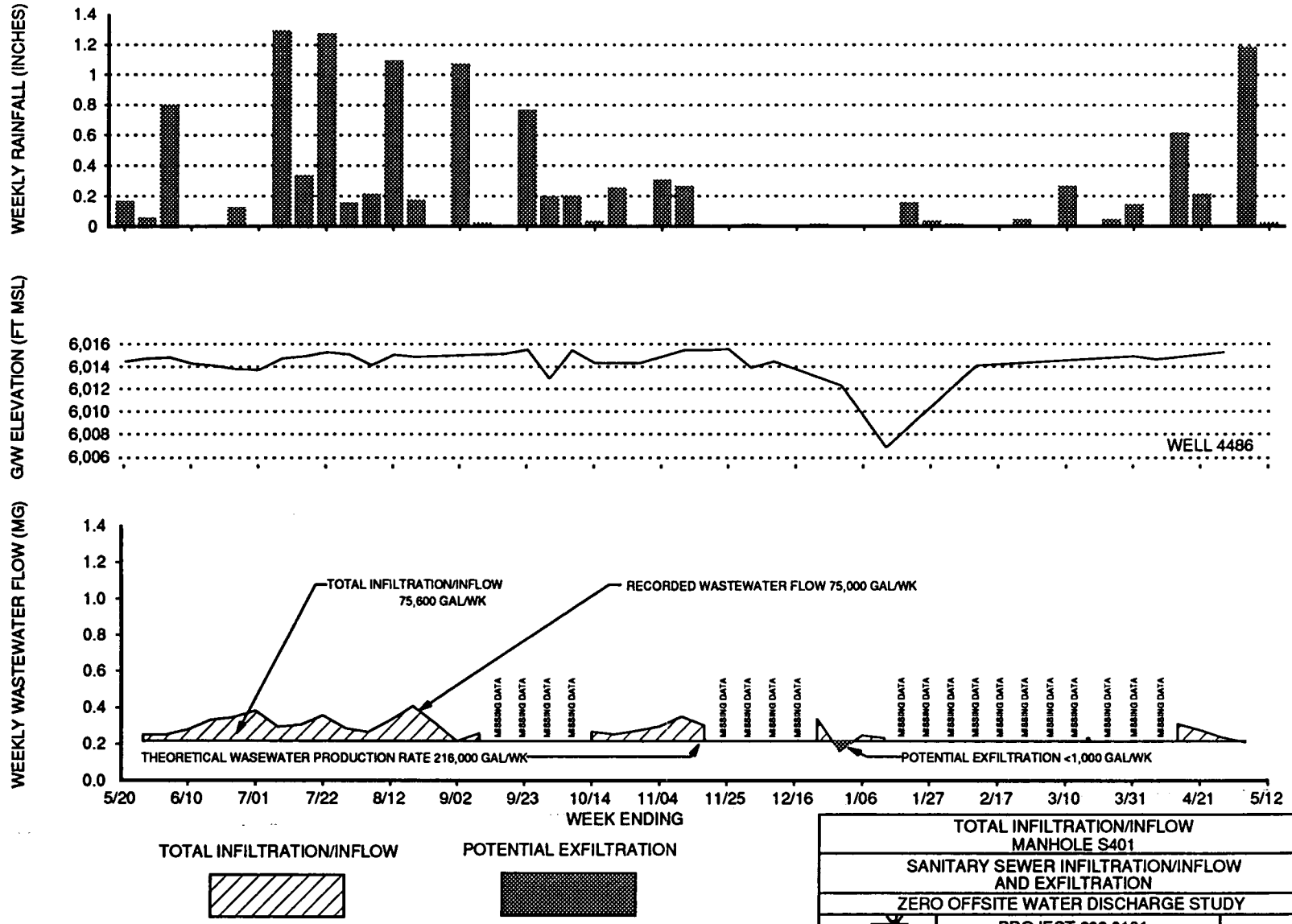
FIG.21



TOTAL INFILTRATION

POTENTIAL EXFILTRATION

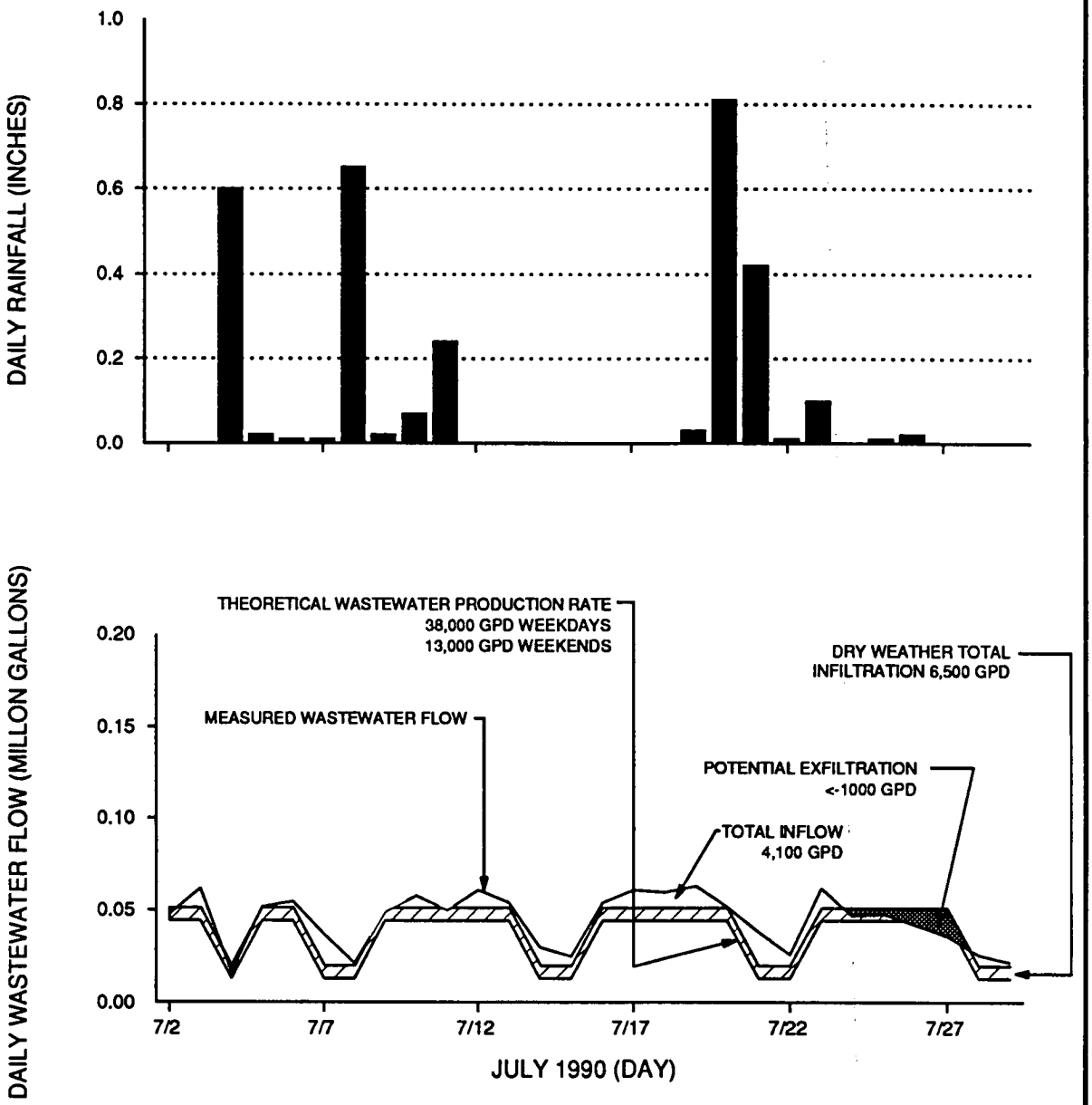
TOTAL INFILTRATION AND TOTAL INFLOW MANHOLE S116a		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.22
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION/INFLOW

POTENTIAL EXFILTRATION

TOTAL INFILTRATION/INFLOW MANHOLE S401		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.23
	DATE: SEPTEMBER 1991	



TOTAL INFILTRATION

POTENTIAL EXFILTRATION

TOTAL INFILTRATION AND TOTAL INFLOW MANHOLE S401		
SANITARY SEWER INFILTRATION/INFLOW AND EXFILTRATION		
ZERO OFFSITE WATER DISCHARGE STUDY		
	PROJECT 208.0101	FIG.24
	DATE: SEPTEMBER 1991	

A

APPENDIX A

DAILY PRECIPITATION AND SANITARY SEWER
DAILY MONITORING DATA

APPENDIX A-1

PRECIPITATION DATA, EG&G METEOROLOGICAL STATION
IN THE WEST BUFFER ZONE, OCTOBER 1989
THROUGH AUGUST 1991

EG&G PRECIPITATION STATION IN WEST BUFFER ZONE

PRECIPITATION, IN INCHES, WATER YEAR OCTOBER 1989 TO SEPTEMBER 1990

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.02	.88
2	.00	.00	.00	.00	.10	.00	.00	.00	.00	.00	.06	.14
3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00*	.00
4	.00	.00	.00	.00	.00	.00	.05	.58	.00	.60	.00*	.00
5	.00	.00	.00	.00	.00	.18	.33	.00	.00	.02	.01*	.00
6	.00	.00	.00	.00	.00	.89	.00	.00	.00	.01	.00*	.02
7	.00	.00	.07	.00	.00	.05	.00	.00	.00	.01	.00*	.00
8	.00	.00	.00	.00	.00	.00	.04	.07	.00	.65	.00	.00
9	.00	.00	.00	.00	.00	.04	.13	.00	.00	.02	.00	.00
10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.07	.00	.01
11	.00	.00	.00	.00	.00	.00	.00	.13	.00	.24	.71*	.00
12	.00	.00	.00	.00	.00	.00	.01	.03	.00	.00	.38*	.00
13	.00	.00	.00	.00	.01	.45	.00	.00	.00	.00	.02*	.00
14	.00	.00	.00	.00	.00	.43	.01	.00	.00	.00	.07	.00
15	.00	.00	.00	.05	.00	.03	.00	.02	.00	.00	.03	.00
16	.00	.00	.00	.00	.00	.00	.04	.14	.00	.00	.00	.00
17	.01	.01	.10	.00	.00	.00	.00	.00	.00	.00	.05*	.05
18	.00	.00	.00	.07	.00	.04	.02	.00	.00	.00	.00*	.61
19	.00	.00	.02	.15	.00	.00	.05	.00	.12	.03	.00*	.01
20	.00	.00	.00	.00	.01	.00	.00	.00	.00	.80	.00*	.08
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.43	.00*	.01
22	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00*	.00
23	.01	.00	.00	.00	.00	.03	.20	.00	.00	.10	.00	.00
24	.00	.00	.00	.01	.00	.00	.25	.00	.00	.00	.00	.00
25	.00	.03	.00	.00	.00	.00	.15	.00	.00	.01	.00	.03
26	.00	.00	.00	.00	.00	.00	.00	.05	.00	.02	.00	.00
27	.00	.04	.00	.00	.03	.21	.00	.00	.00	.00	.00	.01
28	.00	.00	.00	.00	.02	.07	.00	.14	.00	.00	.00	.06
29	.00	.00	.00	.00	---	.15	.05	.48	.00	.02	.00	.09
30	.00	.00	.00	.00	---	.02	.00	.18	.00	.12	.02	.00
31	.09	---	.13	.00	---	.00	---	.00	---	.00	.03	---
TOTAL	.11	.10	.32	.28	.17	2.59	1.33	1.82	.12	3.16	1.40	2.00
MEAN	.00	.00	.01	.01	.01	.08	.04	.06	.00	.10	.05	.07
MAX	.09	.04	.13	.15	.10	.89	.33	.58	.12	.80	.71	.88
MIN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

