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TRANSMITTAL OF SOUTH PLUME REMOVAL ACTION SYSTEM EVALUATION REPORT FOR JULY 1, 1996, THROUGH DECEMBER 31, 1996

03/31/97

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DOE-FEMP EPAS
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REPORT

Department of Energy
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MAR 3 1 1997

DOE-0743-97

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U.S. Environmental Protection Agency
Region V-SRF-5J
77 West Jackson Boulevard
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Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

TRANSMITTAL OF SOUTH PLUME REMOVAL ACTION SYSTEM EVALUATION REPORT FOR JULY 1, 1996, THROUGH DECEMBER 31, 1996

Enclosed for your review is the South Plume Removal Action System Evaluation Report covering the period July 1, 1996, through December 31, 1996. This document meets the reporting requirements defined in the Design, Monitoring, and Evaluation Program Plan (DMEPP) by summarizing the monitoring and operational activities and assessing the effectiveness of the South Plume recovery wellfield.

Please note that the analytical data (i.e., Appendix A) used to prepare this System Evaluation Report is on a computer disk enclosed with the report. The computer disk is being supplied only to the U.S. Environmental Protection Agency (U.S. EPA), Ohio Environmental Protection Agency (OEPA), and their technical support subcontractors.

If you have any questions, please contact John Kappa at (513) 648-3149, or Robert J. Janke at (513) 648-3124.

Sincerely,

Glenn Griffith

for Johnny W. Reising
Fernald Remedial Action
Project Manager

FEMP:Kappa

Enclosure: As Stated

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SOUTH PLUME REMOVAL ACTION DESIGN MONITORING EVALUATION PROGRAM PLAN

SYSTEM EVALUATION REPORT FOR JULY 1, 1996 - DECEMBER 31, 1996

OPERABLE UNIT 5

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MARCH 1997

U.S. DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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SOUTH PLUME REMOVAL ACTION DESIGN MONITORING EVALUATION PROGRAM PLAN

SYSTEM EVALUATION REPORT FOR JULY 1, 1996 - DECEMBER 31, 1996

OPERABLE UNIT 5

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
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EXECUTIVE SUMMARY

This System Evaluation Report summarizes the performance of the South Plume recovery wellfield during the period July 1, 1996 through December 31, 1996. This document fulfills the reporting requirements defined in the South Plume Groundwater Recovery System Design, Monitoring, and Evaluation Program Plan (DMEPP) of April 1993. The reporting schedule was amended by correspondence between the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) and the Ohio EPA (OEPA); reports are due in April and October of each year. As in the last report, a disk containing the analytical data for this reporting period is included in the front binder pocket.

During this reporting period a total of 234 million gallons of water was pumped and 34.1 pounds of uranium were removed from the aquifer. The entire system was shut down only five percent of the time due to a power distribution problem from Cincinnati Gas & Electric in July and for scheduled maintenance in September. Periodic system outages were experienced during the third quarter of 1996 due to failures in the flow controller electrical components. These outages were caused by power line surges associated with electrical storms. The addition of electrical surge suppressing devices to the electronic components of the flow control systems was completed in September 1996 in an effort to alleviate downtime due to these surges.

After Recovery Well 3926 was removed from service during the previous reporting period and the pump was removed, extreme bio-fouling on the pump intake screen was observed. A subsequent down-hole camera survey revealed similar fouling on the well screen. Because of the extent of the fouling, a major well rehabilitation program was initiated to improve recovery well performance. Rehabilitation was completed on Recovery Well 3926 and the well was placed back in service on November 27, 1996. The post-treatment pumping test on Recovery Well 3926 indicated that the specific capacity of the well was significantly improved by the rehabilitation. Recovery Well 3927 was removed from service for rehabilitation after Well 3926 was placed back on line. As of December 31, 1996 Recovery Well 3927 is undergoing rehabilitation and the South Plume recovery system is operating below the target rate of 1400 gpm with Recovery Wells 3924 and 3925 pumping 300 gpm each and Well 3926 pumping at 400 gpm for a combined rate of 1,000 gpm. Recovery Wells 3924 and 3925 are each scheduled for rehabilitation during the next reporting period and will be taken out of service one at a time as soon as Recovery Well 3927 is placed back on line.

The main body of the 20 micrograms per liter (μg/L) uranium plume continues to be captured by Recovery Wells 3924 and 3925. While Recovery Well 3926 was out of service, the target pumping rate was 1100 gpm (Recovery Wells 3924 and 3925 pumping at 300 gpm each and Recovery Well 3927 pumping at 500 gpm). Modeling of this 1100 gpm pumping scenario with Recovery Well 3926 out of service shows some potential breakthrough in the vicinity of Recovery Well 3926. However, considering the retarded uranium contaminant velocity of 1/12th the groundwater advection velocity, contamination near Recovery Well 3926 would have only moved 100 to 120 feet during the period the well was out of service. This distance is well within the capture zone of Well 3926 when it is operational. Furthermore, the concentrations measured in Well 3926 before it was taken out of service and after it was returned to service were 8.8 μg/L and 9.3 μg/L respectively, both well below the 20 μg/L FRL for uranium.

The southwestern lobe of the plume continues to fluctuate seasonally with recharge from Paddys Run as evidenced by the data from third and fourth quarter sampling events. The extent of the southern lobe of the plume is defined by total uranium concentrations in Monitoring Well 2552; those concentrations increased slightly during this reporting period to 24 μg/L. Results of the Mann-Kendall test for trend on the data set for Well 2552 changed from "Down Significant" to "No Trend". Borescope data taken at Monitoring Wells 2552 and 3552 in December 1996 indicate flow to the southeast in Well 2552 away from the recovery system and flow to the north in Well 3552 toward the recovery system.

In the northeastern lobe of the plume the Mann-Kendall test for trend still indicates an "Up Significant" trend for Monitoring Wells 3069 and 2398. However, concentrations in these two wells decreased slightly in this reporting period as did concentrations in Homeowner Well #13. Monitoring Well 3069 which had a maximum total uranium concentration of 233.6 μg/L in the first quarter of 1996 had concentrations of 115.0 μg/L during the third quarter and 164.3 μg/L during the fourth quarter of 1996. Total uranium concentrations in Homeowner Well #13 decreased to 85 μg/L during the fourth quarter sampling event.

An investigation to determine the extent of the deeper portion of the uranium plume in the area around Monitoring Well 3069 is being conducted as part of the Restoration Area Verification Sampling Project Specific Plan (PSP). Preliminary data from this sampling activity is presented in this report and indicates that the deeper portion of the uranium plume in this area extends slightly south of the

FEMP property boundary with concentrations of 300 μg/L in the vicinity of Willey Road and southwest of Well 3069. A more detailed analysis of all the new data collected under this PSP will be prepared once sampling activities are completed. This additional data will also be utilized in the revised Baseline Remedial Strategy Report for determining the need for and location of additional South Plume Optimization Wells.

The hydraulic, chemical, and radiological data collected during the reporting period are, with the exception of those data discussed above, generally consistent with past reports. Evaluation of the data indicates that the South Plume recovery wells are exerting a negligible influence on the Paddys Run Road Site (PRRS) plume.

Pending approval of the Integrated Environmental Monitoring Plan (IEMP) which incorporates the South Plume Recovery System groundwater monitoring program, one more DMEPP System Evaluation Report will be prepared and submitted on October 1, 1997 covering the period from January 1 through June 30, 1997. Subsequent performance and analysis data for the South Plume Recovery System will be incorporated into the IEMP quarterly and annual reports.

1.0 OPERATIONAL SUMMARY

This section summarizes the operation of the recovery wellfield from July 1, 1996 through December 31, 1996. The wellfield includes four recovery wells - 3924, 3925, 3926, and 3927. Well 3928 has been shut down since December of 1994 because it is not needed to meet current system objectives.

As noted in the previous System Evaluation Report, Well 3926 was removed from service in April 1996 for a major rehabilitation and pump replacement. When the pump was pulled from Well 3926, extreme iron fouling was observed around the pump intake and a subsequent down hole camera survey revealed similar fouling of the well screen. Because of the amount of iron fouling, a major well rehabilitation program was initiated for all of the South Plume Recovery System wells.

The well rehabilitation process begins with a pre-treatment pumping test which consists of a short duration step test to assess the specific capacity of the well. The actual well treatment includes cleaning of the recovery well utilizing dual swab and airlift pumping methods to remove debris. After cleaning, the recovery well is acid treated to break down iron encrustation on the recovery well screen and within the local formation. This is followed by chlorination and pumping to inhibit future growth of iron fouling bacteria. A post-treatment pumping test is run and compared against the pre-test to provide a measure of the effectiveness of the rehabilitation program. The post-treatment pumping tests will be used as a baseline for monitoring future performance of the recovery wells.

Recovery Well 3926 was the first well to be rehabilitated. Since the well was out of service before the rehabilitation program was initiated, a pre-treatment pumping test was not performed. During the post-treatment pumping test, Well 3926 was pumped at rates ranging from 125 gpm to 650 gpm for short intervals (less than 10 minutes at each rate) and a maximum drawdown of 2.17 feet was observed in the well. Well 3926 was returned to service on November 27 at the target pumping rate of 400 gpm. During the interim period while Well 3926 was out of service, Wells 3924 and 3925 were pumped at a rate of 300 gpm each, and Well 3927 was pumped at 500 gpm for a total system pumping rate of 1100 gpm.

After Well 3926 was returned to service in November, Well 3927 was removed from service for rehabilitation. A pre-treatment pumping test run on Well 3927 resulted in 17 feet of drawdown in the

well when it was pumped at 175 gpm for short periods of time (less than 15 minutes). After rehabilitation, the post-treatment pumping test resulted in only 1.25 of drawdown in the well when it was pumped at 175 gpm. Well 3927 was returned to service on January 14, 1997 at its target pumping rate of 400 gpm.

While Well 3927 was out of service the average system pumping rate was 1000 gpm; wells 3924 and 3925 were pumped at 300 gpm each and Well 3926 was pumped at 400 gpm. The pumping rate on Well 3926 was not increased to 500 gpm while Well 3927 was being rehabilitated because of its proximity to Paddys Run Road Site (PRRS) and concerns that increased pumping rates in the well above the nominal 400 gpm rate might have adverse impacts on PRRS contaminants.

The rehabilitation program continues into 1997 with Well 3925 currently being rehabilitated and Well 3924 scheduled for rehabilitation after Well 3925 is returned to service. Details on the rehabilitation of these wells will be furnished in the next scheduled DMEPP System Evaluation Report (October 1997).

The following pages provide operational summary sheets for Recovery Wells 3924, 3925, 3926, and 3927. Monitoring data for these wells were collected at the individual well locations. Data representative of the entire recovery wellfield were collected at the storm water retention basin (SWRB) valve house; a wellfield operational summary sheet follows those for the individual recovery wells. Due to the different flow measurement points, minor differences in the cumulative wellhead totals and the valve house measurements for total flow are common. Data from the valve house were used to plot daily total uranium concentrations in the South Plume discharge water for the reporting period (Figure 1-2), monthly average total uranium concentrations since the start-up of the recovery wellfield in 1993 (Figure 1-3), and the cumulative pounds of uranium removed versus the cumulative gallons pumped by the recovery wells (Figure 1-4).

The recovery system operated in a three-well configuration (Wells 3924 and 3925 pumping at 300 gpm each and Well 3926 pumping at 400 gpm or Well 3927 pumping at 500 gpm) for 116 out of 184 days or 63 percent of the time. For 37 percent of the time the system was operating at something less than the three-well configuration. Failed flow controller circuit boards accounted for the majority of the down time. The entire recovery system was shut down only 5 percent of the time (from July 19 to July 23) due to a power distribution problem from Cincinnati Gas & Electric and (from

September 2 to September 6) for replacement of a back pressure control valve in the combined recovery well discharge pipe line.

Over the entire reporting period, the individual recovery wells operated from 18.7 percent of the time for Well 3926 to 87.1 percent of the time for Well 3925. Individual wells were out of service at several times during the reporting period, the most notable of which is the outage of Well 3926 for rehabilitation and pump replacement as discussed above. Wells 3924 and 3925 were out of service from August 16 to August 28 due to operational problems with the flow control systems which resulted from power surges that occurred during thunderstorms. Work was completed on the installation of surge suppressing devices on the electrical components in September. Suppressors were installed on all four recovery wells and on the control building. Since flow controller problems accounted for a significant portion of the down time, additional electrical flow control components have been added to the spare parts inventory to minimize future downtime.

A total of 234 million gallons of water was pumped during this reporting period and accounted for 34.1 pounds of uranium being removed from the aquifer; the average daily total uranium concentration in the South Plume discharge water was 17.6 micrograms per liter (μg/L). There was one extended time period from late November through December 31 when daily total uranium concentrations were above 20 μg\L in the South Plume discharge water, as shown on Figure 1-2. An examination of the operational data for the recovery well field revealed that the initial spike in the daily uranium concentration occurred when Recovery Well 3924 was brought back on line after being down from November 13 through November 20. The remaining time after November 27 concentrations were above 20 μg/L because Well 3927 was taken off line for rehabilitation and Well 3926 (which has higher concentrations than 3927) was returned to service. The uranium concentration in Recovery Well 3924 averages around 44 μg/L compared to 1.2 μg/L for Recovery Well 3927 and 9.3 μg/L for Recovery Well 3926.

WELL 3924 (RW-1)
OPERATIONAL SUMMARY SHEET

Reference Elevation (AMSL) - 531.9 (top of casing)
Northing Coordinate ('27) - 474,190.37
Easting Coordinate ('27) - 1,379,783.13

Hours in reporting period - 4,416
Hours not pumped - 855
Hours pumped - 3,561
Operational percent - 80.6
Target pumping rate - 300 gpm

Monthly Measurements at Wellfield

Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
7/96	210[a]	9.4	43	0.36
8/96	162[b]	7.2	44	0.37
9/96	241[c]	10.7	46	0.38
10/96	296	13.2	43	0.36
11/96	221[d]	9.5	44	0.37
12/96	274[e]	12.2	42	0.35
		Total 62.2	Average 44	Average 0.37

[a]Well out of service 7/1 and 7/24 due to erratic flows. Well out of service 7/7 to 7/11, due to malfunctioning flow controller caused by electrical storm. Recovery well system out of service 7/19 to 7/23, due to disruption of power from CG&E.
[b]Well out of service 8/9 due to disruption of power. Well out of service 8/16 to 8/28, due to malfunctioning flow controller.
[c]Recovery well system shut down 9/2 to 9/6 for scheduled maintenance - replacement of back pressure control valve.
[d]Well out of service 11/13 to 11/20 due to malfunctioning flow controller.
[e]Well out of service 12/7 to 12/9 due to malfunctioning flow controller.

000012

WELL 3925 (RW-2)
OPERATIONAL SUMMARY SHEET

Reference Elevation (AMSL) - 540.3 (top of casing)
Northing Coordinate ('27) - 474,290.32
Easting Coordinate ('27) - 1,380,034.28

Hours in reporting period - 4,416 Hours pumped - 3,845 Target pumping rate - 300 gpm
Hours not pumped - 571 Operational percent - 87.1

Monthly Measurements at Wellfield

Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
7/96	262[a]	11.7	23	0.19
8/96	136[b]	6.1	28	0.23
9/96	228[c]	10.2	25	0.21
10/96	259	11.6	25	0.21
11/96	257	11.1	26	0.22
12/96	249	11.1	25	0.21
	Total	61.8	Average 25	Average 0.21

[a]Recovery well system out of service 7/19 to 7/23, due to disruption of power from CG&E. Recovery well out of service 7/24 due to erratic flows.
[b]Well out of service 8/9 to 8/13, due to disruption of power. Well out of service 8/16 to 8/28, due to malfunctioning flow controller.
[c]Recovery well system shut down 9/2 to 9/6 for scheduled maintenance - replacement of back pressure control valve.

WELL 3926 (RW-3)
OPERATIONAL SUMMARY SHEET

Reference Elevation (AMSL) - 585.0 (top of casing)
Northing Coordinate ('27) - 474,399.22
Easting Coordinate ('27) - 1,380,306.40

Hours in reporting period - 4,416 Hours pumped - 810 Target pumping rate - 400 gpm
Hours not pumped - 3,606 Operational percent - 18.3

Monthly Measurements at Wellfield

Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
7/96	0[a]	0	---	---
8/96	0[a]	0	---	---
9/96	0[a]	0	---	---
10/96	0[a]	0	---	---
11/96	37[b]	1.6	-	-
12/96	395	17.6	9.3	0.08
		Total 19.2	Average 9.3	Average 0.08

[a]Well taken out of service 5/1/96 for rehabilitation and pump replacement.
[b]Well brought on line 11/27.

000014

WELL 3927 (RW-4)
OPERATIONAL SUMMARY SHEET

Reference Elevation (AMSL) - 589.0 (top of casing)
Northing Coordinate ('27) - 474,512.49
Easting Coordinate ('27) - 1,380,596.15

Hours in reporting period - 4,416 | Hours pumped - 3,227 | Target pumping rate - 500 gpm[a]

Hours not pumped - 1,189 | Operational percent - 73.1

Monthly Measurements at Wellfield

Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
7/96	441[b]	19.7	1.1	:01
8/96	464[c]	20.7	1.1	.01
9/96	384[d]	17.2	1.3	.01
10/96	452[e]	20.2	1.1	.01
11/96	292[f]	12.6	---	---
12/96	0[g]	0	---	---
		Total 90.4	Average 1.2	Average .01

[a]Target pumping rate was increased from 400 gpm to 500 gpm on 7/2 due to Recovery Well 3926 being taken out of service for rehabilitation.
[b]Recovery well system out of service 7/19 to 7/23, due to disruption of power from CG&E.
[c]Well out of service 8/9 due to power disruption.
[d]Recovery well system shut down 9/2 to 9/6 for scheduled maintenance - replacement of back pressure control valve.
[e]Maximum average pumping rate for this well before rehabilitation.
[f]Well taken out of service 11/21/97 for rehabilitation.
[g]Well out of service for rehabilitation.

WELL 3928 (RW-5)
OPERATIONAL SUMMARY SHEET

Reference Elevation (AMSL) - 588.3 (top of casing)
Northing Coordinate ('27) - 474,608.92
Easting Coordinate ('27) - 1,380,841.74

Hours in reporting period - 4,416 Hours pumped - 0 Target pumping rate - 0
Hours not pumped - 4,416 Operational percent - 0

Monthly Measurements at Wellfield

Month	Monthly Average Pumping Rate[a] (gpm)	Million Gallons Pumped[a]	Uranium Concentration[a] (μg/L)	Well Efficiency[a] (lbs/M gal)
7/96	0	0	—	—
8/96	0	0	—	—
9/96	0	0	—	—
10/96	0	0	—	—
11/96	0	0	—	—
12/96	0	0	—	—
	Total	0	Average —	Average —

[a]This recovery well is shut down because it is not needed currently to meet system objectives due to observed low concentrations of uranium in this well's discharge water when the system was in operation.

WELLFIELD OPERATIONAL SUMMARY SHEET

Total gallons pumped this reporting period (M gal) - 234
Total uranium recovered this reporting period (lbs) - 34.1
Average system efficiency this reporting period (lbs/M gal) - 0.15
Gallons pumped from August 1993 to December 1996 (billion gal) - 2.1
Uranium recovered from August 1993 to December 1996 (lbs) - 300.3
System efficiency from August 1993 to December 1996 (lbs/M gal) - 0.14

Monthly Measurements at Storm Water Retention Basin Valve House

	Monthly Average Well Pumping Rates (gpm)					Total System Pumping Rate (gpm)	Total System Average Uranium Concentration (μg/L)
Month	3924	3925	3926	3927	3928		
7/96	210	262	0[a]	441	0	914[b]	15.1
8/96	162	136	0[a]	464	0	762	12.8
9/96	241	228	0[a]	384	0	853[c]	17.9
10/96	296	259	0[a]	452	0	1007	16.3
11/96	221	257	37	292	0	807	19.4
12/96	274	249	395	0[d]	0	918	23.9
						Average	17.6

[a]Well out of service due to rehabilitation and pump replacement.
[b]Recovery well system out of service 7/19 to 7/23 due to power disruption.
[c]Recovery well system shut down 9/2 to 9/6 due to scheduled maintenance.
[d]Well taken out of service for rehabilitation.

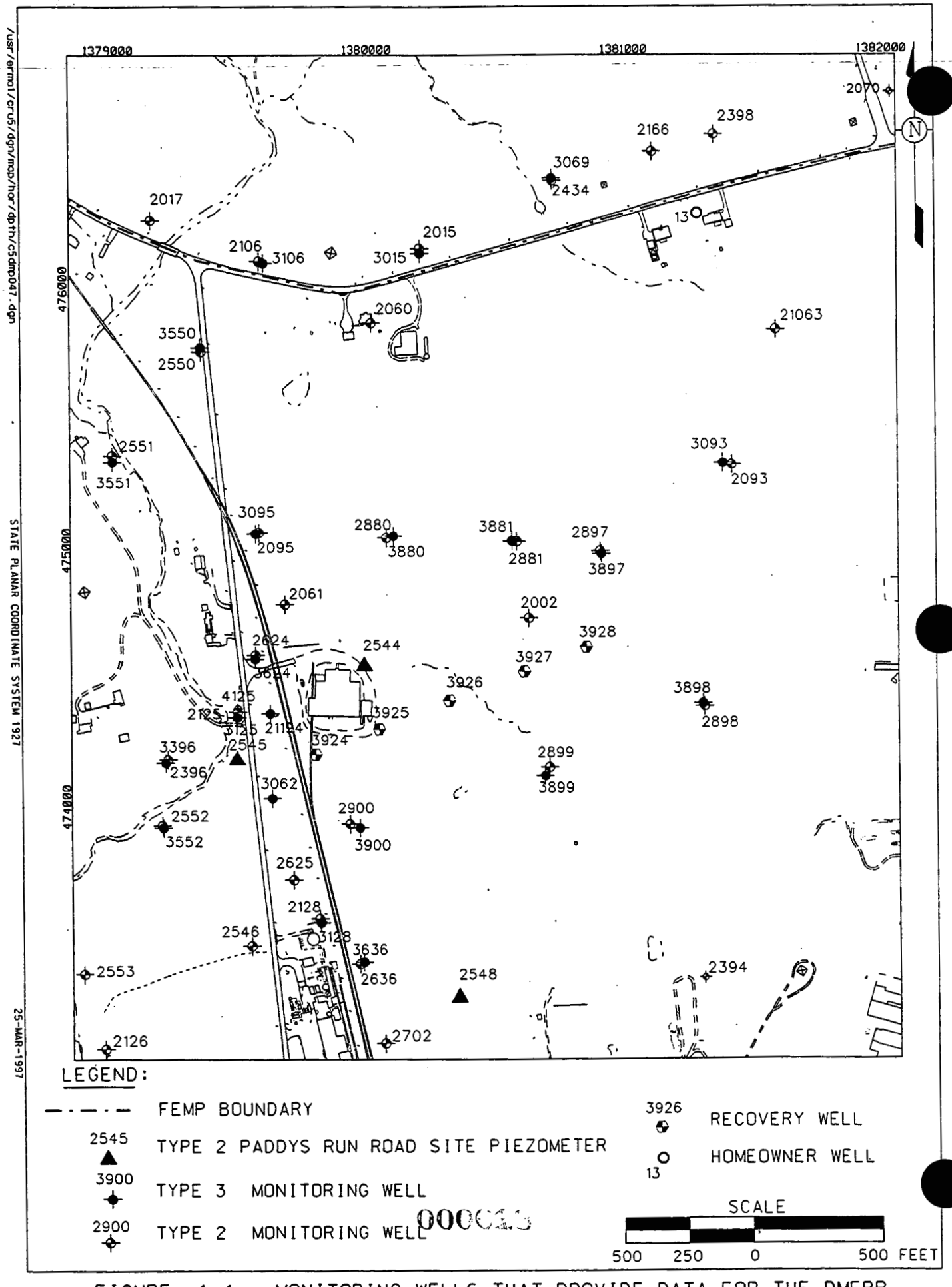

FIGURE 1-1. MONITORING WELLS THAT PROVIDE DATA FOR THE DMEPP

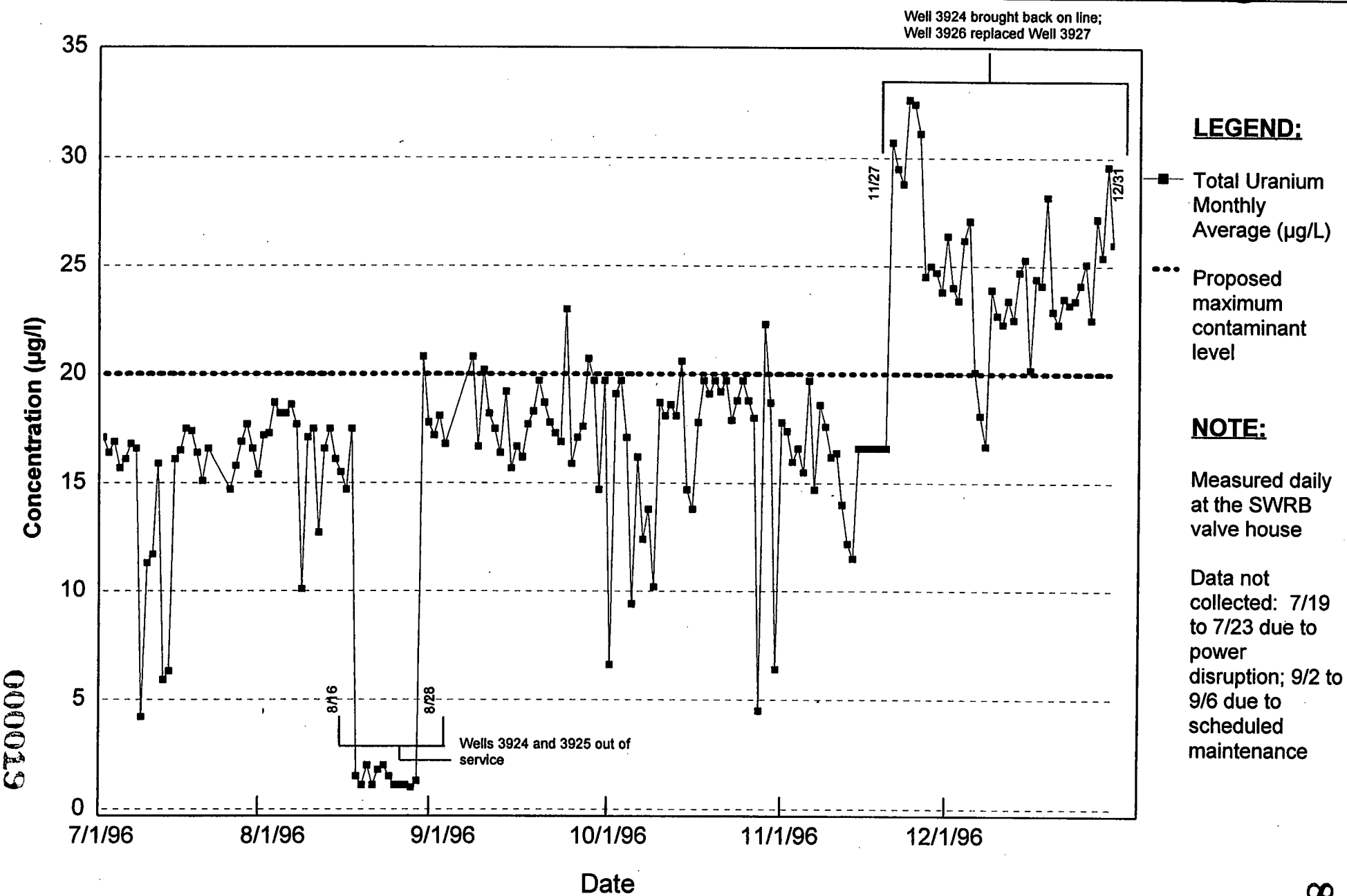

Figure 1-2. Daily Total Uranium Concentration in South Plume Discharge Water, 7/96 - 12/96

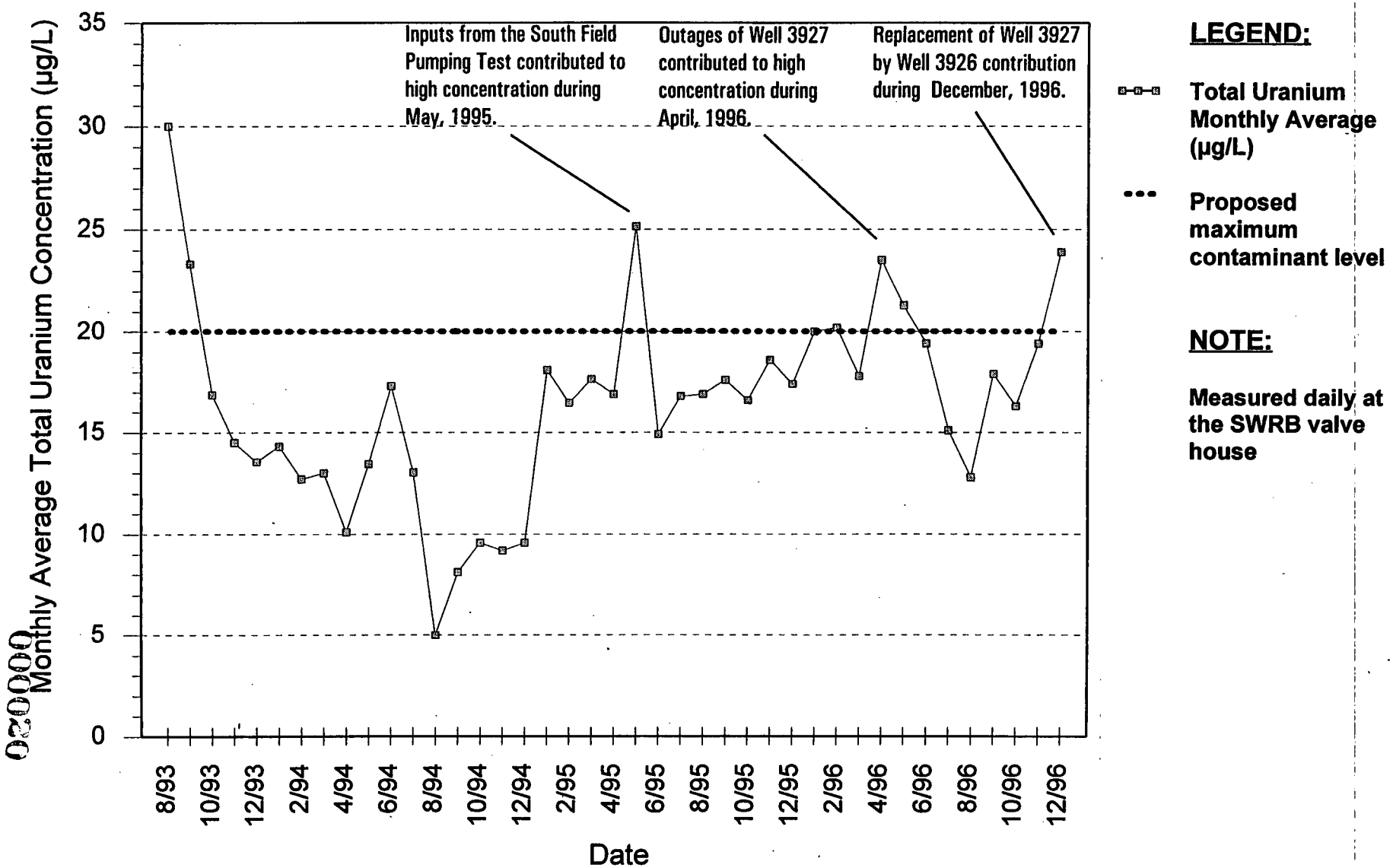

Figure 1-3. Monthly Average Total Uranium Concentration in South Plume Discharge Water, 8/93 - 12/96

020000

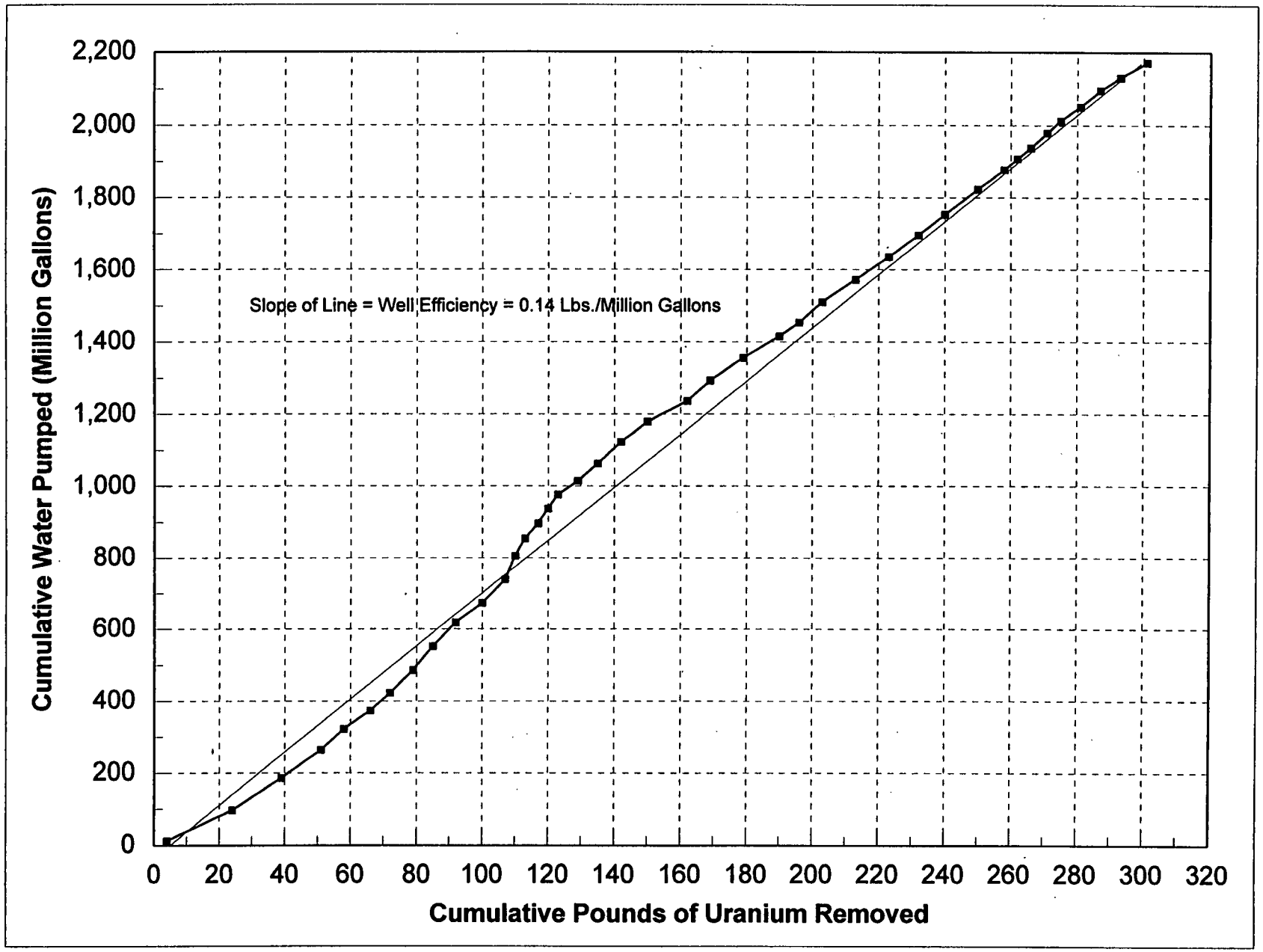

Figure 1-4. Total Uranium Removed -vs- Water Pumped, 8/93 - 12/96

2.0 MONITORING WELL SUMMARY

Currently, water elevation data are collected from the 33 DMEPP monitoring wells shown in Table 2-1. Well 2543 was removed because of damage to the well head due to a vehicular accident. However, Well 2394, which is part of the monitoring program is close enough to Well 2543 to provide the necessary elevation data for this area. As part of the comment resolution following submittal of the October 1996 DMEPP System Evaluation Report, the groundwater elevation monitoring program for Type 3 wells has been discontinued. Therefore, the number of wells being monitored for groundwater elevation has been reduced to 33. For the period covered by this report these measurements were collected monthly. In the future, this frequency could again be reduced to quarterly when the recovery well system appears to have stabilized. These elevation data are used to assess the effective capture of uranium-contaminated groundwater by the recovery wellfield, as reported in Section 4.0.

Currently, groundwater quality data are collected from 58 monitoring wells (Table 2-2). Monitoring Well 2546 was added to the program during this reporting period to provide additional data south and west of the recovery system. Figure 1-1 shows the location of all wells that provide analytical results for the DMEPP and Table 2-2 identifies the constituents analyzed for. This information is used to prepare statistical summary tables (Section 3.0) and to provide contour maps of the uranium plume at the Type 2- and Type 3-well-depth intervals (Section 4.0). During this reporting period, monitoring was not performed at seven of the well locations. Well 2061, previously the sanitary water supply well for Delta Steel was plugged and abandoned pursuant to Hamilton County Department of Health requirements after Delta Steel was connected to the Hamilton County water system (Public Water Supply System). Well 3062, formerly a process water supply well for Albright and Wilson, is no longer available for sampling due to electrical problems associated with the pump. Wells 2095 and 3095 were not available for sampling in the third quarter due to access restrictions because of the presence of agricultural crops. Wells 2548, 2624, and 3624 remain inaccessible for sampling due to the lack of a current access agreement with the property owner, CSX Railroad. Negotiations for an access agreement are ongoing.

Groundwater quality sampling of the DMEPP wells occurs on a quarterly basis. Additional sampling is performed based on data needs determined by analytical review of the data as results become available.

TABLE 2-1

DMEPP MONITORING WELLS FOR THE GROUNDWATER ELEVATION PROGRAM

33 Total Wells[a]	
TYPE 2	**TYPE 3[a]**
2002	3062[a]
2015	3093[a]
2070	3095[a]
2093	3125[a]
2095	3128[a]
2106	3396[a]
21063	3624[a]
21194	3636[a]
2125	3880[a]
2126	3881[a]
2128	3897[a]
2166	3898[a]
2394	3899[a]
2396	3900[a]
2398	3927[a]
2434	
2544	
2545	
2546	
2548	
2551	
2552	
2553	
2624	
2625	
2636	
2702	
2880	
2881	
2897	
2898	
2899	
2900	

[a]Type 3 Wells removed from the groundwater elevation monitoring program per comment resolution following the submittal of the October 1996 DMEPP report. Therefore, these wells will be deleted from future reports.

TABLE 2-2

DMEPP MONITORING WELLS AND ANALYTICAL PARAMETERS FOR THE GROUNDWATER SAMPLING PROGRAM

34 Original Wells	Analytical Parameters[a]	24 Supplemental Wells/Date Added[b]	Analytical Parameters[a]
2002	A,B	2015 / 2/94 (5/95)[c]	A,B
2061[d]	A,B	2017 / 2/94 (5/95)[c]	A,B
2093	A,B	2060 / 2/95 (2/95)[c]	A,B
2095	A,B	2106 / 2/94[c]	A,B
2125	A,B	21063 / 5/94 (5/95)	A,B
2128	A,B,C,D,E	2166 / 5/95 (5/95)[c]	A,B
2544	A,B	2396 / 5/95 (5/95)	A,B
2545	A,B	2398 / 1/94[c]	A,B
2548	A,B,C,D,E	2434 / 1/94[c]	A,B
2624	A,B	2546 / (7/96)	A,B
2625	A,B,C,D,E	2550 / 2/94 (5/95)	A,B
2636	A,B,C,D,E	2551 / 2/94 (5/95)	A,B
2880	A,B	2552 / 2/94 (5/95)	A,B
2881	A,B	2553 / 2/94 (5/95)	A,B
2897	A,B	3015 / 2/94 (5/95)[c]	A,B
2898	A,B,C,D	3062 / (6/95)[e]	A,B
2899	A,B,C,D	3069 / 1/96[c]	A,B
2900	A,B,C,D,E	3106 / 2/94[c]	A,B
3093	A,B	3396 / (6/95)	A,B
3095	A,B	3550 / 2/94 (5/95)	A,B
3125	A,B	3551 / 2/94 (5/95)	A,B
3128	A,B,C,D	3552 / 2/94 (5/95)	A,B
3624	A,B	21194 / 2/95 (2/95)	A,B
3636	A,B,C,D	4125 / (6/95)	A,B
3880	A,B		
3881	A,B		
3897	A,B		
3898	A,B,C,D		
3899	A,B,C,D		
3900	A,B,C,D		
3924	A,B,E		

TABLE 2-2
(Continued)

34 Original Wells	Analytical Parameters[a]	24 Supplemental Wells/Date Added[b]	Analytical Parameters[a]
3925	A,B,E		
3926	A,B		
3927	A,B		

[a]A Dissolved oxygen, pH, specific conductance, temperature (analyzed in the field)
B Total uranium (analyzed at the on-site laboratory)
C Arsenic, phosphorus (total), potassium, sodium (Paddys Run Road Site [PRRS] inorganics)
D Benzene, cumene (isopropyl benzene), ethyl benzene, toluene, xylene (PRRS organics)
E Arsenic (collected on a weekly basis; see results in Appendix A for exact sample collection dates)
[b]Date added identifies when analytical results were first used in support of findings for the DMEPP. The date in parentheses is when the monitoring well was formally added to the DMEPP sampling program.
[c]Monitoring well is sampled under a separate program but provides the necessary analytical results on a sampling schedule compatible with the DMEPP.
[d]Well abandoned and plugged pursuant to Hamilton County Health Department requirements.
[e]Well not available for sampling due to electrical problems with the pump.

3.0 ANALYTICAL DATA SUMMARY

Statistical summaries of results (minimum, maximum, average, standard deviation, and trend) from unfiltered samples from individual wells are presented in Tables 3-1 through 3-5 for total uranium, arsenic, phosphorus, potassium and sodium, respectively. In preparing these tables, a procedural change was made in the way normal and duplicate samples were being counted so as to make the DMEPP reporting mechanism consistent with what has been done in the RCRA program and what will be done in the Integrated Environmental Monitoring Program when it is implemented.

In previous DMEPP System Evaluation Reports, normal and duplicate samples taken in the same day were counted as separate samples and each value used in calculating the average, minimum, maximum, and standard deviation statistics. Normal and duplicate samples were averaged together and counted as one sample for the Mann-Kendall calculation of trend. In this DMEPP System Evaluation Report, normal and duplicate samples taken on the same day were first averaged then counted as one sampling event for that day before the minimum, maximum, average, and standard deviation statistics were calculated. As before, any sample with a non-detect (i.e., a laboratory validation qualifier of "U") was assigned a value equal to one-half the minimum detection limit (MDL) for the analytical method used. If the non-detect sample was one of a duplicate-normal sample pair, the one-half MDL for the non-detect was assigned then averaged with the other member of the sample pair.

Appendix A consists of validation qualifiers and a disk containing the analytical data used to prepare this report. The two files on the disk, one for filtered and one for unfiltered data, are in ASCII format with quotes and semicolons used as delimiters. Appendix B contains total uranium concentration plots for each monitoring well over time for unfiltered samples.

As in previous System Evaluation Reports, the Mann-Kendall trend test was performed on total uranium, arsenic, phosphorus, potassium, and sodium sampling results from August 27, 1993 through December 31, 1996. Tables 3-1 through 3-5 include summaries of the Mann-Kendall test results by analyte and location, the number of distinct sampling events used in the calculation, and the probability that the trend calculated is due to chance. In preparing these tables only data with validation qualifiers "-," "J," "NV," "U," and "UJ" were used (see Appendix A). All "U" and "UJ"

qualified data were used at one-half the reported value. Details of the Mann-Kendall trend calculation are given in Appendix C.

The Mann-Kendall probability value gives the probability that the apparent trend is due to chance and not a real trend. Therefore, a smaller probability value from the Mann-Kendall test indicates that the calculated trend is more likely to be real. For example, a probability value of 0.05 indicates that the calculated trend is real with a certainty of 95 percent; or, in other words, there is only a five percent chance that such a trend could have been calculated from random points. In Tables 3-1 through 3-5 a probability value less than or equal to five percent (.05) was interpreted as a significant trend and a probability value less than or equal to 10 percent (.10) but greater than five (.05) percent was interpreted as a marginally significant trend.

One positive result was found for toluene during this reporting period in Monitoring Well 3636 at a concentration of 3.0 μg/L. This well is located south of the recovery well system within the bounds of the Paddys Run Road Site (PRRS) plume. The sample was taken on August 15, 1996. No statistical summaries or Mann-Kendall trend calculations were performed on toluene or the other volatile organic constituents (benzene, cumene, ethylbenzene, and xylene) sampled for under the DMEPP because, other than the toluene mentioned above, no other detections were noted during the reporting period.

In order to assist in the assessment of data collected since system start-up, Mann-Kendall test results with significant upward or downward trends identified from August 27, 1993 through December 31, 1996 have been compiled in Table 3-6 for total uranium, arsenic, phosphorus, potassium and sodium, along with specific explanations for each trend.

An examination of the trend values for total uranium data (Table 3-6) shows that 14 wells have significant downward trends, and 12 wells have significant upward trends. While these are the same numbers reported during the previous period, two wells changed from an "Up Significant" trend to "No Trend" (Wells 3125 and 4125); two wells changed from "No Trend" to "Up Significant" (Wells 2002 and 2128); two wells changed from a "Decreasing Trend" to "No Trend (Wells 2552 and 3881); and two wells changed from "No Trend" to "Decreasing Trend" (Wells 2434 and 2548).

Of the 26 wells with significant trends in total uranium concentrations, only three, Monitoring Wells 2128 and 2398 with upward trends and Monitoring Well 2548 with a downward trend are outside the capture zone of the recovery system as defined by the groundwater elevation data and supported by the colloidal borescope data and SWIFT site groundwater modeling results. These Wells are shown on Figure 1-1 and are discussed individually below.

The 10 wells with significant upward trends in total uranium concentration located within the capture zone are not a concern because the groundwater contained within them will be extracted and treated as appropriate. Some of these wells, however, also need to be discussed individually.

While Monitoring Wells 2398 and 3069 in the area of the northeastern lobe of the plume continue to show significant upward trends in total uranium concentrations, evaluation of the results from the third and fourth quarter sampling events shows that concentrations have fallen back below the maximum values observed in the first quarter of 1996. Total uranium concentrations in Monitoring Well 3069 were at 223.6 μg/L in the first quarter 1996 but were at 115.0 μg/L in July, 1996 (average of normal and duplicate samples), and were at 164.3 μg/L in September 1996. Monitoring Well 2398 is on the extreme eastern edge of the capture zone based on the recovery well system pumping at 1400 gpm (Refer to Figure 4-11 in the October 1996 DMEPP System Evaluation Report). During this period with the 1100 gpm and 1000 gpm pumping configurations, groundwater modeling indicates that this well was outside the capture zone. However, total uranium concentrations in Monitoring Well 2398 dropped from 25.2 μg/L in the first quarter of 1996 to 14.1 μg/L in July 1996 and at 15.8 μg/L in September, 1996 (average of normal and duplicate samples). While not part of the DMEPP monitoring program, Private Well #13, just south of Willey Road in the same area as Monitoring Wells 2398 and 3069, has also shown decreasing total uranium concentrations from a high of 123.0 μg/L during the first quarter of 1996 to 85.0 μg/L during the fourth quarter. Monitoring Well 21063, immediately down gradient of the northeastern lobe of the plume continues to show no trend in total uranium concentrations. Total uranium concentrations of 2.2 μg/L and 1.7 μg/L were observed in this well in the third and fourth quarters respectively.

Monitoring Well 2002 which is located just north of Recovery Well 3927 exhibited a significant upward trend in total uranium for the first time during this reporting period with an average concentration of 4.3 μg/L. Similarly, Wells 2880, 3880, and 3624 continued to show significant upward trends for uranium even though the average total uranium concentrations (1.2 μg/L for

Well 2880; 1.1 μg/L for Well 3880; and 0.6 μg/L for Well 3624) remain within background levels. The upward trends in these wells, if real, is attributed to the arrival of the leading edge of the total uranium plume as it moves toward the recovery system. Monitoring Wells 2624 and 3624 were not sampled during the third and fourth quarters of 1996 due to continuing negotiations with the land owner (CSX Railroad) for access rights.

Wells 2899 and 2900 continue to exhibit significant upward trends in total uranium with average concentrations of 2.3 μg/L and 6.1 μg/L respectively during this reporting period. These wells are south of the recovery system and near the boundary of the interpreted capture zone, as shown in Figure 4-10. The colloidal borescope data gathered from December 9 through December 17, 1996 from these wells continues to show that groundwater flow direction is to the northwest in Well 2900 as shown in Appendix D. This demonstrates that it is within the recovery well capture zone. Borescope flow data for Well 2899 gathered during this same time shows flow directions to the south east indicating that this well is outside the capture zone of the recovery system. (Note: The recovery well system was pumping at 1000 gpm total with Wells 3924 and 3925 pumping at 300 gpm each and Well 3926 pumping at 400 gpm when this borescope data was collected). With total uranium concentrations within the background range in Well 2899, this upward trend may not be real. Wells 2899 and 2900 will continue to be monitored and reported on in future System Evaluation Reports.

In the same area, Monitoring Well 2128 exhibited a significant upward trend in total uranium with a maximum concentration of 12.0 μg/L observed in both the third and fourth quarters of 1996. A concentration of 12.0 μg/L was previously observed in this well in the third quarter of 1995 and reported in the April 1996 DMEPP as a significant upward trend. As discussed in the April 1996 report, Monitoring Well 2625 is immediately up gradient of Well 2128 and continues to show no trend with a maximum concentration of 2.7 μg/L observed in this reporting period. Monitoring Well 2128 will continue to be sampled and observations reported in subsequent DMEPP System Evaluation Reports.

Total uranium concentrations increased during this reporting period at Monitoring Well 2552, near the southwestern lobe of the plume. Concentrations increased from below 20 μg/L to a maximum of 24.5 μg/L during the third quarter sampling event. Concentrations subsequently decreased to 23.0 μg/L during the fourth quarter sampling event. The increase in concentrations had the effect of

changing the "Down Significant" trend reported in the previous System Evaluation Report for this well to "No Trend". Borescope data collected at this well during December 9 to December 17, 1996 indicate flow directions at 115.9°, or east southeast. Therefore, it is inconclusive as to whether this well was within the capture zone during this time.

An examination of the arsenic trends in Table 3-6 shows that only one well (Monitoring Well 2548) exhibits a significant upward trend. This well was not sampled in the third and fourth quarters of 1996 due to continuing negotiations with the land owner (CSX Railroad) for access rights. Because of its position and distance from the recovery well system (over 1000 feet south of Recovery Well 3925), this trend is believed to be attributable to natural migration of Paddys Run Road Site contaminants and not due to operation of the South Plume Recovery System. Wells 2625 and 2900, which are used as early warning indicators for potential capture of PRRS constituents, both show significant downward trends in arsenic concentrations during this reporting period.