WATER YEAR TOTAL 13.40 MEAN .04 MAX .89 MIN .00

NOTE: --- INDICATES NO DATA FOR A GIVEN DAY

* BOULDER, COLORADO DATA

EG&G PRECIPITATION STATION IN WEST BUFFER ZONE
PRECIPITATION, IN INCHES, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.00	.00	.00	.00	.00	.00	1.11	.00	.04	---
2	.07	.24	.00	.00	.00	.00	.00	.00	.24	.10	.18	---
3	.00	.06	.00	.00	.00	.00	.00	.00	.07	.01	.58	---
4	.00	.00	.00	.00	.00	.00	.00	.50	.00	.00	.04	---
5	.00	.01	.00	.00	.00	.26	.00	.00	.00	.00	.00	---
6	.00	.25	.00	.00	.00	.00	---	.00	.07	.00	1.15	---
7	.13	.00	.00	.00	.00	.00	---	.02	.41	.00	.00	---
8	.03	.00	.00	.00	.00	.00	.04	.00	.00	.00	.00	---
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.78	.17	---
10	.00	.00	.00	.00	.00	.00	.00	.00	.10	.07	.00	---
11	.00	.00	.00	.00	.00	.00	.35	.00	.00	.36	.00	---
12	.00	.00	.00	.00	.00	.00	.22	.00	.00	.03	.04	---
13	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00	.01	---
14	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	---
15	.00	.00	.00	.00	.00	.00	.00	.68	.00	.00	.01	---
16	.00	.00	.00	.00	.00	.00	.00	.96	.06	.00	.16	---
17	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	---
18	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01	---
19	.08	.00	.00	.14	.00	.00	.00	.00	.00	.09	.00	---
20	.17	.00	.00	.01	.00	.00	.00	.00	.00	.00	.02	---
21	.00	.00	.00	.00	.00	.01	.21	.00	.15	.01	.00	---
22	.00	.00	.00	.00	.00	.03	.00	.52	.00	.48	.01	---
23	.00	.00	.00	.03	.00	.00	.00	.15	.00	.25	.00	---
24	.00	.00	.00	.00	.04	.00	.00	.04	.00	.15	.00	---
25	.00	.00	.00	.00	.00	.00	.00	.01	.00	.06	.00	---
26	.00	.01	.00	.00	.00	.01	.00	.00	.00	.14	.00	---
27	.00	.00	.00	.00	.00	.00	.00	.02	.03	.00	.00	---
28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	---
29	.00	.00	.00	.01	---	.10	.31	.00	.02	.00	.00	---
30	.00	.00	.00	.00	---	.00	.37	.00	.00	.00	.00	---
31	.00	---	.00	.00	---	.00	---	.85	---	.00	.00	---
TOTAL	.48	.57	.01	.19	.04	.41	1.50	3.76	2.30	2.53	2.45	---
MEAN	.02	.02	.00	.01	.00	.01	.05	.12	.08	.08	.08	---
MAX	.17	.25	.01	.14	.04	.26	.37	.96	1.11	.78	1.15	---
MIN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	---

WATER YEAR TOTAL 14.24 MEAN .04 MAX 1.15 MIN .00

NOTE: --- INDICATES NO DATA FOR A GIVEN DAY

APPENDIX A-2

AVERAGE DAILY FLOWS FOR SANITARY SEWER
MONITORING SITES AND TOTAL DAILY FLOWS
AT THE STP (BUILDING 995),
MAY 11, 1990 THROUGH MAY 13, 1991

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
5	11	0.137	0.099	0.017	--	0.065	0.007	0.248
5	12	0.092	0.061	0.008	--	0.033	--	0.140
5	13	0.077	0.058	0.010	--	0.027	--	0.114
5	14	0.144	0.078	0.026	--	0.045	--	0.208
5	15	0.162	0.083	0.030	0.065	0.063	0.041	0.218
5	16	0.153	0.123	0.034	0.040	0.100	0.042	0.268
5	17	0.149	0.088	0.034	0.033	0.083	0.022	0.200
5	18	0.160	0.082	0.048	0.045	0.090	0.027	0.220
5	19	0.111	0.063	0.025	0.025	0.061	0.023	0.136
5	20	0.108	0.052	0.021	0.028	0.055	0.025	0.127
5	21	0.165	0.090	0.061	0.047	0.082	--	0.198
5	22	0.129	0.083	0.057	0.040	0.088	--	0.164
5	23	0.178	0.125	0.028	0.070	0.063	--	0.256
5	24	0.138	0.129	0.037	0.033	0.057	0.031	0.226
5	25	0.137	0.109	0.025	0.029	0.058	0.035	0.212
5	26	0.085	0.052	0.017	0.014	0.039	0.032	0.140
5	27	0.079	0.047	0.016	0.015	0.044	0.023	0.104
5	28	0.079	0.056	0.019	0.014	0.041	0.022	0.106
5	29	0.156	0.149	0.045	0.052	0.077	0.025	0.256
5	30	0.124	0.108	0.027	0.047	0.075	0.026	0.242
5	31	0.135	0.116	0.014	0.047	0.081	0.027	0.280
6	1	0.132	0.105	0.014	0.047	0.070	0.023	0.262
6	2	0.075	0.076	0.004	0.023	0.048	0.021	0.146
6	3	0.070	0.072	0.007	0.019	0.045	0.025	0.132
6	4	0.129	0.110	0.018	0.043	0.063	0.026	0.208
6	5	0.153	0.133	0.028	0.043	0.059	0.027	0.208
6	6	0.094	0.134	0.035	0.059	0.067	0.029	0.306
6	7	0.085	0.121	0.024	0.043	0.070	0.029	0.244
6	8	0.092	0.129	0.035	0.043	0.051	0.028	0.216
6	9	0.035	0.066	0.011	0.024	0.042	0.023	0.124
6	10	0.038	0.050	0.008	0.023	0.045	0.021	0.110
6	11	0.107	0.069	0.025	0.044	0.074	0.030	0.216
6	12	0.118	0.089	0.026	0.053	0.061	0.035	0.224
6	13	0.121	0.143	0.023	0.059	0.069	0.036	0.214
6	14	0.105	0.153	0.015	0.059	0.066	0.036	0.212
6	15	0.092	0.165	0.025	0.047	0.074	0.038	0.214

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
6	16	0.033	0.052	0.023	0.026	0.045	0.031	0.110
6	17	0.046	0.060	0.023	0.041	0.047	0.033	0.140
6	18	0.091	0.115	0.023	0.056	0.094	0.035	0.192
6	19	0.081	0.135	0.013	0.056	0.046	0.040	0.168
6	20	0.102	0.111	0.019	0.054	0.053	0.034	0.252
6	21	0.117	0.093	0.020	0.062	0.016	0.032	0.206
6	22	0.109	0.124	0.016	0.048	0.018	0.037	0.210
6	23	0.074	0.070	0.010	0.043	0.016	0.031	0.146
6	24	0.058	0.052	0.009	0.026	0.036	0.027	0.116
6	25	0.125	0.103	0.019	0.070	0.043	0.039	0.202
6	26	0.121	0.134	0.019	0.057	0.000	0.037	0.194
6	27	0.103	0.117	0.050	0.081	0.027	0.039	0.216
6	28	0.096	0.145	0.053	0.076	0.064	0.032	0.242
6	29	0.096	0.171	0.117	0.070	--	0.032	0.284
6	30	0.029	0.052	0.046	0.015	--	0.025	0.086
7	1	0.034	0.078	0.045	0.012	--	0.023	0.112
7	2	0.094	0.104	0.063	0.048	--	0.034	0.190
7	3	0.111	0.114	0.027	0.062	0.037	0.039	0.208
7	4	0.052	0.068	0.006	0.017	0.030	0.050	0.126
7	5	0.116	0.104	0.034	0.052	0.048	0.052	0.160
7	6	0.106	0.101	0.037	0.055	0.042	0.037	0.284
7	7	0.077	0.072	0.019	0.037	0.032	0.032	0.166
7	8	0.098	0.096	0.020	0.021	0.032	0.034	0.166
7	9	0.148	0.142	0.037	0.056	0.040	0.046	0.258
7	10	0.154	0.140	0.036	0.058	0.035	--	0.294
7	11	0.138	0.100	0.070	0.050	0.025	--	0.268
7	12	0.132	0.134	0.011	0.061	0.041	0.063	0.230
7	13	0.160	0.135	0.018	0.054	0.044	0.056	0.276
7	14	0.105	0.069	0.010	0.030	0.033	0.026	0.198
7	15	0.082	0.058	0.017	0.025	0.027	0.030	0.120
7	16	0.129	0.113	0.019	0.054	0.041	0.043	0.232
7	17	0.109	0.095	0.018	0.061	0.043	0.042	0.256
7	18	0.132	0.101	0.024	0.060	0.050	0.050	0.257
7	19	0.143	0.118	0.036	0.063	0.052	0.066	0.288
7	20	0.137	0.118	0.025	0.052	0.060	0.029	0.294
7	21	0.102	0.105	0.010	0.038	0.048	0.032	0.242

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
7	22	0.125	0.092	0.011	0.026	0.043	0.026	0.196
7	23	0.154	0.121	0.025	0.062	0.061	0.037	0.266
7	24	0.162	0.084	0.018	0.047	0.048	0.031	0.250
7	25	0.187	0.088	0.022	0.048	0.062	0.037	0.242
7	26	0.185	0.087	0.026	0.042	0.049	--	0.256
7	27	0.207	0.124	0.040	0.036	0.053	--	0.306
7	28	0.151	0.066	0.029	0.026	0.038	--	0.222
7	29	0.138	0.050	0.019	0.022	0.042	--	0.178
7	30	0.237	0.071	0.036	0.037	0.055	--	0.220
7	31	0.167	0.080	0.026	0.043	0.056	--	0.220
8	1	0.141	0.087	0.023	0.047	0.040	--	0.262
8	2	0.149	0.091	0.030	0.063	0.040	0.055	0.272
8	3	0.149	0.092	0.041	0.045	0.041	0.059	0.284
8	4	0.086	0.071	0.016	0.018	0.033	0.05	0.230
8	5	0.087	0.071	0.035	0.012	0.039	0.037	0.178
8	6	0.138	0.103	0.066	0.045	0.047	0.035	0.224
8	7	0.125	0.106	0.069	0.041	0.052	0.017	0.258
8	8	0.147	0.066	0.077	0.044	0.045	0.017	0.224
8	9	0.164	0.060	0.044	0.061	0.037	0.025	0.230
8	10	0.161	0.063	0.041	0.067	0.034	0.031	0.274
8	11	0.116	0.045	0.033	0.040	0.032	0.025	0.168
8	12	0.113	0.048	0.034	0.031	0.034	0.029	0.166
8	13	0.171	0.079	0.061	0.056	0.039	0.028	0.220
8	14	0.158	0.100	0.047	0.041	0.028	0.029	0.256
8	15	0.121	0.107	0.056	0.066	0.048	0.021	0.254
8	16	0.129	0.092	0.054	0.079	0.047	0.026	0.246
8	17	0.135	0.101	0.037	0.073	0.045	0.026	0.240
8	18	0.085	0.063	0.032	0.052	0.041	0.022	0.200
8	19	0.077	0.053	0.025	0.041	0.043	0.017	0.182
8	20	0.138	0.092	0.027	0.075	0.052	0.027	0.200
8	21	0.127	0.092	0.028	0.067	0.048	0.021	0.276
8	22	0.129	0.099	0.026	0.077	0.050	0.016	0.276
8	23	0.129	0.092	0.045	0.036	0.050	0.039	0.224
8	24	0.135	0.099	0.058	0.030	0.052	0.039	0.286
8	25	0.090	0.072	0.043	0.014	0.034	0.048	0.202
8	26	0.081	0.069	0.045	0.012	0.036	0.046	0.172

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
8	27	0.140	0.096	0.065	0.037	0.043	0.052	0.236
8	28	0.143	0.095	0.048	0.033	0.043	0.050	0.234
8	29	0.143	0.076	0.033	0.043	0.048	0.054	0.220
8	30	0.153	0.079	0.026	0.034	0.040	--	0.230
8	31	0.145	0.074	0.030	0.034	0.041	--	0.232
9	1	0.094	0.073	0.025	0.019	0.037	--	0.146
9	2	0.088	0.054	0.034	0.017	0.040	--	0.158
9	3	0.079	0.057	0.032	0.022	0.040	--	0.148
9	4	0.173	0.063	0.036	0.046	0.048	--	0.190
9	5	0.185	0.059	0.032	0.044	0.039	--	0.240
9	6	0.158	0.064	0.012	0.059	0.037	0.099	0.234
9	7	0.124	0.062	0.008	0.037	0.036	0.054	0.226
9	8	0.109	0.031	0.008	0.028	0.037	0.039	0.144
9	9	0.097	0.029	0.010	0.023	0.051	0.038	0.120
9	10	0.157	0.070	0.008	0.039	0.038	0.053	0.178
9	11	0.167	0.058	0.007	0.043	0.039	0.045	0.218
9	12	0.148	0.065	0.013	0.039	0.044	0.042	0.198
9	13	0.162	0.065	0.021	0.045	0.026	0.054	0.338
9	14	0.175	0.065	--	--	0.024	0.057	0.338
9	15	0.114	0.034	--	--	0.019	0.040	0.270
9	16	0.121	0.041	--	--	0.021	0.047	0.212
9	17	0.206	0.100	--	--	0.025	0.058	0.280
9	18	0.223	0.057	--	--	0.023	0.064	0.324
9	19	0.218	0.043	--	--	0.021	0.081	0.384
9	20	0.202	0.036	--	--	0.033	0.091	0.346
9	21	0.200	0.065	--	--	0.055	0.087	0.240
9	22	0.169	0.075	--	--	0.041	0.063	0.131
9	23	0.171	0.076	--	--	0.043	0.056	0.115
9	24	--	0.083	--	--	0.046	0.044	0.183
9	25	--	--	--	--	0.105	0.038	0.162
9	26	--	--	--	--	0.085	0.037	0.194
9	27	0.129	0.070	--	--	0.034	0.032	0.212
9	28	0.128	0.063	--	--	0.025	0.032	0.190
9	29	0.095	0.040	--	--	0.017	0.025	0.150
9	30	0.085	0.035	--	--	0.017	0.014	0.100
10	1	0.129	0.067	--	--	0.023	0.021	0.166

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
10	2	0.124	0.080	--	--	0.019	0.026	0.168
10	3	0.115	0.077	--	--	0.023	0.021	0.176
10	4	0.098	0.090	0.031	0.028	0.038	0.030	0.182
10	5	0.094	0.058	0.031	0.037	0.045	0.028	0.188
10	6	0.081	0.025	0.034	0.015	0.037	0.041	0.122
10	7	0.083	0.028	0.047	0.017	0.033	0.047	0.102
10	8	0.146	0.080	0.042	0.026	0.049	0.057	0.184
10	9	0.124	0.074	0.010	0.039	0.049	0.050	0.200
10	10	0.127	0.065	0.008	0.028	0.050	0.043	0.194
10	11	0.137	0.059	0.013	0.059	0.047	0.049	0.204
10	12	0.112	0.052	0.008	0.051	0.046	0.037	0.196
10	13	0.067	0.030	0.005	0.029	0.036	0.027	0.130
10	14	0.065	0.037	0.005	0.035	0.034	0.025	0.106
10	15	0.114	0.063	0.007	0.039	0.045	0.031	0.164
10	16	0.120	0.065	0.011	0.034	0.046	0.030	0.160
10	17	0.123	0.071	0.016	0.037	0.054	0.036	0.154
10	18	0.149	0.068	0.021	0.043	0.048	0.058	0.164
10	19	--	--	0.023	0.049	0.037	0.067	0.160
10	20	--	--	0.021	0.027	0.029	0.055	0.132
10	21	--	--	0.011	0.023	0.028	0.044	0.108
10	22	--	--	0.010	0.051	0.038	0.042	0.154
10	23	--	--	0.008	0.040	0.047	0.048	0.166
10	24	--	--	0.007	0.032	0.048	0.054	0.276
10	25	--	--	0.012	0.045	0.047	0.043	0.258
10	26	0.142	0.054	0.010	0.044	0.047	0.037	0.262
10	27	0.108	0.032	0.003	0.037	0.028	0.032	0.210
10	28	0.099	0.037	0.004	0.024	0.028	0.018	0.190
10	29	0.167	0.068	0.017	0.049	0.047	0.034	0.258
10	30	0.157	0.101	0.034	0.044	0.047	0.036	0.278
10	31	0.162	0.068	0.014	0.051	0.046	0.043	0.274
11	1	0.157	0.082	0.019	0.048	0.052	0.043	0.250
11	2	0.130	0.076	0.022	0.051	0.075	0.049	0.268
11	3	0.105	0.021	0.009	0.030	0.032	0.030	0.196
11	4	0.090	0.032	0.005	0.021	0.036	0.035	0.142
11	5	0.197	0.111	0.042	0.068	0.056	0.042	0.248
11	6	0.149	0.089	0.061	0.058	0.057	0.036	0.242

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
11	7	0.183	0.060	0.039	0.045	0.065	0.028	0.222
11	8	0.152	0.052	0.023	0.072	0.063	0.029	0.246
11	9	0.148	0.070	0.012	0.056	0.054	0.023	0.180
11	10	0.087	0.056	0.010	0.026	0.034	0.016	0.194
11	11	0.092	0.033	0.004	0.025	0.034	0.015	0.086
11	12	0.182	0.145	0.055	0.067	0.066	0.021	0.170
11	13	0.160	0.140	0.047	0.047	0.056	0.020	0.202
11	14	0.160	0.094	0.015	0.034	0.047	0.028	0.262
11	15	0.162	0.086	0.014	0.039	0.050	0.030	0.352
11	16	0.148	0.100	0.011	0.050	0.052	0.041	0.338
11	17	0.127	0.090	0.028	0.032	0.030	0.026	0.270
11	18	0.126	0.078	0.008	0.033	0.030	0.023	0.142
11	19	0.193	0.079	0.020	0.054	0.053	0.027	0.234
11	20	0.176	0.074	0.013	0.028	0.052	0.030	0.256
11	21	0.172	0.079	0.013	0.030	0.057	0.037	0.240
11	22	0.078	0.075	0.014	--	0.034	0.028	0.132
11	23	0.079	0.066	0.003	--	0.036	0.023	0.156
11	24	0.061	0.053	0.003	--	0.034	0.023	0.170
11	25	0.081	0.073	0.003	--	0.039	0.023	0.140
11	26	0.174	0.106	0.006	--	0.052	0.039	0.218
11	27	0.149	0.109	0.008	--	0.057	0.041	0.254
11	28	0.150	0.120	0.014	0.035	0.066	0.038	0.256
11	29	0.138	0.089	0.011	0.036	0.065	0.041	0.256
11	30	0.156	0.083	0.012	0.061	0.057	0.042	0.266
12	1	0.082	0.063	0.006	0.027	0.035	0.034	0.154
12	2	0.090	0.059	0.006	0.032	0.044	0.037	0.138
12	3	0.152	0.086	0.012	0.058	0.063	0.042	0.236
12	4	0.158	0.085	0.013	0.065	0.062	0.035	0.266
12	5	0.161	0.101	0.030	0.067	0.067	0.044	0.248
12	6	0.177	0.103	0.032	--	0.063	0.038	0.258
12	7	0.140	0.085	0.027	--	0.063	0.026	0.240
12	8	0.062	0.067	0.024	--	0.047	0.018	0.180
12	9	0.078	0.051	0.003	--	0.044	0.019	0.130
12	10	0.145	0.083	0.018	--	0.074	0.028	0.212
12	11	0.142	0.074	0.028	--	0.073	0.036	0.236
12	12	0.146	0.082	0.026	0.042	0.057	0.059	0.224

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
12	13	0.184	0.138	0.044	0.049	0.058	0.036	0.254
12	14	0.134	0.065	0.016	0.039	0.043	0.034	0.258
12	15	0.069	0.017	0.003	0.021	0.034	0.030	0.166
12	16	0.098	0.019	0.004	0.020	0.032	0.023	0.111
12	17	0.182	0.028	0.021	0.057	0.056	0.030	0.206
12	18	0.140	0.030	0.023	0.055	0.052	0.048	0.238
12	19	0.140	0.032	0.021	0.059	0.065	0.047	0.233
12	20	0.167	0.041	0.010	0.054	0.041	0.026	0.226
12	21	--	--	0.015	0.052	0.052	0.024	0.232
12	22	--	--	0.012	0.030	0.030	0.015	0.142
12	23	--	--	0.011	0.030	0.030	0.022	0.134
12	24	--	--	0.017	0.042	0.046	0.023	0.142
12	25	--	--	0.019	0.017	0.028	0.022	0.148
12	26	0.091	0.058	0.012	0.026	0.033	0.024	0.126
12	27	0.085	0.054	0.017	0.016	0.038	0.023	0.126
12	28	0.077	0.026	0.023	0.019	0.048	0.018	0.122
12	29	0.091	0.021	0.013	0.024	0.046	0.027	0.128
12	30	0.064	0.024	0.010	0.017	0.048	0.020	0.136
12	31	0.083	0.025	0.014	0.020	0.063	0.022	0.106
1	1	0.095	0.021	0.015	0.040	0.057	0.018	0.134
1	2	0.150	0.036	0.028	0.075	0.077	0.037	0.200
1	3	0.128	0.059	0.028	0.037	0.056	0.025	0.210
1	4	0.154	0.057	0.025	0.038	0.066	0.034	0.212
1	5	0.097	0.044	0.019	0.020	0.036	0.027	0.184
1	6	0.097	0.044	0.042	0.016	0.037	0.026	0.164
1	7	0.169	0.043	0.017	0.036	0.072	0.028	0.196
1	8	0.167	0.040	0.019	0.034	0.076	0.016	0.222
1	9	0.172	0.037	0.017	0.042	0.070	0.026	0.238
1	10	0.152	0.069	0.012	0.041	0.072	0.033	0.242
1	11	0.160	0.083	0.021	0.039	0.068	0.023	0.222
1	12	0.098	0.064	0.008	0.021	0.039	0.012	0.146
1	13	0.085	0.098	0.034	0.019	0.038	0.017	0.158
1	14	0.165	0.085	0.030	0.039	0.068	0.026	0.234
1	15	0.174	0.089	0.022	0.046	0.054	0.023	0.250
1	16	0.165	0.083	0.020	0.046	0.054	0.021	0.236
1	17	0.143	0.069	--	--	--	0.030	0.232

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
1	18	0.140	0.067	--	--	--	0.039	0.242
1	19	0.077	0.042	--	--	--	0.026	0.154
1	20	0.071	0.076	--	--	--	0.019	0.164
1	21	0.138	0.083	--	--	--	0.019	0.251
1	22	0.174	0.078	--	--	--	--	0.252
1	23	0.171	0.078	--	--	--	--	0.254
1	24	0.138	0.073	--	--	--	--	0.248
1	25	0.139	0.065	--	--	--	--	0.244
1	26	0.101	0.056	--	--	--	--	0.178
1	27	0.047	0.039	--	--	--	--	0.080
1	28	0.160	0.059	--	--	--	--	0.182
1	29	0.158	0.048	--	--	--	--	0.276
1	30	0.137	0.065	--	--	--	--	0.216
1	31	0.134	0.089	--	--	--	--	0.194
2	1	0.132	0.069	0.010	--	0.049	0.028	0.114
2	2	0.080	0.047	0.003	--	0.026	0.020	0.100
2	3	0.094	0.067	0.017	--	0.023	0.041	0.138
2	4	0.156	0.089	0.010	--	0.039	--	0.180
2	5	0.168	0.144	0.028	--	0.042	--	0.222
2	6	0.173	0.085	0.012	--	0.045	--	0.294
2	7	0.180	0.068	0.010	--	0.038	--	0.232
2	8	--	--	0.011	--	0.042	--	0.192
2	9	--	--	--	--	--	--	0.126
2	10	--	--	--	--	--	--	0.102
2	11	--	--	--	--	--	--	0.186
2	12	--	--	0.025	--	0.037	0.034	0.190
2	13	--	--	0.014	--	0.039	0.037	0.208
2	14	--	--	0.013	--	0.041	--	0.206
2	15	0.107	0.047	0.013	--	0.038	--	0.210
2	16	0.076	0.047	0.008	--	0.031	0.033	0.146
2	17	0.072	0.064	0.027	--	0.036	0.020	0.138
2	18	0.127	0.089	0.022	--	--	0.022	0.200
2	19	0.113	0.058	0.019	--	--	0.023	0.212
2	20	0.160	0.059	0.017	--	--	--	0.182
2	21	0.070	0.068	--	--	--	--	0.180
2	22	0.081	0.059	0.014	--	--	0.005	0.166