Mann-Kendall trend results for the remaining PRRS constituents (phosphorus, potassium, and sodium) are also presented in Table 3-6.

Monitoring Well 2899 was the only well to show a significant upward trend for phosphorus with a maximum concentration of 0.07 mg/L. Since this value is well below the background 95th percentile value of 0.954 mg/L reported in the site background report (Characterization of Background Water Quality for Streams and Groundwater, DOE, May 1994), and since Monitoring Well 2899 is over 1000 feet northeast of Paddys Run Road Site, this trend is not believed to be problematic. Monitoring Well 2899 also continues to show increasing trends for both potassium and sodium with maximum concentrations observed in this reporting period of 3.85 mg/L and 19.20 mg/L respectively. While the 3.85 mg/L maximum observed concentration for potassium is above the 95th percentile value of 1.96 mg/L for background (reference the site background report), the 19.20 mg/L observed concentration for sodium continues to be well below the background 95th percentile value of 47.2 mg/L as reported in the site background report. The maximum observed sodium concentration in this well is 22.90 mg/L. Well 2899 will continue to be monitored for potassium, sodium, and phosphorus and any changes reported in the next System Evaluation Report.

Well 2900 continues to show increasing concentrations and upward trend for sodium. A maximum of 43.40 mg/L was observed in the third quarter sampling round during this reporting period. This

value is still below the 95th percentile background value of 47.2 mg/L. Because sodium is a PRRS constituent, Well 2900 will continue to be monitored for sodium and the results presented in the next scheduled system evaluation report.

TABLE 3-1

STATISTICS FOR TOTAL URANIUM

	Sampling Period										Mann-Kendall Trend Analysis		
	August 27, 1993 - June 30, 1996					July 1, 1996 - December 31, 1996					August 27, 1993 - December 31, 1996		
Well No.	No. of Samples[a]	Min. (µg/L)	Max. (µg/L)	Avg. (µg/L)	SD	No. of Samples[a]	Min. (µg/L)	Max. (µg/L)	Avg. (µg/L)	SD	No. of Samples[a,b]	Probability	Trend[c]
2002	20	1.8	8.9	2.7	1.5	2	3.7	4.8	4.3	0.8	22	0.025	Up, Sig.
2015	11	130.0	170.0	146.9	13.7	2	148.0	156.0	152.0	5.7	13	0.028	Down, Sig.
2017	7	1.9	5.0	4.0	1.2	2	2.2	2.9	2.6	0.5	9	0.060	Down, Mar.
2060	10	30.0	75.0	48.4	14.0	2	28.0	41.0	34.5	9.2	12	0.008	Down, Sig.
2061	20	148.0	380.0	244.5	71.6	0[d]	N/A	N/A	N/A	N/A	20	<0.001	Down, Sig.
2093	12	0.4	0.9	0.5	0.1	2	0.5	0.6	0.6	0.1	14	0.280	No Trend
2095	12	110.0	200.0	155.2	23.8	1	158.0	158.0	158.0	0.0	13	0.291	No Trend
2106	12	6.1	70.0	46.4	17.4	2	42.7	53.0	47.9	7.3	14	0.331	No Trend
21063	9	1.8	15.0	5.1	5.6	2	1.7	2.2	2.0	0.4	11	0.291	No Trend
21194	4	2.5	5.8	3.8	1.4	2	0.6	0.8	0.7	0.1	6	0.274	No Trend
2125	12	8.8	39.0	16.9	9.5	2	8.9	10.0	9.5	0.8	14	0.005	Down, Sig.
2128	13	1.9	12.0	7.1	3.3	2	11.5	12.0	11.8	0.4	15	0.019	Up, Sig.
2166	5	64.0	75.0	69.4	4.3	2	48.0	54.0	51.0	4.2	7	0.089	Down, Mar.
2396	10	0.8	1.3	1.0	0.2	2	0.9	1.0	1.0	0.1	12	0.162	No Trend
2398	12	0.7	25.2	10.2	6.3	2	14.1	15.8	15.0	1.2	14	0.002	Up, Sig.
2434	12	1.0	2.2	1.4	0.3	2	0.9	1.0	1.0	0.1	14	0.031	Down, Sig.
2544	20	0.6	21.0	9.7	5.7	2	8.5	12.0	10.3	2.5	22	0.400	No Trend
2545	13	19.0	81.0	40.0	19.5	2	24.0	30.0	27.0	4.2	15	0.027	Down, Sig.
2546	0	NA	NA	NA	NA	2	0.8	35.0	17.9	24.2	2	-	Insuf. Data
2548	12	0.3	5.5	2.9	1.6	0[e]	N/A	N/A	N/A	N/A	12	0.050	Down, Sig.
2550	10	72.0	84.0	77.6	4.1	2	79.0	86.0	82.5	4.9	12	0.151	No Trend
2551	10	7.5	30.0	20.3	7.6	2	22.0	26.0	24.0	2.8	12	0.205	No Trend
2552	10	16.0	24.0	20.2	2.5	2	23.0	24.5	23.8	1.1	12	0.223	No Trend
2553	9	0.9	1.9	1.4	0.4	2	0.9	1.0	1.0	0.1	11	0.263	No Trend
2624	19	25.0	160.0	78.0	27.9	0[e]	N/A	N/A	N/A	N/A	19	0.003	Down, Sig.
2625	12	0.9	8.2	3.2	1.9	2	0.8	2.7	1.8	1.3	14	0.500	No Trend
2636	11	0.6	3.9	1.5	1.0	2	0.7	1.4	1.1	0.5	13	0.195	No Trend
2880	19	0.4	1.4	0.7	0.3	2	1.1	1.4	1.2	0.2	21	0.001	Up, Sig.
2881	19	0.1	4.0	3.1	0.9	2	2.7	3.0	2.9	0.2	21	0.347	No Trend
2897	12	0.7	1.3	0.9	0.2	2	0.5	0.7	0.6	0.1	14	<0.001	Down, Sig.
2898	13	1.7	3.6	2.7	0.6	2	2.5	2.6	2.6	0.1	15	0.421	No Trend
2899	13	0.9	2.0	1.7	0.3	2	2.2	2.3	2.3	0.1	15	<0.001	Up, Sig.
2900	13	0.5	12.0	3.5	3.1	2	4.5	7.6	6.1	2.2	15	<0.001	Up, Sig.

TABLE 3-1
(Continued)

Well No.	Sampling Period: August 27, 1993 - June 30, 1996					Sampling Period: July 1, 1996 - December 31, 1996					Mann-Kendall Trend Analysis: August 27, 1993 - December 31, 1996		
	No. of Samples[a]	Min. (µg/L)	Max. (µg/L)	Avg. (µg/L)	SD	No. of Samples[a]	Min. (µg/L)	Max. (µg/L)	Avg. (µg/L)	SD	No. of Samples[a,b]	Probability	Trend[c]
3015	11	0.9	1.3	1.2	0.1	2	1.1	1.2	1.2	0.1	13	0.392	No Trend
3062	3	51.0	69.0	58.3	9.5	1	16.0	16.0	16.0	0.0	4	0.167	No Trend
3069[f]	12	7.2	223.6	88.3	62.6	2	115.0	163.0	139.0	34.0	14	0.001	Up, Sig.
3093	11	0.2	0.8	0.5	0.2	2	0.3	0.4	0.4	0.1	13	0.450	No Trend
3095	12	6.0	19.0	10.1	3.9	1	14.0	14.0	14.0	0.0	13	<0.001	Up, Sig.
3106	12	0.7	13.4	2.6	3.6	2	1.6	1.6	1.6	0.0	14	0.137	No Trend
3125	12	43.0	82.0	57.1	12.7	2	58.0	63.0	60.5	3.5	14	0.162	No Trend
3128	13	0.0	1.0	0.5	0.2	2	0.4	0.5	0.5	0.1	15	0.252	No Trend
3396	4	0.5	0.6	0.6	0.1	2	0.5	0.5	0.5	0.0	6	0.360	No Trend
3550	10	2.8	6.1	4.6	1.3	2	2.6	2.9	2.8	0.2	12	<0.001	Down, Sig.
3551	10	0.6	5.0	1.3	1.3	2	0.6	0.9	0.8	0.2	12	0.265	No Trend
3552	4	0.5	0.7	0.6	0.1	2	0.6	0.7	0.7	0.1	6	0.452	No Trend
3624	13	0.3	0.8	0.5	0.1	0[e]	N/A	N/A	N/A	N/A	13	0.033	Up, Sig.
3636	13	0.2	0.6	0.5	0.1	2	0.5	3.0	1.8	1.8	15	0.437	No Trend
3880	12	0.1	2.3	0.9	0.9	2	0.5	1.1	0.8	0.4	14	0.024	Up, Sig.
3881	12	0.0	0.4	0.2	0.1	2	0.3	0.6	0.5	0.2	14	0.500	No Trend
3897	19	0.3	0.8	0.5	0.1	2	0.4	0.5	0.5	0.1	21	0.006	Down, Sig.
3898	13	0.2	175.0	13.9	48.4	2	0.4	0.6	0.5	0.1	15	0.438	No Trend
3899	13	0.6	1.2	0.9	0.2	2	0.6	0.7	0.7	0.1	15	0.004	Down, Sig.
3900	13	0.0	0.5	0.2	0.1	2	0.0	0.2	0.1	0.1	15	0.052	Down, Mar.
3924	30	41.0	145.0	66.3	30.3	6	42.0	46.0	43.7	1.4	36	<0.001	Down, Sig.
3925	38	0.5	33.0	20.1	11.1	6	23.0	28.0	25.3	1.6	44	<0.001	Up, Sig.
3926	37	1.5	8.8	4.7	2.2	1	9.3	9.3	9.3	0.0	38	<0.001	Up, Sig.
3927	33	1.1	5.4	2.0	1.3	4	1.1	1.3	1.1	0.1	37	<0.001	Down, Sig.
4125	5	0.6	9.8	2.6	4.0	2	0.9	1.0	1.0	0.1	7	0.452	No Trend

[a]Variation in number of samples is due to resampling events, different sampling frequencies, and/or number of sampling events in reporting period.
[b]Number of samples used for trend analysis is a count of the number of unique sampling dates.
[c]Up, Sig. = Up, Significant
Up, Mar. = Up, Marginal
No Trend = No Significant Trend
Down, Sig. = Down, Significant
Down, Mar. = Down, Marginal
[d]Delta steel water supply well was plugged and abandoned pursuant to Hamilton County Health Department Regulation when connection was made to Public Water Supply System.
[e]These wells not sampled because negotiations with CSX Railroad for an access agreement are ongoing.
[f]Data collected as part of the RCRA monitoring program.

TABLE 3-2

STATISTICS FOR ARSENIC

	Sampling Period										Mann-Kendall Trend Analysis		
	August 27, 1993 - June 30, 1996					July 1, 1996 - December 31, 1996					August 27, 1993 - December 31, 1996		
Well No.	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a,b]	Probability	Trend[c]
2128	136	0.001	0.142	0.015	0.022	27	0.003	0.005	0.005	0.001	163	<0.001	Down, Sig.
2548	107	0.001	0.706	0.034	0.078	0[d]	N/A	N/A	N/A	N/A	107	0.028	Up, Sig.
2625	128	0.003	0.050	0.012	0.009	27	0.005	0.025	0.011	0.006	155	0.048	Down, Sig.
2636	115	0.010	0.094	0.048	0.018	27	0.019	0.074	0.044	0.016	142	<0.001	Down, Sig.
2898	13	0.000	0.003	0.001	0.001	2	0.003	0.006	0.004	0.003	15	0.090	Up, Mar.
2899	14	0.000	0.003	0.002	0.001	2	0.002	0.003	0.002	0.001	16	0.342	No Trend
2900	136	0.001	0.050	0.005	0.005	27	0.002	0.005	0.005	0.001	163	0.053	Down, Mar.
3128	14	0.001	0.118	0.010	0.031	2	0.003	0.029	0.016	0.019	16	0.249	No Trend
3636	14	0.001	0.003	0.002	0.001	2	0.002	0.003	0.002	0.001	16	0.208	No Trend
3898	14	0.001	0.005	0.002	0.001	2	0.003	0.006	0.004	0.003	16	0.207	No Trend
3899	14	0.000	0.003	0.002	0.001	2	0.002	0.003	0.002	0.001	16	0.446	No Trend
3900	14	0.001	0.005	0.003	0.001	2	0.002	0.003	0.002	0.001	16	0.149	No Trend
3924	99	0.005	0.005	0.005	0.000	25	0.000	0.012	0.005	0.002	124	0.144	No Trend
3925	112	0.005	0.005	0.005	0.000	25	0.005	0.005	0.005	0.000	137	0.500	No Trend

[a]Variation in number of samples is due to resampling events, different sampling frequencies, and/or number of sampling events in reporting period.
[b]Number of samples used for trend analysis is a count of the number of unique sampling dates.
[c]Up, Sig. = Up, Significant
Up, Mar. = Up, Marginal
No Trend = No Significant Trend
Down, Sig. = Down, Significant
Down, Mar. = Down, Marginal
[d]Well not sampled because negotiations with CSX Railroad for an access agreement are ongoing.

TABLE 3-3

STATISTICS FOR PHOSPHORUS

	Sampling Period										Mann-Kendall Trend Analysis		
	August 27, 1993 - June 30, 1996					July 1, 1996 - December 31, 1996					August 27, 1993 - December 31, 1996		
Well No.	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a,b]	Probability	Trend[c]
2128	13	0.09	6.40	2.43	2.07	2	0.30	0.85	0.57	0.39	15	0.030	Down, Sig.
2548	13	0.05	6.20	1.93	1.95	0[d]	N/A	N/A	N/A	N/A	13	0.080	Down, Mar.
2625	12	0.31	12.30	3.73	3.98	2	0.55	0.56	0.56	0.01	14	0.050	Down, Mar.
2636	12	9.29	170.00	104.01	53.70	2	62.50	111.00	86.75	34.29	14	0.292	No Trend
2898	14	0.01	0.08	0.04	0.02	2	0.04	0.06	0.05	0.01	16	0.205	No Trend
2899	14	0.01	0.07	0.03	0.02	2	0.05	0.06	0.06	0.00	16	0.049	Up, Sig.
2900	14	0.05	0.96	0.47	0.27	2	0.07	0.31	0.19	0.17	16	0.081	Down, Mar.
3128	13	0.01	6.53	0.54	1.80	2	0.04	0.27	0.16	0.16	15	0.165	No Trend
3636	14	0.02	0.23	0.06	0.06	2	0.05	0.09	0.07	0.03	16	0.482	No Trend
3898	14	0.02	0.34	0.09	0.09	2	0.06	0.07	0.07	0.01	16	0.139	No Trend
3899	14	0.03	0.83	0.18	0.21	2	0.03	0.06	0.05	0.02	16	0.326	No Trend
3900	14	0.01	1.26	0.14	0.32	2	0.03	0.08	0.05	0.03	16	0.375	No Trend

[a]Variation in number of samples is due to resampling events, different sampling frequencies, and/or number of sampling events in reporting period.
[b]Number of samples used for trend analysis is a count of the number of unique sampling dates.
[c]Up, Sig. = Up, Significant
Up, Mar. = Up, Marginal
No Trend = No Significant Trend
Down, Sig. = Down, Significant
Down, Mar. = Down, Marginal
[d]Well not sampled because negotiations with CSX Railroad for an access agreement are ongoing

TABLE 3-4

STATISTICS FOR POTASSIUM

	Sampling Period										Mann-Kendall Trend Analysis		
	August 27, 1993 - June 30, 1996					July 1, 1996 - December 31, 1996					August 27, 1993 - December 31, 1996		
Well No.	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a,b]	Probability	Trend[c]
2128	14	1.69	18.00	6.18	6.27	2	1.90	2.06	1.98	0.11	16	0.007	Down, Sig.
2548	13	1.36	40.00	12.56	10.85	0[d]	N/A	N/A	N/A	N/A	13	0.038	Down, Sig.
2625	12	0.64	6.26	2.88	1.88	2	3.95	5.26	4.61	0.93	14	0.077	Up, Mar.
2636	12	8.51	218.00	114.52	55.49	2	45.70	81.10	63.40	25.03	14	0.191	No Trend
2898	14	2.50	5.05	3.72	0.71	2	3.93	4.12	4.03	0.13	16	0.172	No Trend
2899	15	1.36	4.42	3.27	0.77	2	3.70	3.85	3.78	0.11	17	0.028	Up, Sig.
2900	15	0.71	6.00	2.06	1.35	2	1.52	1.58	1.55	0.04	17	0.010	Down, Sig.
3128	14	1.88	3.70	2.71	0.54	2	1.79	2.26	2.03	0.33	16	0.029	Down, Sig.
3636	14	1.38	3.50	2.66	0.52	2	2.37	2.54	2.46	0.12	16	0.172	No Trend
3898	14	1.34	3.93	2.41	0.62	2	2.18	2.21	2.20	0.02	16	0.171	No Trend
3899	14	1.34	3.30	2.50	0.49	2	2.30	2.40	2.35	0.07	16	0.057	Down, Mar.
3900	14	0.98	3.19	1.82	0.59	2	1.12	1.65	1.39	0.37	16	0.043	Down, Sig.

[a]Variation in number of samples is due to resampling events, different sampling frequencies, and/or number of sampling events in reporting period.
[b]Number of samples used for trend analysis is a count of the number of unique sampling dates.
[c]Up, Sig. = Up, Significant
Up, Mar. = Up, Marginal
No Trend = No Significant Trend
Down, Sig. = Down, Significant
Down, Mar. = Down, Marginal
[d]Well not sampled because negotiations with CSX Railroad for an access agreement are ongoing

TABLE 3-5

STATISTICS FOR SODIUM

	Sampling Period										Mann-Kendall Trend Analysis		
	August 27, 1993 - June 30, 1996					July 1, 1996 - December 31, 1996					August 27, 1993 - December 31, 1996		
Well No.	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a]	Min. (mg/L)	Max. (mg/L)	Avg. (mg/L)	SD	No. of Samples[a,b]	Probability	Trend[c]
2128	14	28.10	74.05	43.19	13.75	2	27.35	29.20	28.28	1.31	16	0.294	No Trend
2548	13	18.20	35.00	25.60	5.89	0[d]	N/A	N/A	N/A	N/A	13	0.050	Down, Sig.
2625	12	16.50	50.70	37.32	9.60	2	29.90	32.20	31.05	1.63	14	0.222	No Trend
2636	12	43.20	79.90	59.02	10.00	2	57.80	58.10	57.95	0.21	14	0.311	No Trend
2898	14	17.00	29.20	21.74	4.06	2	18.60	18.80	18.70	0.14	16	0.130	No Trend
2899	14	11.20	22.90	16.16	4.13	2	18.30	19.20	18.75	0.64	16	0.029	Up, Sig.
2900	14	23.40	43.10	30.43	6.53	2	36.30	43.30	39.80	4.95	16	0.021	Up, Sig.
3128	14	4.42	13.50	8.68	3.31	2	4.52	4.73	4.63	0.15	16	<0.001	Down, Sig.
3636	14	6.80	15.10	10.89	2.24	2	6.39	6.79	6.59	0.28	16	<0.001	Down, Sig.
3898	14	7.00	14.40	9.14	2.06	2	8.84	9.01	8.93	0.12	16	0.121	No Trend
3899	14	6.24	13.70	9.53	2.12	2	8.20	8.80	8.50	0.42	16	0.069	Down, Mar.
3900	14	4.36	10.80	7.12	2.28	2	4.45	4.84	4.65	0.28	16	0.004	Down, Sig.

[a]Variation in number of samples is due to resampling events, different sampling frequencies, and/or number of sampling events in reporting period.
[b]Number of samples used for trend analysis is a count of the number of unique sampling dates.
[c]Up, Sig. = Up, Significant
Up, Mar. = Up, Marginal
No Trend = No Significant Trend
Down, Sig. = Down, Significant
Down, Mar. = Down, Marginal
[d]Well not sampled because negotiations with CSX Railroad for an access agreement are ongoing

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TABLE 3-6

SUMMARY OF SIGNIFICANT MANN-KENDALL TREND TEST RESULTS FOR SELECT ANALYTES (AUGUST 27, 1993 - DECEMBER 31, 1996)

Well No.	No. of Samples	Probability	Trend[a]	Average Concentration[b] (μg/L)	Explanation
Total Uranium					
2002	22	0.025	Up, Sig.	4.3	Effectiveness of recovery wellfield as uranium is pulled toward recovery well 3927
2015	13	0.028	Down, Sig.	152.0	Source removal and effectiveness of recovery wellfield[c]
2060	12	0.008	Down, Sig.	34.5	Source removal and effectiveness of recovery wellfield[c]
2061	20	<0.001	Down, Sig.	244.5[d]	Source removal and effectiveness of recovery wellfield[c]
2125	14	0.005	Down, Sig.	9.5	Source removal and effectiveness of recovery wellfield[c]
2128	15	0.019	Up, Sig.	11.8	Possibly due to existing contamination prior to south plume removal action pumping, will continue to evaluate.
2398	14	0.002	Up, Sig.	15.0	Continued migration of the northeastern lobe of the plume; will be addressed by optimization of the South Plume recovery system and/or the Injection Demonstration Project in conjunction with South Field Extraction System.
2434	14	0.031	Down, Sig.	1.0	Concentration within background range
2545	15	0.027	Down, Sig.	27.0	Source removal and effectiveness of recovery wellfield[c]
2548	12	0.050	Down, Sig.	2.9[d]	Concentration within background range
2624	19	0.003	Down, Sig.	78.0[d]	Source removal and effectiveness of recovery wellfield[c]
2880	21	0.001	Up, Sig.	1.2	Concentration within the background range
2897	14	<0.001	Down, Sig.	0.6	Source removal and effectiveness of recovery wellfield[c]
2899	15	<0.001	Up, Sig.	2.3	Concentration within background range
2900	15	<0.001	Up, Sig.	6.1	Unknown; will continue to evaluate
3069	14	0.001	Up, Sig.	139.0	Recharge area forcing contamination deeper into the aquifer
3095	13	<0.001	Up, Sig.	14.0	Induced capture
3550	12	<0.001	Down, Sig.	2.8	Source removal and effectiveness of recovery wellfield[c]
3624	13	0.033	Up, Sig.	0.5[d]	Concentration within background range
3880	14	0.024	Up, Sig.	0.8	Concentration within background range
3897	21	0.006	Down, Sig.	0.5	Concentration within background range
3899	15	0.004	Down, Sig.	0.7	Concentration within background range
3924	36	<0.001	Down, Sig.	43.7	Source removal and effectiveness of recovery wellfield[c]

TABLE 3-6
(Continued)

Well No.	No. of Samples	Probability	Trend[a]	Average Concentration[b] (μg/L)	Explanation
Total Uranium (Contd.)					
3925	44	<0.001	Up, Sig.	25.3	Recovery of area of plume with higher concentrations than originally at recovery well
3926	38	<0.001	Up, Sig.	9.3	Recovery of area of plume with higher concentrations than originally at recovery well
3927	37	<0.001	Down, Sig.	1.1	Recovery of area of plume with lower concentrations than originally at recovery well
Arsenic				(mg/L)	
2128	163	<0.001	Down, Sig.	0.005	Natural migration of PRRS plume
2548	107	0.028	Up, Sig.	0.034[d]	Natural migration of PRRS plume
2625	155	0.048	Down, Sig.	0.011	Natural migration of PRRS plume
2636	142	<0.001	Down, Sig.	0.044	Natural migration of PRRS plume
Phosphorous					
2128	15	.030	Down, Sig.	0.57	Natural migration of PRRS plume
2899	16	.049	Up, Sig.	0.06	Concentration within background range
Potassium					
2128	16	0.007	Down, Sig.	1.98	Natural migration of PRRS plume
2548	13	0.038	Down, Sig.	12.56[d]	Natural migration of PRRS Plume
2899	17	0.028	Up, Sig.	3.78	Unknown; will continue to evaluate
2900	17	0.010	Down, Sig.	1.55	Effective operation of recovery wellfield
3128	16	<0.029	Down, Sig.	2.03	Effective operation of recovery wellfield
3900	16	<0.043	Down, Sig.	1.39	Effective operation of recovery wellfield
Sodium					
2548	13	0.050	Down, Sig.	25.60[d]	Natural migration of PRRS plume
2899	16	0.029	Up, Sig.	18.75	Unknown; will continue to evaluate
2900	16	0.021	Up, Sig.	39.80	Unknown; will continue to evaluate
3128	16	<0.001	Down, Sig.	4.63	Natural migration of PRRS plume
3636	16	<0.001	Down, Sig.	6.59	Natural migration of PRRS plume
3900	16	0.004	Down, Sig.	4.65	Natural migration of PRRS plume

[a]Up, Sig. = Up, Significant
Down, Sig. = Down, Significant
[b]Average concentration for July 1 to December 31, 1996
[c]Source removal refers to the 1986 installation of the SWRB which effectively reduced uranium loading to the aquifer by Paddys Run. The term "effectiveness of recovery wellfield" is a reference to the mass removal of uranium from the plume by the recovery system.
[d]Data was not available from the reporting period, average shown is from historical data (8/93 to 6/96)

4.0 CAPTURE ASSESSMENT

One of the requirements of the DMEPP is to determine if the recovery wellfield is serving as a complete hydraulic barrier to migration of the total uranium plume, preventing uranium north of the recovery wellfield from migrating past it. This is accomplished by performing capture zone analyses using actual and modeled data, and by comparing the results. This comparison allows the use of modeled results to predict future capture based on hypothetical changes to the recovery well pumping rates and to assist in assessing various pumping configurations as needed.

In order to evaluate the effectiveness of capture, the most current total uranium concentration data must be posted to maps and the plume data at the Type 2 and Type 3 well depths re-contoured. These plume maps are then compared with the capture zone maps constructed from groundwater elevation and colloidal borescope measurements. The conclusions reached from this comparison are then verified with the modeled groundwater elevations and capture zones to confirm the results.

4.1 TOTAL URANIUM PLUME DATA

Figures 4-1 and 4-2 show the third quarter 1996 total uranium plume at the Type 2 and Type 3 well depths, respectively. The data used to create these figures were gathered in early August 1996. Similarly, Figures 4-3 and 4-4 show the fourth quarter 1996 total uranium plume at Type 2 and Type 3 well depths, respectively. These data were collected in October, 1996. Both the third and fourth quarter total uranium plumes are similar in size and shape to the first and second quarter plumes presented in the October 1996 DMEPP System Evaluation Report. During the third and fourth quarters of 1996, total uranium concentrations decreased in Monitoring Well 2166 in the northeast lobe of the plume. Total uranium concentrations decreased from 68.0 and 69.0 μg/L for the first and second quarters of 1996 respectively to 48.0 and 54.0 μg/L during the third and fourth quarters. Total uranium concentrations in Homeowner Well #13 followed a similar pattern, decreasing from 120.0 μg/L during the third quarter to 85.0 μg/L during the fourth quarter. Monitoring Well 21063 immediately south of the northeastern lobe of the plume has shown slight decreases in uranium concentrations from 3.5 μg/L during the previous reporting period to 2.2 and 1.7 μg/L during the third and fourth quarters respectively.

At the extreme southwestern lobe of the plume, total uranium concentrations in Monitoring Well 2552 once again drifted above the 20 μg/L FRL for uranium with concentrations of 24.0 and 25.0 μg/L

(Normal and Duplicate) during the third quarter and a concentration of 23.0 μg/L for the fourth quarter. These values had the effect of nullifying the "Down Significant" trend reported in the last DMEPP System Evaluation Report so that "No Trend" is currently reported for this well. As seen from the capture zone maps in Figures 4-6 and 4-8 and the colloidal borescope flow directions in Figure 4-10, Monitoring Well 2552 was within the capture zone for the second half of the fourth quarter when Recovery Well 3926 was pumping. Figure 4-6 shows that Monitoring Well 2552 was outside the capture zone during the third quarter and first half of the fourth quarter when Recovery Well 3926 was out of service for rehabilitation. Monitoring at this location will continue during future reporting periods to see if the downward trend returns.

A slight increase in total uranium concentrations to 12.0 μg/L was observed at Monitoring Well 2128 just south of the recovery system during both third and fourth quarters of 1996. While this is up compared to the first and second quarter observations of 4.5 and 2.4 μg/L respectively, similar concentrations were seen in this well during the third quarter of 1995. The Mann-Kendall trend calculation for total uranium in this well resulted in an "Up Significant" designation as compared to a "No Trend" result reported in the October 1996 System Evaluation Report. While 12.0 μg/L is below the 20 μg/L FRL for uranium, the well will continue to be monitored and results reported in future DMEPP System Evaluation Reports to see if the trend continues.

Monitoring Well 2546 was added to the DMEPP program at the beginning of this reporting period to provide additional coverage south of the recovery system. As shown on Plate E-81 of the Operable Unit 5 Remedial Investigation Report (DOE, March 1995), Monitoring Well 2546 is within a separate uranium plume at the Paddys Run Road Site and has exhibited historical total uranium concentrations as high as 144.0 μg/L. During this reporting period, Monitoring Well 2546 had a total uranium concentration of 0.8 μg/L during the third quarter and a concentration of 35.0 μg/L during the fourth quarter. Because two points do not provide sufficient data for a trend calculation, this well will continue to be monitored and reported in future DMEPP System Evaluation Reports to determine if any trend exists and to provide additional coverage in this area.

The Type 3 plume data has not changed significantly from the previous reporting period. The total uranium plume data for the third and fourth quarters are shown in Figures 4-2 and 4-4 respectively. In accordance with the Restoration Area Verification Sampling Project Specific Plan, additional groundwater sampling (conducted via the Geoprobe technique) for total uranium has been performed

around the northeastern lobe of the plume and on the eastern edge of the plume. This activity was initiated after deeper contamination was observed in an area of fresh water recharge around Monitoring Wells 2434 and 3069. As discussed in the October 1996 DMEPP System Evaluation Report, Monitoring Well 3069 has shown a steadily increasing trend in total uranium while Monitoring Well 2434 at the same surface location has shown no increase in total uranium at the shallower depth. This is believed to be due to local recharge from a nearby drainage ditch.

The Geoprobe sampling locations and location specific maximum uranium concentrations available as of December 31, 1996 are shown in Figure 4-5 with the fourth quarter DMEPP sampling results in the Type 2 and Type 3 Monitoring Wells, the fourth quarter RCRA data along the southern fenceline and the location specific maximum uranium concentrations in the recently installed South Field Recovery Wells. This portrayal of the uranium plume is new in that it incorporates the maximum uranium concentrations irrespective of depth and thereby provides a plan view of the highest concentrations within the uranium plume based on the most current data. While the Geoprobe sampling and analysis activities are not complete at this time, a preliminary review of the data that has been acquired indicates that the extent of the 20 μg/L uranium plume in the area south and southwest of Monitoring Well 3069 has been bracketed with the new data. The Geoprobe data southwest of Monitoring Well 3069 showed uranium concentrations up to 490 μg/L. Furthermore, the additional depth information provided by the Geoprobe profiles will provide a more accurate plume representation for modeling which will be completed in support of the revised Baseline Remedial Strategy Report to be submitted in April 1997.

Additional Geoprobe sampling activities are being conducted to further define the extent of the uranium plume in the area south of Willey Road. A more complete analysis of the geoprobe data and the resulting interpretation of plume geometry will be presented in a separate report once the Restoration Area Verification sampling has been completed.

4.2 WATER ELEVATION AND HYDRAULIC CAPTURE ZONE DATA

Because multiple pumping configurations were used during this reporting period, water elevation data continues to be collected monthly instead of quarterly. The frequency of water elevation measurements may be returned to quarterly when the aquifer/pumping system returns to a more stable configuration.

Representative groundwater elevation maps made from the Type 2 monitoring well data for the third and fourth quarters of 1996 were selected from the monthly elevation data sets. These maps are shown with the third and fourth quarter Type 2 and Type 3 uranium plumes in Figures 4-6 through 4-9. While the water elevations were, on average, between one to two feet higher in August 1996 than in November, the overall water elevation surfaces appear to be similar in shape. Furthermore, the hydraulic capture zones inferred from the water elevation contours are similar to capture zones presented in previous DMEPP reports.

Based on the differences in water elevations between Monitoring Wells 2625 and 2900 which shows the water table dipping to the North in the direction of Well 2900, the capture zone was drawn between these two wells. This continues to be in good agreement with both the colloidal borescope flow data from Well 2900 as shown in Figure 4-10 and the capture zone inferred from the modeling data for both the 1100 and 1000 gpm pumping scenarios as shown in Figures 4-12 and 4-14. The borescope data is presented for reference in Appendix D.

Because the water levels were lower in November than in August, the extreme western end of the capture zone is drawn through Monitoring Well 2552 in the November elevation map (Figures 4-8 and 4-9) but is shown to be north of Well 2552 in the August elevation maps (Figures 4-6 and 4-7). This is consistent with previous interpretations that Monitoring Well 2552 is sometimes within the capture zone of the recovery system and sometimes outside the capture zone as water levels in the aquifer fluctuate from seasonal drawdown and recharge.

4.3 MODELED CAPTURE ZONES

As described in Section 1.0, two pumping configurations were used during this reporting period when Recovery Wells 3926 and 3927 were being rehabilitated. These two pumping scenarios were modeled to assess capture. These scenarios are:

- For July 1 through the middle of November, the system was pumped at 1100 gpm while Recovery Well 3926 was being rehabilitated. Wells 3924 and 3925 were pumped at 300 gpm each and Well 3927 was pumped at 500 gpm.

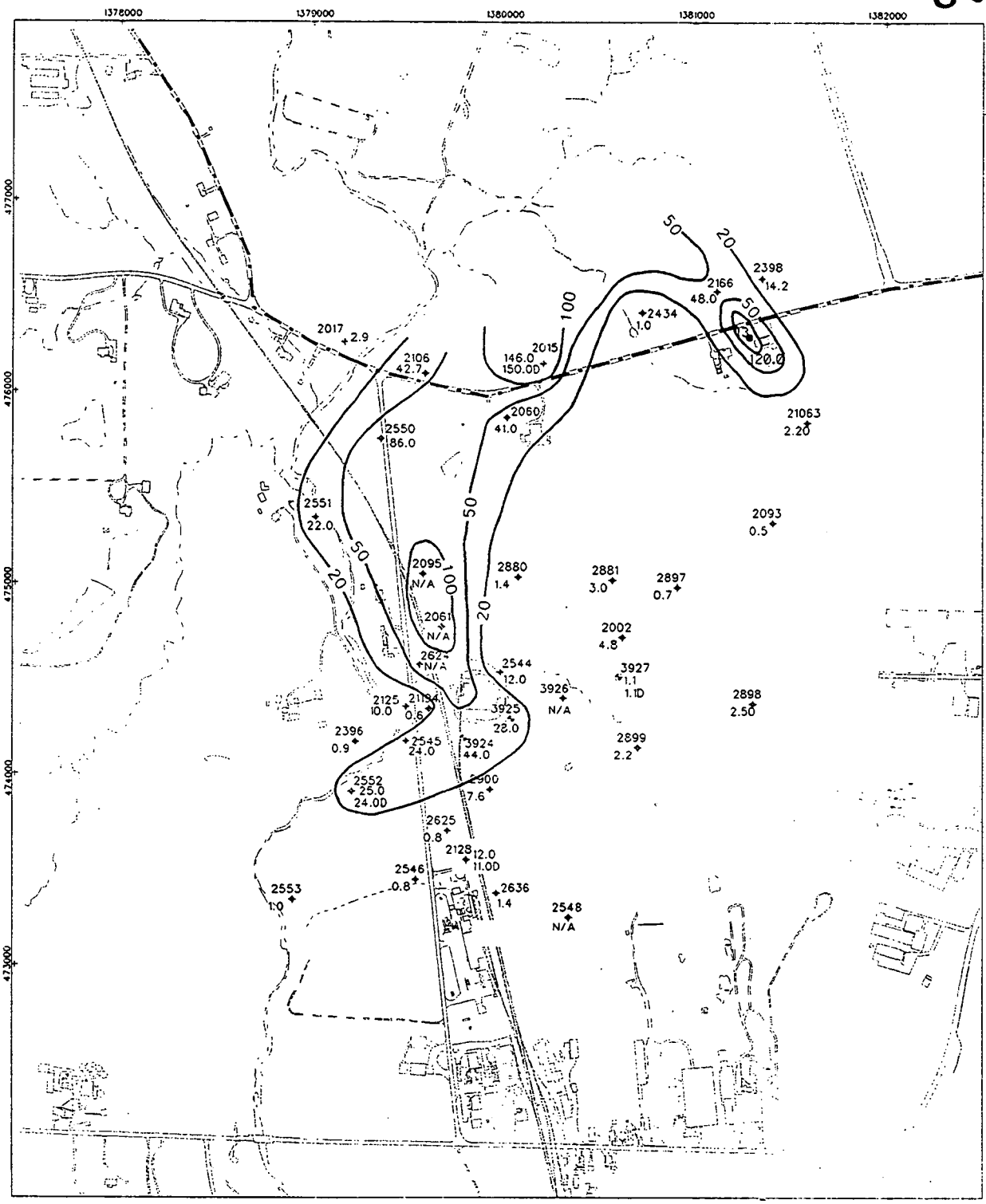
- From the middle of November to December 31, the system was pumped at 1000 while Recovery Well 3927 was being rehabilitated. Well 3924 and 3925 were pumped at 300 gpm each and Well 3926 was pumped at 400 gpm.

These alternate pumping scenarios were modeled with the site groundwater model to define the changes in the hydraulic capture zone. The results are presented in Figures 4-12 through 4-15 with the capture zone being defined by the particle tracks.

The main body of the total uranium plume at both the Type 2 and Type 3 well depths continues to be captured by Recovery Wells 3924 and 3925 in both the 1000 gpm and 1100 gpm scenarios. The 1100 gpm modeling scenario shows one particle which appears to break through the line of recovery wells at Well 3926 when it is off line. With three wells pumping (3924, 3925, and 3927) at a total of 1100 gpm, the hydraulic gradient in the vicinity of Well 3926 is about 2 feet per 300 feet or 0.007. (See Figure 4-6). The horizontal hydraulic conductivity in this area of the model is 280 ft/day and the effective porosity is assumed to be 30%. This gives an advective groundwater velocity of 6.5 ft/day. Recalling that uranium contaminant velocity is retarded by approximately 1/12th the groundwater advection velocity the contamination in this area would move about 6.5 inches per day or approximately 100 to 120 feet during the seven months Well 3926 was out of service for rehabilitation. This distance is well within the capture zone of Well 3926 when it is operating. Given this information, any contamination passing through to the south of the recovery system would be pulled back once the well was returned to service. Furthermore, based on the second quarter total uranium concentration in Recovery Well 3926 being 8.8 μg/L before it was removed from service and the uranium concentration being 9.3 μg/L in December after it was returned to service, it appears that any uranium contamination which might have broken through during this time was well below the 20 μg/L FRL for uranium.

As shown in Figures 4-12 through 4-15, the modeled capture zone on the east end of the pumping array was reduced from the capture zone of the optimum 1400 gpm pumping configuration in the east-west direction by approximately 350 feet when Recovery Well 3926 was out of service and the system pumping target rate was 1100 gpm (Refer to Figure 4-11 of the October 1996 DMEPP System Evaluation Report for the 1400 gpm capture zone). When Recovery Well 3926 was put back in service and Well 3927 was removed from service, the east side of the capture zone moved westward an additional 450 feet. The model indicates that the northeastern lobe of the plume was not completely within the capture zone for the two pumping configurations used during the reporting period.

The modeled capture zones presented in Figures 4-12 through 4-15 when compared to the observed capture zones from water elevation data and borescope data (Figures 4-6 through 4-11) do not extend as far to the east or west. Based on previous experience, the model tends to be overly conservative in this area when compared to field data. Therefore, it is believed that capture zones for the 1100 gpm and 1000 gpm pumping configurations based on field measurements as presented in Figures 4-6 through 4-11 are more reflective of the actual areal extent of the capture zone created by the extraction wells during this reporting period.



NOTE: BASED ON THIRD QUARTER 1996 DATA

LEGEND:

— · — · — FEMP BOUNDARY

20 TOTAL URANIUM CONCENTRATION CONTOUR

2553 / 1.1D WELL NUMBER / TOTAL URANIUM CONCENTRATION (μg/L) (D INDICATES DUPLICATE SAMPLE)

000046

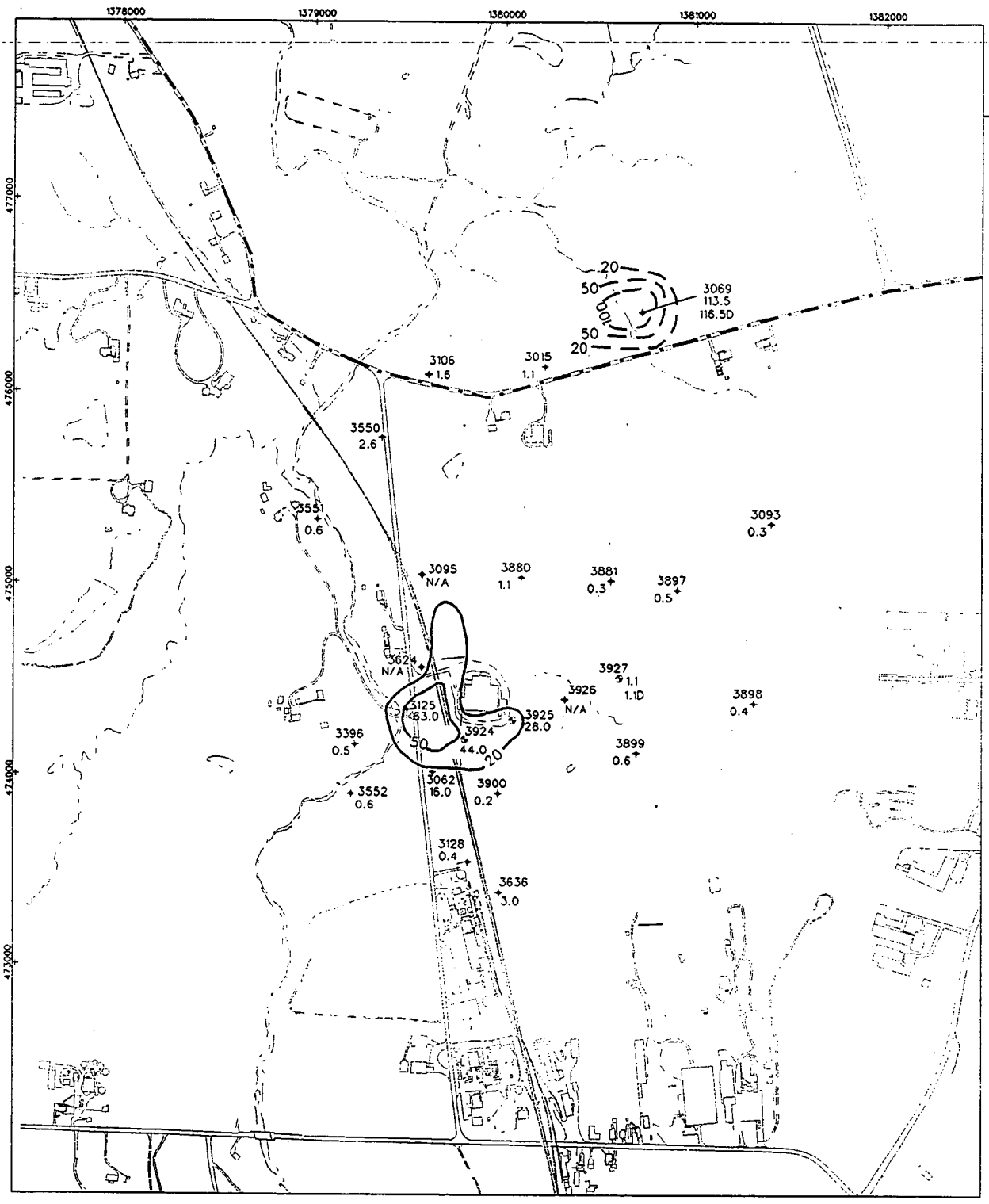
SCALE

800 400 0 800 FEET

FIGURE 4-1.
TOTAL URANIUM PLUME, TYPE 2 MONITORING WELLS, THIRD QUARTER 1996

/USR/ERMA1/GRU5/DGN/MAP/HOR/DPTH/C5DMP062.DGN FER OU5 2/18/97 STATE PLANAR COORDINATE SYSTEM 1927

/USR/ERMA1/CRU5/DGN/MAP/HOR/DPTH/C5DMP064.DGN FER OU5 2/19/97 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

FEMP BOUNDARY

20 TOTAL URANIUM CONCENTRATION CONTOUR

3553 1.1D WELL NUMBER
TOTAL URANIUM CONCENTRATION (μg/L)
(D INDICATES DUPLICATE SAMPLE)

NOTE: BASED ON THIRD QUARTER 1996 DATA
DASHED CONTOURS BASED ON ONE DATA POINT

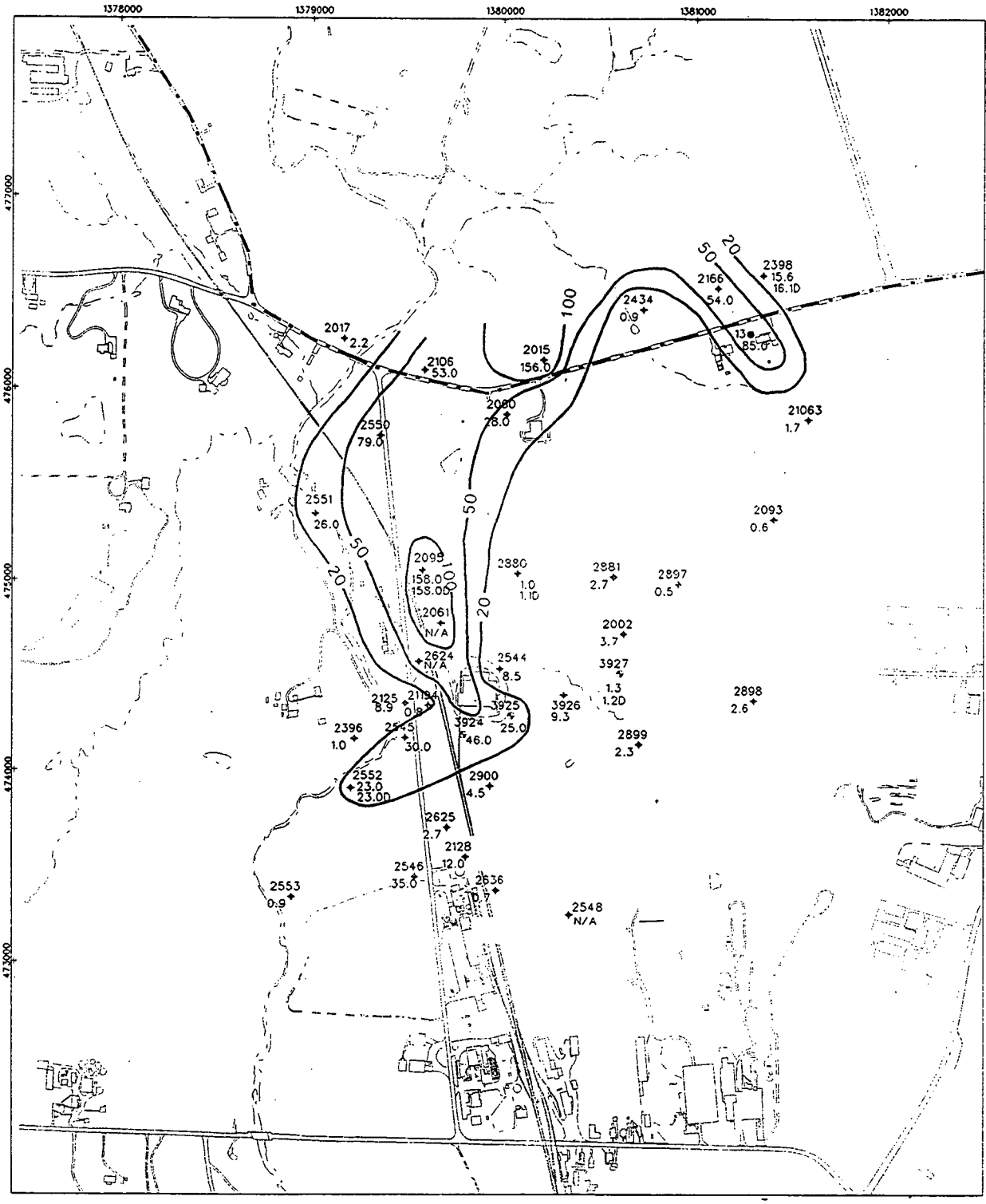
000047

SCALE

800 400 0 800 FEET

FIGURE 4-2.
TOTAL URANIUM PLUME, TYPE 3 MONITORING WELLS, THIRD QUARTER 1996

/USR/ERMA1/CRU5/DGN/MAP/HOR/DPTH/C5DMP063.DGN FER OU5 8/20/96 STATE PLANAR COORDINATE SYSTEM 1927



NOTE: BASED ON FOURTH QUARTER 1996 DATA

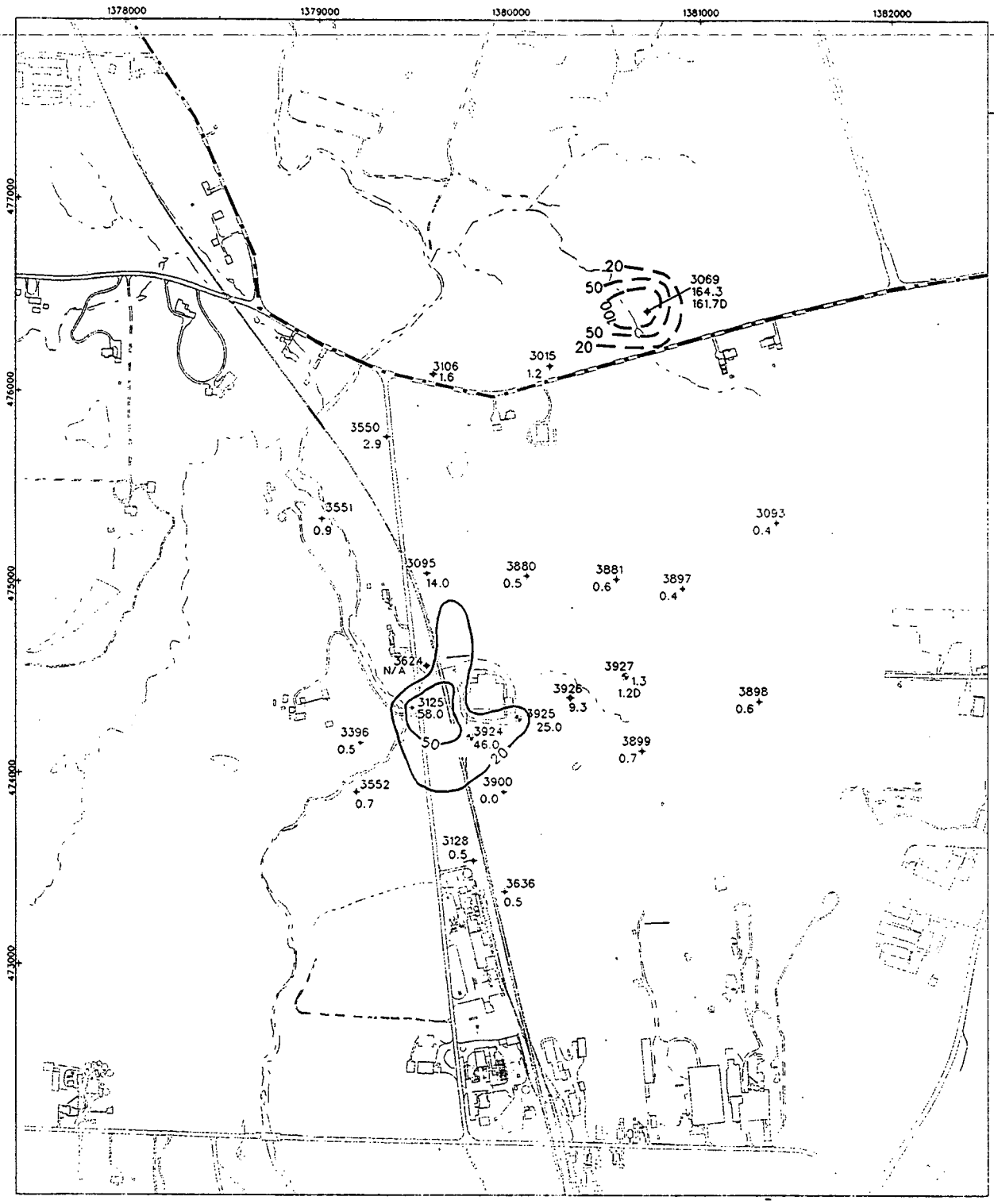
LEGEND:

- FEMP BOUNDARY
- 20 — TOTAL URANIUM CONCENTRATION CONTOUR
- 2553 / 1.1D — WELL NUMBER / TOTAL URANIUM CONCENTRATION (μg/L) (D INDICATES DUPLICATE SAMPLE)

800 400 0 800 FEET

FIGURE 4-3.
TOTAL URANIUM PLUME, TYPE 2 MONITORING WELLS, FOURTH QUARTER 1996

/USR/ERMA1/CRU5/DGN/MAP/HOR/DPTH/C50MP065.DGN FER OU5 8/20/96 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

FEMP BOUNDARY

20 TOTAL URANIUM CONCENTRATION CONTOUR

3553 1.1D WELL NUMBER
TOTAL URANIUM CONCENTRATION (μg/L)
(D INDICATES DUPLICATE SAMPLE)

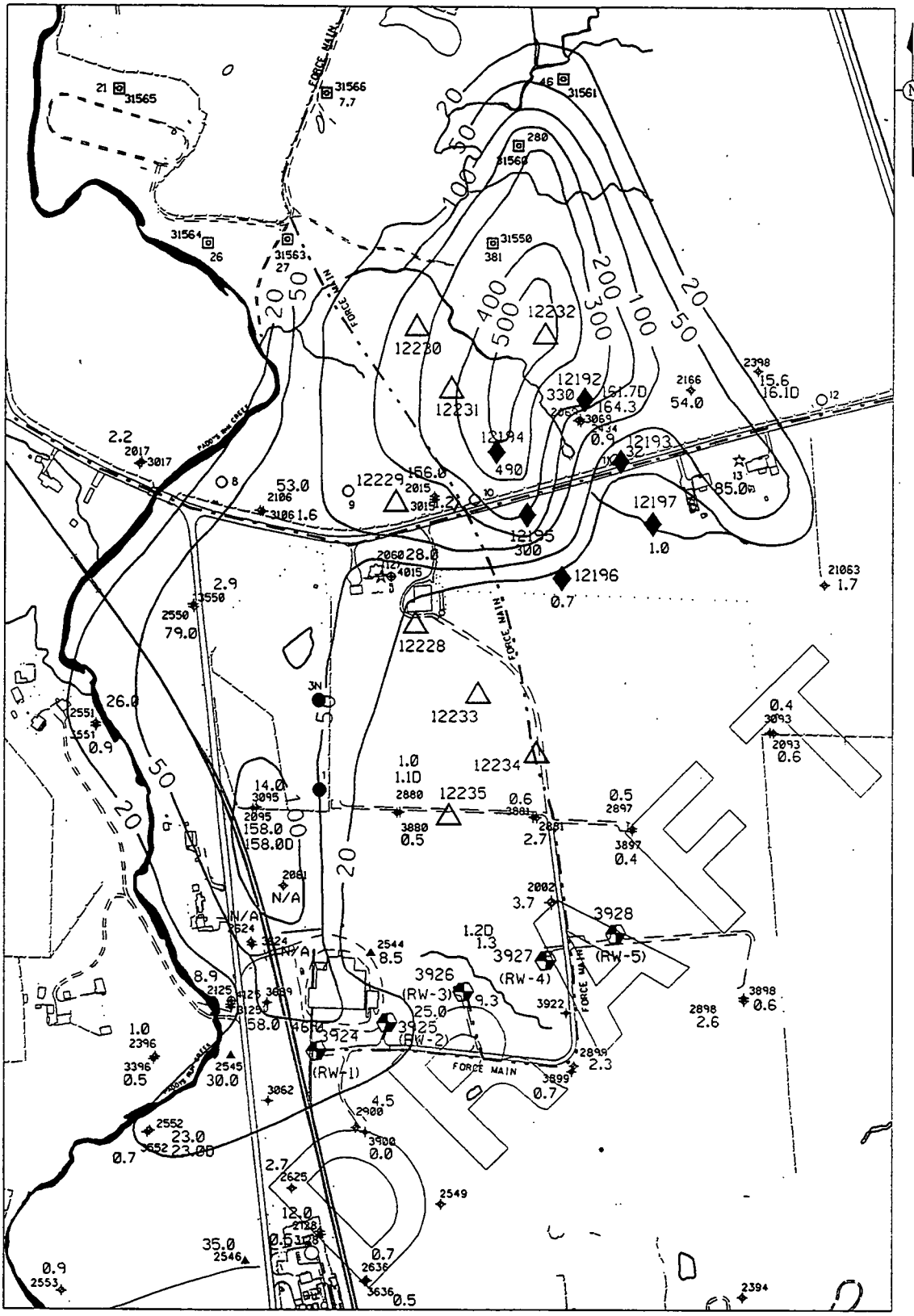
NOTE: BASED ON FOURTH QUARTER 1996 DATA
DASHED CONTOURS BASED ON ONE DATA POINT

000049

SCALE

800 400 0 800 FEET

FIGURE 4-4.
TOTAL URANIUM PLUME, TYPE 3 MONITORING WELLS, FOURTH QUARTER 1996



LEGEND:

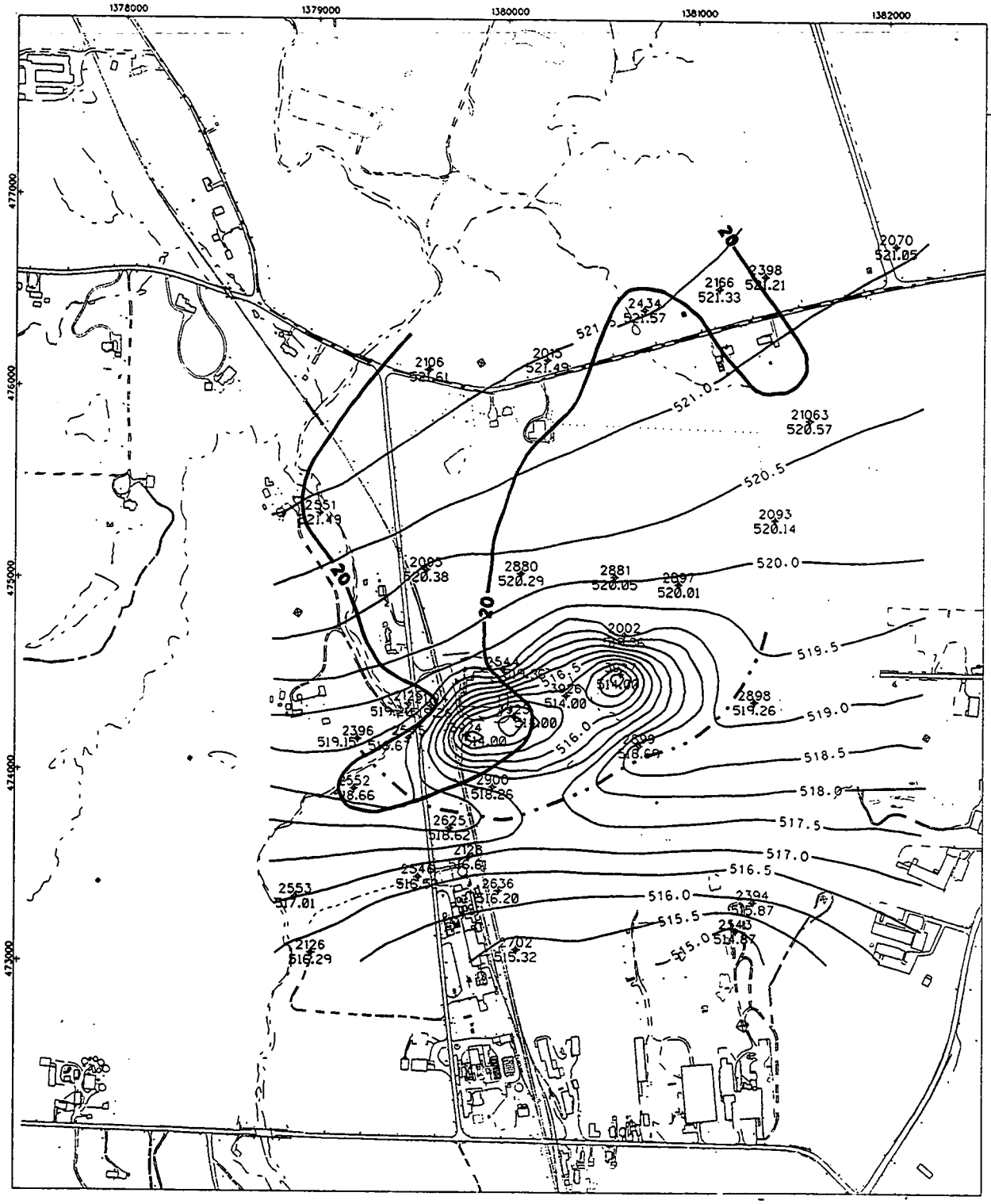
- FEMP BOUNDARY
- FORCE MAIN
- TYPE 2 MONITORING WELL
- TYPE 3 MONITORING WELL
- TYPE 4 MONITORING WELL
- HOMEOWNER WELL
- PROPOSED GEOPROBE LOCATION
- PHASE I GEOPROBE LOCATION (COMPLETED)
- EXTRACTION WELL
- PIEZOMETER
- PROPOSED INJECTION WELL
- EXTRACTION WELL
- URANIUM CONCENTRATION CONTOURS
- PROPOSED EXTRACTION WELLS

SCALE 350 175 0 350 FEET

000050

FIGURE 4-5. MAXIMUM CONCENTRATIONS IN SOUTH PLUME AND SOUTH FIELD AS OF DECEMBER 31, 1996

/USR/ERMA1/CRUS/DGN/MAP/HOR/DPTH/C5DMP054.DGN FER OU5 1/28/97 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

— · — · — FEMP BOUNDARY

— · · — · · FLOW DIVIDE

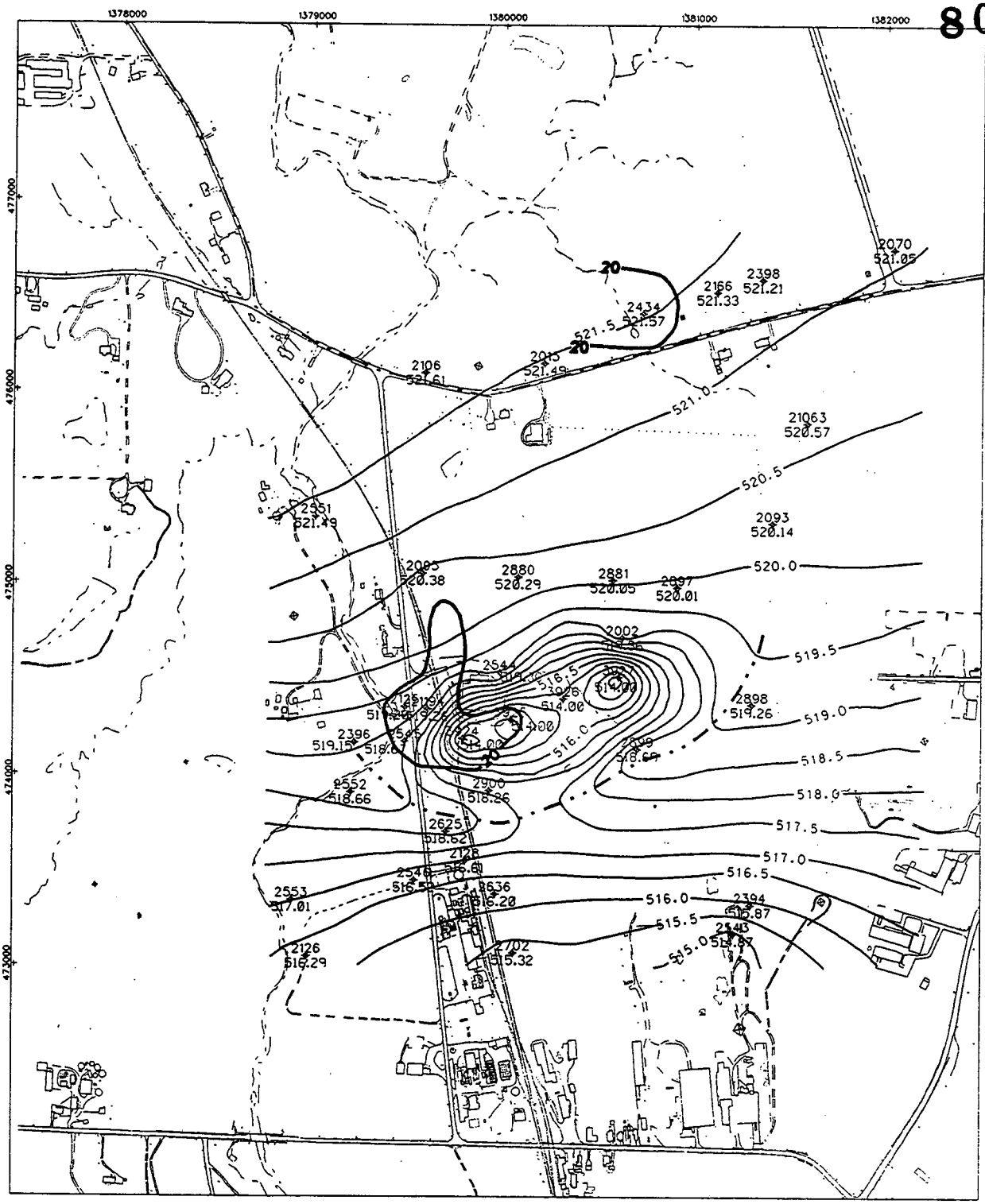
—515.0— GROUNDWATER ELEVATION CONTOUR (AMSL)

000051

SCALE

800 400 0 800 FEET

FIGURE 4-6. GROUNDWATER ELEVATIONS AUGUST 1996 AND TYPE 2 TOTAL URANIUM PLUME, THIRD QUARTER 1996



LEGEND:

— · — · — FEMP BOUNDARY

— · · — · · FLOW DIVIDE

515.0 GROUNDWATER ELEVATION CONTOUR (AMSL)

SCALE

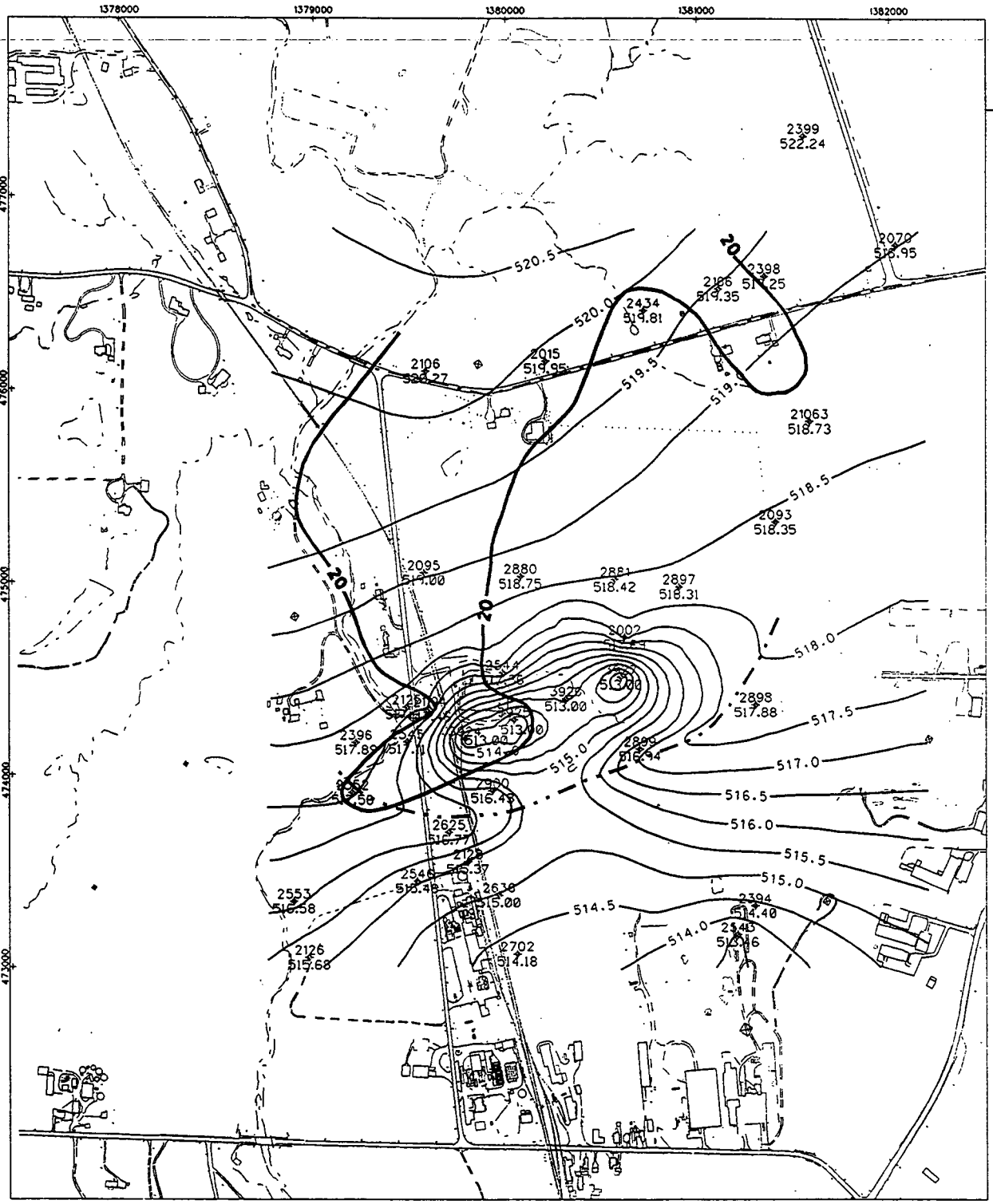
800 400 0 800 FEET

DRAFT

FIGURE 4-7. GROUNDWATER ELEVATIONS AUGUST 1996 AND TYPE 3 TOTAL URANIUM PLUME, THIRD QUARTER 1996

/USR/ERMA1/CRUS/DGN/MAP/HDR/DPTH/C5DMP066.DGN FER OU5 2/19/97 STATE PLANAR COORDINATE SYSTEM 1927

/USR/ERMA1/CRU5/DGN/MAP/HOR/DPTH/C50MP055 FER OU5 1/28/96 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

FEMP BOUNDARY

FLOW DIVIDE

515.0 GROUNDWATER ELEVATION CONTOUR (AMSL)

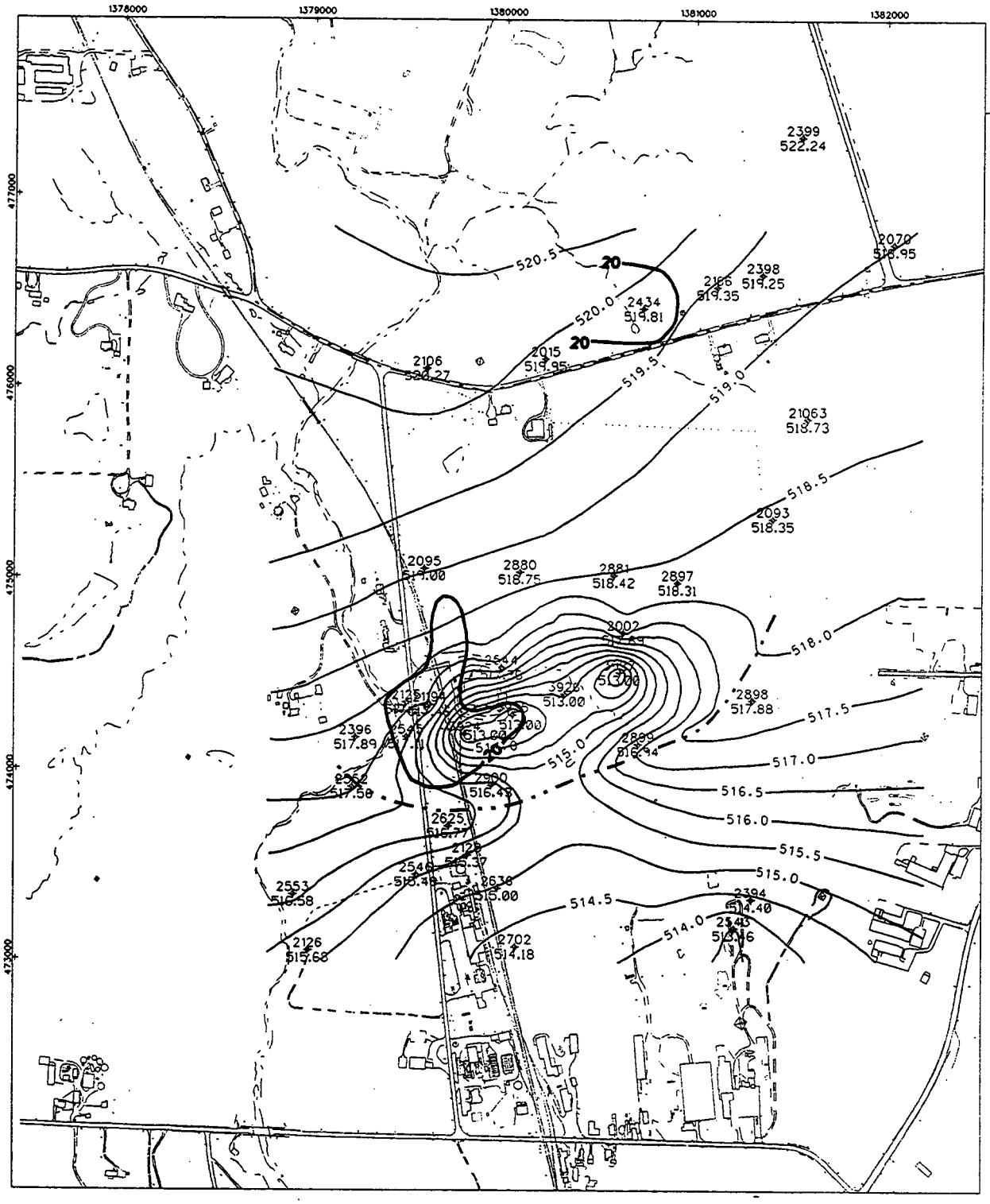
000053

SCALE

800 400 0 800 FEET

FIGURE 4-8. GROUNDWATER ELEVATIONS NOVEMBER 1996 AND TYPE 2 TOTAL URANIUM PLUME, FOURTH QUARTER 1996

/USR/ERMA1/CRU5/DGN/MAP/HDR/DPTH/C5DMP067.DGN FER OU5 2/19/97 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

FEMP BOUNDARY

FLOW DIVIDE

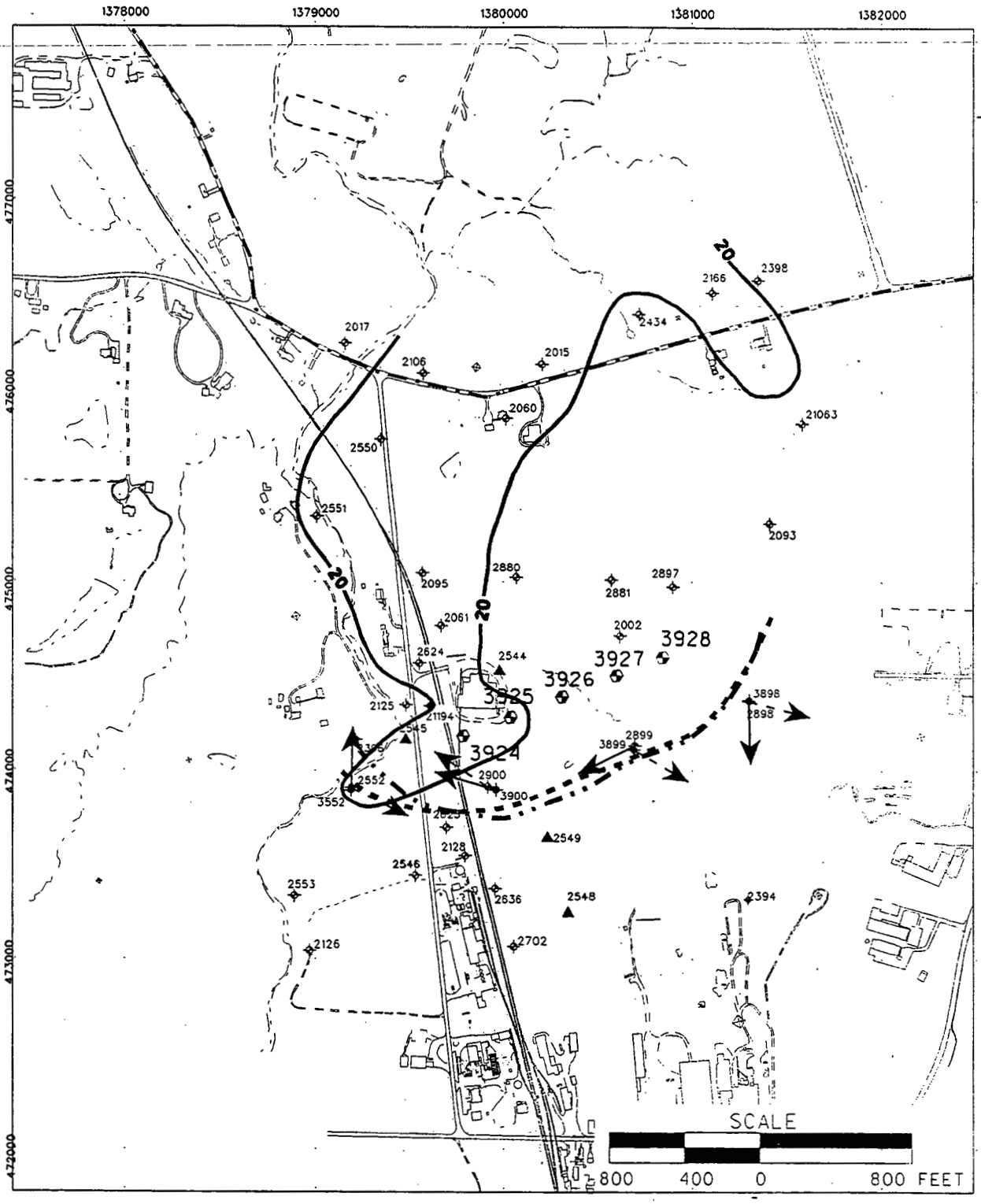
515.0 GROUNDWATER ELEVATION CONTOUR (AMSL)

SCALE

800 400 0 800 FEET

000054

FIGURE 4-9. GROUNDWATER ELEVATIONS NOVEMBER 1996 AND TYPE 3 TOTAL URANIUM PLUME, FOURTH QUARTER 1996



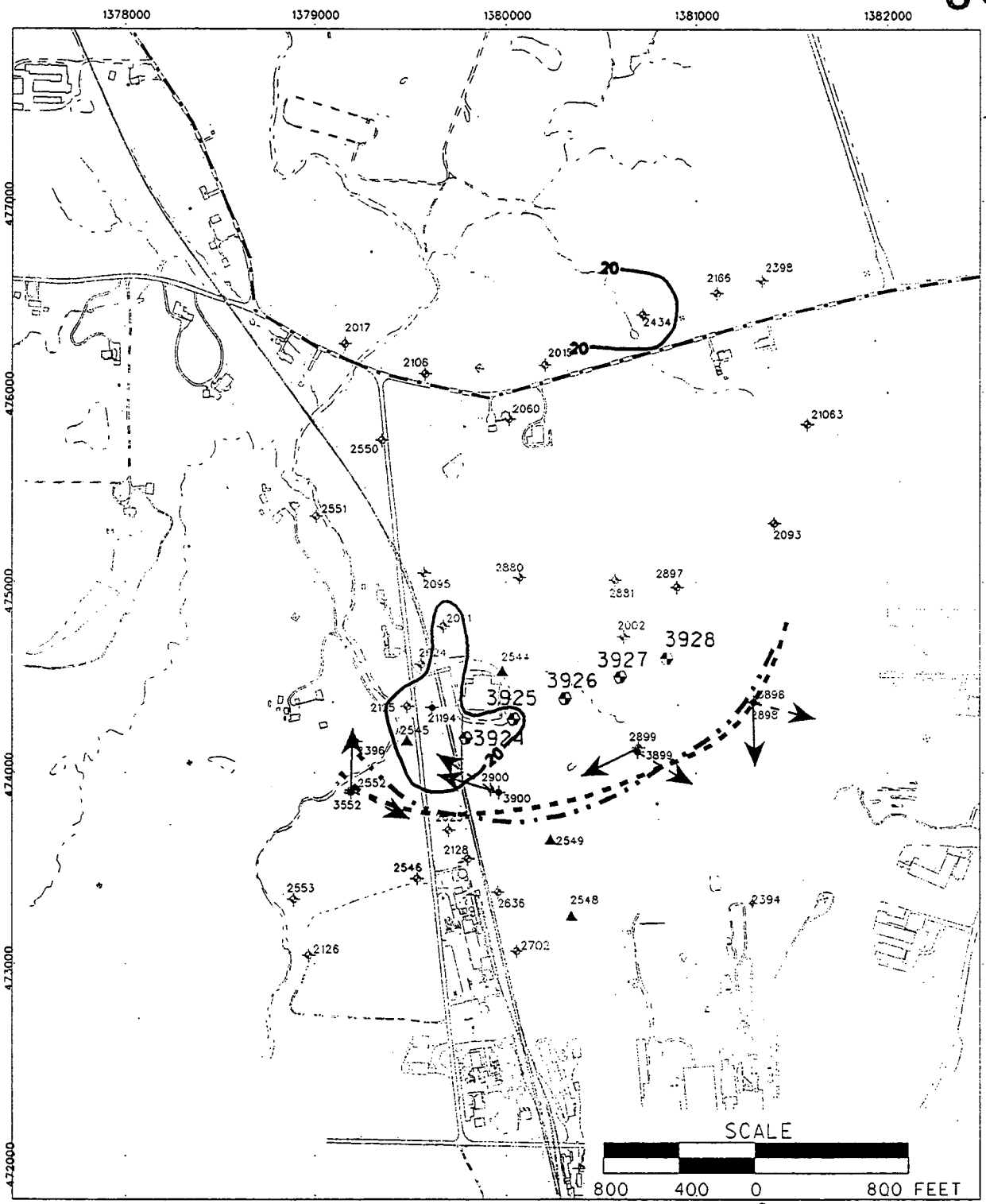
LEGEND:

- FEMP BOUNDARY
- CAPTURE ZONE BASED ON THIRD QUARTER GROUNDWATER ELEVATIONS
- CAPTURE ZONE BASED ON FOURTH QUARTER GROUNDWATER ELEVATIONS
- GROUNDWATER FLOW FOR TYPE 3 DEPTH
- GROUNDWATER FLOW FOR TYPE 2 DEPTH
- FOURTH QUARTER 1996 TYPE 2 TOTAL URANIUM PLUME

0000 73

FIGURE 4-10. HYDRAULIC CAPTURE ZONES AND GROUNDWATER FLOW VECTORS

/USR/ERMAT/CRU5/DGN/MAP/HOR/DPTH/C5DMP056.DGN FER OU5 2/12/97 STATE PLANAR COORDINATE SYSTEM 1927



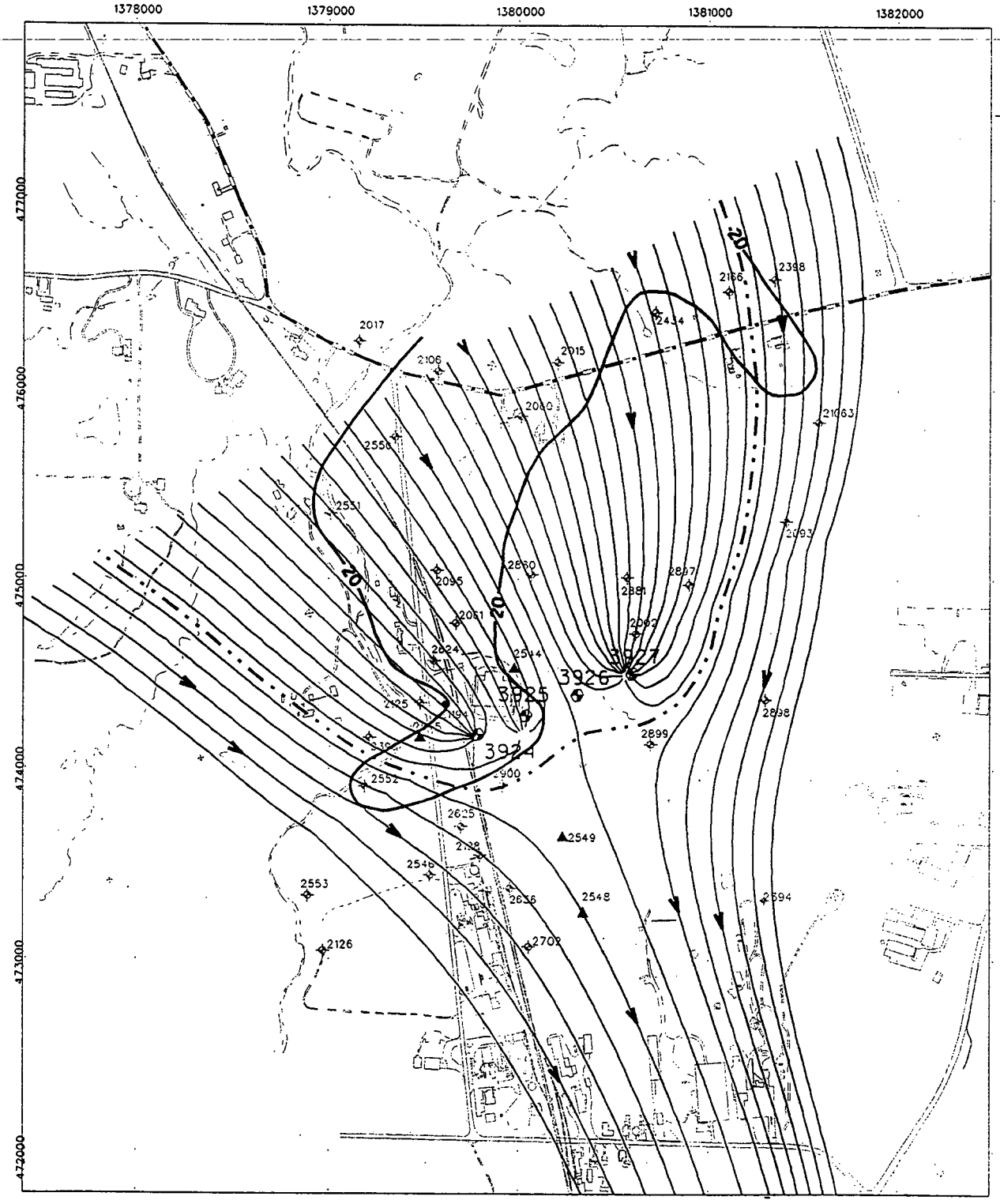
LEGEND:

- FEMP BOUNDARY
- CAPTURE ZONE BASED ON THIRD QUARTER GROUNDWATER ELEVATIONS
- CAPTURE ZONE BASED ON FOURTH QUARTER GROUNDWATER ELEVATIONS
- GROUNDWATER FLOW FOR TYPE 3 DEPTH
- GROUNDWATER FLOW FOR TYPE 2 DEPTH
- FOURTH QUARTER 1996 TYPE 3 TOTAL URANIUM PLUME

000056

FIGURE 4-11. HYDRAULIC CAPTURE ZONES AND GROUNDWATER FLOW VECTORS

/USR/FERMAT/CRU5/DGN/MAP/HOR/DPTH/C5DMP05T.DGN FER 005 2/12/97 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

- FEMP BOUNDARY
- CAPTURE ZONE
- MODELED FLOW PATH (ARROW INDICATES DIRECTION)
- 20 — TYPE 2 TOTAL URANIUM CONCENTRATION CONTOUR FOR THIRD QUARTER 1996

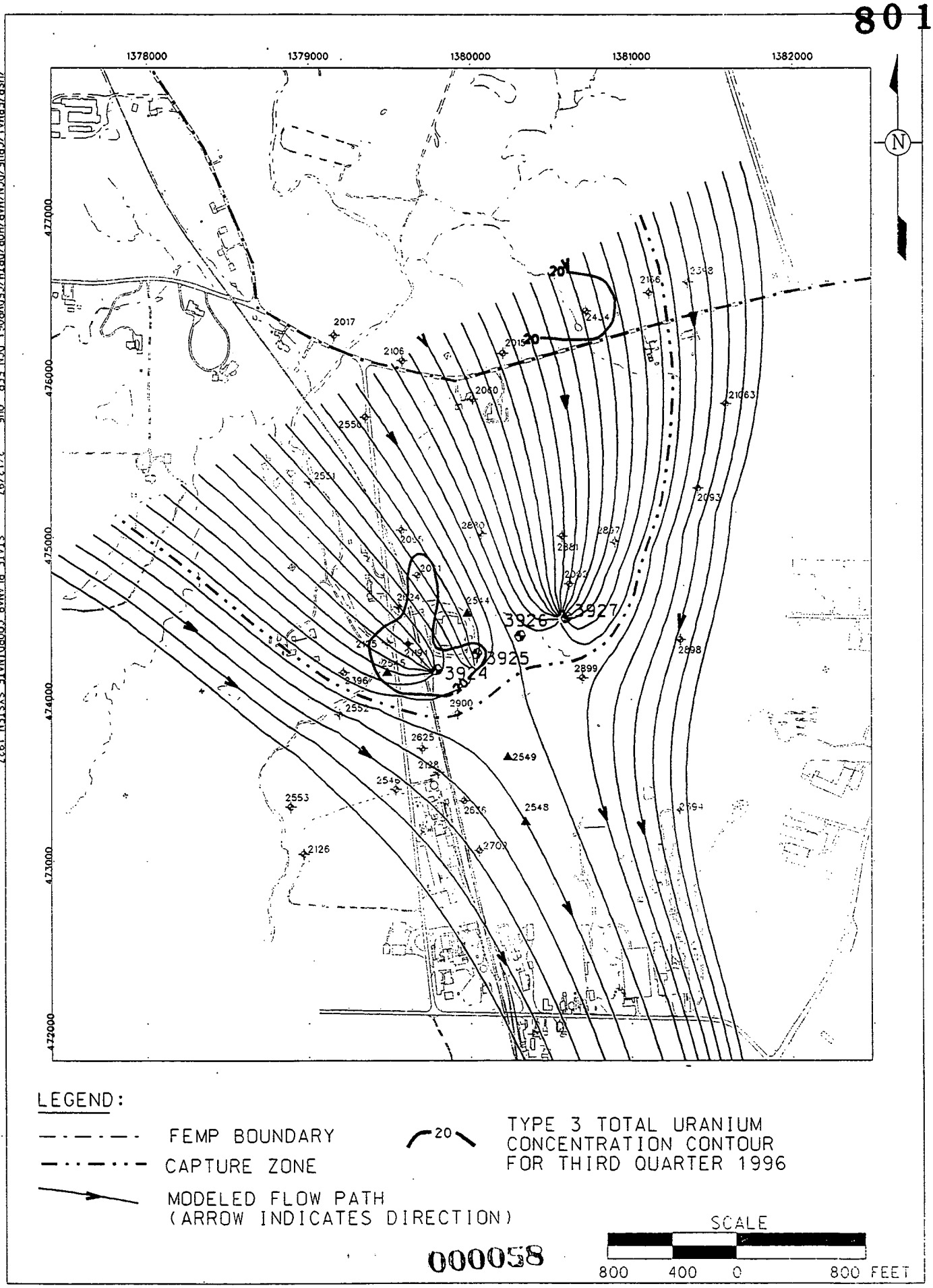
SCALE

800 400 0 800 FEET

000057

/USR/ERMA1/CRU5/DGN/MAP/HOR/DPTH/C5DMP059.DGN FER 005 2/12/97 STATE PLANAR COORDINATE SYSTEM 1927

FIGURE 4-12. MODELED 1100 GPM PUMPING CONFIGURATION, PARTICLE TRACKS AND CAPTURE ZONE



LEGEND:

FEMP BOUNDARY

CAPTURE ZONE

MODELED FLOW PATH
(ARROW INDICATES DIRECTION)

20 TYPE 3 TOTAL URANIUM CONCENTRATION CONTOUR FOR THIRD QUARTER 1996

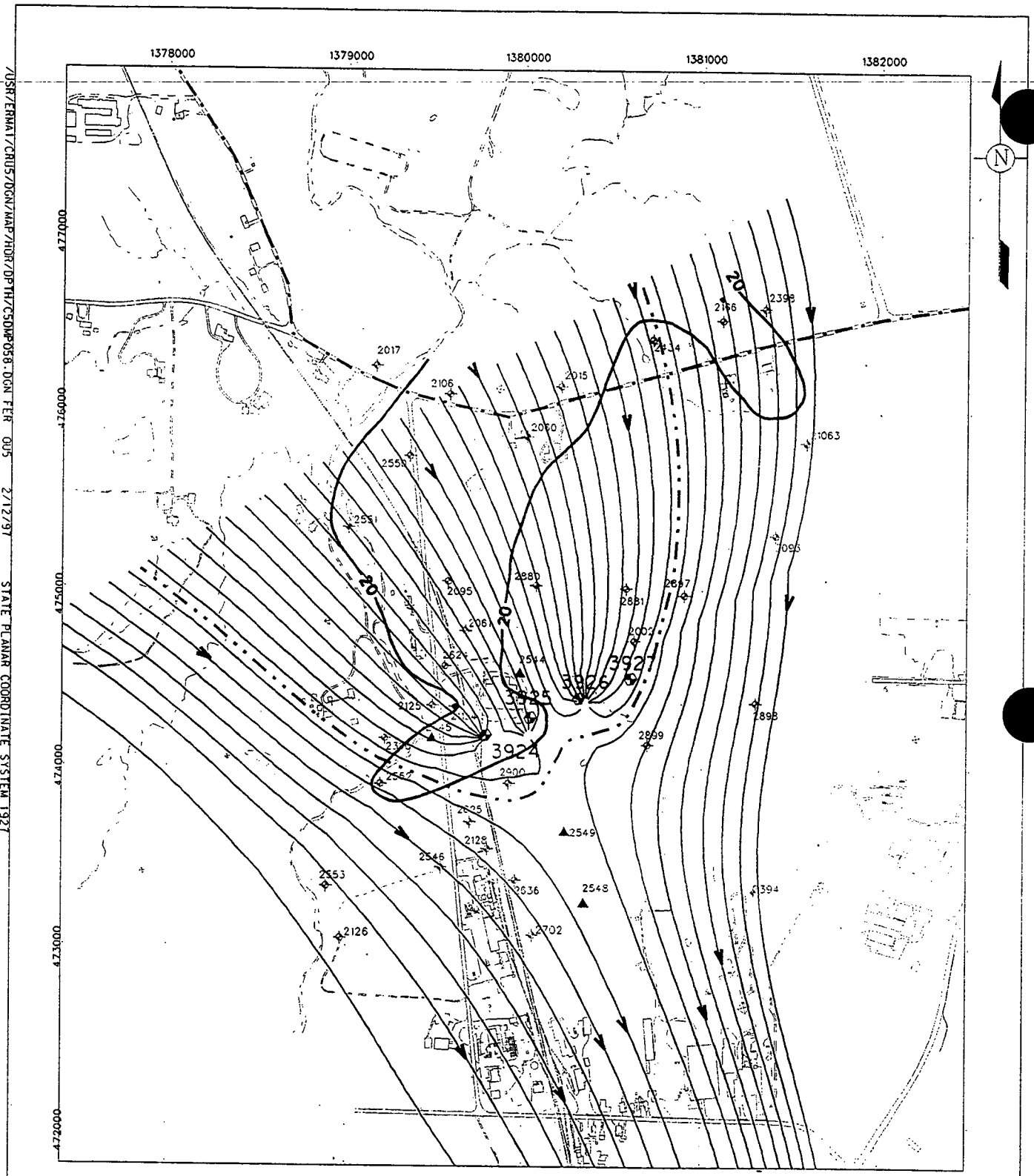
SCALE

800 400 0 800 FEET

000058

FIGURE 4-13. MODELED 1100 GPM PUMPING CONFIGURATION. PARTICLE TRACKS AND CAPTURE ZONE

/USR/ERMA1/CRU5/DGN/MAP/HOR/DPTH/C50MP061.DGN FER 0015 2/12/97 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

FEMP BOUNDARY

CAPTURE ZONE

MODELED FLOW PATH (ARROW INDICATES DIRECTION)

20 TYPE 2 TOTAL URANIUM CONCENTRATION CONTOUR FOR FOURTH QUARTER 1996

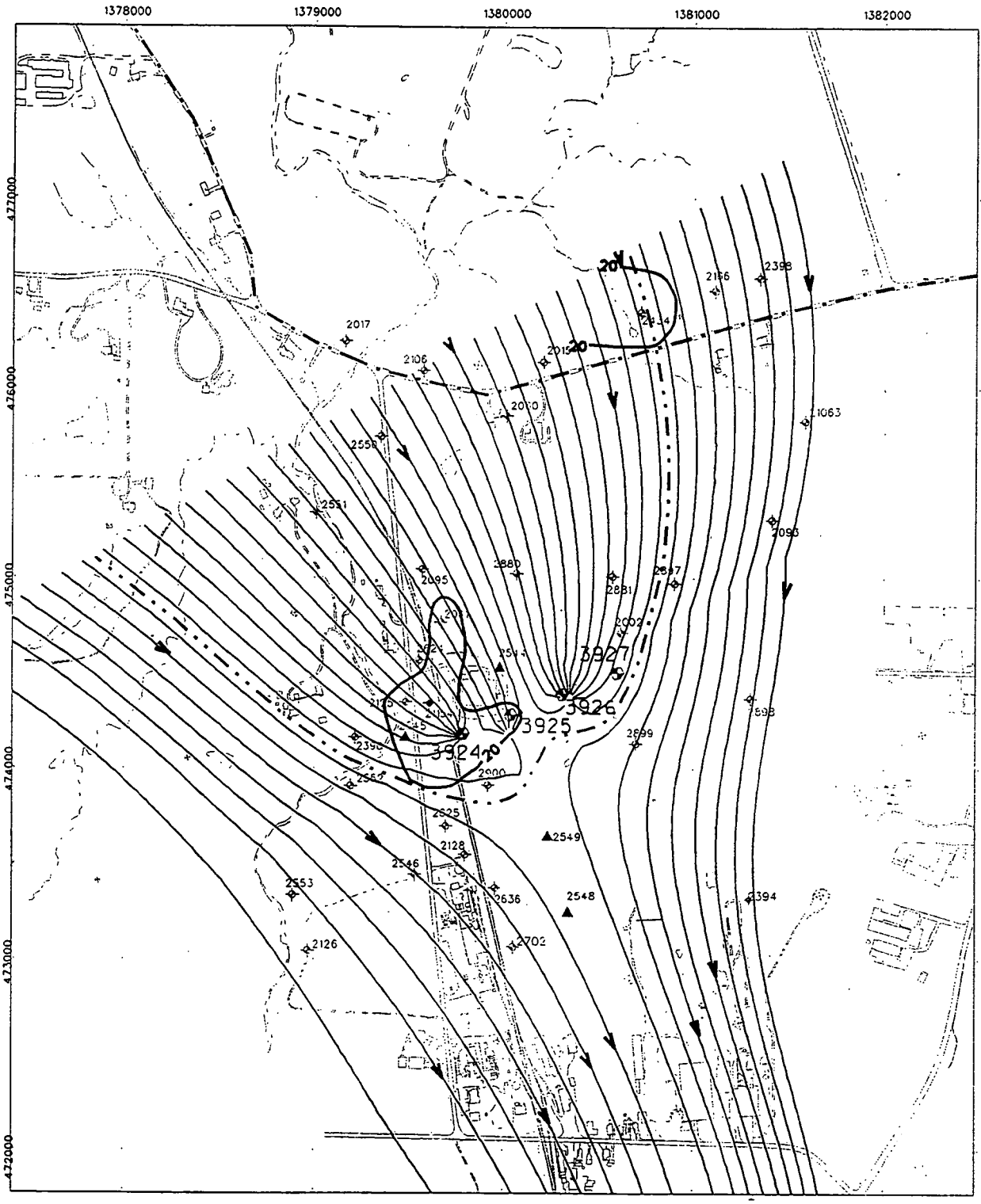
SCALE

800 400 0 800 FEET

FIGURE 4-14. MODELED 1000 GPM PUMPING CONFIGURATION. PARTICLE TRACKS AND CAPTURE ZONE

/USR/ERMAI/CRU5/DGN/MAP/HDR/DPTH/C50MP058.DGN FER 005 2/12/97 STATE PLANAR COORDINATE SYSTEM 1927

/USR/ERMAT/CRU5/DGN/MAP/HOR/DPTH/C50MP060.DGN FER 005 2/12/97 STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

- FEMP BOUNDARY
- CAPTURE ZONE
- MODELED FLOW PATH (ARROW INDICATES DIRECTION)
- 20 TYPE 3 TOTAL URANIUM CONCENTRATION CONTOUR FOR FOURTH QUARTER 1996

000060

SCALE

800 400 0 800 FEET

FIGURE 4-15. MODELED 1000 GPM PUMPING CONFIGURATION. PARTICLE TRACKS AND CAPTURE ZONE

5.0 SUMMARY AND CONCLUSIONS

A total of 234 million gallons of groundwater was pumped and 34.1 pounds of uranium were removed from the aquifer during the reporting period (July 1 through December 31, 1996); the average system efficiency for the reporting period was 0.15 pounds of uranium removed per million gallons of water pumped. Since operations began in August 1993, a total of 2.1 billion gallons of water have been pumped and 300.3 pounds of uranium have been removed from the aquifer. The net system efficiency (August 1993 through December 1996) is 0.14 pounds of uranium recovered per million gallons pumped.