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
2	23	0.047	0.043	0.010	--	--	0.018	0.096
2	24	0.052	0.091	0.021	--	--	0.021	0.148
2	25	0.105	0.090	0.012	--	--	0.034	0.182
2	26	0.116	0.100	0.014	--	--	0.028	0.210
2	27	0.123	0.072	0.016	--	--	0.025	0.200
2	28	0.125	0.088	0.025	--	--	0.021	0.204
3	1	--	--	0.032	--	--	0.025	0.196
3	2	--	--	--	--	--	0.019	0.134
3	3	--	--	--	--	--	0.012	0.122
3	4	--	--	0.011	--	--	0.019	0.196
3	5	--	--	0.013	--	--	0.023	0.220
3	6	--	--	0.007	--	--	0.025	0.228
3	7	--	--	0.014	--	--	0.025	0.232
3	8	--	--	0.015	0.039	0.039	0.026	0.240
3	9	--	--	0.006	0.018	0.030	0.014	0.168
3	10	--	--	0.008	0.016	0.032	0.006	0.138
3	11	0.141	0.092	0.014	0.037	0.045	0.012	0.204
3	12	0.146	0.078	0.014	0.040	0.039	0.015	0.218
3	13	0.141	0.111	0.011	0.036	0.043	0.017	0.212
3	14	0.148	0.115	0.011	0.043	0.044	0.021	0.286
3	15	0.142	0.078	0.012	0.032	0.047	0.021	0.238
3	16	0.085	0.072	0.014	0.025	0.034	0.020	0.138
3	17	0.081	0.051	0.013	0.018	0.033	0.023	0.130
3	18	0.164	0.092	0.025	0.043	0.054	0.031	0.206
3	19	--	--	0.083	0.038	0.048	0.032	0.226
3	20	--	--	0.016	0.040	0.050	0.044	0.216
3	21	--	--	0.014	0.038	0.057	0.026	0.236
3	22	--	--	0.019	0.055	0.053	0.023	0.228
3	23	--	--	--	--	0.068	--	0.148
3	24	--	--	--	--	--	--	0.140
3	25	0.125	0.043	--	--	--	--	0.198
3	26	0.154	0.059	0.014	0.039	0.046	0.026	0.226
3	27	0.142	0.062	0.012	0.030	0.043	0.030	0.246
3	28	0.132	0.061	0.009	0.033	0.048	0.022	0.220
3	29	0.099	0.068	0.006	0.036	0.031	0.013	0.150
3	30	0.093	0.056	0.008	0.036	0.032	0.016	0.186

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
3	31	0.072	0.034	0.007	0.029	0.028	0.019	0.110
4	1	0.178	0.084	0.062	0.048	0.047	0.030	0.224
4	2	0.143	0.085	--	0.045	0.047	0.032	0.222
4	3	0.145	0.073	--	--	--	0.024	0.248
4	4	0.171	0.098	0.070	0.053	0.051	0.029	0.238
4	5	0.157	0.097	0.032	0.037	0.052	0.025	0.268
4	6	0.114	0.059	0.025	0.022	0.034	0.016	0.218
4	7	0.127	0.074	0.021	0.016	0.033	0.017	0.144
4	8	0.121	0.101	0.026	0.052	0.054	0.025	0.224
4	9	0.103	0.074	0.014	0.061	0.054	0.024	0.238
4	10	0.118	0.081	0.015	0.067	0.055	0.024	0.178
4	11	0.126	0.084	0.012	0.050	0.056	0.031	0.102
4	12	0.118	0.096	0.014	0.041	0.058	0.027	0.200
4	13	0.072	0.090	0.024	0.016	0.040	0.020	0.220
4	14	0.079	0.061	0.006	0.023	0.037	0.017	0.164
4	15	0.164	0.096	0.011	0.046	0.054	0.023	0.268
4	16	0.105	0.079	0.012	0.053	0.051	0.030	0.202
4	17	0.121	0.079	0.009	0.047	0.057	0.030	0.204
4	18	0.139	0.088	0.016	0.050	0.066	0.029	0.206
4	19	0.142	0.084	0.011	0.043	0.054	0.028	0.196
4	20	0.067	0.070	0.006	0.019	0.041	0.021	0.130
4	21	0.070	0.083	0.006	0.016	0.043	0.021	0.130
4	22	0.156	0.118	0.023	0.039	0.061	0.025	0.216
4	23	0.131	0.078	0.011	0.036	0.054	0.024	0.228
4	24	0.130	0.070	0.014	0.034	0.052	0.023	0.204
4	25	0.136	0.070	0.014	0.039	0.055	0.025	0.204
4	26	0.118	0.089	0.016	0.038	0.045	0.021	0.202
4	27	0.058	0.059	0.014	0.023	0.031	0.016	0.172
4	28	0.059	0.066	0.023	0.028	0.034	0.016	0.144
4	29	0.110	0.063	0.013	0.032	0.056	0.023	0.192
4	30	0.182	0.094	0.023	0.028	0.057	0.030	0.214
5	1	0.197	0.075	0.016	0.039	0.053	0.025	0.272
5	2	0.196	0.067	0.016	0.037	0.056	0.028	0.268
5	3	0.172	0.071	0.019	0.038	0.056	0.030	0.210
5	4	0.121	0.073	0.012	0.016	0.037	0.021	0.214
5	5	0.145	0.080	0.015	0.019	0.037	0.018	0.188

AVERAGE DAILY FLOWS FOR SANITARY SEWER MONITORING SITES AND TOTAL DAILY FLOWS AT THE STP (BUILDING 995), MAY 11, 1990 THROUGH MAY 13, 1991

MONTH	DAY	SPUA FLOW (MGD)	NPUA FLOW (MGD)	MH3 FLOW (MGD)	S401 FLOW (MGD)	S120a FLOW (MGD)	S116a FLOW (MGD)	METERED STP EFFLUENT (MGD)
5	6	0.205	0.087	0.019	0.036	0.052	0.028	0.220
5	7	0.148	0.078	0.018	0.037	0.047	0.031	0.268
5	8	0.151	0.078	0.019	0.043	0.047	0.028	0.248
5	9	0.152	0.074	0.013	0.041	0.047	0.029	0.258
5	10	0.137	0.063	0.012	0.042	0.054	0.028	0.212
5	11	0.095	0.036	--	--	--	--	0.152
5	12	0.078	0.052	--	--	--	--	0.136
5	13	0.154	0.065	--	--	--	--	0.206

B

APPENDIX B

WATER-LEVEL AND WATER-QUALITY MEASUREMENTS

APPENDIX B-1

SHALLOW-WELL FIELD WATER-LEVEL AND WATER-QUALITY MEASUREMENTS, MAY 1990 TO MAY 1991

SITE NAME : WELL 3586

N75017 E2086218

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/30/90	08:45	8.63	5903.51	16.5	6.66	1000
06/06/90	09:20	8.75	5903.39	15.0	7.24	1050
06/13/90	09:00	9.07	5903.07	14.5	7.68	1060
06/19/90	12:40	9.26	5902.88	19.0	6.70	1150
06/28/90	08:00	9.38	5902.76	16.5	6.67	1180
07/03/90	08:10	9.30	5902.84	17.5	6.82	1100
07/12/90	--	10.16	5901.98	17.5	6.98	1150
07/18/90	08:45	10.02	5902.12	21.0	6.51	1250
07/25/90	10:20	9.77	5902.37	23.5	6.70	1150
08/02/90	08:50	9.82	5902.32	20.0	6.39	1200
08/09/90	07:20	10.02	5902.12	16.0	6.48	1190
08/15/90	--	10.90	5901.24	16.5	6.64	2200
08/23/90	09:08	9.80	5902.34	15.0	6.96	1400
08/29/90	09:40	--	--	16.0	6.76	1000
09/14/90	12:00	9.75	5902.39	16.2	3.90	1300
09/24/90	14.20	10.50	5901.64	18.0	6.44	1400
09/27/90	12:30	9.50	5902.64	18.5	6.77	--
10/04/90	07:50	9.60	5902.54	16.5	6.82	1300
10/11/90	10:00	9.65	5902.49	15.0	--	1500
10/18/90	--	10.24	5901.90	17.0	6.90	1200
10/25/90	11:39	10.36	5901.78	21.5	6.87	1500
11/09/90	16:37	10.20	5901.94	12.0	6.96	1950
11/16/90	08:06	10.35	5901.79	5.0	6.68	2000
11/21/90	06:50	10.60	5901.54	7.0	6.66	2000
11/28/90	13:45	10.30	5901.84	--	--	--
12/05/90	14:15	10.38	5901.76	--	--	--
12/12/90	12:20	--	--	--	--	--
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	14:05	9.92	5902.22	--	7.75	--
01/03/91	11:46	10.18	5901.96	3.0	7.63	1800
01/09/91	15:12	10.16	5901.98	--	7.28	--
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14:00	9.36	5902.78	9.0	7.22	1750
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	10:42	9.12	5903.02	13.0	6.90	1900
04/04/91	12:38	9.35	5902.79	18.0	6.90	1800
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	10:13	8.71	5903.43	6.0	7.50	1170
05/03/91	--	--	--	--	--	--

SITE NAME : WELL 4486

N749254 E2082234

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/15/90	11:30	7.98	6014.80	19.0	7.03	290
05/23/90	--	8.34	6014.44	18.0	7.56	360
05/30/90	11:20	8.06	6014.72	18.5	7.47	400
06/06/90	11:05	7.98	6014.80	20.5	6.92	380
06/13/90	11:40	8.53	6014.25	18.0	6.56	410
06/19/90	12:50	8.70	6014.08	24.5	7.38	455
06/28/90	09:45	9.04	6013.74	21.0	6.55	475
07/03/90	09:45	9.09	6013.69	23.5	7.06	520
07/12/90	--	8.06	6014.72	24.0	7.34	420
07/18/90	11:20	7.88	6014.90	23.0	7.56	400
07/25/90	08:50	7.55	6015.23	20.0	6.65	445
08/02/90	10:20	7.70	6015.08	24.0	6.48	360
08/09/90	10:40	7.87	6014.91	25.0	7.29	440
08/15/90	15:20	7.77	6015.01	23.0	7.03	500
08/23/90	12:15	7.92	6014.86	24.0	6.91	460
08/29/90	11:46	--	--	21.0	6.87	350
09/14/90	14:49	7.65	6015.13	22.5	6.43	1800
09/24/90	16:20	7.30	6015.48	22.0	6.51	470
09/27/90	14:50	7.30	6012.94	20.8	4.94	460
10/04/90	10:55	7.35	6015.43	22.0	4.98	495
10/11/90	15:30	7.40	6014.28	19.0	--	490
10/18/90	--	8.50	6014.28	19.0	6.80	510
10/25/90	13:56	8.50	6014.28	24.0	7.16	440
11/09/90	15:27	7.34	6015.44	16.0	7.05	560
11/15/90	10:40	7.62	6015.44	19.0	7.14	620
11/21/90	11:18	7.25	6015.53	13.5	7.16	600
11/28/90	12:09	8.57	6014.21	7.0	--	625
12/05/90	13:25	8.87	6013.91	12.5	7.71	580
12/12/90	15:05	8.34	6014.44	--	--	--
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	13:50	10.48	6012.30	8.0	--	1600
01/03/91	--	--	--	--	--	--
01/09/91	13.28	15.98	6006.80	11.0	7.30	620
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14.55	8.73	6014.05	8.5	7.60	1100
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	11:50	7.90	6014.88	14.0	7.90	420
04/04/91	13:43	8.16	6014.62	16.0	7.30	400
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	12:20	7.54	6015.24	17.0	8.30	690
05/03/91	--	--	--	--	--	--

SITE NAME : WELL PZ 0789

N748510 E2083546

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/23/90	00:00	9.07	6001.92	18.0	7.83	735
05/30/90	09:15	9.05	6001.94	15.0	7.31	760
06/06/90	09:35	9.36	6001.63	17.5	7.23	760
06/13/90	09:20	9.07	6001.92	18.0	7.10	790
06/19/90	12:20	9.97	6001.02	20.0	7.42	850
06/28/90	08:15	9.05	6001.94	20.0	6.94	880
07/03/90	08:25	9.20	6001.79	20.0	7.09	835
07/12/90	--	9.98	6001.01	20.5	7.21	910
07/18/90	09:20	9.88	6001.11	20.5	6.71	900
07/25/90	10:50	9.75	6001.24	28.0	6.88	900
08/02/90	09:25	9.95	6001.04	22.5	6.58	950
08/09/90	08:00	10.10	6000.89	21.0	6.89	990
08/15/90	14:35	9.32	6001.67	21.0	6.74	1100
08/23/90	09:50	9.40	6001.59	22.0	7.02	1000
08/29/90	10:30	--	--	24.0	6.86	900
09/14/90	12:54	8.65	6002.34	22.5	4.34	1200
09/24/90	16:05	8.70	6001.30	21.1	6.43	1050
09/27/90	14:15	8.80	6002.19	21.8	4.98	1100
10/04/90	09:45	9.10	6001.89	22.0	5.13	1050
10/11/90	13.40	10.05	6000.94	18.5	--	1100
10/18/90	14:10	10.02	5999.98	20.0	6.60	1200
10/25/90	12:10	9.73	6000.27	22.0	7.11	1200
11/09/90	16:12	9.87	6001.12	14.5	7.16	1140
11/16/90	08:46	7.95	6003.04	11.0	9.95	1650
11/21/90	09:52	9.70	6001.29	11.5	7.17	1400
11/28/90	12:45	9.94	6001.05	10.0	--	1200
12/05/90	12:08	10.17	6000.82	17.0	7.60	1200
12/12/90	13:15	9.50	6001.49	10.0	7.79	1600
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	12:50	11.50	5999.49	11.0	8.01	1250
01/03/91	14:15	11.28	5999.71	16.0	7.89	1200
01/09/91	13:40	11.50	5999.49	9.0	8.65	1150
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	15:05	10.38	6000.61	9.0	7.40	1200
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	13:10	10.90	6000.09	15.0	7.40	1030
04/04/91	13:19	11.10	5999.89	18.0	7.30	1600
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	11:12	9.80	6001.19	10.0	8.10	1160
05/03/91	--	--	--	--	--	--

SITE NAME : WELL PZ 2389

N749461 E2083653

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/23/90	--	9.74	5989.56	17.5	7.46	1650
05/30/90	09:05	9.95	5989.35	15.0	6.78	2335
06/06/90	12:05	10.16	5989.14	17.0	7.11	2450
06/13/90	09:35	10.47	5988.83	15.0	6.83	2300
06/19/90	12:10	11.15	5988.15	20.0	7.48	2400
06/28/90	10:00	11.00	5988.30	19.0	6.70	2800
07/03/90	08:40	11.03	5988.27	18.5	6.92	2550
07/12/90	10:35	11.09	5988.21	18.5	6.80	2750
07/18/90	09:10	11.05	5988.25	19.0	6.37	2900
07/25/90	10:40	11.30	5988.00	25.0	6.70	2650
08/02/90	09:10	11.75	5987.55	21.0	6.47	2800
08/09/90	07:40	11.96	5987.34	17.5	6.48	2850
08/15/90	--	11.80	5987.50	23.5	6.73	3800
08/23/90	09:35	11.95	5987.35	22.0	6.65	3200
08/29/90	09:55	--	--	19.0	6.61	3000
09/14/90	15:20	--	--	20.0	5.59	3400
09/24/90	14:20	11.25	5988.05	21.0	5.67	3600
09/27/90	12:45	11.40	5987.90	19.0	6.70	3400
10/04/90	08:10	11.60	5987.70	18.5	6.54	3300
10/11/90	11:00	11.70	5987.60	17.0	--	3800
10/18/90	15:35	12.68	5986.62	18.0	6.90	4100
10/25/90	11:25	13.05	5996.95	22.5	6.20	4000
11/09/90	16:25	12.94	5986.36	15.0	7.12	4300
11/16/90	08:25	10.95	5988.35	6.5	7.07	4800
11/21/90	07:20	12.40	5986.90	7.5	6.98	4800
11/28/90	13:33	13.17	5986.13	6.0	--	4000
12/05/90	14:00	13.66	5985.64	12.5	7.48	3990
12/12/90	13:00	12.88	5986.42	8.0	7.06	4200
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	12:28	13.99	5985.31	9.0	8.01	4800
01/03/91	13:36	14.00	5985.30	--	7.99	5000
01/09/91	15:05	14.00	5985.30	--	--	--
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14:07	11.99	5987.31	9.5	7.13	4100
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	13:25	12.32	5986.98	12.0	7.20	4020
04/04/91	12:48	12.65	5986.65	17.0	6.80	2800
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	10:32	12.29	5987.01	5.0	7.90	3800
05/03/91	--	--	--	--	--	--

SITE NAME : WELL PZ 4289

N749943 E2803043

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/15/90	10:45	10.15	5996.17	19.0	6.60	340
05/23/90	--	10.43	5995.89	19.0	7.40	460
05/30/90	11:40	10.58	5995.74	15.0	6.97	295
06/06/90	11:30	10.70	5995.62	17.5	6.99	465
06/13/90	11:40	10.70	5995.62	16.5	6.62	470
06/19/90	11:50	11.48	5994.84	18.0	7.42	470
06/28/90	09:30	11.33	5994.99	18.5	6.86	520
07/03/90	09:00	11.40	5994.92	18.0	7.02	490
07/12/90	08:00	11.18	5995.14	27.5	7.05	400
07/18/90	11:30	10.95	5995.37	20.0	6.58	550
07/25/90	09:50	10.24	5996.08	26.0	6.90	460
08/02/90	10:40	10.80	5995.52	22.0	6.56	550
08/09/90	09:30	11.76	5994.56	22.0	7.33	520
08/15/90	14:10	11.30	5995.02	27.5	6.71	615
08/23/90	10:50	11.45	5994.87	24.0	7.04	620
08/29/90	12:07	--	--	20.5	6.88	590
09/14/90	14.29	11.40	5995.12	19.5	8.21	2800
09/24/90	14:40	11.20	5995.12	18.0	5.60	300
09/27/90	13:00	11.40	5994.92	20.1	6.50	620
10/04/90	08:25	11.77	5994.55	19.5	6.61	640
10/11/90	11:30	11.85	5994.47	18.0	--	700
10/18/90	15:25	12.77	5993.55	20.0	6.90	720
10/25/90	13:31	12.64	5993.68	26.5	7.19	730
11/09/90	15:40	11.36	5993.68	16.0	7.21	800
11/15/90	11:56	11.52	5994.80	17.0	7.06	770
11/21/90	07:41	11.05	5995.27	7.0	7.20	880
11/28/90	12:35	12.11	5994.21	10.0	--	795
12/05/90	11:35	12.35	5993.97	15.0	7.44	725
12/12/90	14:45	12.23	5994.09	9.0	7.31	850
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	13:33	13.87	5992.45	--	7.94	1100
01/03/91	12:55	14.40	5991.92	9.0	7.96	820
01/09/91	14:41	14.76	5991.56	--	8.47	--
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14:15	13.24	5993.08	9.5	7.25	800
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	12:36	14.07	5992.25	15.0	7.30	820
04/04/91	14:11	14.30	5992.02	16.0	7.00	780
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	13:03	11.40	5994.92	13.0	8.00	1100
05/03/91	--	--	--	--	--	--

SITE NAME : WELL PZ 4589
N749958 E2081661

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/15/90	11:00	15.61	6017.19	19.0	7.26	160
05/23/90	--	15.55	6017.25	19.5	7.95	205
05/30/90	10:00	15.53	6017.27	13.9	6.71	200
06/06/90	10:20	15.53	6017.27	14.0	7.16	205
06/13/90	10:10	15.47	6017.33	14.5	7.23	210
06/19/90	11:35	16.28	6016.52	17.5	7.52	220
06/28/90	09:20	15.10	6017.70	16.5	6.97	225
07/03/90	13:20	16.08	6016.72	18.0	7.06	245
07/12/90	10:20	15.70	6017.10	18.5	6.92	240
07/18/90	10:00	15.33	6017.47	19.0	6.94	245
07/25/90	11:40	14.55	6018.25	25.0	7.01	215
08/02/90	10:10	15.13	6017.67	20.0	7.02	230
08/09/90	08:30	15.06	6017.74	18.0	7.28	240
08/15/90	15:10	14.03	6018.77	14.0	7.41	350
08/23/90	10:40	13.95	6018.85	24.0	7.39	300
08/29/90	11:00	--	--	18.5	7.30	240
09/14/90	14:04	10.80	6022.00	17.5	7.10	1200
09/24/90	15:10	13.70	6019.10	15.0	6.42	395
09/27/90	13:35	12.70	6020.10	16.0	5.60	560
10/04/90	8:55	12.75	6020.05	19.0	5.70	320
10/11/90	12:30	12.75	6020.05	16.5	--	350
10/18/90	15:05	13.68	6019.12	18.0	7.70	390
10/25/90	13:09	13.75	6019.05	22.5	7.41	420
11/09/90	15:52	13.86	6018.94	15.0	7.55	420
11/16/90	09:30	14.00	6018.80	13.5	7.57	420
11/21/90	08:41	13.20	6019.60	7.5	7.63	530
11/28/90	13:22	14.10	6018.70	7.5	--	420
12/05/90	11:54	14.31	6018.49	14.0	8.20	380
12/12/90	14:30	14.45	6018.35	10.5	7.72	420
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	13:18	14.98	6017.82	8.0	8.41	1400
01/03/91	14:50	15.25	6017.55	7.0	8.14	450
01/09/91	14:32	15.36	6017.44	--	8.75	--
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14:30	15.32	6017.48	10.0	8.05	390
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	12:45	16.53	6016.27	14.0	8.00	410
04/04/91	14:19	16.73	6016.07	15.0	7.20	380
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	11:40	16.45	6016.35	14.0	8.20	500
05/03/91	--	--	--	--	--	--

SITE NAME : WELL PZ 5589

N748604 E2080719

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/15/90	15:15	5.90	6048.87	19.5	6.75	150
05/23/90	--	6.50	6048.27	19.0	7.10	225
05/30/90	09:50	6.50	6048.27	15.5	7.05	205
06/06/90	10:10	7.90	6046.87	17.0	6.32	200
06/13/90	09:55	7.30	6047.47	16.0	6.71	220
06/19/90	11:20	7.96	6046.81	26.0	6.11	220
06/28/90	08:55	9.97	6044.80	18.0	6.14	230
07/03/90	13:00	8.52	6046.25	24.5	6.22	215
07/12/90	10:00	9.13	6045.64	24.0	6.10	220
07/18/90	09:45	9.33	6045.44	21.0	6.06	240
07/25/90	11:20	6.75	6048.02	25.5	6.81	215
08/02/90	09:50	8.05	6046.72	24.0	5.96	225
08/09/90	09:15	--	--	19.5	6.80	225
08/15/90	14:55	9.28	6045.49	15.0	6.68	400
08/23/90	10:18	9.81	6044.96	20.0	6.85	260
08/29/90	10:50	--	--	21.0	6.30	220
09/14/90	13:34	10.12	6044.65	17.0	7.33	1000
09/24/90	13:29	9.00	6045.77	15.0	5.49	262
09/27/90	13:35	9.65	6045.12	16.5	4.28	250
10/04/90	09:10	10.25	6044.52	18.5	5.01	280
10/11/90	13:00	10.30	6044.47	16.5	--	300
10/18/90	14:45	12.25	6042.52	19.0	6.90	310
10/25/90	13:00	11.72	6043.05	20.0	6.66	600
11/09/90	15:59	9.45	6045.32	13.5	7.03	320
11/16/90	09:06	9.75	6045.02	9.0	6.99	400
11/21/90	09:00	9.20	6045.57	9.0	6.90	360
11/28/90	13:10	10.11	6044.66	8.0	--	320
12/05/90	12:25	11.07	6043.70	14.5	7.47	320
12/12/90	13:45	11.40	6043.37	9.0	7.13	380
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	13:05	14.74	6040.03	10.0	8.15	380
01/03/91	14:35	16.02	6038.75	4.0	8.08	380
01/09/91	14:15	16.84	6037.93	--	8.72	--
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14:40	16.00	6038.77	9.0	8.14	310
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	12:55	15.34	6039.43	17.0	6.90	320
04/04/91	14:26	15.55	6039.22	13.0	5.80	330
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	11:30	10.22	6044.55	12.0	7.60	500
05/03/91	--	--	--	--	--	--