A major well rehabilitation program was initiated with Recovery Well 3926 which was returned to service at a target pumping rate of 400 gpm on November 27, 1996. As soon as Well 3926 was back on line, Well 3927 was removed from service for rehab. Post-treatment pumping tests on both Recovery Wells 3926 and 3927 indicate significant improvement in well performance after rehabilitation was completed. The rehabilitation program continues into 1997 with Recovery Well 3925 currently undergoing treatment and Well 3924 scheduled for rehabilitation when Well 3925 is back on line.

The wellfield was pumped at two configurations during the reporting period to accommodate individual well outages during rehabilitation:

- From July 1 through November 27, Wells 3924 and 3925 were pumped at 300 gpm each and Well 3927 was pumped at 500 gpm while Well 3926 was being rehabilitated. The total system target pumping rate during this time was 1100 gpm.

- From the end of November through the end of the reporting period (December 31) Wells 3924 and 3925 were pumped at 300 gpm each and Well 3926 was pumped at 400 gpm while Well 3927 was being rehabilitated. The total system target pumping rate during this time was 1000 gpm.

Because of variation in the pumping configurations which occurred in this reporting period groundwater elevation data continues to be collected monthly instead of quarterly. The frequency of groundwater elevation measurements may be returned to quarterly when the aquifer/pumping system returns to a more stable configuration.

Groundwater elevation data indicate that the main body of the total uranium plume continues to be captured by Recovery Wells 3924 and 3925. While groundwater modeling indicates the possibility of some breakthrough at Recovery Well 3926 when it is not pumping, consideration of the retarded flow velocities for uranium indicate that the plume would have moved 100 to 120 feet while Well 3926 was out of service. This is well within the capture zone of Well 3926 when it is operational. Furthermore, sampling data from Well 3926 indicates total uranium concentrations at this well were significantly below the 20 μg/L FRL both before it was removed from service and after it was returned to service.

Borescope data obtained in December confirm the capture zone analysis from groundwater elevation data. On the west side of the recovery array, Monitoring Well 2552 continues to move in and out of the capture zone depending on the groundwater elevations and the amount of recharge to the aquifer from Paddys Run which is in close proximity to the well. Total uranium concentrations at Monitoring Well 2552 increased slightly during this reporting period to just over the 20 μg/L FRL. The net effect was to nullify the "Down Significant" statistical trend reported during the previous period so that Well 2552 now exhibits "No Trend" as measured by the Mann-Kendall test for trend.

At the northeastern lobe of the plume total uranium concentrations decreased slightly in Monitoring Wells 2166 and 2398 and in the Private Homeowner Well #13. While concentrations decreased in Monitoring Well 3069 to levels below the 223.6 μg/L reported for the first quarter of 1996, the overall trend continues to be "Up Significant" as measured by the Mann-Kendall test for trend.

Geoprobe sampling under the Restoration Area Verification Sampling Project Specific Plan in the area of Monitoring Well 3069 continues into 1997. Preliminary results indicate higher than anticipated total uranium concentrations both on property and in a localized area south of Willey Road. The need for any additional South Plume optimization wells and their locations will be finalized after all Geoprobe data has been analyzed and included in the site groundwater model. This will be completed as part of the revision of the Baseline Remedial Strategy Report. The revised report is scheduled to be submitted to the US EPA and Ohio EPA on April 7, 1997.

Pending the approval of the Integrated Environmental Monitoring Plan, one more DMEPP System Evaluation Report after this one will be prepared covering the period from January 1 through

June 30, 1997 and will be submitted as scheduled for review on October 1, 1997. After that time, the quarterly and annual IEMP reports will replace the DMEPP System Evaluation Reports.

In conclusion, significant results for this reporting period and recommendations for the next reporting period are summarized below.

Operational changes of note during this reporting period:

- A major well rehabilitation program was undertaken to restore Well 3926 to service and to rehabilitate the other recovery wells in the system. Post-treatment pumping tests and down hole camera surveys indicate significant improvements in well/screen conditions.
- The installation of electrical surge suppressors on all recovery wells and on the control building was completed in September so that flow controller electrical components will be less susceptible to electrical interference from nearby thunderstorms.
- Additional flow controller electrical components have been added to the spare parts inventory to minimize future downtime due to failed circuit boards.
- An average uranium recovery efficiency of 0.15 pounds per million gallons pumped was maintained for the reporting period.
- Two target pumping configurations of 1100 gpm and 1000 gpm utilizing three of the four recovery wells were used during the reporting period while Wells 3926 and 3927 were being rehabilitated.

Significant data analysis results include:

- Trend analysis indicates 12 wells with increasing uranium concentrations for this reporting period. While this is the same number reported during the previous period, two wells changed from an "Up Significant" trend to "No Trend" (Wells 3125 and 4125) and two wells changed from "No Trend" to "Up Significant" (Wells 2002 and 2128). See Section 3.0.
- Trend analysis indicates 14 wells with decreasing uranium concentrations for this reporting period. While this is the same number reported during the previous period, two wells changed from a "Decreasing Trend" to "No Trend (Wells 2552 and 3881) and two wells changed from "No Trend" to "Decreasing Trend" (Wells 2434 and 2548). See Section 3.0.
- Of the 26 wells with significant trends in total uranium concentrations, only three, Monitoring Wells 2128 and 2398 with upward trends and Monitoring Well 2548 with a downward trend are outside the capture zone of the recovery system as defined by the groundwater elevation data and supported by the colloidal borescope data and SWIFT site groundwater modeling results. These Wells are discussed in Section 3.0.

- Total uranium concentrations in Monitoring Well 2552 increased slightly during this period to 24.5 and 23.0 μg/L during the third and fourth quarters respectively. The Mann-Kendall trend analysis for this well changed from "Down Significant" to "No Trend".

- Uranium concentrations in Monitoring Well 3069 near the northeastern lobe of the plume have decreased from a high of 223.6 μg/L observed during the previous reporting period to 115.0 μg/L and 164.3 μg/L measured in the third and fourth quarters of 1996 respectively. The statistical trend for this well remains "Up Significant".

- Preliminary Geoprobe sampling conducted under the Restoration Area Verification Sampling PSP indicates the presence of total uranium contamination of up to 490 μg/L southwest of Monitoring Well 3069 where concentrations were previously thought to be in the range of 100 μg/L. Based on the Geoprobe results this area of higher concentration extends slightly south of Willey road where the leading edge of contamination has been defined. See Section 4.0 and Figure 4-5.

Recommendations and areas of focus for the next reporting period include:

- Continue to collect groundwater level measurements monthly with provisions to return to quarterly elevation measurements when the aquifer/pumping systems stabilize.

- Return the wellfield to the optimum 1,400 gpm rate as soon as Recovery Wells 3924 and 3925 have been rehabilitated and returned to service.

- Continue to collect borescope flow direction data to assist in confirming capture zone interpretations.

- Continue to monitor the recovery wellfield to ensure negligible influence to the Paddys Run Road Site plume.

- Continue to evaluate capture of the contiguous 20 μg/L uranium plume with the use of groundwater elevation data in Type 2 monitoring wells and borescope data collected in both Type 2 and selected Type 3 wells.

- Investigate alternative monitoring options to replace Wells 2061 and 3062 which are no longer available for sampling.

- Continue to seek ways to improve the mechanical reliability of the system and to enhance the operating time of the system as remedial design of the South Plume Optimization System progresses.

- Continue to monitor the southwestern lobe of the uranium plume which at times resides outside the capture zone of the recovery wellfield (Monitoring Well 2552).

- Continue to evaluate the northeastern lobe of the plume at the Type 3 well depth interval and integrate geoprobe sampling results into the plume interpretations.

000064

- Continue to monitor and evaluate uranium concentrations in Well 2900 and 2128 which are south of the recovery system.
- Continue to monitor and evaluate sodium concentrations in Wells 2899, 2900, and 3898.
- Continue to refine the streamlined reporting approach as necessary, based on agency input.

APPENDIX A

SUMMARY OF ANALYTICAL DETECTIONS

(See disk in front pocket of binder)

VALIDATION QUALIFIERS

J — These data are considered quantitatively estimated, and may be biased due to effects reflected in the associated quality control results. Analyte identification is reliable, however, and EPA guidance allows the use of "J" qualified data to be used in baseline evaluation of risk assessment as well as nature and extent of contamination. This qualifier is also applied to organic data when the actual result is less than the contract required detection limit; these data are also considered quantitatively estimated. "J" may carry additional meaning when used in radiochemical validation; the Data Validation Summary Report further defines the use of this qualifier.

NV — These data are not validated. Reasons for nonvalidation can be found in the Data Validation Summary Report associated with the data set. These data cannot be used in risk assessment evaluation.

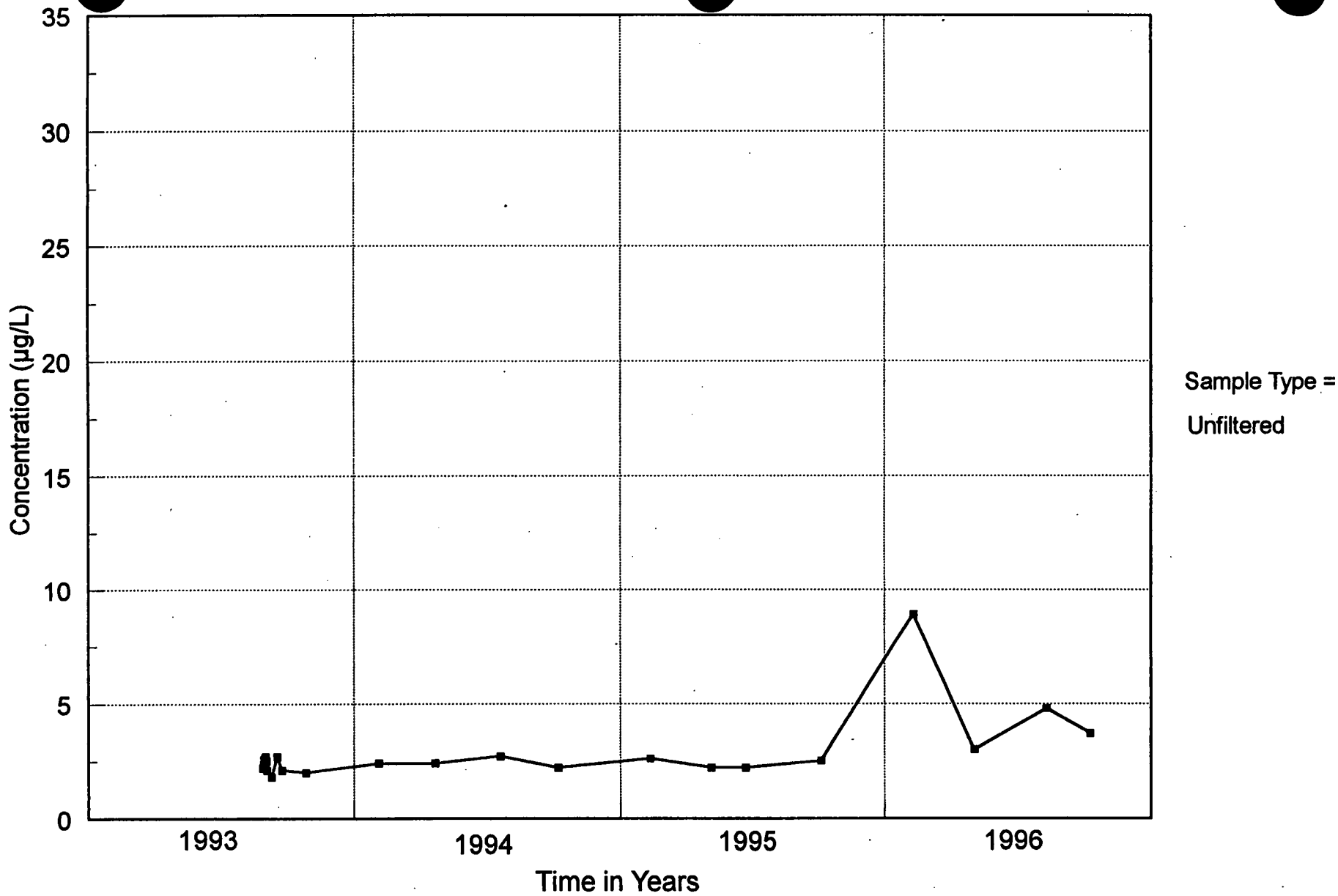
-(dash) — A dash (-) indicates that the result is CONFIDENT AS REPORTED; the validator did NOT assign any of the above qualifiers to the positive result. (NOTE: When an undetected result is not further qualified, the validator will still enter the "U" qualifier in the qualifier column.)

U — Data that were observed at levels less than the corresponding limit of detection were qualified as U, meaning not detected above the associated value. This qualifier is assigned by the laboratory, and it was also used as a validation qualifier when common field or laboratory blank contaminants were detected in a sample less than action level as defined by the validation criteria. For nature and extent, the U qualifier establishes the lowest concentration of an analyte that can confidently be defined as nondetect. If an analyte was not detected in a certain media of a specific waste area, the calculation for concentration source terms did not include one-half the sample quantitation limits. Like the laboratory qualifier U, one-half of the sample quantitation limit has been used as a surrogate in calculating the concentration term in risk calculations.

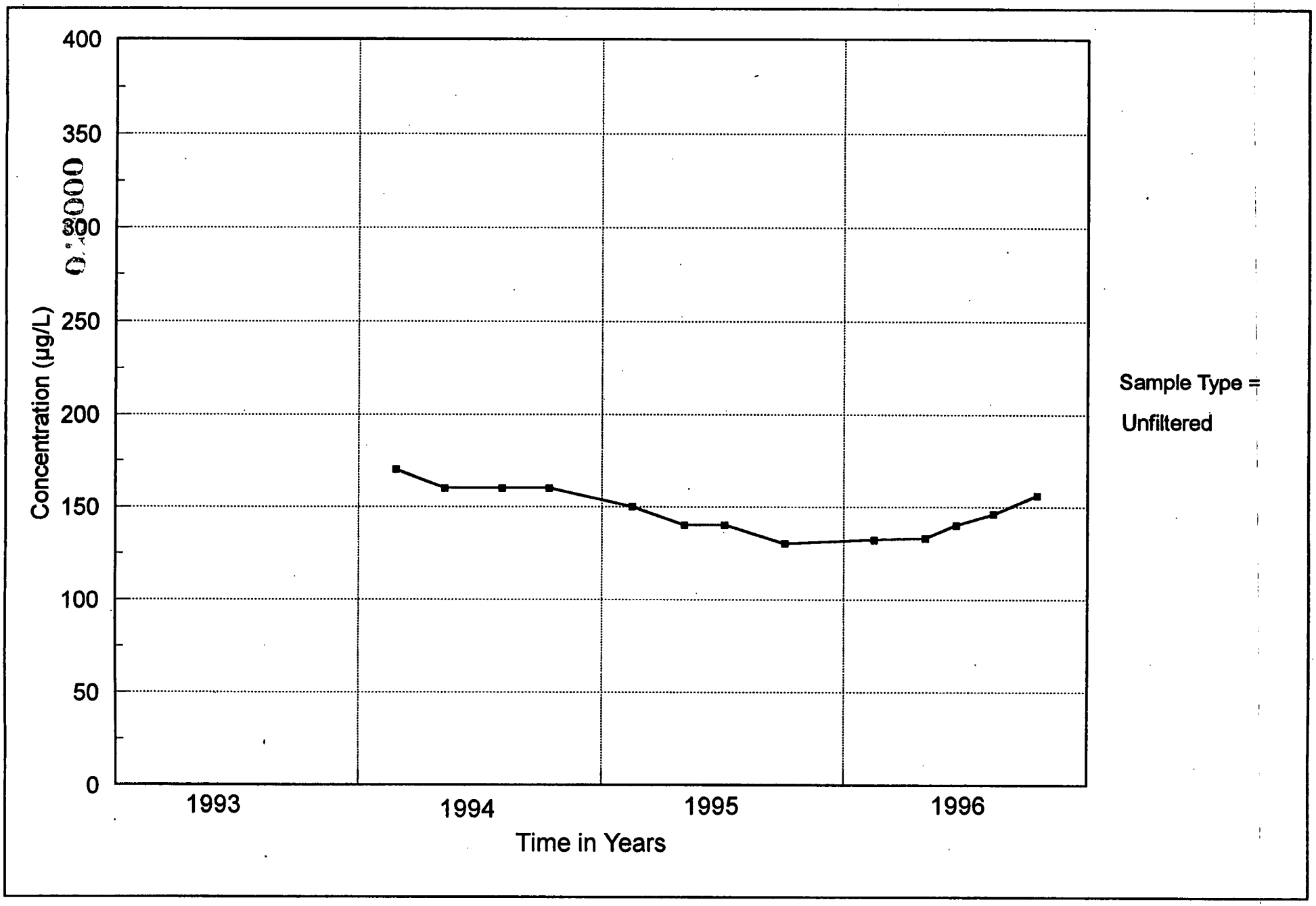
UJ — Data that were quantitatively estimated at levels less than the corresponding limit of detection.

APPENDIX B

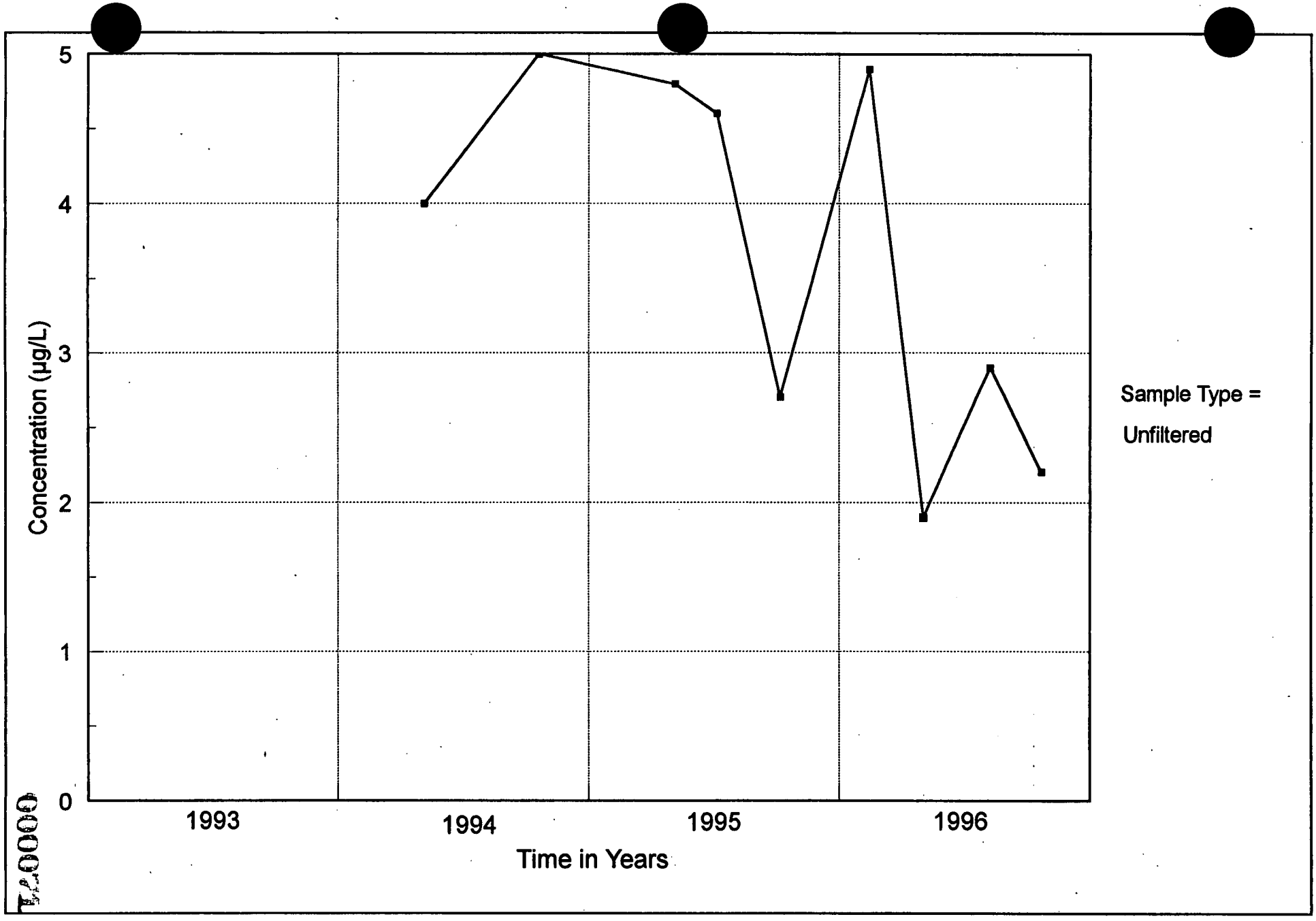
CONCENTRATION PLOTS
FOR DMEPP MONITORING AND RECOVERY WELLS
(Data are for total uranium from unfiltered samples)



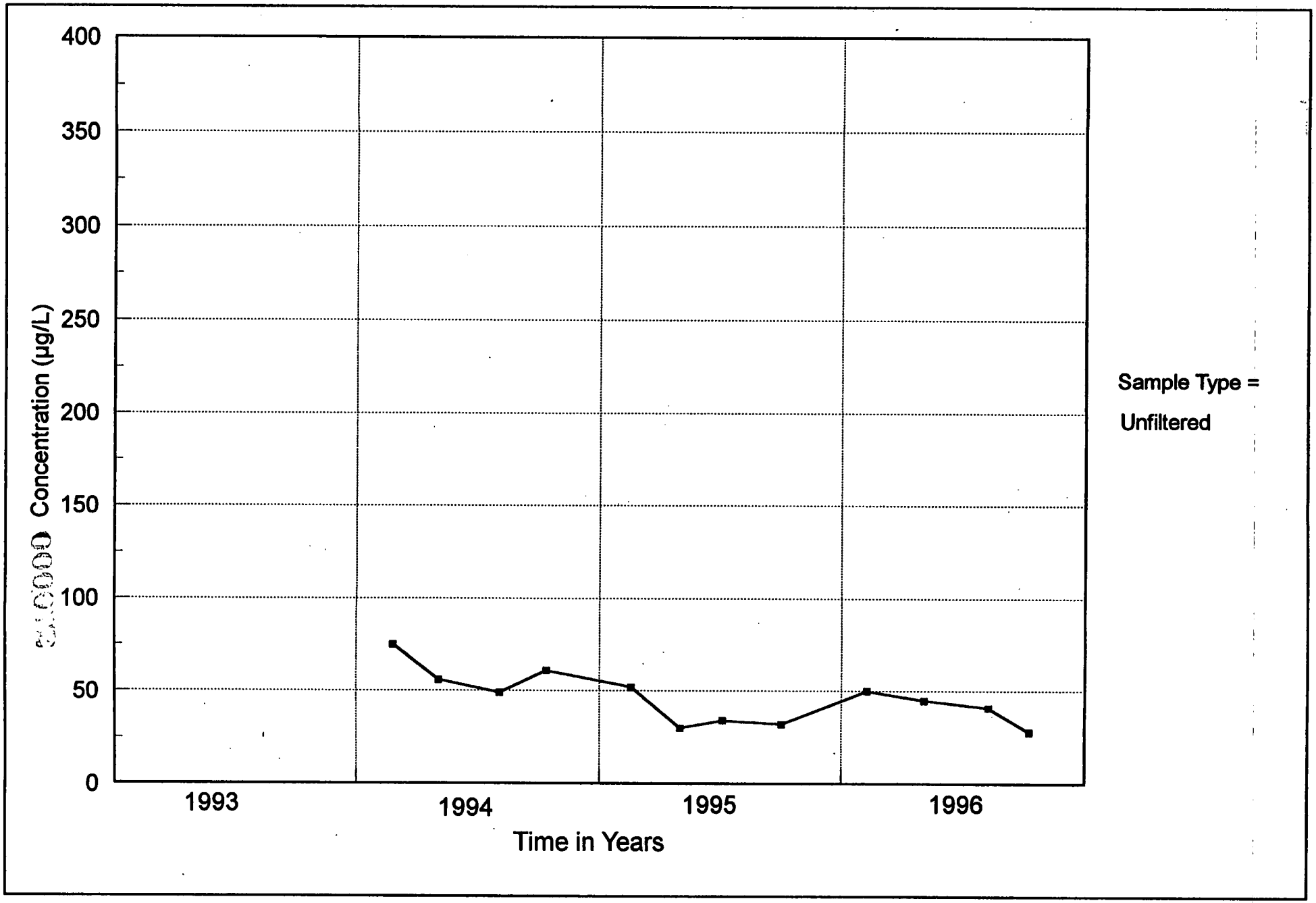
Monitoring Well 2002 Total Uranium Concentrations



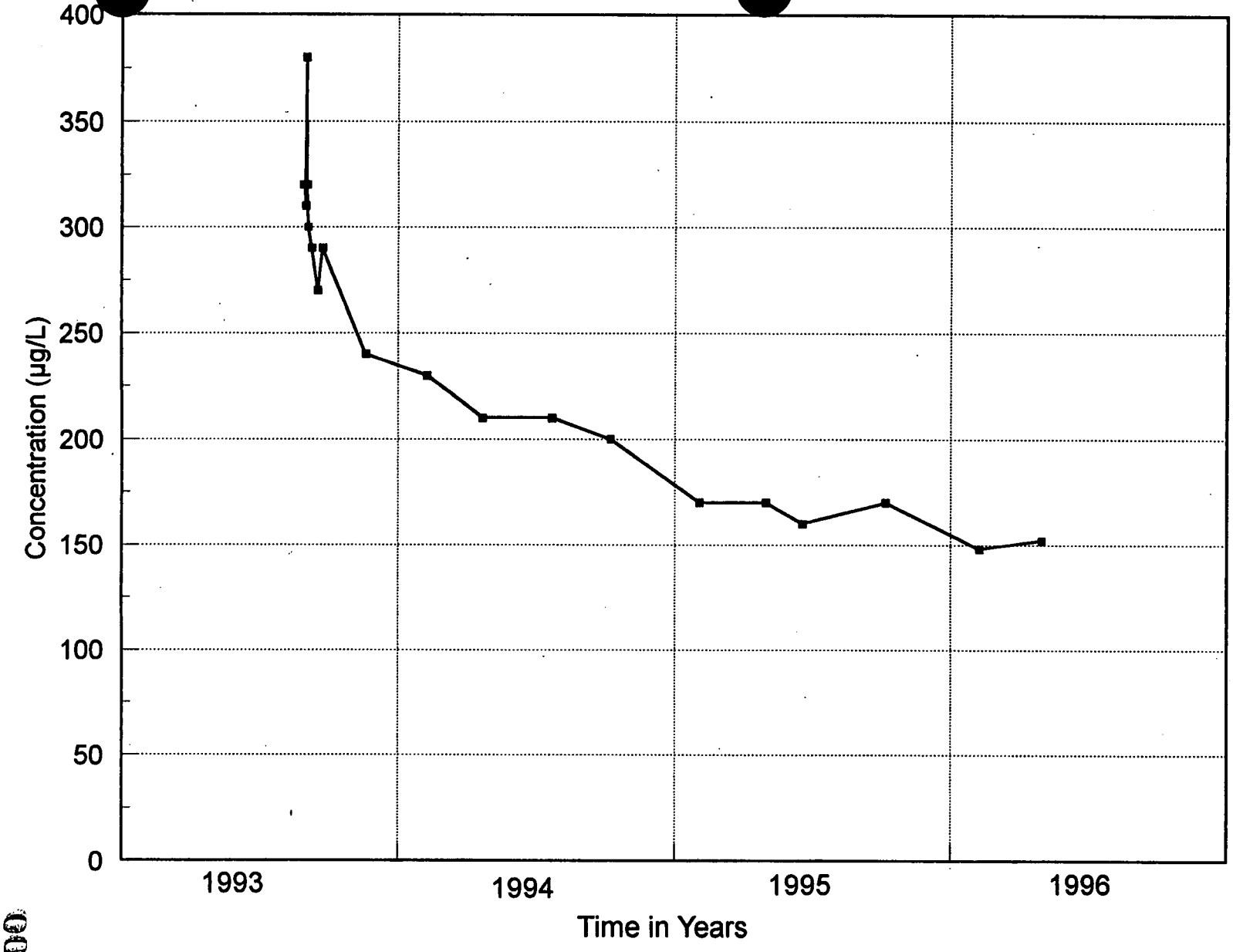
Monitoring Well 2015 Total Uranium Concentrations



Monitoring Well 2017 Total Uranium Concentrations



Monitoring Well 2060 Total Uranium Concentrations

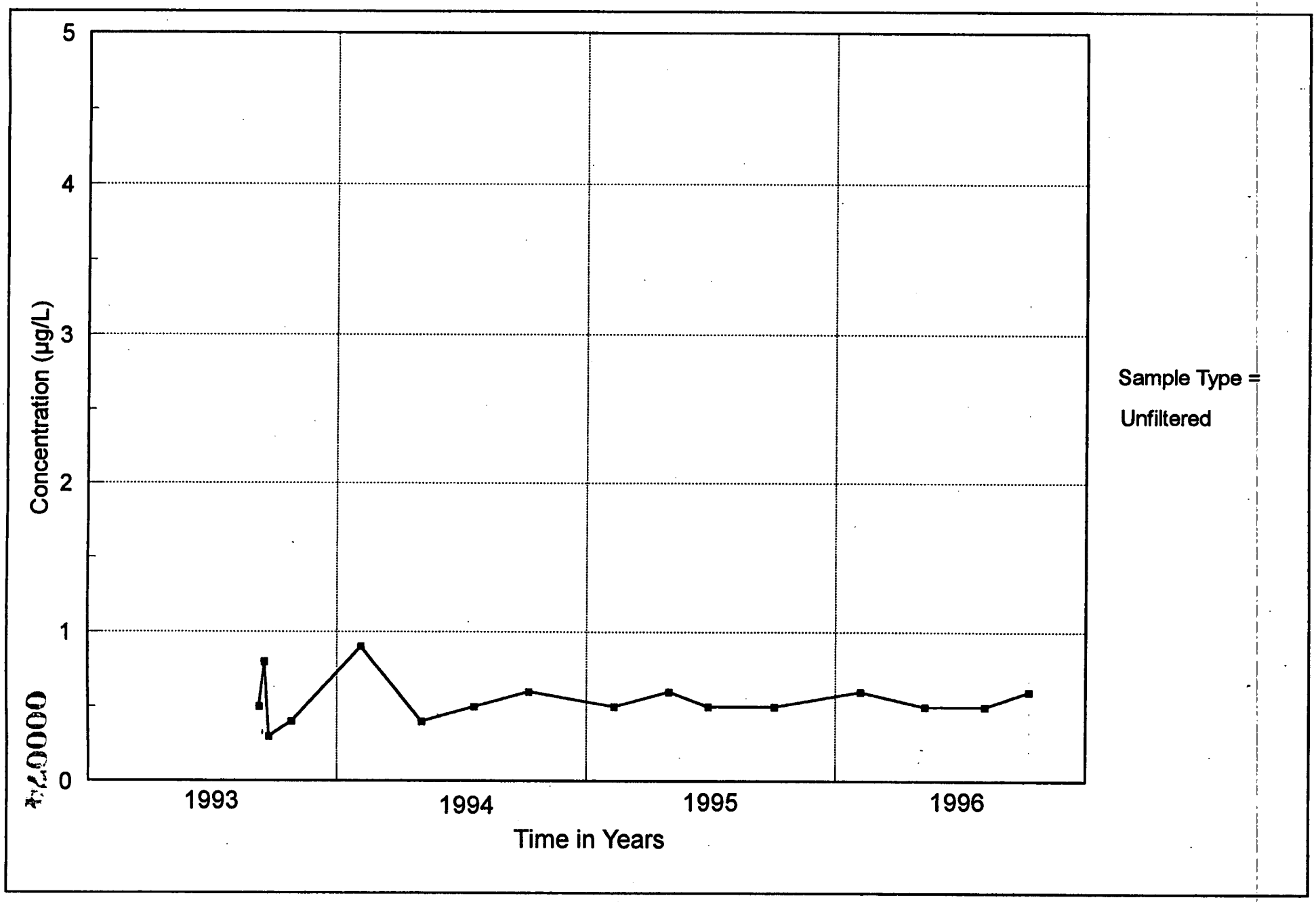


Sample Type =

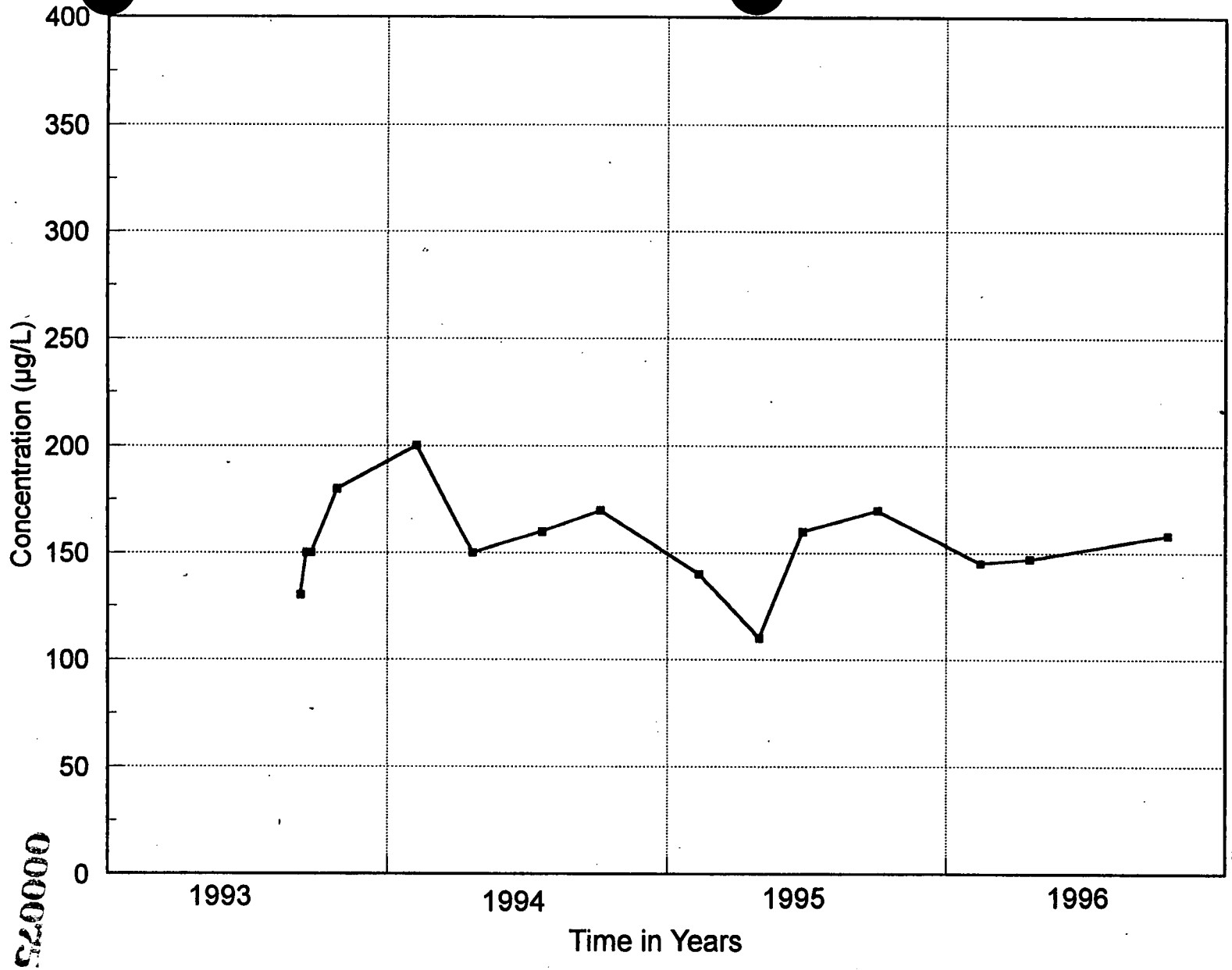
Unfiltered

Well 2061 was the supply well for Delta Steel. It was plugged per Ohio Department of Health requirements, and therefore, can longer be sampled.

Monitoring Well 2061 Total Uranium Concentrations



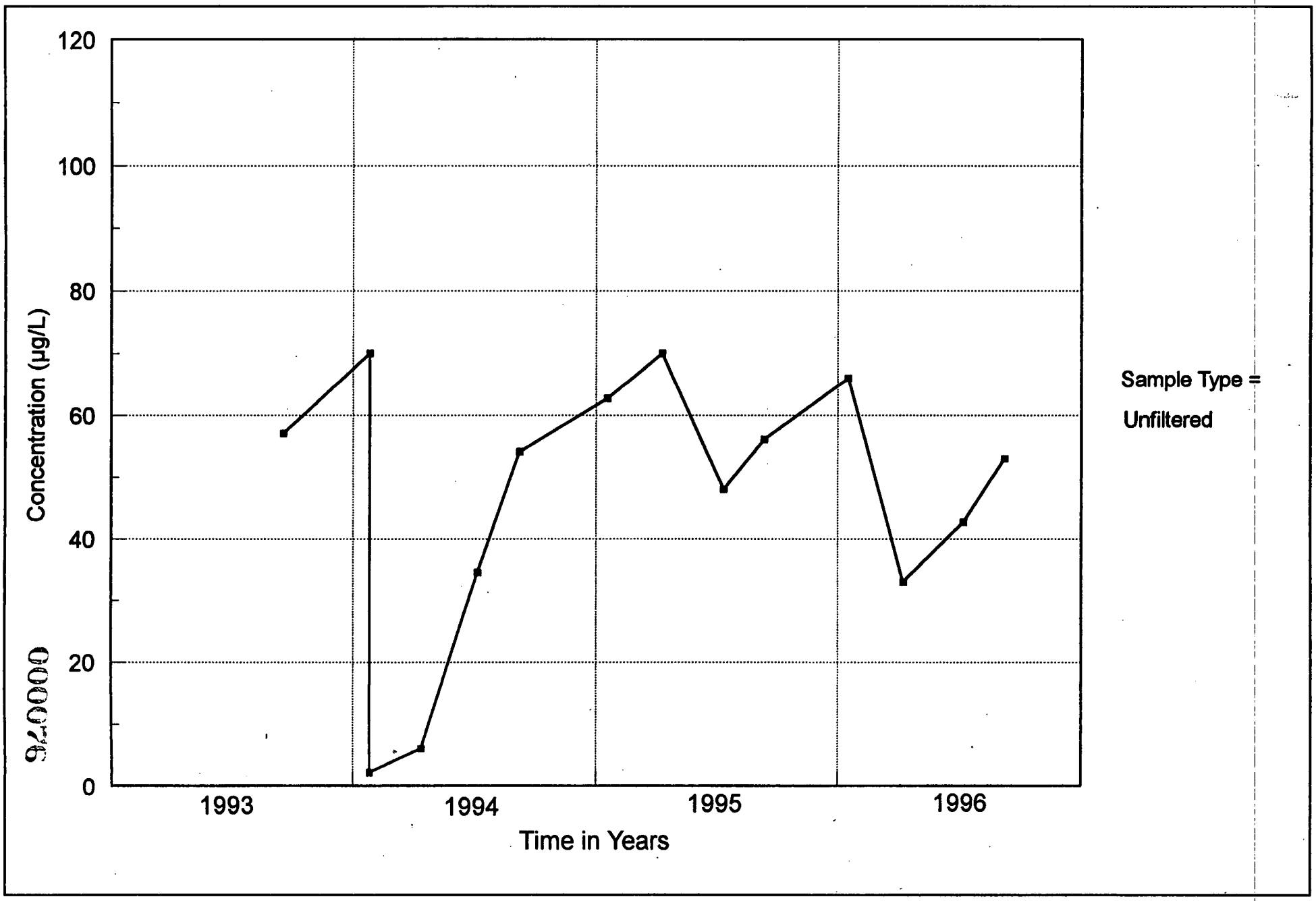
Monitoring Well 2093 Total Uranium Concentrations



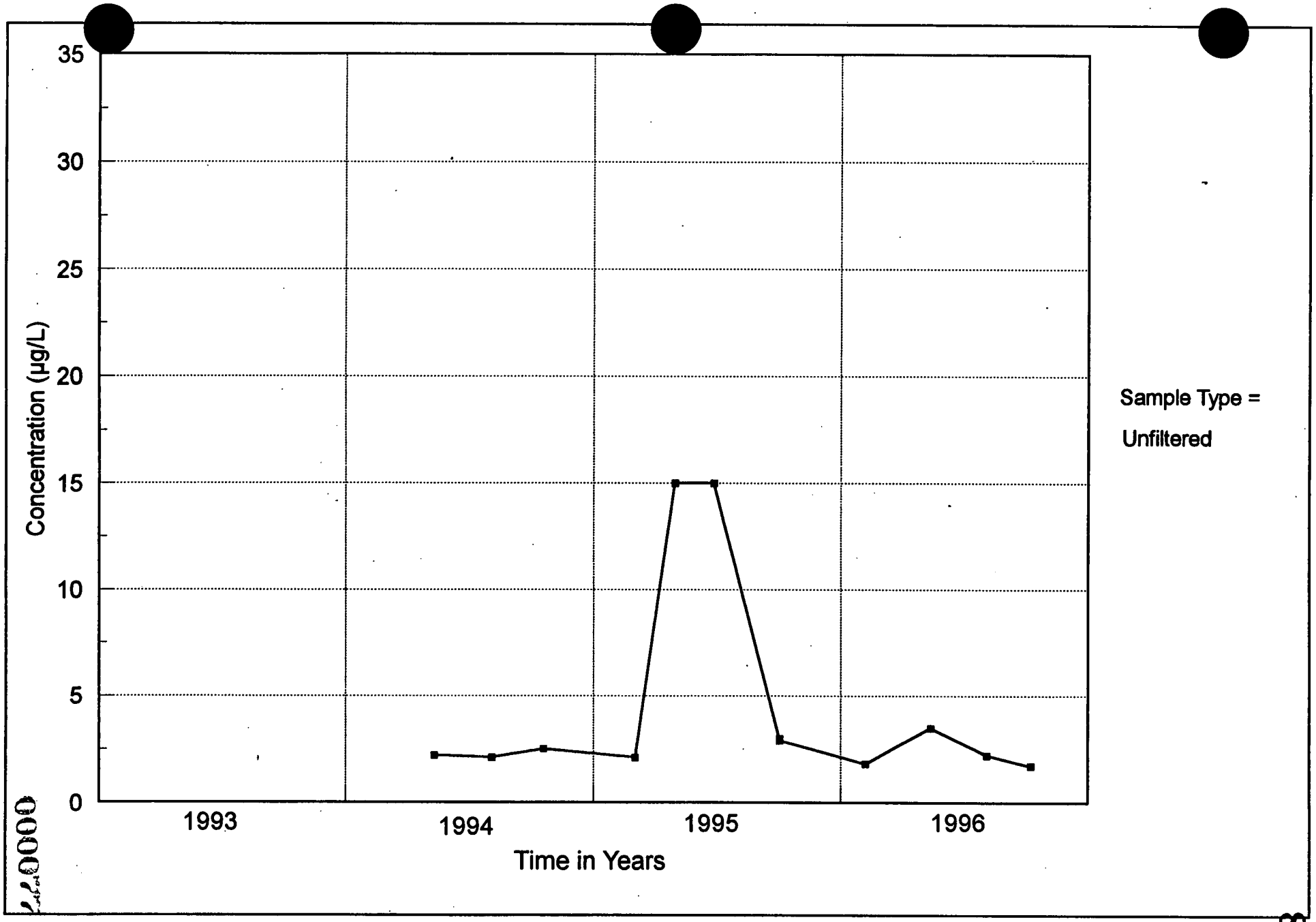
Sample Type =
Unfiltered

Due to access restrictions no third quarter 1996 sample was collected.

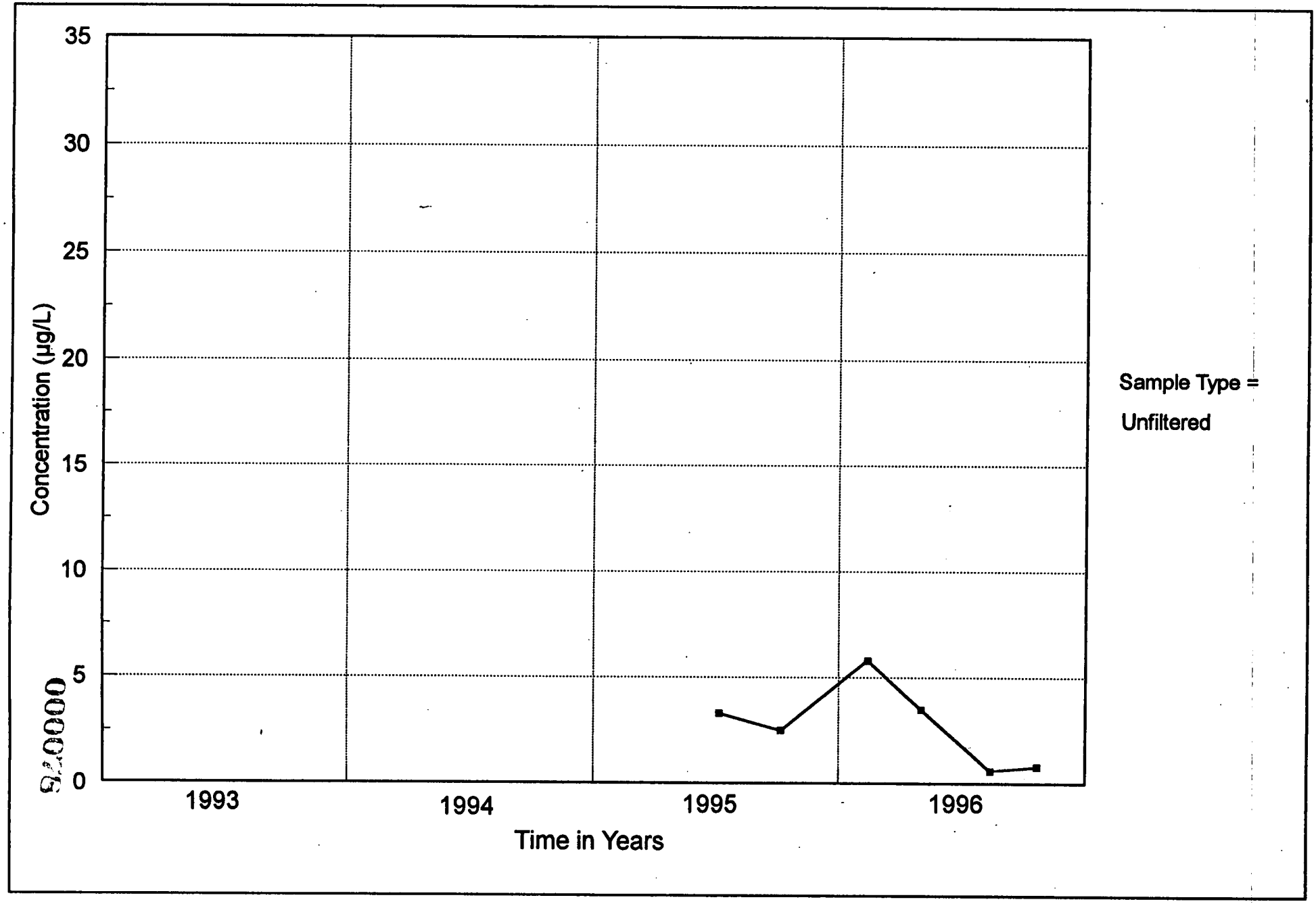
Monitoring Well 2095 Total Uranium Concentrations



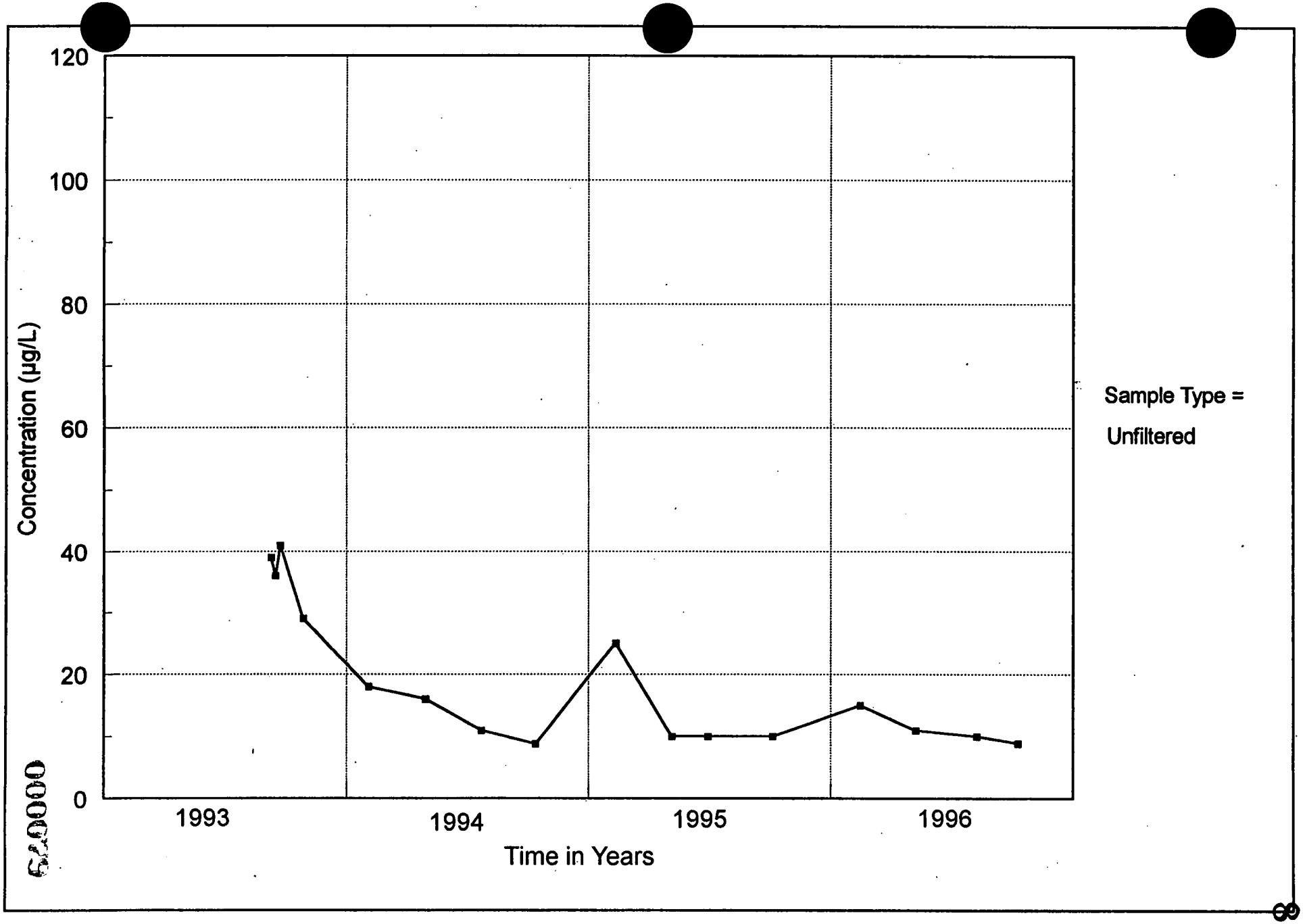
Monitoring Well 2106 Total Uranium Concentrations



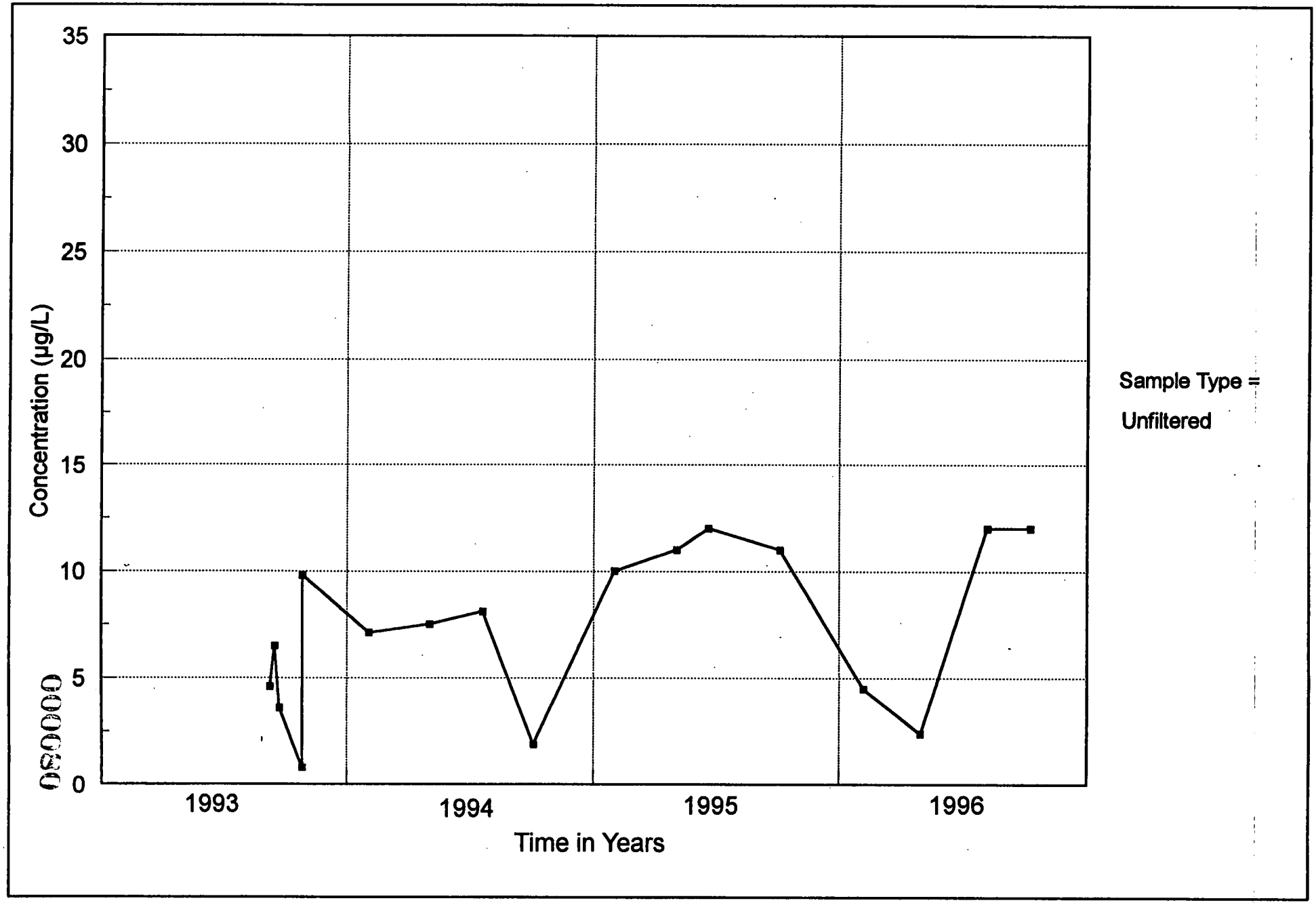
Monitoring Well 21063 Total Uranium Concentrations



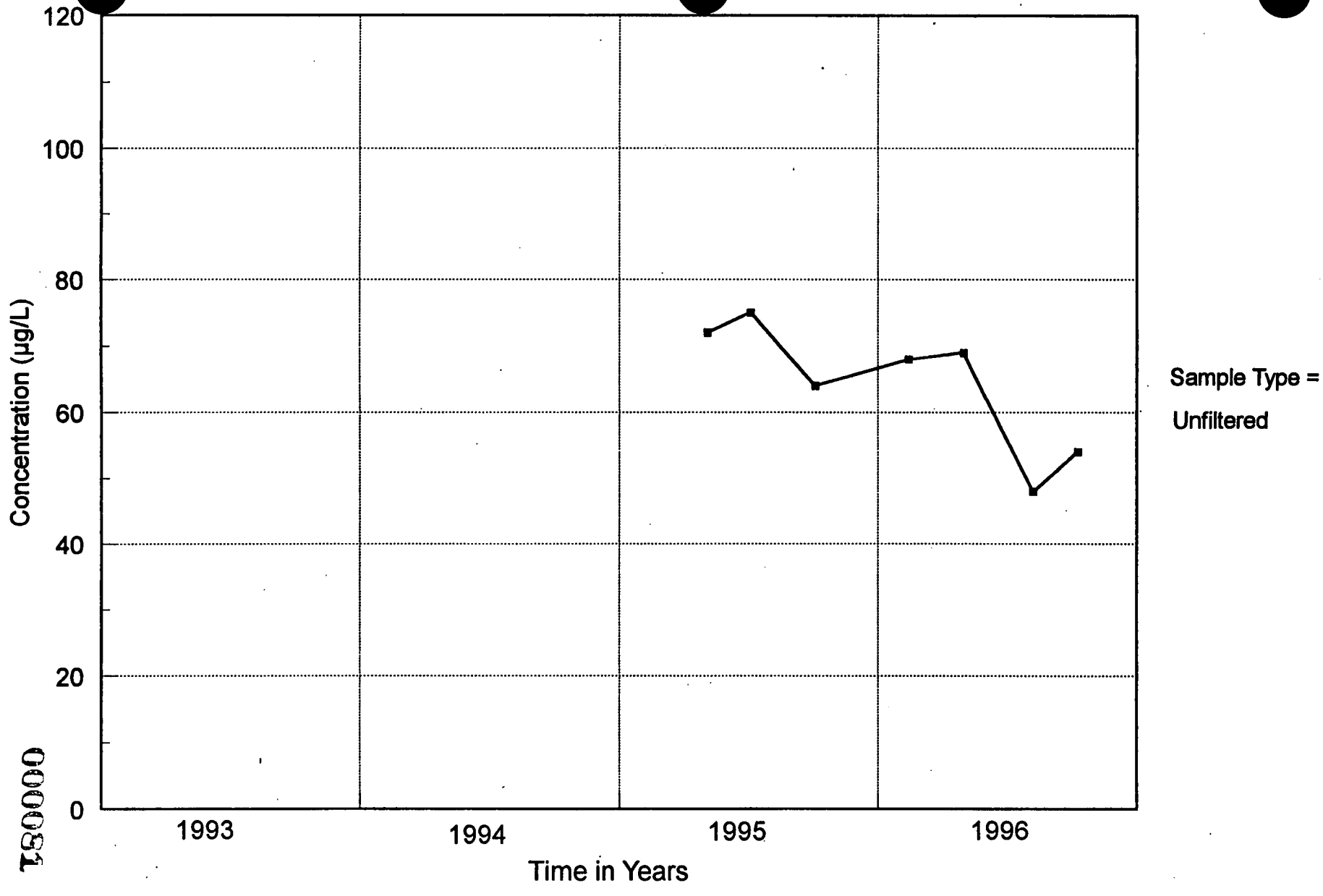
Monitoring Well 21194 Total Uranium Concentrations



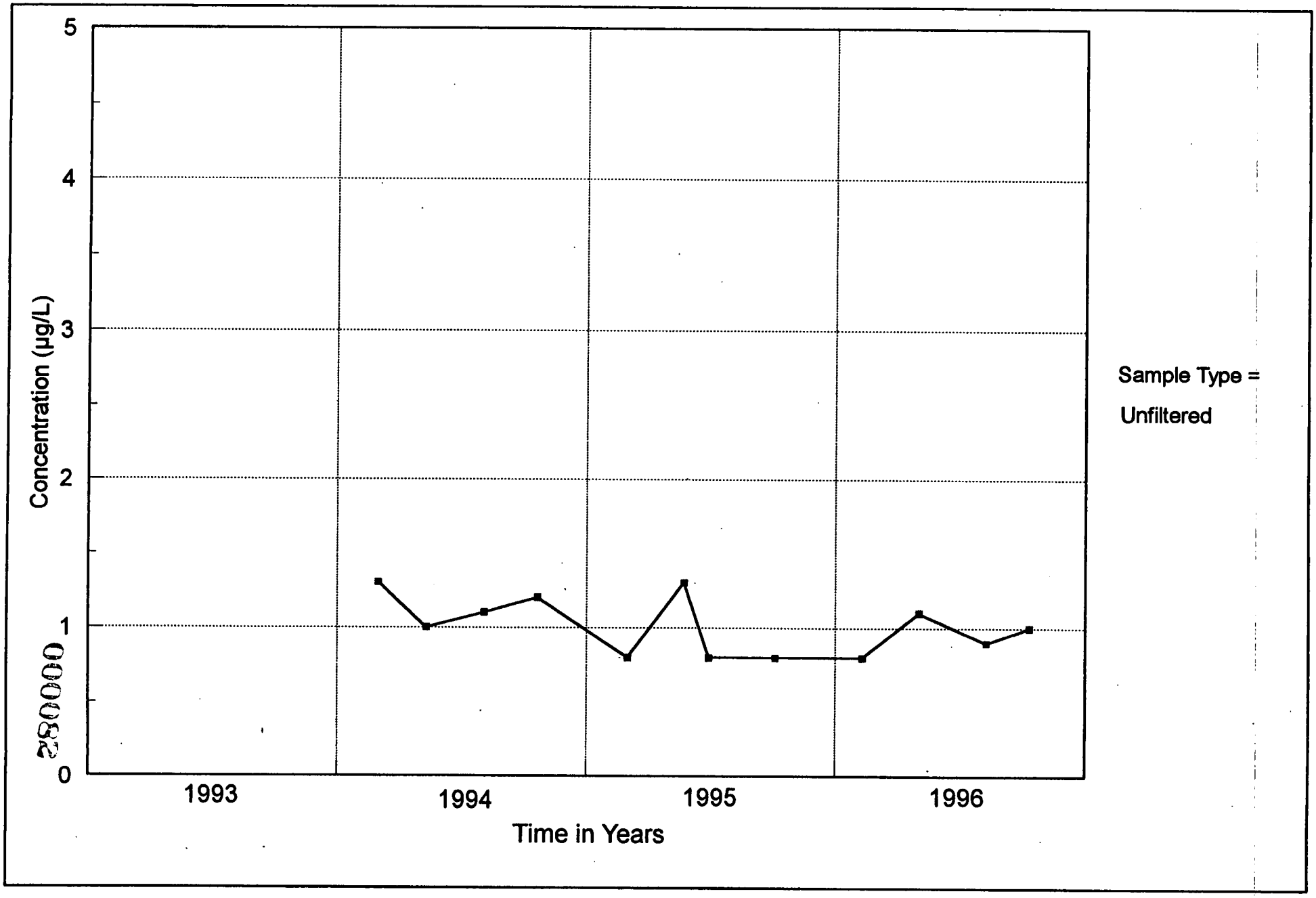
Monitoring Well 2125 Total Uranium Concentrations



Monitoring Well 2128 Total Uranium Concentrations



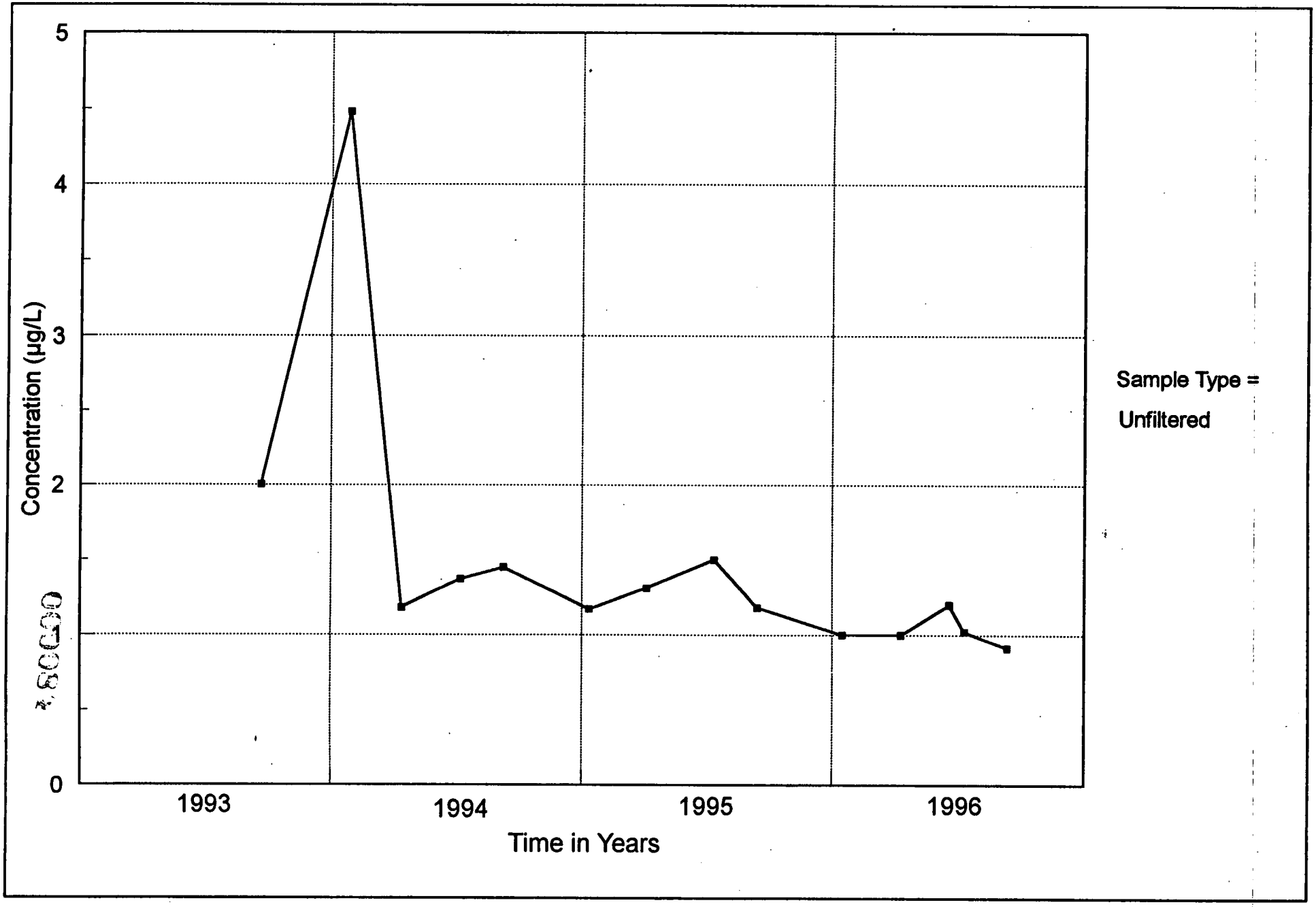
Monitoring Well 2166 Total Uranium Concentrations



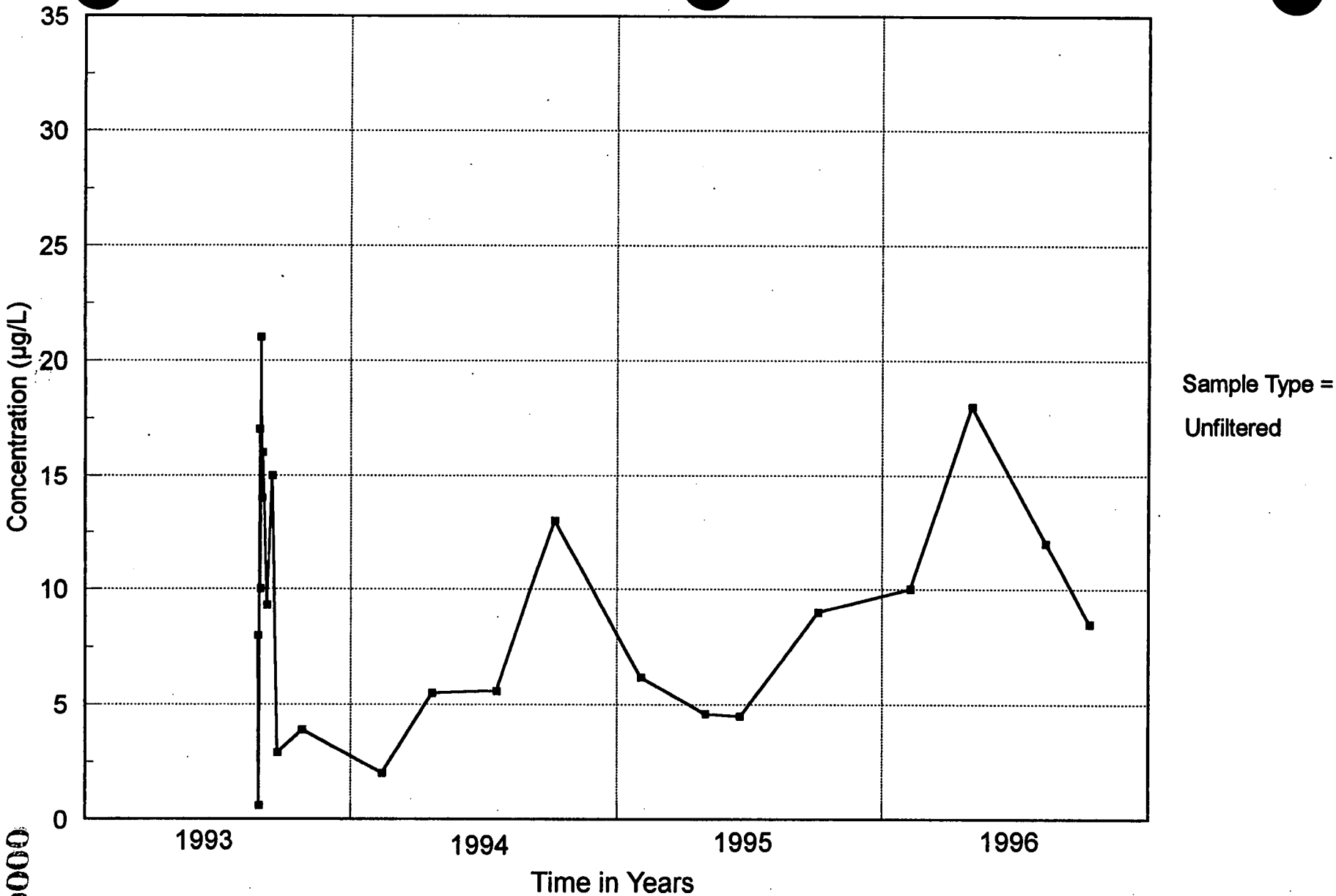
Monitoring Well 2396 Total Uranium Concentrations

280000

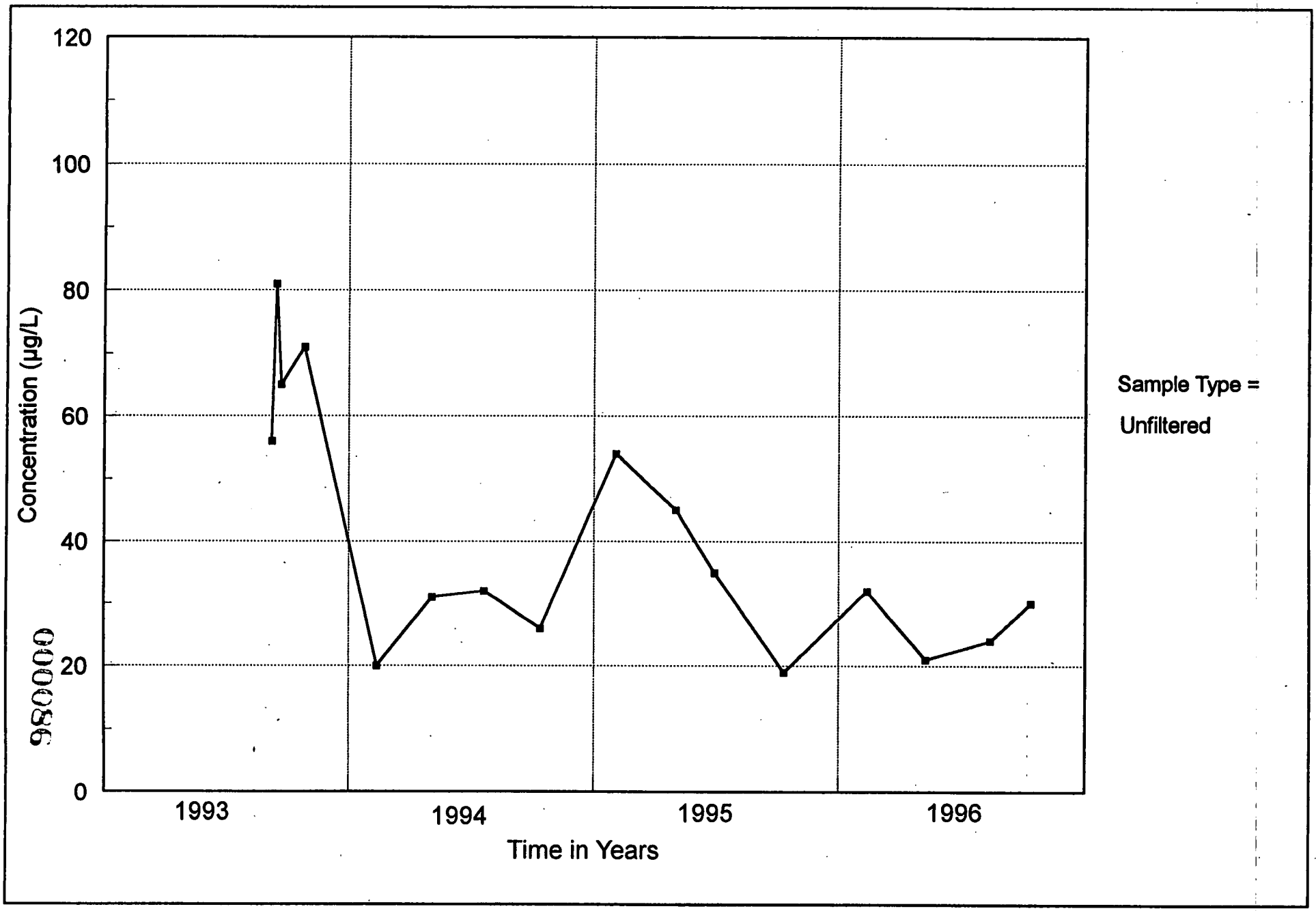
Monitoring Well 2398 Total Uranium Concentrations



Monitoring Well 2434 Total Uranium Concentrations

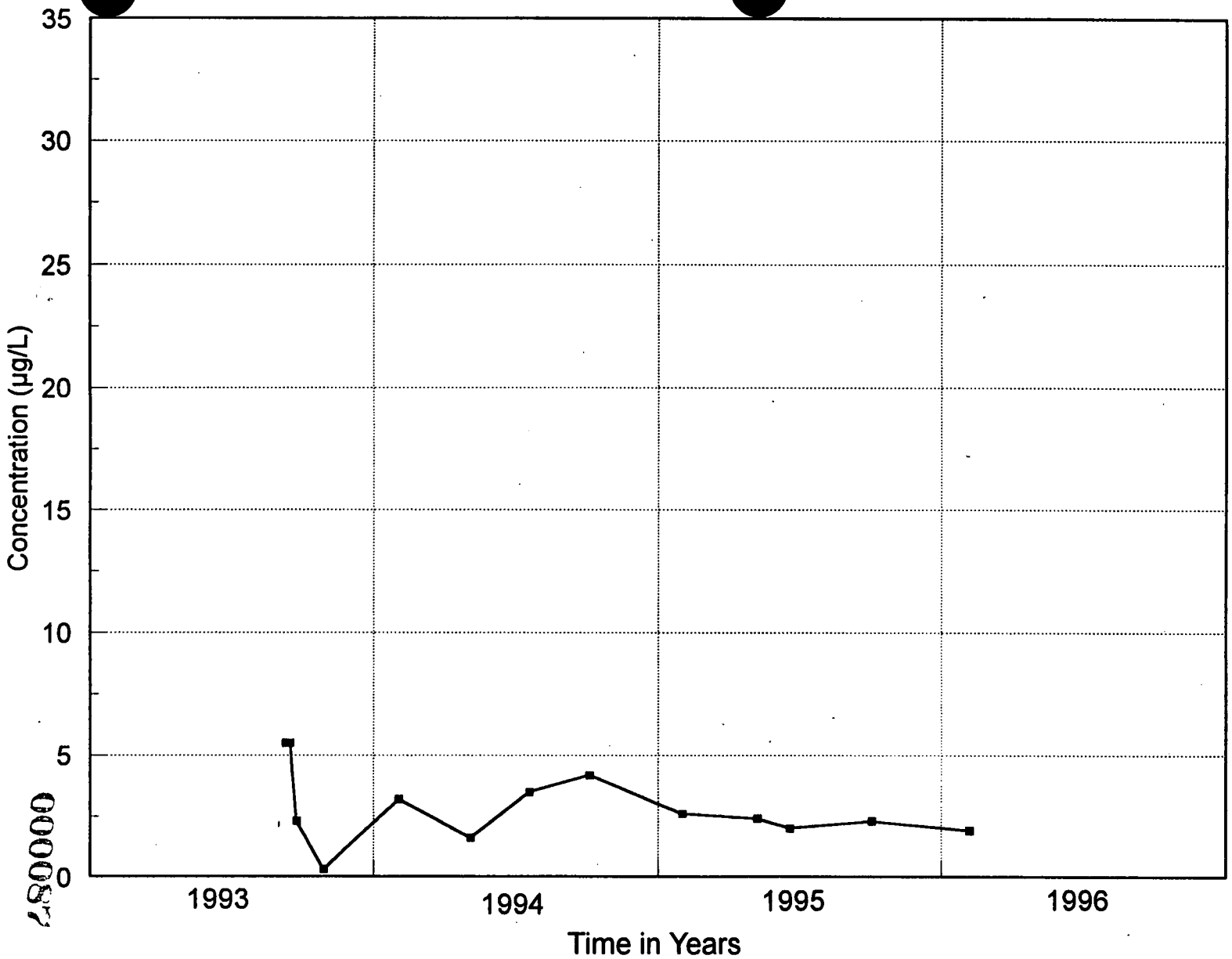


Monitoring Well 2544 Total Uranium Concentrations



Monitoring Well 2545 Total Uranium Concentrations

980000

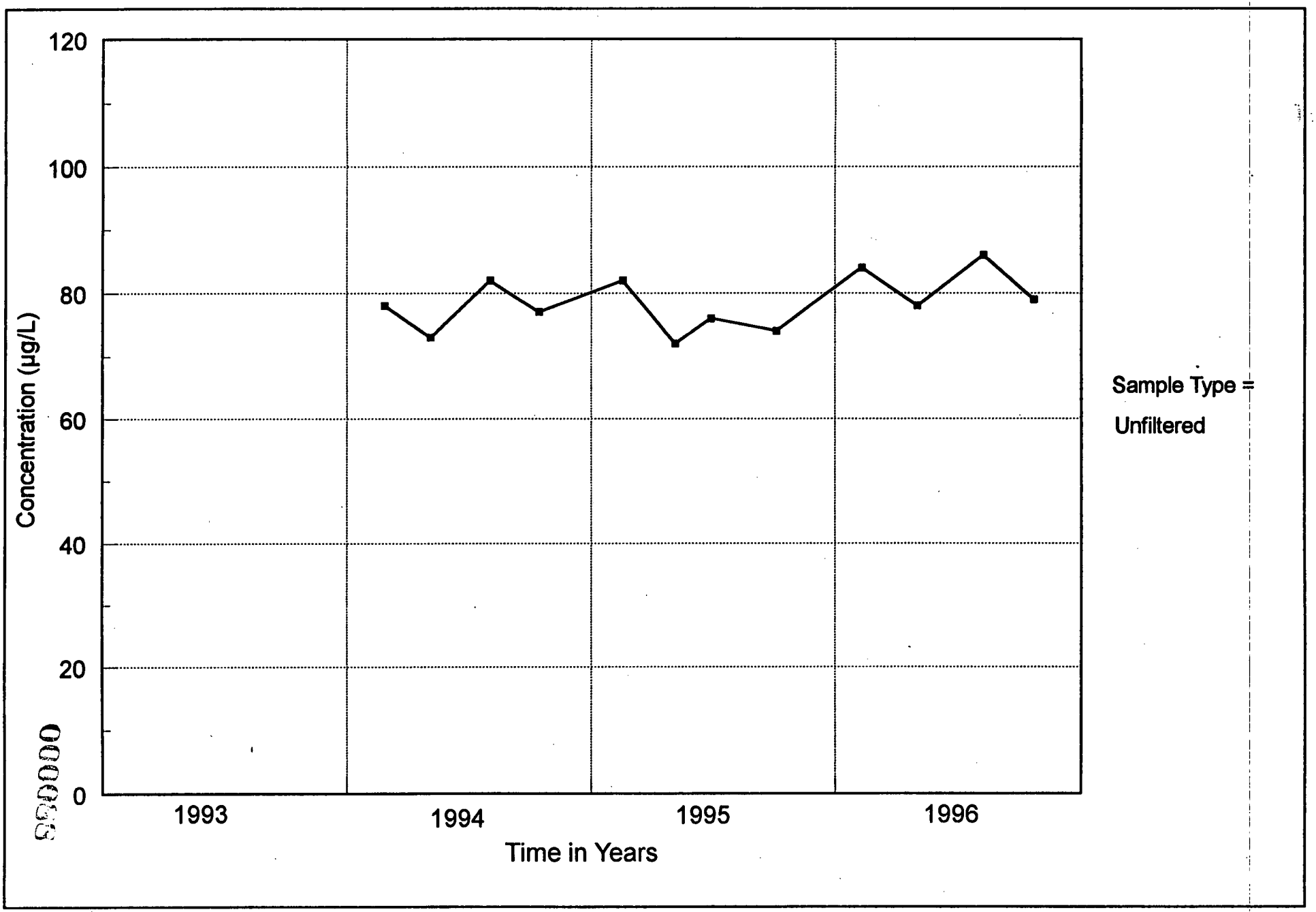


Sample Type =

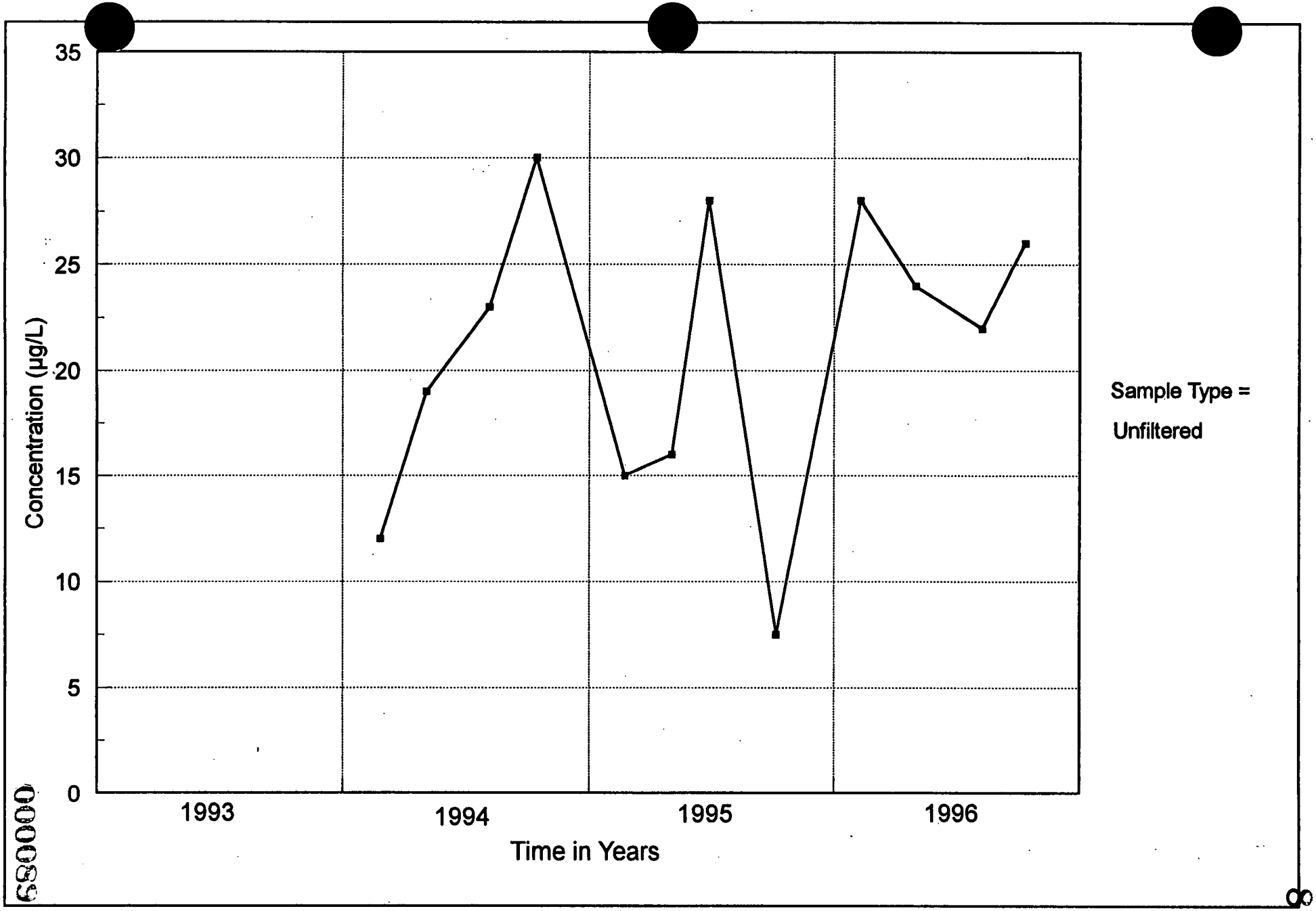
Unfiltered

Due to access restrictions no samples have been collected since the first quarter of 1996.

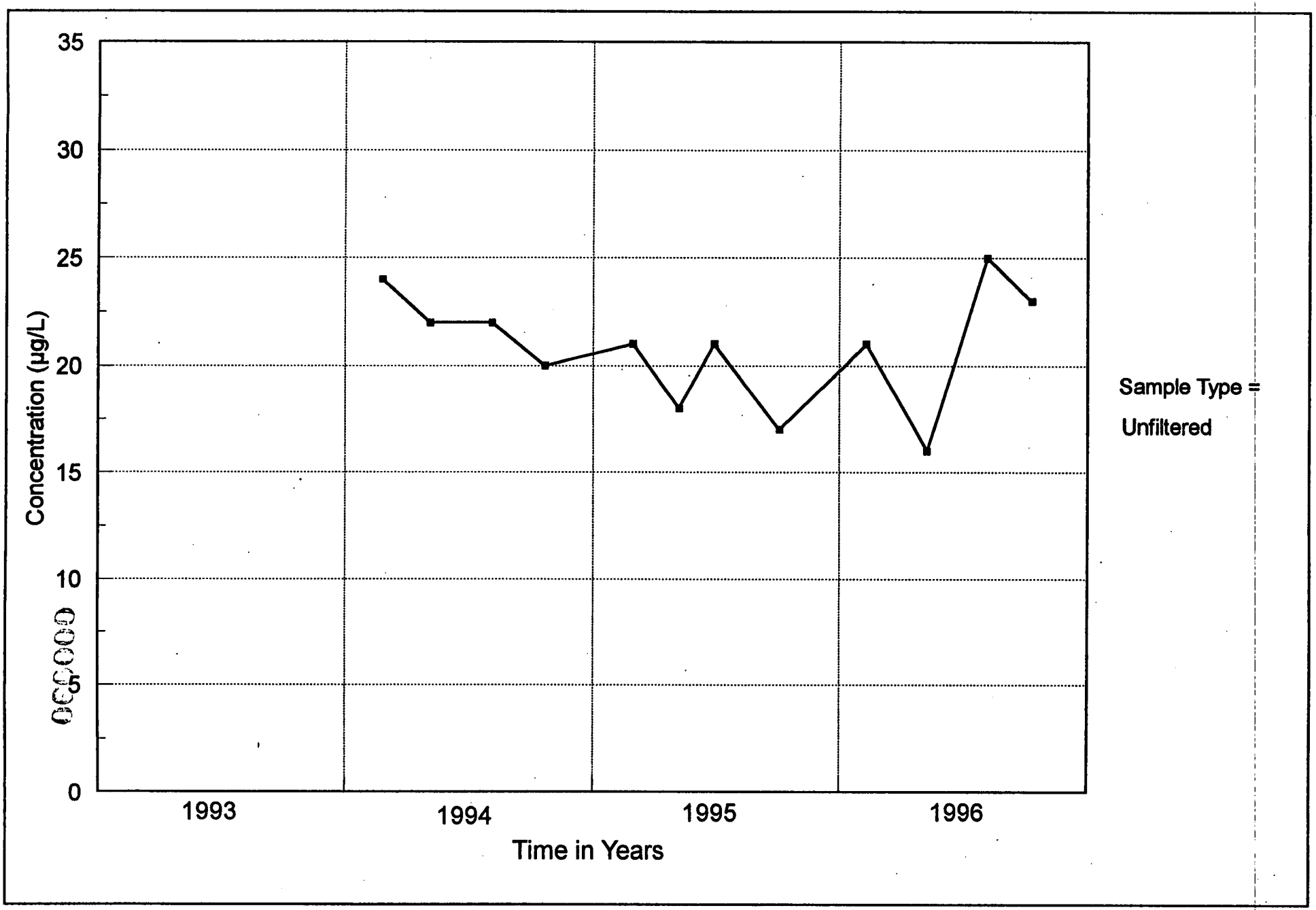
Monitoring Well 2548 Total Uranium Concentrations



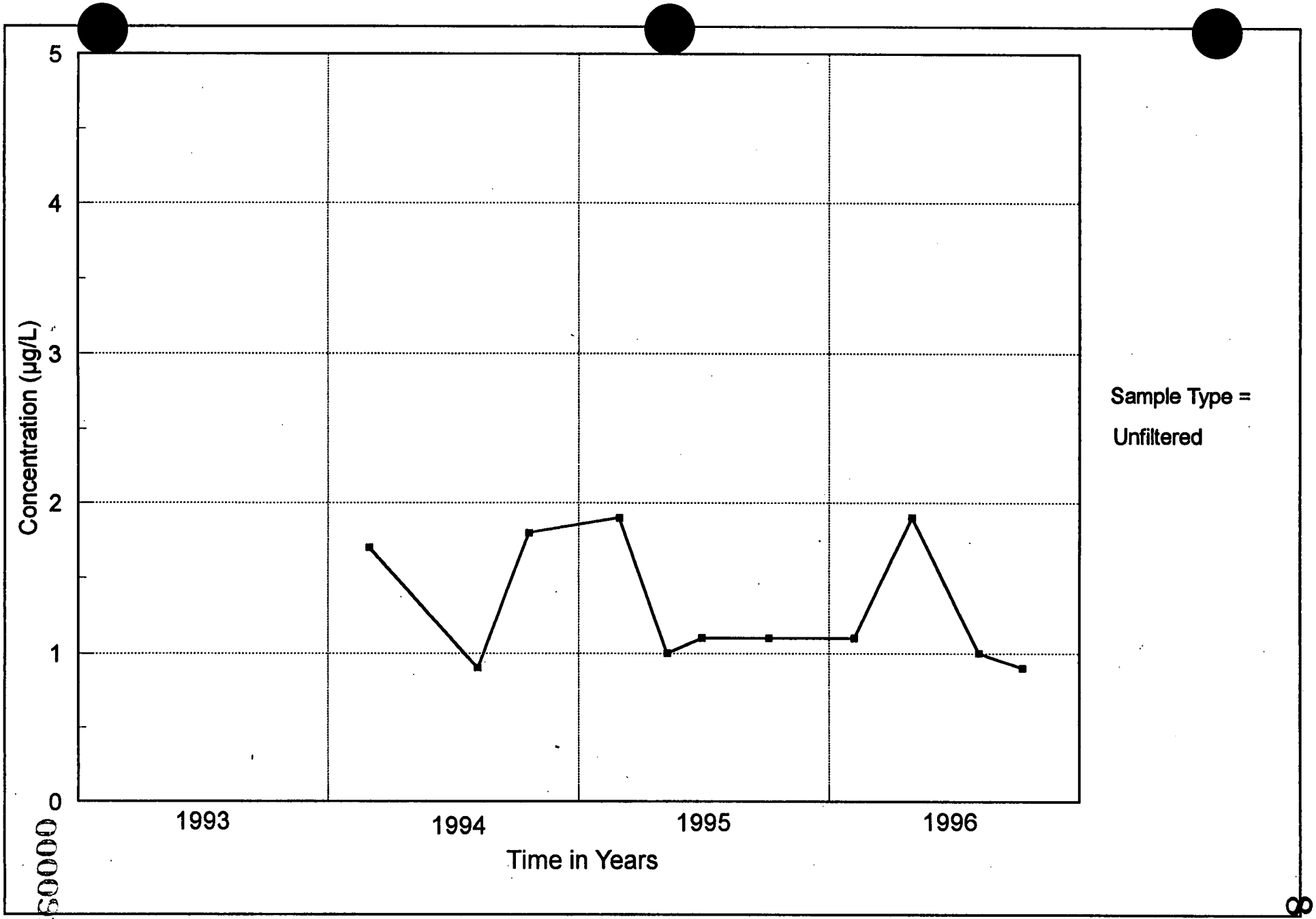
Monitoring Well 2550 Total Uranium Concentrations



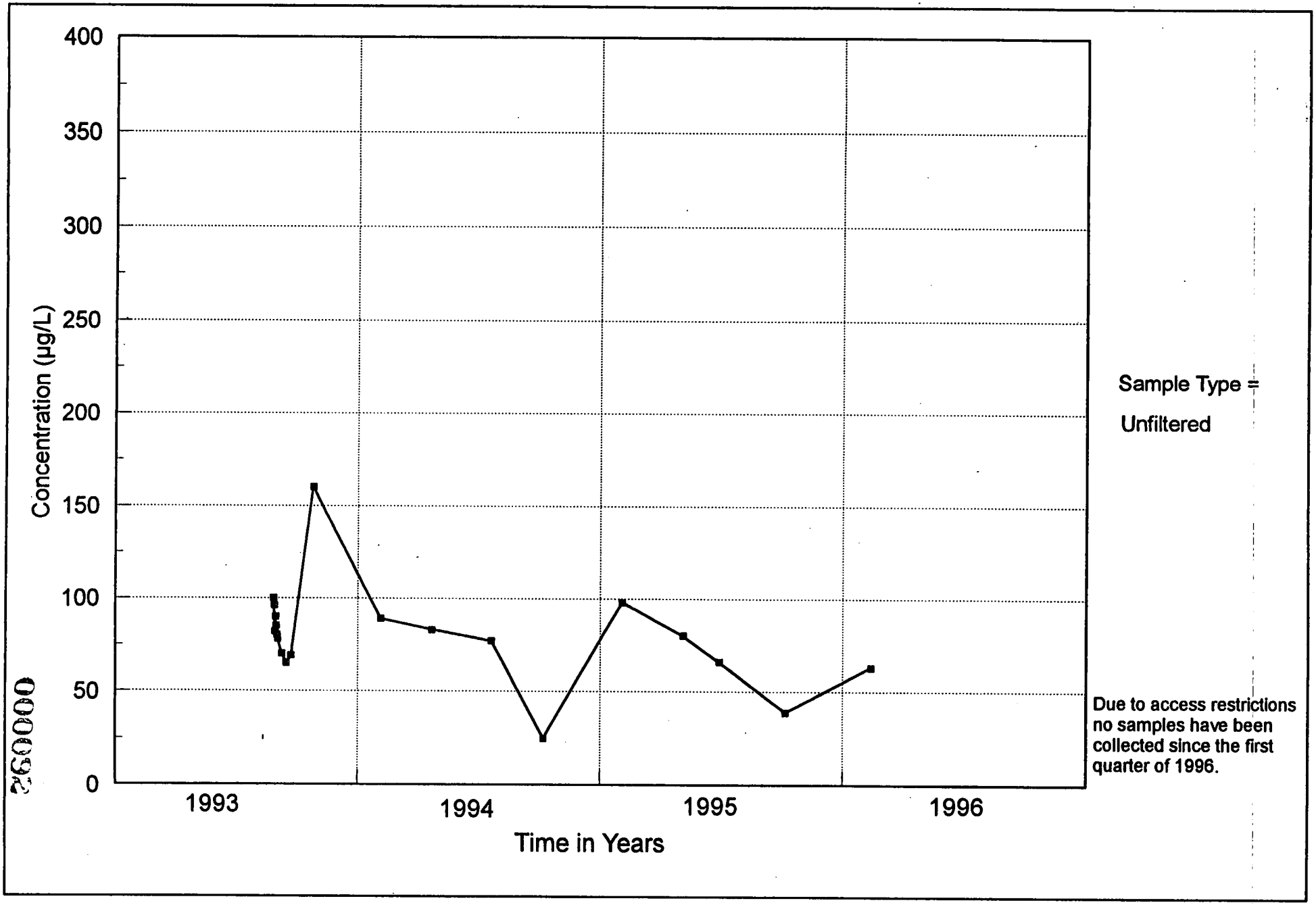
Monitoring Well 2551 Total Uranium Concentrations



Monitoring Well 2552 Total Uranium Concentrations

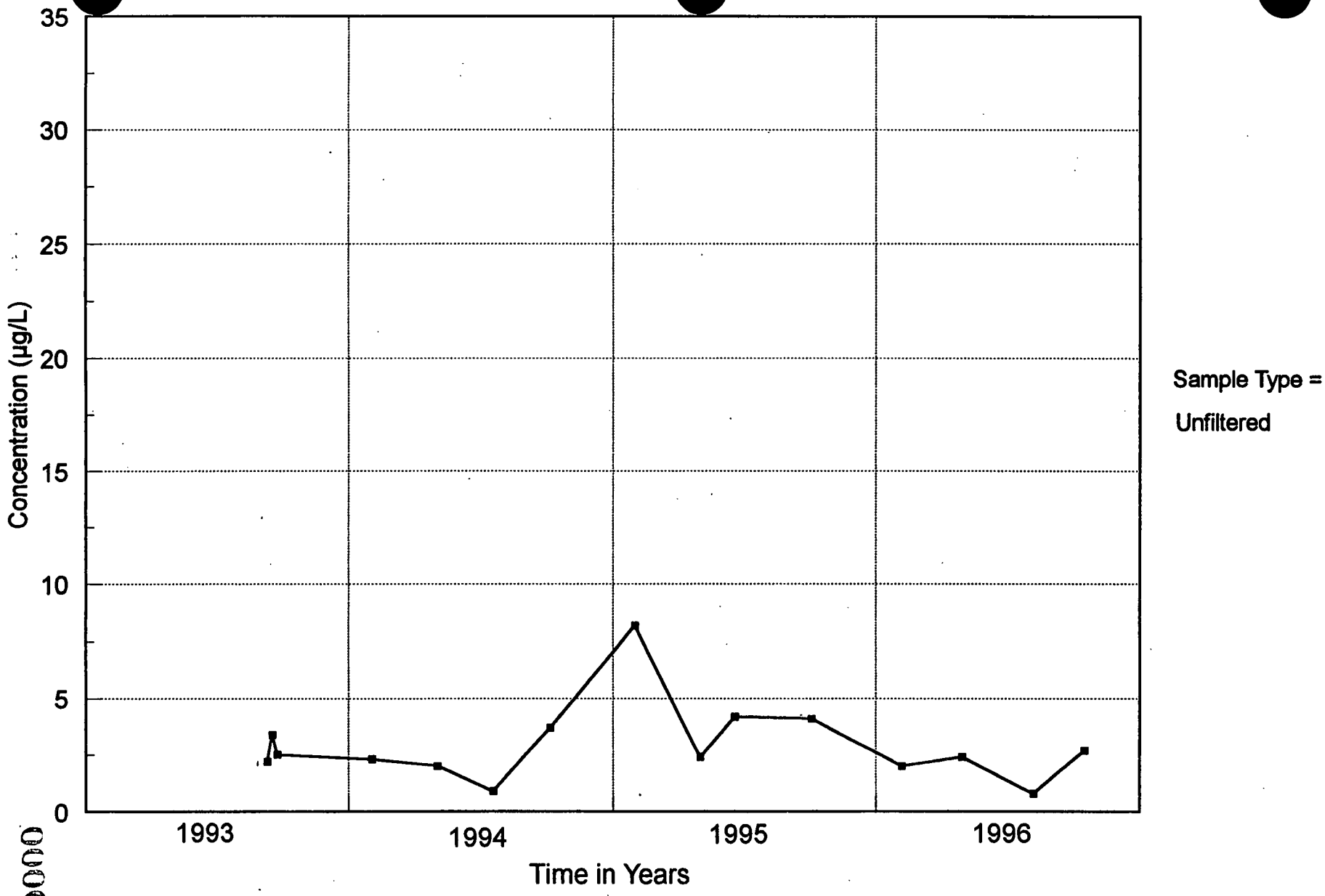


Monitoring Well 2553 Total Uranium Concentrations



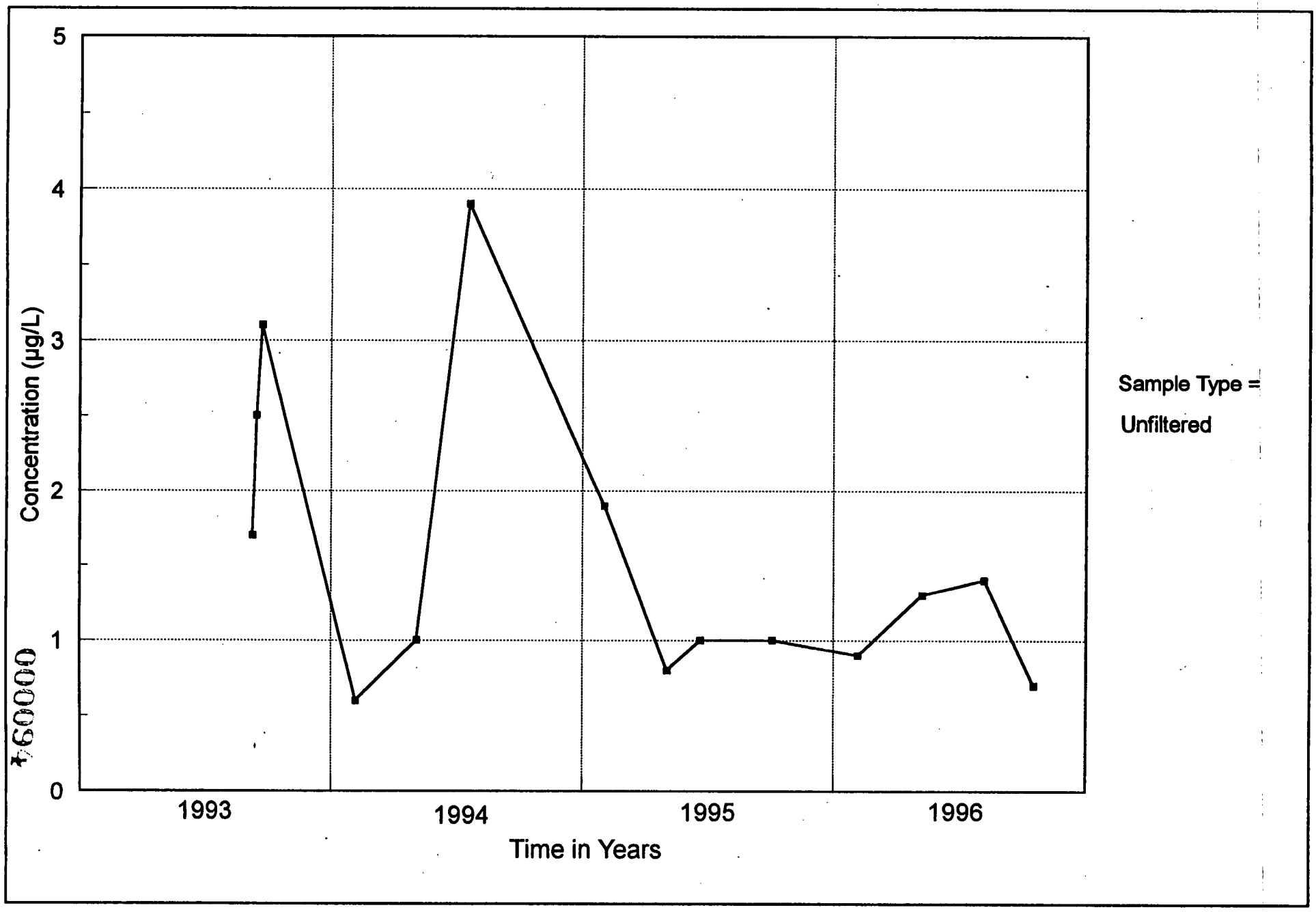
Monitoring Well 2624 Total Uranium Concentrations