SITE NAME : WELL PZ 6189
N748147 E2081941

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/23/90	00:00	29.70	6007.61	19.0	5.70	640
05/30/90	09:30	29.78	6007.53	16.0	7.51	640
06/06/90	09:20	29.48	6007.83	16.0	7.31	600
06/13/90	09:40	30.57	6006.74	15.5	7.57	610
06/19/90	12:30	30.77	6006.54	22.5	7.27	610
06/28/90	08:35	30.08	6007.23	17.5	7.53	650
07/03/90	09:30	30.20	6007.11	18.0	7.32	635
07/12/90	--	30.05	6007.26	18.5	7.30	620
07/18/90	09:35	29.65	6007.66	18.0	6.97	600
07/25/90	11:00	29.00	6008.31	21.5	7.30	495
08/02/90	09:35	30.42	6006.89	17.5	6.89	505
08/09/90	08:15	29.80	6007.51	16.5	6.82	530
08/15/90	14:45	29.87	6007.44	14.5	7.41	680
08/23/90	10:05	30.05	6007.26	18.0	8.45	620
08/29/90	10:40	--	--	15.0	7.45	620
09/14/90	13:16	23.30	6014.01	16.5	5.80	620
09/24/90	15:52	23.25	6014.06	16.1	6.79	710
09/27/90	13:50	29.25	6008.06	17.0	5.45	700
10/04/90	9:30	29.25	6008.06	17.0	5.37	700
10/11/90	13:15	28.30	6009.01	14.0	--	760
10/18/90	14:25	30.12	6007.19	16.0	7.50	890
10/25/90	12:21	30.30	6007.01	22.0	7.27	840
11/09/90	16.07	30.35	6006.96	13.5	7.70	920
11/16/90	8:58	30.32	6006.99	10.0	7.67	980
11/21/90	9:27	28.45	6008.86	8.5	7.34	940
11/28/90	12:55	30.43	6006.88	9.5	--	960
12/05/90	12:16	30.48	6006.83	15.0	7.84	800
12/12/90	13:30	29.70	6007.61	11.0	7.40	980
12/19/90	--	--	--	--	--	--
12/26/90	--	--	--	--	--	--
12/27/90	12:56	30.70	6006.61	12.0	8.27	1000
01/03/91	14.25	30.81	6006.50	10.0	8.08	910
01/09/91	13:50	30.87	6006.44	*	8.73	2200
02/01/91	--	--	--	--	--	--
02/05/91	--	--	--	--	--	--
02/12/91	14:45	31.05	6006.26	11.0	7.47	890
02/22/91	--	--	--	--	--	--
03/01/91	--	--	--	--	--	--
03/08/91	--	--	--	--	--	--
03/15/91	--	--	--	--	--	--
03/26/91	13:02	31.15	6006.16	14.0	7.60	980
04/04/91	--	--	--	--	--	--
04/11/91	--	--	--	--	--	--
04/18/91	--	--	--	--	--	--
04/26/91	11:20	30.96	6006.35	12.0	8.40	1100
05/03/91	--	--	--	--	--	--

APPENDIX B-2

SANITARY SEWER FIELD WATER-QUALITY
MEASUREMENTS, MAY 1990 TO MAY 1991

SITE NAME : MH3

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/10/90	11:10	7.35	5995.65	14.0	--	480
05/15/90	09:20	7.35	5995.65	--	--	--
05/23/90	10:05	7.37	5995.63	16.0	7.87	285
05/30/90	11:50	7.36	5995.64	18.5	8.57	335
06/06/90	11:50	7.35	5995.65	21.5	7.56	610
06/13/90	11:50	7.44	5995.56	18.0	8.03	530
06/19/90	12:00	7.45	5995.55	18.0	8.90	600
06/27/90	09:10	7.43	5995.57	23.0	8.66	610
07/03/90	11:10	7.45	5995.55	22.5	8.35	620
07/12/90	07:45	7.41	5995.59	24.0	7.61	290
07/18/90	11:45	7.45	5995.55	21.0	7.70	650
07/25/90	09:40	7.40	5995.60	29.5	7.95	620
08/02/90	13:30	7.35	5995.65	29.0	8.14	420
08/09/90	09:30	7.40	5995.60	25.0	8.48	620
08/15/90	13:55	7.30	5995.70	23.5	7.88	475
08/23/90	11:05	7.40	5995.60	27.0	7.71	750
08/29/90	12:15	--	--	33.0	8.38	460
09/06/90	12:30	7.40	5995.60	--	--	--
09/13/90	13:50	7.55	5995.45	25.0	8.06	670
09/20/90	15:27	7.40	5995.45	28.0	--	400
09/27/90	13:10	7.50	5995.50	22.1	4.85	740
10/04/90	08:35	7.30	5995.70	26.0	4.89	560
10/11/90	11:55	7.55	5995.45	21.0	--	660
10/18/90	11:45	7.63	5995.37	18.0	7.80	720
10/25/90	15:00	7.47	5995.53	26.0	9.00	860
11/01/90	15:45	7.41	5995.59	22.0	8.22	410
11/08/90	14:48	7.44	5995.56	23.0	7.90	460
11/15/90	11:18	7.45	5995.55	21.0	8.52	1000
11/21/90	08:05	7.50	5995.50	12.5	7.60	880
11/28/90	12:20	7.43	5995.57	10.5	--	750
12/05/90	11:22	7.30	5995.70	16.5	8.62	620
12/12/90	15:20	7.33	5995.67	13.0	8.21	830
12/19/90	10:55	7.26	5995.74	9.0	8.02	820
12/26/90	13:24	7.50	5995.50	2.0	8.35	1000
12/27/90	--	--	--	--	--	--
01/03/91	12:43	7.80	5995.20	13.0	9.15	920
01/09/91	14:52	7.42	5995.58	--	9.30	--
02/01/91	12:40	7.40	5995.60	--	--	730
02/05/91	--	--	--	--	--	--
02/12/91	12:41	7.37	5995.63	15.0	8.00	1000
02/22/91	14:05	7.41	5995.59	15.0	8.48	820
03/01/91	16:00	7.27	5995.73	15.5	8.16	360
03/08/91	14:15	7.35	5995.65	12.0	7.70	950
03/15/91	16:50	7.40	5995.60	9.5	12.80	720
03/26/91	12:35	7.38	5995.62	15.0	8.70	820
04/04/91	14:00	7.30	5995.70	21.0	7.50	1500
04/11/91	12:32	7.44	5995.56	9.0	8.90	1100
04/18/91	15:05	7.43	5995.57	--	--	--
04/26/91	13:15	7.45	5995.55	15.0	8.70	1140
05/03/91	15:30	7.32	5995.68	--	--	--

SITE NAME : MH-S116A

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/09/90	13:20	12.35	5988.70	14.0	7.64	310
05/15/90	13:35	12.40	5988.65	--	--	--
05/23/90	10:50	12.35	5988.70	19.0	8.66	175
05/30/90	12:15	12.35	5988.70	18.5	8.71	300
06/06/90	12:15	12.40	5988.65	19.5	7.42	620
06/13/90	12:25	12.37	5988.68	21.5	8.26	475
06/21/90	--	12.35	5988.70	23.5	8.40	510
06/27/90	08:15	12.30	5988.75	27.0	6.82	320
07/03/90	10:00	12.13	5988.92	27.5	6.99	400
07/12/90	09:35	12.28	5988.77	28.5	7.92	320
07/19/90	15:00	12.25	5988.80	28.5	7.22	410
07/25/90	09:10	12.20	5988.85	17.0	7.60	650
08/02/90	13:50	12.20	5988.85	30.0	7.52	410
08/09/90	--	12.20	5988.85	25.0	8.14	250
08/15/90	14:20	12.25	5988.80	25.0	6.82	440
08/23/90	13:05	12.14	5988.91	--	7.18	420
08/29/90	10:08	--	--	19.5	8.09	400
09/06/90	12:30	12.00	5989.05	--	--	--
09/13/90	13.50	12.20	5988.85	32.0	8.01	510
09/19/90	09:35	12.15	5988.90	21.5	6.25	3300
09/27/90	15:49	12.60	5988.45	28.5	5.93	240
10/04/90	10:00	12.30	5988.75	22.0	5.72	200
10/11/90	14:00	12.30	5988.75	19.5	--	340
10/18/90	13:40	12.23	5988.82	19.0	7.30	590
10/25/90	15:15	12.26	5988.79	24.0	8.45	305
11/01/90	--	12.26	5988.79	18.0	8.23	440
11/08/90	15:00	12.28	5988.77	25.0	6.75	450
11/15/90	13:20	12.20	5988.85	21.5	7.82	755
11/21/90	10:25	12.35	5988.70	11.5	8.30	660
11/28/90	10:45	12.37	5988.68	11.5	--	590
12/05/90	08:25	12.30	5988.75	12.5	8.10	320
12/12/90	11:31	12.17	5988.88	11.5	6.91	340
12/19/90	11:45	12.15	5988.90	11.0	7.88	750
12/26/90	13:36	12.32	5988.73	5.0	8.64	2400
12/27/90	--	--	--	--	--	--
01/03/91	10:50	12.30	5988.75	7.0	8.47	675
01/10/91	13:11	12.23	5988.82	--	--	--
02/01/91	11:12	12.24	5988.81	--	--	420
02/05/91	13:32	12.28	5988.77	--	--	--
02/12/91	12:17	12.22	5988.83	13.0	8.54	560
02/22/91	16:10	12.30	5988.75	12.0	8.18	560
03/01/91	15:34	12.20	5988.85	12.0	8.61	415
03/08/91	13:55	12.22	5988.83	12.0	8.00	450
03/15/91	16:00	12.30	5988.75	8.5	8.20	1000
03/26/91	11:05	12.23	5988.82	16.0	8.70	630
04/04/91	12:57	12.32	5988.73	20.0	8.10	240
04/11/91	11:40	12.32	5988.73	7.0	8.70	570
04/18/91	14:34	12.31	5988.74	--	--	--
04/26/91	10:41	12.32	5988.73	13.0	9.20	780
05/03/91	15:00	12.33	5988.73	--	--	--

SITE NAME : MH-S120A

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/10/90	14:55	10.05	6016.09	17.5	7.38	395
05/15/90	14:30	10.10	6016.04	--	--	--
05/23/90	08:30	10.06	6016.08	15.8	7.75	255
05/30/90	11:00	10.06	6016.08	29.0	7.95	320
06/06/90	10:40	10.13	6016.01	24.5	8.02	320
06/13/90	10:20	10.12	6016.02	25.5	7.92	240
06/19/90	13:10	10.13	6016.01	29.0	7.48	460
06/27/90	08:45	10.15	6015.99	28.0	7.56	450
07/03/90	11:40	10.04	6016.10	28.5	8.13	480
07/12/90	09:20	10.13	6016.01	28.0	7.88	330
07/18/90	10:40	10.10	6016.04	27.5	7.82	520
07/25/90	08:20	10.13	6016.01	25.5	7.90	660
08/02/90	13:00	10.06	6016.08	28.5	8.72	520
08/09/90	--	10.15	6015.99	27.5	8.22	360
08/15/90	13:30	10.08	6016.06	25.0	7.03	300
08/23/90	12:30	10.08	6016.06	25.0	7.29	560
08/29/90	11:19	--	--	26.0	7.36	650
09/06/90	12:30	10.10	--	--	--	--
09/13/90	14:27	10.45	--	32.0	7.11	819
09/20/90	15:59	10.41	6015.73	21.0	--	560
09/27/90	15:25	10.40	6015.74	21.0	5.16	1000
10/04/90	10:20	10.30	6015.84	24.5	5.03	200
10/11/90	14:30	10.40	6015.84	21.0	--	700
10/18/90	13:20	10.10	6016.04	20.0	7.70	530
10/25/90	14:31	10.10	6016.04	24.0	6.12	1200
11/01/90	13:20	10.09	6016.05	21.5	6.94	700
11/08/90	14:20	10.09	6016.05	24.0	7.03	300
11/15/90	10:18	10.80	6015.34	20.0	7.01	655
11/21/90	11:00	10.10	6016.04	19.0	10.49	3000
11/28/90	11:30	10.12	6016.02	10.5	--	670
12/05/90	12:50	10.10	6016.04	15.0	7.87	645
12/12/90	12:15	10.00	6016.14	16.0	6.98	380
12/19/90	09:15	9.96	6016.18	14.0	7.10	585
12/26/90	10:48	10.15	6015.99	10.0	7.81	520
12/27/90	--	--	--	--	--	--
01/03/91	11:15	10.20	6015.94	6.0	8.04	700
01/09/91	12:48	9.99	6016.15	11.0	8.37	600
02/01/91	14:08	10.20	6015.94	--	--	610
02/05/91	13:45	10.04	6016.10	--	--	--
02/12/91	13:30	10.10	6016.04	11.0	7.66	580
02/22/91	14:20	9.98	6016.16	14.5	7.12	780
03/01/91	16:30	10.08	6016.06	13.5	7.94	650
03/08/91	14:58	10.09	6016.05	10.0	6.90	2100
03/15/91	16:36	10.06	6016.08	9.0	7.10	785
03/26/91	12:10	10.15	6015.99	19.0	7.80	660
04/04/91	13:50	10.07	6016.07	22.0	6.90	1500
04/11/91	12:15	10.07	6016.07	11.0	7.70	840
04/18/91	14:48	10.08	6016.06	--	--	--
04/26/91	12:50	10.10	6016.04	14.0	8.50	1100
05/03/91	15:35	10.10	6016.04	--	--	--