260092



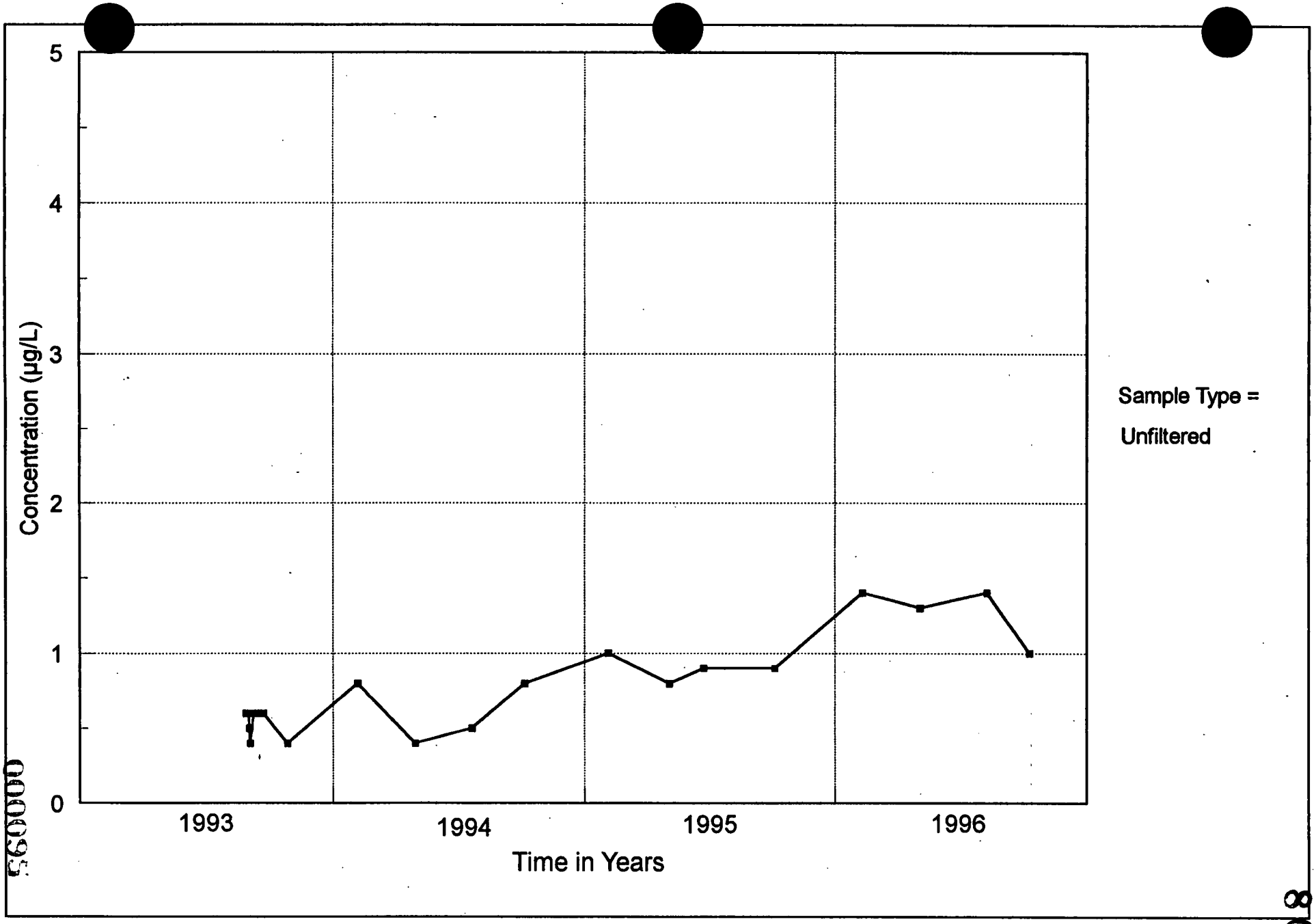
Monitoring Well 2625 Total Uranium Concentrations