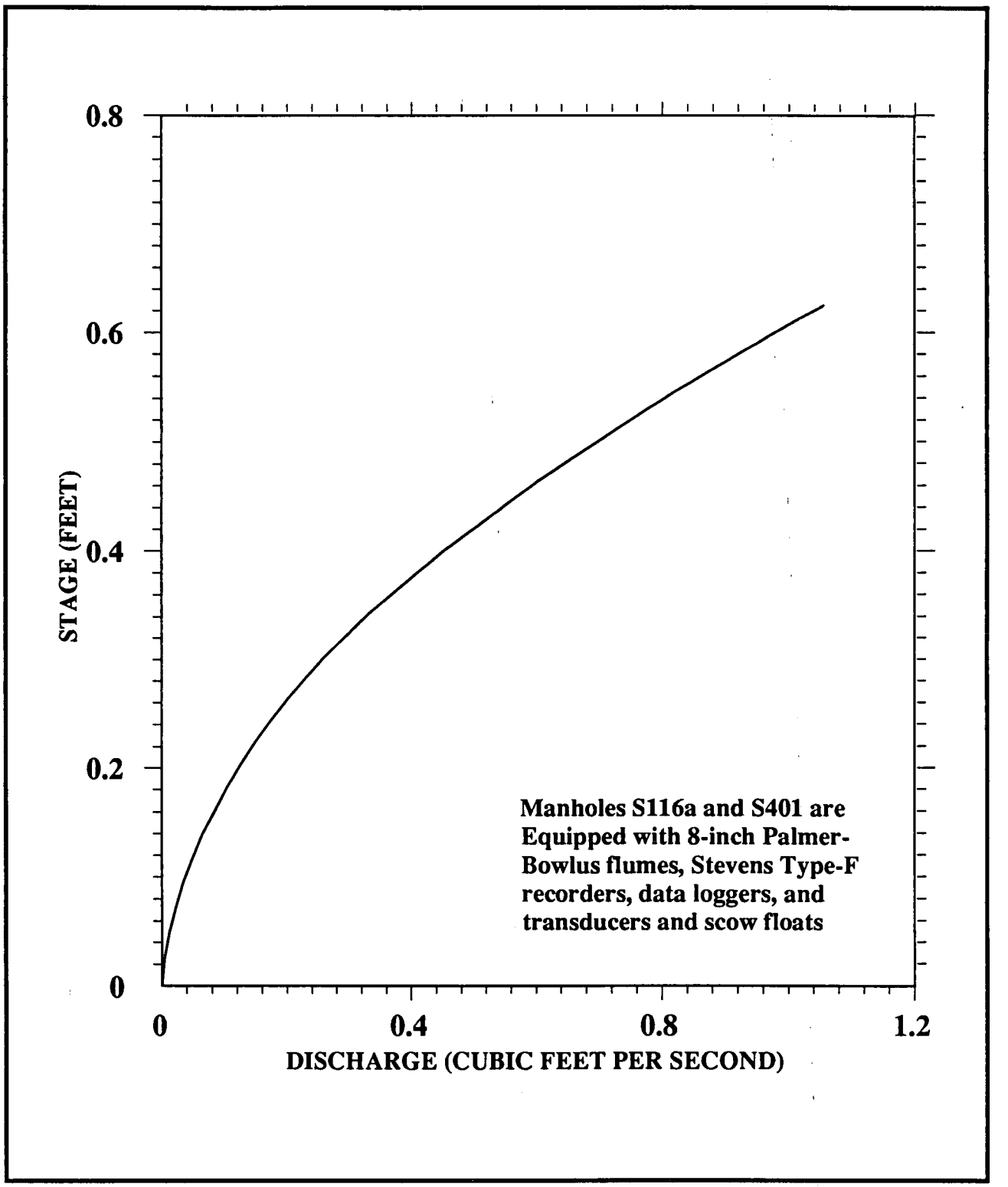
SITE NAME : MH-S401

DATE	TIME	DEPTH (FT)	ELEVATION (FT MSL)	TEMP (C)	pH (STD)	SC (uS/cm)
05/10/90	15:50	9.52	6013.17	28.0	8.02	300
05/15/90	14:10	9.51	6013.18	--	--	--
05/23/90	09:40	9.53	6013.16	15.5	8.85	370
05/30/90	11:00	9.55	6013.14	30.0	8.14	230
06/06/90	10:50	9.53	6013.16	25.5	8.28	380
06/13/90	11:20	9.48	6013.21	26.5	7.42	135
06/19/90	13:30	9.52	6013.17	29.5	7.92	350
06/27/90	08:50	9.45	6013.24	27.0	7.10	200
07/03/90	12:00	9.55	6013.14	28.0	6.52	220
07/12/90	08:20	9.54	6013.15	26.5	8.57	260
07/18/90	11:00	9.52	6013.17	26.5	7.55	200
07/25/90	08:35	9.55	6013.14	25.5	7.70	410
08/02/90	13:15	9.53	6013.16	29.0	9.32	240
08/09/90	10:45	9.55	6013.14	28.0	8.77	200
08/15/90	15:25	9.48	6013.21	32.0	7.76	350
08/23/90	12:00	9.57	6013.12	29.5	8.30	360
08/29/90	11:45	--	--	27.0	8.41	200
09/06/90	12:30	9.55	6013.14	--	--	--
09/13/90	13:50	9.75	6012.94	34.0	13.60	200
09/20/90	16:10	9.70	6012.99	26.5	--	410
09/27/90	15:00	10.90	6011.79	27.5	6.54	295
10/04/90	10:45	10.65	6012.04	27.5	5.22	195
10/11/90	15:00	9.65	6013.04	25.5	--	290
10/18/90	12:40	9.53	6013.16	22.0	8.70	470
10/25/90	14:07	9.55	6013.14	25.0	9.00	490
11/02/90	14:25	9.55	6013.14	18.0	8.28	410
11/08/90	14:35	9.48	6013.21	28.0	8.70	200
11/15/90	11:00	9.50	6013.19	21.0	7.22	525
11/21/90	11:30	9.55	6013.14	19.0	8.48	520
11/28/90	11:55	9.58	6013.11	14.0	--	320
12/05/90	13:10	9.45	6013.24	18.0	8.20	240
12/12/90	11:59	9.51	6013.18	15.5	8.68	820
12/19/90	09:40	9.55	6013.14	10.5	7.20	655
12/26/90	11:30	9.65	6013.04	23.0	8.14	2100
12/27/90	--	--	--	--	--	--
01/03/91	12:17	9.50	6013.19	9.0	8.56	500
01/09/91	13:10	9.44	6013.25	11.0	7.08	200
02/01/91	11:45	9.51	6013.18	--	--	395
02/05/91	13:35	9.48	6013.21	--	--	--
02/12/91	13:01	9.53	6013.16	13.0	8.83	360
02/22/91	14:40	9.52	6013.17	25.5	8.14	580
03/01/91	16:10	9.54	6013.15	20.0	8.71	735
03/08/91	14:42	9.54	6013.15	21.0	8.10	450
03/15/91	16:17	9.56	6013.13	12.0	8.50	340
03/26/91	11:36	9.50	6013.19	24.0	8.60	400
04/04/91	13:27	9.90	6012.79	23.0	8.10	220
04/11/91	11:56	9.62	6013.07	17.0	8.40	460
04/18/91	14:55	9.50	6013.19	--	--	--
04/26/91	12:30	9.64	6013.05	22.0	7.80	650
05/03/91	17:02	9.64	6013.05	--	--	--