000095

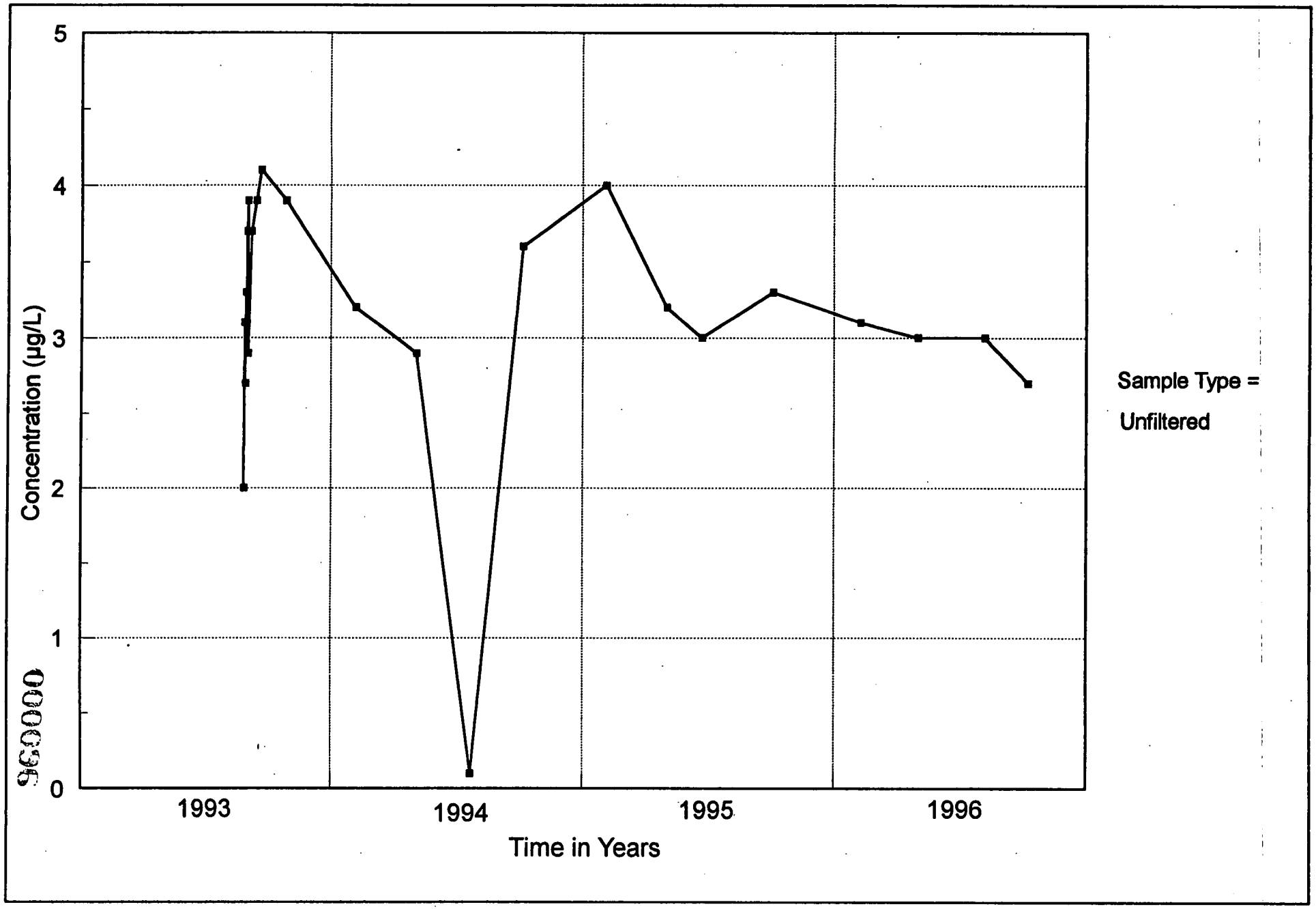


Monitoring Well 2636 Total Uranium Concentrations

460000

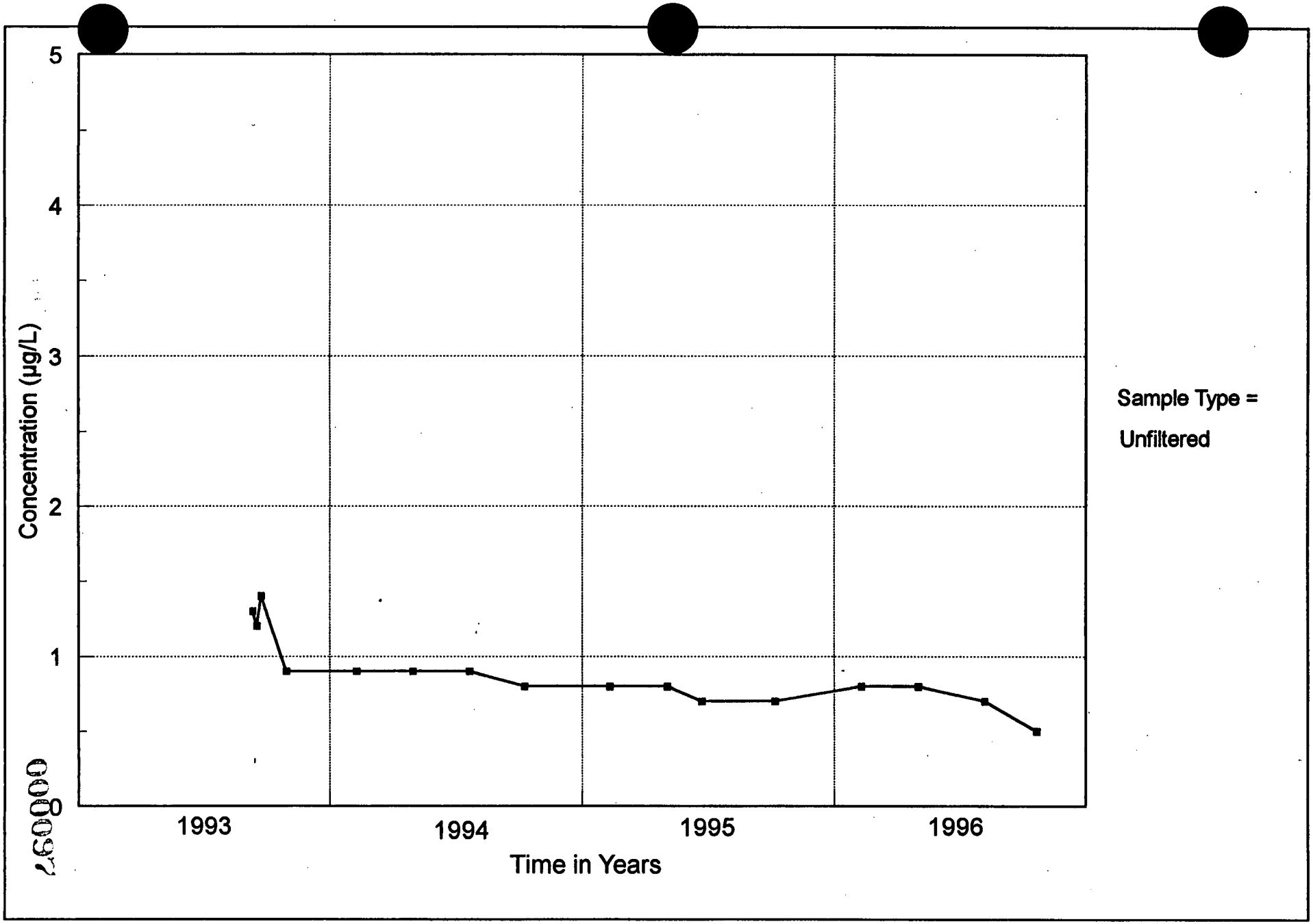


Monitoring Well 2880 Total Uranium Concentrations

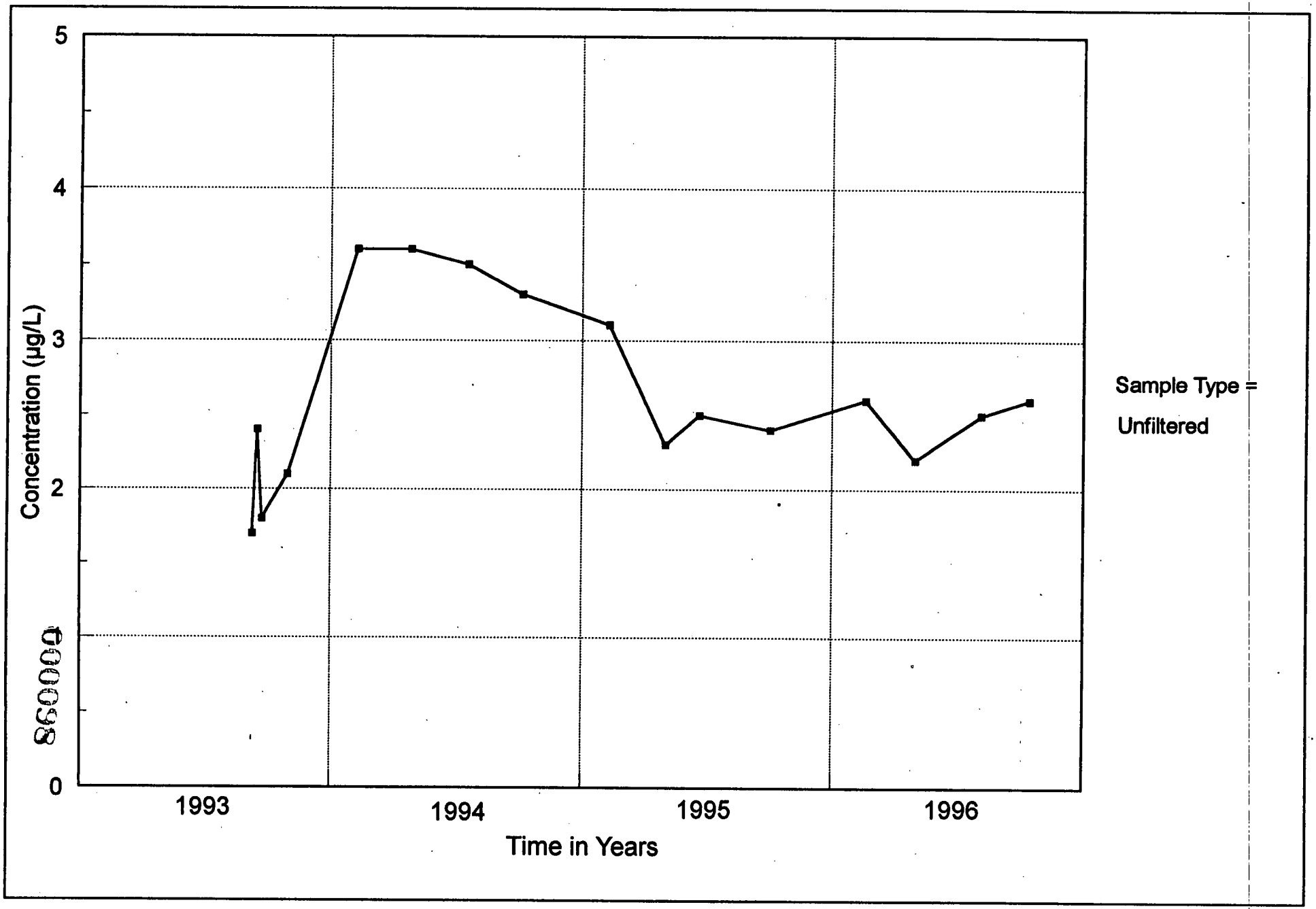


Monitoring Well 2881 Total Uranium Concentrations

960000

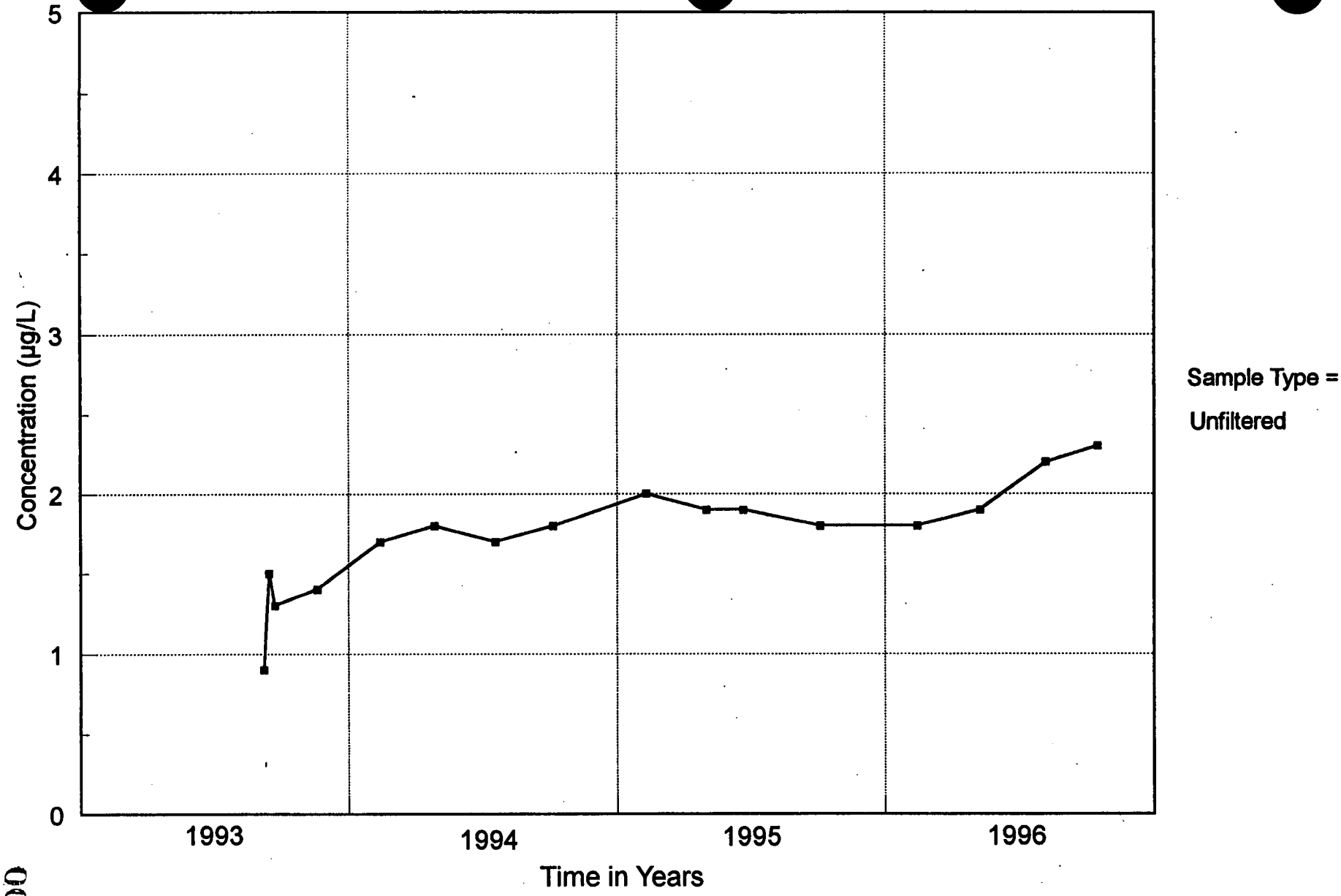


Monitoring Well 2897 Total Uranium Concentrations

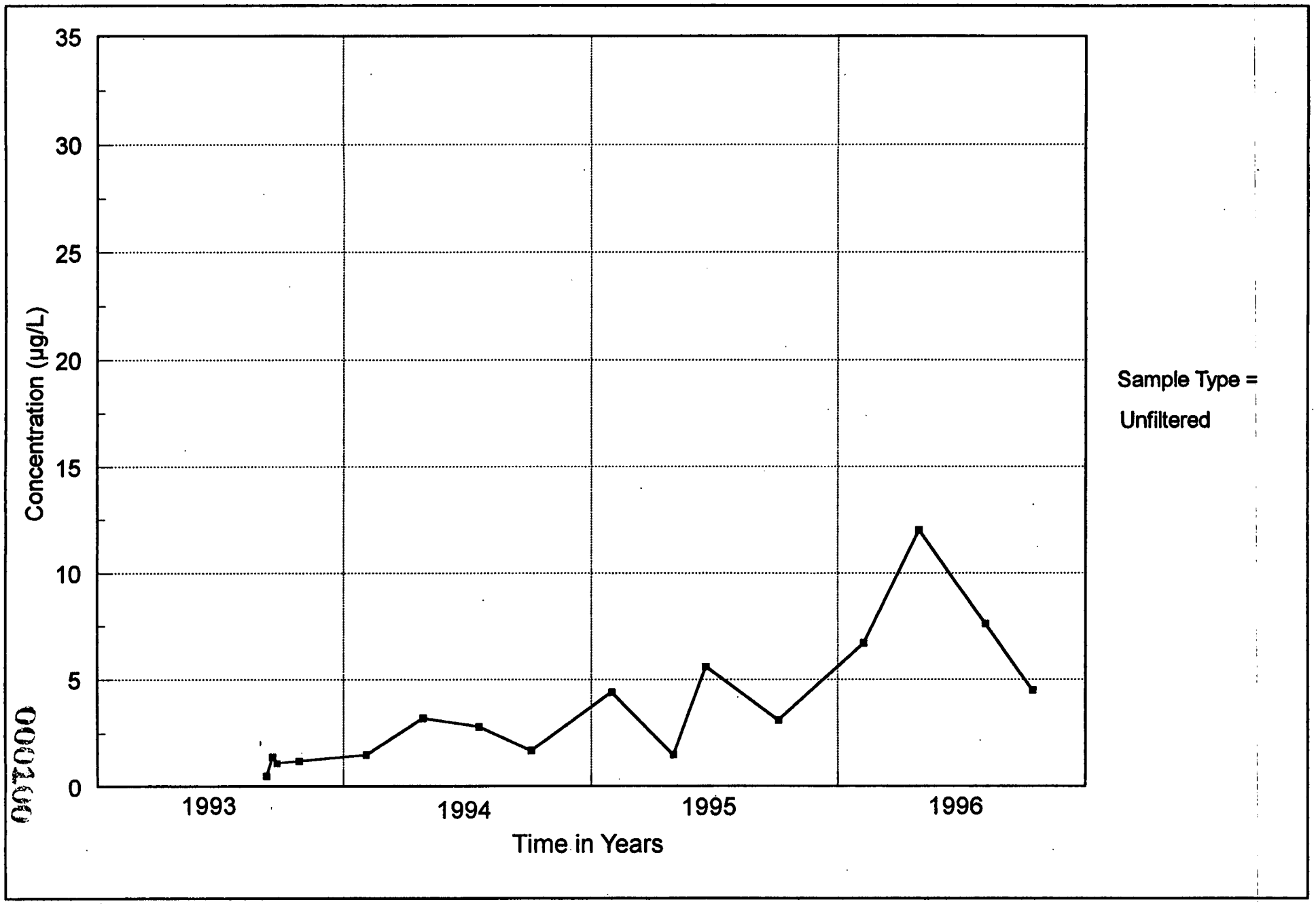


Monitoring Well 2898 Total Uranium Concentrations

000098

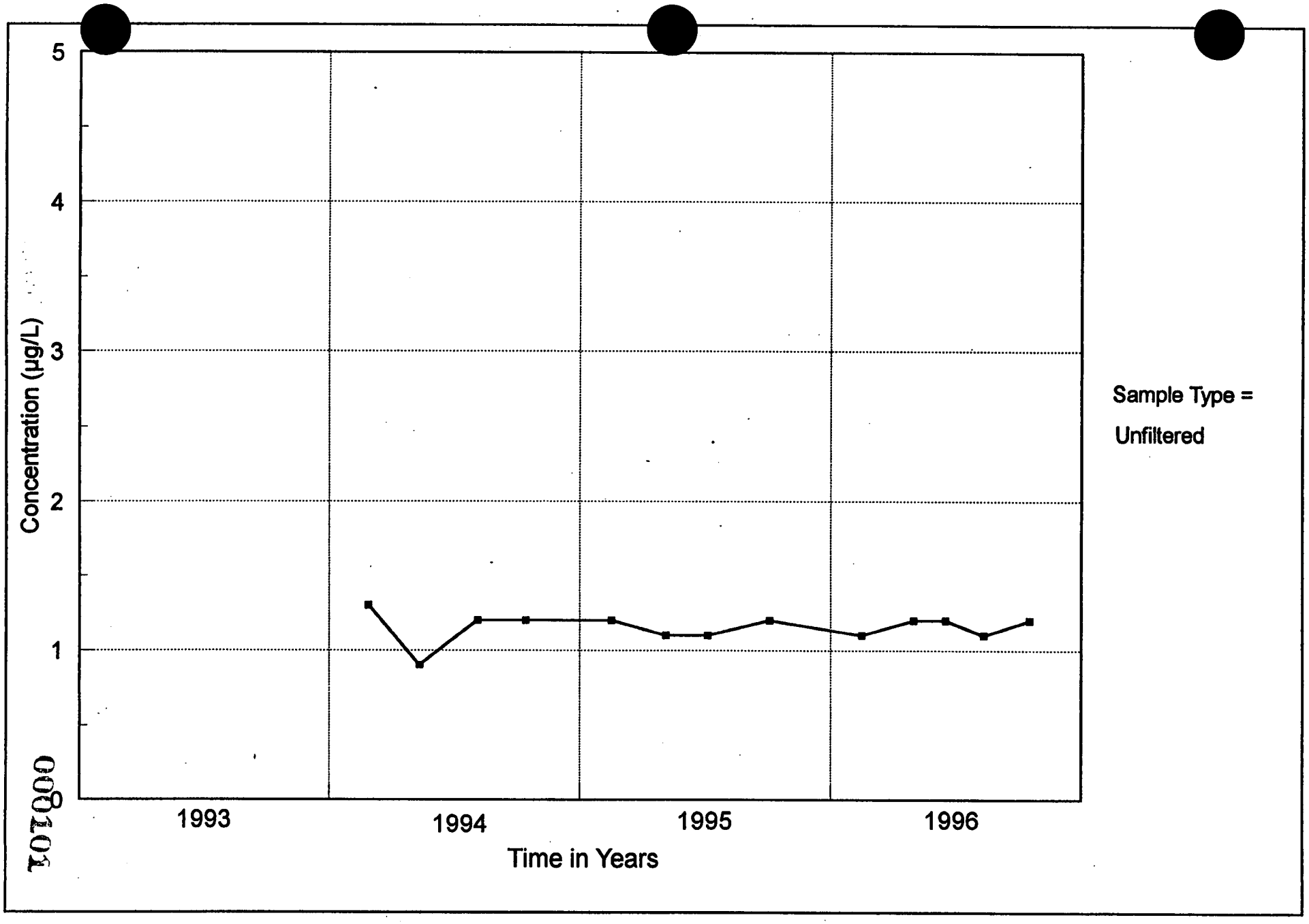


Monitoring Well 2899 Total Uranium Concentrations



Monitoring Well 2900 Total Uranium Concentrations

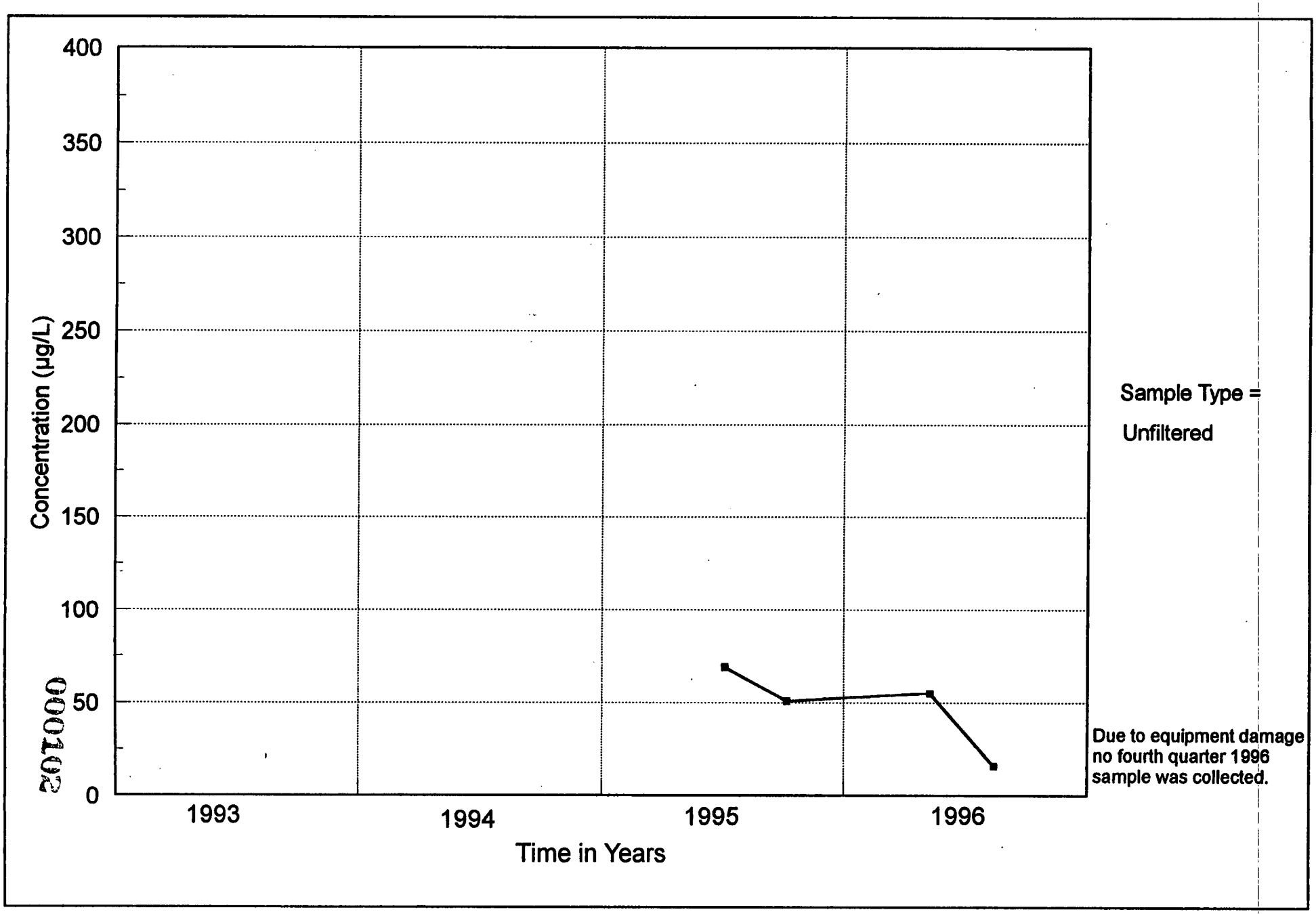
000200



Monitoring Well 3015 Total Uranium Concentrations

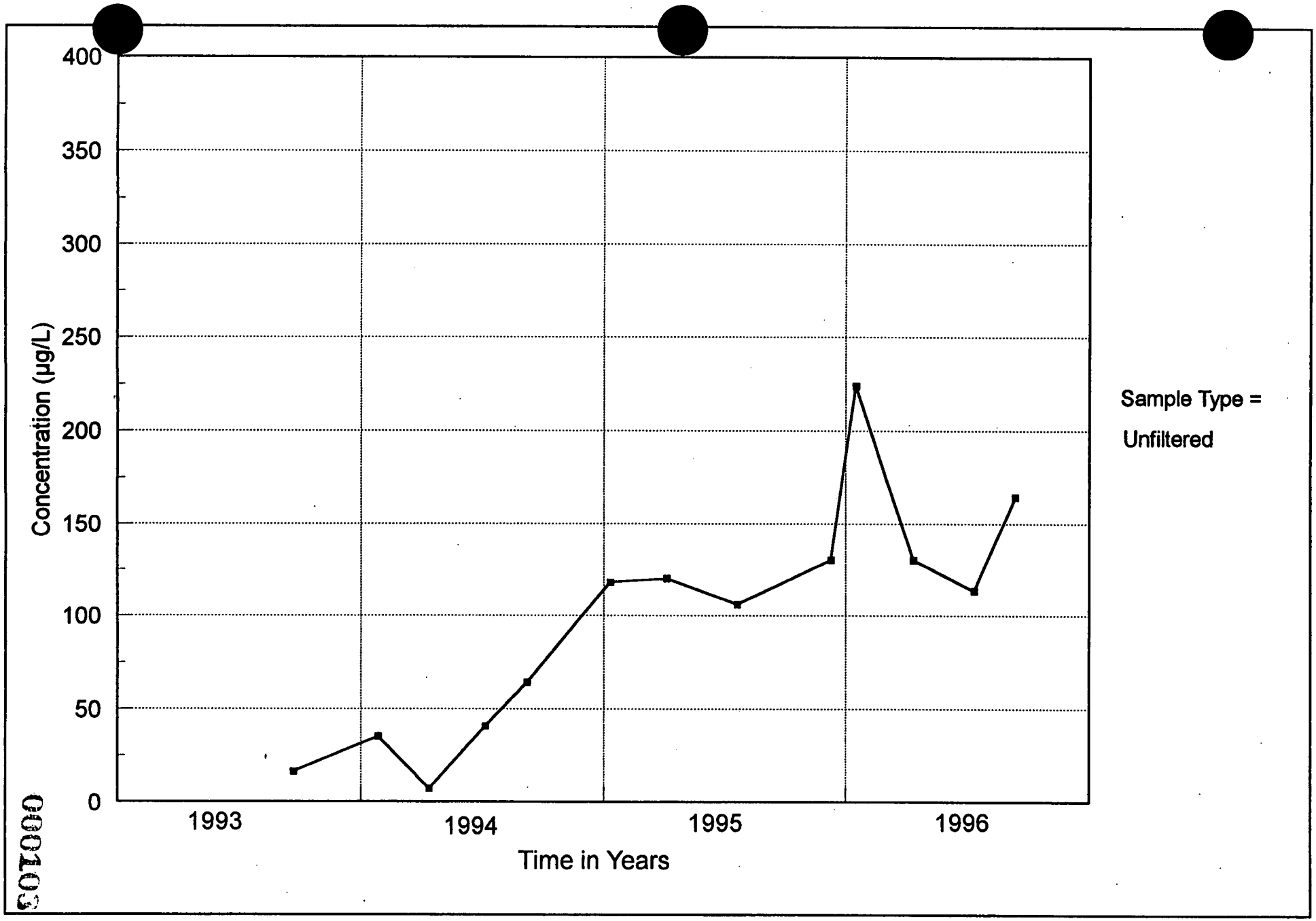
000101

80 16



Monitoring Well 3062 Total Uranium Concentrations

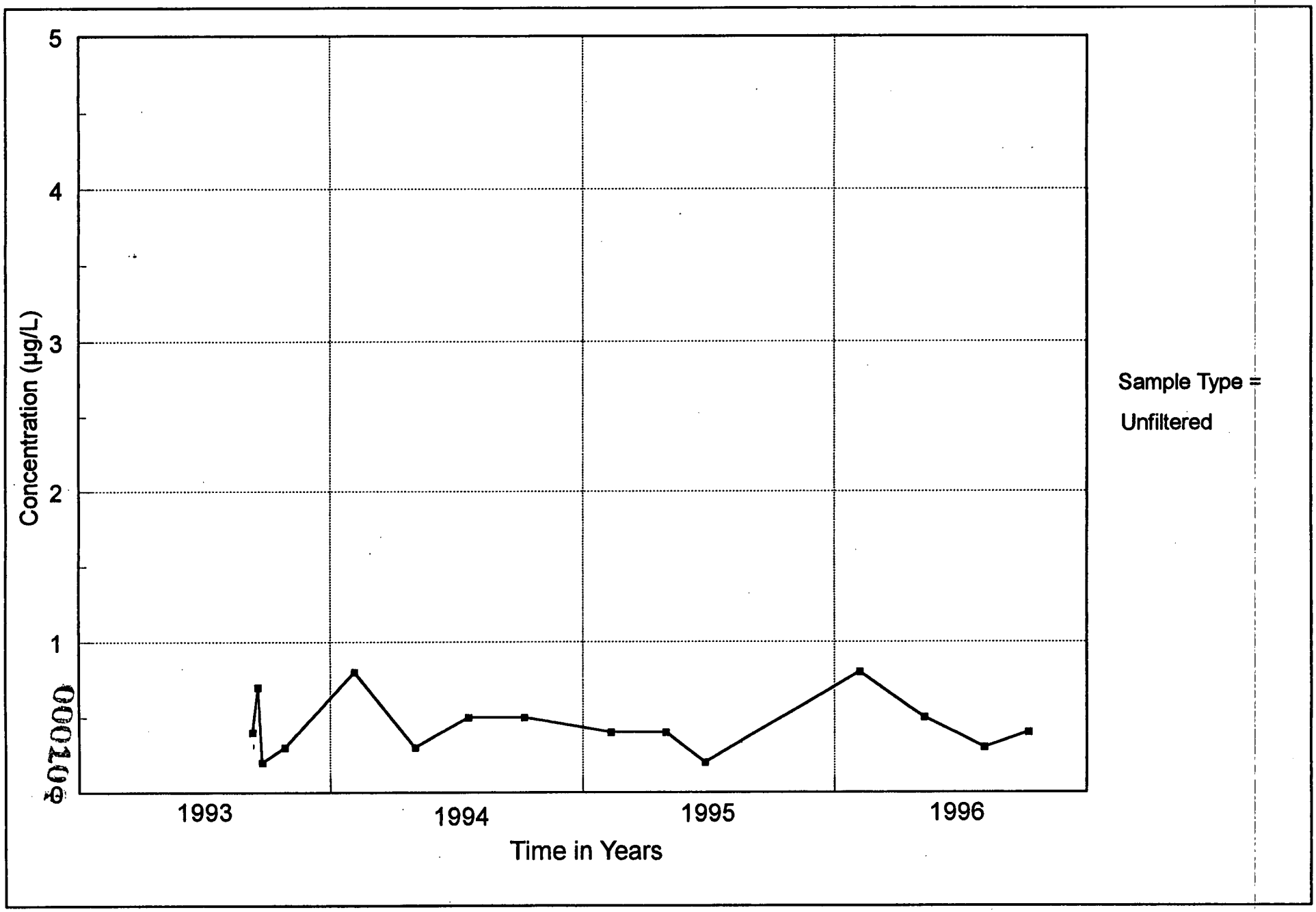
201000



Monitoring Well 3069 Total Uranium Concentrations

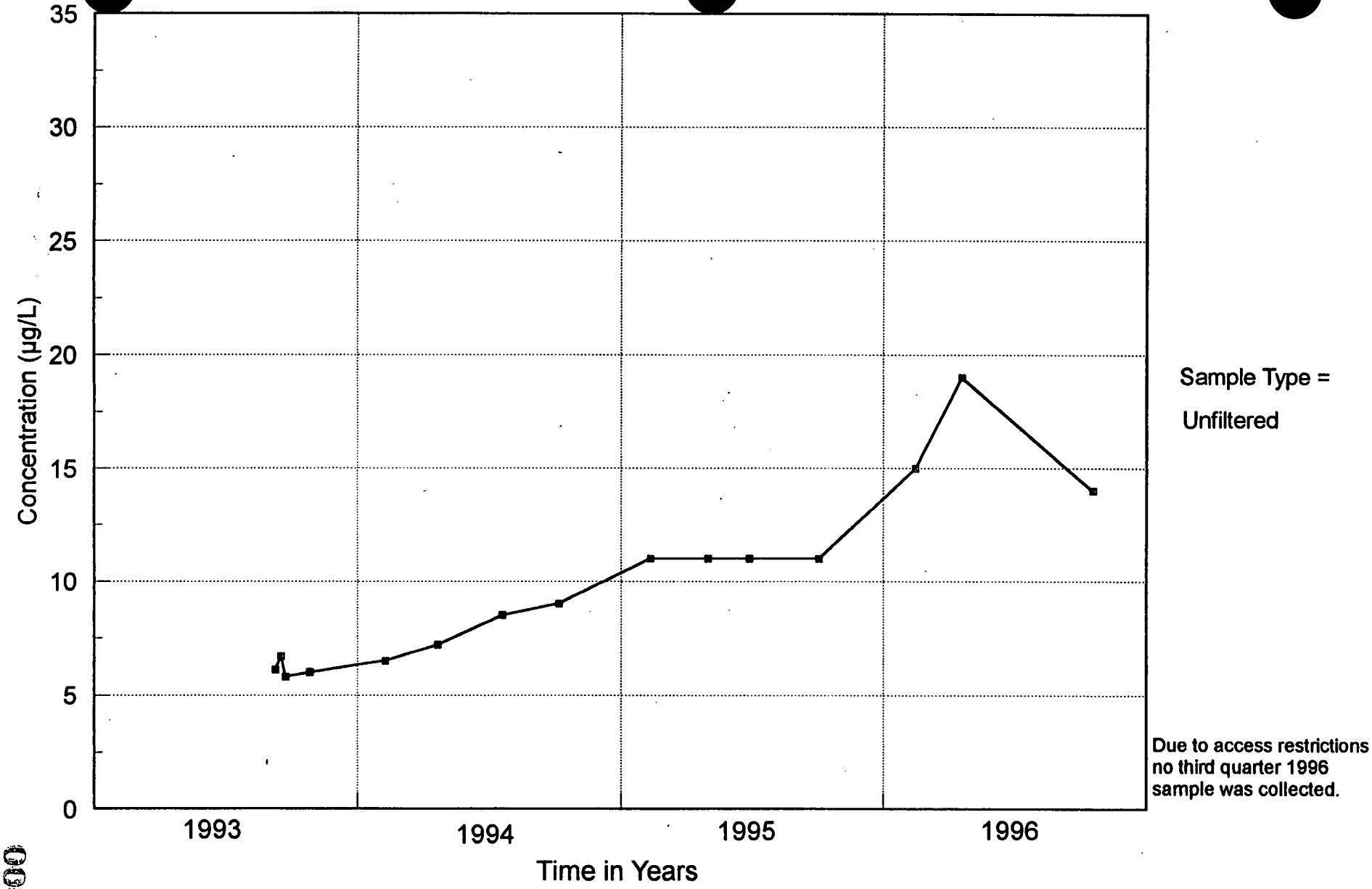
001003

8016



Monitoring Well 3093 Total Uranium Concentrations

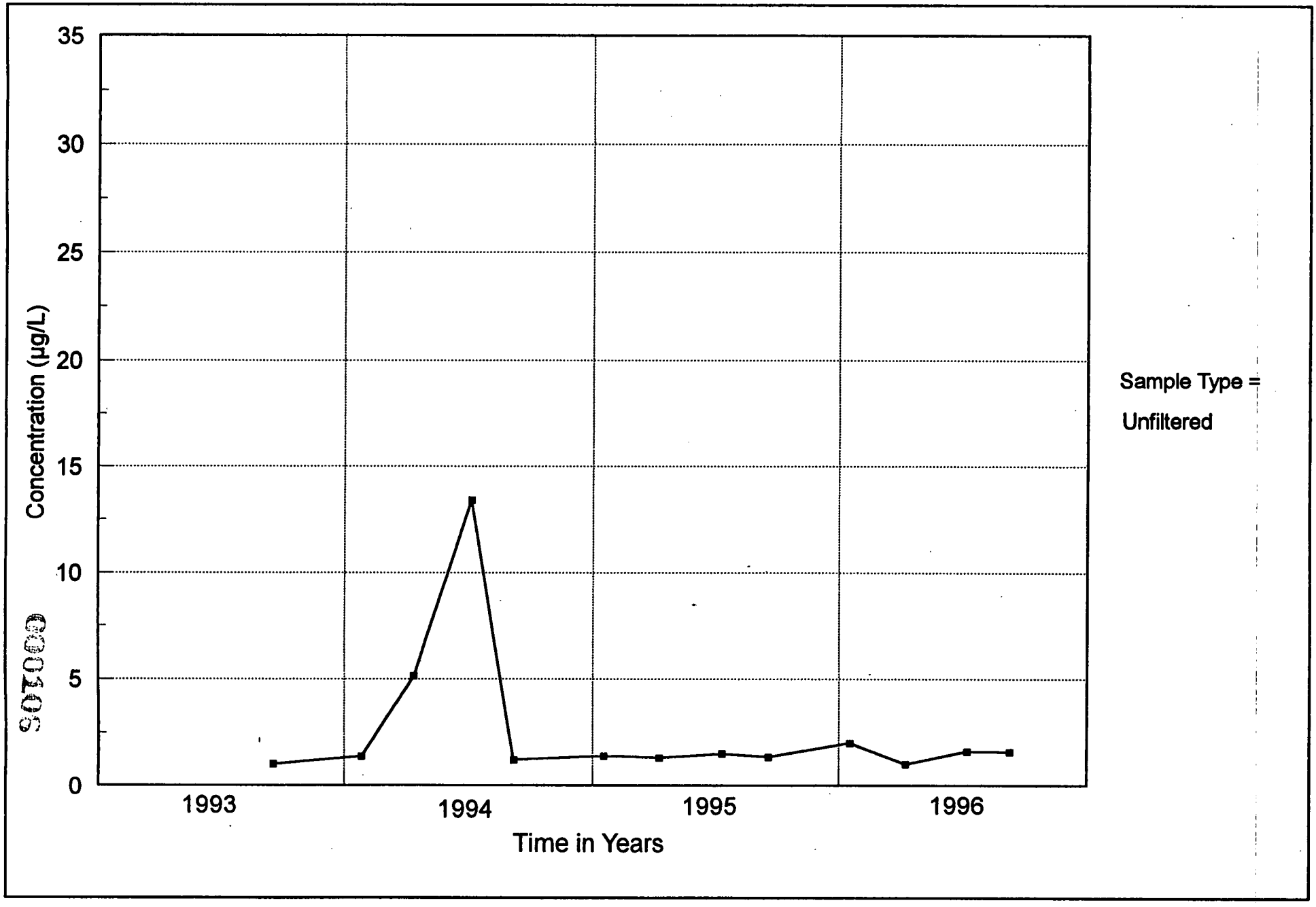
000106



Monitoring Well 3095 Total Uranium Concentrations

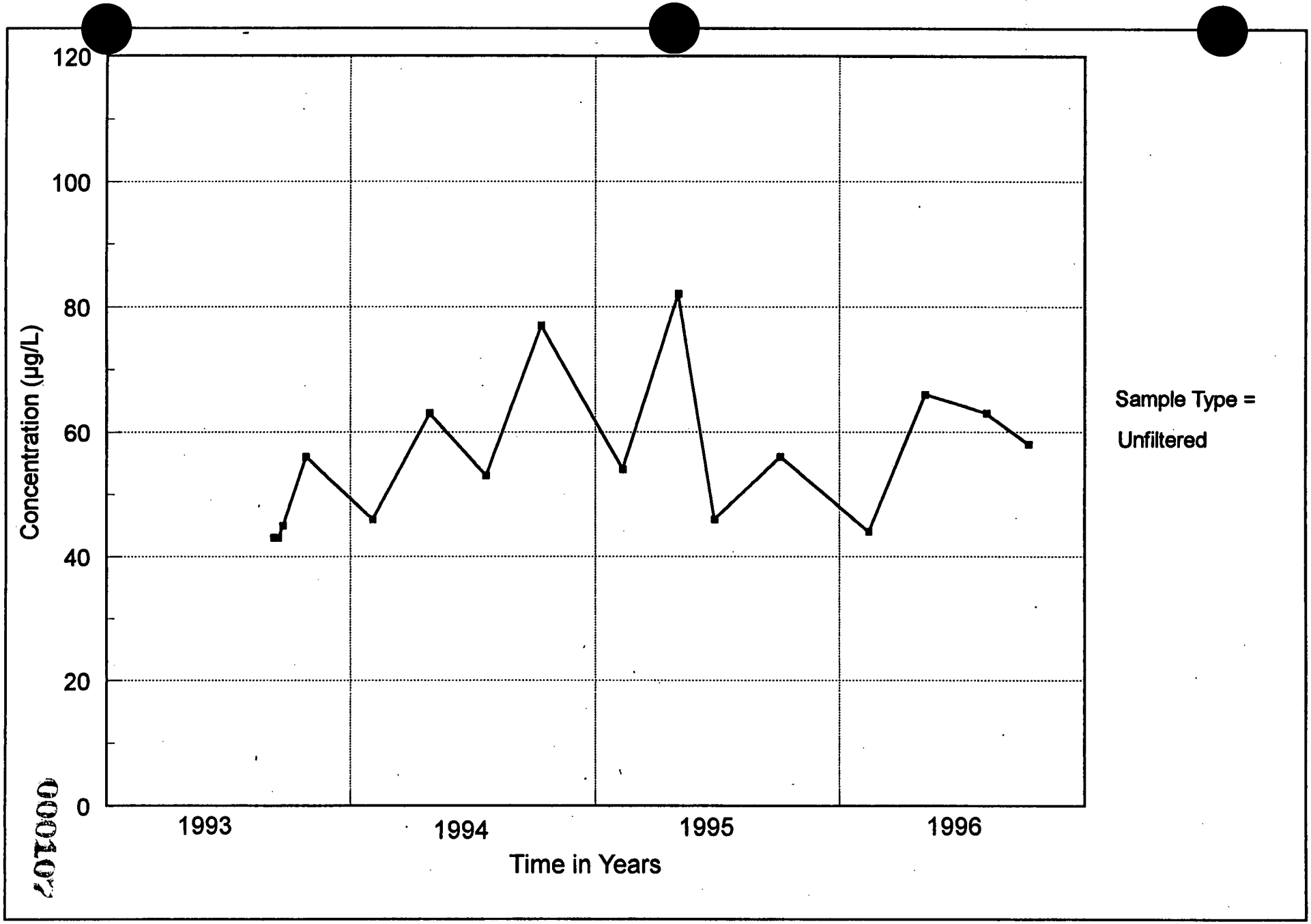
000103

8016



Monitoring Well 3106 Total Uranium Concentrations

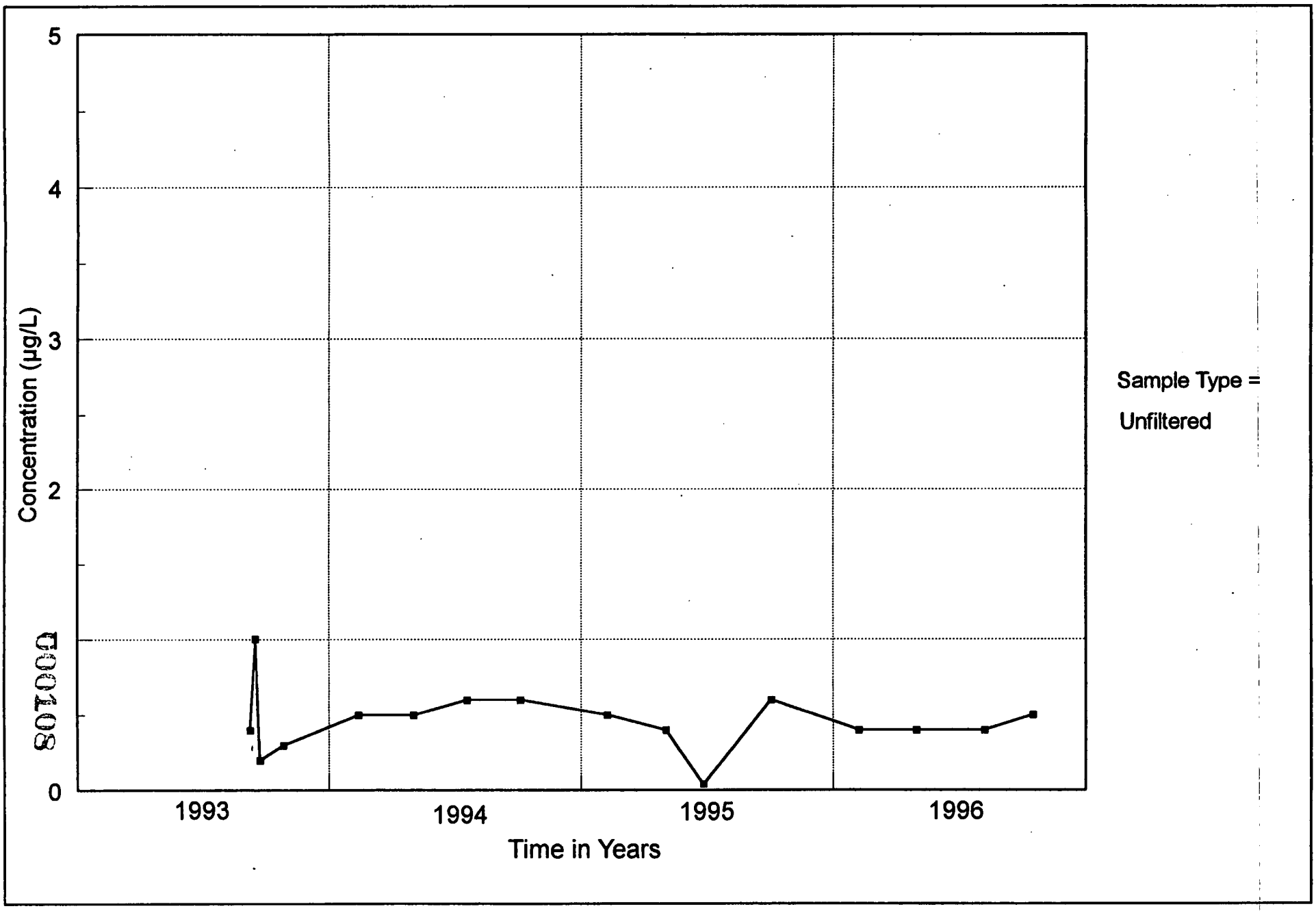
000106



Monitoring Well 3125 Total Uranium Concentrations

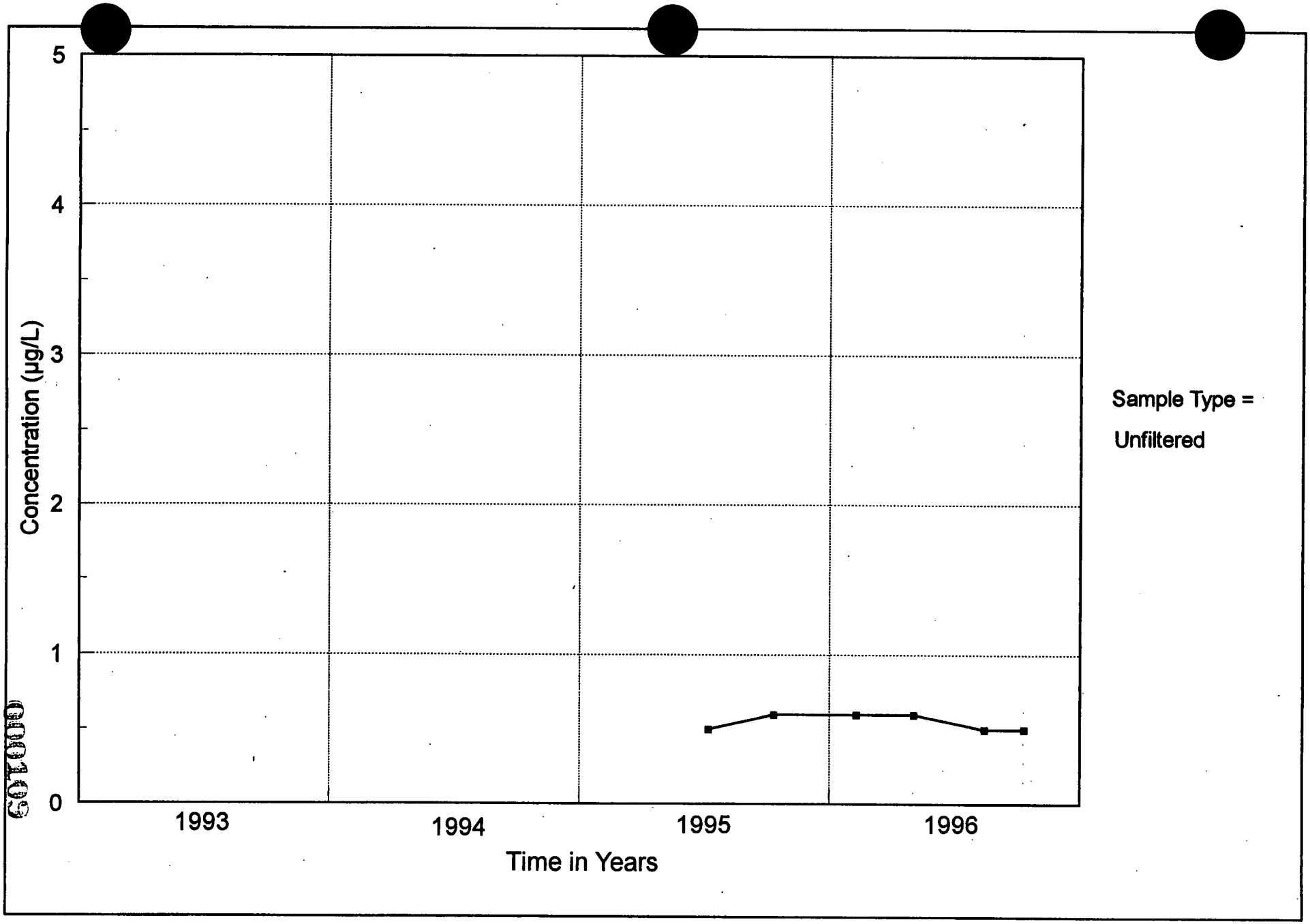
000107

8016



Monitoring Well 3128 Total Uranium Concentrations

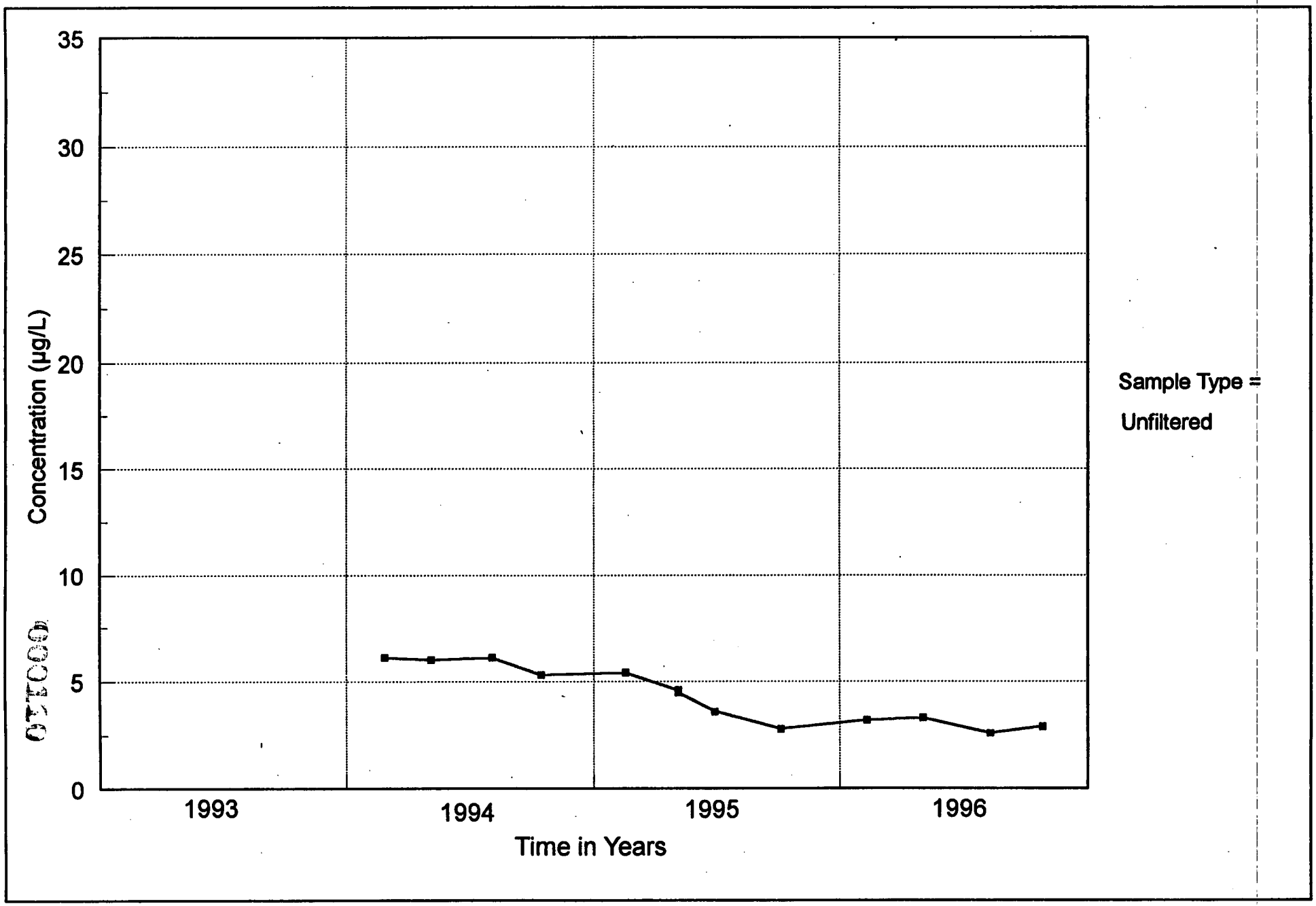
000108



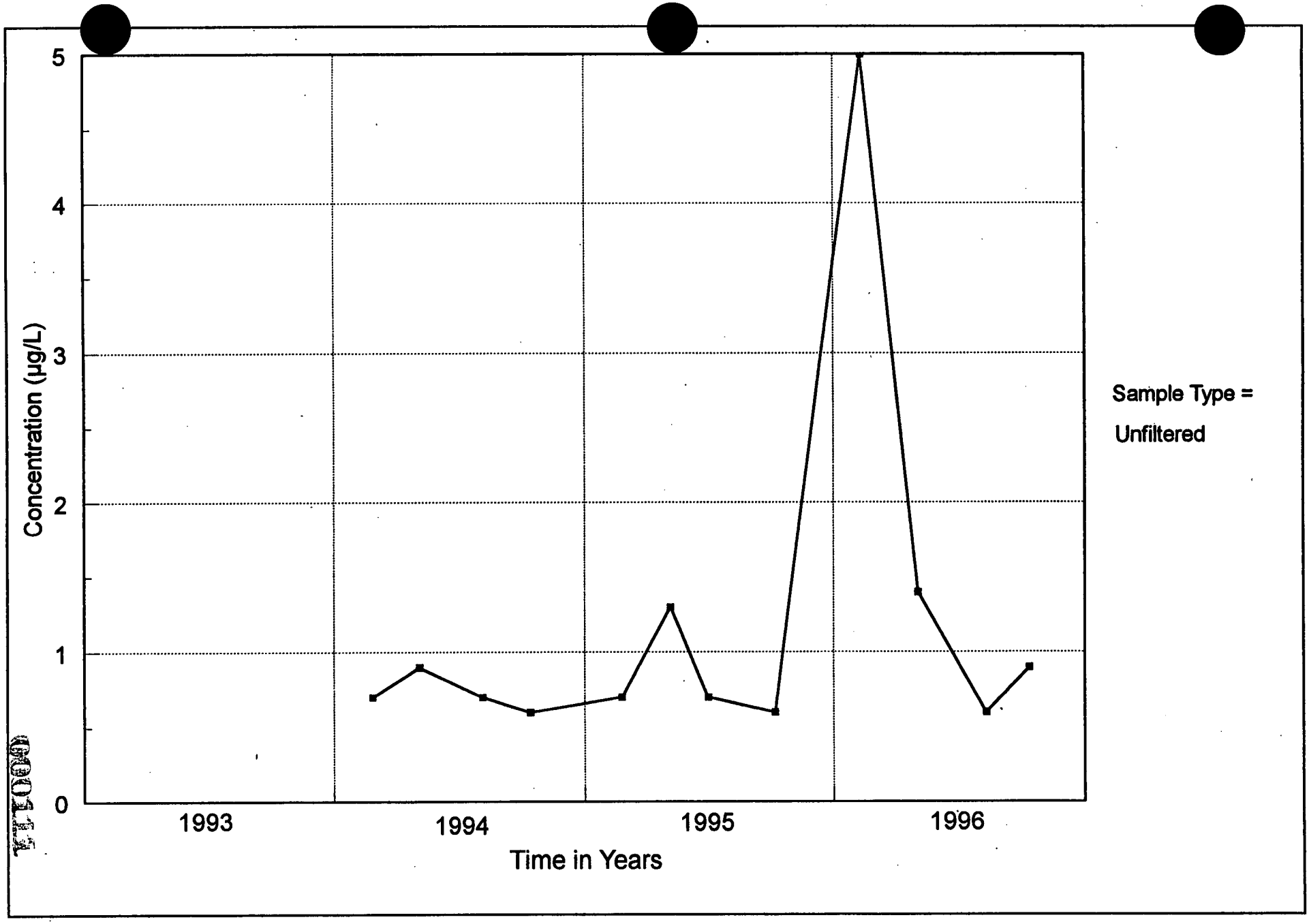
Monitoring Well 3396 Total Uranium Concentrations

G0100G

80 16



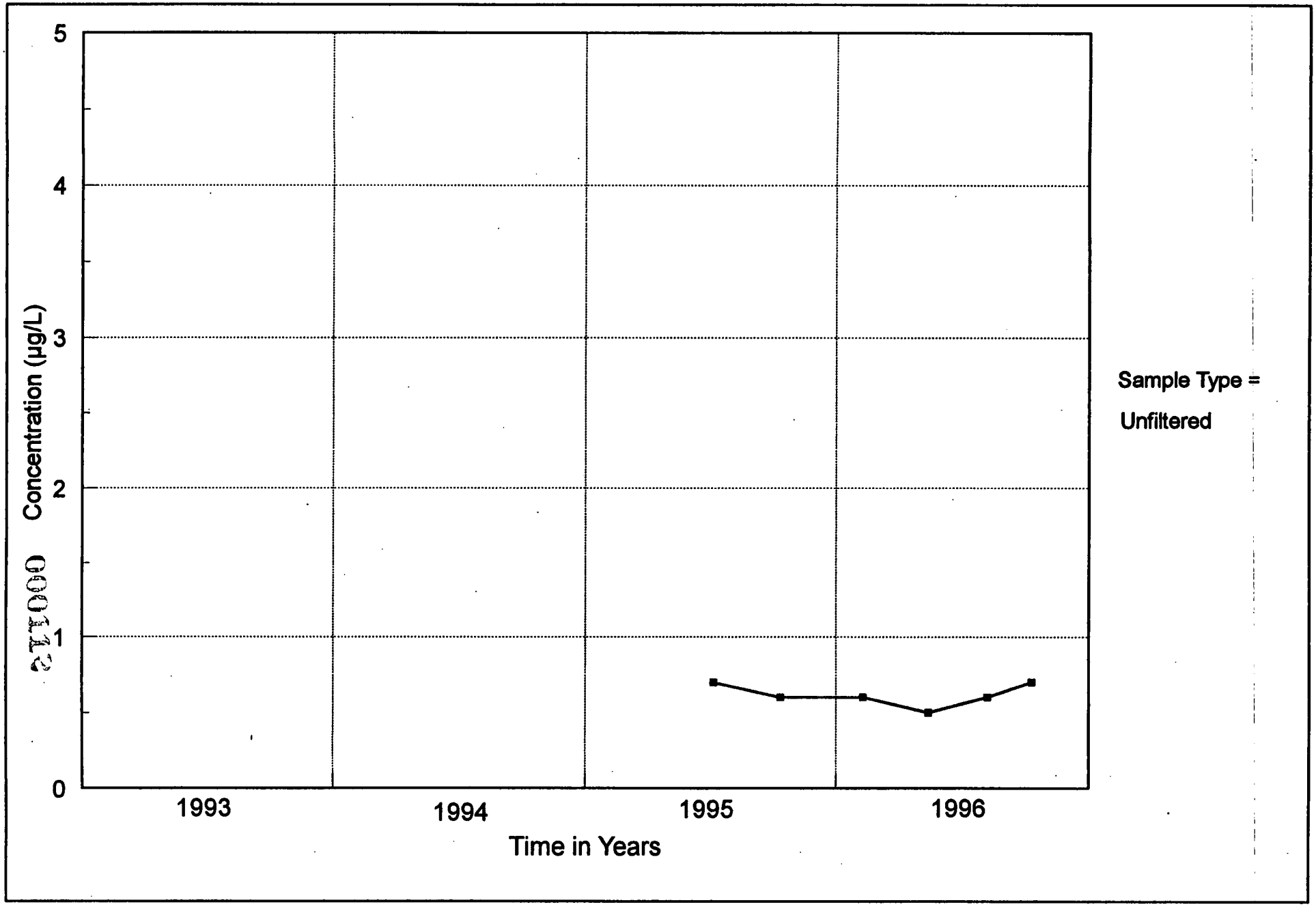
Monitoring Well 3550 Total Uranium Concentrations



Monitoring Well 3551 Total Uranium Concentrations

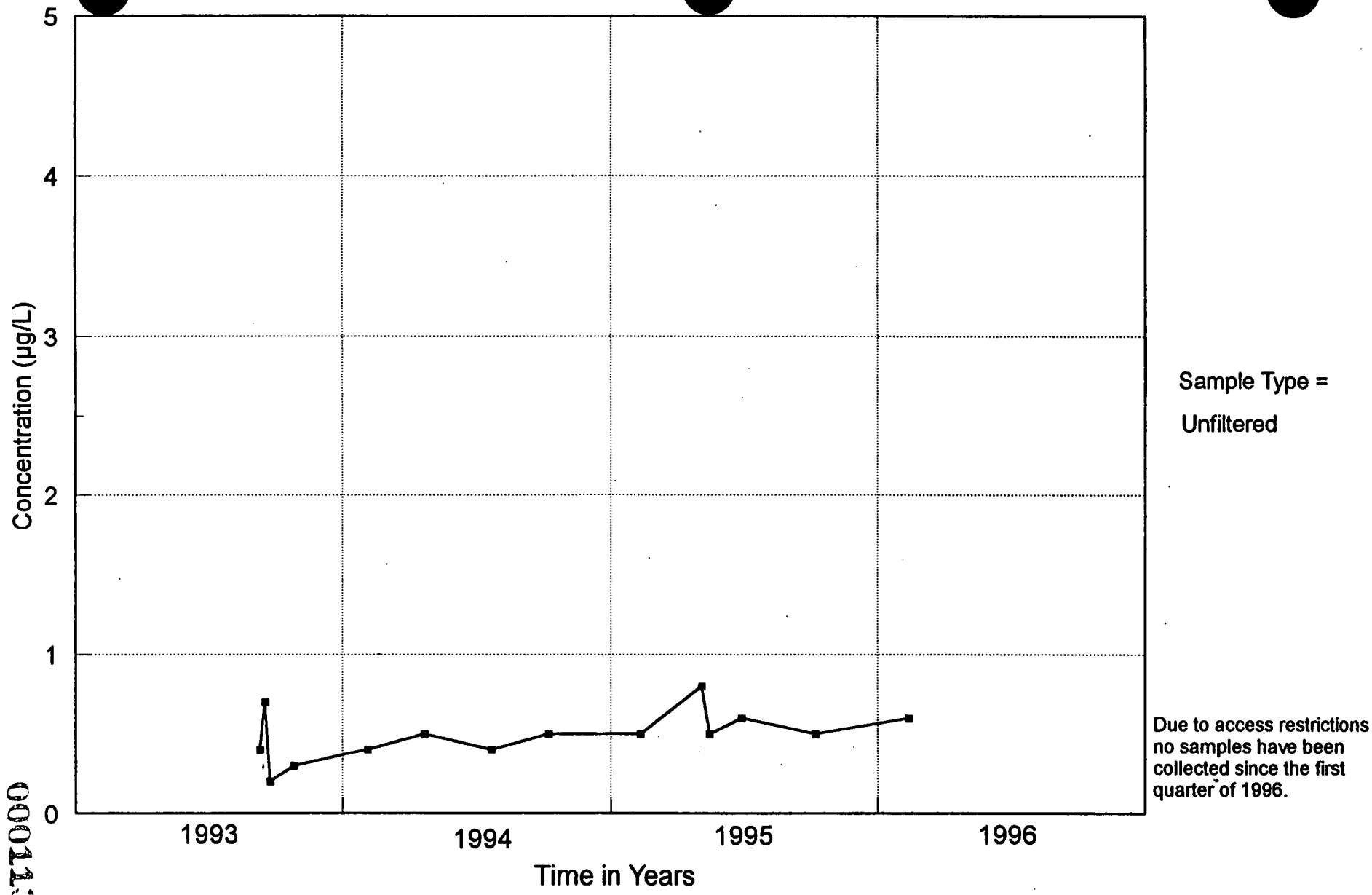
000144

8016



Monitoring Well 3552 Total Uranium Concentrations

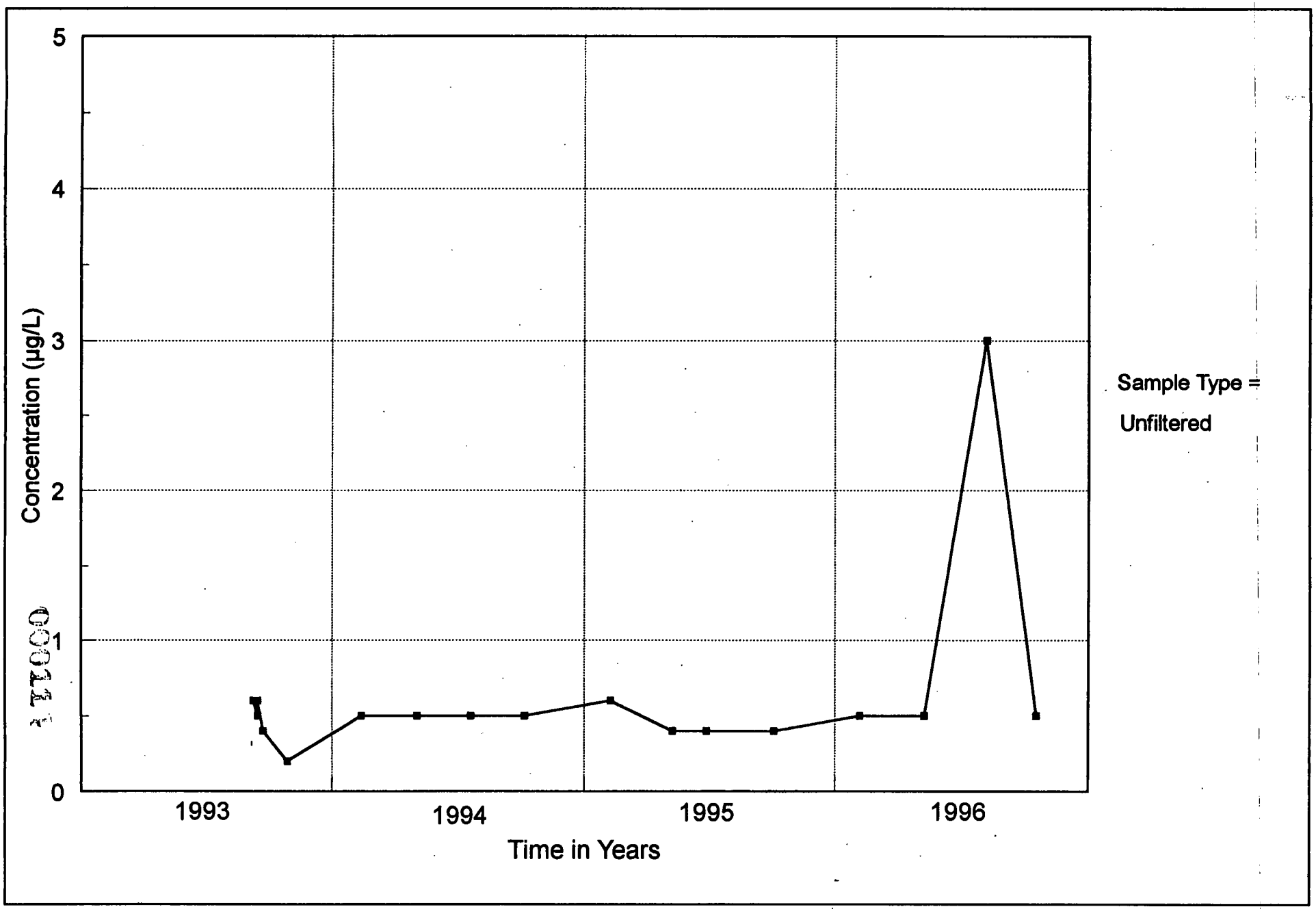
000112



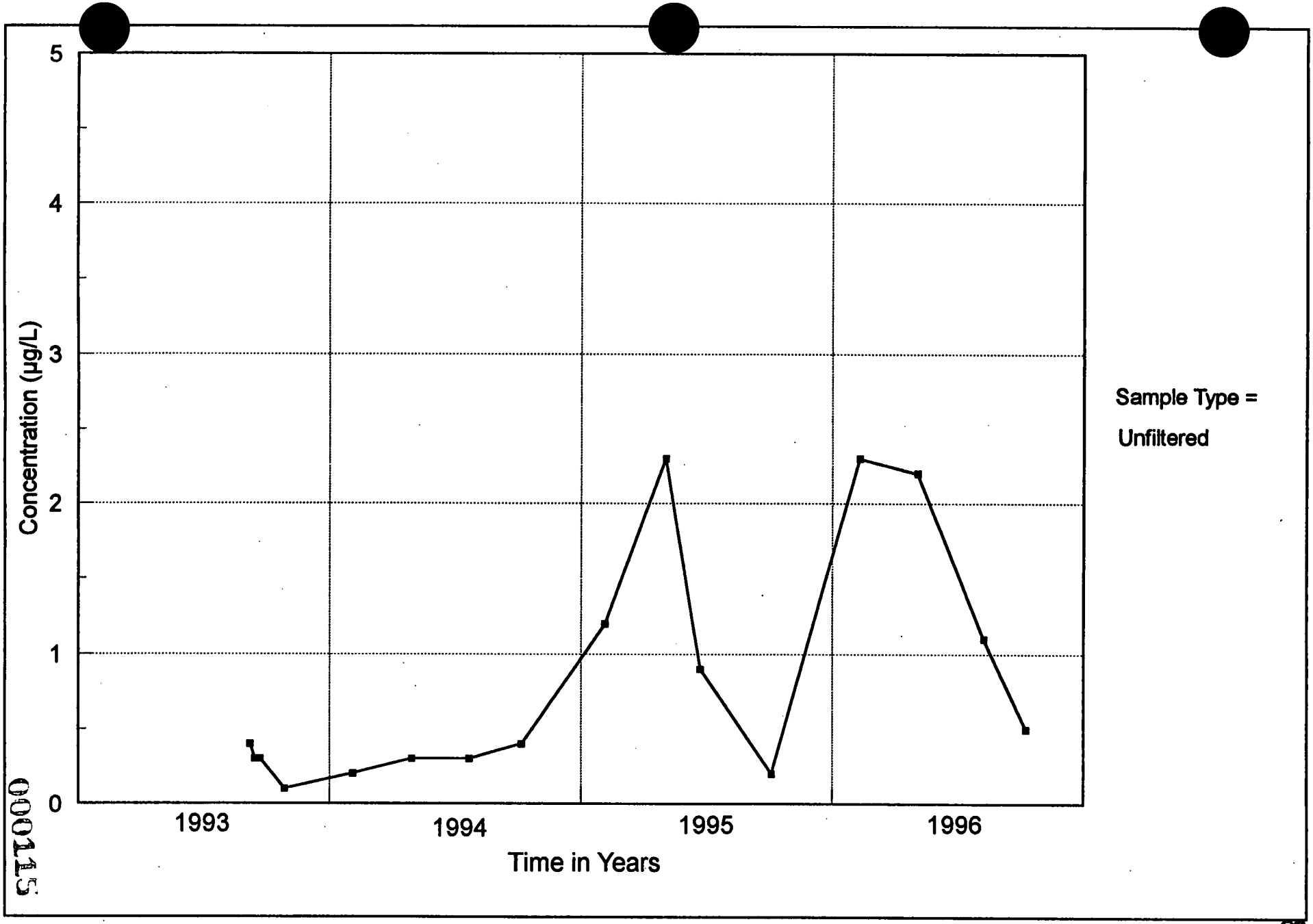
Monitoring Well 3624 Total Uranium Concentrations

000113

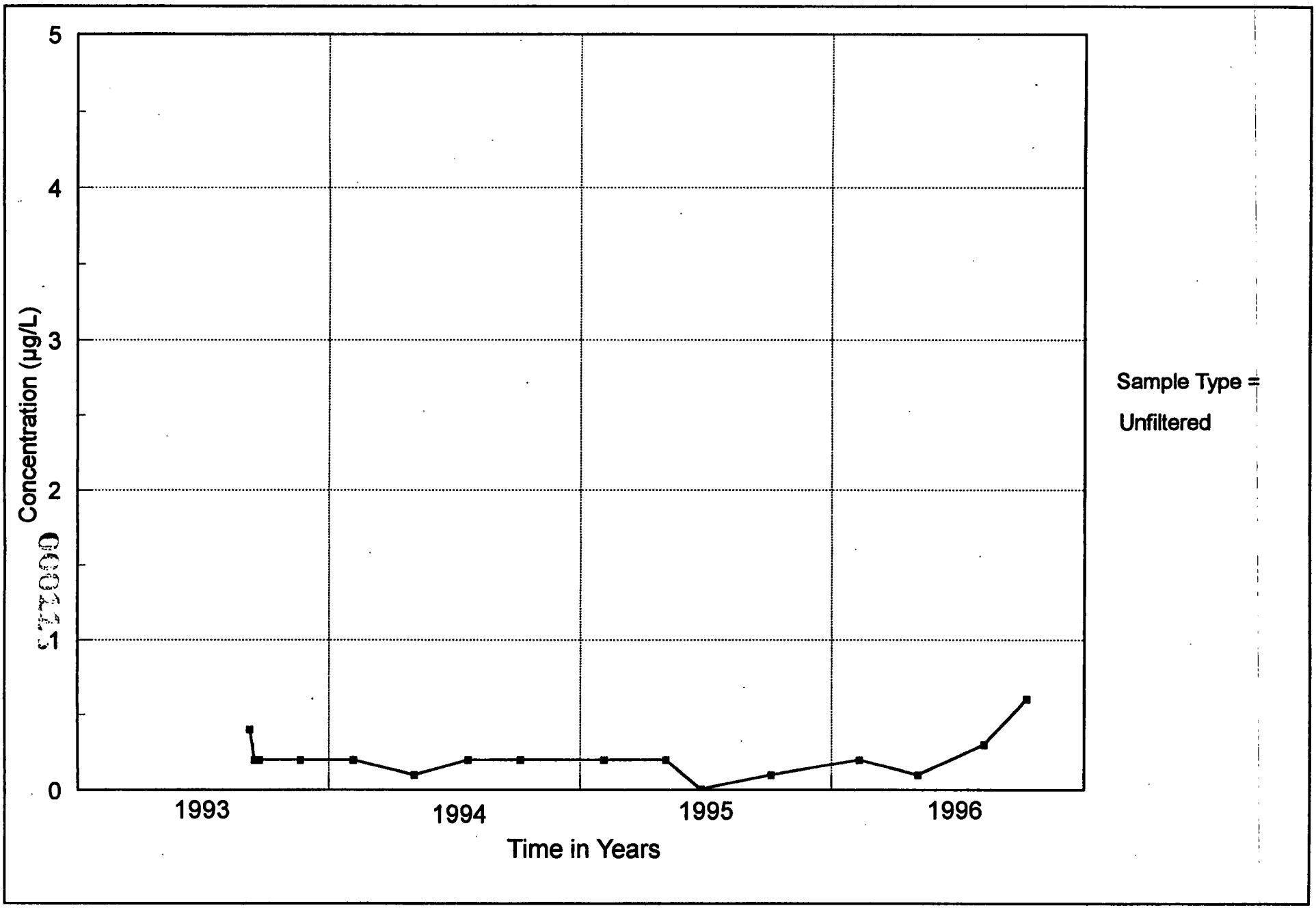
8016



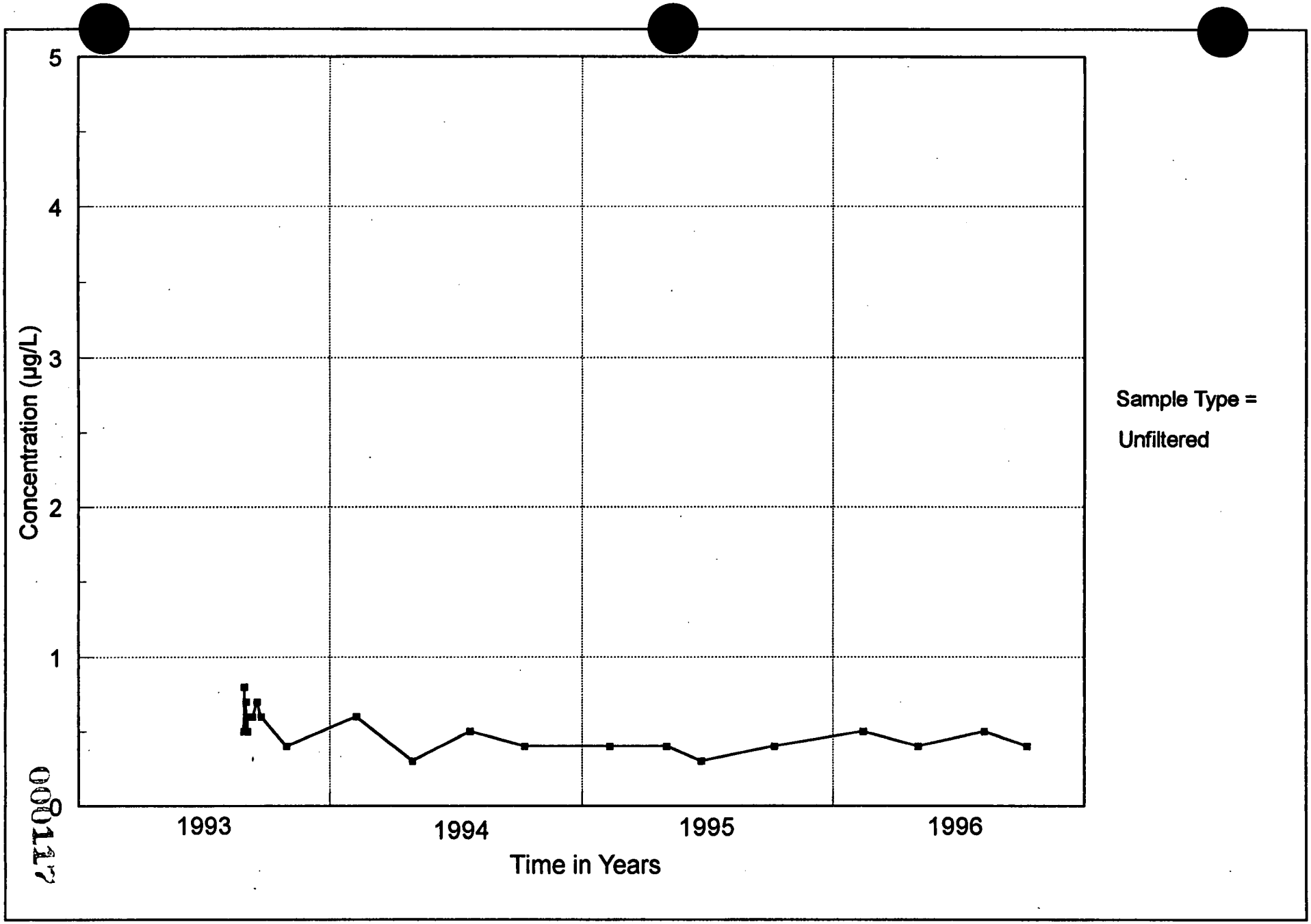
Monitoring Well 3636 Total Uranium Concentrations



Monitoring Well 3880 Total Uranium Concentrations



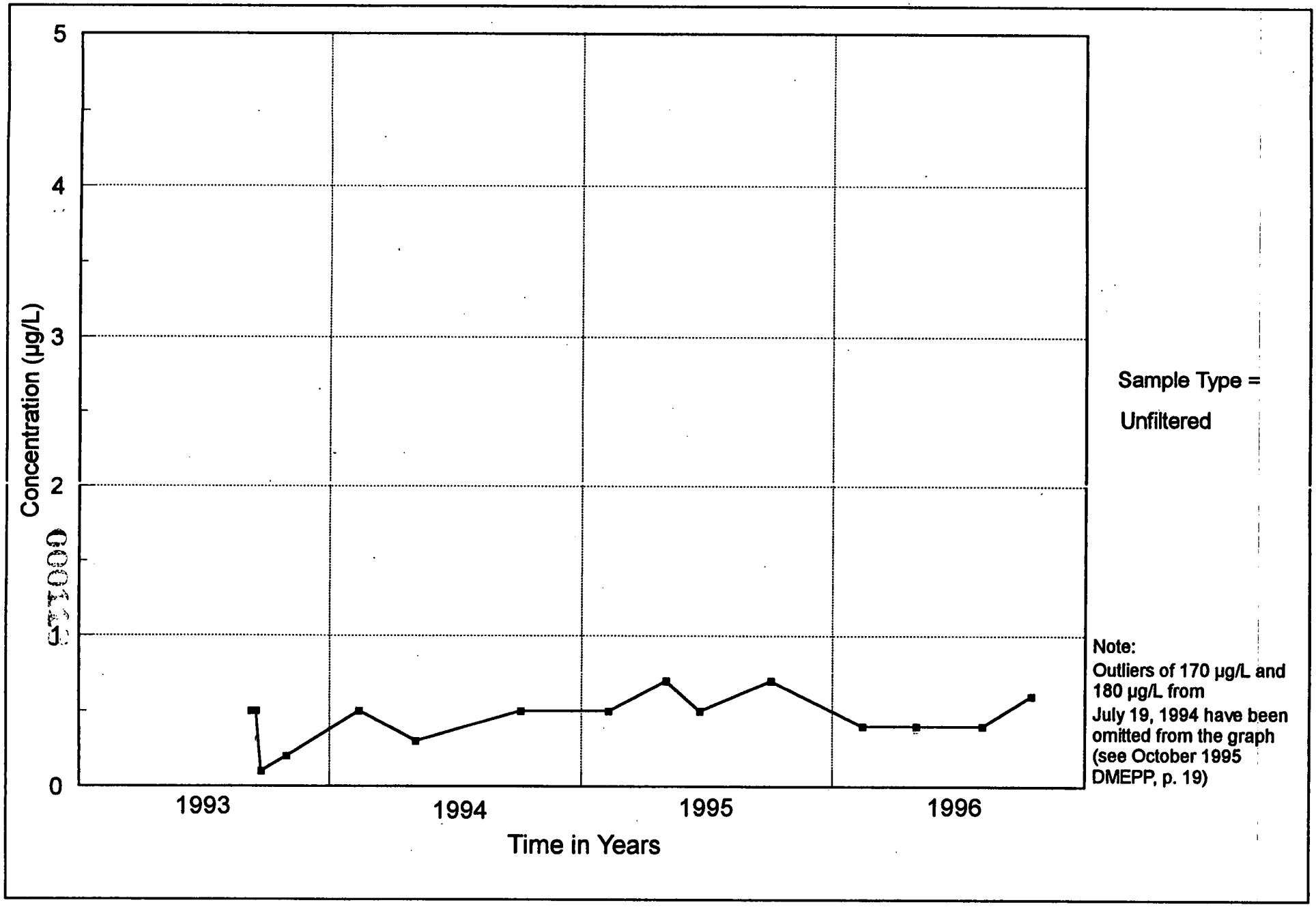
Monitoring Well 3881 Total Uranium Concentrations



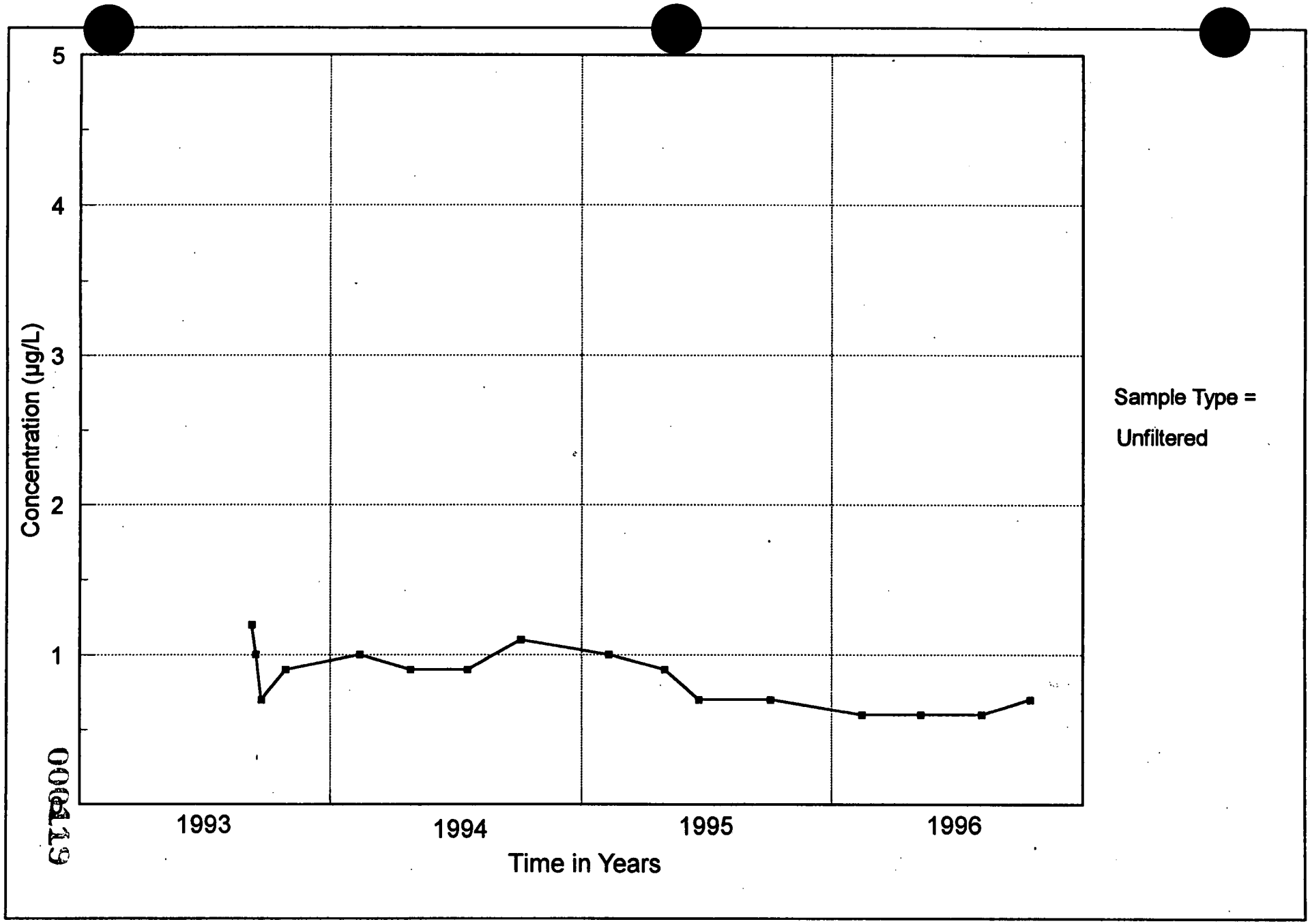
Monitoring Well 3897 Total Uranium Concentrations