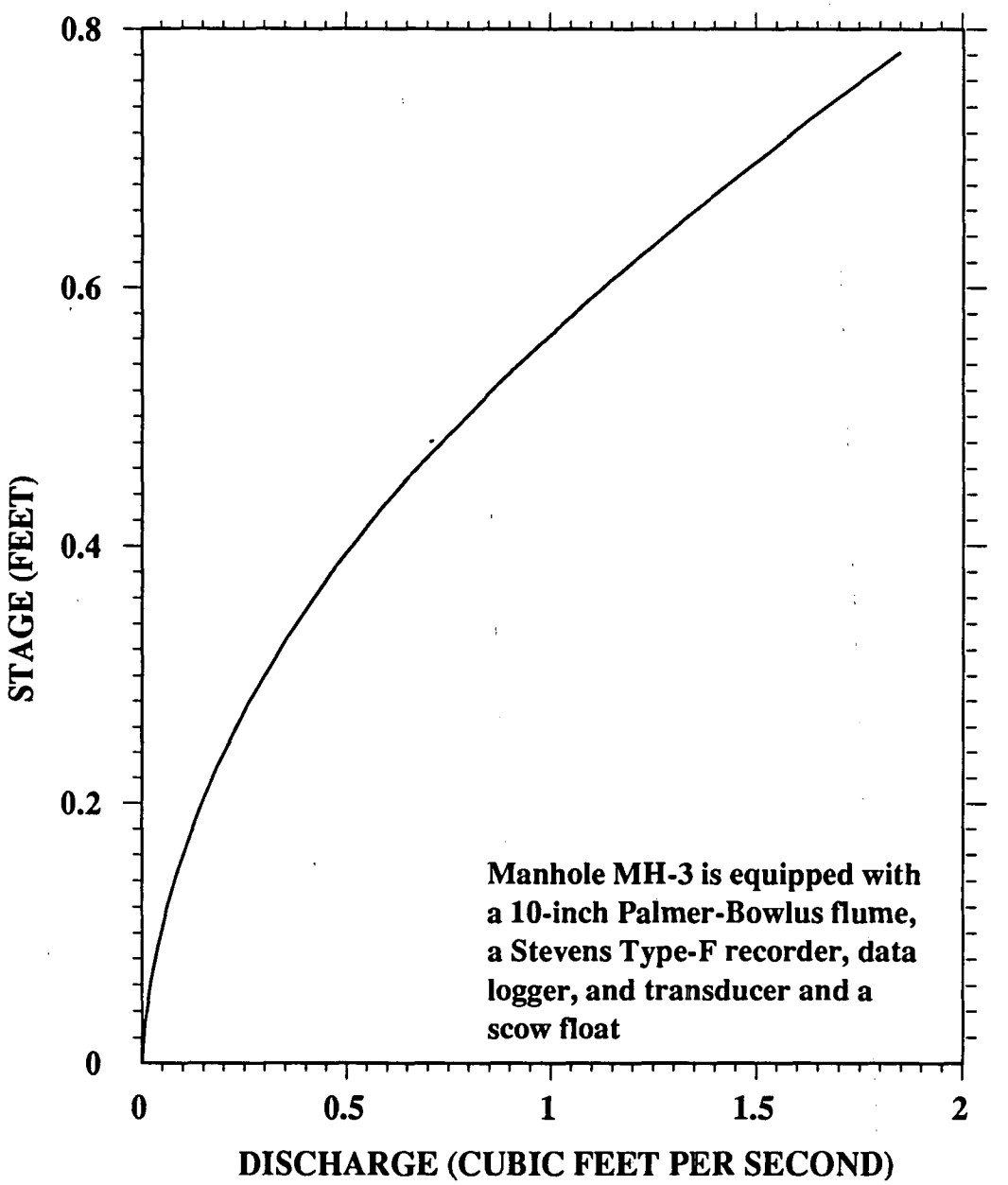
C

APPENDIX C

FLOW RATING CURVES AND TABLES AT SANITARY SEWER MONITORING SITES



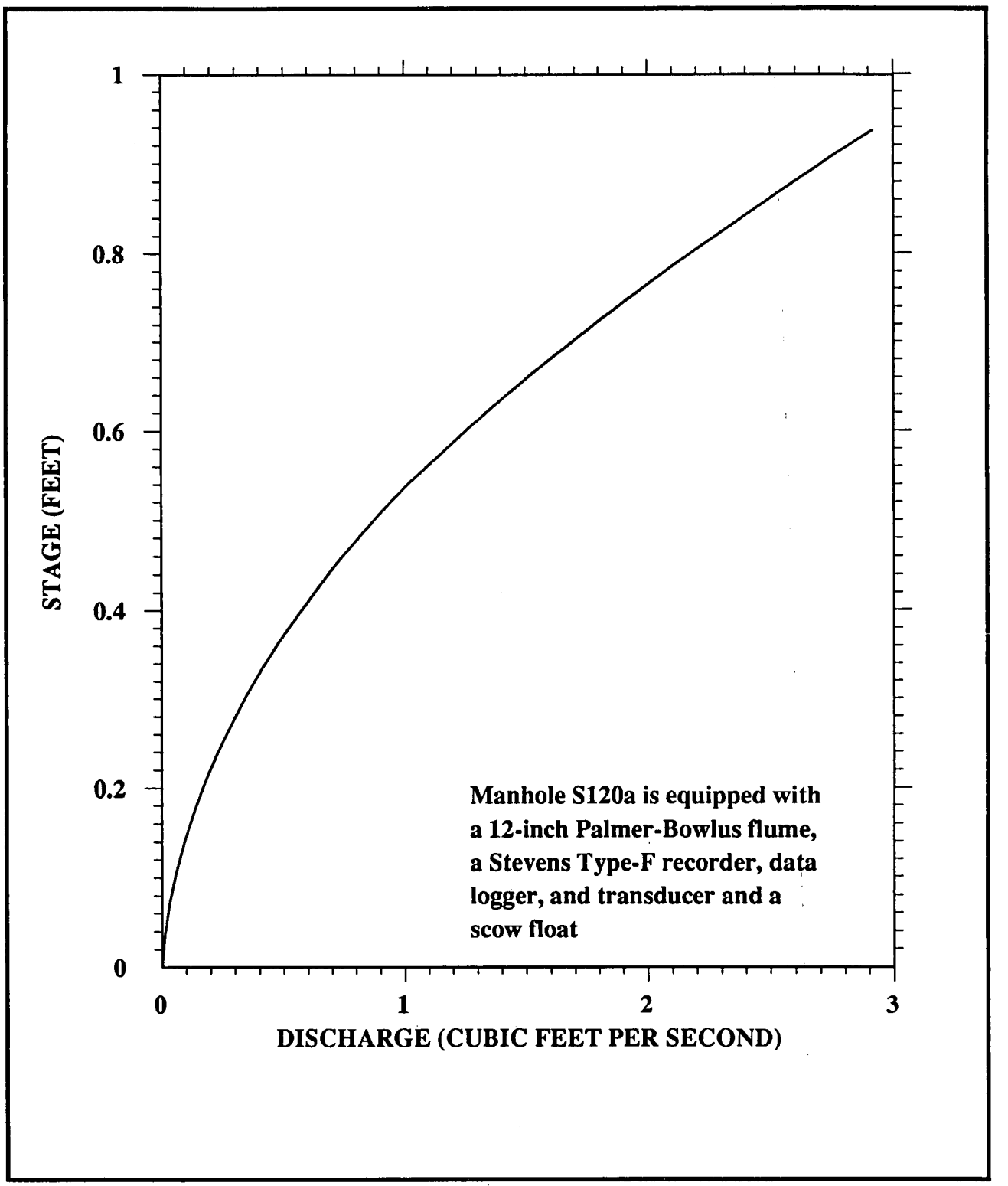
RATING CURVE FOR MANHOLES
S116a AND S401



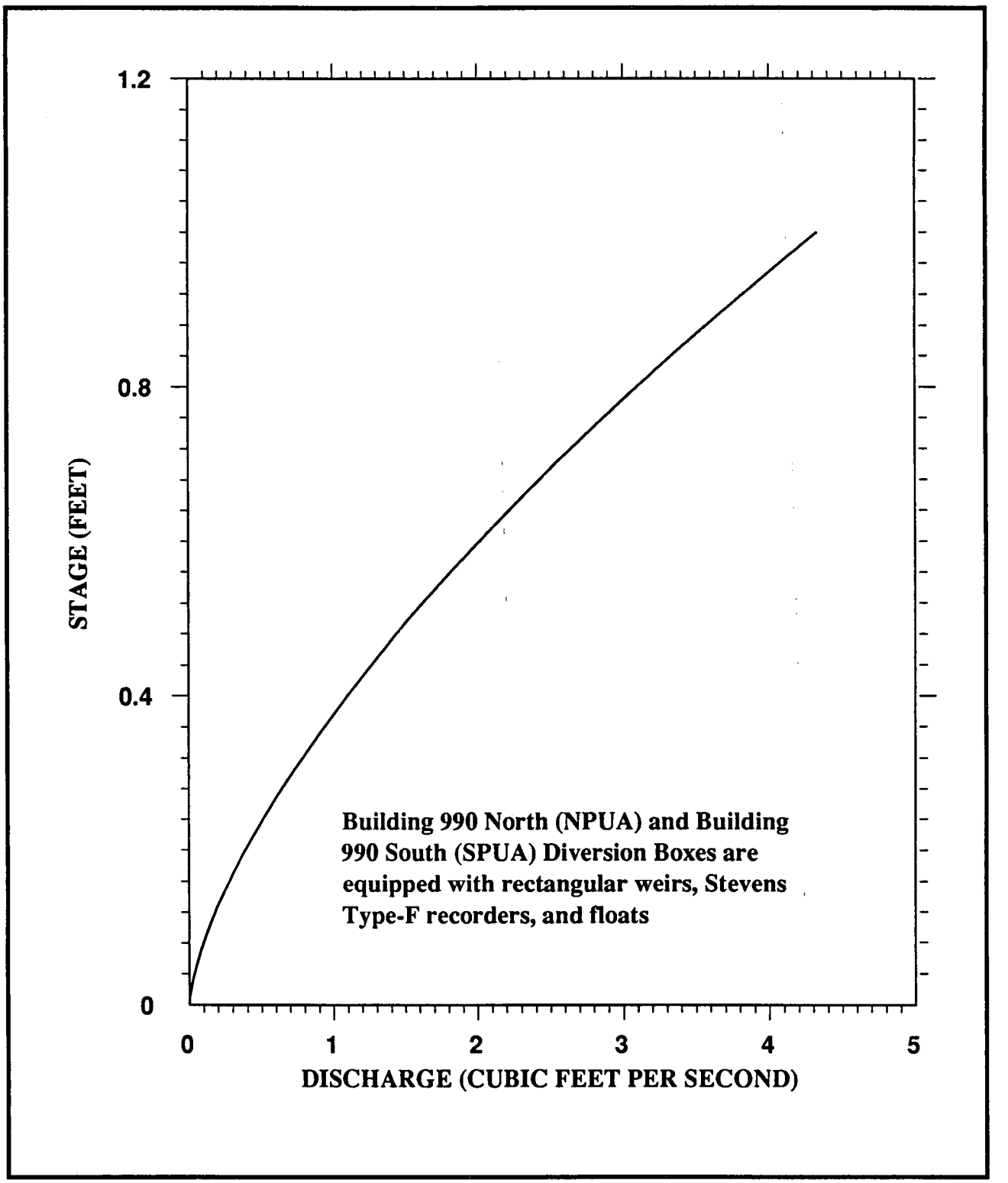
RATING CURVE FOR MANHOLE
MH-3

SANITARY SEWER I/I & E
ZERO-OFFSITE WATER-DISCHARGE STUDY

PROJECT NO. 208.0101
FIGURE C-2



RATING CURVE FOR MANHOLE S120a



RATING CURVE FOR BUILDING 990
NORTH DIVERSION BOX (NPUA) AND SOUTH DIVERSION BOX (SPUA)

SANITARY SEWER I/I & E
ZERO-OFFSITE WATER-DISCHARGE STUDY

PROJECT NO. 208.0101
FIGURE C-4

TABLE C-1

Theoretical Stage-Discharge Rating Table for Manholes S116a and S401[1)]

Stage (feet)	Discharge (cfs)	Stage (feet)	Discharge (cfs)
0.000	0.000	0.322	0.296
0.025	0.004	0.342	0.331
0.049	0.012	0.360	0.368
0.072	0.022	0.380	0.410
0.095	0.034	0.402	0.456
0.117	0.049	0.422	0.503
0.139	0.065	0.443	0.553
0.160	0.084	0.464	0.603
0.182	0.104	0.484	0.655
0.203	0.126	0.504	0.708
0.224	0.149	0.525	0.763
0.244	0.175	0.545	0.819
0.264	0.202	0.565	0.876
0.284	0.232	0.585	0.935
0.304	0.263	0.606	0.996
		0.625	1.056

1) 8-inch Palmer-Bowlus flumes. Rating table taken from manufacturer's literature.

TABLE C-2

Theoretical Stage-Discharge Rating Table for Manhole MH-3[1)]

Stage (feet)	Discharge (cfs)	Stage (feet)	Discharge (cfs)
0.000	0.000	0.402	0.518
0.031	0.007	0.427	0.579
0.061	0.020	0.450	0.643
0.090	0.039	0.475	0.718
0.118	0.060	0.502	0.800
0.146	0.085	0.528	0.880
0.173	0.114	0.553	0.966
0.200	0.146	0.579	1.054
0.228	0.182	0.605	1.145
0.253	0.220	0.630	1.239
0.279	0.261	0.656	1.334
0.304	0.306	0.681	1.432
0.329	0.354	0.706	1.532
0.354	0.406	0.732	1.635
0.379	0.460	0.757	1.739
		0.782	1.846

1) 10-inch Palmer-Bowlus flume. Rating table taken from manufacturer's literature.

TABLE C-3

Theoretical Stage-Discharge Rating Table for Manhole S120a[1)]

Stage (feet)	Discharge (cfs)	Stage (feet)	Discharge (cfs)
0.000	0.000	0.483	0.818
0.037	0.011	0.512	0.915
0.073	0.033	0.540	1.016
0.108	0.061	0.570	1.134
0.142	0.095	0.602	1.260
0.175	0.135	0.633	1.391
0.208	0.181	0.664	1.527
0.240	0.231	0.695	1.666
0.272	0.287	0.726	1.809
0.304	0.347	0.756	1.957
0.335	0.413	0.787	2.108
0.365	0.484	0.817	2.263
0.395	0.560	0.847	2.421
0.425	0.640	0.878	2.583
0.455	0.727	0.908	2.748
		0.983	2.917

1) 12-inch Palmer-Bowlus flume. Rating table taken from manufacturer's literature.

TABLE C-4

Theoretical Stage-Discharge Rating Table for Building 990 North Diversion Box (NPUA) and South Diversion Box (SPUA)[1)]

Stage (feet)	Discharge (cfs)	Stage (feet)	Discharge (cfs)
0.00	0.000	0.27	0.607
0.01	0.004	0.30	0.711
0.02	0.012	0.35	0.896
0.03	0.022	0.40	1.095
0.04	0.035	0.45	1.307
0.05	0.048	0.50	1.530
0.07	0.080	0.55	1.766
0.09	0.117	0.60	2.012
0.11	0.158	0.65	2.269
0.13	0.203	0.70	2.535
0.15	0.252	0.75	2.812
0.17	0.303	0.80	3.098
0.19	0.358	0.85	3.392
0.21	0.417	0.90	3.696
0.25	0.541	0.95	4.008
		1.00	4.329

1) 18 inch rectangular, sharp-crested wiers. Rating table calculated from $Q = 4.329H^{1.5}$, where H = stage.