000117

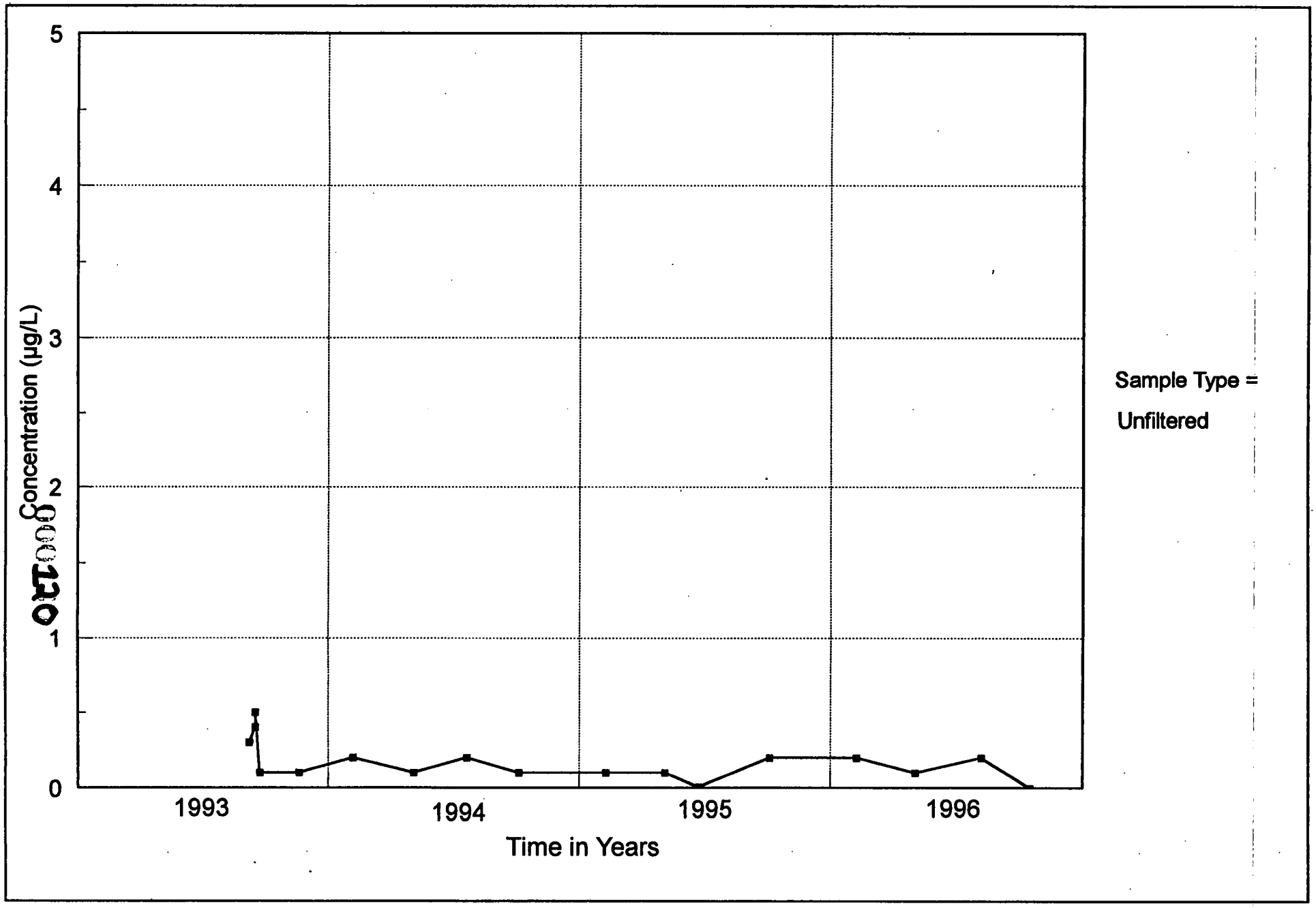
80 16



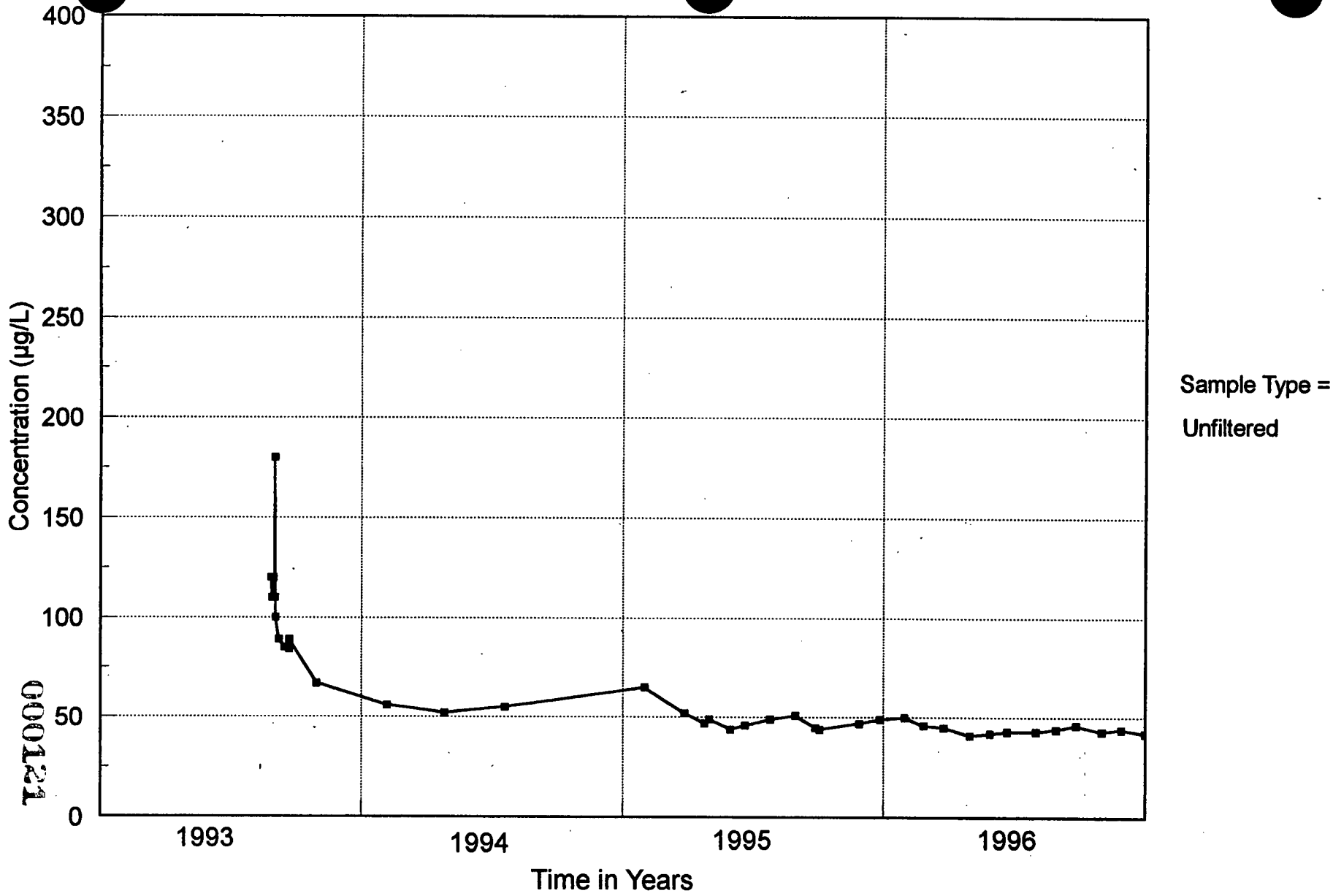
Monitoring Well 3898 Total Uranium Concentrations



Monitoring Well 3899 Total Uranium Concentrations



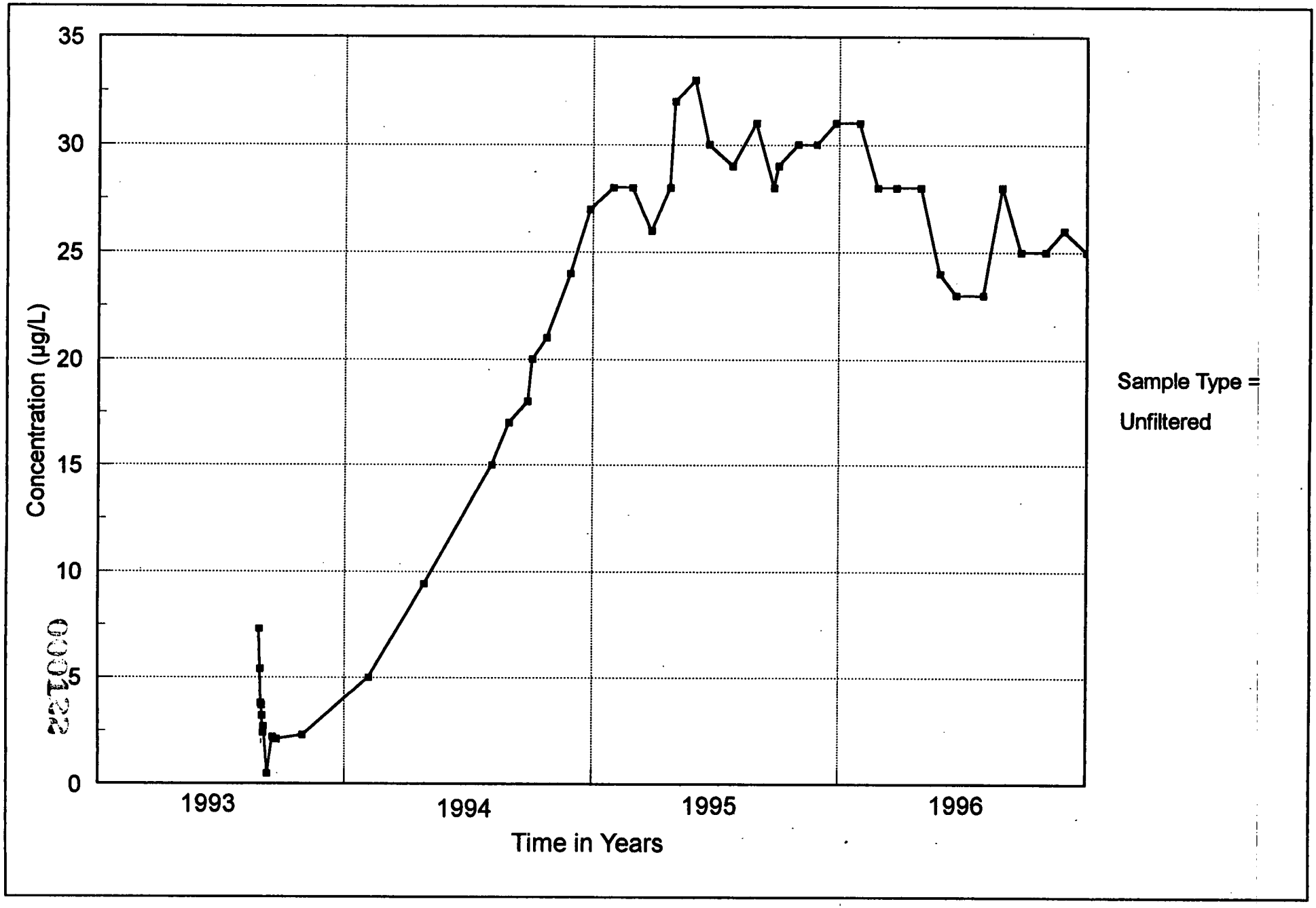
Monitoring Well 3900 Total Uranium Concentrations



Monitoring Well 3924 (RW-1) Total Uranium Concentrations

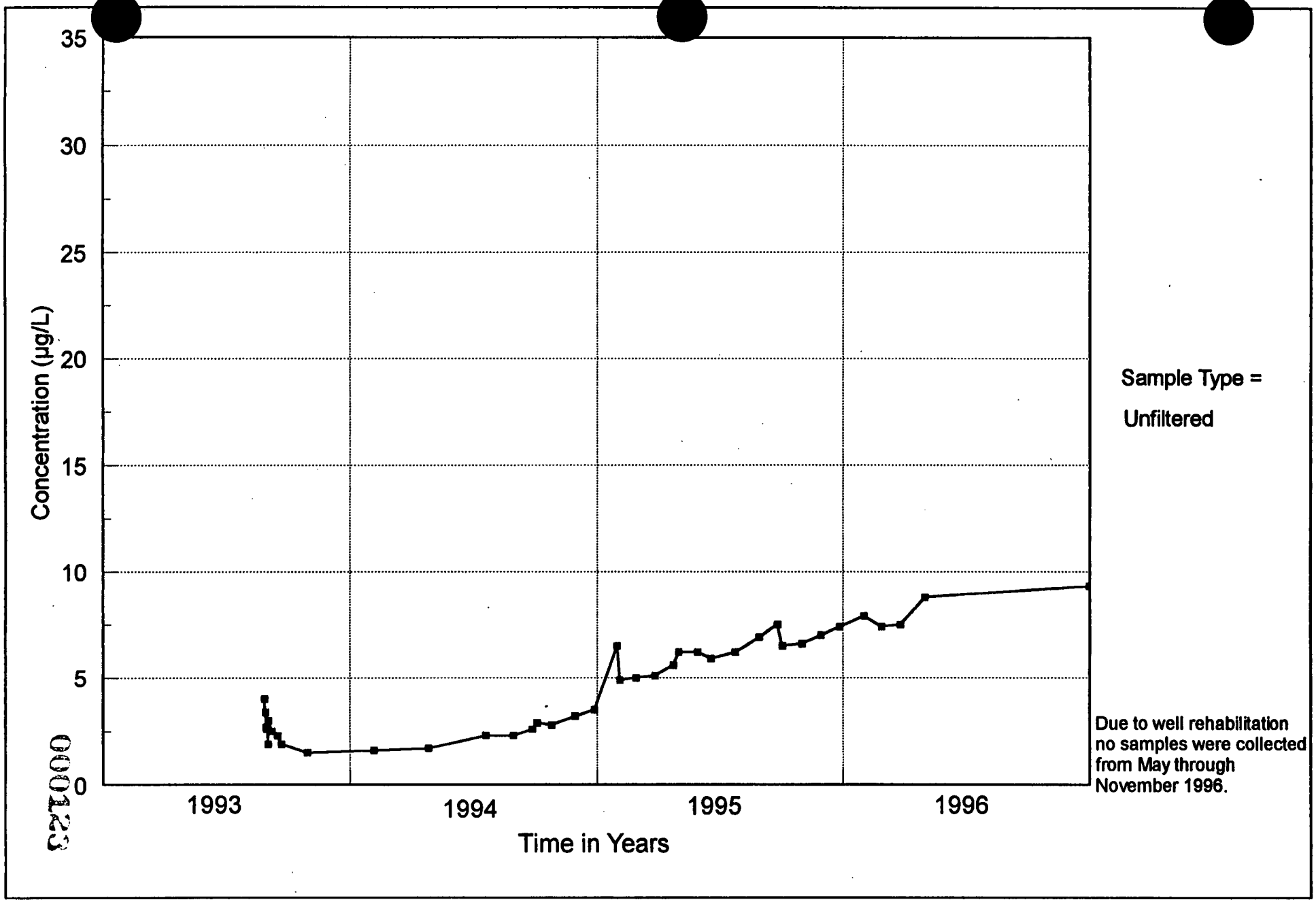
0001121

80 16



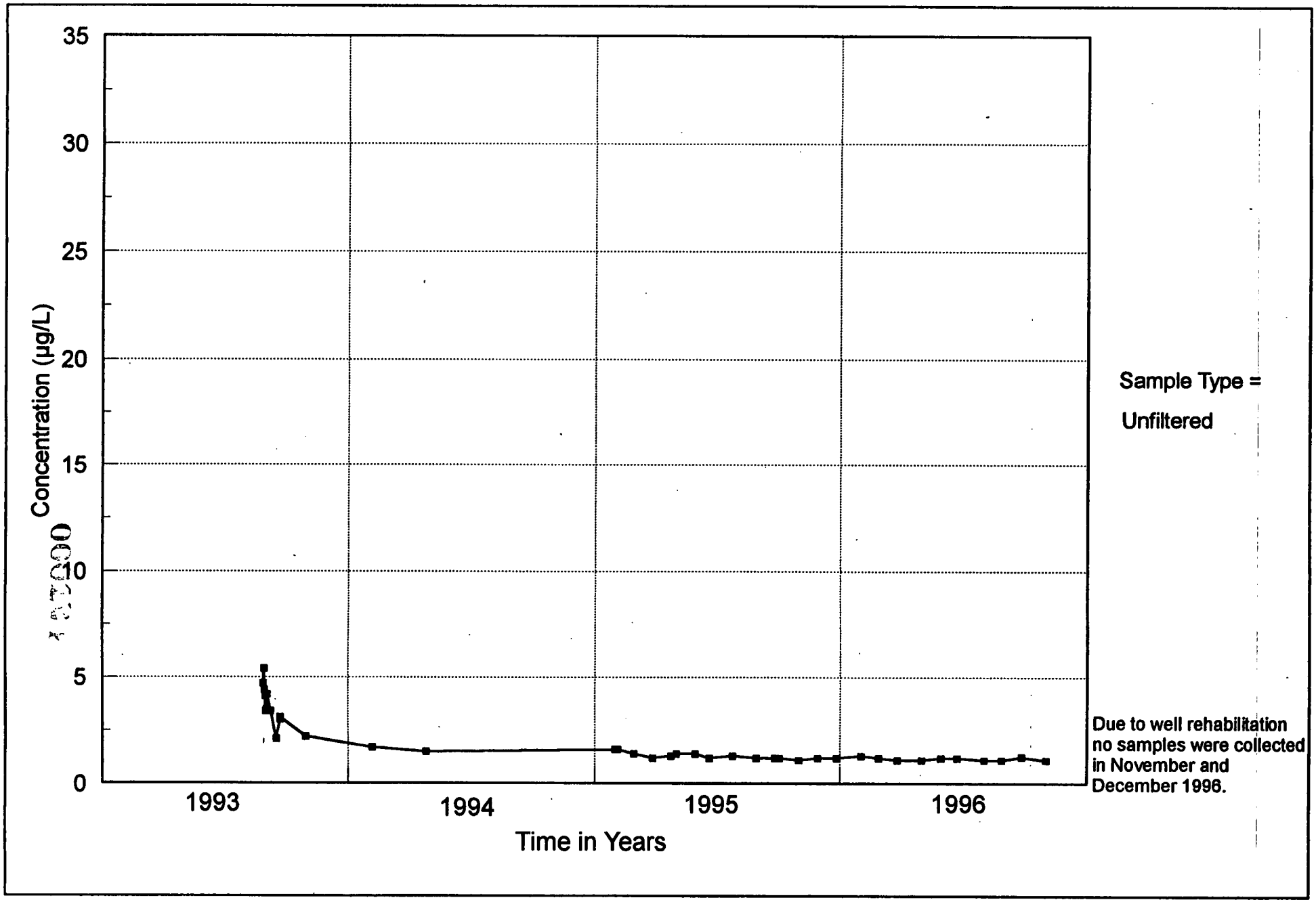
Monitoring Well 3925 (RW-2) Total Uranium Concentrations

000122

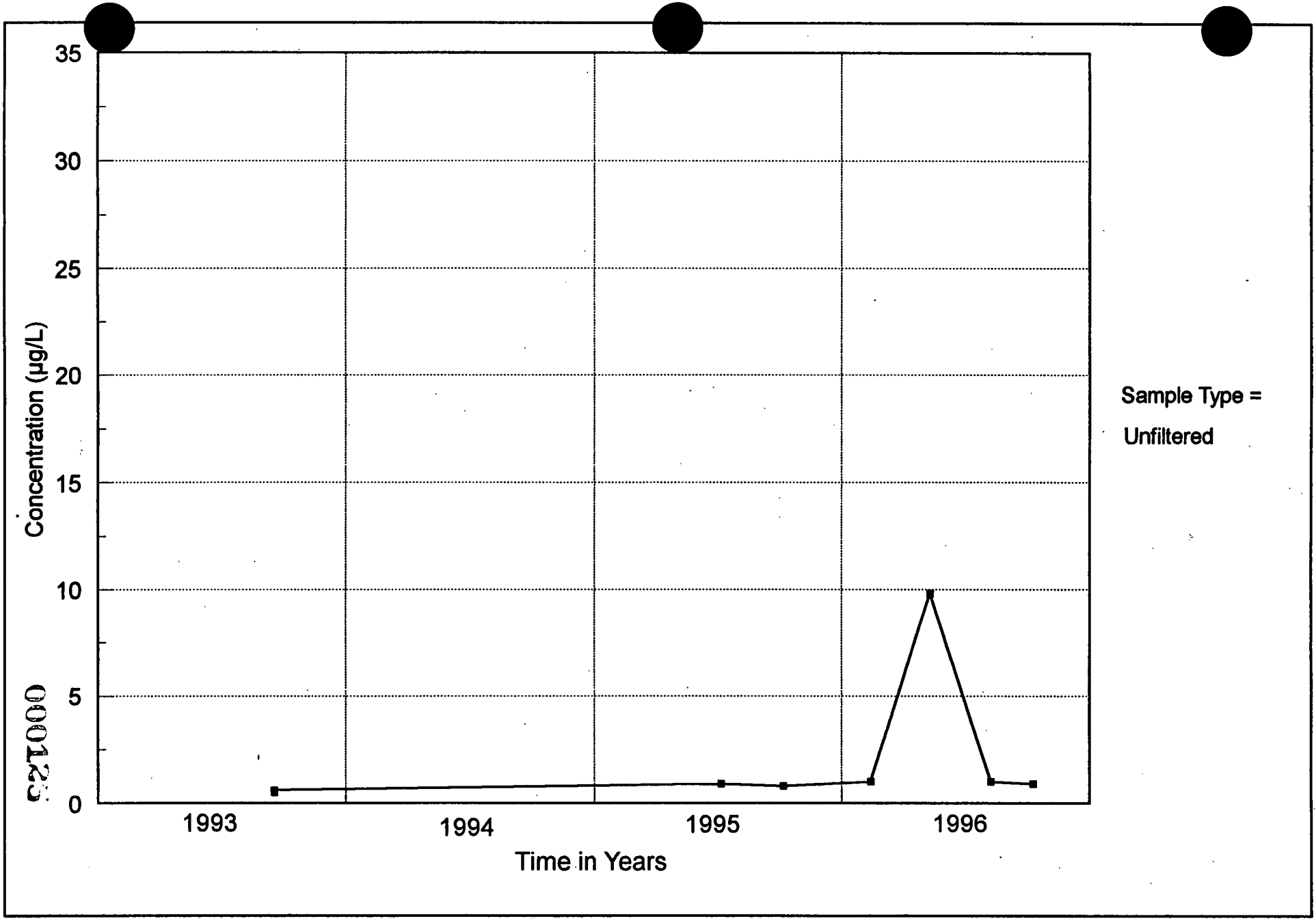


Monitoring Well 3926 (RW-3) Total Uranium Concentrations

000123



Monitoring Well 3927 (RW-4) Total Uranium Concentrations



Monitoring Well 4125 Total Uranium Concentrations

APPENDIX C

MANN-KENDALL TREND CALCULATION

CALCULATION

The time-ordered data are represented as x_i, x_2, ... x_n, where x_k is the datum at time interval k. All possible differences are represented as x_i - x_j, where i < j. The Mann-Kendall test for trend assigns an integer (-1, 0, or 1) such that:

$$\text{sgn}\,(x_j - x_i) = \begin{cases} -1, \text{ if } x_i > x_j \\ 0, \text{ if } x_i = x_j \\ 1, \text{ if } x_i < x_j \end{cases}$$

The Mann-Kendall statistic is then calculated as:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn\,(x_j - x_i)$$

A value for S greater than one implies a possible upward trend, a value for S less than one implies a possible downward trend, and a value of S = 0 implies no trend.

APPENDIX D

COLLOIDAL BORESCOPE DATA

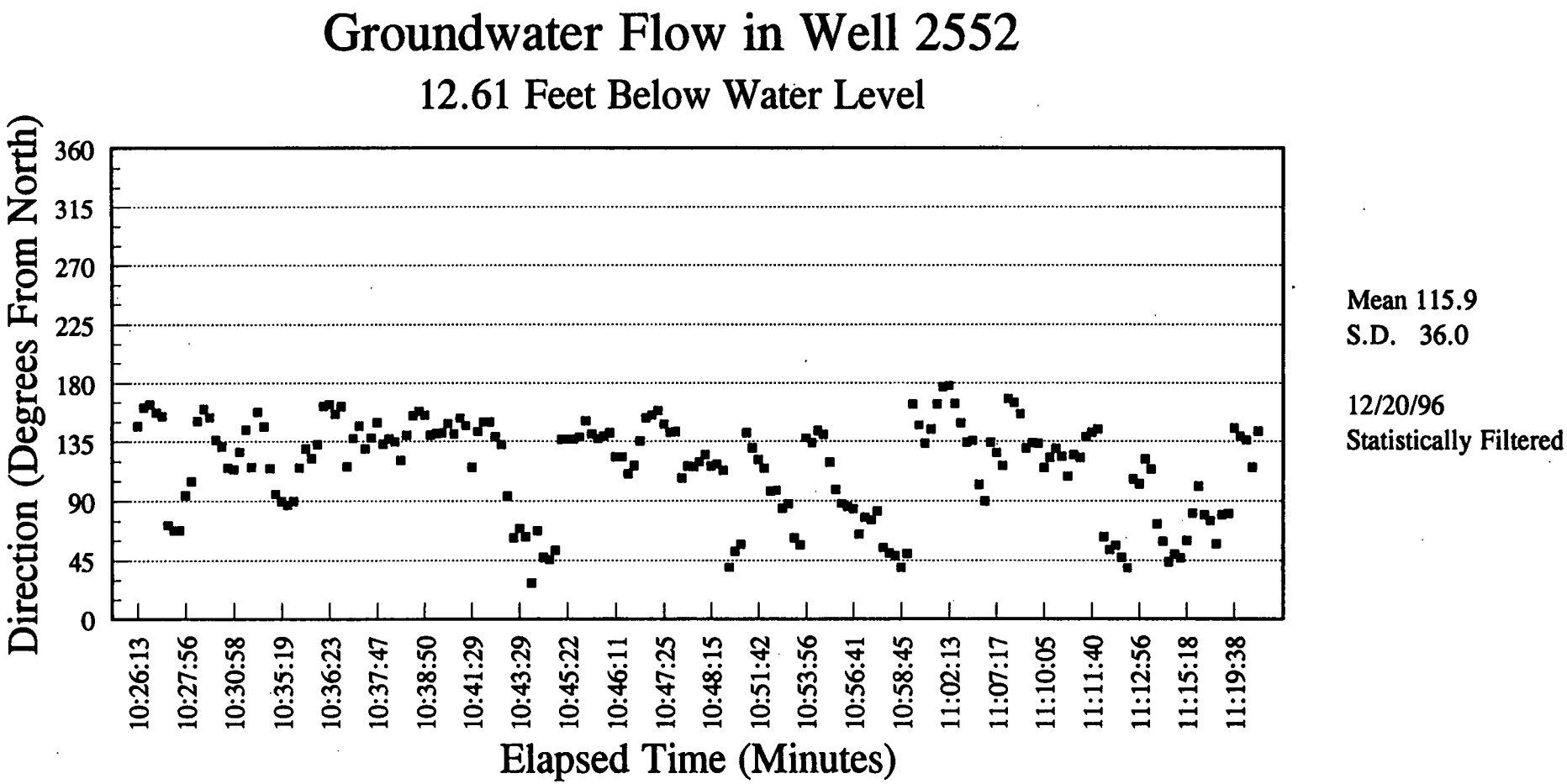


Figure D-1. Groundwater Flow Direction in Monitoring Well 2552

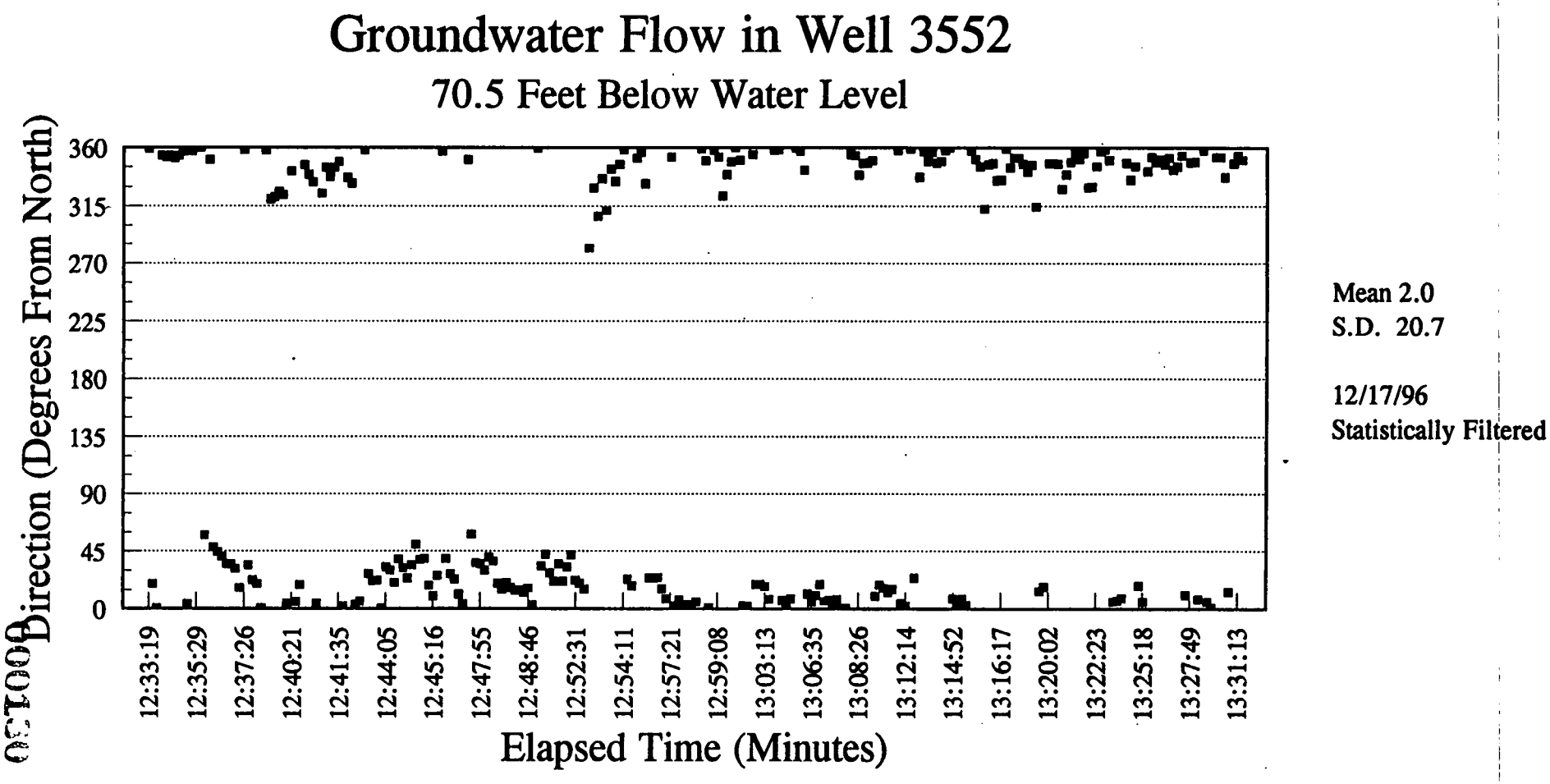


Figure D-2. Groundwater Flow Direction in Monitoring Well 3552

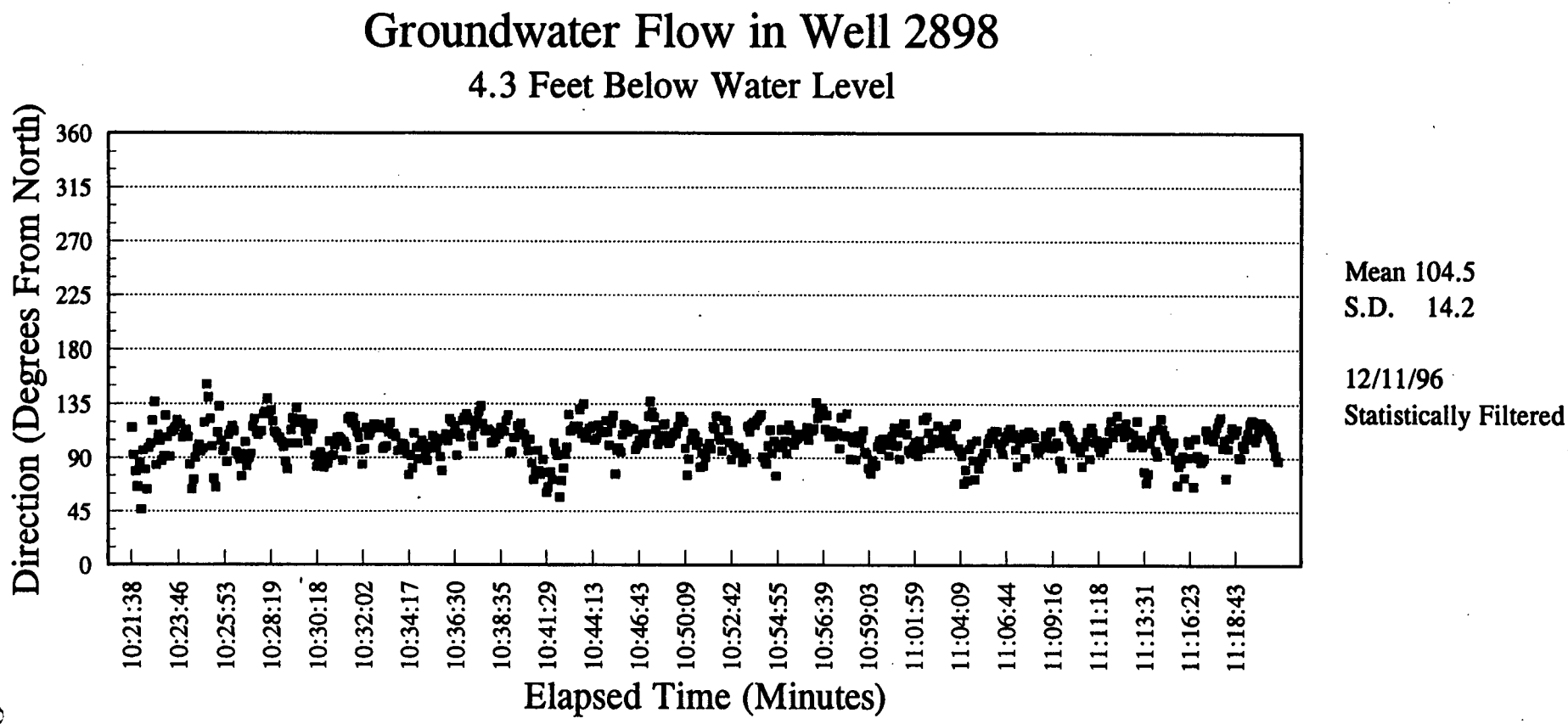


Figure D-3. Groundwater Flow Direction in Monitoring Well 2898

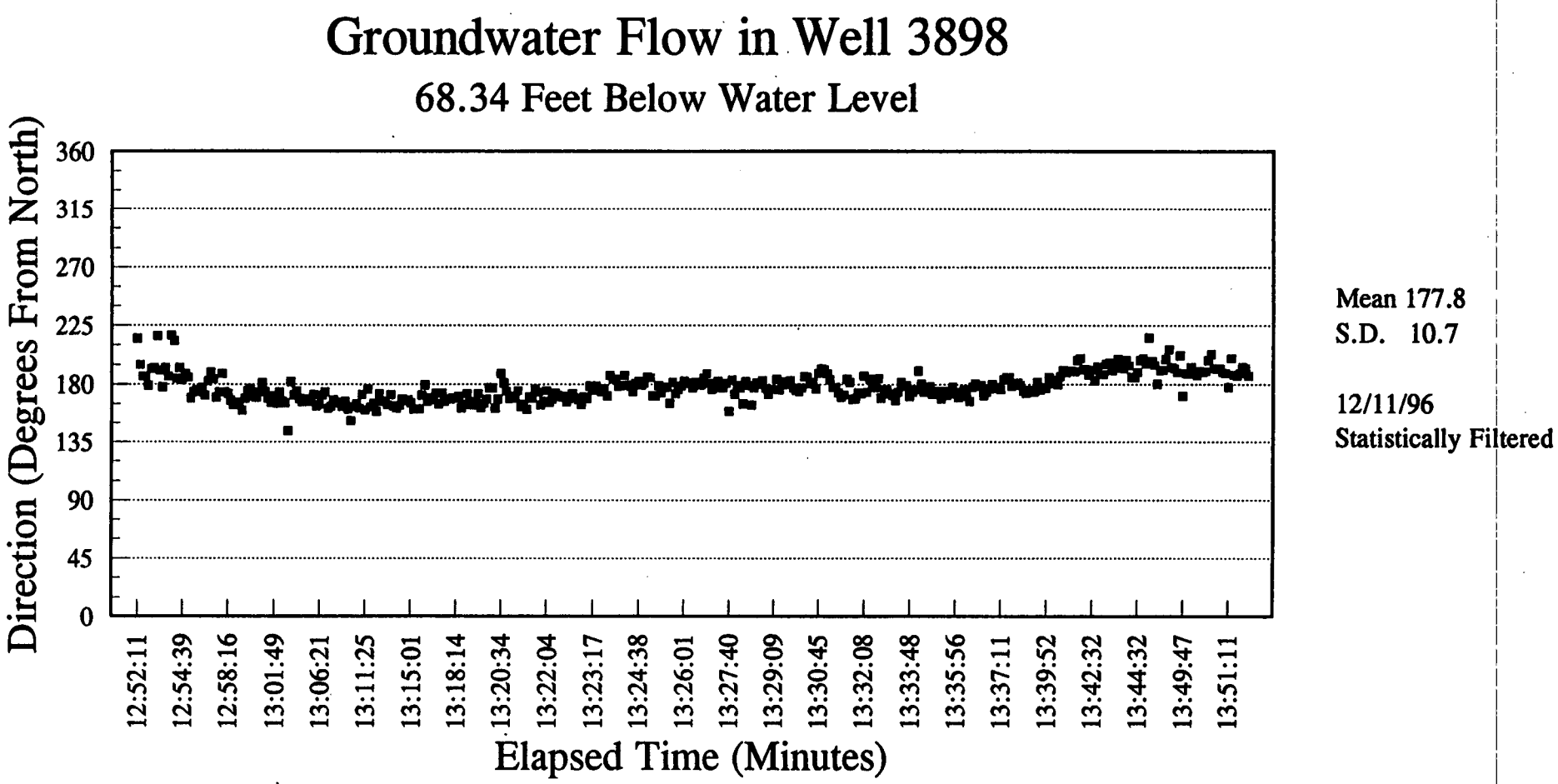


Figure D-4. Groundwater Flow Direction in Monitoring Well 3898

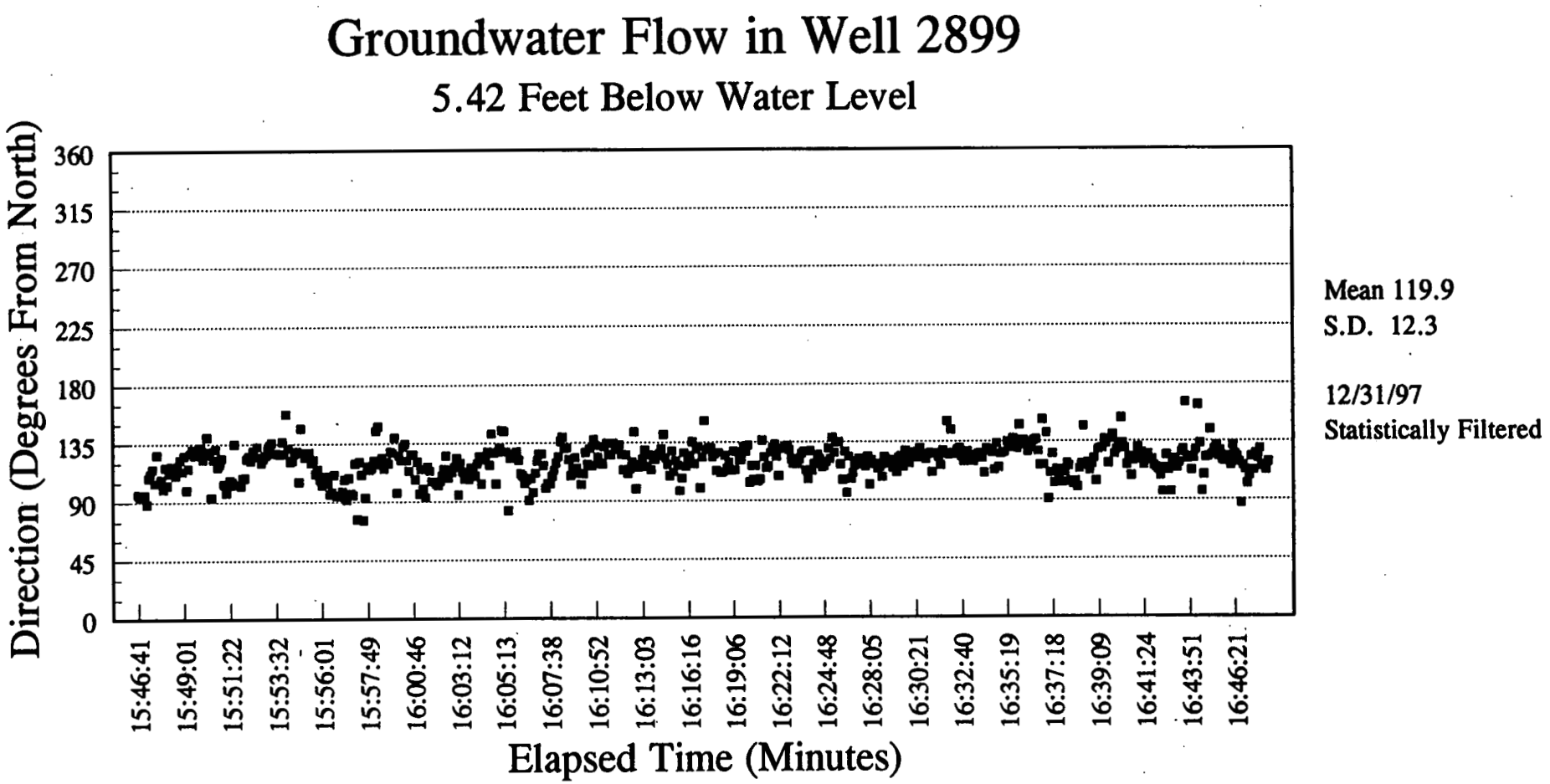
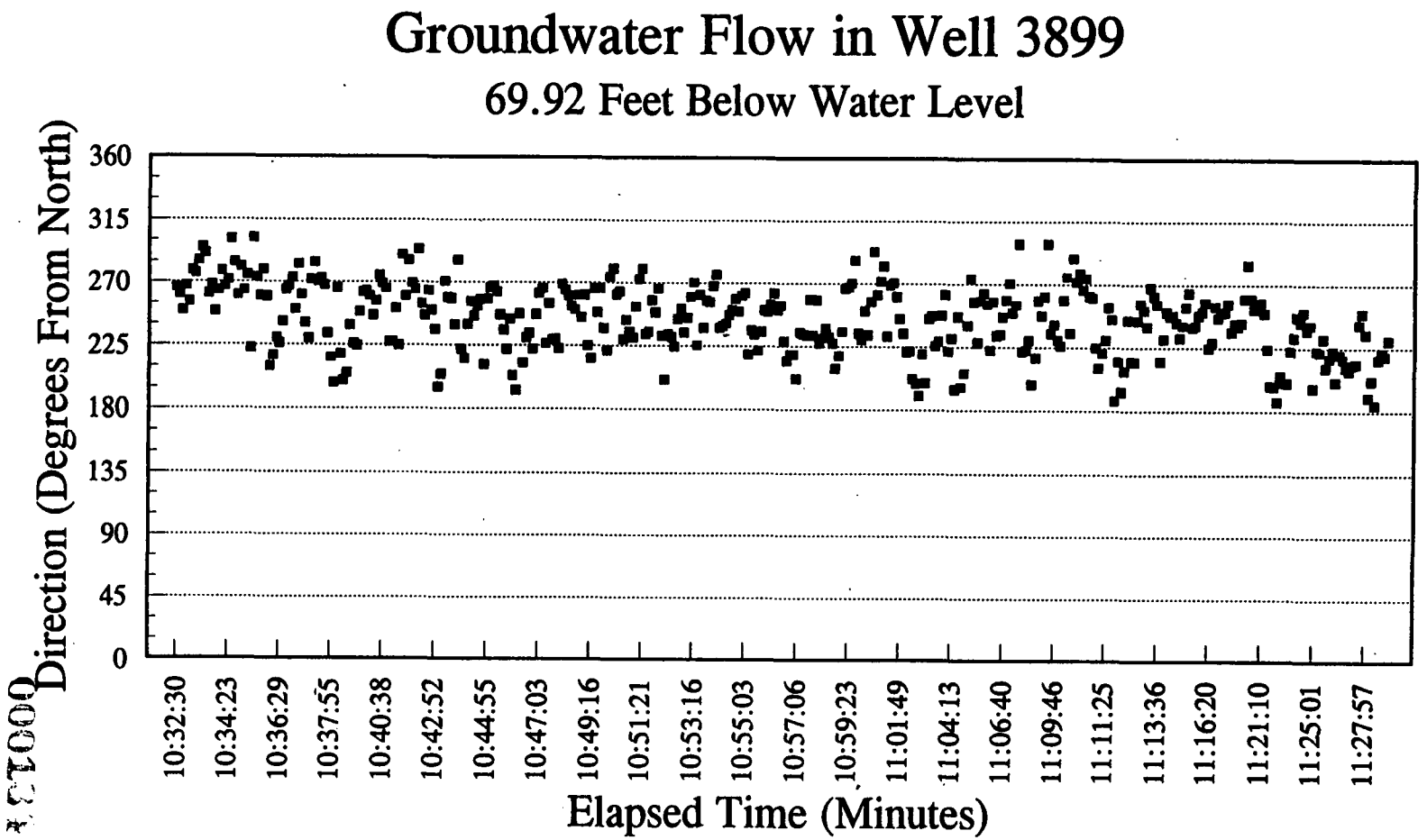


Figure D-5. Groundwater Flow Direction in Monitoring Well 2899



Mean 243.8
S.D. 23.9

12/10/96
Statistically Filtered

Figure D-6 Groundwater Flow Direction in Monitoring Well 3899

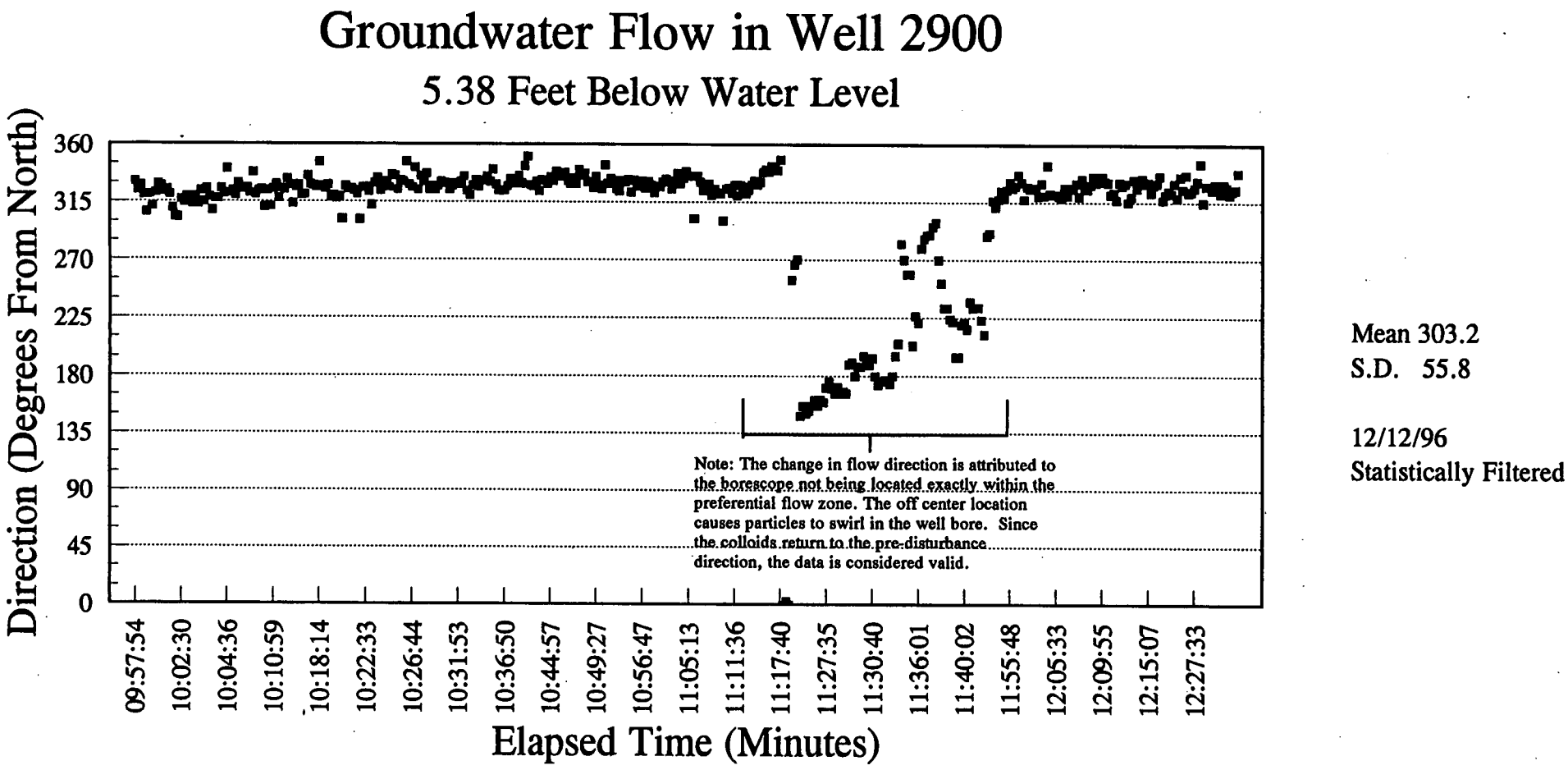


Figure D-7. Groundwater Flow Direction in Monitoring Well 2900

0001136

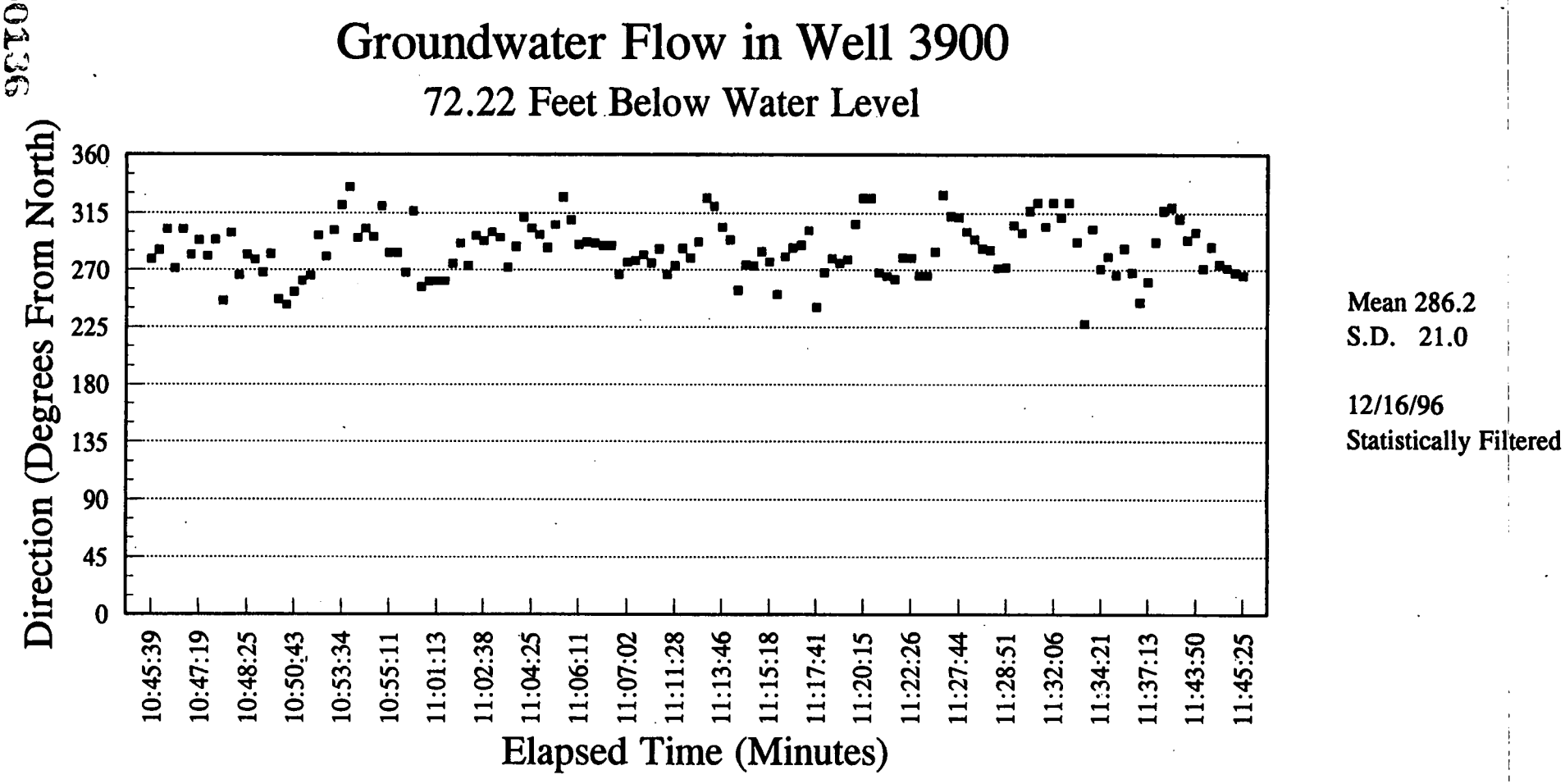


Figure D-8. Groundwater Flow Direction in Monitoring Well 3900